# *Graduate Catalogue*

# *2025 - 2026*

**UNIVERSITY OF PUERTO RICO**

**MAYAGÜEZ CAMPUS**

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At the University of Puerto Rico at Mayagüez, every effort is made to provide accurate and up-to-date information. However, the University reserves the right to change without notice statements in the Graduate Catalogue concerning rules, policies, fees, curricula, courses, or other matters when necessary. Changes may apply to current and former students.

In addition, UPRM is currently reviewing and restructuring many of its academic programs in an effort to enhance their quality and efficiency. In that process, some of the programs and courses mentioned in this catalogue may be modified, consolidated with other programs or courses, or eliminated. If you have questions about a particular program or course, you should contact the appropriate university college or department.

The UPRM Graduate Catalogue is available at:
https://www.uprm.edu/asuntosacademicos/catalogos-graduados/

A publication of the Office of the Dean of Academic Affairs.

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# Graduate Academic Degrees Offered at UPRM

## DOCTOR OF PHILOSOPHY

Applied Chemistry, Bioengineering, Electrical Engineering, Mechanical Engineering, Marine Sciences, School Psychology with subspecialties in clinical and neuropsychology, Chemical Engineering, Civil Engineering, Computing and Information Sciences and Engineering, Tropical Agriculture, Software Engineering

## MASTER OF BUSINESS ADMINISTRATION

Finance, General Program, Human Resources, Industrial Management

## MASTER OF ENGINEERING

Bioengineering, Chemical Engineering, Civil Engineering, Computer Engineering, Electrical Engineering, Industrial Engineering, Materials Science and Engineering, Mechanical Engineering, Software Engineering

### PROFESSIONAL MASTER

Food Science and Technology

## MASTER OF SCIENCE

**Agricultural Sciences**

Agricultural Economics, Agricultural Economics (Online Program), Agricultural Education, Agricultural Extension, Agronomy, Soils, Animal Science, Horticulture, Crop Protection, Food Science and Technology

**Arts & Sciences**

Biology, Chemistry, Geology, Marine Sciences, Physics, Applied Mathematics, Statistics Mathematics, Pure Mathematics, Teaching Mathematics at Secondary Level, Scientific Computing, School Psychology with subspecialties in clinical and neuropsychology

**Engineering**

Bioengineering, Chemical Engineering, Civil Engineering, Computer Engineering, Electrical Engineering, Industrial Engineering, Materials Science and Engineering, Mechanical Engineering, Software Engineering

## MASTER OF ARTS

Cultural and Humanistic Studies, Hispanic Studies, English Education, English Literatures, Kinesiology

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## *HISTORICAL SKETCH*

The University of Puerto Rico was created by an act of the Legislative Assembly on March 12, 1903 emerging as an outgrowth of the Normal School, which had been established three years earlier to train teachers for the Puerto Rican school system. In 1908, the benefits of the Morill-Nelson declared applicable to the island, fostered the rapid growth of the University. Eloquent evidence of that growth was the establishment of the College of Liberal Arts at Río Piedras in 1910 and the College of Agriculture at Mayagüez in 1911.

It was in the College of Agriculture where the Mayagüez Campus as we know it today had its origin. Credit for the establishment of the College is given to the joint effort of D. W. May (Director of the Federal Experiment Station), José de Diego, and Carmelo Alemar. A year later, the school received the name that it bore for 50 years: the College of Agriculture and Mechanic Arts. The strengthening and diversification of the academic programs at Mayagüez were recognized years later when, in 1942, as a result of university reform, the campus was organized with a considerable degree of autonomy into the Colleges of Agriculture, Engineering, and Science under the direction of a vice-chancellor. The expansion continued through the 1950s when many programs flourished in the University. The College of Arts and Sciences and the Nuclear Center were established in Mayagüez. The Colleges of Humanities, Natural Sciences, Social Sciences, and Business Administration emerged in Río Piedras. The Schools of Medicine, Odontology, and Tropical Medicine were established in San Juan.

In 1966, the Legislative Assembly reorganized the University of Puerto Rico as a system of autonomous campuses, each under the direction of a chancellor. The College of Agriculture and Mechanic Arts became the University of Puerto Rico, Mayagüez Campus.

Today, the Mayagüez Campus of the University of Puerto Rico continues its development in the best tradition of a Land Grant institution. It is a co-educational, bilingual, and non-sectarian school comprising the Colleges of Agricultural Sciences, Arts and Sciences, Business Administration, Engineering, and the Division of Continuing Education and Professional Studies.

The College of Agricultural Sciences includes the Agricultural Experiment Station and the Agricultural Extension Service. At present, the campus population is composed of 13,316 students, 1,181 regular staff members and 625 members of the educational staff.

## *Accreditations and Affiliations*

The Mayagüez Campus of the University of Puerto Rico is fully accredited by the **Council of Higher Education of Puerto Rico**. It holds membership in the **Middle States Commission on Higher Education** since 1946. Our academic programs are accredited by professional entities such as the **Council for the Accreditation of Educator Preparation (CAEP), Accreditation Council for Business Schools and Programs (ACSBSP), The American Chemical Society, Accreditation Commission for Education in Nursing, Inc. (Formerly NLNAC), and ABET**.

The Mayagüez Campus of the University of Puerto Rico is a member of **Oak Ridge Associated Universities (ORAU)** since 1966. ORAU is a private, non-profit consortium of 65 colleges and universities that acts as management and operating contractor for the US Department of Energy (DOE).

## *Vision, Mission*

### Our Vision

*"To be a leading institution in higher education and research, transforming society through the pursuit of knowledge in an environment of ethics, justice, and peace."*

### Our Mission

"To provide excellent service to Puerto Rico and to the world by:

- Forming educated, cultured, capable, critical thinking citizens professionally prepared in the fields of agricultural sciences, engineering, arts, sciences, and business administration so they may contribute to the educational, cultural, social, technological and economic development.
- Performing creative work, research and service to meet society's needs and to make available the results of these activities.

We provide our students with the skills and sensitivity needed to effectively resolve problems and to exemplify the values and attitudes that should prevail in a democratic society that treasures and respects diversity."

### *Strategic Objectives*

- Objective #1: To institutionalize a culture of strategic planning and assessment
- Objective #2: To lead higher education throughout Puerto Rico while guaranteeing the best education for our students
- Objective #3: To increase and diversify the Institution's sources of revenue
- Objective #4: To implement efficient and expedient administrative procedures
- Objective #5: To strengthen research and competitive creative endeavors
- Objective #6: To impact our Puerto Rican society
- Objective #7: To strengthen school spirit, pride, and identity

### *General Education Student Learning Outcomes (SLOS)*

The Academic Senate of the University of Puerto Rico in Mayagüez, established by Certification 18-25, the General Education Student Learning Outcomes (SLOS). By the time of their graduation, UPRM students will be able to:

1. Become an intentional learner
2. Demonstrate creative and critical thinking
3. Communicate effectively
4. Identify, study, and propose solutions to problems; transform knowledge into action
5. Apply mathematical, scientific, and technological skills
6. Apply interpretative and integrative skills
7. Relate global contexts and issues of importance to Puerto Rico
8. Show moral autonomy; develop a sense of wellbeing; understand ethical conduct
9. Practice civic virtues
10. Value diversity

# *Organization of the University of Puerto Rico*

The University of Puerto Rico is a well-established and mature institution, with a total enrollment of over 61,967 students. The University consists of the Mayagüez Campus, the Medical Sciences Campus, and the Río Piedras Campus, which are dedicated to both undergraduate and graduate education; and eight Campus at Aguadilla, Arecibo, Bayamón, Carolina, Cayey, Humacao, Ponce, and Utuado which provide undergraduate education. Each autonomous institutional unit has a Chancellor as chief administrator and academic officer.

**Governing Board**

The Governing Board (JG) was created in 2013 as an independent and autonomous body that governs the system of 11 units comprising the University of Puerto Rico. Prior to its creation, these responsibilities were in charge of the former Higher Education Council and the former Board of Trustees (JS).

It is composed of 13 members, namely a regular undergraduate student, a regular graduate student, two tenured professors in the university system, the Secretary of Education, as an ex officio, a broad professional knowledge and experience in the field of finance, a resident of Puerto Rico who has participated with distinction in the social and community leadership, five residents of Puerto Rico featured in artistic knowledge, scientists and professionals, and a citizen residing in Puerto Rico, linked Puerto Rican communities abroad.

Except for the two students and two professors, who are elected, the other members of the Governing Board are appointed by the Governor with the advice and consent of the Senate. All members of the Governing Board serve for staggered terms laid down in the University Act and until their successors are appointed and qualified.

The Governing Board elects its president from among its members. It is responsible for:

- examining and reviewing the budgetary and institutional development plans of the University
- authorizing the institution of new campus, centers, and other institutional units appointing the President and chancellors of each autonomous unit
- defining rights and duties of various constituents in the institutional community
- defining student financial aid standards
- preparing an annual report to the Governor and the Legislature on the state of the University of Puerto Rico

**President**

The President of the University, the chief executive officer of the University system, is appointed to an indefinite term by the Governing Board. Subject to the approval of the Board, he appoints chancellors to the various campuses and colleges. The President represents the University on corporate matters before courts and government agencies. He acts as an ex-officio member of all the UPR faculties, academic senates, and administrative boards.

The President is responsible for submitting an annual budget, an annual report, the institutional development plan and its revisions, regulations, contracts, and agreements which require university approval. He develops and maintains relationships with other cultural and educational institutions.

**University Board**

The University Board is constituted by:

- the President of the University
- eleven chancellors representing each autonomous institutional unit
- a financial director
- three additional members appointed by the President with the approval of the Governing Board
- one faculty representative from each Academic Senate
- one student representative from each institutional unit

The Board is responsible for the preparation of the following documents:

- general bylaws of the University
- general bylaws of the student body
- university's strategic plan with recommendations from the Academic Senates

These documents are submitted to the President and to the Governing Board for their consideration and approval. The Board also considers the integrated university budget, and it is the first avenue of appeals against any decision taken by the Administrative Board or the Academic Senate of an autonomous unit.

## *Organization of the Mayagüez Campus*

The Mayagüez Campus serves a student population of 13,316 students. It was organized as a result of the University Act (PL1), which was approved on January 20, 1966 and amended by Law No. 16 in 1993.

### *Chancellor*

The Chancellor of the Mayagüez Campus is the chief executive officer of the institutional unit. The Chancellor's main responsibilities include:

1. Presiding over the Administrative Board, the Academic Senate, and faculty meetings.
2. Appointing deans, departmental directors and university personnel.
3. Resolve controversial appeals against decisions made by deans.
4. Representing the campus at functions, ceremonies, and academic activities.
5. Preparing the campus' annual report and budget petition for submission to the President.
6. Considering and granting promotions and leaves of absence.

### *Administrative Board*

The Administrative Board of the Mayagüez Campus consists of the Chancellor as presiding officer, the deans, two academic senators elected among those faculty members of the Senate who are not ex-officio, senators, and an elected student representative. The President of the University serves as an ex-officio member. The Board acts as an advisory body to the Chancellor, prepares the development plan of the Campus, approves the proposed budget prepared by the Chancellor, and grants tenure, promotions and leaves of absence.

### *Academic Senate*

The Academic Senate at UPRM is composed by a member of the Administrative Board, the Director of the Library, the Director of the Counseling Office, representatives elected from the faculties whose total must not be less than twice the number of the elected ex-officio members, an elected member of the Library and Counseling Office, and ten student representatives. The Academic Senate is the official forum of the academic community. Its main task is to participate in the formulation of academic processes within the University's legal structure.

### *Faculty*

The faculty is composed of the chancellor, the deans, department's directors and the teaching personnel. The General Regulations of the University of Puerto Rico define the faculty's functions, privileges, duties, and, rights.

### *Students*

The rights and duties of students are set forth in the General Student Regulations. The General Student Council represents students before the university administration, and individual student councils represent them before each of their respective colleges and schools. The students are also represented on the Academic Senate, the Administrative Board, the University Board, and the Governing Board.

### *Student Ombudsman Office*

The Students Ombudsman Office was created on November 10, 1999. It is a direct result of the interest and effort of both the Chancellor and the Students General Council. Its creation reinforces our University's belief in dialogue and communication as the best way to pursue truth and the integral development of its students. It also provides adequate and appropriate conditions which enhance their quality of life.

The mission of the Students Ombudsman Office (Oficina de Procuraduría Estudiantil) is to provide an independent, confidential, neutral, and accessible individual support for our students. The informal process facilitates fair solutions to the situations and problems of the parties involved.

The Students Ombudsman Office does not do formal investigations. Instead we listen to people, examine their options for dealing with a particular situation and help guide them toward making wise and healthy decisions. Moreover, the Office offers timely and relevant information concerning campus policies and procedures. The Office welcomes all community members, including professors and employees that wish to present any situation related to students.

**Office:** Luis D. Celis Building, 3th floor, 324
**Phone:** 787-265-5462; 787-832-4040 exts. 3588, 5462
**Website:** http://www.uprm.edu/procuraduria
**Email:** procuraduria@uprm.edu

## *UNIVERSITY REGULATIONS*

**Rights and Duties of Students of the University of Puerto Rico**

Article 1

A. The fundamental right of university students in the academic community is the right to an education. This right is not limited to the classroom but encompasses the aggregate of the students' possible relations and experiences with their fellow students, teachers, and administrators at the University and with their fellow citizens in the community at large. In like manner, the students' principal duty consists of fully exercising that right and conducting themselves in a manner that does not hinder other community members in the exercise of their rights or in the fulfillment of their duties.

B. These regulations cover separately: (1) student rights and duties inherent in the sphere of the educational program; (2) those pertaining to extracurricular activities within the facilities of the University; (3) those related to student participation in the different aspects of institutional services; (4) those indicated by the standards and restrictions characteristic of academic life; and (5) the sanctions corresponding to violations of regulations and the procedure for the imposition of these sanctions.

Article 2

A. The work involved in the subject under study constitutes the basis of teacher-student relationship. Maximum integrity and intellectual honesty should govern the drive to attain knowledge. The teacher shall foster creative dialogue and freedom of discussion and expression among students. The student shall have the opportunity to present reasonable objections to the facts and opinions stated by the teacher if in disagreement. Both may examine any aspect of the subject under discussion in accordance with the standards of intellectual responsibility vital to all academic endeavors. Neither one nor the other shall use the classroom as a forum to preach political, sectarian, religious, or other doctrines alien to the subjects being taught. The right to dissent from the opinion of the teacher does not release the student from the responsibility of complying with the teacher's requirements for the course. The student's grade shall be based on considerations relative to academic achievements measured in the varying ways in which this is possible.

B. The basis of the teacher-student relationship is trust and confidence which should be respected by both and by the administration. Opinions and beliefs expressed by students in the classroom are of a privileged nature, and students are entitled to have their teachers refrain from disclosing them to third parties. The preceding does not bar teachers from stating opinions about students' character and abilities or from discussing their progress with colleagues as part of the academic program and of the students' formative process.

C. The relationship between students and teachers outside the classroom constitutes a part of the educational process. Students shall have the right to meet with teachers at specially designated times to request guidance on and clarification of aspects of their academic work.

D. Academic and disciplinary files shall be kept separate. Any information relative to disciplinary files shall not be made available to unauthorized persons within or outside the University without the students' consent except by a court order. No record of the students' political beliefs shall be kept.

The legal and academic tradition recognizes the rights of students as members of the University community and also the obligation of moral and intellectual responsibility concomitant with these rights. The legal and academic tradition also recognizes the responsible participation of students in assuring and maintaining order, safety, and normalcy of academic life. These rights and responsibilities, the disciplinary procedures for dealing with their violation, and many other matters of interest are described in the UPRM Student Manual (Reglamento de Estudiantes del Recinto Universitario de Mayagüez) available in the Office of the Dean of Students**.**

## *UPRM STUDENT REGULATIONS*

University law and tradition recognize the rights of students as members of the University community and dictate the students' moral and intellectual responsibilities as members of that community. Also recognized is the responsible participation of students in insuring and preserving order, safety and normalcy of institutional tasks and procedures. The University graciously welcomes the democratic and responsible participation of its students in the institutional processes.

**Rights and Duties**

Article 1. To the extent that they are collaborators in the University's mission of education, culture, and service, students are members of the University community and, as such shall be entitled to participate effectively in the life of the community. They shall have all the moral and intellectual responsibilities of members of the community.

Article 2. Students have the duty and right to engage in the search for truth and strive for its expression, always respecting opinions. Academic discipline, behavior intrinsic to the academic community, and the dictates of conscience, itself, shall serve as guides.

Article 3. University students have the duty to seek the elements of intellectual and spiritual formation which can lead to their full development as persons. They also have the right to demand them in view of their responsibility as members of the Puerto Rican community.

Also incumbent upon them is the duty and the rights to preserve, enhance, and disseminate the values of learning and culture both universal and Puerto Rican.

Article 4. Students may hold, pursuant to established standards, any public function, meeting, or ceremony and invite any person they wish to hear speak on any subject of interest provided that the exercise of any of the aforementioned rights does not interrupt the educational, technical, or administrative work of the institution and that there is compliance with the provisions of the regulations in effect.

Article 5. Students may associate freely and may publish and circulate publications in accordance with the prevailing standards set forth by the office of the Dean of Students.

Article 6. No student may be deprived, by reason of sex, race, origin, social condition, or political or religious creed, of the right of association nor of the services and programs offered by the University.

Article 7. University students are entitled to have the University refrain from disclosing information or keeping records related to their political, religious, or philosophical beliefs.

Academic and disciplinary files shall be kept separate. The information contained in the academic and disciplinary files shall be confidential and shall not be made available for use by unauthorized persons within or outside the University without the written consent of the student or the student's parent or guardian, unless a court order to that effect has been obtained.

Article 8. Students shall have the right to meet with teachers at specially designated hours in order to receive guidance and clarification on matters related to their academic work.

Article 9. Students shall have the right and the duty to actively participate in classes and related activities, consult their teachers, express their doubts and differences on criteria, and be informed of their deficiencies and achievements in academic work.

Students shall be entitled to receive from their teachers at the beginning of each session proper guidance on oral or written contents of the course, which shall include: explanations of academic ends and objectives, teaching methods, topics of study, reading assignments, and other work requirements, grading criteria, and other pertinent data. All this must in no way affect the necessary flexibility of the courses.

Students shall have the right to discuss with their teachers the tests taken, the grades received, and the evaluation of the course as an essential part of the college learning process.

Article 10. Students have an obligation to exercise in a comprehensive and responsible manner all the rights and duties established in these Regulations so that the example they set inside and outside the classroom may serve as a bulwark for the continual enjoyment of such rights and duties by them and their fellow students.

**(**Copies of these Regulations including the remaining provisions are available from the Office of the Dean of Students.)

**Equal Opportunity**

The Mayagüez Campus of the University of Puerto Rico guarantees applicants equal opportunities for employment and academic admission. It also guarantees student and employee equality in study and employment opportunities as well as in the benefits of the services and academic programs offered and the terms and conditions of employment. UPRM does not exclude from participation nor denies benefits to nor discriminates against any person by reason of age, race, sex, color, place of birth, social origin or condition, physical or mental handicap, political or religious beliefs, ancestry, marital status, gender, sexual preference, ethnic origin, or status of veteran of the armed forces**.** Any applicant for academic admission or employment or any student or employee, who feels discriminated against for any of the reasons cited above may file a complaint in writing with the Dean of Academic Affairs. The establishment of this policy as well as its compliance and publication are pursuant to Federal regulations for the implementation of Title IX, Educational Amendments of 1972 and Section 504 of the 1973 Rehabilitation Act.

**Disabilities**

UPRM is committed to promote a safe atmosphere for disabled students where they will have access to all academic programs, support services, social events, and physical facilities.

Regulations specified in Section 504 of the Vocational Rehabilitation Act (1973) and the Americans with Disabilities Act (ADA) 1980, establish norms and procedures which guarantee people with disabilities equal access to programs and services.

At present, responsibility for the effective means of providing these services lies in the Office of the Dean of Students through the Coordinator of Services to Handicapped Students (OSEI).

Services for handicapped students stem from the following principles:

1. Request for reasonable accommodations must be initiated by the student.
2. Accommodations offered by the university have a shared responsibility among student, faculty, staff and Office of the Dean of Students.
3. Procedures and policies must be reasonable and easily understood by all parties involved.
4. The student's right to confidentiality will be protected at all times during the process of accommodation.
5. Appeal processes will take place in a fair manner and within a designated time frame.

**Foreign Non-Immigrant Students**

The Mayagüez Campus is authorized by law to admit foreign non-immigrant students. Refer to the sections on "Academic Regulations" and to the section on "Special Fees for Non-resident Students" for additional information.

**Use of Vertebrate Animals in Research**

This institution complies with all applicable provisions of the Animal Welfare Act and other Federal statutes and regulations concerning animals. It also complies with the U. S. Public Health Service policy on human care and use of laboratory animals. Its practices are guided by the U.S. government principles for the utilization and care of vertebrate animals used in testing, research, and training.

**Protection of Human Subjects in Research**

This institution complies with all Federal Regulations regarding human subjects in research, including those stated in the Code of Federal Regulations, the Department of Health and Human Services, Title 45 (Public Welfare), Part 46: Protection of Human Subjects (Revised June 19, 2018; Effective January 21, 2019), and the Belmont Report.

**Intellectual and Scientific Misconduct**

It is the institutional policy of the Mayagüez Campus to observe the highest standards of intellectual and scientific integrity, and to pursue the prosecution of all violations. The lack of integrity and the perpetration of academic and scientific fraud include plagiarism, fabrication, falsification, false attribution, and other violations of the cannons and practices of honesty generally accepted in the academic community, always excepting those which may result from involuntary errors or honest differences in the interpretation or handling of data or information.

**Research Integrity**

Allegations of research misconduct (specifically falsification, fabrication, or plagiarism) must be submitted to the Research Integrity Officer of UPRM, through the office of the Dean of Academic Affairs.

For information concerning research integrity and misconduct as defined by Certification Number 45, 2006-2007, of the UPRM Board of Trustees (now known as the Governing Board), or requests for appointments, contact halley.sanchez@upr.edu.

**Sexual Harassment**

This institution adheres to the principles and statutes concerning sexual harassment and discrimination because of gender in the areas of employment, conduct in the workplace, and provision of services. Grievance procedures are stated in the Certification #107 (2021-2022) approved by the Governing Board of the University of Puerto Rico on March 15, 2022 and the Administrative Board Certification #93-94-303 [as amended by Certification 93-94-324] of April 7, 1994.

**Smoking**

Smoking is forbidden in all enclosed campus areas, including, but not limited to, classrooms, laboratories, lecture rooms, elevators, auditoriums, offices, museums, and all other places where people regularly meet, in accordance with Article 3 of Law 40 of 1993, Law to Regulate Smoking in Certain Public and Private Places, as amended. Smoking is permitted in public areas such as open hallways and other open spaces.

**Drugs**

The University of Puerto Rico pursues a vigorous policy in combating the manufacture, distribution, supply, possession, and illegal use of controlled substances within its grounds as defined by Puerto Rico Law No. 40 of August 3, 1993, and further treated in subsequent Federal and Commonwealth legislation. The policy means and procedures for its enforcement are detailed in the Certification #033-1999-2000 approved by the Governing Board of the University of Puerto Rico.

## *RESEARCH AND DEVELOPMENT ADMINISTRATION CENTERS & OFFICES*

**Agricultural Experiment Station**

Established in 1910 by the Sugar Producers Association, the Agricultural Experiment Station was ceded to the Government of Puerto Rico in 1913 and transferred to the University of Puerto Rico by legislative action in 1933. Its main objective is to conduct research, develop technology and improve agriculture and the quality of life in rural areas. The Station, a component of the College of Agricultural Sciences, has two main research centers, one at Mayagüez and the other at Río Piedras, six research substations located in Adjuntas, Corozal, Juana Díaz, Gurabo, Isabela, and Lajas and the laboratory farm for beef cattle management at Montana Farm in Aguadilla. The Agricultural Experiment Station laboratories, research library, farms, and other facilities are available to graduate students for thesis research. The Station is an active member of the Southern Association of Agricultural Experiment Stations Directors. This Association serves as a regional link to the U.S. Department of Agriculture, U.S. Congress, National U.S. Association of State Universities and Land Grant Colleges (NASULGC).

***Contact:***
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Associate Dean for Research
College of Agricultural Sciences
decanoasociado.eea@upr.edu
Phone: (787) 832-4040 x 5977

Adjuntas Substation: Coffee, Citrus, agroforestry research projects
***Administrator:*** Agro. Jennifer Pagán Rodríguez
jeniffer.pagan@upr.edu
Phone: (787) 829-3614

Corozal Substation: farinaceous crops, livestock, forage, IR-4 pest management projects
***Administrator:*** Agro. Luis E. Almódovar
luis.almodovar2@upr.edu
Phone: (787) 859-3075

Gurabo Substation: farinaceous & horticultural crops, improved pastures, slick livestock, organic farm, Tropical Animal Reproduction Research Center
***Administrator:*** Agro. Ramón Couto
ramon.coutomarrero@upr.edu
Phone (787) 737-2601

Isabela Substation: grains, root crops, forage, fruits research projects
***Administrator:*** Agro. Abiezer González
abiezer.gonzalez@upr.edu
Phone (787) 830 – 2280

Juana Díaz Substation: research on vegetable crops, fruit trees and starchy crops Germplasm collections of mangoes, avocados, kineps, sapote, guava
***Administrator:*** Agro. Carlos Almodóvar
carlos.almodovar@upr.edu
Phone (787) 837-3905

Lajas Substation: research on fruit, organic production of vegetables, forage grasses and rice winter nurseries. Research on small ruminats, dairy farm used for teaching and research.
***Administrator:*** Agro. Anthony Rivera
anthony.rivera5@upr.edu
Phone (787) 899-1530

Research Center at Río Piedras: publications/technical editor, agricultural Library
***Administrator:*** Prof. Luis Méndez
luis.mendez4@upr.edu
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**External Resources Research and Development Center**

**R&D Center** was established in 1986 at UPRM to encourage and manage research and development activities in the areas of engineering, technology, and science, and to provide a technological basis to serve the Puerto Rican community. The R&D Center manages several research programs that include basic and applied research, research sub-stations for seismic investigation, industrial handling and disposal of hazardous chemical substances, natural resources renewal, and biotechnological research as well as technical support for the development of the Caribbean Basin. The R&D Center's mandate and principal functions are to promote, coordinate, and administer externally funded research projects conducted by faculty members of the Mayagüez Campus for clients from business and industrial segments, public and private organizations, and government agencies.

All funding for the Center's research projects comes from grants provided by government agencies (Federal and insular), educational institutions, and private sponsors within the industrial community of Puerto Rico.

The R&D Center offers technical and administrative assistance to the UPRM research community through its Accounting and Finance, Budget, Purchasing, Receiving, and External Resources Offices (ORE). The Center has its own reference library within the General Library of the UPRM, which holds a specialized collection in the fields of scientific and technological research.

The R&D Center acts on behalf of researchers in conjunction with the university community and the general public. It is the instrument of promotion for the development of research on the Mayagüez Campus and serves as an intermediary between the University, the government, and the private sector. In this role, the R&D Center represents the interests of researchers on academic and administrative forums, plans and establishes UPRM's research policy regarding the island's economy and technology transfer to the community, and administers research centers, institutes, and individual projects to encourage their development and to promote excellence.

***Contact:***
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directorcid@uprm.edu
R&D Director
Phone: 787-831-2065

**Puerto Rico Resource Center for Science and Engineering**

**RCSE** is a consortium of the major institutions of higher education on the island, which includes the University of Puerto Rico System, Inter-American University System, and the Pontifical Catholic University of Puerto Rico. RCSE's mission is to achieve excellence in science technology, engineering, and mathematics (STEM) education in order to promote full participation of Puerto Rican students in these fields and to develop the human resources and research base needed to support the island's economic and technological development. Created in 1980 with joint funding from the National Science Foundation and the University of Puerto Rico, RCSE has been extremely successful in pursuing its goals and has experienced a sound and steadfast growth in the scope of its programs.

The high level of success at RCSE is in great part due to its development as a consortium based on a collaborative network among major institutions of higher education, while providing access to a broad pool of resources by promoting excellence. Its goals range from efforts to improve science and mathematics curricula from grades K-12 in the island's schools to the establishment of research and development capability on the island. Due to the multi-institutional nature of its structure and complexity of its goals, RCSE was established as an administrative unit of the University's Central Administration. As a special entity which is not identified with any particular academic program, level or unit, the RCSE has effectively promoted maximum collaboration among all institutions, facilitating a synergistic effect through the improvement of STEM education on the island. RCSE has acted as an intermediary among consortium institutions, bringing them together to identify major problems and needs in STEM education and to develop innovative programs to address these needs. Key academic and administrative officials from all member institutions participate actively in the planning and implementation of the RCSE programs. Offices for RCSE are located on Río Piedras and Mayagüez Campuses.

**Center for Hemispherical Cooperation in Research and Education in Engineering and Applied Science**

**CoHemis** is part of the University of Puerto Rico. It is housed in and primarily serves the Mayagüez Campus.

CoHemis was founded in 1991 at a hemispheric conference-workshop sponsored by the National Science Foundation. It brought together national science and technology organization (ONCyT) delegates from 13 countries of the Americas to discuss ways to increase hemispheric collaborations in science and technology. CoHemis today is the hub of a network of 52 institutions from most countries of the Americas and Spain interested in collaborations by such means as joint research faculty, student exchanges, short courses and workshops.

The Center promotes and facilitates the development of human resources, technology, and programs that help to organize research and educational initiatives in science and engineering for the benefit of the western hemisphere countries. The main objectives of CoHemis are: increase the industrial competitiveness of the Western Hemisphere, enhance the science and

technology capabilities of the Americas and the Caribbean, stimulate the protection of the hemisphere's resources and environment, increase the knowledge of regional problems of high priority among researchers and educators in the Americas, increase the number and quality of Hispanic engineers and scientists in the global market.

For more information contact:
http://cohemis.uprm.edu/

**Business & Economic Development Center (BEDC)**

Since 1986, the University of Puerto Rico Business and Economic Development Center (BEDC) has been working to promote the entrepreneurship, innovation and commercialization of technologies. The BED Center is the only EDA-University Center (UC) in Puerto Rico and Caribbean, headquartered at the College of Business Administration (CBA) in the Mayaguez Campus (UPRM). In 2021, the University of the Virgin Islands (UVI) Center for Excellence in Leadership and Learning (CELL) joined the BEDC. As a Caribbean Regional Center focused on strengthening Puerto Rico and the Virgin Islands' innovation ecosystems, promote the establishment of companies, commercialize technologies, innovate through product creation, provide services, and improve existing businesses growth opportunities. Additionally, the BEDC is the host of the UPRM NSF I-Corp Site, and the UPRM E-ship Network. The service provide include technical assistance for business ideas, startups and existing businesses, conduct applied research, and provide networking opportunities.

Currently the BEDC is composed of three other programs: AREA-E: an incubator & accelerator which provides trainings, mentoring, and technical assistance for small businesses, funded by the CDBG-DR program; CAPITAL SEMILLA: incentive program which provides seed funds for small businesses (3.5 years+) through a grant by Banco Popular Puerto Rico; PAMG-TAP: a program that provides training and technical assistance on compliance requirements for government beneficiaries managing recovery funds, with a focus on economic development projects.

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Professor at College of Business Administration
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Phone: 787-832-4040 Ext. 5591, 5600
Office: AE-202B, AE-202A & AE-252
More info: https://www.uprm.edu/cnde/

**Business Research Center (CIE)**

Established in 2010, the Business Research Center is located on the basement level of the Business Administration building at UPRM. The center supports the research efforts of professors and students by providing various academic and technical resources.

The center's team consists of a coordinator and six service assistants. Its facilities include individual work cubicles with computers, a reading area, and a conference room.

The Business Research Center offers a wide range of services, including assistance with literature reviews, journal selection, data search, data entry, and document formatting (MLA, APA, Chicago, and other styles). Additionally, the center organizes workshops and seminars to enhance research skills.

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**Engineering Office of the Associate Dean for Research and Innovation (DR&I)**

The DR&I proposes and implements the course of action of the College of Engineering (CoE) towards the strengthening of its leading position in Translational Research across UPRM, Puerto Rico and the Americas. The DR&I objectives are overseeing of the research facilities within the CoE, recognize emerging research areas, and promoting the development and implementation of strategic research clusters aligned to new graduate programs while up-dating of the current ones. The DR&I is also responsible for the guidance, evaluation, and verification of administration & compliance issues associated to research activities. Intellectual property (IP) matters are inherent to many of the activities within the CoE; therefore, a working understanding of IP becomes indispensable to manage related issues when interacting with academic peers, governmental offices or

industrial partners. Accordingly, the Office of Intellectual Property and Technology Transfer (IP & TT), hosted by the DR&I, provides specialized support to UPRM at large, starting from education and training, passing through invention disclosures, patent application and final patent assignment.

The above-described activities are complemented with a dynamic and effective dissemination of the achievements and contributions of the CoE to the well-being of Puerto Rico in concordance with a healthy and robust partnership with Academia and Industry partners. On this basis, the DR&I office has been re-structured to provide qualified technical and administrative support in: (1) Research & Compliance; (2) Innovation & Intellectual Property; (3) Corporative Image & Partnerships; (4) Research Infrastructure & Facilities, and (5) Project Support.

***Contact:***
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**Center for Agroindustrial Innovation and Technology (CITAI)**

The Center for Agro-industrial Innovation and Technology (CITAI) is managed by the College of Agricultural Sciences of the Mayagüez Campus of the University of Puerto Rico (UPR). Currently, this center operates as part of the Food Science and Technology Program. Its creation in 2008 was largely financed by donations from the Alfredo Ramírez de Arellano y Rosell Foundation and the Puerto Rico Department of Agriculture. CITAI has laboratory spaces, an experimental kitchen, areas for the processing of meat and dairy products, and a pilot food processing plant.

Since its founding, CITAI's mission has been to promote the agricultural and agro-industrial development of Puerto Rico by offering services such as training, technical assistance, development of new products and industry incubation. The motivation behind this mission is to promote the growth of the agro-industrial sector, which will encourage greater demand for local agricultural products and generate a chain of economic activity that will reduce capital flight due to imports, in addition to creating more and better employment opportunities.

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Food Science and Technology Program
Phone: 787-265-5410
https://www.uprm.edu/citai/industria/

## *MAJOR RESEARCH INSTRUMENTATION & SERVICES FACILITIES*

**Center for Nanostructure Characterization (CeNaC)**

The Center for Nanostructure Characterization is managed by the Department of Chemical Engineering and is located in an adjacent building in the UPRM Engineering Complex. It houses a high resolution JEOL 2100F Field Emission Transmission Electron Microscope and other advanced nanomaterial characterization instruments, such as XRD, XPS and confocal microscope. Its purpose is to provide access to unique advanced instrumentation capabilities to academic researchers and industry, and to promote competitive research.

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Chemical Engineering Department
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https://www.uprm.edu/inqu/research/facilities/

**Center for Center of AdVanced Aerospace Engineering (CAVE)**

Employing proven prototyping technologies and processes, we can take any concept or design and bring it to life in just days. With access to a wide range of materials, we have an efficient, fast and effective solution that's right for you, whether it's a prototype to test form, fit and function or as a starting point for our downstream processes.

- CAD/CAE/CAM Support Services: Our CAD/CAE/CAM team's technical knowledge and practical experience across a variety of CAD/CAE/CAM software allows us to work with and validate most file formats.
- Stereolithography (SLA): Our stereolithography service is fast and flexible and offers a choice of eight different resins. With Pro SLA machines at our disposal, we are typically able to deliver parts within two to three days

from acceptance of CAD data. Clients can choose from one of the widest ranges of materials available on the market today, including water clear, white, ABS simulant, and flexible resin.

- Rapid CNC Machining: We can offer customers a wide range of CNC machining options from our new rapid CNC service in PR through to low volumes manufactured out of CAVE facilities. Our CNC service offers outstanding quality prototype modelling in metal or plastics. We can cut from a wide range of materials, including various grades of Aluminium, Brass, Stainless Steel, ABS, and nylon to name but a few.

***Contact:***
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Mechanical Engineering Department
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http://uprm.edu/inme/resources/CAVE

**Microscopy Center**

The Microscopy Center, located in the Biology Department building, houses scientific instrumentation to study the magnified appearance of biological and non-biological samples, enlarged up to 200,000 times in relation to their size real. Available instruments enable the acquisition of high-quality digital images, ranging in resolution from macro photography (equivalent to using a handheld magnifying glass) to the nanometer scale.

The Center supports research activities of faculty members and undergraduate and graduate students of our campus, as well as other campuses of the UPR System and other Universities, as well as Industry personnel. The technical support offered can be of different levels, depending on the researcher's preferences - from complete training in all aspects of sample preparation, use of instruments and photomicroscopy; up to a complete service, in which the Center takes charge of all the technical work (sample preparation, microscopy and photography) and delivers the final results to the client, in the form of digital images. Research-related services are offered free of charge to all RUM Biology Department students and faculty, and at very low costs, compared to most Research Centers, for clients from outside the Department.

***Contact:***
José Almodóvar (Scientific Instrumentation Specialist)
Department of Biology
Phone: (787) 832-4040 Ext. 3721, 3910
*For more information:*
https://www.uprm.edu/microscopico/

**Center of Nuclear Magnetic Resonance**

This Center was created in 2001 through funds from the National Science Foundation to provide services to undergraduate and graduate students, as well as members of the Faculty of Chemistry and related areas. It is a multi-user facility and consists of a 500 MHz multinuclear NMR instrument with four frequency channels and a broadband probe and a QXI probe for performing 1-dimensional, 2-dimensional, and 3-dimensional experiments. Typical experiments such as COSY, NOESY, HSQC, HMBC, and 3D 1H-13C-15N are performed to characterize compounds and organic proteins, inorganic, and organometallic. A NEO AVANCE 500 MHz NMR system is being purchased to renovate the facility.

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**Center for Training, Research, and Services in School Psychology (CAISPE)**

The Centro de Adiestramiento, Investigación y Servicios en Psicología Escolar (CAISPE; Center for Training, Research, and Services in School Psychology) is a unit of the Department of Psychology, in the College of Arts and Sciences, at the University of Puerto Rico in Mayagüez. It began operations in 2024 and arose from the need for a space for training, research, and the provision of psychological services to students and faculty of the Graduate Program in School Psychology. CAISPE allows students and faculty to integrate theory with practice, as well as provide a variety of psychological services to the community at large.

Students of the Graduate Program in School Psychology at the University of Puerto Rico at

Mayagüez Campus are responsible for providing psychological services to the community through their practicum at CAISPE. Faculty members, who are licensed to practice psychology in Puerto Rico, are responsible for their supervision and assume ethical and professional responsibility for each case the students see. CAISPE also serves as a research center.

***Contacts:***
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**XPlora-Plus Confocal Raman Microscope**

Pharmaceutical grade vibrational spectroscopic tool for the analysis of chemical and bioactive agents. The system includes multiwavelength capabilities (532nm, 638nm and 785 nm), a high-sensitivity EMCCD detector, polarizers, multivariable and particle finder data collection capabilities and nanoGPS location system to correlate electron microscopy data with Raman microscopy making this the first instrument of its kind on the region. The instrument is a powerful tool for the detection of antimicrobials, pharmaceutical drugs, personal care products, micro-organisms, pesticides, herbicides and microplastics. The system was acquired with support of the NSF-1951499 y NASA EPSCoR 80NSSC20M0232 projects.

***Contact:***
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Chemistry Department
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**SF 2320480 MRI: Acquisition of a Zeiss 560 VP FE-SEM for chemical and surface characterization and training**

Harnessing morphological features of biofilm and biocomposites materials poses a serious scientific challenge with promising economic, medical, and engineering applications. Nanoscale variations in surface topography are hypothesized to disturb how bacterial agents become attached, proliferate, and subsequently form biofilms. Particularly when those features are smaller than the microorganism itself. Similarly, matrix-reinforcements of chitosan-bionanocomposites containing anatase has proven effective to shorten its band gap with promising applications to treat emerging contaminants of concern and the construction of electronic devices. In addition to provide new insights on how ocean acidification reduces the ability of various marine organisms to build shells and exoskeletons. This instrument will lead to new insights into how changes in nanoscale topographies (i.e., shape, elevation, pitch, width, length, and density) can regulate those properties with numerous biomedical, engineering, and environmental applications. Due to its diverse range of analytical capabilities is key to provide effective solutions to a variety of interdisciplinary applications from the fields of Chemistry, Materials Science and Engineering, Biology, Biotechnology, and Marine Sciences.

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Jose Almodovar M.S.
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**Tropical Animal Reproduction and Investigation Center (TARIC)**

**Centro de Investigación y Reproducción Animal Tropical (CIRAT)**

The TARIC was developed towards the end of 2019 with the objective to expand programs associated to animal reproductive phisiology and include assisted reproductive technologies. These programs are designed for teaching, research and extension purposes in order to benefit members of the academic, research and production communities. The laboratory is equipped with semen collection, sperm analysis and semen straw preparation, and is acquiring equipment and materials for in vitro production of embryos. At the Gurabo Agricultural Experiment Station, the TARIC has received students and farmers for animal reproduction seminars, workshops and basic practices.

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Animal Science Department
Phone: 787-737-3511

## *RESEARCH LABORATORIES*

**Advanced Manufacturing Lab (AML)**

The Advanced Manufacturing Lab (AML) focuses on cutting-edge research to investigate the Process-Structure-Property (PSP) relationships of advanced manufacturing technologies. Our focus lies on the hybrid and multi-material additive manufacturing of metallic components, with applications in aerospace propulsion and In Space Manufacturing & Assembly (ISAM). Our research integrates experimental design, advanced characterization techniques, and performance evaluation to study the microstructural evolution and their influence on material behavior in extreme environments.

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**Bio-Industrial Engineering Laboratory (Bio IE Lab)**

The Bio IE Lab focuses on the use of engineering analysis methods to extract biological knowledge from scientific in-silico, in-vitro and in-vivo experiments. The laboratory integrates high computing capabilities and state-of-the-art algorithms to lead data-based biological discovery. The lab work relates statistical, soft-computing and optimization techniques to biological data analysis. In particular, the search and discovery of biomarkers of cancer is a central line of work of the Bio IE lab. Located in the Industrial Engineering Department, the laboratory is equipped with four MacPro workstations and one iMac capable of running UNIX, Mac and Windows software.

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Industrial Engineering Department
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**Biomechanics and Biomaterials Laboratory (BBL)**

The Biomechanics and Biomaterials Laboratory is dedicated to research and education principally in the area of characterization and testing of biomaterials. This Laboratory is equipped with a Tribometer, Minimat tensile tester, Potentiostat/Galvanostat and an Analytical balance. Characterization of the wear resistance, tensile, compressive and fatigue properties are performed in this facility. Corrosion resistance and behavior through potentiodynamic polarization, cyclic voltammetry and electrochemical impedance spectroscopy are measured in this laboratory.

***Contact:***
Mechanical Engineering Department
Phone: 787-832-4040 Ext 3719

**BioNANO Systems Laboratory**

This Laboratory is located on the first floor of the Main Engineering Building (Stefani 106) and is devoted to do research on nanomaterials-based platforms for nanomedicine and biomedical applications. This 426 $ft^2$ layout facility hosts chemical-resistant bench tops, sinks, cabinets and Class 100 acoustic panels. The lab has a safety shower, eye irrigation station, flammables and acids storage cabinets, and a first aid kit. All equipment and facilities for cancer cell culture are available for research and training purposes at the graduate and undergraduate levels. Among the most important pieces of equipment, this laboratory hosts 2 Forma Scientific cell incubators, a laminal flow hood, a chemical hood, one Olympus phase-contrast microscope, one Olympus Eclipse 8000 fluorescence microscope, one BioRad cell counter, a ThermoFisher Scientific spectrophotometer, PCR equipment, a $CO_2$ chamber and one cell counter for cell viability measurements.

***Contact:***
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Department of Engineering Sciences and Materials
Phone: 787-832-4040 Ext 2398

**Bio-Optical Oceanography Laboratory**

**BIOL** is the site of an active teaching and research program in water optics and satellite remote sensing. Interdisciplinary studies of coastal and oceanic waters of the intra-Americas' sea include: variability of inherent and apparent water optical properties, effects of ultraviolet radiation on tropical marine organisms and on public health, satellite data validation and algorithm development and estimation of oceanic primary

production. The laboratory is located at Isla Magueyes Field Station of the Department of Marine Sciences in La Parguera, Lajas, Puerto Rico.

***Contact:***
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Phone: 787-832-4040, Ext. 3838

**Caribbean Coral Reef Institute (CCRI)**

Located at the Department of Marine Sciences, at Isla Magueyes Marine Station in La Parguera, Lajas, Puerto Rico. This institute sponsor's competitive, peer reviewed scientific research and monitoring programs that address short and long-term management driven priorities for the understanding and managing of coral reef ecosystems in Puerto Rico and the US Caribbean.

- Develop, implement, and administer research and monitoring activities that improve the management of coral reef ecosystems and build management capability.
- Interact as appropriate with the Federal and Commonwealth agencies as well as other public and private organizations having a demonstrated capacity to assist in the management of coral reef ecosystems.
- Fully use the resource-base of the region to collaborate and conduct research and monitoring activities on coral reef ecosystems.

***Contact:***
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**Biosensing and Microfluidics Research Laboratory (BMRL)**

The Biosensing and Microfluidics Research Laboratory (BMRL), led by Dr. Rubén Díaz-Rivera and Dr. Pedro Resto, is 900 sq. ft. facility located in the Department of Mechanical Engineering at UPRM. The purpose of this laboratory is to facilitate the design, construction and use of microfluidic systems for cell studies and biosensing applications. The laboratory houses a faraday-caged microscopy setup for electrical/optical characterization of microfluidic devices, a LabSmith Synchronized Video Microscope workstation with black & white and EPI-fluorescent optic modules, controlled with a Dell Precision T1700 desktop computer, for microfluidic visualization and data acquisition, and tools for performing PDMS soft lithography. The laboratory has access to a rapid prototyping facility having a 3D printer, a small scale CNC, an EPILOG Mini 60W Laser Cutter and an electronics workstation.

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**Bubble Dynamics Laboratory (BDL)**

At the bubble dynamics laboratory of the University of Puerto Rico – Mayaguez, cutting edge research is being conducted for understanding, producing and characterizing milli-micro- and nano-bubbles through the design of acoustic resonators. We develop experimental systems for validation and/or formulation of theoretical models involving the generation and collapse of bubbles with applications on the mechanical, naval, biomedical, agricultural and nuclear energy industry. The laboratory, located in the Mechanical Engineering Department at UPRM (Lucchetti Building), houses state of the art equipment including: a 3D stereoscopic PIV (Particle Image Velocimetry) system with the capability to perform shadow-sizing micro-PIV and Laser Induced Fluorescence (LIF), a Dynamic Mechanical Analyzer (DMA), an Asymmetric Flow Field Flow Fractionator (AFFFF), a Nanoparticle Tracking Analyzer (NTA) and a Static and dynamic light scattering (SLS-DLS) equipment. The BDL laboratory is also equipped with modern data acquisition and measuring devices and it is supported through research funded by the National Science Foundation, Department of Defense, Department of Energy, the US Nuclear Regulatory Commission and the Puerto Rico Science Technology and Research Trust.

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**Center for Applied Ocean Science and Engineering (CAOSE)**

Our research group conducts fundamental and applied research in coastal hydrodynamics, renewable ocean energy, ocean physics and geophysical fluid dynamics using a combination of numerical, observational and laboratory methods. We are also passionate about supporting coastal communities in increasing their resilience, ensuring public beach access, and promoting sound public policy regarding the management of Puerto Rico's maritime terrestrial zone.

Our lab and field work takes place out of the Applied Ocean Science and Engineering Lab, an 1800 sq. ft facility located in the Department of Engineering Sciences and Materials (Stefani 111). Lab facilities include:

- A wave flume with a piston-type wave generator
- Machine shop and tools
- Rotating table
- Graduate student space
- Hydrostatic tank
- Hydrodinamic sensors
- A jet-ski based bathymetric surveying system with RTK capabilities

The lab also serves as launching pad for many field operations of the CARICOOS group, including HF Radar, wave and current sensor deployments, and wave buoy refurbishment, among others.

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**Computational Fluid Dynamics Laboratory (CFD Lab)**

The goal of the Computational Fluid Dynamics (CFD) lab at the University of Puerto Rico – Mayagüez is to model, understand and control fluid flows in engineering applications using numerical techniques. We develop numerical models and perform simulations of turbulent and atmospheric flows with applications in renewable energy and wind energy, heat transfer, and gas turbine engines. The lab is equipped with two 8-cores 16GB workstations, several desktop workstations, and has access to supercomputers at high-performance computing centers in the Nation through the NSF ACCESS network. The lab has developed an in-house parallel CFD code to perform direct numerical simulations and large-eddy simulations of turbulent flows. The lab research is funded by the Department of Energy, the National Science Foundation, and the Puerto Rico Science Technology and Research Trust.

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**Earthquake Engineering Simulation Laboratory (EESL)**

The Earthquake Engineering Simulation Laboratory (EESL) is dedicated to achieving a comprehensive understanding of the intricate dynamic interactions that occur during earthquakes. Through advanced numerical simulations in structural, geotechnical, and engineering seismology, our goal is to develop robust methodologies for seismic assessment and to contribute to the design of more resilient structures and infrastructure. The laboratory is located in Stefani 510 and houses several workstations powered by cutting-edge simulation software.

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**Human-Centered Design Research and Development Laboratory**

The Human-Centered Design Research and Development Laboratory purpose is to enhance quality of life by understanding human behavior and cognition to connect Design and Engineering for the development of knowledge and products for social well-being. Currently, the laboratory focuses in three areas: the intersection between Design and entrepreneurship, Design for aesthetics, and Virtual Reality for Engineering applications. The laboratory is equipped with various high performance computers and head mounted displays (e.g. Oculus Rift) for the virtual

reality experiments. In addition, a range of input output devices is available for inclusion in virtual reality experiments. The laboratory offers visualization of complex engineering analysis and product assemblies in support of ME courses and other partnerships.

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**Human Factors/Ergonomics and Work Measurement Laboratory**

This educational laboratory has been designed to provide students with hands-on experience in the analysis and evaluation of humans and their working environment. Tasks are simulated and evaluated based on anthropometrics, biomechanics, cardiovascular, and force requirements. The laboratory is equipped with modern equipment for the analysis of work systems and computers with software for the analysis of manual material handling activities. The following is a list of some of the equipment available in the laboratory: Computers with licenses of ErgoIntelligence for analysis and evaluation of workstation design as well as the analysis of lifting tasks with the NIOSH lifting guide; Chatillon digital force measurement gauges and equipment for the analysis of pushing and pulling tasks; hand dynamometers and pinch gauges to measure hand force; anthropometers and calipers for the collection of anthropometric data; goniometers and data collection software for the analysis of flexion, extension, and rotation of body members; heat stress monitors and Wet-bulb globe temperature meter for the analysis of environmental variables, among others.

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**Laboratory for Applied Remote Sensing, Imaging and Photonics**

LARSIP is a multidisciplinary laboratory dedicated to the research and implementation of Remote Sensing, Hyperspectral Image Processing, Optical Imaging, Signal and Image Processing, Geographical Information Systems (GIS), Emergency Response Systems, Global Positioning Systems (GPS) technologies, Applied Electromagnetics and Bio-Optics applications. LARSIP is a facility located within the Department of Electrical and Computer Engineering at UPRM.

The objectives of LARSIP are to develop advanced data analytics and machine learning algorithms and technologies for information extraction and management (particularly from remote sensing platforms), and to educate and train students in the different technologies associated with remote sensing and signal processing. LARSIP provides a focus for multi-disciplinary research and education by promoting research and education projects that involve electrical and computer engineering along with computer science and engineering researchers interacting with researchers and students in application areas such as marine sciences, geology, civil engineering, bioengineering and chemistry. LARSIP has extensive computing and image processing equipment such as advanced hyperspectral optical imaging equipment (ranging from the visible and infrared spectrum) as well as portable spectrometers and underwater enclosures for fieldwork and collection of diverse imaging data.

The National Science Foundation (NSF), National Aeronautics and Space Administration (NASA), and the American Telephone and Telegraph Corporation (AT&T) provided initial funding for LARSIP and its research projects. Currently, LARSIP receives funding from NSF, NOAA, Lockheed Martin Corporation, L3Harris Technologies and the DoD. LARSIP function as a training center in a bilingual (Spanish and English) environment for current and future scientists and engineers of the Caribbean region and the South and Central Americas. The training centers are multidisciplinary in scope, serving Mayaguez and other UPR campuses. Universities and institutions in other countries are encouraged to form and establish liaisons with LARSIP through Memoranda of Understanding or other similar arrangements.

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**Lean Logistics (LeLo) Lab**

The Lean Logistics (LeLo) Lab is a student-centered lab established in 2011 to provide hands-on experience while creating practical research-based solutions to contemporary logistics problems. The LeLo Lab currently has three main streams of research: Ergonomics & Human Factors, Logistics, and Industry 4.0. Ergonomics & Human Factors focuses on designing work-spaces, standards, and systems considering human abilities, needs, and safety. Logistics-related research focuses on the design and optimization of distribution and fulfillment centers, material handling systems, and supply chain networks. Research on Industry 4.0 focuses on smart manufacturing, Industrial Internet of Things (IIoT), cyber-physical systems, autonomous systems, and self-organizing systems. Consulting and training at the supply chain, facility, or production line level are available through the lab. The LeLo Lab, which was founded in 2011 and is located in II-115, is partly funded by public agencies and corporate donations.

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**Manufacturing Automation Laboratory**

This teaching-learning facility is the hands-on laboratory for the Real Time Process Control course where students design, build, and control scaled models, mainly emulating real manufacturing operations. The emphasis is in the use of programmable logic controllers (PLC), industrial sensors and actuators, pneumatics, and computer-based human machine interfaces. The laboratory counts with 20 workstations equipped with all the necessary software and hardware. The facility is available for demonstration and custom trainings.

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**Mechanical Engineering Machine Science Laboratory**

The Mechanical Engineering Machine Science Laboratory (MEMSL) is situated within the Mechanical Engineering Building. This laboratory facilitates departmental research in Machine Science, focusing on mechanical and material component systems, including additive manufacturing for mechanical and aerospace applications with structural optimization and manufacturing constraints, vibration research for damage detection and material characterization (fatigue life), sensor design and anomaly detection, and composites involving sandwich core design and optimization. Computing facilities for AI Generative Design and Machine Learning methodologies are accessible. MEMSL is equipped with two 3D printers, a laser vibrometer, electromagnetic shakers, amplifiers, data acquisition systems, software, transducer conditioning amplifiers, a power supply, an oscilloscope, and limited computing resources.

The Laboratory is presently overseen by three faculty members from the Mechanical Engineering department: Dr. Marco Menegozzo, Dr. David Serrano, and Dr. Frederick Just-Agosto. MEMSL has received external financing from the National Science Foundation, the Department of Defense, Pratt & Whitney, and the Puerto Rico Science Technology and Research Trust.

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**Mechatronics Laboratory**

The Mechatronics Laboratory at the Mechanical Engineering (ME) Department is dedicated to the study of electromechanical systems. The laboratory offers training and support to existing ME courses while providing facilities and resources for research in the control of mechanical and electromechanical systems. The laboratory is equipped with PLC Pick-and-Place

and Sorting workstations. The laboratory has materials and equipment to perform experiments and projects using microcontrollers. The laboratory also includes a prototyping station with additional equipment to conduct independent research projects; a design center where students will be able to share ideas and make presentations; and a full-time technician to support the laboratory's activities. The laboratory also utilizes the equipment available in the Manufacturing Processes Laboratory to handle a wide variety of complex projects involving the fusion of mechanics, electronics, and software technologies.

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**Micro and Nano Devices Research Laboratory**

The Micro and Nano Devices Research Laboratory is a Class 100 (ISO Class 5) cleanroom for photolithography located at the UPRM Research and Development Center. The facility houses a SUSS MicroTec Mask Aligner (MA-6) with backside alignment, a Reactive Ion Etcher with CF4 chemistry, a multiple target (AC/DC) Sputtering System (AJA Orion Thin Film Deposition System), a Stylus Profilometer (KLA Tencor P-6), a chemistry hood and photolithography peripherals.

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**Microgrid Laboratory**

The Microgrid Laboratory offers several experimental research, development, and education platforms, integrated in a single operational system. The facility is designed to run experiments at all levels of controls. It is composed of a DSPACE system and an inverter-based setup, two electronic DC power sources, loads, and two computers. The setup consists of four inverter-based generators, which can simulate different microgrid configurations. The microgrid setup includes the following equipment: 1×dSPACE system, which includes: 1 CPU board (ACE1006), an expansion box (PX10), a 16-channel A/D board (DS2004) and a connection (CP2004), 2 digital I/O boxes (DS4003), output board (DS5101) and connector (CP5101), the box of the whole system, and the digital bus cable, 1×10kVA transformer for grid connection; 4×2.2kW DANFOSS inverters; 1×Data logger; 2×screens; and 1× PC. In addition, to generate the DC link that supply each DC/AC inverter the facility has a 5kW AC/DC power electronics supply.

Also, an electric motors and drives setup is dedicated to component testing and prototyping, component modeling, and simulation. There is a test bench for implementation of control and identification algorithms for drives and power electronics applications. The test bench is based on the rapid prototyping system for control algorithms using the Dspace 1104 board. The laboratory also has the following equipment: UPRM built 3 phase rectifier/inverter for motor control, 1 HP; Controllable DC power supplies.

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**Microwave and Millimeter-wave Antennas and Remote Sensing Systems Laboratory (MAReS)**

MAReS was created in 2000 through a Major Research Instrumentation grant from NSF. The laboratory instrumentation includes microwave and millimeter-wave instrumentation that allows us to perform circuit and antenna measurements up to 67 GHz, rapid prototyping equipment for printed circuit boards up to 10 GHz, and design workstations with commercial software for microwave circuits and electromagnetic simulations. The laboratory facilities have supported numerous research projects throughout the years, including projects under the NSF Engineering Research Center for Subsurface Sensing and Imaging Systems (CenSSIS), NSF Engineering Research Center for Collaborative Adaptive Sensing of the Atmosphere (CASA),

and the NASA Tropical Center for Earth and Space Studies (TCESS). The laboratory has also supported projects from the Army Research Office, the Air Force Research Laboratory, the Department of Energy, and the Puerto Rico Science, Technology and Research Trust, in addition to NSF and NASA. The laboratory currently supports the NOAA Cooperative Science Center for Earth System Sciences and Remote Sensing Technologies (NOAA CESSRST), as well as other unfunded graduate and undergraduate projects. The laboratory has been a central component in obtaining more than $7.35M in research funding since its creation in 2000, with an initial investment of $677,000 by NSF.

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**NANOmaterials Processing Laboratory**

This multiple user laboratory, located at Stefani 313/314, comprises 900 sq ft of space intended for basic manufacturing and advanced synthesis of materials. Among the instrumentation relevant, there is a Cee 200 Spin-coater system from Brewer Science, Inc., a Mercury-Xenon 200W-UV lamp from Oriel Instruments, Inc., and a Thermo Fisher vacuum oven. Additional pieces of equipment available in this laboratory are: a Buehler Beta manual polishing unit, a Sartorius T212 balance with two density determination kits, a Struers Lectropol 5 electropolishing unit that permits final preparation of samples free of mechanical polishing hardening, a Buehler ISOMET 1000 high-precision diamond saw, and a fully automatic Leco LCR-500 Rockwell-type hardness testing system. Three dispersing tools available in the lab are: a high spindle speed homogenizer (KA T18 with S18N-19G dispersing tool), a low spindle speed Labmill – 8000, and a Cole Parmer ultrasonic processor. Additional equipment for materials synthesis and/or processing include: a 4575 model HP/HT Pressure Reactor from Parr Instruments Company, a 1100°C Vacuum Chamber Furnace (7.5"IDx 13"L, 7.6 Liter) with 30 Segments Programmable Temperature Controller - VBF-1200X-H8, and a model AUT-501 Automated Laboratory Titrator from DKK – TOA Corporation. The latest acquisition for materials synthesis is a Microwave Accelerator Reactor System, Model MARS 6 from CEM Corporation and a Siemens D500 X-ray diffractometer for al structural analysis.

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**Neuropsychoanalysis Lab / Unconscious Lab**

The main purpose of this laboratory is to investigate how affect and unconscious processes impact our personality. From the framework of neuropsychoanalysis, it also addresses the influence of culture and society on our behavior, as well as the impact of our narratives on our affect and pattern formation.

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**New Materials Development Laboratory (NMDL)**

NMDL is responsible for matching many new differentiated materials and technologies with market needs in the areas of bioengineering, alternative energy and electronics. The NMDL include a materialographic laboratory, a mechanical testing facility (including a 5000 lb Instron machine), thermal chambers, tribometers. Basic equipment for materialographic preparation including an automatic mounting press and various grinder/polishers, hardness testers, heat treatment furnaces and a various optical imaging systems are available. NMDL performs sponsored research from various government and private agencies.

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**The Oral History Lab @UPRM (OHL)**

The OHL was established in 2022 through a Digital Humanities Grant from the National Endowment for the Humanities. Located in the

UPRM General Library, the OHL brings together assets from the Department of English, General Library, and Film Certificate program in a center dedicated to recording, archiving, analyzing, and disseminating interviews from the Puerto Rican archipelago about climate change and related social issues. Affiliated OHL courses train students in oral history and documentary filmmaking, and collected materials are preserved in digital archives with bilingual metadata and advanced search filters. Modes of dissemination include publications, documentary films, digital exhibitions, data visualization tools, infographics, social media campaigns, and entries in UPRM's institutional repository. The OHL includes an interview room and four video editing rooms and maintains the equipment necessary for recording oral histories and making films. The OHL is a member of the Humanities Action Lab, a partner in the *Archivo de Respuestas Emergencias de Puerto Rico*, and collaborates with research projects on campus and with community groups throughout the archipelago.

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**Parallel and Distributed Computing Laboratory**

The PDC Group performs research in the design, implementation, and efficiency measurements of parallel algorithms. It also addresses research issues related to parallel and distributed computing systems with an emphasis in high-performance cluster computing and Grid computing. Our work includes a wide spectrum of experiences from computing systems to modeling and simulation of physical and biological phenomena.

The mission of the PDCLab is to stimulate and facilitate the growth necessary to extend the state of the art in parallel and distributed computing systems, while fostering a multidisciplinary research and educational environment for faculty, undergraduate and graduate students, and partners at UPRM.

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**Rapid System Prototyping Laboratory (RASP)**

The Rapid System Prototyping Laboratory (TI-ICDL) is located in Room 208, Stefani Building in the UPRM campus. The facility provides 420sq. ft. of space devoted to the tasks of developing technologies and applications for prototyping algorithms, circuits and electronic systems on quick turn-around technologies like Field Programmable Gate Arrays (FPGA) and advanced hardware platforms. RASP was established in 2002 with the sponsorship of multiple entities, including Texas Instruments, The National Science Foundation, IBM, Xilinx, Harris, and Lockheed-Martin, among others. The main mission of the RASP Laboratory is to enable graduate students acquire the necessary training, skills, expertise, and capabilities to conduct academic and industrial research work in the field of rapid prototyping digital and mixed-signal electronic systems.

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**School NeuroLab**

To offer comprehensive training in neuropsychological research that enhances the understanding of the relationship between the brain and human behavior in educational contexts. Our commitment is to foster the professional growth of teachers and students through learning communities. We promote an interdisciplinary and transdisciplinary approach that bridges theory and practice. We strive for the development and implementation of neuropsychological assessment and intervention practices, grounded in ethics and scientific evidence.

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**Smart Power Electronics and Aerospace Research (SPEAR) Laboratory**

The main focus of the UPRM's Smart Power Electronics and Aerospace Research Laboratory is for advance undergraduate education on power electronics and aerospace systems using graduate research techniques. Graduate students are welcome to do partially their related research work in the facility and serve as mentors to the undergraduate research students. This facility is located in Stefani building (S222E) and occupies about 220 sq ft. This laboratory has one Chroma Photovoltaic Emulator, Printed Circuit Board Rapid Prototyping System, 3D Printers, High temperature PCB Oven, Portable Drill/Saw Machinery, Network/Impedance/Spectrum Analyzer 10Hz-500 MHz, Milling/Drilling Machinery, and Lead-Free Soldering Station. This facility also includes the usual assortment of oscilloscopes, waveform generators, multi-meters, computers, etc. The laboratory has Software Licenses for REOpt, SABER, P-Spice, Matlab, and others useful for the design unmanned systems, and renewable energy systems like Microgrids. This facility is useful for fabrication, characterization, testing unmanned system, power electronics prototypes and renewable energy systems. The UPRM's Smart Power Electronics and Aerospace Research (SPEAR) Laboratory is sponsored in part by the UPRM's CHRES Project, the US DoEnergy/NNSA, Sandia National Laboratory, and UPRM's ECE Industry Affiliates Program.

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**Space Information Laboratory (SIL)**

SIL was founded as part of the NASA Tropical Center for Earth and Science Studies (TCEESS) with the purpose of receiving and distributing satellite data from different sources. The facility currently houses a NOAA Direct Broadcast Satellite Receiving Station, with capability of receiving data from the Suomi-NPP, JPSS-1, Aqua, Terra, NOAA-18, NOAA-19, METOP-A, METOP-B, and GCOM-W1 satellites, among others. Data is primarily used by the Space Science and Engineering Center from the University of Wisconsin, Madison, for ingestion into their forecast models, and for developing diverse imagery. Data is also used by UPRM NOAA CESSRST researchers for remote sensing of coastal environments and for calibration and validation of localized optical and microwave sensors, and other researchers at UPRM. This data is available for academic and academic research purposes. In addition, SIL houses the University of Colorado project for Multi-Constellation Multi-Frequency GNSS Data Collection Arrays for Low Latitude Atmospheric Effects Studies.

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**Statistical Quality Control Laboratory**

The laboratory is equipped with Statistical software for data analysis, design of experiments, and validation procedures. It can also provide hands-on demonstrations for applied statistics courses and for simulation courses.

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**Texas Instruments Integrated Circuits Design Laboratory (TI-ICDL)**

The Texas Instruments Integrated Circuits Design Laboratory (TI-ICDL) is located in Room 210B, Stefani Building in the UPRM campus. The facility provides 800 sq. ft. of space devoted to the tasks of designing and testing analog, digital, and mixed-signal integrated circuits and systems. The facility was established in 1999 with the sponsorship of Texas Instruments (TI) under the UPRM-TI Collaborative Program. It provides 16 design workstations running industry-grade software tools for the design entry and

verification of integrated circuits developed in bipolar and MOS technologies. In addition, the lab provides four testing stations with state-of-the- art test and measurement tools used by senior and graduate students, in advanced and graduate course projects in electronics as well as graduate research students for their projects.

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**TRIN Lab**

The Trauma-Informed Research Lab is dedicated to the research and development of trauma-informed practices within educational systems and school psychology. Our focus is on understanding how trauma impacts students' learning, behavior, and mental health, as well as on strategies to foster safe, inclusive, and resilient school environments. We explore the implementation of evidence-based practices to enhance the responsiveness of educators, psychologists, and other professionals to the needs of students with adverse experiences. Additionally, the lab promotes the training of future researchers and practitioners through interdisciplinary collaboration, policy analysis, and the creation of resources to strengthen equity and well-being in school communities. Our commitment is to transform educational systems to be trauma-sensitive and to support the healthy development of all students.

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**UPRM Model Factory**

The UPRM Model Factory integrates modern equipment, materials, and people into a manufacturing system. Its mode of operation is through interdisciplinary working teams from several engineering and business disciplines. This is a coordinated effort between Industrial, Electrical & Computer, and Mechanical Engineering. The goals of these laboratory facilities are to provide the following:

- Basic training to students through course labs and project initiatives
- Practice based experiences dealing with all aspects of an actual manufacturing system.
- A space where local manufacturing industry issues can be studied.
- A place where modern production technology and techniques can be studied as they are applied in an integrated manufacturing system.
- The opportunity to assist local manufacturers in the development of their production system.
- Incubator facilities where products and process can be developed or improved.
- Serve as a meeting place where people from several disciplines can meet and learn to work in teams, and get an appreciation for the technical aspects of the other's area of knowledge.

Currently, this laboratory houses a for-profit manufacturing activity and provides students with an exemplary manufacturing experience inside the university. The factory hosts a surface mount technology (SMT) printed circuit assembly (PCA) line and a three-axes CNC milling machine in which production and prototype runs are performed.

As for-profit initiatives are defined, students receive pay for their involvement, similar to a COOP experience. These students are then ideal candidates for course projects and summer and COOP internship in related endeavors. Such young but experienced graduates are then positioned to initiate new business ventures or play lead roles in interested recruiters. Various companies (notably Hewlett Packard, Fuji America and FeatureCam) have contributed to this initiative, which has been active for over ten years.

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**Vehicle Design and Research Laboratory**

Vehicle Design and Research Laboratory is involved with research and development of high performance and alternate fueled vehicles for current and future transportation needs. It is equipped with a Design Center and a Machine Shop, two chassis dynamometers both and emissions measurement equipment. The Machine Shop includes 3D printers, CNC Router/Plasma Cutter and Laser Cutters. Data acquisition instrumentation is available for vehicle development and optimization. Current research projects include: energy management for solar powered vehicles, motorsport vehicle optimization, autonomous vehicles, intelligent transportation systems and remote control aircraft. Undergraduate student projects include Formula SAE, Solar Powered Vehicles (FSGP/ASC), SAE Mini Baja, Shell Eco-Marathon and SAE Aerodesign.

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**Weather Radar Network of Puerto Rico at UPRM**

A weather research network comprised of two types of X-band weather radars was developed thanks to funding from two NSF programs; Engineering Research Centers (ERC) and Major Research Instrumentation (MRI). The first type of radars are the small Off-the-grid (OTG) radars which measure rainfall rate and are capable of operating with renewable (wind and/or solar) power in case of blackouts which are common during extreme weather events. The other type of radars are more sophisticated Doppler Polarimetric weather radars called Tropinet, which are capable of measuring rainfall, wind speed and other hydrometeors such as hail, among others. The network comprises 3 Tropinet and 5 OTG distributed mainly on the west side of the island of Puerto Rico and they could complement the data from the NWS radar located on the East of the island (in Cayey).

The new network uses a dense network of radars capable of very high spatial and temporal resolution, which is necessary for better prediction of landslides, flooding, tornado warnings and other meteorological phenomena. These systems operate collaboratively within a dynamic information technology infrastructure, adapting to changing conditions in a manner that meets competing needs of end users, the government, private industry, and the public.

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**Soil and Water Chemistry Laboratory**
**Agricultural Experiment Station**
**Agronomy Building**
**South Botanical Garden**
**Río Piedras**

The Soil and Water Chemistry Laboratory of the Agricultural Experiment Station is exclusively dedicated to evaluating the impact of nutrients on the integrity of surface waters and promoting environmentally sound management practices of nutrients in agricultural and natural landscapes. The laboratory specializes in the analysis of phosphorus in soil (Olsen-P, Bray-P, Mehlich-P, $CaCl_2$-P), as well as the analysis of nutrients in waters (i.e., Nitrogen (nitrate-N, Total Kjeldahl-N), phosphorus (total and dissolved). Chlorophyll *a* is also analyzed as a measure of water body productivity. All water analyzes are conducted through EPA certified methodology. The laboratory is managed by Dr. Gustavo A. Martínez (gustavo.martinez3@upr.edu), a soil chemist with over 15 years of experience and over 30 scientific publications in this field. The staff includes a laboratory technician, a research assistant, and a laboratory assistant. Active areas of research include: Establishment of numeric nutrient criteria for surface fresh waters (rivers, wetlands, reservoirs), Evaluation of the impact of anthropogenic activities on the nutritional status of waters, and Development of environmentally sound animal waste management practices.

**Facilities:**
Soil and Water Chemistry Laboratory (Agricultural Experiment Station- UPR)
20´ x 40´ laboratory space equipped with the following: Seal Analytical AA3 analyzer, BRAN_LUEBBE Ion Analyzer, Thermo

Scientific C, N, S analyzer, Turner model 10AU fluorometer, UV/VIS Beckman Spectrophotometer, 2 Oxitop® IS12 BOD measuring systems, LABCONCO freeze dry unit, Lachat block digestor, Perkin Elmer atomic absorption spectrophotometer, various miscellaneous equipments (e.j., pH and conductivity meters, analytical balances, several storage freezers, etc). In addition, the research team has several YSI multiparameter sondes for field data collection.

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**Phytopathology and Tissue Culture Laboratory**
**Agricultural Experiment Station**
**Agronomy Building 2-24**
**South Botanical Garden, Río Piedras**

The Phytopathology and Tissue Culture Laboratory is part of the Research Center of the Agricultural Experimental Station (EEA) of Río Piedras. It was inaugurated on October 4, 2018. This laboratory aims to strengthen the tools in biotechnology and microscopy that allow us to carry out research studies at the cellular level and better understand the Plant-Pathogen interaction, providing support to farmers, researchers and students of the College of Agricultural Sciences. We also have a line of research in the production of propagation material through tissue culture and the Temporary Immersion Bioreactor (TBI) system. These research works will allow us to scale the production of disease-free propagation material. The crops currently being worked on in the laboratory are: apio (*Arracacia xanthorrhiza*), plantain and bananas (*Musaceae*), and tanier (*Xanthosoma* spp.).

The laboratory also provides disease diagnosis services to farmers in the northeast and center of the Island, as support to the Mayagüez Plant Clinic (https://www.facebook.com/clinicauprm). Analysis of plant material and soil is carried out to detect and identify diseases that affect crops. Integrated management recommendations for the identified disease will be included in the reports of each analysis.

The mission of the Phytopathology and Tissue Culture Laboratory is to meet the needs of farmers with research that allows improving phytosanitary practices of propagation material for crops of food importance. Understand the relationship between the crop and its pathogens to generate integrated management practices that allow greater food production from healthy crops. Our mission is aligned with the mission of the College of Agricultural Sciences, which is to develop, through education, research and extension, new technologies to innovate in agricultural production through economically viable, sustainable and safe agriculture that contributes to improving the quality of life of Puerto Rican families.

The Phytopathology and Tissue Culture Laboratory's vision is to study and understand the interactions between plants and the pathogen towards the development of methods for their control and promote their adoption through economic and environmentally sustainable agricultural practices. In addition, the implementation of a scientific integrated management program to control pests and diseases that limit our food production, critical in our daily basic diet, is aimed at developing food security in Puerto Rico and the Caribbean.

**Facilities:**
The Laboratory of Phytopathology and Tissue Culture has a microscopy room with microscopes and stereocopes and a Nikon Epi-fluorescent Microscope. A main room equipped for molecular and biotechnology protocols, equipment with three PCR blocks, speed vac, BioSpectrophotometer, incubators, shaker incubators, -80 ultra freezer, electrophoresis system with gel visualization. The laboratory also has an independent space of three rooms for tissue culture, with two transfer chambers, and two types of bioreactor systems: the rocking system and the SETIS.

The laboratory can support research to follow the plant-pathogen interaction, using fungal effector protein fluorescent and having the hands-on experience on the fungal transformation, and on the use of the fluorescent microscope for the visualization of in vivo plant-pathogen interaction. As well as the use of molecular tools for DNA extraction, and their quantification and visualization.

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## *MULTIDISCIPLINARY CENTERS*

**Caribbean Coastal Ocean Observing System (CARICOOS)**

CARICOOS is the Caribbean Coastal Ocean Observing System. This effort, funded by the NOAA IOOS office http://ioos.noaa.gov/, is one of eleven coastal observing systems and regional associations which along with federal agencies constitute the national coastal component of the US Integrated Ocean Observing System.

CARICOOS operates a network of observing assets including data buoys, coastal meteorological stations, vessels, instruments and radars. Data from these assets and value-added data products such as graphs and maps are provided free of charge to the general public through the web page www.caricoos.org. This web page brings together coastal ocean data and forecasts from a variety of sources including satellites, ocean instruments and numerical models to give the user an integrated view of past, present conditions in the US Caribbean region. Data are provided online by a number of organizations including NOAA, NASA, ONR Universities and others to whom credit is given. Data and graphics, other than NOAA National Weather Service products, are presented as experimental products.

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**Center for Aerospace and Unmanned Systems Engineering (CAUSE)**

Center for Aerospace and Unmanned Systems Engineering (CAUSE) provides a framework for broad-based, competitive, multi-institutional, multidisciplinary science and engineering research that will advance the aims of aeronautic, and astronautic Mission Directorates across the nation and world at large. The center will foster synergy between the following science and engineering directorates: (i) unmanned systems, (ii) aeronautics, and (iii) space. The center provides an interdisciplinary environment that enables and facilitates participants to carry out collaborative educational activities and research. The Center's overall mission is to leverage our strong theoretical, computational, and experimental programs to advance the frontiers of fundamental and applied research while educating a new cadre of STEM students. We intend to create strong collaborative relationships with the current aerospace industries, centers, institutes, schools and universities.

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**Center for Pharmaceutical Engineering Development and Learning (CPEDaL)**

CPEDaL is a center focused on providing education and services related to process and product development, troubleshooting, materials and product characterization. The center supports the learning of undergraduate students through formal courses, for example InQu 4029 Pharmaceutical Operations, and undergraduate research. The support to INQU 4029 is crucial for the pharmaceutical engineering minor concentration, which is open to students from different engineerings. In addition, CPEDaL receives students from junior and high schools to spend a day at the laboratory performing experiments and learning about pharmaceutical engineering. Every summer the Pharmaceutical Engineering Summer Camp (PESCa) is held at the laboratory where students from the 10$^{th}$ and 11$^{th}$ grades spend a whole week performing experimental work.

Regarding the pharmaceutical industry, companies such as Janssen, Lilly del Caribe, Astra Zeneca, Neolpharma, BMS, Pfizer have used CPEDaL in the past for specific projects. We have performed investigations of specific problems and material characterization for product development. CPEDaL counts with many technologies, similar to those used by companies, which can be employed to generate data that they can use for their decisions.

For more details, please visit cpedal.uprm.edu.

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**Chemical Sensors Development/Chemical Imaging Center/ALERT-DHS-COE**

Chemical Sensor Development / Chemical Imaging Center / ALERT-DHS-COE are centralized facilities for Research, Development, Education and Training. The main areas of research and education include small-scale chemical sensors, albeit a wide variety of other chemical and physical products. Detection modalities are also used. The origin to target distances range from microscopic distances to several meters within the CCSD umbrella. At the core of the CCSD structure is the goal of providing our best clients, undergraduate and graduate students, with the best education and training to enable them to become qualified scientists and engineers. Cooperation with the Research and Education Center in the Chemistry Department: the UPRM Chemical Imaging Center is promoted through joint projects involving students and teachers from both centers. Collaborations are also sponsored with scientists from all over the island and with national and international colleagues.

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**Center for Applied Social Research**

The Center for Applied Social Research (CASR) is affiliated with the Department of Social Sciences of the University of Puerto Rico, Mayagüez campus. CASR has an operations center in the Center of Research and Development (CRD) on campus. CASR is an academic organization dedicated to social research, used not only to improve our understanding of human social action and various social problems and challenges but also to develop practical solutions to these problems and challenges. The Center carries out interdisciplinary applied social research to inform and promote academic studies, public policy, planning, social services, and community action.

Research conducted at the CASR involves the collaboration of researchers and students of various disciplines: anthropology, political science, psychology, sociology, history, and social work, among others. From an interdisciplinary perspective CASR researchers develop multifaceted and complex social research to improve our understanding of human social action and develop practical solutions to various social problems and challenges. CASR promotes interdisciplinary social research and collaboration among researchers through various working groups, coordination of research projects with other research institutes, governmental and non-governmental organizations, and other stakeholders.

CASR also promotes public and academic debates with respect to various social problems, social services, public policy, and planning. It also promotes public and academic debates about theoretical and methodological issues relevant to applied social research. CASR organizes and sponsors talks, presentations, and symposia that encourage reflection and debate on campus and the community in general.

CASR, committed to the teaching and learning of applied social research, also promotes workshops and other educational activities for the benefit of researchers, students, educators, and the community in general. Finally, CASR offers students the opportunity to apply the concepts and methods learned in their university courses to social reality, through participating in various research projects conducted at the Center. CASR is one of the most important research "workshops" for college students. The interdisciplinary perspective that permeates our projects exposes faculty and students to processes of analysis, and to a diversity of social and cultural situations. As part of this effort, the Center co-sponsors the Symposium of Research in the Social Sciences: The Contribution of Undergraduate Students to Applied Social Research, together with the Department of Social Sciences and various student organizations.

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**Centro para la investigación del bilingüismo y aprendizaje (CeIBA)**

CeIBA was founded in 2012 as a research center from the Department of English dedicated to the study of language and learning in Puerto Rico. The intersections of language and education in

Puerto Rico are a highly politicized, contested, and dynamic area of investigation that offers endless opportunities for interdisciplinary study. CeIBA's goal is to serve as a nexus where researchers from diverse fields such as linguistics, education, cultural studies, history, anthropology, and sociology can collaborate, share resources, train students, and learn from each other in the process of investigating language and learning in Puerto Rico with the purpose of improving language learning for Puerto Rican students at all levels of education.

Our primary objectives are: to create and support a community of scholars working on issues related to language and education in Puerto Rico; to promote student-centered undergraduate and graduate research on language and education; to facilitate fieldwork and interdisciplinary research projects; to serve as a clearinghouse for research on language and education in Puerto Rico; to provide empirically grounded resources to policy makers to aid in language and education decision making matters.

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**Center for Excellence in Quarantine & Invasive Species**

Invasive pest species are affecting world agriculture, forests and natural areas, causing billions of dollars of losses. With globalization and increases in trade and movement of people, the frequency of species invasions has substantially grown in the last decades. Puerto Rico is geopolitically located in a key strategic position and has the potential to host and play a crucial role in studies of *Prevention and Preparedness for Invasive Species.* Puerto Rico is located in a region where the probability of interception of new pests coming to the Americas and US mainland is high and where a proactive approach could be the front line for management of invasive species. In addition, Puerto Rico has its own agricultural interests and it, along with the rest of the Caribbean basin, directly benefits from an US offshore quarantine facility that provides research and appropriate training on target pests and potentially beneficial organisms. The 10,000 sq. ft. state of art laboratory and greenhouses facilities support the Center's mission that is to develop expertise, promote education and generate tools to aid in the quarantine and mitigation of invasive species and help support sound decision-making. This Center is an initial effort between University of Puerto Rico (UPR) and US Department of Agriculture, and have collaborations with several national and international institutions.

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**Civil Infrastructure Research Center**

Founded in 1991, the CIRC began operating within the Department of Civil Engineering and Surveying in January 1992. For 10 years, the CIRC received funds from the National Science Foundation through the Puerto Rico Office of the Experimental Program to Stimulate Cooperative Research (PR-EPSCoR). CIRC serves as the umbrella organization for a large portion of the research activities conducted by the Civil Engineering and Surveying faculty at the University of Puerto Rico at Mayagüez. CIRC's mission is to develop basic and applied research that help government and industry improve infrastructure systems while contributing to the expansion and improvement of the College of Engineering's undergraduate and graduate programs in infrastructure-related disciplines. Our strengths in civil infrastructure engineering include design, construction management, operations, repair, and rehabilitation of civil infrastructure systems, the development of new systems, the assessment of the infrastructure condition, performance, and safety, the consideration of consequences of natural, man-made, and technological hazards on infrastructure, and the study of the environmental impact of systems. Research activities are supported by external funding from Federal agencies, such as DHS, DOD, DOE, DOT, EPA, NASA, NSF and NIH, local agencies, such as the Highways and Transportation Authority and the Department of Environmental and Natural Resources, the University of Puerto Rico, and private organizations. CIRC also participates in technology transfer of research results through the offering of international and local conferences and workshops.

The center maintains a computer center in support of research activities which is updated with funding from projects and from the Department of Civil Engineering and Surveying. Notable research efforts supported include the Coastal Resilience Center (CRC), the National Institute for Congestion Reduction (NICR UTC), the Puerto Rico Testsite for Exploring Contamination Threats (PRoTECT), the Resilient Infrastructure and Sustainability Education Undergraduate Program (RISE-UP), and the Safety Research Using Simulation (SAFER-SIM UTC), among others.

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**UPRM Coastal Resilience Center (UPRM-CRC)**

The UPRM-CRC at the Department of Civil Engineering and Surveying (https://www.uprm.edu/inci/crc_copy/) under the Coastal Resilience Center of Excellence at the University of North Carolina (https://www.coastalresiliencecenter.org/) is sponsored by the U. S. Department of Homeland Security (DHS) (https://www.dhs.gov/). The CRC conducts research and education to improve the social, infrastructural, economical, and the natural environments towards multi-hazards threats. It also focuses on orienting and motivation a new generation of professionals to pursue the USA and Puerto Rico homeland enterprise workforce development. It focuses on natural disasters such as flash floods (storm surge, waves, riverine, urban, landslides), earthquakes (tsunamis, liquefaction), and hurricane winds and any other abrupt change in weather or long-term changes in climate) at coastal zones and it surrounding environments.

The project namely "Education for Improving Resiliency of Coastal Infrastructure" is the focus of the UPRM-CRC. It offers Certificates of participation and achievement in topics offered Resilience Coastal Infrastructure (RCI) on how to assess impacts of natural hazards on coastal infrastructure based on various states of education through the resilience cycle. The education of the coastal communities on RCI, seeks transferring the state of practice knowledge to stakeholders (students, faculty, professionals, first responders, and workforce) through learning experiences. These can be done through formal (curriculum, internships, student projects, undergraduate research) and formal (workshops, seminars, lectures, short courses, webinars) learning experience and special project participation. The UPRM-CRC serves as a vehicle to engage the community to understand and learn their members' roles and responsibilities in providing resilient coastal infrastructure systems during the stages in coastal infrastructure: understanding the phenomenology, addressing the coastal risks (hazards, exposure and vulnerability), mitigation, prevention, and preparedness, response, recovery, and learning to move on to more resilient states of the coastal infrastructure. The CRC focuses on understanding the natural phenomenology, the engineering methodologies to address the level of risk the infrastructure is exposed to the engineering methodologies and technology to analyze and predict the level of resistance and vulnerability the infrastructure and community is exposed to. The CRC project motivates students and faculty and helps create pipelines of students and professionals into CRI careers and practice. It provides access to an Interactive Learning Hub (IL HUB) which contains a repository of recorded webinars, presentations, lectures, and other relevant educational resources. Visit our IL HUB (https://crc-uprm-dhs-lms.uprm.edu/), register and start obtaining your Certificates of Participation.

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**ERC for Structured Organic Particulate Systems (C-SOPS)**

The Center for Structured Organic Particulate Systems (C-SOPS) was established through the NSF Engineering Research Center (ERC) program. This NSF program supports convergent research, education, and technology translation at U.S. universities that will lead to strong societal impacts.

At UPR-Mayaguez, the Center is led by Rodolfo J Romañach, from the Chemistry Department. The Center has evolved by including the analysis of costs and benefits of the implementation of the technology in pharmaceutical manufacturing with the support of Dr. Mayra Méndez. The Center is also studying small businesses that are an important part of the ecosystem through the efforts of Dr. Moraima De Hoyos Ruperto, who leads the UPRM Center for Business and Economic Development. The Center involves Professor Rafael Méndez and Dr. Rodolfo J Romañach focusing on particulate based systems, and Dr. Torsten Stelzer at the University of Puerto Rico, School of Pharmacy, who specializes in crystallization of active pharmaceutical ingredients.

The Center maintains collaborations with researchers at Rutgers University, Purdue University, and the New Jersey Institute of Technology, the original institutions in the Center for Structured Organic Particulate Systems (C-SOPS). The Center also participates in NIPTE (National Institute for Pharmaceutical Technology and Education, NIPTE.org).

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**Interdisciplinary Center for Coastal Studies (CIEL)**

The Interdisciplinary Center for Coastal Studies (CIEL, according to its acronym in Spanish) is a research center affiliated to the Department of Social Sciences, at the Faculty of Arts and Sciences, at the University of Puerto Rico, Mayagüez Campus. It was founded by Dr. Manuel Valdés Pizzini in 2006 from what use to be the COSTAS project (Capacity-building for Oceanic Sustainability via Training Aimed at Students), a NOAA-founded mentoring and training program for students in the management of marine and coastal resources of the Island.

Based on interdisciplinary study and applied research, CIEL affiliates conduct interdisciplinary research, educate, and disseminates information about coastal processes with an emphasis on the relationship between humans, society, and the environment. CIEL is also a workplace for undergraduate and graduate students from various disciplines, providing them a space for training and to acquire experience in applied research. CIEL has received support and funding from the Faculty of Arts and Sciences, the UPR Sea Grant Program, and through externally funded proposals.

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**Plant Diagnostic Clinic Agro-Environmental Sciences**

The Puerto Rico Plant Diagnostic Clinic (PRPDC) is part of a consortium of plant diagnostic laboratories established in 2002 by USDA - NIFA (National Institute of Food and Agriculture) and the Office of Homeland Security to enhance agricultural biosecurity and safeguard US agriculture and natural systems. The insect and disease diagnostic data is submitted to the NPDN (National Plant Diagnostic Network) national repository at the Center for Environmental and Regulatory Information Systems CERIS at Purdue University. The PRPDC is an accredited plant diagnostic laboratory that meets quality standards to conduct timely and quality detections. The aim of the PRPDC is to provide fast and accurate plant disease diagnosis and pest identification. The clientele of the PRPDC are commercial growers, researchers, extension specialists, seed companies and homeowners. The PRPDC is part of the Southern Plant Diagnostic Network (SPDN), a plant pest diagnostic and reporting system, which helps with diagnosis of plant disease and insect samples, using digital images, and detailed crop information diagnosis. Specific areas of diagnosis include vegetables, fruits, corn, soybeans and ornamentals, fungal, bacterial and viral diseases. The PRPDC is part of the Citrus Clean Plant Network (CCPN) that promotes the use of tested citrus propagative material to ameliorate citrus greening in the island.

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**Puerto Rico and US Virgin Islands Climatology Center**

Located at the Department of Physics, this center provides the latest climate data and weather information available for the Caribbean. It has access to a network of over 120 stations located throughout Puerto Rico and over 20 stations around the U. S. Virgin Islands. The Climate Center is also a repository for a wealth of information on climate data obtained from many other organizations, such as the National Climate Center, Asheville, North Carolina, and the Climate Analysis Center, Washington, D. C. The Center receives journals on climate topics and holds a large collection of climate data on CD-ROMS.

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**Puerto Rico Seismic Network**

**PRSN** is administered by the Department of Geology. The staff oversees a network of 25 broad and short period seismic stations and 6 tide gauges and weather stations installed in the Puerto Rico region. The main objective of PRSN is to process and analyze local, regional, teleseismic earthquakes. Data are made available to the general public and distributed among scientific and academic communities and emergency management organizations. The PRSN also operates a tsunami warning system monitoring seismic and tsunami events in Puerto Rico the Caribbean and adjoining regions.

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**Puerto Rico Water Resources and Environmental Research Institute**

PRWRERI is one of 54 water research centers established throughout the United States and its territories by an act of Congress in 1964, which presently operates under Section 104 of the Water Research and Development Act of 1984 (P.L. 98-242). Since its foundation, the Puerto Rico Water Resources and Environmental Research Institute (formerly Puerto Rico Water Resources Research Institute) has sponsored many research projects supported jointly by federal and university funds. The PRWERRI is ascribed to the Research and Development Center of the University of Puerto Rico at Mayagüez. It acts as the official liaison of the University of Puerto Rico with industry and government agencies for all water resources and environmental research activities. The Institute also functions as an advisor to these two sectors on water resources issues. This role translates into multidisciplinary functions and activities that add relevance and impact to the Institute's research efforts.

Our research program seeks to develop new scientists and students in specialized areas related to water resources and the environment. To accomplish this, a call for proposals is issued annually to faculty from all accredited universities in Puerto Rico, and meritorious projects are funded. By the local relevance of its research and the prestige and leadership of its investigators, the Institute has become the focal point for water-related research in Puerto Rico. Meetings, seminars, technical reports, and a quarterly newsletter keep the water resources community and the general public informed about advances in research. Approximately once every two years, the Institute organizes major conferences on water-related research in Puerto Rico and the Caribbean in collaboration with other technical organizations in the region. All these activities facilitate the translation of the Institute's sponsored research into practical applications of direct benefit to the industry, government, and the public.

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**Puerto Rico Transportation Technology Transfer Center – Local Technical Assistance Program**

The Puerto Rico Transportation Technology Transfer Center, also known as the T² Center, was created on April 1st, 1986, in the Department of Civil Engineering and Surveying. The T² Center is funded by the Puerto Rico Department of Transportation and Public Works (PR-DTPW) and the Federal Highway Administration (FHWA). The T² Center is part of the National network of 51 centers (one in each state and

Puerto Rico) of the Local Technical Assistance Program (LTAP) under the direction of the FHWA Center for Local Aid Support (CLAS). The Puerto Rico LTAP Center is a member of the National Local Technical Assistance Program Association (NLTAPA) and is part of the Southeastern region along with the States of Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee.

The T² Center provides local municipalities and transportation agencies with direct access to resources, including training, technical assistance, and support, to encourage the use of innovative solutions in transportation in four focus areas:

- **Safety** – improve awareness and increase implementation of best practices in roadway and worker safety.
- **Infrastructure Management** – hasten the implementation of best practices in planning, design, construction, maintenance, management, and operations of the surface transportation system.
- **Workforce Development** – help stakeholders attract, retain, and retrain a knowledgeable and skilled transportation workforce.
- **Organizational Excellence** – endeavor to deliver efficient services to stakeholders through the effective management of organizational resources, striving for continuous improvement.

*Seminar Program*

The seminar program is geared to local transportation officials from the 78 Puerto Rico municipalities and the PR-DTPW and its public corporations. The annual training program includes about 50 events-days, and is prepared under the guidance of an Advisory Committee with representation from the PR-DTPW, the Puerto Rico Highways and Transportation Authority (PRHTA), the Puerto Rico Integrated Transit Authority, and the Metropolitan Bus Authority. The training program include in-person seminars, hands-on workshops, and webinars. The program includes topics related to the planning, design, construction, management, evaluation, maintenance, operations, safety, equity, resilience, and sustainability of transportation infrastructure and services. Topics of administrative nature that complements transportation-related activities are also offered such as motivational and leadership aspects, supervisory and management skills, tort liability, and ethics. All seminars are accredited by the *International Association for Continuing Education and Training* (*IACET*), through the College of Engineers and Surveyors of Puerto Rico (CIAPR). Engineers and Surveyors in good standing can register on our seminar program for contact hours applicable to the renewal of their professional license.

*Technical Assistance, Library & Information Services*

The T² Center provides technical assistance and information services on transportation-related issues to municipalities and transportation agencies as requested. The center provides advice, guidance, or referral to pertinent published technical materials, regulations, policies, manuals, etc. The T² Center maintains an extensive technical library associated with the field of transportation that includes over 3,000 publications, reports, textbooks, manuals, guidelines, and audiovisual materials (CDs and DVDs) that is available to municipalities and transportation officials upon request. Requests for information and technical assistance are handled through phone, e-mail, the Facebook site, and the Internet website at http://prltap.org/eng/.

*Every Day Counts (EDC) and the State Transportation Innovation Council (STIC)*

The T² Center also offers training, technology transfer, research activities, technical assistance, and support to PRHTA as part of the FHWA Every Day Counts (EDC) Initiative. This federal program, established in 2011, promotes innovation, ingenuity, invention, and imagination as pillars in the selection of emerging technologies associated with highway transportation. The T² Center has been involved in the seven EDC rounds of transportation innovations for Puerto Rico in strategic areas aimed at shortening project delivery, enhancing the safety of our roadways, and protecting the environment. Some of those EDC innovations include Safety Edge, Warm-Mix Asphalt, Prefabricated Bridge Elements, High-Friction Surface Treatments, Accelerated Bridge Construction, Traffic Incident Management, Safe Transportation for Every Pedestrian, Crowdsourcing for Operations, e-Ticketing,

Environmental Product Declarations, and Internally Cured Concrete, among others.

The Center Directors participate in the State Transportation Innovation Council (STIC). The STIC was established in Puerto Rico in 2013 to bring together key players of the highway transportation system to determine which proven technologies and innovations are to be promoted and launched. The Puerto Rico STIC includes representation from PR-DTPW, PRHTA, FHWA Puerto Rico Division, the CIAPR, and the Association of General Contractors.

*Special Projects and Complementary Projects*

The T² Center participates in short-term projects that complement its research and technology transfer activities in areas of interest to the municipalities and the PR-DTPW. The Center also provides support to transportation research centers and workforce development activities in programs such as the US-DOT University Transportation Centers (UTC), the US-DOT Dwight D. Eisenhower Transportation Fellowship Program, and the FHWA Summer Transportation Institute, among others.

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**NOAA Collaborative Science Center for Earth Systems Sciences and Remote Sensing Technologies (NOAA – CESSRST)**

NOAA-CESSRST conducts research, educates, and trains a diverse group of students, early career scientists, and engineers, in NOAA-related science missions. The goal is to help create a diverse STEM workforce for NOAA and its contractors, Academia, Industries and the Private Sector. Established in 2016 through a national competition, and funded by the National Oceanic and Atmospheric Administration, CESSRST is led by The City University of New York (CUNY) and brings together Hampton University, University of Puerto Rico at Mayaguez; San Diego State University, University of Maryland Baltimore County, and University of Texas at El Paso. CREST also incorporates several industrial partners like STC, AER, Nobilis, SSAI, ERT, and IMSG. The consortium brings together world class research capabilities for remote sensing technology consisting of exemplary faculty and research staff, advanced computational facilities, instrumentation for direct readout of satellite data and calibration/validation, experience in state-of-the-art remote sensing technology development for satellite and surface-based remote sensing, and in situ sensor systems. These capabilities drive an ambitious and research agenda for new applications of remote sensing and advancing the understanding of Earth System processes and improving predictions of weather and climate.

Faculty, scientists, and students from the Departments of Electrical and Computer Engineering, Computer Sciences and Engineering, Civil Engineering and Surveying, and Marine Science comprise the UPRM CESSRST team. The focus of the UPRM team research work is in remote sensing of land and coastal ecosystems, using satellite and UAV-mounted sensor data.

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**SpectrumX: An NSF Spectrum Innovation Center**

SpectrumX, initiated by a 5-year, $25M center grant from the U.S. National Science Foundation, is the world's largest academic hub where all radio spectrum stakeholders can innovate, collaborate, and contribute to maximizing social welfare of this precious resource.

SpectrumX brings together broad and synergistic research capabilities from a team of 41 founding researchers and staff from 27 universities, including 14 minority serving institutions (MSIs), a key federal research facility, and a pioneering corporate partner; a multitude of relationships across industry, government, and academia; and significant experience in interdisciplinary research collaboration, policy engagement, and educating students at all levels about spectrum use and related topics.

The SpectrumX vision is to become a trusted resource within the spectrum ecosystem offering objective, long-term and innovative policy and technical contributions through collaborative, inclusive and integrative education and research activities.

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**NSF-CREST: Nanotechnology Center for Biomedical, Environmental and Sustainability Applications**

With National Science Foundation support, this Center for research and excellence in science and technology further develops the Nanotechnology Center for Biomedical, Environmental and Sustainability Applications at the University of Puerto Rico-Mayaguez (UPRM). The Center's mission is to combine transformational and interdisciplinary research and education efforts in the area of nanoscale materials by focusing on: biomedical, environmental remediation, and sustainability applications. Faculty members involved in the Center will investigate application-oriented processing of materials with properties and applications that depend on phenomena occurring at the nanometer scale: (1) Medical and Biological Applications; (2) Remediation of Recalcitrant and Emerging Contaminants from the Environment; and (3) Sustainability. This project will establish effective means to institutionalize research and education aimed at founding a sustainable platform at UPRM of international recognition. Through formative and summative assessments, a systematic project evaluation will provide information to ensure continuous improvement, focusing on achieving the proposed objectives.

This Center for Biomedical, Environmental and Sustainability Applications will develop technologies for cancer therapy, water disinfection and air cleaning, and sustainability. Despite dramatic improvements in cancer chemotherapeutics, there is still an unmet need to understand the underlying causes of treatment failures. The knowledge acquired through the proposed activities will become invaluable for the development of novel cancer therapies and materials with applications in medicine. Center goals will also address global environmental challenges associated with water and air. Sustainability-related research will also be impacted by the Center. At the undergraduate level, the Center will impact the Undergraduate Certificate in Materials Science and Engineering program, as well as undergraduate research courses in the various engineering departments.

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**TurboLab**

A Pratt and Whitney Center of Excellence is the first center of excellence in Puerto Rico and the Caribbean. The central objective of TurboLab, an ongoing initiative developed with funds committed from Pratt & Whitney Puerto Rico, is to enhance the curriculum and laboratory facilities with the purpose of reducing training time once graduates join the workforce. This will be accomplished by strengthening the capabilities in three main areas: (i) Gas Turbine Engines, (ii) Computational Design and Analysis and (iii) Controls and Embedded Systems, to cross-train students so that they have working knowledge in a broad range of disciplines to meet the current and future needs or the aerospace field. This effort also enables students, working under the guidance of UPRM faculty, to be provided with the knowledge (e.g., terminology, systems, technologies, and tools), know-how and skills used in industry through project-based learning, expanding capabilities for conducting high-impact project-based training activities in areas of interest to the aerospace industry. The lab is equipped with two fully instrumented, scaled-down gas turbines (turbojet and turboshaft), a high-performance computer cluster, a performance real time target machine, module stations for embedded software development and prototyping, and software for computational design and optimization of systems, including simulation of propulsion systems.

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## *SPECIAL PROGRAMS*

Several comprehensive programs on campus have a special impact on research and education.

**Puerto Rico Strong Motion Program**

The Puerto Rico Strong Motion Program (PRSMP) has the mission to minimize the fatalities and the economic losses during moderate and high intensity earthquakes through the seismic instrumentation and supporting related research since 1994. The PRSMP has two main divisions: the free field stations and the seismic instrumentation of structures. Regarding the free field stations there are 118 strong motion stations distributed as follow: 101 in Puerto Rico, including its surrounding islands (Caja de Muerto, Culebra and Vieques) and the rest in the following countries: one in US Virgin Islands, ten in the British Virgin Islands (BVI), one in Anguilla, and five in the Dominican Republic. Ninety-four stations out of the 101 are continuous recording and transmitting by either modem (52), radio (14), private internet (12), or by a different combination of modem, radio, and private internet. In addition, there are twelve continuous recording joint seismic stations where an accelerograph and a broad band seismograph are one beside the other. The program uses both the Earthworm and Seiscom Network Administrator.

Regarding the instrumentation of structures, there are five buildings, twelve dams, two bridges, and the Control Tower of the BVI main airport instrumented. Strong Motion records are available upon request. The program is housed in the Civil Engineering and Surveying Department where its primary Data Center is located. A secondary Data Center is located at UPRM Finca Montaña in Aguadilla. The PRSMP is funded from a grant assigned by the PR Legislature.

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**Education and Research Internship Program (ERIP)**

ERIP is part of an Educational Partnership Agreement (EPA) with the Engineer Research and Development Center (ERDC) (https://www.erdc.usace.army.mil/) under the US Army Corp of Engineers. As part of the EPA, a model Education and Research Internship Program (ERIP) (https://www.uprm.edu/inci/erdc-erip/) offered to UPRM graduate and undergraduate students. Over 700 interns from 20 different UPRM programs have participated in more than three decades the program has been offered. It serves as a pipeline for our students to graduate programs, terminal degrees, and competitive research and development permanent jobs. Over 80 permanent hires have worked for ERDC, including one who became the Director of the Laboratory. ERDC provides internship opportunities for summer or semester work. Students apply online and they are selected based on their merits, level of education, and expertise. Students work in real research and development projects in one of ERDC seven laboratories. For ten weeks our students receive technical and scientific training in ERDC's research facilities where our students participate based on the availability of opportunities. The program sponsors the students' compensation, round trip traveling, local shared transportation, and research course registration fees. Interns have the opportunity to practice their oral and written communication skills, work in highly competitive research job environment with high technological laboratory facilities and researchers who support students' research work. This research internship provides a great opportunity for students to acquire job, research, and academic experiences that will help them be better prepared for their future academic and professional interest. Students express this has been a life changing experience in their lives.

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**UPR Sea Grant College Program**

Since 1980, the University of Puerto Rico Sea Grant College Program has been working to promote the conservation, sustainability and wise use of the coastal and marine resources of Puerto Rico and the U.S. Virgin Islands. This is one of 31 programs which conform the National Sea Grant Program created in 1966 with the signing of Public Law 89-688, the National Sea Grant and College Program Act. The aim of UPR Sea Grant

is to better inform public policy makers, change resource user attitudes and practices, develop educational curricula and promote conservation and sustainable economic development. The UPR Sea Grant program achieves its mission through a multifaceted approach which includes research, outreach and formal(K-12) education programs.

UPR Sea Grant links the university setting, which focuses on the development of theoretical and applied research, with regional and national agencies, and stakeholders producing a better understanding of marine technologies, seafood production (including marine aquaculture), coastal ecosystem health, and coastal economic development (including human environmental impact, and public safety). Sea Grant provides research and educational opportunities to graduate and undergraduate students of all fields related to conservation of marine resources. The information produced by research activities is organized and disseminated through workshops and activities developed by the Marine Outreach Program and the education component of our program.

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**Puerto Rico Landslide Hazard Mitigation Office**

The Puerto Rico Landslide Hazard Mitigation Office is a program of the Department of Geology devoted to landslide hazard science and community engagement in Puerto Rico. The office works with diverse agencies, stakeholders, community organizations, and others on the issues related to landslide hazards in Puerto Rico.

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## *PUBLICATIONS*

**Boletín de Avances Técnicos:**
A free monthly publication by the Technical Information Center comprising titles and abstracts of recently published articles and documents which informing of new advances and developments in the areas of engineering, technology, and related fields.

**Boletín Marino:**
A monthly publication of the Sea Grant Program containing information about the program's activities.

**Bulletins and Publications:**
A series of technical and informative bulletins and publications about research in agriculture and related areas published by the Agricultural Experiment Station.

**JOUST: The Journal of Undergraduate Research Students**

JOUST is an initiative of the College of Engineering at UPRM motivated by the need to disseminate the very energetic, but often overlooked, undergraduate efforts in research. JOUST is a two-component forum for undergraduate research: (1) an online technical journal with peer-reviewed short communications (5-pages maximum per article), and (2) a companion website to enrich the learning experience with pictures, interviews, videos and additional information especially prepared for the undergraduate audience. JOUST is issued online twice a year (once per academic semester) and accepts submissions from STEM fields and the Social Sciences both in English and Spanish. A submission entails a technical article as well as additional multimedia material geared to enrich the undergraduate learning experience. JOUST follows an Open Access format with articles distributed under the terms and conditions of the Creative Commons Attribution License. JOUST can be reached through Facebook: https://www.facebook.com/JoustContact

**The Caribbean Journal of Science:**
A scientific journal published by the College of Arts and Sciences highlighting research in the Caribbean region.

**Ceteris Paribus:**
**The Puerto Rico Economic Review**
An academic journal of socioeconomic research published online twice a year by the Department of Economics of the College of Arts and Sciences focusing on the most recent research on the socioeconomic aspects of Puerto Rico and the Caribbean.

**Journal of Agriculture of the University of Puerto Rico:**
A scientific journal published continuously since 1917 by the Agricultural Experiment Station. Issued biannually, it is now published exclusively online and includes technical and scientific articles related to agriculture in Puerto Rico, the Caribbean and Latin America. https://revistas.upr.edu/index.php/jaupr

**Miscellaneous Publications:** The Cooperative Extension Service publishes a series of bulletins and leaflets of interest to farmers and housekeepers about livestock, agriculture, agricultural engineering, health and hygiene, nutrition, child care, home economics, clothing and textiles, 4-H Clubs, and other subjects.

**Newsletter El Puente**

A bilingual digital newsletter (English/ Spanish) of the Puerto Rico Transportation Technology Transfer Center (Puerto Rico LTAP) that serves as a bridge of information with local transportation officials in Puerto Rico and the US Virgin Islands and as a vehicle for reader response consisting of brief articles about the latest transportation-related technology and innovations. Keeping abreast on the latest technical publications and training materials available, it provides a schedule of seminars and workshops sponsored by the center as well as web sites related to training and information in transportation. The digital newsletter is available at https://prltap.org/eng/.

**Revista Internacional de Desastres Naturales, Accidentes e Infraestructura Civil**

An international Spanish Portuguese journal published twice a year by the Department of Civil Engineering and Surveying discussing areas of natural hazards, accidents and civil infrastructure problems, as well as fundamental and applied research case studies. Papers submitted to the journal are considered through a peer-review process. Its editorial board is formed by researchers from Puerto Rico, U.S., Latin America, and Spain. An electronic version is available at https://www.uprm.edu/ridnaic/. It has been continuously published since 2001.

**Sábanas Bilingual Literary Magazine**

*Sábanas* has been providing a platform for aspiring poets and short story writers in western Puerto Rico ambiance to publish their literary works. The magazine's name and guidelines are based on the idea of creating a safe space for writers to express themselves while still feeling vulnerable. The focus is on sincerity and vulnerability rather than impressing with extensive knowledge of form and structure; Volume X was published in 2023. The magazine is run by student volunteers and interns from all four colleges on our campus. Sábanas also provides students interested in publishing and writing with the opportunity to develop and improve their skills in magazine production, such as editing, selecting and proofreading, creating illustrations and layouts, understanding brands, and working with social media. Published since 2016.
https://www.uprm.edu/english/sabanas-bilingual-literary-magazine/,
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## *COLLECTIONS*

**The UPRM Art Gallery** located in the floyer Carlos Chardón Building, was inaugurated in 1959. The Gallery hosts several exhibitions each semester. These include artworks by students, faculty and invited artists. The Department of Humanities holds a permanent collection of copies of some of the work exhibited.

A **Natural History Collection** located in Celis Hall and collections in the Departments of Geology and Marine Sciences serve as a nucleus for an expanding museum in the near future.

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**The Planetarium** and the **Astronomical Observatory,** located in the Physics building, offer monthly evening shows.

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**The MAPR Herbarium**

The MAPR herbarium, founded in 1958, includes about 50,000 specimens of vascular plants, bryophytes, and fungi. Most of the collections are from Puerto Rico, Cuba, and the Dominican Republic; the herbarium is especially rich in collections from western Puerto Rico and the islands of the Mona Passage (Desecheo, Mona, and Monito). It also includes collections from other geographical areas, including North America, Central America, South America and Europe.

Our herbarium also includes about 3500 historical collections, mostly from 1885 to 1925. Some of the important historical collectors represented in the collection include O. W. Barrett, E. G. Britton, N. L. Britton, O. W. Hess, and F. L. Stevens. The herbarium also have important collections from A. González-Más and A.H. Liogier. The MAPR herbarium is a depository of 60 Type specimen collections, mostly from Puerto Rico and Dominican Republic. It also hosts the largest bryological collection in Puerto Rico.

Important contemporary collectors that are well represented in the collection include G. J. Breckon, J. Veléz Gavilán, and O. Monsegur Rivera. The herbarium has exchange programs with various institutions, the most active of which are with the Jardín Botánico Nacional Dr. Rafael M. Moscoso (JBSD), Santo Domingo, Dominican Republic, the U. S. National Herbarium (US), Washington, D.C., US-FWS, and the Royal Botanic Gardens, Kew (K), England, U.K. Over the years we have had active participation in endangered species projects to provide data and characterization of habitats for rare and endangered species in the Puertorrican bank, including the characterization of TIPAS (Tropical Important Plant Areas) in the BVI. Other collaborative agreements have included activities such as mounting herbarium specimens for the U.S. National Herbarium, and collecting seeds for the Millennium Seed Bank.

The herbarium is located in the Biology building and is open to the university community and general public. The collection is databased using BRAHMS, and is available at: http://herbaria.plants.ox.ac.uk/bol/mapr.

Beginning in 2017, the MSM herbarium, the "Herbario Marino Puertorriqueño," has been transferred to the Biology building and is in the process of being maintained and curated by the MAPR staff and students as a distinct herbarium. The MSM collection includes about 35,000 specimens of marine algae, primarily from across the Caribbean. Important collectors include M. A. Howe, H. G. Schweiger, M. Díaz-Piferrer, H. L. Blomquist, L. R. Almodóvar, G. R. Smith, J. E. Tilden, and H. J. Humm. The MSM collection is in the very initial steps of being databased.

The MAPR and MSM herbaria are two of the six formal herbarium collections located in Puerto Rico, among the approximately 35 herbaria located within the West Indies.

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**Museo de Entomología y Biodiversidad Tropical del Recinto Universitario de Mayagüez "Museum of Entomology and Tropical Biodiversity of the Mayagüez Campus"**

The "*Museo de Entomología y Biodiversidad Tropical del Recinto Universitario de Mayagüez*" (MEBT) is one of a group of seven diverse university-based museums within the University of Puerto Rico (UPR) system. The museum, which opened in 1997, is linked to the identity and history of the Agricultural Land-Grant University at the University of Puerto Rico Mayaguez (UPRM). The MEBT contains the oldest and largest active insect collection in Puerto Rico. An accession number catalogue, which includes biological documentation of individual collections since 1910, supports its valuable specimen holdings. The rich chronicle of this collection is tied to the history of entomological research in Puerto Rico. It has been fundamental to the island's agricultural development, and continues to serve as a unique source of information for students, researchers, and the public at large. MEBT's building is 1,300 $m^2$, and includes: a large environmentally controlled room

equipped with a new Burroughs cabinet compactor system, with a storage capacity of 2,000 Cornell drawers to house the collection; two exhibit rooms, six offices, a conference room, a curatorial laboratory, and a large storage area.

Taxonomically, MEBT's insect collection is the most important repository of Hexapoda in Puerto Rico, containing specimens from every island in the "Puerto Rican Bank", which encompasses a rich diversity of taxa and ecosystems that span the Central Caribbean. Twenty-three insect orders are represented in MEBT holdings. Estimates of species numbers exist for a limited number of groups, owing particularly to the attention received from different entomologists throughout its history. Groups such as Diptera (Muscidae), Hemiptera (Auchenorrhyncha and Heteroptera), Thysanoptera, Coleoptera (Coccinellidae and Chrysomelidae), and Lepidoptera (Pyraloidea, Noctuidea, Rhopalocera) are generally well curated and identified. Other groups remain housed in drawers organized by family. We estimate that less than 20% of specimens have been expert-identified to the level of species.

MEBT information assets also include a biologically invaluable accession number catalogue that contains documentation of over 20,000 individual collections since 1910. This remarkable catalogue contains prized biological information, such as host plant records, behavioral and ecological annotations, climatic and weather observations going back over a century ago. Other important historical documents, such as letters, drawings and photos, and other artifacts comprise other MEBT collections.

As an integral part of the University of Puerto Rico, the insect collection is a well-used educational resource, both for its faculty and for its students. Specimens from its holdings are regularly used in several entomology courses offered by our institution, such as: Introduction to Entomology, Insects of Tropical Crops, Integrated Pest Management, Biological Control, and Undergraduate Special Research Topics.

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**Museo de Arte (MUSA)**

A center of cultural and intellectual life on campus, the **Museo de Arte (MUSA)**, serves as a recreational space that promotes creativity through formal and informal learning. The museum hosts the legacy of the late local artist Marcos Irizarry as well as watercolors by botanical Dr. Agustín Stahl and a collection of contemporary works by Puerto Rican and Latin American artists.

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**The Invertebrate Collection (INVCOL)**

The Invertebrate Collection (INVCOL) is home to one of the Caribbean's largest collections of terrestrial invertebrates. Our holdings include insects, arachnids, myriapods, and terrestrial molluscs.

Mission Statement: To conserve invertebrate specimens collected from Puerto Rico and the Caribbean as part of ongoing and past research at UPRM. To increase local and international awareness of Puerto Rican biological diversity. Provide excellence in teaching cutting edge museum based research at UPRM.

The holdings of UPRM-INVCOL generally overlap with those of the Museo de Entomología y Biodiversidad Tropical in Río Piedras, with a more pronounced geographic emphasis on southwestern Puerto Rico, including the regions around Mayagüez and Ponce. All 26 Puerto Rican orders are represented (see Maldonado Capriles 1996), including obscure groups such as Protura and Zoraptera. The collection harbors some of the earliest records of insects from ecologically valuable areas such as Guánica, Maricao, and Mona Island including specimens from José Ramos' (1946) pioneering survey. The holdings are particularly strong in Neotropical Collembola, corresponding to the José Mari Mutt collection. The taxonomic coverage for these groups is very thorough thanks to extensive personal collections throughout the Caribbean in the 1930s to 1970s (primarily Puerto Rico, Dominican Republic, and Jamaica), exchanges with colleagues, and purchasing of specimens from South America (primarily Colombia, Venezuela, Argentina, and Chile). Both the Puerto Rican Coleoptera and Diptera are well represented and identified. The Hymenoptera, on the other hand, are lacking in the parasitoid lineages. Finally, the Lepidoptera holdings are strongest in the Puerto Rican butterflies is also quite good. All total we have

around 52,000 specimens many of which are of historical importance.

Regarding the non-hexapods, the valuable mollusks shell collection assembled by Carlos Aguayo contains nearly 9500 catalogued specimens. It is notable for its strong representation of species in the genus Cerion Roding (Gastropoda: Ceriidae) from the Antilles. There are also approximately 1230 specimens of Crustacea. Data of holdings of non-hexapod type specimens are not available at this time. The holdings of UPRM-INVCOL are presently increasing at an annual pace of 2-5k specimens.

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## *OFFICE OF THE DEAN OF ACADEMIC AFFAIRS*

The Office of the Dean of Academic Affairs coordinates and supervises all academic activities of the four academic colleges and the Division of Continuing Education and Professional Studies at UPRM. These include graduate programs, academic institutional research, continuing education programs, and the professional development of academic personnel. The Office is responsible for the assessment, analysis, and implementation of new curricular proposals and of revisions to existing curricular offerings in order to ensure their academic excellence and promote scholarly research activities across campus.

The Office also oversees the enforcement of existing academic procedures and regulations in order to ensure teaching, research, and service excellence. Moreover, it serves as a liaison with other higher education institutions in Puerto Rico, the United States, and around the globe in order to promote intellectual collaborations with a global vision.

The Office of the Dean of Academic Affairs supervises the following units and programs:

- Admissions Office
- Center for Resources in General Education (CIVIS)
- Department of Aerospace Studies (Air Force ROTC)
- Department of Military Science (Army ROTC)
- Division of Continuing Education and Professional Studies (DECEP)
- General Library
- Office of Graduate Studies
- Office of Immigration Affairs
- Professional Enrichment Center (CEP)
- Registrar's Office
- Resource Center for Distance Education (CREAD)
- Teacher Preparation Program (PPM)
- UPRM Night, Weekend and Online Program (RUMex)

**Website:** https://www.uprm.edu/asuntosacademicos/

## CENTER FOR RESOURCES IN GENERAL EDUCATION (CIVIS)

The Center for Resources in General Education (CIVIS) was born as a federal Title V grant project in 2004 that created the Spanish Writing Center (CRE) and the English Writing Center (EWC). This project was institutionalized by the Mayagüez University Campus. The mission of the CIVIS is the development of writing as an integral professional skill. The centers effectively use peer tutoring to help college students with their writing needs. Students teaching students together with reference services as needed, help students create consistent texts across disciplines.

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**Website**: https://www.uprm.edu/civis/

## DEPARTMENT OF AEROSPACE STUDIES (Air Force ROTC)

### AIR FORCE RESERVE OFFICER TRANING CORPS (ROTC)

Air Force ROTC is designed to recruit, educate and commission officer candidates through college campus programs based on Air Force requirements.

### Mission

Our mission is to develop quality leaders for the Air Force, Space Force, Puerto Rico, and America.

### Vision

The AFROTC vision is to be a highly successful organization, respected throughout the Air Force, the educational community and the nation.

### Program Overview

The Air Force ROTC program offered at the University of Puerto Rico-Mayaguez is a 3 or 4 year undergraduate-level program by which

young men and women are educated, motivated, and trained for Air Force commissioned service.

The program consists of the General Military Course (GMC) and the Professional Officer Course (POC).

**General Military Course (GMC)**

The GMC is a 1 or 2-year course, consisting of the following four courses: Aerospace Studies (ESAE) 3001, 3002, 3011, and 3012. These courses are designed to motivate and prepare cadets for entry into the POC. Each course meets once weekly and is a two academic-hours course.

**Professional Officer Course (POC).**

The POC is a 2-year course, consisting of ESAE 4001, 4002, 4011, and 4012. These courses are designed to prepare cadets for active duty as Air Force officers. Each course meets twice a week and is a four academic-hours course.

**Leadership Laboratory (LLAB)**

LLAB is a dynamic and integrated grouping of leadership developmental activities designed to meet the needs and expectations of prospective Air Force second lieutenants and complement the Air Force ROTC academic program. It is a student planned, organized, and executed practicum conducted under the supervision of the Professor of Aerospace Studies and Assistant Professor of Aerospace Studies.

**Field Training**

Students selected for the POC will attend a 13-day Field Training program that takes place in Maxwell AFB, AL. The primary objective of Field Training is to evaluate leadership potential to enter the POC through a transformational training environment.

## Membership Eligibility

Each individual must:

1. Be a full-time undergraduate student enrolled at any of the following universities:

   University of Puerto Rico:
   Aguadilla
   Arecibo
   Mayaguez
   Ponce

   Inter-American Universities:
   Aguadilla
   Arecibo
   Ponce
   San German

   Pontifical Catholic University of Puerto Rico

2. Participate in both AS classes and LLAB while enrolled in school to be considered a GMC or POC member.

3. Be age 14 or older.

4. Have an AFROTC calculated GPA of 2.0 or greater for all previous college-level coursework.

## Program Goals

Each student must demonstrate:

1. An understanding of the fundamental concepts and principles of military, naval, and aerospace sciences.

2. A basic understanding of associated professional knowledge.

3. A strong sense of personal integrity, honor, and individual responsibility.

4. An appreciation of the requirements for national security.

## Air Force ROTC Scholarships

Air Force ROTC offers three different type of scholarships (up to $18,000) for outstanding students. Scholarships include funding for tuition, most fees and books. Upon activation, all scholarship cadets receive a monthly living expenses stipend during the academic year. Currently, the monthly stipend is $300 for first year cadets, $350 for second year cadets, $450 for third year cadets and $500 for fourth year cadets.

**Website**: https://www.uprm.edu/afrotcdet756

**FACULTY**

**LIEUTENANT COLONEL TAYLOR VALENTINE,** *Professor Aerospace Studies*. M.S. National Security Studies, National Defense University, DC. B.A. Environmental Engineering, US Air Force Academy, CO.

**CAPTAIN MICHAEL DEATON**, *Assistant Professor of Aerospace Studies*, Operations Flight Officer, Air Force ROTC, Det 756, University of Puerto Rico, Mayaguez Campus.

**CAPTAIN JALEN JACKSON**, *Assistant Professor of Aerospace Studies*, Recruiting Officer, Air Force ROTC, Det 756, University of Puerto Rico, Mayaguez Campus.

# DEPARTMENT OF MILITARY SCIENCE
**(Army ROTC)**

## US ARMY ROTC

### Mission

Military Science at the University of Puerto Rico is presented under the provisions of the National Act of June 3, 1916, as amended, which established the Reserve Officers' Training Corps (ROTC) Program at colleges and universities throughout the United States.

The mission of the US Army ROTC Program is to obtain well-educated, commissioned officers in sufficient numbers to meet Army requirements. The objectives of the ROTC Program are to attract, motivate, and prepare selected students to serve as commissioned officers in the regular Army, Army National Guard, or the Army Reserve; to provide an understanding of the fundamentals, concepts, and principles of military science; to develop leadership, managerial skills, basic professional knowledge, and a strong sense of personal integrity, honor, and individual responsibility among students in the program; and to develop an appreciation of' the requirements for national security. The Army ROTC program draws upon the many educational disciplines required for the modern Army. It ensures that men and women educated at a broad spectrum of institutions of higher learning are commissioned annually in the Army Officer's Corps.

### Vision

In the future, the Army ROTC program will continue to be the major source of newly commissioned officers for the active Army and reserve components.

### GENERAL EDUCATION

The Army ROTC offers college students a four-year program composed of two separate two year programs; the two-year basic course (CIMI 3011-3012, CIMI 3021- 3022) and a two-year advanced course (CIMI 4011-4012, CIMI 4021-4022). Credits obtained in these courses will be included in the student's general grade point average. Deans may consider these courses as general electives for academic credit by granting up to a maximum of 12 credit-hours.

The basic course is conducted on a voluntary basis as an elective. Students may drop the course at any time as they would any other elective. Students must satisfactorily complete both years of studies in order to be eligible for the advanced course. The advanced course is optional and selective. The ROTC furnishes all required uniforms and equipment for both basic and advanced courses. All students that contract with the ROTC with the intent of receiving a commission as an Army officer will receive a tax-free stipend of $420 per month.

Students may qualify to enter the advanced course without completing the basic course if they have completed the U.S. Army Basic Combat Training. Students may also qualify to enter the Advanced Course by attending a summer camp offered by the ROTC called the Basic Camp (BC). Basic Camp is a 32-day training event designed to introduce Cadets to the Army. The objective is to develop Cadet leadership skills and train them on individual and junior leader tasks to develop and reinforce Warrior Ethos and our Army Values. Basic Camp provides the critical thinking skills necessary to succeed in ROTC, and, ultimately, the Army. Students may attend the camp and decide not to pursue ROTC if they choose.

Students in the Advanced Course are required to attend a paid summer camp known as the Advanced Camp (AC) between their third and fourth years. Advanced Camp is a 35-day training event that is designed to assess a Cadet's ability to demonstrate proficiency in basic officer

leadership tasks. Cadets are evaluated on their ability to lead at the Squad and Platoon levels, both in garrison and tactical environments. Cadets are mentally and physically tested during a 12-day consequence driven field training exercise that replicates a combat training center rotation. Successful completion of the Advanced Camp is a prerequisite for commissioning.

Students requesting admission to the advanced course, senior division, are screened and tested by the Professor of Military Science (PMS). These students must satisfy requirements established by the Department of the Army before they are formally enrolled.

**A. Basic Course Requirements:**

1. Enrollment in a baccalaureate or graduate degree program full time (12 credits or more).
2. 2.00 GPA or better to enter second year of basic course.
3. Enrollment in the ROTC English program or satisfy the English requirement by approving an examination.

Note: Cadets will not fail the basic courses for lack of English skills. ROTC will prepare cadets in this area (75 ECLT, 2/1 + OPI).

**B. Advanced Course Requirements:**

1. 2.00 GPA or better.
2. Be medically qualified (Medical exam is free of charge).
3. Be a full-time student (12 credits or more).
4. Score 80 or more on Comprehension Level Test (ECLT).* and 2/2 on the OPI.
5. Having four semesters left including the ROTC classes according to the CC Form 104-R Academic Program Worksheet.

**Program Outcomes:**

The goals, objectives and assessment plans for the Military Science Department are outlined below. The ROTC Program objective and assessment strategies are consistent with the goals of the U. S. Army in preparing students to become commissioned officers. We are responsible for providing men and women valuable skills such as self-discipline, personal development, problem solving and knowledge to complete demanding missions entrusted to them.

A program for tomorrow's leaders. Army ROTC enrolls well-rounded students with the proven ability to set goals and achieve high standards of excellence in academics, fitness and leadership in their schools and communities.

**Critical Success Factors**

- Meet or exceed enrollment goals.
- Increase program retention rates.
- Pursue strategies to maintain a Corps demographic profile that promotes and reflects diversity.
- 100% graduation of Cadets from the Advanced Camp (AC)
- 100% graduation of Cadets from the Basic Camp (BC)

**ROTC Scholarship Program**

The Department of the Army grants scholarships to selected outstanding students enrolled in the ROTC Program. The scholarships, ranging from two to three and a half years, depending on availability of funds, include full tuition and laboratory fees, approximately $1,200 a year for textbooks, and a living allowance of up to $6,000 per semester or $12,000 for tuition each academic year that the scholarship is in effect. In addition, ROTC scholarship students receive approximately $1,200 for attending Leadership Development and Assessment Course.

**Website**: https://www.uprm.edu/army/

## FACULTY

**MRS. MARIA DE LOURDES PEREZ**, *English Instructor*, M.A. ED, 2009, University of Puerto Rico, Mayaguez.

**MR. PEDRO J. ROSARIO,** *GS Recruiting and Operations Officer*, M.B.A., 2005 University of Phoenix.

**MR. MOISES VAZQUEZ MANZANO**, *Assistant Professor of Military Science*, M.A. in History, 2016, Centro de Estudios Avanzados de Puerto Rico y el Caribe.

**LIEUTENANT COLONEL PHILLIP T. VAUGHN**, *Professor of Military Science*, M.A. in Management and Leadership, 2015, Webster University.

# DIVISION OF CONTINUING EDUCATION AND PROFESSIONAL STUDIES (DECEP)

**History**

The Division of Continuing Education and Professional Studies was created during the 1958-59 academic year. It was established to integrate within a unit several UPRM programs which were not administered jointly: the summer program, the evening program and the Saturday course program. The inclusion of these three programs as a new academic unit has served as basis for innovative and extended services in non-traditional fields.

**Goals and Objectives**

The goals of the Division of Continuing Education and Professional Studies are to attend the special educational needs at the university level or those related to university work that are not presently addressed by traditional offerings and to foster a closer collaboration between the university's physical and human resources and the community's problems and needs.

**Objectives:**

1. To provide educational opportunities for the adult working population and for adults who have interrupted their schooling.
2. To provide educational opportunities to disadvantaged groups, minorities, and other sectors of the community not benefiting from traditional offerings.
3. To initiate educational programs and credit courses in response to educational needs that have not been fulfilled by traditional offerings.
4. To create continuing education offerings for professional groups.
5. To identify continuing education needs of the community at large and provide courses and educational experiences to meet these needs.
6. To provide the community with information and orientation services.
7. To develop awareness and sensitivity to the needs of the community and undertake initiatives to meet those needs.

The Division of Continuing Education and Professional Studies addresses its goals and objectives through various initiatives such as the creation of projects, educational offerings, and programs which are transitory in nature and short in duration.

At present, the work of the Division consists of the following programs:

1. Continuing Education Program
2. Special Training Programs
3. Community Services
4. Education Program

**Continuing Education Program**

Continuing Education is recognized as a growing need for all adults. The Division offers educational options on weekdays, evenings, and Saturdays to enable working adults to further their education. It also fulfills different needs for children, adolescents, adults and elderly interested in developing their knowledge, talents, or abilities.

This non-traditional service offers continuing education hours/credits required to renew licenses and/or certifications pertaining to a variety of professions and provides educational alternatives in special areas such as business administration, microcomputer applications, technical skills, arts, language, handicrafts, and sports where professional and cultural growth might occur independently of traditional degree programs. Continuing Education embraces a wide field of strategies to fulfill the teaching-learning process at different stages in formal or informal settings. It is offered through non-credit courses, seminars, workshops, or special projects.

**Special Training Programs**

The Division of Continuing Education and Professional Studies collaborates with community institutions, other departments and campuses of the University of Puerto Rico in the creation of these special training programs which blend the traditional offerings at the University, such as language, mathematics, and science courses, with special instruction emphasizing immediately marketable skills. Courses in these programs do not carry college credits and cannot be used to fulfill degree requirements. At the completion of a program, however, a certificate will be issued which might serve as credential for the job market.

**Community Services**

The Division of Continuing Education and Professional Studies in association with civic and professional groups offers educational services to the community.

Community activities include conferences, seminars, workshops, group meetings, continuing education courses, and short-term special training sessions.

Building Efrain Sanchez Hidalgo, Office 401
**Phone**: (787) 832-4040 ext. 3054 o 3058
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## GENERAL LIBRARY

**Vision**

To distinguish itself as a facilitator of teaching, learning, and research. To promote lifelong learning and ethical values in the academic community. To be recognized as a leader in service, resources, information literacy skills, innovative technology, and access to the Campus intellectual output.

**Mission**

The General Library supports the institutional mission of excellence. The library guarantees access to information and resources needed for teaching, research, and creative endeavors. It is a pioneer in offering formal courses, incorporating information literacy skills in the curriculum, and establishing the liaison program with the university faculty.

**LIBRARY SYSTEM**

The General Library serves the local campus community as well as the residents of Mayagüez and nearby towns. It fully supports UPRM's educational and research mission and objectives by providing adequate library and information resources, facilities and services. It consists of a main library and a special departmental collection.

The main library has an area of approximately 124,335 square feet, with a seating capacity of 1,079, five individual study rooms, six small team study rooms, eight study rooms for group discussions and collaborative work, a computer lab with 67 workstations, and two library instruction classrooms. There is also a large conference room as well as a smaller meeting room.

To fulfill its mission, the Library is divided into key areas: Collections and Departments

- Álvarez Nazario Collection
- Audiovisual Collection
- Center for Technological Assistance (CAT)
- Circulation/Reserve Collection
- Graduate Research and Innovation Center (GRIC)
- Electronic Resources Center
- Interlibrary Loan Department
- Marine Sciences Collection
- Oral History Lab (OHL)
- Patent and Trademark Resources Center
- Puerto Rican Collection (Manuel María Sama y Auger)
- Reference/Documents Collection
- Research and Information Literacy Center (CEDIBI)
- Technical Process Department
- Systems Department

The library offers a wide range of services designed to support the academic and research needs of both the university community and the general public. Collections and Departments manage the circulation of materials, course reserves, user accounts, reference and audiovisual services, the information literacy program, and campus outreach initiatives. The library also provides instructional modules, online guides, orientations, and a faculty liaison program to strengthen academic collaboration. A key resource for graduate students and researchers is the Graduate Research and Innovation Center (GRIC), a dedicated space offering specialized support in scholarly communication, research methodology, and data management.

The Library holdings include: 763,842 volumes; 279,936 book volumes; 140,351 journals; 6,924,851 electronics journals; 332,959 electronic books; 69,805 microfiches; 400 microcards; 2,497 microfilms; 173,203 government documents; 3,545 films; 5,379 maps; 10,300 sound recordings; 442 musical scores; 508 sound magnetic tapes; 2,852 videocassettes; 3,660

CD/DVD; 5,056 theses; and access to millions of U.S. patents and trademarks.

The Library is a selective depository for the publications of the U.S. Government and one of the coordinating agencies of the Puerto Rico Census Data Center under the State Planning Board. It serves as depository for the publications of the U.S. Bureau of the Census, and holds membership in the Patent and Trademark Resource Centers Program of the U.S. Patent and Trademark Office since 1995. It's one of the centers serving Puerto Rico, the Caribbean Basing and Latin America.

The academic library offers a wide range of services to support teaching, learning, and research, including loans of bibliographic resources, interlibrary loan services, traditional and virtual reference, as well as printing and photocopying. In addition, users can access digital reserves, electronic resources, online databases, the library catalog, and the institutional repository through our webpage, enhancing research capabilities and promoting academic excellence.

The Faculty librarians teach INTD 3355: Research Methods in Libraries, a three-credit interdisciplinary course designed for students interested in developing library-based research skills. Additionally, they collaborate with other academic departments, delivering specialized credit courses such as AGRO 4019: Seminar in Agronomy and Soils (Agronomy and Soils Department), BIOL 3055: Bibliography and Library Research in the Biological Sciences (Biology Department), and CIAG 3025: Library Resources in Agricultural Sciences. These courses ensure that students across disciplines achieve essential competencies in information management and research methodologies. In addition to these credit-bearing courses, the library also offers guided tours of its facilities, complemented by workshops on information literacy, specialized library instruction sessions, and service orientations.

The Library keeps its academic community informed through various social media platforms, media display within the library and institutional email. Further information about library services, facilities, resources and collections are available at: www.upr.edu/biblioteca-rum. You can also find us in Facebook (BibliotecaUPRM), Twitter (bibliotecauprm), Pinterest (General Library-UPRM) and YouTube (Biblioteca UPRM).

**Phone:** (787) 265-3810; (787) 832-4040 exts. 3810, 2151, 2155
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**Email**: library@uprm.edu

## GENERAL LIBRARY FACULTY

**JAQUELINA E. ÁLVAREZ**, Librarian IV, M.L.I.S., 1997, University of Wisconsin, Madison.

**MARÍA VIRGEN BERRÍOS-ALEJANDRO**, Librarian IV, M.L.S., 1989, University of Puerto Rico, Río Piedras Campus.

**CYNDIA CARABALLO-RIVERA**, Librarian IV M.L.S., 1997, Interamerican University, San Germán, Puerto Rico.

**LUIS O. CASIANO-TORRES**, Librarian IV, M.L.S., 1989, University of Puerto Rico, Río Piedras Campus.

**GLADYS E. LÓPEZ-SOTO**, Librarian IV, Ed. D., 2021, University of Puerto Rico, Río Piedras Campus., M.L.S., 2002, University of Puerto Rico, Río Piedras Campus.

**JOSÉ JAVIER MORALES-BENITEZ**, Librarian I, M.I.S., 2018, University of Puerto Rico, Río Piedras Campus, J.D., 2005, University of Puerto Rico, Río Piedras Campus.

**LOURDES RIVERA-CRUZ**, Librarian IV, M.L.S., 1990, University of Puerto Rico, Río Piedras Campus.

**GRISELL RODRÍGUEZ-VELÁZQUEZ**, Librarian IV, M.L.I.S., 1996, University of Wisconsin at Milwaukee.

**EDITH M. TORRES-GRACIA**, Librarian IV, M.B.A., 1988, Interamerican University, San Germán; M.L.I.S., 1992, Long Island University, CW, Post Campus, Brookville, New York.

**ANIDZA VALENTÍN-RODRÍGUEZ**, Librarian III, Director, D.B.A., 2013, Turabo University, M.I.S., 2014, University of Puerto Rico, Río Piedras Campus, M.B.A. Management Information Systems, 2007, Interamerican University, San Germán, Puerto Rico.

## OFFICE OF GRADUATE STUDIES

Graduate offerings at the University of Puerto Rico, Mayagüez Campus began in 1957, prompted by the establishment of the Nuclear Center and postgraduate programs in Mathematics, Physics, and Nuclear Technology. The graduate program in Chemistry was established in 1960, followed by the Biology and Physics programs in 1962. Our first doctoral program, in Marine Sciences, was established in 1972. Doctoral programs in the fields of Tropical Agriculture, Bioengineering, Civil Engineering, Chemical Engineering, Applied Chemistry, Computing and Information Sciences and Engineering, Electrical Engineering, Mechanical Engineering, School Psychology and Software Engineering have also been established. The Mayagüez Campus offers a total of eleven Doctoral (Ph.D.) programs, four master's degrees in Business Administration (M.B.A.), six Masters of Arts (M.A.), twenty-nine Masters of Science (M.S.), one Professional Master (M.P.) degree, and nine Master of Engineering (M.E.) degrees.

According to Certification 09-09 of the Mayagüez Campus Academic Senate, this Office supervises and enforces the rules and regulations related to graduate studies. The Office deals with three main areas: graduate admissions, assistantships, and active students. The Office is directed by the Director of Graduate Studies, and an Associate Director of Graduate Studies.

**Office**: 111 Celis Building
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**Website**: http://grad.uprm.edu
**Email**: egraduados.uprm@upr.edu

## OFFICE OF IMMIGRATION AFFAIRS

The ***Office of Immigration Affairs*** is currently under the Deanship of Academic Affairs, it's principal mission is to provide assistance and guidance to all international students and scholars who study and work at the UPRM. Since 2013 the office is focused solely on matters related to our international students and scholars. The Principal Designated School Official (PDSO) or Designated School Official (DSO) prepares Form I-20 for students who are admitted to the UPRM. We work closely with the Admissions Office, the Graduate School and the Registrar's Office, making sure that all requirements for the preparation of Form I-20 are met. This office issues Form I-20 to students admitted to the UPRM, in order for them to be able to get the entry visa into United States territory at the US Embassy in their country of origin. We also prepare and submit H1B visa petitions on behalf of scholars that are being hired by academic departments, in coordination with such departments.

Our office also plays an important role in guidance and advising not only for our international students and scholars, but also for all administrators and faculty working with them. Our vision is to facilitate study and work at the UPRM for foreign nationals following all federal regulations and requirements established by ***Student and Exchange Visitor's Program*** (***SEVP)*** and ***United States Citizenship and Immigration Services*** (***USCIS)***, as well as other federal agencies under the ***Department of Homeland Security (DHS)***.

Every fall and spring session starts off with an orientation for all newly admitted undergraduate and graduate students. During this orientation we emphasize the importance of maintaining status while in F1 visa classification, and we go over regulations regarding international students as contemplated in the ***Code of Federal Regulations***: 8 ***CFR*** 214.2(f).

The ***Office of Immigration Affairs*** is continually collaborating with all academic departments and UPRM dependencies (Human Resources Office and others) giving guidance and advice on all matters relating to international students and scholars. Our PDSO is continuously keeping up to date as an active member of NAFSA (The Association of International Educators).

***Contacts:***
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Ms. Janet Estrada Vargas, DSO
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**Website:** https://www.uprm.edu/international-diversity-inclusion/
**Fax:** (787) 265-5418

## PROFESSIONAL ENRICHMENT CENTER (CEP)

The Professional Enrichment Center was established in July 1996 with matching non-recurrent funds from the Central Administration. The concept for the Center originated in the Division of Continuing Education and Professional Studies under the Dean of Academic Affairs in coordination with the Project Pro-Excellence in Teaching and Learning (PEEA). The PEEA initiative arose mainly from a resolution from the Parents' Association presented to UPRM's Chancellor in 1990.

CEP was created in 96-97 by the Administrative Board, through Certification number 596, which mandates professional development activities for all faculty personnel hired since August 1997. Faculty must comply with 29 contact hours during the first year of service. The professor's participation is kept on record and it is taken into consideration for the various personnel actions at the institutional level. Additionally, certifications number 11-12-105 (2011) and 14-15-247 requires all graduate students receiving assistantships to complete 21 hours of professional development during their first year to maintain eligibility.

Services include annual orientations for new faculty and all graduate students, trainings for graduate lab assistants, retreats to recruit and develop interdisciplinary teams of resource professors, and seminars for faculty and graduate students during the academic year. Activities are tailored to fit the audience's needs, involve theory along with hands-on activities. Services also include workshops for academic management, educational research activities, and individual assistance for departments and faculty. In accordance with Certification 96-76-596, CEP keeps track of faculty and graduate student participation in professional development activities.

To fulfil its mission, the CEP coordinates with various stakeholders in order to provide offer a wide range of activities. Partners includes the Graduate Studies Office, Center for the Development of Information Literacy and Bibliographic Research (CEDIBI), Graduate Research and Innovation Center (GRIC), Research and Development Center (R&DC), Information Technology Center (CTI), Resource Center for Distance Education (CREAD), and the Office of Services for Students with Disabilities (OSEIRUM)

**Mission**

To expose faculty members to diverse educational strategies to promote academic excellence and ensure high-caliber student performance.

Building José de Diego, Office 107
**Phone**: (787) 832-4040 ext. 3829, 3674
**Website**: https://www.uprm.edu/cep
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## REGISTRAR'S OFFICE

**Vision**

To be a leader and model of the Registrar's Offices processes, implementing innovative processes and advanced technology that allow us to provide our students with high quality services, reliable and accessible, placing the student at the center and rationale of university life.

**Mission**

Protect the information and manage the processes that allow students to advance in their academic program, and ensure that the active and inactive students and university officials have access to accurate, timely and relevant information related to academic performance. To achieve this consistently the Office of the Registrar should ensure:

- Maintenance and confidentiality of student records, according to applicable regulations
- Easy access to services by students
- Efficient enrollment and graduation processes

**Confidentiality and Privacy of Academic Records**

The University of Puerto Rico, Mayagüez Campus, fully complies with the provisions of the Buckley Amendment (Family Educational Rights and Privacy Act of 1974, as amended). This Act protects the privacy of students' educational records and establishes the students' right to examine their own files. It also provides guidelines for correcting the accuracy of the

information contained in those files through informal and formal hearings. In relation to alleged violations of the Act by the institution, students have the right to file complaints written complaints to: The Family Educational Rights and Privacy Act Office, U. S. Department of Health and Human Services, 200 Independence Ave. S.W., Washington, D.C. 20201.

Copies and questions related to the institutional policy established by the University in compliance with the Act may be obtained in the Office of the Registrar.

**Veteran Services Office**

The Veteran Services Office attends to veterans, dependents of veterans, servicemen, and servicewomen in matters pertaining to the Veterans Administration such as: educational benefits, registration, and studies at the university. All beneficiaries must comply with the norms established by this office.

For more information:

- Title 38 United States Code Section 3679(e) School Compliance Form
- Official School Catalog Addendum (P.L. 117-68)

**Education and training benefits for veterans**

The school is approved by the Puerto Rico State Approving Agency to provide academic training to the students under the various GI Bill® programs. GI BILL® is a registered trademark of the U.S. Department of Veterans Affairs (VA). UPR students who are veterans (as defined by the Veteran's Administration) of the United States Armed Forces can receive benefits under chapters 1606 – Montgomery GI Bill® Selected Reserve, CH. 30 – Montgomery GI Bill® Active Duty, CH. 35 – Survivor and Dependents Educational Assistance, CH. 31 – Veteran Readiness and Employment, CH. 33 – POST-9/11 GI Bill®, and Title 38 - United States Code Section 3679(e) School Compliance Form.

Section 103, PL 115-407 prevents a school from penalizing the student while waiting for VA to make tuition and fee payments. The institution cannot deny a student access to classrooms, libraries or other institutional facilities. It cannot make the student borrow money to cover the cost while waiting for payment or charge a student a late fee or penalty. This applies to students benefiting from Chapter 31 or Chapter 33 of Post 9/11 GI Bill®.

**Academic Progress (applicable to veterans and/or beneficiaries)**

Veterans and/or beneficiaries should complete their studies during the regular time allotted (100%) as stated in the program curricula. If they exceed the time allotted they lose eligibility for the benefits of Veterans Programs. This norm is not applicable to federal aids such as Pell Grant or others where eligibility is established by the institution and/or the entity/agency granting the scholarship if the recipients maintain the correspondent requisites. Also, students must maintain the minimum average required (general and major average) as established for each program in order to graduate.

**Repetition of courses (applicable to veterans and/or beneficiaries)**

The Veterans Administration (VA) only approves payment for the repetition of a failing grade ("F"). The VA does not approve payment for repeated courses with passing grades, unless they are repeated in order to comply with the requirements of the program of study.

**Office**: Celis Building, 2nd floor, 203
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## RESOURCE CENTER FOR DISTANCE EDUCATION (CREAD)

**Mission**

The mission of CREAD is support and guide the faculty in the development of digital educational materials and multimedia technology-based processes, ensuring compliance with the highest quality standards.

**Vision**

Position the UPR-RUM at the forefront of the development of distance education modalities. In addition, study and develop educational

methodological procedures supported by digital and multimedia resources.

**Objetives:**

1. To guide and train the faculty in the best distance practices, hybrid and face-to-face education, assisted by technologies.
2. To provide technical support in the planning, development and implementation of courses.
3. To facilitate access for technology to adequate spaces for the creation of multimedia digital materials to be used in courses attended by the Center.
4. To develop work guides for offering technology-assisted courses.
5. To help maintain high quality instructional design and pedagogical interaction mechanism in courses attended by the center.
6. To coordinate biannual training with the Professional Enrichment Center (CEP) on planning and creation of digital and multimedia educational materials, and forums or discussions on topics related to best practices in the development and implementation of distance, hybrid and face-to-face education assisted by technology.

CREAD develops and manages the offer of continuous distance education; proposals writing and make possible collaborative agreements of distance training.

Building Efrain Sanchez Hidalgo, Office 202
**Phone**: (787) 832-4040 ext. 6406, 5478
**Website**: https://www.uprm.edu/cread/
**Website**: https://decepenlinea.uprm.edu/
**Email**: cread@upr.edu

# TEACHER PREPARATION PROGRAM (TPP)

**Mission**

The mission of the Teacher Preparation Program reflects the UPRM mission. The unit's mission is to serve society by preparing professional educators who are subject matter specialists with dispositions of social, cultural, humanistic sensibilities and ethical values, who also possess competence, skills and general knowledge, all of which will allow them to be highly effective teachers. The unit prepares subject matter specialists as professional educators, committed to vanguard educational paradigms, with an inquisitive attitude, capable of creative and critical thinking, and with mastery of pedagogical and conceptual knowledge in their discipline.

**Vision**

In the context of the vision and mission of the institution, the Teacher Preparation Program aspires to develop subject matter specialists who are active teachers and lifelong learners who are highly capable, effective, dedicated educators in their fields.

**Goal of the Education Unit**

The Teacher Preparation Program's principal goal, as stated in Certifications No. 27 2003-04 and No. 47 2004-05 of the Board of Trustees of the University of Puerto Rico, is to offer the curricular sequence for teacher certification in secondary education in accordance with the norms and regulations of the Department of Education of Puerto Rico. Consistent with the University's vision and mission, the program offers a sequence designed to update and strengthen knowledge and skills of professional educators, Certification No. 190 2000-01 of the Board of Trustees of the University of Puerto Rico. To expand our academics offerings and not limit them to the secondary level, the teacher preparation program decides to change its official name to "Curricular Sequence for Teacher Certification", change approved March 2, 2016 by the Academic Senate of the University of Puerto Rico at Mayaguez, Certification Num. 16-14.

The goal of the Teacher Preparation Program of the Mayagüez Campus of the University of Puerto Rico is to prepare professional educators committed to new educational paradigms, leaders

in education with an inquisitive attitude, creative and critical thinkers, with a mastery of pedagogical and conceptual content in their discipline. The program seeks to foster that the candidate develops cognitive, affective, psychomotor, research, technological and communication skills. The intention is that the candidate becomes a lifelong learner to be a competent, effective teacher.

## Teacher-Preparation Program

This intensive training program is designed for students pursuing a bachelor's degree in the College of Arts and Sciences, College of Business Administration, and College of Engineering. In addition to education courses, the program includes observations and practice in the classroom under the direct supervision of experienced teachers, and university faculty.

The Education Program offers the sequence of courses required by the Department of Education of Puerto Rico to obtain Certification as Secondary and Elementary Level Teacher. To receive a teaching license, students must present evidence to the Department of Education at the conclusion of the Education Program. In addition, students must approve the required State Teaching Certification Test (PCMAS), offered by the College Board.

**The new legal requirements of the Department of Education.**

The Puerto Rico Department of Education has established by Circular Letter No. 04-2020-2021, that every teacher candidate before entering one of the country's Educational Centers must obtain the following documents:

1. Negative certification of the Registry of Persons Convicted for Sexual Offenses and Abuse against Minors of Puerto Rico
2. Certification of Criminal Records
3. Health Certificate

All candidates to take the methodology or practice course in August must meet the aforementioned requirements. Must have all documents at the time of beginning the classes and they must be given to the professor of the method course and / or the practice supervisor.

**Teacher Preparation Program**

**Transition Point #1:**
Prospective candidates may enroll in the Teacher Preparation Program after completing a bachelor's program or while pursuing a bachelor's degree at UPR-Mayagüez.

To be admitted to the program candidates are encouraged to maintain an overall GPA of 3.0 and a GPA of 3.0 in their major, as this is highly recommended by the Council for Accreditation of Educator Preparation. They must fill an admission document to the sequence at the Register Office and then make an interview at TPP with regards to their disposition towards teaching. The candidate could have credits on fundamental education before formal admission to the TPP. All the credits of Foundations courses must have a grading pass of B or more. Admitted students must completed a disposition interview.

**Transition Point #2: Enrollment in Theory and Methodology Course**
To enroll in the Theory and Methodology Course candidates must have completed three foundations of education courses EDFU 3012 (Foundations of Educational Psychology), EDFU 3007 (Social Foundations of Education), and EDFU 4019 (Philosophical Foundations of Education) and EDPE 3077 (Integration of Technology with Distance and Virtual Teaching Strategies) with a recommended grade point average of 3.0 or better. All students are required to take EDES 4055 (Educational Strategies for the Inclusion of Students with Special Needs in the Regular Classroom). Additionally, we advise applicants to have completed at least 18 credits in their major, with a GPA of 3.0 or higher overall and in their major. Also, we recommend teacher students to take EDFU 3017 (Evaluation of Learning) and EDFU 3011 (Foundations of Human Development). Sciences and Math teacher students are also required to take EDUC 5005 (Introduction to the STEAM Teaching Strategy).

In some education courses including, EDFU 3017, EDES 4006, EDPE 3077, Methodology and Student's Teacher Courses the candidate must satisfactorily develop an electronic portfolio. In Methodology the portfolio must include a Teacher Candidate Work Sample (TCWS) that demonstrates the candidate's content knowledge, applied knowledge of human development and learning, sensibility to diversity, pedagogical

content knowledge skills and reflective habits on the effectiveness of their practice. In the TCWS the candidate must include artifacts such as lesson or unit plans, samples of assessment techniques including pre and posttest, and classroom management techniques. They also must prepare a reflection diary about the observation they do in schools.

**Transition Point #3: Entrance to Practicum**
To enroll in the Teaching Practice Course candidates must have completed the Theory and Methodology course with a grade of B or better. They must score 80% or higher on the Educational Philosophy Essay Rubric and on the evaluation of the Electronic Portfolio with the Teacher Candidate Work Sample. It is recommended that candidates possess a minimum of 21 credits in their major, with an overall GPA of 3.0 or higher, as well as a GPA of 3.0 or higher in their major.

**Transition Point #4: Program Completion**
Candidates fulfill the requirements for the Teacher Preparation Program when they complete 21 credits in core courses in the teaching specialty and the 36 credits. The 36 credits include: 9 credits in foundation of education courses; 3 credits in Integration of Technology with Distance and Virtual Teaching Strategies); 3 credits in Educational Strategies for the Inclusion of Students with Special Needs in the Regular Classroom: 3 credits in Nature and Needs of Exceptional Learners; 3 credits in the history of Puerto Rico; 3 credits in the history of the United States; 3 credits in theory and methodology; and 6 credits in student teaching. Candidates are advised to take the PCMAS after completing their methodology course. Sciences and Math teacher students are also required to take EDUC 5005 (Introduction to the STEAM teaching strategy).

In the Student Teaching Course, the candidate must satisfactorily develop an electronic portfolio with Teacher Candidate Work Sample (TCWS) that demonstrates the candidate's content knowledge, applied knowledge of human development and learning, sensibility to diversity, pedagogical content knowledge skills and reflective habits on the effectiveness of their practice. In the TCWS the candidate must include artifacts such as lesson or unit plans, exams with their analysis, and classroom management techniques. A systemic assessment process database that addresses the candidate's proficiencies is being designed by the unit.

**TEACHER'S CERTIFICATION**

The following courses are available to UPRM students and in-service teachers.

***Courses in Education***

| Number | Credits | Title |
|---|---|---|
| EDFU 3011 | 3 | Foundation of Human Development (Recommended course) |
| EDFU 3012 | 3 | Foundation of Educational Psychology |
| EDFU 3007 | 3 | Social Foundations of Education |
| EDFU 3017 | 3 | Evaluation of Learning (Recommended course) |
| EDFU 4019 | 3 | Philosophical Foundations of Education |

***General Courses***

| Number | Credits | Title |
|---|---|---|
| EDES 4006 | 3 | Nature and Needs of Exceptional Learners |
| EDES 4055 | 3 | Educational Strategies for the Inclusion of Students with Special Needs in the Regular Classroom |
| EDPE 3077 | 3 | Integration of Technology with Distance and Virtual Teaching Strategies |
| EDUC 5005 | 3 | Introduction to the Steam Teaching Strategy |
| HIST 3241 | 3 | History of Puerto Rico |
| or | | |
| HIST 3242 | 3 | History of Puerto Rico |
| HIST 3111 | 3 | History of the United States of America |
| or | | |
| HIST 3112 | 3 | History of the United States of America |

***Courses in Methodology***

Students select among these courses according to their professional major.

| Number | Credits | Title |
|---|---|---|
| EDPE 4059 | 3 | Theory and Methodology in the Teaching of Business and Occupational Subjects |
| EDPE 4060 | 3 | Curriculum and Methodology of the Integration of Technology in Education |
| EDPE 4135 | 3 | Theory and Methodology in the Teaching of Science in Secondary School |
| EDPE 4145 | 3 | Theory Methodology Teaching Mathematics Secondary School |

| | | |
|---|---|---|
| EDPE 4155 | 3 | Theory and Methodology in the Teaching of History and Social Studies in Secondary School |
| EDPE 4167 | 3 | Theory and Methodology of Teaching Fine Arts K-12 |
| EDPE 4185 | 3 | Theory and Methodology in the Teaching of Theatre (K-12) |
| EDPE 4215 | 3 | Theory and Methodology in the Teaching of Physical Education in K-12 |
| EDPE 4235 | 3 | Methodology Teaching Spanish Second Language |
| EDPE 4245 | 3 | Theory and Methodology in the Teaching of English (K-12) |
| EDPE 4301 | 3 | Montessori General Methodology for Preadolescents and Adolescents |
| EDPE 4302 | 3 | Content and Applied Methodology in Montessori Secondary Education with the Integration of Mathematics, Language, History, Geography, Arts, and Movement |

***Courses in Practice Teaching (Laboratory Experiences)***

| Number | Credits | Title |
|---|---|---|
| EDES 4089 | 6 | Practice in Special Education |
| EDPE 4088 | 6 | Practicum for the Information Technologies and Learning Communication Teaching |
| EDPE 4137 | 6 | Student Teaching of Biology in Secondary School |
| EDPE 4138 | 6 | Student Teaching of Physics in Secondary School |
| EDPE 4139 | 6 | Student Teaching of Chemistry in Secondary School |
| EDPE 4146 | 6 | Practice Teaching of Mathematics in Secondary School |
| EDPE 4156 | 6 | Student Teaching of Social Studies in Secondary School |
| EDPE 4157 | 6 | Student Teaching of History in Secondary School |
| EDPE 4166 | 6 | Practicum in Teaching of Art in K-12 School |
| EDPE 4186 | 6 | Practicum Teaching of Theatre in K-12 School |
| EDPE 4187 | 6 | Student Teaching of Business Education in Secondary School |
| EDPE 4216 | 6 | Practicum in Teaching Physical Education |
| EDPE 4236 | 6 | Student Teaching of Spanish in Secondary School |
| EDPE 4246 | 6 | Student Teaching of English in Secondary School |

Students must complete three credits in History of Puerto Rico or History of the United States.

Total credits for certification: 36

***Other Courses***

| Number | Credits | Title |
|---|---|---|
| EDIN3005 | 3 | Principles and Practices of Industrial and Vocational Education |
| EDIN3006 | 3 | Special Methods in Industrial Education |
| EDIN 4005 | 3 | Test and Measurements for Industrial Vocational Education |
| EDIN4006 | 3 | Labor Relations |
| EDIN 4029 | 3 | Shop Organization and Management |

**Special Education Courses**

| Number | Credits | Title |
|---|---|---|
| EDES 3055 | 3 | General Methodology and Assessment for Teaching Special Education K-12 |
| EDES 3205 | 3 | Assistive Technology in Special Education |
| EDES 4019 | 3 | Nature and Diagnosis of Specific Difficulties in Children |
| EDES 4048 | 3 | Behavior Modification Applied to a Classroom Setting |
| EDES 4077 | 3 | Communication Techniques for the Hearing Impaired. |
| EDES 4096 | 3 | Methods in Teaching Reading and Writing in Special Education K-12 |
| EDES 4125 | 3 | Autism: Psychological & Neuro-Biochemical Aspects |
| EDES 4055 | 3 | Educational Strategies for the inclusion of students with special needs in the regular classroom |
| EDES 4097 | 3 | Language Arts Methods in Special Education K-12 |
| EDES 4098 | 3 | Methodology of Teaching Mathematics in Special Education K-12 |

**Montessori Secondary-Level Courses**

| Number | Credits | Title |
|---|---|---|
| EDUC 3005 | 3 | Foundations of the Montessori Teaching Philosophy |
| EDUC 3006 | 3 | Integration of Montessori Curriculum and effectively Management of Learning Environments for Preadolescents and Adolescents |
| EDUC 3007 | 3 | Observation and Assessment of Preadolescents and Adolescents in Montessori Education |
| EDUC 5006 | 3 | Learning Neurology |
| EDUC 5007 | 3 | Educational Research for Montessori Teachers |

**Curriculum Sequence (Professional Certificate) in Distance Education with a Specialty in Online Teaching**

The Curriculum Sequence was developed to provide competencies, skills and knowledge of how to teach effectively at a distance using the online mode. The certificate is for educators or candidate educators of all specialties. This professional certificate does not lead to a degree or a teacher certificate as other sequences in the Teacher Preparation Program. The certificate is the perfect complement for teachers and educators, in general, who require this preparation to teach using this modality and are looking for a formal academic credential and validated credits. It is also a preparation for continuing graduate studies in education with a specialty in distance education or instructional design.

The professional certificate consists of 15 credits at the advanced undergraduate level, allowing people with a register. Alumni of our university, students or graduates of other universities can also participate using "professional development" admission. The sequence of courses is approved for the PR Department of Education's Use of computers teacher's certification. The courses are:

| Number | Credits | Title |
|---|---|---|
| TEED 4007 | 3 | Administration of Educational Technology Programs |
| TEED 4045 | 3 | Computer Laboratory Management |
| TEED 5007 | 3 | Creating Online Courses |
| TEED 5008 | 3 | Design and Creation of Educational Materials for Online Courses |
| TEED 5015 | 3 | Advanced Strategies for Online Courses |
| TEED 5016 | 3 | Learning Management System Online Courses Practicum |
| TEED 5017 | 3 | Distance Education Trends |
| EDPE 4060 | 4 | Curriculum and Methodology of the Integration of Technology in Education |

The minimum requirements to be considered for admission to the Curriculum Sequence are:

1. Undergraduate student - Having completed at least 50% of their curriculum with a 2.50 average or higher and ensuring the student can complete the required courses of the sequence within 150% of the time normally required for their primary degree.
2. Master's and Ph.D. students - having a 2.50 average or higher.
3. Professional development students - having a 2.50 average or higher.

In order to pass the sequence and have the credits be recognized officially on the academic record, each course must be approved with an A or B. Students who obtain a C or less in one of the courses must repeat it. Upon successful completion of the sequence, the student will receive a special annotation on their transcript as specified in Certification SA 15-07 (section D.1).

**Efrain Sánchez Hidalgo Building, Suite 402**
**Phone:** 787-832-4040 Ext. 6580, 2210
**Website:** https://www.uprm.edu/ppm/
**Email:** ppmrum@upr.edu

**FACULTY**

**CARMEN BELLIDO-RODRIGUEZ,** *Professor*, Ph.D., 1997, University of Puerto Rico.

**JOSE R. FERRER LOPEZ,** *Professor***,** Ed.D., 2010, *Universidad del Turabo.*

**JANETTE FERRER MONTES**, *Associate Professor*, Ph.D., 2013, University of Wisconsin, Madison Campus.

**SANTIAGO MENDEZ-HERNANDEZ**, *Auxiliary Professor*, 2014, Pontifical Catholic University of Puerto Rico.

**GRISEL RIVERA-VILLAFAÑE**, *Professor*, Ed.D., 2006, Interamerican University of Puerto Rico.

**Educational Programs and Teaching**

All the THEORY AND METHODOLOGY TEACHING courses are based on a theoretical and practical approach. All aspects related to the teaching of that curricular area are studied: planning, innovative education and curriculum analysis; basic content in the area of specialization; preparation, adaptation and utilization of resources; methodology, teaching techniques and strategies; fundamentals of evaluation and measurement; educational

administrative skills. These contents are integrated to the class on a practical basis. All students must complete at least 15 hours per semester of observation experiences and laboratory work, inside and outside of the classroom, in public or private schools. These experiences will enable students to develop critical, dynamic and creative attitudes towards the Puerto Rican educational problems.

Prerequisite: A Baccalaureate degree or 18 credits or more in the discipline of study, *in one of the following majors:* Biology, Chemistry, English, History, Social Studies, Mathematics, Office Administration, Marketing, Accounting, Physics, Computers, Vocational or Occupational Subjects, Physical Education, Arts, Spanish and Theater.

The student should have also approved 9 credits or more in foundation of education courses: EDFU 3011 or EDFU 3012, EDFU 3007, EDFU 3017, EDFU 4019.

## UPRM NIGHT, WEEKEND AND ONLINE PROGRAM (RUMex)

RUMex was created in 2021 under the Academic Senate Bylaw 21-46. RUMex is an administrative and fiscal unit, authorized to offer credit-bearing courses within academic programs leading to a degree, at a distance, and face-to-face in extended hours and on Saturdays, and other formats related to the needs of non-traditional students under a self-financing model.

The objectives of RUMex are:

1. Raise awareness among the UPRM academic programs, its graduates, and the general public about the relevance of a non-traditional alternative study option, which can positively impact non-traditional students who aspire to obtain a university degree.
2. To propose and implement viable alternatives that satisfy the demand of higher education leading to an academic degree at the UPRM.
3. Coordinate with the departments and academic programs the offering of courses leading to academic degrees for non-traditional students.
4. Plan, coordinate, submit recommendations and supervise the stages of development of RUMex according to the demand for services and in accordance with the current institutional certifications.
5. Coordinate administrative and support services to meet the needs of RUMex students.
6. Promote the expansion and enrichment of the RUMex offer.
7. Seek partnerships and agreements between departments, faculties and universities within and outside of the UPR system, to facilitate the development of non-traditional students.

Building José De Diego, Office 107
**Phone**: (787) 832-4040 ext. 6505
**Website**: https://www.uprm.edu/rumex
**Email**: rumex@upr.edu

## *OFFICE OF THE DEAN OF STUDENTS*

The Office of the Dean of Students assures and maintains an optimal learning environment by providing a variety of services and activities as support systems for academic programs. Students are urged to take full advantage of these services and are encouraged to participate in extra-curricular activities which are designed to enrich their personal development and academic growth. The office is located in the Dean of Students building in room DE-1. For more information contact Dr. Jonathan Muñoz Barreto at decano.estudiantes@uprm.edu or 787-265-3862.

**Website:** https://www.uprm.edu/decestu/

## BAND AND ORCHESTRA

**Vision**

To become a service unit that supports the transformation of society by strengthening the institutional environment.

**Mission**

To train students in the pro-active participation in the fine arts through musical performance, so as to contribute to the emotional, cultural and educational development to complement their comprehensive training, educational and ethical.

Students with musical talent may join different music groups such as the marching band, chamber choir "Chorium", Coral Universitaria, strings orchestra, and Latin American group "Alma Latina". Students interested in participating in any of these groups are required to perform in an audition.

Groups are required to rehearse twice or more weekly to develop interpretive skills and maintain an ample musical and artistic program. The ensembles present a variety of concerts and performances as representatives of the university also international performances, festivals and competitions. For more information contact: BAND AND ORCHESTRA DEPARTMENT at (787) 265-3895; 787-832-4040 exts. 3415, 3895.

**Website:** http://www.uprm.edu/cms/index.php/page/380

## DEPARTMENT OF COUNSELING AND PSYCHOLOGICAL SERVICES

The Department is fully accredited by the International Association of Counseling Services (IACS). Counseling and Psychological Services are offered to the students so that they may achieve better self-understanding and make adequate adjustment to the university environment. Programs and services are offered to diminish the negative impact of everyday stress and to help students cope with academic and environmental demands.

The Department of Counseling and Psychological Services provide personal counseling, career and life planning, testing, and psychological services.

**Psychologists** provide individual therapy, crisis intervention, workshops and lectures on personal, emotional, and social growth topics.

**Social worker** provide preventive, diagnostic, and intervention services at both the individual and group levels, with the goal of addressing psychosocial issues, reduce disparities, and enhance student well-being.

**Professional Counselors** assist students with personal, educational, and career development issues and concerns. They also teach a freshman orientation course, known as:

**Freshman Orientation Days** are offered a week prior to the registration period for the first semester. It is a campus wide activity in which new students receive information about facilities, academic programs, services, and student organizations. It offers freshmen the opportunity to meet faculty, staff, and other students. Members of the Peer Counseling Program work intensely during this week and throughout the year in coordination with the Department of Counseling and Psychological Services assisting Professional Counselors with campus tours, group guidance, open house, and career days.

**The Introduction to University Way of Life (UNIV 3005)** is designed to enhance students' understanding of the key factors that influence university life and support a smooth transition into the academic environment. It aims to promote the development of essential skills for both academic success and social integration throughout their college experience. The topics covered will include study and communication

strategies, career planning, personal growth, basic computer literacy, academic policies, and available campus resources.

### COUNSELING AND PSYCHOLOGICAL FACULTY

***PROFESSIONAL COUNSELORS:***

**MARÍA E. ALMODÓVAR-ALMODÓVAR**, *Professor*, *(Counselor IV & Interim Director*), Ed.D. 2010, Interamerican University of Puerto Rico-Metropolitan Campus.

**MAYRA L. GONZÁLEZ-ORNES,** *Associate Professor*, *(Counselor III & Associate Dean Of Student),* Ed.D. 2016, Interamerican University of Puerto Rico- Metropolitan Campus.

**MAGALY MERCADO-NAZARIO,** *Associate Professor*, (*Counselor IV*), Ed.D. 2012, Interamerican University of Puerto Rico-Metropolitan Campus.

**CAROLYN MERCADO ROSADO,** *Professor (Counselor IV),* Ed.D. 2016, Interamerican University of Puerto Rico-Metropolitan Campus.

**NELSON PAGÁN-SUÁREZ**, *Professor (Counselor IV)*, Ed.D, 2014, Interamerican University of Puerto Rico – Metropolitan Campus.

**MADELINE J. RODRÍGUEZ-VARGAS**, *Professor (Counselor IV)*, Ed.D. 2013, Interamerican University of Puerto Rico - Metropolitan Campus.

**ARLEEN SANTANA MERCADO**, *Auxiliar Professor (Counselor II)*, Ed.D. 2015, Interamerican University of Puerto Rico - Metropolitan Campus.

***PSYCHOLOGISTS:***

**GLORYMAR ORTIZ TORO**, *Auxiliar Professor (Psychologist II)*, Psy.D., 2012, Ponce School of Medicine.

**EMIR S. RIVERA-CATILLO**, *Professor*, (*Psychologist IV*), Psy.D., 2008, Ponce School of Medicine.

**Office:** Fifth floor, Students Center Building
**Phone:** 787-832-4040 exts. 2040, 3372, 3864
**Website:** http://www.uprm.edu/DCSP

## FINANCIAL AID DEPARTMENT

The Financial Aid Department administers financial aid programs to assist students with educational expenses. Each year approximately 70% of the student body qualifies for financial assistance. This assistance is provided through Federal, state, institutional, and private sources. These programs include grants and scholarships which do not have to be repaid, part-time employment for students who wish to work, and loans that require repayment. The philosophy followed in rendering financial assistance is based on the principle that parents are the ones who are primarily responsible for providing financial means to educate their children. Students are also considered responsible in helping finance their college education through self-help which includes resources from assets, earnings from work, and loans to be repaid from future earnings. Some of the established requirements for financial assistance are:

- US citizenship or eligible non-citizen.
- Enrollment in a degree or certificate program.
- Not in default status in Title IV Program.
- Justified financial need.

Financial need is determined by the difference between the cost of education and the amount of aid that parents and student can contribute and the economic resources and aids that the students receive from the institution. The amount which a student may receive is determined according to students' financial need and fund availability. In order to be considered for all financial aid programs, students must complete and submit once every academic year the Application for Federal Student Aid and all other required documents.

**Financial Aid Programs:**

**Grants and Scholarships**

***Private scholarships and grants*** are received at the University on behalf of a student. They are administered according to criteria and guidelines specified by each donor or entity. Our sole responsibility is to administer, a distribute each award according to those guidelines.

**Federal Work-Study Program**

The Federal Work-Study Program provides on campus or off-campus employment opportunities for graduate students with financial need. To be considered to apply for work and study you must complete the FAFSA form. There are some eligibility requirements that a candidate must have in order to receive the award. Even though, this opportunity serves as work experience for the participant, the revenue it's not considered as received from work but as a grant awarded, such as Pell, SEOG or others.

**Loans**

Based on their determined financial need, the ***Direct Loan Program*** allows graduate students to borrow low-interest federally unsubsidized funds based on need. Repayment begins six months after the student graduates or ceases to be enrolled. Our institution manages all the administrative procedure of a Direct Loan, but once the loan is awarded and disbursed, all the responsibility of the loan falls toward the student.

The ***Geer Loan Program*** is funded through a private trust donation to the Mayagüez Campus. It provides 5 percent interest loans for up to a maximum yearly amount of $1,000 based on financial need. Repayment begins 46 days after the loan proceeds are disbursed. The student must have an impeccable record in order to be granted this type of loan. Also, there's an enforceable interview with the Dean of Students, in order to finally award the loan.

The ***Emergency or Short-Term Loan*** are granted to students who have urgent needs for unforeseen expenses such as: books, medicines, urgent trips home and others. The maximum amount awarded is $200.00. The loans expire one month after they are granted and in case of late payment surcharges will be charged. The loan check takes 3-4 business days to arrive.

**Office:** Financial Aid, Deanship Students Building
**Phone:** 787-265-3863; 787-832-4040 ext. 3440, 3863
**Website:** http://www.uprm.edu/asistenciaeconomica
**Email:** aeconomica@uprm.edu

# DEPARTMENT OF MEDICAL SERVICES

The mission of the Department of Medical Services is to offer primary health care and medical emergency aid for all students. Among the services provided are medical consultations, emergency and short-stay recuperation care (emergency room), ambulance services, clinical laboratory tests, chiropractor services, psychology services, addiction counseling, health education and promotion programs, nursery room, stress management center, gynecology services, and a family planning clinic (PREVEN).

The vision of the Department of Medical Services is to offer medical services directed at collaborating in the integral development of the student community, forming effective professionals and positively improving the quality of life of our society.

The services offered by the department are classified into three areas: physical, emotional, and social health. The principal objective is to offer preventive medicine with emphasis on primary and secondary prevention, and therapeutic medicine. Preventive medicine pursues the prevention, detection, and treatment before the emergence of possible complications. Therapeutic medicine covers control of medical conditions for students who may need immediate attention, observation, or special and emergency care.

Services are offered from Monday to Friday from 8:00 am to 4:30 pm. Ambulance transportation services are coordinated on a twenty-four hour daily basis by the University Security Department through the municipal or state emergency services, when the Department of Medical Services is not within its operating hours.

Medical consultations and emergency services are offered by general physicians and professional nurses. A clinical laboratory complements these services during regular working hours, as well.

Psychological services are also part of the services offered. These services include: psychotherapy, crisis intervention, emergency room assistant, group therapy, and consultation referrals to external health professionals. Workshops on various mental health topics are also provided.

The Stress Management Center offers services to the university community as a whole primarily through scheduled appointments. This center specializes in teaching techniques for stress management which include: music therapy, visualization, and direct relaxation. The Psychology Department also collaborates with the department's psychologist in order to provide its students with hands-on experience.

Through "Mano Amiga Colegial" (Health Promotion and Prevention Program), individual and group orientations are offered covering various health topics. Some of the areas covered are: nutrition, sexual health, eating disorders, sexually transmitted diseases, alcohol and other drug abuse prevention, counseling on addiction, among other topics. Secondary prevention for chronic illness such as heart diseases, diabetes, and asthma, as well as other health related areas with emphasis in the promotion of maintaining a healthy lifestyle.

All students enrolling in the University for the first time are required to complete and submit important documents required by the university and laws of P.R. Among these are a medical exam that includes complete medical history, laboratory tests, legal authorization, and other important documents. Evidence of immunization record (original document) is also required. Failure to comply with submitting the required documentation will result in complications for students during the course selection periods and payment periods for these courses. The Department of Medical Services has a responsibility to ensure that all students have a medical insurance plan for the duration of their University careers. The University of Puerto Rico also provides a health insurance plan through a private provider for students who are not insured through a private or government health insurance.

The university medical health plan offers medical specialists services, X-rays and laboratory tests, emergency room care, hospitalization, surgical procedures, maternity services including prenatal and postnatal care, among others. The medical insurance plan offers a selection of coverages including pharmacy, dental and/or major medical services. Some services require eligibility time.

The Family Planning Program Title X (PREVEN) offers comprehensive sexual and reproductive health to members of the university community and the surrounding community. This program offers evaluation and medical consultation by a gynecologist, as well as sexual health education, guidance in reference to abstinence, natural family planning, referrals, PAP smears tests, tests for sexually transmitted diseases, as well as education and availability of supplying contraceptive methods.

The Medical Services Department considers the social health of students a very important component of maintaining a healthy environment within the university. Some of the actual health issues such as alcohol and other substance abuse are related to social health. A Smoke Cessation Program is available to students and university staff. Chiropractor services are available to the general community.
The department also sponsors student organizations that advocate and promote healthy lifestyles among the student community.

**Phone**: (787) 832-4040 Exts. 3408, 3416
**Website**: http://www.uprm.edu/medical
**Email**: servmed@uprm.edu

## PLACEMENT DEPARTMENT

### Vision

Serve as liaison between students and businesses while providing the best and most effective service for both parts.

### Mission

Provide students the necessary tools that will help them achieve an effective job search, while helping businesses recruit the best talent by working with their employment needs so the students can be placed effectively in a summer, full time, temporary or part time employment.

The Placement Department's main objective is to assist students in obtaining permanent, summer, or temporary employment. Services provided include arrangement of on-campus interviews with prospective employers, coordination of employer presentations, and job referrals. The Department offers seminars and workshops to facilitate job search, résumé preparation, and interviewing skills.

Twice a year, the Placement Department organizes and hosts a **Job Fair** with the participation of private and government agencies form Puerto Rico and the United States.

Annually, the department prepares a study with each graduating class that reflects the number of students that find job placement in and outside of the island, continue their graduate studies in Puerto Rico or the United States or continue to seek employment. Students are advised to initiate their job search as early as their freshmen year, since this will increase their chances of obtaining summer or co-op experience.

**Office:** Student Center Bldg., 4th Floor Office 405
**Phone:** (787) 265-3898; (787) 832-4040 Exts. 2070, 3858, 3691 Fax: (787) 834-5115
**Website:** http://www.uprm.edu/placement
**Email:** placement@uprm.edu

## QUALITY OF LIFE OFFICE

The Quality-of-Life Office offers a wide variety of services in order to promote a safe campus environment and achieve the educational objectives of this institution. This office encourages a safe and secure environment through various activities each semester. It sponsors peer education and support student groups.

Proactive prevention programs are offered in order to prevent campus crime, violence, sexual assault, and the use and abuse of alcohol and other drugs, which may affect the quality of life on campus. Further information about the office, its services, and activities may be obtained by calling 787-832-4040, Extensions 3894, 3107, 5467 or at calidaddevida@uprm.edu http://www.uprm.edu/calidaddevida.

**Mission**

Our mission is to raise community awareness about total welfare, alcohol abuse and prevention, drugs, smoking, crime alert, prevention of sexual harassment and sexual assault, violence, aggression and safety and adjacent areas. We seek to contribute to the integral development of our students by offering alternatives to develop healthy lifestyles in the university community. Coordinate activities directed to meet, the regulations established by the Department of Education and the University of Puerto Rico.

**Vision**

To be the leading office in prevention and safety and to promote healthy lifestyles, responding to the needs of the university community. To promote a culture of tolerance and diversity, with the determination of improving the Institutional Climate of our campus.

## CAMPUS SAFETY AND SECURITY

Emergency Numbers: Security Office (787) 265-1782, Office of the Dean of Students (787) 265-3862, Quality of Life Office (787) 265-5467, Medical Services (787) 265-3865, Counseling and Guidance (787) 265-3864.

At UPRM, the safety and well-being of our students, faculty, and staff is an important priority.
UPRM's urban campus and its environs are safe and have a relatively low crime rate.

The University is required by federal law to publish an annual security report containing information with respect to campus security policies and statistics on the incidence of certain crimes on and around our campus.

**FEDERAL CAMPUS SEX PREVENTION LAW**

The Department of Superior Education of the United States of America established an order that any educational institution that receives federal funds must have open access to the university community of the sex offender's register.

That database contains public record information of offenders classified as sexual predators and sex aggressors under the law of Puerto Rico known as Registration of Convicted Persons of Sexual Crimes and Abuses Against Children Law (Law No. 266 of September 9, 2004).

This information would be available on the website Quality of Life Office, https://www.uprm.edu/calidaddevida/2016/06/20/ofensores-sexuales-2/, and on the website of the Information System of Criminal Justice, https://sor.cjis.pr.gov/#/.

**Statistics of Campus Crime Report:**

**ON-CAMPUS CRIME REPORT-2022-2024 REQUIRED BY THE PUBLIC LAW 101-542 (STUDENT RIGHT TO KNOW AND CAMPUS SECURITY ACT)**

| CATEGORIES* | In Campus | | | Students Residence | | |
|---|---|---|---|---|---|---|
| | 2022 | 2023 | 2024 | 2022 | 2023 | 2024 |
| Murder/Negligent Manslaughter | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-Negligent Manslaughter | 0 | 0 | 0 | 0 | 0 | 0 |
| Forcible Sex Offenses (Including forcible rape) | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-forcible Sex Offenses | 0 | 0 | 0 | 0 | 0 | 0 |
| Robbery | 0 | 0 | 0 | 0 | 0 | 0 |
| Aggravated Assault | 0 | 0 | 0 | 0 | 0 | 0 |
| Burglary | 0 | 0 | 0 | 0 | 0 | 0 |
| Motor Vehicle Theft | 0 | 0 | 0 | 0 | 0 | 0 |
| Arson | 0 | 0 | 0 | 0 | 0 | 0 |
| Property Damage | 0 | 5 | 3 | 0 | 0 | 0 |
| Illegally Appropriated by Force | 2 | 5 | 7 | 0 | 0 | 0 |
| *Hate Crimes | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | |
| Disciplinary Actions/Judicial Referrals and/or Arrests for: | | | | | | |
| Liquor Law Violations | 0 | 0 | 0 | 0 | 0 | 0 |
| Drug Law Violations | 0 | 0 | 0 | 0 | 0 | 0 |
| Illegal Weapon Possession | 0 | 0 | 0 | 0 | 0 | 0 |

**ON-CAMPUS CRIME REPORT-2022-2024 REQUIRED BY THE PUBLIC LAW 101-542 (STUDENT RIGHT TO KNOW AND CAMPUS SECURITY ACT)**

| CATEGORIES* | Non-Campus | | | Public Properties | | |
|---|---|---|---|---|---|---|
| | 2022 | 2023 | 2024 | 2022 | 2023 | 2024 |
| Murder/ Negligent Manslaughter | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-Negligent Manslaughter | 0 | 0 | 0 | 0 | 0 | 0 |
| Forcible Sex Offenses (Including forcible rape) | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-forcible Sex Offenses | 0 | 0 | 0 | 0 | 0 | 0 |
| Robbery | 0 | 0 | 0 | 0 | 0 | 0 |
| Aggravated Assault | 0 | 0 | 0 | 3 | 1 | 2 |
| Burglary | 0 | 0 | 0 | 0 | 0 | 0 |
| Motor Vehicle Theft | 0 | 0 | 0 | 0 | 0 | 0 |
| Arson | 0 | 0 | 0 | 0 | 0 | 0 |
| Property Damage | 1 | 2 | 2 | 6 | 12 | 4 |
| Illegally Appropriated by Force | 0 | 2 | 1 | 7 | 15 | 15 |
| *Hate Crimes | 0 | 0 | 0 | 0 | 0 | 0 |
| Disciplinary Actions/ Judicial Referrals and/or Arrests for: | | | | | | |
| Liquor Law Violations | 0 | 0 | 0 | 0 | 0 | 0 |
| Drug Law Violations | 0 | 0 | 0 | 0 | 0 | 0 |
| Illegal Weapon Possession | 0 | 0 | 0 | 0 | 0 | 0 |

**ON-CAMPUS CRIME REPORT-2022-2024 REQUIRED BY THE PUBLIC LAW 101-542 (STUDENT RIGHT TO KNOW AND CAMPUS SECURITY ACT)**

| CATEGORIES* | Total | | |
|---|---|---|---|
| | 2022 | 2023 | 2024 |
| Murder/Negligent Manslaughter | 0 | 0 | 0 |
| Non-Negligent Manslaughter | 0 | 0 | 0 |
| Forcible Sex Offenses (Including forcible rape) | 0 | 0 | 0 |
| Non-forcible Sex Offenses | 0 | 0 | 0 |
| Robbery | 0 | 0 | 0 |
| Aggravated Assault | 0 | 1 | 2 |
| Burglary | 0 | 0 | 0 |
| Motor Vehicle Theft | 0 | 0 | 0 |
| Arson | 0 | 0 | 0 |
| Property Damage | 7 | 19 | 9 |
| Illegally Appropriated by Force | 9 | 22 | 23 |
| *Hate Crimes | 0 | 0 | 0 |
| Disciplinary Actions/Judicial Referrals and/or Arrests for: | | | |
| Liquor Law Violations | 0 | 0 | 0 |
| Drug Law Violations | 0 | 0 | 0 |
| Illegal Weapon Possession | 0 | 0 | 0 |

**STATE POLICE CRIME REPORT OF CAMPUS ADJACENT AREAS REQUIRED BY THE PUBLIC LAW 101-542 (STUDENT RIGHT TO KNOW AND CAMPUS SECURITY ACT)**

| CATEGORIES* | In Campus | | | Students Residence | | |
|---|---|---|---|---|---|---|
| | 2022 | 2023 | 2024 | 2022 | 2023 | 2024 |
| Murder/ Negligent Manslaughter | 0 | 0 | 0 | 1 | 0 | 0 |
| Non-Negligent Manslaughter | 0 | 0 | 0 | 0 | 0 | 0 |
| Forcible Sex Offenses (Including forcible rape) | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-forcible Sex Offenses | 0 | 0 | 0 | 0 | 0 | 0 |
| Robbery | 0 | 0 | 0 | 1 | 0 | 0 |
| Aggravated Assault | 0 | 0 | 0 | 14 | 0 | 3 |
| Burglary | 0 | 0 | 0 | 0 | 0 | 3 |
| Motor Vehicle Theft | 0 | 0 | 0 | 1 | 0 | 1 |
| Arson | 0 | 0 | | 0 | 0 | 0 |
| Property Damage | 0 | 0 | 0 | 0 | 0 | 0 |
| Illegally Appropriated by Force | 0 | 0 | 0 | 14 | 0 | 5 |
| *Hate Crimes | 0 | 0 | 0 | 0 | 0 | 0 |
| Disciplinary Actions/Judicial Referrals and/or Arrests for: | | | | | | |
| Liquor Law Violations | 0 | 0 | 0 | 0 | 0 | 0 |
| Drug Law Violations | 0 | 0 | 0 | 0 | 0 | 0 |
| Illegal Weapon Possession | 0 | 0 | 0 | 0 | 0 | 0 |

**STATE POLICE CRIME REPORT OF CAMPUS ADJACENT AREAS REQUIRED BY THE PUBLIC LAW 101-542 (STUDENT RIGHT TO KNOW AND CAMPUS SECURITY ACT)**

| CATEGORIES* | Total | | |
|---|---|---|---|
| | 2022 | 2023 | 2024 |
| Murder/Negligent Manslaughter | 1 | 1 | 0 |
| Non-Negligent Manslaughter | 0 | 0 | 0 |
| Forcible Sex Offenses (Including forcible rape) | 0 | 1 | 0 |
| Non-forcible Sex Offenses | 0 | 0 | 0 |
| Robbery | 1 | 2 | 0 |
| Aggravated Assault | 14 | 5 | 3 |
| Burglary | 0 | 4 | 3 |
| Motor Vehicle Theft | 1 | 8 | 1 |
| Arson | 0 | 0 | 0 |
| Property Damage | 0 | 0 | 0 |
| Illegally Appropriated by Force | 14 | 10 | 5 |
| *Hate Crimes | 0 | 0 | 0 |
| Disciplinary Actions/Judicial Referrals and/or Arrests for: | | | |
| Liquor Law Violations | 0 | 0 | 0 |
| Drug Law Violations | 0 | 0 | 0 |
| Illegal Weapon Possession | 0 | 0 | 0 |

*Subcategories under hate crimes:
Theft
Aggression
Intimidation
Vandalism, property damage
Domestic violence
Gender violence
Stalking

**ADYACENT AREAS:**

Parking Satellites Area
(Palacio de Recreación y Deportes and Juan Rivero Zoo)
Pedro Albizu Campos Avenue
Barrio Dulces Labios
Barrio Paris
Bosque Street, West Side
Dr. Basora Street, West Side
Martínez Nadal Street
Mayagüez Town Center
Méndez Vigo Street (Darlington Building)
Morell Campos Street, West Side
Los Próceres Park
Urb. Ensanche Ramírez
Urb. La Riviera
Urb. Mayagüez Terrace
Road 108, 2 km.

## SOCIAL AND CULTURAL ACTIVITIES

The Social and Cultural Department offers diverse social and cultural activities such as theatrical and musical plays, concerts, sport events, and art exhibitions. The department is responsible for all UPRM student organizations accreditation and work with the approval of all their campus events and fundraising initiatives. Although most activities are on campus, university-sponsored activities are also offered at municipal government facilities such as the Yagüez Theater and the Cultural Center.

The department also has a leading role on Institutional events like Christmas Concert, Graduation, Freshmen Welcome and other events from the Dean of Students and the Chancellor's Office.

The office has a small shop with UPRM merchandise to promote the institutional identity, sense of belonging and to provide support to student organizations.

**Vision**

To complement the formal education through social and cultural activities that give students the interpersonal, leadership, communication and social skills needed to give society active, creative, social and self-confident individuals.

**Mission**

To present and promote an agenda of extracurricular activities for the UPRM community through artistic, social and cultural events that contributes to an integral student education, promoting also arts and culture development.

### STUDENT ORGANIZATIONS AND CLUBS

The UPRM has over 300 recognized student organizations and clubs which respond to student's social needs and interests. These organizations include chapters of national organizations, local clubs and groups of interest which give them an opportunity to enrich their cultural wealth and educative experiences. They also help their professional network to grow, and to develop leadership, interpersonal skills and sensibility through community service events.

**Office:** Students Center Building, 3rd floor, 306
**Phone:** 787-832-4040 exts. 3366, 3370
**Website:**
http://www.uprm.edu/actividadessociales
**Email:** actividadessociales@uprm.edu

## STUDENT GOVERNANCE

The General Student Council, is composed of representatives from each academic faculty elected by the student body. Additional information regarding the student council and its functions may be obtained at the General Student Council Office located on the 1st floor of the Student Center or at (787) 832-4040 ext. 3409.

## STUDENT CENTER

The Student Center is the university's community center and it is open to all students, faculty, staff, alumni, and visitors every day.

**Mission**

To provide students with a comfortable facility that meets recreational, entertaining, dining, and social needs in a safe environment.

There is always something going on in the UPRM Student Center. It is a focal point for cultural, social, and recreational activities while providing study areas for students. The 3rd Floor is being use for academic purposes as Colloquiums, Symposiums, Research Poster Exhibitions, Music, Theater and Performances, Movies and Graduated School Fairs.

Service Departments from the Dean of Students Office are located in the Student Center like Placement, Social and Cultural Activities, and the Student Exchange Program-International Services, Student Government and Professional Counseling and Psychological Services. It also houses a Computer Center with free printing services for students, a relaxation room and a breastfeeding room. Other offices located in Center include the Students Affairs Council Office, Book Store, and the "Café Colegial", an alcohol free club and cafeteria managed by UPRM students. A food court, a game room, a branch of a local bank Banco Popular de Puerto Rico and a branch of the First Credit and Savings Coop of Puerto Rico, are also in the building and free wireless connection to UPRM network and the WWW is available.

Students, faculty and administrators also hold meetings, conferences and special events at the Student Center. The facility has the *Tarzan Room* to accommodate 125 sitting people with audio/visual equipment. Also, the 3rd floor is available with a stage and audio for events like these.

The Student Center provides services to the community in the Ramón Figueroa Chapel Amphitheater. This room holds the largest audience for academic and cultural activities. It is equipped with a state of art and upgraded audio-visual system. The walls of this theater holds one of the biggest art installations called *Presencias…esencias del quehacer universitario* by Maestro Antonio Martorell, inaugurated in 2019.

Services are available at the Student Center from:
Monday to Thursday: 7:00 am to 12:00 midnight
Friday: 7:00 am to 6:00pm
Sunday and holidays: Available by reservation

Ramón Figueroa Chapel Amphitheater:
Service available by reservation
*Check dates for availability

**Administrator's Office:** Students Center Building, 4th floor, 411
**Phone:** 787-832-4040 exts. 2711, 3366, 3370
**Website:** https://www.uprm.edu/centro-de-estudiantes/

## STUDENT EXCHANGE PROGRAMS AND INTERNATIONAL STUDENT SERVICES

**Mission**

Our mission is to offer our students the opportunity to expand their educational and cultural horizons through their participation in the student exchange programs. To provide information to international students who visit our campus, and familiarize them with our college community and with the Puerto Rican culture.

The Mayagüez Campus is an active member of the National Student Exchange Consortium and the International Student Exchange Program. Also, we have Agreements with universities in: Europe, Latin America, Dominican Republic and U.S.A.

Exchange programs offer excellent opportunities to explore academic, social, and cultural settings.

**The National Student Exchange** offers students the opportunity to attend and study at another college or university in the United States and its territories.

www.nse.org

**The International Student Exchange Program** offers students the opportunity to study, experience and learn from exposure to different regional, cultural, and ethnic perspectives and to broaden their educational background. A qualified, full-time undergraduate student may participate in the exchange program for a semester and live in one of 50 countries.

www.isep.org

The Exchange Program office provides orientation services to students from other countries as they become acquainted with registration procedures, educational facilities, and student services. Information is offered in areas of immigration, financial assistance, foreign embassies located in Puerto Rico, programs sponsored by international agencies, and housing. The office works closely with the academic community, the administration, and the local community.

**Office:** Students Center Building, 4th floor, 409
**Phone:** 787-832-4040 exts. 3896, 2270
**Website:** https://www.uprm.edu/intercambio/

# *OTHER SERVICES*

## Alumni

The UPRM Alumni Office is engaged in activities designed to strengthen relationships between UPRM and its graduates.

**Vision**

Be a life-long liaison between the University of Puerto Rico at Mayagüez (UPRM), its current and future alumni, fostering their collaboration and philanthropic support to achieve institutional goals for the benefit of future generations.

**Mission**

To establish, strengthen and maintain the relationship between the University of Puerto Rico at Mayagüez and its alumni so they can contribute to institutional goals and support the University. This is addressed by:

- Promoting communication and active alumni participation in campus events
- Recognizing and reporting alumni contributions to our society
- Managing stewardship and donation process
- Promoting UPRM love and pride

This office tracks UPRM alumni, run fundraising campaigns, and organize events for the UPRM alumni community.

**Office**: Celis Building, 3rd floor 323B
**Phone**: 787-832-4040 ext. 2998, 2999
**Website**: https://www.uprm.edu/exalumnos/
**Website for donations:**
https://www.uprm.edu/donaciones/
**Email**: exalumnos@uprm.edu

## Bookstore

UPRM Bookstore is located at the Campus Student Center on the first floor and provides ongoing service Mondays through Fridays from 7:45 AM to 4:00 PM. Recent restructuring of services that were traditionally offered, allow us to provide our campus community bookstore supplies, textbooks, office and school supplies, university logo souvenirs and personal care supplies. Additional information available at http://www.uprm.edu/decadmi/libreria/librecolegial.php. Please contact us at

leixam.lopez@upr.edu, or call 787-265-3885, 787-832-4040 Exts. 2294, 3885 or 6457, 787-834-8290 (fax).

## Campus Dorms

An in-Campus accommodation for pre-qualified athletes is provided through the University Enterprises Department. UPRM Athlete Residence is located at Building A, Las Marias Avenue. Resident students are provided with the following services and amenities: laundromat, vending machines, common-use kitchen and study area.

**Phone**: 787-265-3891
**Website**: http://hotelcolegial.com/
**Email**: margarita.quintana@upr.edu

## Department of Athletic Activities

**Athletics**

UPRM is a member of the Puerto Rico Inter-University Athletic League (LAIPR) and fully participates in a variety of intercollegiate sports. It is also an active member of the National Collegiate Athletic Association (NCAA) Division II. The program offers 15 men's and 14 women's sports for students who demonstrate superior athletic abilities. Men's sports include baseball, basketball, beach volleyball, cross country, judo, soccer, swimming, table tennis, taekwondo, tennis, track and field, volleyball, weightlifting, wrestling and cheerleading. Women's sports include weightlifting, basketball, beach volleyball, soccer, cross country, judo, softball, swimming, taekwondo, table tennis, tennis, track and field, volleyball and cheerleading. The NCAA sponsors six men's and six women's sports (volleyball, basketball, track and field, cross country, swimming and tennis). Exhibition sports include a co-ed dance team.

The Intramural Program provides activities and competitions that take place mostly on campus grounds. Students, faculty and staff participate in a wide variety of competitions including 3 on 3 basketball, indoor soccer, softball, 5 on 5 basketball, volleyball, employee softball tournament and other recreational activities sponsored by students in their free time.

Athletics facilities include and old gymnasium, a coliseum, a world class natatorium with an Olympic size swimming pool, a diving pool and a 25 meter warm up pool, a tennis complex with 8 lighted courts that includes a grand stand court, 3 indoor racket ball courts, synthetic 400 meters running track, weightlifting gymnasium, training and conditioning exercise room, old athletic field for soccer practice and recreational activities, lighted softball field, and fitness trail.

The mascot is an English male bulldog name Tarzan and the female, Jane. The athletic nickname is Colegio and the moto is: Antes, Ahora y Siempre COLEGIO.

**Office**: Rafael A. Mangual Coliseum, 2nd floor, #209
**Phone**: 787-265-3866; 787-832-4040, ext. 2565, 3866, 3679, 3540, 3534, 3527, 3549
**Website**: www.uprm.edu/actividadesatleticas
**Email**: felix.vega3@upr.edu

## Dining

Food service is provided in our Cafeteria which is conveniently located in the Student Center. Ongoing service is provided in specific time slots separately at our main dining room and snack bar. Mondays through Thursdays from 6:30 AM to 8:00 PM, our main dining room will serve breakfast, lunch and dinner. Food service on Fridays will run up to 3:00 PM. Snack bar service will be available Mondays through Fridays from 7:00 AM until 3:00 PM.

**Phone**: 787-832-4040 ext. 2991

## Information Technology Center

As one of the units of the Chancellor's Office, the Information Technology Center, also known as the Campus Computer Center, serve the academic and administrative community by providing support to their technological needs. The CTI facilities are located at Office 107 of the Luis Monzón Building. Our servers are located in an adequate space, and we are continually working to provide the best infrastructure to maintain our computer services running in a 7/24 basis.

The institutional network **RUMNET** (Recinto Universitario de Mayagüez Network) is the most valuable resource supported by the Center. With a strong fiber optic infrastructure interconnecting

over 40 buildings throughout the campus, it is part of the Internet 2 project. The Center also supports the most widely deployed wireless network for academic purposes in Puerto Rico, covering the most part of the campus. The university community can access information resources, including Internet access wirelessly from almost anywhere, anytime.

Computing services for the academic users, are offered through the User Support Unit. Consulting and training services in academic and administrative tools like WordPress and the Portal, preparation of online user guides and manuals, academic support to the learning management system (LMS) Moodle and administration of institutional software licensing agreements, are some of the services provided.

The Analyst/Programming and Systems Units, ensure the flow of information needed for the day-to-day tasks of the academic and administrative community. Also, the Technical Services Unit provide network infrastructure, computer equipment maintenance and repair services, in coordination with other technical personnel around the campus.

The University covers the operational expenses of the computer network to provide Internet access through the wireless system inside the campus.

Additionally, to the services provided from the CTI, several academic departments operate their own computer laboratories, some with specialized hardware or software, so their use is restricted to students who are enroll in certain courses or engaged in research. Most departmental laboratories are open to the general campus population.

**Phone**: 787-832-4040 ext. 2059, 2132, 3331
**Email**: support@uprm.edu
**Website**: https://www.uprm.edu/cti

## Press and Publications

The Press Office is the link between the university community as well as local and international media. Press releases and articles regularly published in daily and weekly newspapers and internal publications such as *Cartelera Semanal*, *La Gaceta Colegial*, and the UPRM web page (www.uprm.edu), keep the general public informed of UPRM's main events. The Press Office produces *Foro Colegial*, an interview format program with host from Mayagüez Campus, which is broadcasted weekly on Radio Universidad WRTU FM. The Press Office also manages the content of the institution official social networks pages. Radio and TV announcements are also prepared by the Press Office.

**Website:** https://www.uprm.edu/prensa/

# *TUITION, FEES AND EXPENSES*

The following fees, prescribed by the university are tentative for new students and transfers for 2021-2022 and are subject to change at the discretion of trustees. University charges such as tuition and fees are due and payable in full by the date announced before the beginning of each term.

## Tuition Fees

## Cost per credit Masters and Doctoral

**For U.S.A. citizen's residents and non residents of Puerto Rico and foreign students:**

$195.00 per credit for students enrolled in **masters** programs plus applicable regular or special fees.

$205.00 per credit for students enrolled in **doctoral** programs plus applicable regular or special fees.

$50.00 for students enrolled in thesis only.

## Visiting students:

$67 per graduate course plus $13 maintenance fee and $25 technology for each academic session.

## Regular Fees

| | |
|---|---|
| Application for admission | $30.00 |
| Maintenance fee (per registration period) | $75.00 |
| Technology Fee | $25.00 |
| Graduation fee | $80.00 |
| Application for transfer to a different program | $20.00 |
| Application for readmission | $35.00 |
| Late registration fee | $20.00 |
| Academic transcript of credits (per copy) | $ 5.00 |
| Duplicate of admission letter, class ticket or schedule card (per copy) | $ 5.00 |
| Identification card | $10.00 |
| Letter of recommendation of the Dean of Students | $ 5.00 |
| Repetition courses | $20.00 |
| Partial withdrawal | $10.00 |
| Total withdrawal | $15.00 |

Students applying for admission, readmission, or transfer after the corresponding due date will pay one-and-a-half times the regular fee. Late applications are accepted only after complete justification is presented.

## Special Fees

| | |
|---|---|
| Laboratories fees (per laboratory course) | $100.00 |
| Maintenance fee (per registration period) | $175.00 |
| Technology Fee | $75.00 |

## Annual Medical Insurance

Basic $1,112.00

Basic including pharmacy and dental charges $1,430.00

Basic including pharmacy, dental and mayor medical charges
$1,486.00

Basic including pharmacy and major medical charges
$1,168

## Regulations

**Date for Payment of Fees:** All general student fees for each semester are paid in advance on the corresponding registration day.

**Deferred Payment of Fees:** As a general rule, no deferred payment of fees is granted. However, in very exceptional cases, the Dean of Students is authorized to grant an extension of time which cannot exceed 10 days before the end of the

course. In those exceptional cases, a student must apply for deferred payment of fees in ample time prior to the registration date so that the merits of the application may be evaluated. On registration day, those students to whom deferred payment of fees is granted, must pay 100% of Special Fees plus the corresponding percent of Tuition Fees. The balance must be paid at least 10 days before the last day of classes of the semester. Students who fail to pay accordingly must pay a late fee of $3.00 per credit.

Students who fail to settle their accounts with the university 30 days before the last day of classes every semester or the specified date for each Summer Session will receive no credit for their work, nor will the Registrar release any transcript of record or other official documents until all outstanding fees and charges have been paid. All fees must be paid in United States currency, certified check, or postal money orders made out for the exact amount to the University of Puerto Rico.

## Reimbursements

**Fees**: Students who drop out of the University of Puerto Rico, Mayagüez Campus within the first two weeks of any semester or the first week of the Summer Session, are entitled to a 50 percent refund of tuition fees excluding special fees. The application for reimbursement must be approved by the corresponding Dean and the Registrar, and filed in the Treasurer's Office within five days following the date of approval. No refunds are allowed thereafter.

Visitors and students forced to withdraw for disciplinary reasons are not entitled to a refund of fees.

The Medical Services fee, the transfer and readmission fees, the construction fee, laboratory fee and late registration fees are not refundable.

## Return of University Property

Before leaving the university, the student must return, in good condition, all ROTC and AFROTC property and any other university properties that he or she may have used during the year. The ROTC and AFROTC property custodians will send a written notice to all students who do not return property. If the property is not returned within 30 days of notification, the individual's name will be forwarded to the Registrar. The value of any property that has been lost, damaged or not returned will be deducted from the total of his or her deposits.

The University will retain all fees and deposits not claimed by the end of the second semester of the academic year following payment. All books and/or library materials should be returned to the Library. If any of these materials are overdue, fines should also be paid. Failure to comply with these regulations will cause the student to be included in the Finance Department Debtor's List.

# *ACADEMIC INFORMATION*

## GRADUATE STUDIES PROGRAMS AT UPRM

UPRM offers graduate programs which lead to the degrees of Master of Arts, Master of Business Administration, Master of Engineering, Master of Science, and Doctor of Philosophy. The departments and programs of study are as follows:

**Master of Arts in:**
Cultural and Humanistic Studies, Hispanic Studies, English Education, English Literatures, and Kinesiology.

**Master of Business Administration in:**

Human Resources, Industrial Management, Finance, and General Business Administration.

**Master of Engineering in:**
Bioengineering, Chemical Engineering, Civil Engineering, Computer Engineering, Electrical Engineering, Industrial Engineering, Materials Science and Engineering, Mechanical Engineering and Software Engineering.

**Master of Science in:**
Agricultural Economics, Agricultural Economics (Online Program), Agricultural Education, Agricultural Extension, Agronomy, Animal Science, Horticulture, Crop Protection, Food Science and Technology, and Soils;

Biology, Chemistry, Geology, Marine Sciences, Applied Mathematics, Pure Mathematics, Statistics Mathematics, Teaching Mathematics at Secondary Level, Physics, Scientific Computing, and School Psychology with subspecialties in clinical and neuropsychology;

Bioengineering, Chemical Engineering, Civil Engineering, Computer Engineering, Electrical Engineering, Industrial Engineering, Materials Science and Engineering, Mechanical Engineering and Software Engineering.

**Doctor of Philosophy in:**

Marine Sciences, Applied Chemistry, Bioengineering, Chemical Engineering, Civil Engineering, Electrical Engineering, Mechanical Engineering, Computing and Information Sciences and Engineering, School Psychology with subspecialties in clinical and neuropsychology, Tropical Agriculture and Software Engineering.

## PHILOSOPHY AND OBJECTIVES

Graduate programs at UPRM seek to develop graduate students' expertise in their field of studies as well as their ability to conduct original research and/or creative, professional and community education projects in the fields of arts, sciences, engineering, agriculture and business. All graduate programs encourage and support students to attain a high level of scholarship and/or professional development in their fields.

Additional objectives of the graduate programs are:

1. To extend the boundaries of knowledge through original research committed to developing students' academic formation as well as their ability to contribute to the development of their surrounding communities.
2. To preserve, acquire, and transmit knowledge to successive generations.
3. To serve as a focus for research and teaching in the Caribbean, with the recognition of Puerto Rico's unique position as a crossroad of the Americas.

### Graduate Studies Organization

Graduate studies at UPRM are overseen by four basic units:

- Office of Graduate Studies
- Graduate Council
- Departmental Graduate Committee
- Student's Graduate Committee

The functions and responsibilities of these units are described below.

### Office of Graduate Studies

The Office of Graduate Studies (OGS) is an academic and administrative unit within the Office of Academic Affairs. The OGS oversees all academic and administrative regulations at the graduate level, manages graduate admissions, coordinates graduate student professional development activities, and serves as a liaison between graduate students, graduate programs and other units that pertain to graduate students'

admissions, enrollment, employment and support at UPRM.

The Director of Graduate Studies chairs this office. An Associate Director collaborates in all duties assigned by the Director.

In addition to the usual administrative duties, the Director presides over the Graduate Council, schedules final dissertation, thesis or project examinations, and participates in such exams personally or through the designation of a representative.

**The Graduate Council**

The Graduate Council is composed of representatives from all academic units which offer graduate programs. The Council consists of the Director and Associate Director of Graduate Studies, the Dean (or representative) of each college sponsoring graduate programs, a representative of each Departmental Graduate Committee, and a representative of the graduate students of each college.

The Council acts as an advisory board to the Office of Graduate Studies. Its main duties include:

- Serve as forum for the discussion of all matters pertaining to graduate studies.
- Make recommendations on the administration and regulations involving graduate studies.
- Evaluate and decide on regulations which a department submits for its own program.
- Evaluate and decide on those administrative and academic decisions of its jurisdiction.

**The Departmental Graduate Committee**

The Departmental Graduate Committee consists at least of three elected members, including the Director of the Department. In multidisciplinary programs, it includes representation from each department involved**.**

The functions and responsibilities of the committee include:

- Formulation of complementary regulations.
- Evaluation of applications for admission, readmission, and transfer.
- Accreditation of courses taken in other institutions or prior to admission to UPRM.
- Preparation of qualifying and comprehensive examinations with the assistance of qualified faculty.
- Promotion and periodic evaluation of graduate programs.

**The Student's Graduate Committee**

The committee consists of three to five members in Master's programs and four to six members in Doctoral programs. The student chooses the committee members and chair based on his/her research interests.

This committee is responsible for:

- Overseeing the preparation of the student's plan of study and, if applicable, its amendments.
- Revising and approving the student's dissertation, thesis, or project proposal.
- Directing studies and research until the student completes the degree.
- Revising and approving the dissertation, thesis, or project report and its oral defense (if included in the student's plan of study).

**The Graduate Advisor**

The student's graduate advisor must hold an academic degree equal to or higher than the degree sought by the student. The graduate advisor´s responsibilities include:

- Informing the student of regulations and procedures related to graduate studies.
- Overseeing, in consultation with the student and the student’s committee, the preparation of the student’s plan of study.
- Revising and approving the dissertation, thesis, or project proposal, and recommending changes.
- Meeting regularly with the student to evaluate academic progress, research and/or project development.
- Providing adequate resources to carry out research.

- Verifying that other members of the graduate committee collaborate efficiently.

**The Representative of Graduate Studies**

The representative of graduate studies is a professor or professional who is appointed by, and represents, the Director of Graduate Studies in the oral examination of the dissertation, thesis, or project report. The representative of the OGS cannot belong to the same department or the same program of study of the student who is under examination. The representative oversees the examination of the dissertation, thesis, or project report and ensures that it takes place according to regulations. The representative participates in the administration, evaluation and decisions concerning the exam, and makes corrections and changes to improve the final document.

**Application Procedure**

A candidate for admission to graduate studies at UPRM must file an online application with the Office of Graduate Studies at https://admisiones.upr.edu. Additional supporting documents are required. Information about these requirements is available at https://www.uprm.edu/oeg/en/home/

**Admission**

Admission to graduate studies requires the favorable recommendation of the Departmental Graduate Committee. The department forwards its recommendation to the Director of the Office of Graduate Studies for final action.

**Academic Requirements**

General requirements for admission to graduate studies include:

1. Holding a bachelor's degree from the University of Puerto Rico or an equivalent degree from an accredited institution.
2. Have a working knowledge of Spanish and English, as determined by the corresponding academic program.
3. Satisfying one of the following academic index requirements:
   (a) a minimum graduation 2.50 GPA;
   (b) a minimum 3.00 GPA in the area of specialization;
   (c) successfully completed a minimum of 60 credit hours during the last five semesters of the bachelor's program with a 3.00 GPA or better.
4. Satisfying all departmental requirements, which may include, but are not limited to, holding a bachelor's degree in an area of specialization, having a grade point average higher than 3.00, and having successfully completed courses in specific subjects, along with the required exams such as GRE, TOEFL, etc.

Detailed regulations are available in the departmental sections of this catalogue.

Applicants who do not meet the academic index requirements listed under (3) above, but who have practiced their profession for a minimum of three years, may be considered for regular admission if they obtain admission as a professional improvement student and successfully complete, with at least a 3.00 G.P.A., a minimum of nine credits in advanced undergraduate and/or graduate courses during the first three semesters following admission. Up to twelve credits successfully completed under this provision may be credited towards a degree if the applicant is admitted as a graduate student.

Meeting the above requirements does not automatically grant admission. Candidates are elected on a competitive basis from among those who apply and satisfy the requirements.

**Readmission and Transfer**

Students who have voluntarily interrupted their studies and desire to continue later must apply for readmission. The student will pay a non-refundable fee of US $40 (late: US $57.50).

Students in good standing (with a GPA of at least 3.00) are eligible to apply for transfer to another department or program within the Mayagüez Campus. The student will pay a non-refundable fee of US $25 (late: US $35).

In both cases, the application must be filed at the Registrar's Office before the deadline established in the official academic calendar. The department director will send his/her recommendation to the director of graduate studies for final action. The allowable time periods for completing the studies are stipulated in the Academic Senate's Certification 09-09.

## STUDENT CLASSIFICATION

Graduate students at UPRM are classified according to

- admission status
- academic load
- academic status

**Admission Status**

A student with **Full Admission** is one who at the time of admission satisfies all requirements and is admitted unconditionally.

A student with **Conditional Admission** is one who at the time of admission satisfies all requirements except for some deficiencies in undergraduate courses (up to four maximum). Full-standing status can be granted once the student successfully removes the deficiencies within the first two years of study. Courses with deficiencies must be passed with a grade of C or better maintaining a grade point average of 3.00 or better.

A **Professional Development** student is one who does not seek a graduate degree, but desires to take advanced undergraduate or graduate courses for academic or professional benefit. Up to 12 credits of advanced undergraduate or graduate courses successfully completed under this classification may be used to satisfy degree requirements if the student is conditionally or fully admitted.

A **Visiting Student** is one registered at another university and who registers in a course at the Mayagüez Campus. Up to 12 credits of advanced undergraduate or graduate courses successfully completed under this classification may be used to satisfy degree requirements if the student is conditionally or fully admitted.

## Academic Load

A **Regular** or **Full-time** student is one who takes at least nine advanced undergraduate or graduate credits per semester, including deficiency courses, and/or who is registered for dissertation, thesis, or project, or who participates in the COOP Plan.

An **Irregular** or **Part-time** student is one who does not meet the academic load requirements of a regular student.

**Academic Status**

A student on **Probation** is one whose grade point average drops below 3.00 or receives a non-satisfactory (NS) grade for dissertation, thesis research, or project**.** Increasing the grade point average to 3.00 or above, or receiving a satisfactory (S) grade in research or project, removes the probation status. Probation for a third time will lead to academic suspension from graduate studies. Suspended students may apply for a second and final admission to graduate studies after one year of suspension.

A student in **Good Standing** is one who is not on probation.

## GRADES

**The Grading System** is as follows: A, excellent; B, satisfactory; C, approved; D or F, failed; W, authorized withdrawal; I, incomplete (does not carry a provisional grade); S, satisfactory; NS, not satisfactory. Incompletes must be removed during the term following the one in which the course was registered; otherwise an F will be posted. The Academic Index or grade point average is computed as a weighted average (by credit) using these point equivalencies A=4, B=3, C=2, D=0, F=0. Courses with an incomplete grade are not included. Credit for thesis research or project is not given until the oral examination of the thesis, dissertation or project is successfully passed and the final report is completed and submitted. A graduate grade point index of 3.00 is considered satisfactory and it is the minimum required for graduation.

## GRADUATE COURSE NUMBERING SYSTEM

Advanced undergraduate courses are codified in the 5000's. Graduate courses are codified with numbers between 6000 and 8999. Courses codified between 8000 and 8999 are intended for the doctoral level.

***ALPHABETICAL DISCIPLINE CODES***

ADMI BUSINESS ADMINISTRATION
AGRO AGRONOMY
ASTR ASTRONOMY
BING BIOENGINEERING
BIOL BIOLOGY
BOTA BOTANY
CIAN ANIMAL SCIENCE
CIIC COMPUTER AND INFORMATION SCIENCES AND ENGINEERING
CIIM MATERIAL SCIENCE AND ENGINEERING
CIMA MARINE SCIENCES
CITA FOOD SCIENCE AND TECHNOLOGY
CMOB MARINE SCIENCES BIOLOGICAL OCEANOGRAPHY
CMOF MARINE SCIENCES PHYSICAL OCEANOGRAPHY
CMOG MARINE SCIENCES GEOLOGICAL OCEANOGRAPHY
CMOQ MARINE SCIENCES CHEMICAL OCEANOGRAPHY
COMP COMPUTER SCIENCE
CONT ACCOUNTING
ECAG AGRICULTURAL ECONOMICS
ECON ECONOMICS
EDAG AGRICULTURAL EDUCATION
EDFI PHYSICAL EDUCATION
EDMA TEACHING MATHEMATICS
EING ENGLISH EDUCATION
ESCH CULTURAL AND HUMANISTICS STUDIES
ESHI HISPANIC STUDIES
ESMA MATHEMATICAL STATISTICS
ESTA STATISTICS
EXAG AGRICULTURAL EXTENSION
FINA FINANCE
FISI PHYSICS
GEIN INDUSTRIAL MANAGEMENT
GEOL GEOLOGY
GEOP OPERATIONS MANAGEMENT
GERE MANAGEMENT
GERH HUMAN RESOURCES MANAGEMENT
HORT HORTICULTURE
ICOM COMPUTER ENGINEERING
INCI CIVIL ENGINEERING
INEL ELECTRICAL ENGINEERING
INGL ENGLISH
ININ INDUSTRIAL ENGINEERING
INME MECHANICAL ENGINEERING
INQU CHEMICAL ENGINEERING
INTD INTERDISCIPLINARY
INSO SOFTWARE ENGINEERING
KINE KINESIOLOGY
LING LINGUISTIC
MATE MATHEMATICS
MECU QUANTITATIVE METHODS
MERC MARKETING
PSIC PSYCHOLOGY
PROC CROP PROTECTION
QUIM CHEMISTRY
REHU HUMAN RESOURCES MANAGEMENT
SICI COMPUTERIZED INFORMATION SYSTEMS
UNIV UNIVERSITY COURSES
ZOOL ZOOLOGY

### Course Offerings

**I=course usually offered during the first semester**
**II=course usually offered during the second semester**
**S=course usually offered during a summer session**

**PLAN OF GRADUATE STUDY**

The student's Plan of Graduate Study should be submitted to the Registrar's Office (original) and the Office of Graduate Studies (copy) by the beginning of the second semester of the student's enrollment as a graduate student at UPRM. This plan must be approved by the student's committee members, the Graduate Program Coordinator and the Department Chair.

**PROPOSAL**

Graduate students pursuing a degree in which a dissertation, thesis, or project is required must submit a proposal describing goals, objectives, previous work, justification, and proposed work. This document must be completed before the student is registered for master's thesis, or project credit for a third time or doctoral dissertation for a fourth time.

# GENERAL ACADEMIC REGULATIONS FOR GRADUATE STUDENTS

**Academic Load**

The maximum academic load is eighteen credits during the academic semester and six credits during the summer. Class attendance is compulsory.

**Academic Residence**

Studying two academic semesters and successfully completing 60 percent of the courses at the Mayagüez campus satisfies residence requirements for the master's degree. Studying four academic semesters and successfully completing 60 percent of the courses at the Mayagüez campus satisfies residence requirements for the doctoral degree.

**Validations**

A maximum of fifteen credits in elective courses at 5000 level or higher taken at the UPR and approved with an A or B grade can be part of the graduate student's plan of studies if validated by the Departmental Graduate Committee. Of these fifteen credits, it will be allowed to validate up to a maximum of nine credits in courses at 5000 level. The number of validated courses cannot be in conflict with the academic requirements established by the UPRM.

**Repetition of Courses**

Courses not completed successfully may be repeated once up to a maximum of three advanced undergraduate or graduate courses, including courses with a grade of C.

**Withdrawal from Courses**

Graduate students should avoid withdrawing from courses but can do so during the period prescribed in the official academic calendar. Graduate students must be careful to comply with Certification 09-09 and Certification 05-62 of the Academic Senate.

**Withdrawal from the University**

A student may withdraw completely from the Mayagüez campus at any time until the last day of classes. The Registrar will post a "W" in every course for the applicable semester. Any student intending to continue graduate work who has withdrawn from Graduate Studies is eligible for readmission within the stipulations of Certification 09-09 (Academic Senate).

**Academic Dismissal**

A graduate student may be dismissed from the graduate school if any of the following conditions occur:

1. During the first two years of study, deficiency courses indicated in the conditional admission are not successfully completed with a 3.0 GPA or higher.
2. Placed on probation three times.
3. Fails for the second time any of the required degree examinations.
4. Fails to satisfy all requirements for a master's degree within six academic years after being admitted.
5. Fails to satisfy all requirements for a doctoral degree within ten academic years if admitted with a bachelor's degree, or within eight academic years if admitted with a master's degree.

# REQUIREMENTS FOR THE MASTER'S DEGREE

At UPRM, there are four options in programs leading to a master's degree. Applicants should seek information on the program of interest to best determine available options.

In all cases, the student needs to complete all courses in the Plan of Graduate Study with a GPA of at least 3.00. Graduate courses taken by the student as an undergraduate within the UPR system may be accepted up to a maximum of fifteen credits as long as courses were approved with B or higher.

**PLAN I. With Thesis Requirement**

In addition to the common requirements stated above, the student shall:

1. Pass all the courses in the Plan of Graduate Study with a 3.0 minimum graduate point average and complete:
   (a) The minimum number or credits required by the academic program.
   (b) Up to nine credits in advanced undergraduate courses.
   (c) Up to six credits in thesis research.
   (d) A minimum of six credits in courses related to, but outside the area of interest.
2. Carry out a research project, as specified in the Plan of Graduate Study and prepare a thesis.
3. Pass an oral exam on the thesis subject. If the student fails the exam, the student will have the opportunity to take a second exam during the same semester or in the following semester within the stipulations of Academic Senate's Certification 09-09. The result of the second exam shall be final.

**PLAN II. With Project Requirement**

In addition to the common requirements stated above, the student shall complete specific requirements in PLAN I´s description, except that all work completed will lead to a project report instead of a thesis. An oral exam on the project will also be required. If the student fails the exam, a second exam can be taken in the same or following semester. The result of the second exam shall be final.

**PLAN III. Without Thesis or Project Requirements**

In addition to the common requirements stated above, the student shall:

1. Complete all courses in the Plan of Graduate Study as follows:
   (a) The minimum number or credits required by the academic program.
   (b) Up to nine credits in advanced undergraduate courses.
   (c) A minimum of six credits in courses related to, but outside the area of specialization. Courses within the area of specialization will be used to satisfy this requirement only when there are two or more distinct and well-defined areas.
2. If required by your program, pass a written examination on the material covered in courses taken within the area of specialization. In the event of failure, the student may take a second exam during the same semester or in the following semester within the stipulations of Certification 09-09. The result of the second exam shall be final.

## REQUIREMENTS FOR THE DOCTOR OF PHILOSOPHY DEGREE

The Doctor of Philosophy degree is conferred for distinguished scholarly attainment and original contribution to knowledge.

To qualify for the degree, the student should:

1. Pass a qualifying examination.
2. Complete all the courses in the Plan of Graduate Study with an academic index of at least 3.00, including other requirements.
3. Comply with the academic residence requirements.
4. Pass a comprehensive examination on the courses included in the academic program. The exam may be written or written and oral. If the student fails, a second exam may be taken later that semester or in the following semester within the stipulations of Certification 09-09. The result of the second exam is final.
5. Carry out an independent research project which will produce a significant contribution to the advancement of knowledge and write a dissertation. The dissertation should be a scholarly presentation suitable for publication.
6. Pass a final oral exam on the research and dissertation. If the student fails, a second exam may be taken later during the same semester or in the following semester within the stipulations of Certification 09-09. The result of the second exam is final.
7. Complete all courses in the Plan of Graduate Study as follows:
   (a) Up to nine advanced undergraduate courses.
   (b) Up to eighteen credits in thesis research.
   (c) A minimum of nine credits outside the field of specialization but in related areas.
8. Courses completed before admission to the doctoral program may be accepted upon recommendation of the departmental graduate committee, as long as the student

meets residence requirements. Master's thesis, or Master's project research will not be awarded credit.

## FINAL EXAMINATION

The final thesis or dissertation exam takes place after the student has satisfied all other requirements for the degree, except for any courses in which the student is registered at the time. No exam will take place after the last day of classes. The exam should last at least two hours but no more than four.

The examining committee consists of the student's committee and a representative of the Director of Graduate Studies. The examining committee will be presided by the student's advisor. All corrections to the thesis or report should be completed within the period specified by the committee. Such period shall not extend beyond the last day of school of the semester immediately following the day the exam was taken.

**Additional Graduation Requirements**

In addition to the requirements specified in the section on general academic regulations, the student must:

1. Satisfy all financial obligations to the University of Puerto Rico, Mayagüez Campus.
2. File an application for the degree at the Registrar's Office before the deadline established in the official academic calendar.
3. Receive recommendation for the degree by the Faculty.

UPRM celebrates commencement exercises once during the academic year at the end of the second semester. Students who meet their course requirements for the degree at the end of the summer session or at the end of the first semester may apply at the Registrar's Office for a certificate indicating that they have completed their studies but will receive their degree at commencement.

## GUIDE FOR THE PREPARATION OF PROPOSALS, DISSERTATIONS, THESES, AND PROJECT REPORTS

Please refer to the Office of Graduate Studies website https://www.uprm.edu/oeg/en/home//.

# *COLLEGE OF AGRICULTURAL SCIENCES*

The College of Agricultural Sciences is the unit within the Mayagüez Campus where formal teaching, research, and extension in agricultural sciences are integrated. The three functions are mutually complementary and are under a central scheme of a three-dimensional organization that includes the Faculty of Agricultural Sciences, the Agricultural Experiment Station, and the Agricultural Extension Service.

University teaching in the field of agriculture began formally in Puerto Rico in 1911 with the establishment of the College of Agriculture at Mayagüez. Graduate instruction in agricultural sciences began in 1963-64 with the approval of the Master of Science degrees in Agricultural Economics, Agricultural Education, Agricultural Extension, Horticulture, Animal Science, Agronomy, and Soils. A program leading to the M. S. in Crop Protection was approved in 1981-82, and in Food Science and Technology in 1990-91. In 2021 an online M.S. in Agricultural Economics was established and in 2023 the Professional Master's in Food Science and Technology and the Ph.D. in Tropical Agriculture.

The Agricultural Experiment Station of the University of Puerto Rico was originally established in 1910 as a private entity of the Sugar Producers' Association of Puerto Rico. In 1914 it was transferred to the Government of Puerto Rico. With the Jones Act of 1917, the Agency became part of the Department of Agriculture and Labor and it was given the name "Insular Experiment Station". In 1933 the Experiment Station was transferred to the University of Puerto Rico.

The Smith-Lever Act of 1914 created the Cooperative Extension Service. In Puerto Rico, the establishment of the Agricultural Extension Service in 1934, was made possible by an understanding between the United States Department of Agriculture and the University of Puerto Rico.

The College of Agricultural Sciences was created in accordance with Public Law No. 1, approved on January 20, 1966, known as the University Law, and Certification No. 13 of the Council of Higher Education, dated September 11, 1968, integrating within the Mayagüez Campus the formal teaching, research, and extension in agricultural sciences. A management team, composed of the Dean and Director of the College of Agricultural Sciences, the Associate Dean of the Faculty of Agricultural Sciences, the Associate Dean and Deputy Director of the Agricultural Experiment Station, and the Associate Dean and Deputy Director of the Agricultural Extension Service, provides direction for the plans and programs of the College.

The Mayagüez Campus is one of two Land-Grant universities in the tropics and the only one where Spanish is the native language (although the English language is also used extensively). The Campus provides a unique setting and, to some extent, is in a privileged position to serve as an international center for studies, training, and research in the fields of agricultural sciences. At the Graduate level, the Faculty of Agriculture offers study programs leading to the Master of Science degree in Animal Science, Agricultural Economics, Agricultural Education, Agricultural Extension, Agronomy, Soils, Crop Protection, Food Science and Technology, and Horticulture. In addition, a Doctorate of Philosophy (PhD) degree in Tropical Agriculture (PhD).

Besides the library, laboratories, and farm facilities for research at the Mayagüez Campus, facilities are also available at the Río Piedras Research Center (AES) and at the six research substations located at different geographic regions of Puerto Rico. The Substations at Adjuntas and Corozal are located in the central, humid mountain region. Those at Lajas and Juana Díaz are in the dry, flat coastal southern region. The Substation at Isabela is in the sub-humid northern region and the Gurabo Substation is in the east central region. This wide distribution allows for the evaluation of different crops and animal production systems in the ecological zones where they best adapt.

Also, the USDA Tropical Agriculture Research Station (TARS), adjacent to the Mayagüez Campus, offers technical assistance and makes available to the graduate students its Library and other physical facilities for research.

**Website:** https://www.uprm.edu/ciag/

# DEPARTMENT OF AGRICULTURAL ECONOMICS

The Department of Agricultural Economics and Rural Sociology offers a program leading to the degree of Master of Science in Agricultural Economics.

Since Fall 2021, this degree has been offered fully online. It is the first fully online master's degree at the University of Puerto Rico, Mayaguez Campus. The online master's degree emphasizes the application of agricultural economic knowledge to problems facing farms, agribusiness and the food industry. The master's degree will develop leaders in the agricultural sector that will have knowledge and skill in new technologies.

In addition to the admission requirements of the Office of Graduate Studies, a bachelor's degree in Agricultural Economics or its equivalent is required. There are no specific program requirements above those of the Office of Graduate Studies. All students are required to conduct original research and to write a thesis. A strong knowledge of macroeconomics, microeconomics, and quantitative methods is needed for every candidate willing to pursue the degree.

It is possible for students to focus their thesis research on the department's research projects. The research facilities of the Agricultural Experiment Station are available to students.

The program includes course offerings and research opportunities in the following areas: Agricultural Production Economics, Farm Management, Marketing, Natural Resource Economics, Global Marketing and others.

**Website:** https://www.uprm.edu/ciag/ecag/

**Curricular Sequence**

The curricular sequence of the Master of Science in Agricultural Economics is established in coordination between the student, the advisor, and the director of the program. The student's Plan for Graduate Study will be prepared by the committee while taking into consideration the student's individual needs. The curricular sequence requires that students take a total of **30 credits:**

- **12 credits (core courses)** offered by the Department of Agricultural Economics and Rural Sociology
- **6 credits in thesis research**
- **6 credits (major courses)** that must be taken as elective courses offered by the Department of Agricultural Economics and Rural Sociology
- **6 credits (electives courses)** that must be taken from other departments.

However, as occurs for the present on-campus program, each student will be evaluated individually and assessed if he/she must take deficiency (makeup) courses (e.g., economic theory, applied statistics, calculus, crop production, animal science, among others). As per Certification SA 09-09, a student in *Conditional Standing* is one who at the time of admission satisfies all requirements except for some deficiencies in undergraduate courses (up to four maximum).

Ideally, students will be able to complete the program in two years. The current average completion time (for on-campus students) is four (4) years. The completion time varies from student due to the number of deficiencies, academic progress, thesis topic, and research data to collect.

The curricular sequence is as follow:

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| ECAG 6665 | 3 | Applied Econometrics I |
| ECAG 6611 | 3 | Economics of Agricultural Production |
| ECAG 6XXX | 3 | Elective (major) course from the department |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| ECAG 6660 | 3 | Agricultural Prices |
| ECAG 6651 | 3 | Elements of Applied Mathematical Economics I |
| ECAG 6XXX | 3 | Elective (major) course from the department |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| ELECTIVE | 3 | Elective from another department |
| ECAG 6999 | 3 | Research in Agricultural Economics |
| | 6 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| ELECTIVE | 3 | Elective from another department |
| ECAG 6999 | 3 | Research in Agricultural Economics |
| | 6 | |

**Total Credits 30**

**AGRICULTURAL ECONOMICS FACULTY**

A list of professors who engage in graduate activities in the Department follows, including the highest earned degree, date, and institution granting the degree. Research and teaching interests are also included.

**ALICIA V. BARRIGA-BURGOS**, *Assistant Professor* (Agricultural and Resource Economics), Ph.D., 2020, University of Connecticut. Research and Teaching interests: Agricultural and Resource Economics; Development Economics; and Global Health.

**VIVIAN CARRO-FIGUEROA**, *Professor*, M.A., 1976, University of London. Research and Teaching interest: Rural Sociology.

**MYRNA COMAS-PAGÁN**, *Professor*, (International Business), Ph.D., 2009, University of Puerto Rico. Research and Teaching interests: Farm Management, Agricultural Marketing, and Food Supply.

**MILDRED CORTÉS-PÉREZ**, *Professor* (Economics), M.A., 1995, University of Puerto Rico, Río Piedras Campus. Research and Teaching interest: General Economics.

**LETICIA GAYOL SANTNA**, *Auxiliary Extension Specialist-External Resources* (Social Work), Ph.D., 2018, University of Puerto Rico, Río Piedras Campus. Research interests: Public Policy, and social work.

**GLADYS M. GONZÁLEZ-MARTÍNEZ**, *Professor* (Natural Resources Economics), Ph.D., 1984, University of Missouri. Research and Teaching interests: Natural Resources Economics, Land Use, Production Economics.

**JULIO C. HERNÁNDEZ-CORREA,** *Associate Professor***,** (Applied Economics), Ph.D., 2010, Western Michigan University, Kalamazoo**.** Research and Teaching interests: Agricultural Economic Development, Econometrics, Health Economics, International Business, Demography Economics, and Program Evaluation.

**ALEXANDRA GREGORY-CRESPO**, *Professor*, (Agricultural Economics), Ph.D., 2008, Kansas State University. Research and Teaching interests: Consumer Economics and Computers in business.

**ALWIN J. JIMÉNEZ-MALDONADO**, *Professor* (Agricultural Economics), Ph.D., 2011, Pennsylvania State University, University Park, PA. Research interest: Production and Risk Management; Financial Management.

**GERMÁN RAMOS-CARTAGENA**, *Associate Professor* (Sustainable Community Development), Ed.D., 2008, University of Puerto Rico.

**ROBINSON RODRÍGUEZ-PÉREZ**, *Professor* (Rural Sociology), Ph.D., 2005, State University of New York, Binghamton. Research and Teaching interests: Communities Development and Rural Development.

**HÉCTOR S. TAVÁREZ-VARGAS,** *Associate Professor***,** (Environmental Sciences, Economics), Ph.D., 2016, University of Idaho, Moscow**.** Research and Teaching interests: Environmental and Natural Resource Economics, Experimental Economics, Regional Development, Economic Valuation and Computers use.

# DEPARTMENT OF AGRICULTURAL EDUCATION

**Mission**

- Contribute to improving the quality of life in our communities.
- Commitment to preparing formal and non-formal educators, communicators and leaders have a successful performance in educational institutions and community development.
- Serve as a catalyst in the College of Agricultural Sciences for the dissemination of knowledge and practices among farmers, youths, housewives and community leaders.
- Serve catalyst agent in the College of Agricultural Sciences to establish the impact on educational and research programs of the different academic programs.
- Contribute to the educational, cultural, social, technological and economic development of global society.
- Strengthen the training of educators and communicators leaders to facilitate the process of teaching-learning innovative and creative research.
- Encourage critical thinking to insert ourselves successfully in public policy issues affecting the agricultural sector and community welfare.
- Prepare researchers to work on social issues of agriculture, natural resources, youth and community development.

**Vision**

Being recognized locally, nationally, and internationally for driving research and disseminate information of good quality, to develop curricula and academic programs dynamic and relevant to education, both formal and non-formal; fully prepare educators for agriculture, natural resources, environmental management, individual development, family and community. Stand for excellence at the local, national and international level in the social research and the training of educators and communicators leaders for agricultural and community development, relevant to the times and global society.

**Program Description**

The Department of Agricultural Education offers programs leading to a Master of Science degree with emphasis in Agricultural Education and Extension Education. In addition to the admission requirements of the Office of Graduate Studies, a Bachelor of Arts in Home Economics, a Bachelor of Science degree in Agricultural Education, in Agriculture, in Home Economics or its equivalent is required.

**Program Educational Objectives**

1. To provide an education of excellence that promotes competitive intellectual and scientific training.

2. Promoting a program that is at the forefront of intellectual and scientific knowledge to respond in turn to the aspirations of students and the global society.

3. Encourage leadership and teamwork among the faculty and students.

4. Encouraging creativity of the university community through special research projects of an interdisciplinary nature which contribute significantly to the development of society.

5. Fostering a climate of peaceful coexistence in which they use the human and physical resources to encourage reflection and critical thinking.

6. Offer guidance, counseling and skills necessary to facilitate the optimum development of the intellectual and personal potential of students.

7. Encourage students to use the latest technology in the seeking knowledge and in everyday lite.

**Courses that fulfill the general education requirements**

Graduate programs include the following areas: Teaching Methods, Farming Programs, Evaluation, Curriculum Designs and Construction, Adult Education, Program Planning, Organization and Administration in Education, Community Organization, Communication and Supervision.

The total credits required for the Master of Science degree for **both programs is 30**, including: 21 credits in the study program, 6 credits outside the area of study, but in related areas and 3 credits of Research and Thesis.

The curricular sequence is as follow:

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| EDAG 6607 | 3 | Research Processes |
| EXAG 6640 | 3 | Social Research Methods |
| EDAG XXXX or EXAG XXXX | 3 | Concentration course |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| EDAG XXXX or EXAG XXXX | 3 | Concentration course |
| EDAG XXXX or EXAG XXXX | 3 | Concentration course |
| EDAG XXXX or | 3 | Elective course |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| EDAG XXXX or EXAG XXXX | 3 | Concentration course |
| EDAG XXXX or EXAG XXXX | 3 | Concentration course |
| EDAG XXXX or | 3 | Elective course |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| EDAG 6999 | 3 | Research and Thesis |
| | 3 | |

**Total Credits. 30**

**Agricultural Education Program**

| Number | Credits | Course |
|---|---|---|
| EDAG 6601 | 3 | Advanced Teaching Methods in Vocational Agriculture |
| EDAG 6602 | 3 | Agricultural Programs |
| EDAG 6603 | 3 | Evaluation |
| EDAG 6605 | 3 | Training for Teachers |
| EDAG 6607 | 3 | Research Processes |
| EDAG 6608 | 3 | Preparation of Instructional Materials |
| EDAG 6610 | 3 | Seminar in Agricultural Education |
| EDAG 6611 | 3 | Curriculum Development |
| EDAG 6612 | 3 | Adult Education in Vocational Agriculture |
| EDAG 6631 | 3 | Organization and Administration in Vocational Agriculture |
| EDAG 6671 | 3 | Program Planning |
| EDAG 6999 | 6 | Research and Thesis |

**Agricultural Extension Program**

| Number | Credits | Course |
|---|---|---|
| EXAG 6601 | 3 | Communications and Leadership Development |
| EXAG 6603 | 3 | Oral and Written Communication |
| EXAG 6610 | 3 | Principles of Teaching and Extension |
| EXAG 6612 | 3 | Psychology in Extension |
| EXAG 6614 | 3 | Administration and Supervision in Extension Education |
| EXAG 6616 | 3 | Research in Extension Education |
| EXAG 6620 | 3 | Extension Evaluation |
| EXAG 6622 | 3 | Extension Program Development |
| EXAG 6628 | 3 | Advanced Extension Seminar |
| EXAG 6630 | 3 | Principles and Philosophy in Adult Education |
| EXAG 6640 | 3 | Social Research Methods |
| EXAG 6642 | 3 | Rural Youth Problems |
| EDAG 6999 | 6 | Research and Thesis |

**Website:** https://www.uprm.edu/edag/

## DEPARTMENTAL FACULTY

A list of professors who engage in graduate activities in the Department follows, including the highest earned degree, date, and institution granting the degree. Research and teaching interests are also included.

**SANTIAGO ARIAS VEGA**, *Retired Professor* (Ad honorem) MS., 1988, University of Puerto Rico, Mayagüez Campus.

**LORNA I. CAMPOS MUÑOZ,** *Food and Nutrition Specialist* – EFNEP, LND, RD, MHScN, 2002, University of Puerto Rico, Medical Sciences Campus, Río Piedras. ***Research and Teaching Interests:*** Register Dietitian Food and Nutrition Education, Renal, Diabetes and Inborn Errors of Metabolism Certifications.

**JANIS DEL ROSARIO MORALES**, *Assistant Specialist,* Specialist in Positive Youth Development. 4-H Specialist, Ph.D., 2021, University of Puerto Rico, Río Piedras. ***Research and Teaching Interests:*** Curriculum and teaching; General Education; Fine Arts (Theater, Dance, Music, Art); Diction (Vocal Expression Skills)

**IVYS A. FIGUEROA SÁNCHEZ,** *Professor,* DPH, 2009, University of Puerto Rico, Medical Sciences Campus. ***Research and Teaching interests:*** Public Health.

**YVONNE LARACUENTE BERNAT,** *Extension Specialist Auxiliary in Gerontology*, Inter-American University of Puerto Rico, San Germán Campus Ph.D., 2019, ***Research and Teaching Interests:*** Ageism, dementia and technology use in older adults.

**IRCHA I. MARTÍNEZ RODRÍGUEZ**, *Associate Extension Specialist in Consumer Education,* Ph.D. 2016, Specialist in Family and Consumer Sciences; Educational Leadership, University of Puerto Rico - Rio Piedras Campus. ***Research and Teaching Interests:*** Personal finance; Saving; Consumer Education; Entrepreneurship; Leadership.

**GLORISELLE NEGRÓN RÍOS**, *Associate Professor, Specialist in Environmental Health*, M.A., 1994, University of Puerto Rico, Medical Sciences Campus. ***Research and Teaching Interests:*** Drinking and wastewater quality and air quality.

**DAVID PADILLA VÉLEZ**, *Professor*, Ph.D., 1993, Ohio State University. ***Research and Teaching Interests:*** Agricultural Education, Teacher Education.

**ROBERTO L. RIGAU LLORÉNS**, *Professor*, EdD., 2022, University of Phoenix. ***Research and Teaching Interests:*** External Resource.

**JANITZA SAAVEDRA LUGO**, *Assistant Professor*, Ed.D., 2018, Pontifical Catholic University of Puerto Rico, ***Research and Teaching Interests*:** Curriculum Development, Teachers Preparation in Agricultural Education, Youth Organizations, Educational Leadership.

**EDLY SANTIAGO ANDINO**, *Professor*, Ph.D., 2005, Pennsylvania State University. ***Research and Teaching Interests:*** Teachers Preparation in Agricultural and Environmental Education, Adult Education, Curriculum Development, Active and Experiential Learning.

**LUIS F. SILVA GUERRERO**, *Retired Professor* (Ad honorem) Ph.D., 1988, University of Cornell.

# DEPARTMENT OF AGROENVIRONMENTAL SCIENCES

The Department of Agro Environmental Sciences offers a graduate curriculum leading to a Master of Science (M.S.) degree in the program areas of Agronomy, Crop Protection, Horticulture, and Soils. In addition to the admission requirements of the Office of Graduate Studies, a Bachelor of Science or its equivalent is required, but a degree in Agricultural Sciences is preferred.

The M.S. degree is oriented towards research, and students must present and defend a six credits thesis project. The research thesis will be supervised by the student's Primary Advisor and Graduate Committee. Although there are no specific course requirements, graduate students are expected to take at least a graduate seminar course, and 3 credits in agricultural biometrics. At least 30 graduate credits are required to complete the M.S. degree, including thesis research.

The graduate program emphasizes in sustainable and environmentally sound research that increases the efficiency of crop production, assists in the use and development of cropland, forest and water resources, and improves the overall quality of the human environment in rural and urban settings. Teaching and research facilities include laboratories, greenhouses, and an on-campus experimental farm, and seven research centers of the Agricultural Experiment Station located off-campus.

General areas of specialty within each program area are described below. Opportunities for development of thesis projects, within these specialties, can vary depending on departmental resources (external funding) and availability of academic faculty to supervise research. Applicants can contact the Department Director or individual faculty members to learn about research opportunities.

**Webpage:** https://www.uprm.edu/ciag-ciagro/

## PROGRAM OF AGRONOMY

The Agronomy program leads to a Master of Science. Students may specialize in plant breeding, production and management of agronomic crops, crop ecology, crop physiology, crop modeling, or management of forestry and water resources.

**Program Learning Outcomes**

- To provide an education of excellence with specialization in plant breeding, production and management of agronomic crops, crop ecology, crop physiology, crop modeling, or management of forestry and water resources.
- To encourage the creativity of the students and the university community through special research which contributes to the development of agriculture and society.

**Curricular Sequence**

The curricular sequence of the Master of Science in Agronomy is established in coordination between the student, the advisor, and the director of the program. The student's Plan for Graduate Study will be prepared by the committee while taking into consideration the student's individual needs. The curricular sequence requires that students take a **Minimum Total of 30 credits:**

- **18 credits in major courses** recommended by Student Graduate Committee
- **6 credits in thesis research**
- **6 credits in Related Area** recommended by Student Graduate Committee

However, as occurs for the present on-campus program, each student will be evaluated individually and assessed if he/she must take deficiency (makeup) courses (e.g., Basic soil, applied statistics, crop production, among others). As per Certification SA 09-09, a student in *Conditional Standing* is one who at the time of admission satisfies all requirements except for some deficiencies in undergraduate courses (up to four maximum).

Ideally, students will be able to complete the program in two years. The current average completion time (for on-campus students) is four (4) years. The completion time varies from student due to the number of deficiencies,

academic progress, thesis topic, and research data to collect.

The curricular sequence is as follow:

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| XXXX | 6 | Major course |
| ELECTIVE | 3 | Related Area Course |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| XXXX | 6 | Major course |
| ELECTIVE | 3 | Related Area Course |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| XXXX | 3 | Major course |
| AGRO 6999 | 3 | Research in Agronomy |
| | 6 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| XXXX | 3 | Major course |
| AGRO 6999 | 3 | Research in Agronomy |
| | 6 | |

**Total Credits 30**

## PROGRAM OF CROP PROTECTION

The Crop Protection program leads to a Master of Science. Students may specialize in entomology, nematology, plant pathology, and weed science. Research is focused on developing sustainable, biologically based, and crop management technologies to control economically important arthropods, nematodes, plant diseases, and weeds.

**Program Outcomes**

- To provide an education of excellence with specialization in entomology, nematology, plant pathology, and weed science.
- To promote research focused on developing sustainable, biologically based, and crop management technologies to control economically important arthropods, nematodes, plant diseases, and weeds.
- To encourage the creativity of the students and the university community through special research which contributes to the development of agriculture and society.

**Curricular Sequence**

The curricular sequence of the Master of Science in Crop Protection is established in coordination between the student, the advisor, and the director of the program. The student's Plan for Graduate Study will be prepared by the committee while taking into consideration the student's individual needs. The curricular sequence requires that students take a **Minimum Total of 30 credits:**

- **18 credits in major courses** recommended by Student Graduate Committee
- **6 credits in thesis research**
- **6 credits in Related Area** recommended by Student Graduate Committee

However, as occurs for the present on-campus program, each student will be evaluated individually and assessed if he/she must take deficiency (makeup) courses (e.g., Basic soil, applied statistics, crop production, among others). As per Certification SA 09-09, a student in *Conditional Standing* is one who at the time of admission satisfies all requirements except for some deficiencies in undergraduate courses (up to four maximum).

Ideally, students will be able to complete the program in two years. The current average completion time (for on-campus students) is four (4) years. The completion time varies from student due to the number of deficiencies, academic progress, thesis topic, and research data to collect.

The curricular sequence is as follow:

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| XXXX | 6 | Major course |
| ELECTIVE | 3 | Related Area Course |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| XXXX | 6 | Major course |
| ELECTIVE | 3 | Related Area Course |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| XXXX | 3 | Major course |
| PROC 6999 | 3 | Research in Crop Protection |
| | 6 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| XXXX | 3 | Major course |
| PROC 6999 | 3 | Research in Crop Protection |
| | 6 | |

## Total Credits 30

### PROGRAM OF HORTICULTURE

The Horticulture program leads to a Master of Science. Students may specialize in the application of ecological, sustainable, organic, and conventional concepts and principles to improve the production and management of vegetables, starchy crops, fruits, coffee, ornamentals, landscapes, and other intensively cultivated/high value commodities**.** Physiological regulation and manipulation in horticultural crops, and postharvest management are other areas of specialization.

**Program Outcomes**

- To provide an education of excellence with specialization in the application of ecological, sustainable, organic, and conventional concepts and principles to improve the production and management of vegetables, starchy crops, fruits, coffee, ornamentals, landscapes, and other intensively cultivated/high value commodities**.** Physiological regulation and manipulation in horticultural crops, and postharvest management are other areas of specialization.
- To encourage the creativity of the students and the university community through special research which contributes to the development of agriculture and society

**Curricular Sequence**

The curricular sequence of the Master of Science in Horticulture is established in coordination between the student, the advisor, and the director of the program. The student's Plan for Graduate Study will be prepared by the committee while taking into consideration the student's individual needs. The curricular sequence requires that students take a **Minimum Total of 30 credits:**

- **18 credits in major courses** recommended by Student Graduate Committee
- **6 credits in thesis research**
- **6 credits in Related Area** recommended by Student Graduate Committee

However, as occurs for the present on-campus program, each student will be evaluated individually and assessed if he/she must take deficiency (makeup) courses (e.g., Basic soil, applied statistics, crop production, among others). As per Certification SA 09-09, a student in *Conditional Standing* is one who at the time of admission satisfies all requirements except for some deficiencies in undergraduate courses (up to four maximum).

Ideally, students will be able to complete the program in two years. The current average completion time (for on-campus students) is four (4) years. The completion time varies from student due to the number of deficiencies, academic progress, thesis topic, and research data to collect.

The curricular sequence is as follow:

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| XXXX | 6 | Major course |
| ELECTIVE | 3 | Related Area Course |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| XXXX | 6 | Major course |
| ELECTIVE | 3 | Related Area Course |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| XXXX | 3 | Major course |
| HORT 6999 | 3 | Research in Horticulture |
| | 6 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| XXXX | 3 | Major course |
| HORT 6999 | 3 | Research in Horticulture |
| | 6 | |

**Total Credits 30**

## PROGRAM OF SOILS

The Soils program leads to a Master of Science. Areas of specialization in soils include chemistry, fertility, soil and crop management, genesis and morphology, microbiology, mineralogy, and physics.

**Program Outcomes**

- To provide an education of excellence with specialization in soil chemistry, soil fertility, soil physics, soil and crop management, soil genesis and morphology, soil microbiology, and soil mineralogy.
- To encourage the creativity of the students and the university community through special research which contributes to the development of agriculture and society.

**Curricular Sequence**

The curricular sequence of the Master of Science in Soils is established in coordination between the student, the advisor, and the director of the program. The student's Plan for Graduate Study will be prepared by the committee while taking into consideration the student's individual needs. The curricular sequence requires that students take a **Minimum Total of 30 credits:**

- **18 credits in major courses** recommended by Student Graduate Committee
- **6 credits in thesis research**
- **6 credits in Related Area** recommended by Student Graduate Committee

However, as occurs for the present on-campus program, each student will be evaluated individually and assessed if he/she must take deficiency (makeup) courses (e.g., Basic soil, applied statistics, crop production, among others). As per Certification SA 09-09, a student in *Conditional Standing* is one who at the time of admission satisfies all requirements except for some deficiencies in undergraduate courses (up to four maximum).

Ideally, students will be able to complete the program in two years. The current average completion time (for on-campus students) is four (4) years. The completion time varies from student due to the number of deficiencies, academic progress, thesis topic, and research data to collect.

The curricular sequence is as follow:

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| XXXX | 6 | Major course |
| ELECTIVE | 3 | Related Area Course |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| XXXX | 6 | Major course |
| ELECTIVE | 3 | Related Area Course |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| XXXX | 3 | Major course |
| AGRO 6999 | 3 | Research in Soils |
| | 6 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| XXXX | 3 | Major course |
| AGRO 6999 | 3 | Research in Soils |
| | 6 | |

**Total Credits 30**

## FACULTY

A list of professors who engage in graduate activities in the Department follows, including the highest earned degree, date, and institution granting the degree. Research and teaching interests are also included.

**OSCAR ABELLEIRA MARTINEZ**, *Professor,* Ph.D., 2015, Idaho University and CATIE, Costa Rica. Teaching and Research Interest: forest management, natural resources conservation, management and development.

**WANDA I. ALMODÓVAR CARABALLO,** *Professor*, M.S., 1989, University of Puerto Rico. Teaching and Research interests: plant pathology, diagnosis and control of plant diseases.

**ADA N. ALVARADO ORTIZ**, *Professor*, M.S., 1992, University of Puerto Rico. Teaching and Research interests: integrated pest management, plant pathology, diagnosis and control of plant diseases.

**ALFREDO APONTE ZAYAS**, *Assistant Professor,* Ph.D., 2016, North Dakota State University. Teaching and Research interests: forage and pasture management, energy crops, agroecological practices.

**ARÍSTIDES ARMSTRONG RAMÍREZ**, *Professor*, M.S., 1981, University of Puerto Rico, Mayagüez Campus. Teaching and Research interests: general entomology, and control of insect pests on economic crops.

**LUCAS N. AVILÉS RODRÍGUEZ**, *Professor - Ad Honorem*, M.S., 1988, University of Florida, Gainesville.

**DANIEL BAIR GALLEGOS**, *Associate Professor*, Ph.D., 2015, University of California, Davis. Teaching and Research interests: soil and biogeochemistry.

**LINDA WESSEL BEAVER**, *Professor - Ad Honorem*, Ph.D., 1981, University of Illinois at Urbana. Teaching and Research interests: plant breeding.

**IRMA CABRERA ASENCIO**, *Professor*, Ph.D., 2021, University of Puerto Rico. Teaching and Research Interest: general entomology, biological control.

**ROSA N. CHÁVEZ JÁUREGUI**, *Professor*, Ph.D., 1995, University of Sao Paulo. Teaching and Research interests: food science.

**JOAQUÍN A. CHONG-NÚÑEZ**, *Professor*, Ph.D., 2005, Clemson University, South Carolina. Research and Teaching interests: sustainable agriculture.

**JOSÉ A. DUMAS RODRÍGUEZ**, *Professor*, Ph.D., 1999, University of Puerto Rico-Río Piedras. Research interest: Pesticide Residues Analysis. Teaching interests: analytical chemistry.

**ELVA CONSUELO ESTÉVEZ DE JENSEN**, *Professor*, Ph.D., 2000, University of Minnesota. Teaching and Research interests: diagnostic and management of fungal diseases, etiology and control of soilborne diseases, developing integrated disease management programs for vegetable cropping systems, interactions between cropping systems, soil amendments, residue management, and tillage practices on the management of soilborne

diseases, the effects of environmental and edaphic factors on host characteristics contributing to disease susceptibility.

**MERARI FELICIANO RIVERA,** *Professor*, Ph.D., 2007, University of Kentucky. Teaching and interest: plant pathology.

**GEORGES FELIX LANCELOTTI**, *Assistant Professor,* Ph.D., 2019, Wageningen University, The Netherlands. Teaching and Research interest: agroecology and agroforestry.

**FEIKO H. FERWERDA**, *Assistant Researcher*, Ph.D., 2001, University of Florida. Research and Teaching interests: plant tissue culture and molecular markers.

**MARIO L. FLORES MANGUAL,** *Professor*, Ph.D., 2009, University of Wisconsin. Teaching and interest: soil science.

**CARLOS A. FLORES ORTEGA**, *Associate Professor*, M.S., 1993, University of Puerto Rico. Teaching and interest: Coffee.

**ROSA A. FRANQUI RIVERA**, *Professor*, Ph.D., 1995, University of Wisconsin, Madison. Teaching and Research interests: general entomology and biological control.

**FERNANDO GALLARDO COVAS**, *Professor*, Ph.D., 1990, Louisiana State University. Research and Teaching interests: biological control of insects.

**JOHN M. GILL ECCLES**, *Professor*, Ph.D., 1994, Rutgers University. Research and Teaching interests: plant tissue culture and plant genetic transformation.

**MARTHA C. GIRALDO ZAPATA**, Associate Professor, Ph.D., 2010, Kansas State University. Research and Teaching interests: plant pathology, plant-pathogen interactions, integrated plant management to control diseases, farinaceous crops.

**LIZZETTE GONZÁLEZ-GILL**, *Professor*, Ph.D., 1996, Rutgers University. Research and Teaching interests: ornamental horticulture, plant physiology, soilless culture, urban horticulture.

**SALLY GONZÁLEZ MIRANDA**, *Specialist of Extension*, M.L.A., 1987, Ball State University. Research and Teaching interests: landscape design, arboriculture and urban forestry, urban horticulture.

**ERMITA HERNÁNDEZ HEREDIA**, *Professor*, Ph.D., 2013, Penn State University. Research and Teaching interests: vegetable physiology, sustainable agriculture.

**ANGELA M. LINARES RAMÍREZ**, *Professor,* Ph.D., 2014, North Dakota University. Research and Teaching interests: vegetable crop physiology and plant breeding.

**WANDA I LUGO MARTY**, *Researcher*, M.S., 1982, North Carolina State University. Teaching and Research interests: Crop Production and Physiology.

**RAÚL E. MACCHIAVELLI**, *Professor*, Ph.D., 1992, Pennsylvania State University. Teaching and Research interests: statistics, biometry.

**EDDA L. MARTÍNEZ CALEZ,** *Assistant Specialist,* Ph.D., 2010, Mississippi State University. Teaching and Research interest: entomology.

**GUSTAVO A. MARTÍNEZ RODRÍGUEZ**, *Professor*, Ph.D., 1995, The Ohio State University. Teaching and Research interests: soil chemistry.

**SILVERIO MEDINA-GAUD**, *Emeritus Professor*, Ph.D., 1978, Iowa State University. Teaching and Research interests: entomology.

**JOSÉ P. MORALES-PAYÁN**, *Professor*, Ph.D., 1999, University of Florida, Gainesville. Teaching and research interests: organic horticulture, fruit crops, bio-stimulants and physiology regulators, biopesticides and alternative management of weeds.

**MIGUEL A. MUÑOZ MUÑOZ**, *Professor*, Ph.D., 1988, Ohio State University. Teaching and Research interests: soil chemistry and soil mineralogy.

**JULIA O'HALLORANS CASTILLO**, *Associate Professor*, Ph.D., 2001, New Mexico State University. Teaching and Research interests: soil fertility.

**LYNETTE E. ORELLANA FELICIANO**, *Professor*, Ph.D., 2004, Washington State University. Teaching and Research Interests: food microbiology, food processing, food toxicology, food safety, food laws and regulations, Food quality pre and post-harvest handling, edible films, Natural Antimicrobials for Food Safety.

**JORGE E. PÉREZ AROCHO**, *Assistant Professor*, Ph.D., 2017, University of Nebraska-Lincoln. Teaching and research areas of interest: plant breeding.

**MARÍA DE L. PLAZA DELESTRE**, *Professor*, Ph.D., 2010, University of Florida, Gainesville. Teaching and Research interests: food science, food chemistry, food processing, food safety, food laws and regulations, Food quality and post-harvest handling, food analysis.

**DANIA RIVERA OCASIO,** *Professor*, Ph.D., 2011, The Ohio State University. Teaching and Research interests: tree production and ornamental horticulture.

**WILFREDO ROBLES VÁZQUEZ,** *Professor*, Ph.D., 2007, Mississippi State University. Teaching and Research interests: field assessments and preliminary screening of pesticide and biopesticides to manage pests, diseases in tropical crops, invasive plants and their impact on pollinator population.

**ELVIN ROMÁN-PAOLI**, *Professor*, Ph.D., 1997, Kansas State University. Teaching and Research interests: agronomy.

**JESSE ROMÁN**, *Emeritus Professor*, Ph.D., 1968, North Carolina State University. Research and Teaching interests: nematology, taxonomy, chemical control, biological control of nematodes and insects.

**CARLOS ROSARIO PÉREZ***, Professor - Ad Honorem*, Ph.D., 1988, Pennsylvania State University. Research and Teaching interests: urban entomology, integrated pest management and medical entomology.

**YANIRIA SÁNCHEZ DE LEÓN**, *Professor*, Ph.D., 2007, University of Idaho, Moscow. Teaching and Research interests: soil microbiology.

**JAMES SCOTT BEAVER**, *Emeritus Professor*, Ph.D., 1980, University of Illinois at Urbana. Teaching and Research interests: plant breeding.

**ALEJANDRO E. SEGARRA-CARMONA**, *Professor - Ad Honorem*, Ph.D., 1985, University of Maryland. Teaching and Research interests: entomology, ecology and behavior of insects, biotechnology and agricultural research policy.

**VÍCTOR A. SNYDER SEVITS**, *Professor*, Ph.D., 1980, Cornell University. Teaching and Research interests: soil physics.

**DAVID SOTOMAYOR RAMÍREZ**, *Professor*, Ph.D., 1996, Kansas State University. Teaching and Research interests: soil fertility, nutrient management.

**REBECCA TIRADO CORBALA**, *Researcher*, Ph.D., 2010, The Ohio State University. Teaching and Research interests: soils.

**ELIDE VALENCIA CHIN**, *Professor*, Ph.D., 1997, University of Florida. Teaching and Research interests: pasture and forage management.

**ROBERTO VARGAS AYALA**, *Professor*, Ph.D., 1995, Auburn University. Teaching and Research interests: general nematology, plant pathology, biological control, rhizosphere microecology, organic nematicides and sustainable agriculture.

**DIEGO M. VITERI DILLON**, *Associate Professor*, Ph.D., 2014, University of Idaho. Teaching and Research interests: genetics and plant breeding.

**LINDA WESSEL BEAVER**, *Professor - Ad Honorem*, Ph.D., 1981, University of Illinois at Urbana. Teaching and Research interests: plant breeding.

**JOSÉ L. ZAMORA ECHEVARRÍA**, *Professor*, M.S., 1991, University of Puerto Rico. Research and Teaching interests: tropical fruit crop production and management.

## DEPARTMENT OF ANIMAL SCIENCE

The Department of Animal Science offers a program leading to a Master of Science degree in Animal Science. All applicants must have a Bachelor of Science degree in Agricultural Sciences or in a closely related field. They must meet the requirements for admission set by the Office of Graduate Studies, and the department and must conduct a research project and write a thesis on a subject related to animal science.

The graduate program in Animal Science is designed to develop research skills in subjects related to food producing animals, including dairy and beef cattle, swine, poultry, rabbits, fish, and small ruminants and pets. Available courses deal with production and management of the most important animal species as well as nutrition, breeding, reproduction, health, behavior, molecular biotechnology, molecular biology, and animal products' processing and manufacturing.

Students accepted to the program take advanced courses in statistics and biochemistry, and courses in management, nutrition, and physiology and other electives offered by the Department to complete their coursework.

Research facilities consist of up-to-date laboratories located on-campus and animal facilities located at research centers and agricultural experiment stations of the College of Agricultural Sciences. Our facilities for processing poultry, swine and cattle are located at the Lajas Experiment Station.

As part of their training, graduate students may apply for an assistantship and acquire teaching experience while serving as instructors in charge or as an aide in the laboratory sections of certain courses. Another option is a research assistantship which are awarded on a need basis by professors with research grants.

**Webpage:** https://www.uprm.edu/cian

### MASTER of SCIENCE in ANIMAL SCIENCE CURRICULUM

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| AGRO 5005 | 3 | Biometrics |
| CIAN 6637 or | | Neuroendocrine and Circulatory Physiology |
| CIAN 6638 | 3 | Renal, Respiratory and Digestive Physiology |
| *CIAN XXXX | 3 | Professional Elective |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| AGRO 6600 | 3 | Advanced Biometrics |
| *CIAN XXXX | 3 | Professional Elective |
| *CIAN XXXX | 3 | Professional Elective |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| *CIAN XXXX | 3 | Professional Elective |
| CIAN 6607 | | Graduate Seminar |
| or CIAN 6608 | 1 | Graduate Seminar |
| CIAN 6999 | 3 | Research and Thesis |
| | 7 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| *CIAN ---- | 2 | Professional Elective |
| CIAN 6999 | 3 | Research and Thesis |
| | 5 | |

**Total Credits 30**

* The program allows a maximum of 9 credits of Professional Electives selected from those offered by the Department (CIAN 5--- code). The remaining Professional Electives must also be offered by the Department but with CIAN 6--- code). All Professional Electives require approval from the Graduate Committee of the student and the Director of the Department.

## ANIMAL SCIENCE FACULTY

The following is a list of professors who engage in graduate activities in the Department, including the highest earned degree, date, and institution granting degree as well as research and teaching interests:

**ENID ARCELAY-RUIZ**, *Professor*, Ph.D. 2009, University of Massachusetts. Teaching and Research interest: Andrology, Animal Reproduction, Cellular Physiology.

**AMÉRICO CASAS-GUERNICA**, *Professor*, M.S., 1984, University of Puerto Rico. Teaching and Research interest: Beef Cattle Production-Ruminant Nutrition.

**JAIME E. CURBELO-RODRÍGUEZ,** *Professor*, Ph.D., 2011, Mississippi State University. Teaching and Research interest: Dairy Science.

**KATHERINE DOMENECH-PÉREZ,** *Associate Professor,* Ph.D., 2016, University of Nebraska, Lincoln. Teaching and Research interest: Meat Science and Technology.

**JOHN A. FERNÁNDEZ-VAN CLEVE,** *Professor*, Ph.D., 1986, University of Kentucky. Teaching and Research interest: Reproductive Physiology.

**TATIANA GARCÍA-MARRERO**, *Assistant Professor*, DVM, MS., 2024, Iowa State University, Ames, Iowa. Teaching and Research interest: Animal Health and Non-ruminant nutrition.

**ESBAL JIMÉNEZ-CABÁN**, *Professor*, Ph.D., 2008, The Ohio State University. Teaching and Research interest: Physiology of Reproduction, Endocrinology, Animal Biotechnology.

**JOSÉ R. LATORRE,** *Retired professor (Ad honorem)*, Ph.D., 1986, University of Arkansas. Teaching and Research interest: Poultry Production, Reproduction, Physiology, Food Safety.

**MARINÉ LUGO-RUIZ,** *Assistant Professor*, DVM, MS., 2023, Oregon State University. Teaching and Research interest: Small Ruminant physiology and health.

**ALEXANDER MESONERO-MORALES,** *Associate Professor*, DVM, MS., 2008, Louisiana State University. Teaching and Research interest: Animal Health, Pathology.

**CARLOS A. NAZARIO-PAGÁN,** *Associate Professor*, M.S., 1988, North Carolina State University. Teaching and Research interest: Poultry Science.

**VERÓNICA NEGRÓN-PÉREZ,** *Associate Professor*, Ph.D., 2017, University of Florida. Teaching and Research interest: Physiology of Reproduction, Embryology, Animal Molecular and Cell Biology.

**GUILLERMO ORTIZ-COLÓN**, *Professor*, Ph.D., P.A.S., 2006, Michigan State University. Teaching and Research interest: Dairy Cattle Nutrition, Animal Welfare, Dairy Cattle Heat Tolerance and Calf Management.

**MELVIN PAGÁN-MORALES**, *Professor*, Ph.D., 2002, Michigan State University. Teaching and Research interest: Molecular Genetics & Growth Physiology.

**LEYDA PONCE DE LEÓN-GONZÁLEZ,** *Professor*, Ph.D., 1999, University of Wisconsin-Madison. Teaching and Research interest: Manufacture and development of dairy products. Milk quality and dairy microbiology.

**ABNER RODRÍGUEZ-CARIAS,** *Professor*, Ph.D., 1996, Michigan State University**.** Teaching and Research interest: Ruminant Nutrition, Small Ruminant Production, Silage Conservation.

**HÉCTOR L. SÁNCHEZ-RODRÍGUEZ,** *Professor,* Ph.D., 2011, Mississippi State University**.** Teaching and Research interest: Dairy Science, Cattle Management, and Physiology of Reproduction.

**CARMEN SANTANA-NIEVES,** *Associate Professor*, Ph.D., 1993, University of Illinois. Teaching and Research interest: Swine Production; Environmental Physiology; Animal Behavior.

**VÍCTOR SIBERIO-TORRES**, *Professor*, Ph.D., 1996, Michigan State University. Teaching and Research interest: Swine Production; Non-ruminant Nutrition.

**COLLEGE OF AGRICULTURAL SCIENCE**
**Doctor of Philosophy (Ph.D.) in Tropical Agriculture**

## Program Description

The Ph.D. Program in Tropical Agriculture prepare new cohorts of highly skilled and ethical professionals at the doctoral level, trained to excel mainly, but not exclusively, in their work in tropical conditions, experts and leaders in their fields, capable of solving existing problems and generating new information and technology to expand basic and applicable knowledge related to agriculture, natural resources, and food science and technology. These new generations of thinkers, problem-solvers and innovators in the agricultural sciences should have a tremendous impact in the body of practical and basic knowledge as well as in the advancement of solutions for critical issues in food production and conservation of natural resources to sustain growing populations, situations that plague both in Puerto Rico and the rest of the planet.

## Mission

The mission of the Doctoral Program in Tropical Agriculture is to prepare in Puerto Rico, through rigorous scientific and academic training, human resources (new doctors of philosophy in agricultural sciences) who are competent researchers, innovators and leaders, capable of generating new knowledge to expand the frontiers of science and to solve problems and overcome limitations in agricultural systems, with emphasis in tropical environments, useful to Puerto Rico and other places with similar conditions and language. This Doctoral Program is aimed at fulfilling the need of educating professionals at the highest academic level directly in the tropical region, a geographical area with its special circumstance, challenges and opportunities, with a strong need for human resources able to create and use scientific knowledge for sustainable growth and development of its 18 natural resources and food security, by working in governmental and non-governmental agencies, various industry, and academia, becoming a force change.

## Program Goals

The Program Goals are to academically prepare new cohorts of highly skilled and ethical professionals at the doctoral level, trained to excel mainly, but not exclusively, in their work in tropical conditions, experts and leaders in their fields, capable of solving existing problems and generating new information and technology to expand basic and applicable knowledge related to agriculture, natural resources, and food science and technology. These new generations of thinkers, problem-solvers and innovators in the agricultural sciences should have a tremendous impact in the body of practical and basic knowledge as well as in the advancement of solutions for critical issues in food production and conservation of natural resources to sustain growing populations, situations that plague both in Puerto Rico and the rest of the planet.

## Program Educational Objectives

Graduates from the Tropical Agriculture program will be expected to have the following skills:

1. Analytic capabilities, communication skills and knowledge of scientific research methods.
2. Ability to conduct independent multidisciplinary research.
3. Knowledge in agricultural, animal sciences and soil and water resource management that will permit the graduate to contribute to the improvement of the academic and professional environments of research institutions and higher education.
4. Oral and written communication skills; the capacity to formulate clear short and medium-term objectives, and the ability to publish research results in refereed journals.
5. Ability to communicate the most recent knowledge and advances in science to the agricultural sector and to the scientific community in Puerto Rico and the Caribbean.
6. Awareness of the impact of his/her research on the quality of life, including a clear understanding and respect for the legal, ethical, social, and cultural aspects of the practice of his/her profession.
7. High moral and intellectual standards that will permit the graduate to make significant contributions toward the advancement of agricultural science and natural resources management. The graduate should also strive to demonstrate ethical leadership and respect for cultural diversity and differences in opinion.

**Admission Requirements**

BS in Agricultural Sciences or similar discipline. It is generally desirable that before enrolling in the doctoral program, the student earns a master's degree from an accredited University in Sciences or its equivalent with a major in Agriculture, Environmental Sciences, General Science, Chemistry or Biology. A minimum GPA of 3.25 is required for Science courses under the aforementioned disciplines, and GPA of 3.00 in other discipline courses. The applicant must have at least 9 credits in Agricultural Sciences related courses such as courses code in General Agriculture, Animal Sciences, Agronomy, Soil Sciences, Plant Science, Horticulture and Crop Protection. In addition, applicants must have at least 3 credits in Biostatistics or equivalent courses. Students will be accepted with a maximum of 4 courses on deficiencies and will be encourage to fulfill deficiencies requirements through professional development

Applicants will be required to submit the general Graduate Record Exam (GRE) taken within three years prior application to graduate school. The scores from verbal and quantitative portions of the exam will be considered. The applicant must submit a 2-page CV along with a short essay (max. 1,000 words) indicating short and long term goals. The essay must include applicant's research experience, interests and potential contribution of research goals to foster Tropical Agriculture. It is expected that the applicant has adequate Spanish and English language proficiency in both oral and written forms.

The Doctor of Philosophy degree will require the completion of a minimum of fifty-seven (57) credits. Twenty (20) credits for seven core courses, twenty-one (21) credits for recommended elective courses, fifteen (15) credits for the doctoral research and thesis and one (1) credit for the doctoral seminar.

Upon satisfactory completion of at least 36 credits after being admitted doctoral students will be required to take a written qualifying exam, the student will have two opportunities to pass the exam. After passing the written qualifying exam, the student will also take an oral candidacy exam to become a doctoral candidate, the student will have two opportunities to pass the exam. All doctoral candidates must prepare an original publishable dissertation describing a topic of research and successfully defend his/her dissertation. Doctoral students who enter the program with a master's degree should complete the PhD degree within 3-4 years, and doctoral students who enter the program with a bachelor's degree should complete the PhD degree within 6-8 years.

## DOCTOR OF PHILOSOPHY IN TROPICAL AGRICULTURE CURRICULUM

### FIRST YEAR

**First Semester**

| Number | Credits | Course |
|---|---|---|
| XXXX | 3 | Medular Course |
| XXXX | 3 | Medular Course |
| XXXX | 3 | Elective Course |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| XXXX | 3 | Medular Course |
| XXXX | 3 | Medular Course |
| XXXX | 3 | Elective Course |
| | 9 | |

### SECOND YEAR

**First Semester**

| Number | Credits | Course |
|---|---|---|
| XXXX | 3 | Medular Course |
| XXXX | 3 | Medular Course |
| XXXX | 3 | Elective Course |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| XXXX | 2 | Medular Course |
| XXXX | 3 | Elective Course |
| XXXX | 3 | Elective Course |
| | 1 | Doctoral Dissertation |
| | 9 | |

**THIRD YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| XXXX | 1 | Doctoral Dissertation |
| XXXX | 3 | Elective Course |
| | 4 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| XXXX | 2 | Doctoral Dissertation |
| XXXX | 3 | Elective Course |
| | 5 | |

**FOURTH YEAR**

| Number | Credits | Course |
|---|---|---|
| XXXX | 1 | Doctoral Seminar |
| XXXX | 5 | Doctoral Dissertation |
| | 6 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| XXXX | 6 | Elective Course |
| | 6 | |

**Total Credits 57**

**FOOD SCIENCE AND TECHNOLOGY PROGRAM**

Please refer to the Interdisciplinary Programs section for information on this program.

# *COLLEGE OF ARTS AND SCIENCES*

The School of Science was organized in 1943 according to the provisions of the University Act of 1942 and was authorized to grant the degree of Bachelor of Science in the fields of Biology, Chemistry, Geology, Mathematics, and Physics. A Division of General Studies was set up later, independently, with the purpose of offering a series of introductory or basic courses leading an incoming student to a better understanding of the physical, intellectual, and social world in which we live. The School of Science and the Division of General Studies were fused to form the College of Arts and Sciences of the Mayagüez Campus in 1959.

Graduate instruction at UPRM began in 1957 with the establishment of the Puerto Rico Nuclear Center. The construction of this facility in Mayagüez led to the beginning of graduate studies in the fields of nuclear science and technology, radiological physics and mathematics. At present the College offers graduate instruction leading to the degree of Master of Science in Biology, Chemistry, Geology, Marine Sciences, Mathematics and Physics as well as the Master of Arts in Hispanic Studies and the teaching of English as a second language. In 1972, the College initiated a program leading to the degree of Doctor of Philosophy in Marine Sciences. The Mayagüez Campus is the only institution in Puerto Rico offering a Ph.D. in this field. The Applied Chemistry Ph.D. program started on 2004. A multidisciplinary doctorate degree in Computer Information Science and Engineering is offered in collaboration between the Mathematics and the Electric and Computer Engineering Departments.

Depending on individual department regulations, the student may have various options for fulfilling Master's degree requirements. Most departments require a thesis, while some may also offer the option of a project report or grant the degree under a non-thesis option.

**Webpage:** https://www.uprm.edu/arci/

# DEPARTMENT OF BIOLOGY

The Department of Biology offers a program leading to a Master's degree in Science. Although there are no formal options, students are able to specialize in conservation biology, environmental microbiology, botany, cellular and molecular biology, ecology, physiology, genetics, mycology, virology, microbiology (bacteriology), parasitology, zoology, entomology, herpetology and limnology.

In addition to the admission requirements of the Graduate Studies Office, a Bachelor of Science degree in Biology or its equivalent is required. Generally, more than 90% of the admitted students had a 3.00 GPA or higher in the biology courses.

Requirements for the Master's Degree in the Department of Biology are met with the approval of a minimum of thirty credit hours of graduate courses including the thesis, of which a maximum of nine credits can be advanced undergraduate (5000) courses. BIOL 6689 (Biological Research Methods) and BIOL 6690 (Graduate Seminar) are core courses required to all students. All students are required to write a thesis, and to present a departmental seminar related to their thesis research prior to graduation. All other program requirements are those established by the Graduate Studies Office.

## PROGRAM OF STUDY

## MASTER IN BIOLOGY CURRICULUM

### FIRST YEAR

**First Semester**

| Number | Credits | Course |
|---|---|---|
| BIOL 6991 | 3 | Special Studies in Biology |
| BIOL **** | 3 | Specialization Course* |
| BIOL **** | 3 | Specialization Course* |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| BIOL 6992 | 3 | Special Studies in Biology |
| ELECTIVE | 3 | Elective in specialization or outside of specialization |

| | | |
|---|---|---|
| BIOL 6689 | 2 | Biological Research Methods |
| BIOL 6690 | 1 | Graduate Seminar |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| BIOL 6990 | 6 | Research |
| BIOL **** | 3 | Specialization Course* |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| ELECTIVE | 3 | Elective in specialization or outside of specialization |
| BIOL 6990 | 0 | Research |
| | 3 | |

**Total Credits: 30**

*Major course in or outside Biology Department, depending on Research Project.

Specialization areas: Conservation Biology, Bioremediation, Botany, Cellular and Molecular Biology, Ecology, Entomology, Physiology, Genetics, Mycology, Microbiology (Bacteriology), Parasitology, Limnology, Virology, Zoology, among others.

**Facilities**

Departmental facilities include laboratories dedicated to research in botany, cellular and molecular biology, comparative physiology, entomology, virology, microbiology, mycology, and other areas of biology; an herbarium and a greenhouse; and zoological collections. In addition, the Biology Department operates a Microscopy Center and the Caribbean Genome Center.

**Webpage:** https://www.uprm.edu/biology/

**BIOLOGY FACULTY**

A list of professors who engage in graduate activities in the Department follows including the highest earned degree, date, and institution granting the degree. Research and teaching interests are also included.

**CARLOS ACEVEDO SUÁREZ** *Professor*, Ph.D., 2006, Vanderbilt University School of Medicine. Research Interests: Cellular and Molecular Immunology. Teaching Interests: Immunology, Cellular and Molecular Biology of Cancer.

**JAIME A. ACOSTA MARTÍNEZ**, *Professor*, Ph.D., 1995, Virginia Polytechnic Institute and State University. Research Interests: Entomology, Biocontrol of Lepidoptera, Ecology of Fire Ants. Teaching Interests: Biology, Ecology, Zoology, Entomology.

**DIMARIS ACOSTA MERCADO**, *Professor*, Ph.D., 2003, University of Guelph, Canada. Research Interests: Protist, Trophic Networks in Microecosystems, Ecology of Soil Protozoa, Biodiversity and Ecosystem Function. Teaching Interests: Ecological and Research Methods, Protistology.

**MÓNICA ALFARO LOZANO**, *Professor*, Ph.D., 2002, University of Puerto Rico. Research Interests: Marine Biology, Ecology of Zooplankton. Teaching Interests: Marine Ecosystems, Zoology, Ecology, Biological Sciences.

**MATÍAS J. CAFARO**, *Professor*, Ph.D., 2003, University of Kansas, Lawrence. Research Interests: Mycology, Symbiosis, Interactions between Arthropods and Fungi. Teaching Interests: Topics in Symbiosis, Advanced Mycology, Systematics of Fungi, Molecular Systematics.

**TIMOTHY J. COLSTON**, *Associate Professor*, Ph.D., 2017, University of Mississippi. Research Interests: Evolutionary Biology, Microbial Ecology, Bioinformatics. Teaching Interests: General Biology, Herpetology, Ornithology.

**ALONDRA M. DÍAZ LAMEIRO**, *Assistant Professor,* Ph.D., 2016, Binghamton University, New York. Research Interests: Population and Conservation Genomics, Ancient/Museum DNA, Evolution of Populations, Molecular Ecology, Molecular Anthropology. Teaching Interests: Genetics, Evolution, General Biology.

**PABLO GUTIERREZ FONSECA,** *Assistant Professor*, Ph.D., 2016, University of Puerto Rico. Research Interests: Ecology and Systematics, Tropical Stream Ecology, Freshwater Ecosystems, Aquatic Ecosystem Function in the Tropics.

**CLARA E. ISAZA BRANDO**, *Assistant Professor*, Ph.D., 2005, Ohio State University. Research Interests: Neurodegradation, Public Health, Biological Mechanisms. Teaching Interests: General Biology.

**SEAN A. LOCKE**, *Associate Professor*, Ph.D., 2010, Concordia University. Research Interests: Parasitology, Molecular Systematics, Community Ecology, Aquatic Ecosystems. Teaching Interests: Parasitology, Invertebrate Zoology, Field Ecology.

**YADIRA MALAVEZ ACEVEDO,** *Associate Professor*, Ph.D. 2012, The Ohio State University, Research Interests: Antimicrobial Resistance, Genetics, Bioinformatics, Food and Applied Microbiology, Apoptosis, Inflammation. Teaching Interests: Food Microbiology, Eukaryotic Molecular Genetics, Molecular Biology.

**SANDRA L. MALDONADO RAMÍREZ**, *Professor*, Ph.D., 2001, Cornell University, Ithaca, New York. Research Interests: Mycology, Aerobiology, Plant Pathology, Fungal Endophytes. Teaching Interests: Mycology, Aerobiology, General Biology.

**ARTURO A. MASSOL DEYÁ**, *Professor*, Ph.D., 1994, Michigan State University. Research Interests: Biodegradation, Microbial Diversity, Environmental Microbiology. Teaching Interests: Microbial Ecology, General Microbiology, Industrial Microbiology.

**AMELIA MERCED ALEJANDRO,** *Assistant Professor*, Ph.D., 2015, Southern Illinois University. Research Interests: Botany, Bryology (Mosses/Liverworths/Hornworts), Plant Anatomy and Morphology, Floristics, Conservation, Herbaria.

**RAFAEL MONTALVO RODRÍGUEZ**, *Professor*, Ph.D., 2003, University of Nebraska. Research Interest: Extremophiles, Taxonomy, Physiology, Genetics of Archaea. Teaching Interests: Microbiology, Microbial Physiology, Bacterial Biodiversity, General Biology.

**ALEJANDRO ORTIZ ACEVEDO**, *Associate Professor*, Ph.D., 2000, University of California, Davis. Research Interests: Embryology, Cellular Physiology. Teaching Interests: General Biology, Human Physiology, Cell Physiology.

**ALBERTO R. PUENTE ROLÓN,** *Associate Professor*, Ph.D., 2012, University of Puerto Rico. Research Interests: Invasive Species, Herpetology, Wildlife Management, Conservation and Population Biology. Teaching Interests: General Biology, Ecology, Natural History, Animal Behavior, Zoology, Evolution.

**LUIS A. RÍOS HERNÁNDEZ**, *Professor*, Ph.D., 2003, University of Oklahoma. Research Interests: Anaerobic Processes, Syntrophic Metabolism. Teaching Interests: General Microbiology, Microbial Physiology, Anaerobic Microbiology, General Biology.

**CARLOS RÍOS VELÁZQUEZ**, *Professor*, Ph.D., 2000, University of Wisconsin-Madison. Research Interests: Bacterial Genetics and Physiology, Microbial Biotechnology, Bioprospecting. Teaching Interests: Microbial Physiology, Prokaryotic Molecular Genetics and Gene Regulation, Microbial Biotechnology.

**CARLOS J. SANTOS FLORES**, *Professor*, Ph.D., 2001, University of Wisconsin-Madison. Research Interests: Limnology, Freshwater Ecology, Taxonomy of Algae and Micro Invertebrates, Aquatic Fungi Taxonomy and Ecology. Teaching Interests: Limnology, Freshwater Biology, Plankton Ecology, Zoology, General Biology.

**DIMUTH SIRITUNGA**, *Professor*, Ph.D., 2002, Ohio State University. Research Interests: Plant Molecular Biology, Metabolic Engineering, Genetics, Diversity in Crop Genetics/Plants. Teaching Interests: Plant Molecular Biology, Plant Physiology, Genetics, Plant Biotechnology.

**BENJAMIN W. VAN EE**, *Professor*, Ph.D., 2006, University of Wisconsin-Madison. Research Interests: Plant Evolution, Phylogenetics, Taxonomy, Biogeography. Teaching Interests: Botany, Bioinformatics, Evolution, Taxonomy of Vascular Plants, General Biology.

**MARÍA M. VARGAS RODRÍGUEZ**, *Professor*, Ph.D., 1997, Arizona State University. Research Interests: Mycology, Entomopathogenic Fungi, Microscopy. Teaching Interests: Mycology, Microbiology, Microscopy.

**ALEX J. VEGLIA**, *Assistant Professor*, Ph.D., 2023, Rice University. Research Interests: Coral Reefs, Biological Oceanography, Virus Ecology and Evolution, Virus Bioinformatic Tool Development, Virus-host Interactions, Symbiosis, Metazoan Holobionts, Transcriptomics, Genomics. Teaching Interests: Genetics, Virology, Field Virology, Virus Bioinformatics, Bioinformatics and Sequence Processing.

# DEPARTMENT OF CHEMISTRY

The Department of Chemistry offers a program leading to a Master of Science Degree in Chemistry with applied research in both traditional and interdisciplinary fields of chemistry; and a Doctor of Philosophy Degree program in Applied Chemistry with cutting edge interdisciplinary research.

The department is housed in a four-story building (214,000 square feet) with modern facilities for teaching and research. It has forty research and twenty teaching laboratories, as well as ten lecture rooms, a computer center, and cold and dark rooms. Research facilities include a large variety of sophisticated instrumentation, including electrothermal deposition systems, atomic force microscopy (AFM), scanning electron microscopy (SEM), state-of-the-art Raman microscopes; high performance liquid chromatographs with inductively coupled plasma, mass spectrometers, as well as, electroanalytical systems. In addition, there are two 2,000 square feet multi-user facilities with routine analytical instrumentation including gas and liquid chromatographs, electrothermal and flame atomic absorption spectrometers, fluorimeters, ultraviolet-visible and Fourier Transform infrared spectrometers; and ion selective electrodes and sensors. The department hosts a diverse and interdisciplinary number of research groups and two research centers: the Center for Development of Chemical Sensors and the new Center for Education and Training in Agricultural and Related Sciences.

There are 28 faculty members along with 3 joint professors from the fields of engineering and materials science (1) and chemical engineering (2). Approximately 18 faculty members have on-going research projects in the research fields of biophysics; chemistry of materials; environmental chemistry; food and agricultural chemistry; organic, inorganic and bio-inorganic; synthesis, analytical; molecular spectroscopy; pharmaceuticals, computational chemistry, electrochemistry, and biochemistry.

**Website**: http://www.uprm.edu/chemistry

**The Master of Science Degree Program**
Admission Requirements:

1. A bachelor's degree in chemistry from a recognized university or its equivalent, with a minimum general grade point average of 2.80 (or 3.00 in chemistry courses) in a scale of 0 to 4.00. Applicants who have a bachelor's degree which is not in chemistry may be considered.

2. Proficiency in Spanish and English. ***If there are deficiencies in either one of the languages the student must take remedial courses when they enter the program.***

Within the M.S. option, students are able to specialize in one of the following areas:

- Biophysics
- Chemistry of Materials
- Environmental Chemistry
- Analytical Chemistry
- Physical Chemistry
- Inorganic Chemistry
- Organic Chemistry
- Biochemistry

***Program Requirements:***

***The requirements for the Master's Degree in the Department of Chemistry are met with the approval of at least seventeen credit hours of graduate courses in Chemistry, exclusive of the thesis.*** Three of the following core courses are required: Advanced Inorganic Chemistry I (QUIM 6011), Advanced Organic Chemistry I (QUIM 6401), Advanced Physical Chemistry (QUIM 6605), Advanced Analytical Chemistry (QUIM 6215), and Advanced Biochemistry (QUIM 6715). In addition, students are required to take QUIM 6005 and QUIM 6006, (Graduate Seminar I and II), and to write and defend a thesis.

Also, thirteen credits will be on electives courses in the selected area of specialization. Total credits are 30 for the MS degree.

**PROGRAM OF STUDY**

**MASTER OF SCIENCE IN CHEMISTRY CURRICULUM**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| | 3 | Core course 1 |
| | 3 | Core course 2 |
| | 3 | Elective course |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| | 3 | Core course 3 |
| | 3 | Elective course |
| QUIM 6998 | 3 | CHEMISTRY RESEARCH |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| | 3 | Elective course |
| | 1 | Elective course |
| QUIM 6005 | 1 | GRADUATE SEMINAR I |
| QUIM 6998 | 2 | CHEMISTRY RESEARCH |
| | 7 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| | 3 | Elective course |
| QUIM 6006 | 1 | GRADUATE SEMINAR II |
| QUIM 6998 | 1 | CHEMISTRY RESEARCH |
| | 5 | |

**Total Credits 30**

**Ph.D. in Applied Chemistry**

The Ph.D. Program in Applied Chemistry emphasizes three principal fields of research: biophysical chemistry, chemistry of materials and environmental chemistry. The Department's web site: http://www.uprm.edu/chemistry, offers additional information on the program and the research interests of the professors involved in the program.

***Admission Requirements:***

1. A bachelor's or master's degree in chemistry from an accredited university or its equivalent, with a minimum general grade point average of 2.80 (or 3.00 in chemistry courses) in a scale of 0 to 4.00. Applicants within a field other than Chemistry may be evaluated on an individual basis.

2. Proficiency in Spanish and English. ***If there are deficiencies in either one of the languages the student must take remedial courses when they enter the program.***

***Program Requirements:***

***Research Proposal*** - Students will present a written research proposal that defines their doctoral dissertation project. This proposal will be presented and defended before the student's graduate committee.

***Doctoral Exam*** - Students will take a Doctoral Exam which will assess their knowledge at the graduate level. This should occur during the third year of studies. The exam will include both, a written and oral component.

***Internship ("Practicum")*** – Every student will work during four months or one semester in an academic, industrial, or government laboratory outside the UPR-Mayagüez Campus. Students are encouraged to make arrangements with their advisors early in their careers in order to properly fulfill this requirement.

It is recommended that the four-month period be flexible, but cumulative to include a period of at least four months. This period may be distributed as follows:

1. A period of four months without interruption.
2. Two summer terms.

The internship period may include a maximum of three weeks in workshops related to the student's research. Each workshop should have a minimum duration of one week.

After returning from the internship, students must present a written progress report, make a presentation in the Graduate Seminar or in a scientific conference such as an ACS National Meeting; and receive a formal evaluation from the Practicum supervisor or host.

Upon approval of the report, the research advisor, as president of the student's Graduate Committee will submit a letter to the Department's Graduate Coordinator, notifying of the completion of this requirement.

As established by the Departmental Graduate Program Committee, the internship results and findings must also be a part of the student's dissertation.

***Publications*** - Students will be required to have two accepted publications on a peer-reviewed journal before defending their doctoral dissertation.

***The academic requirements to grant the degree are:***

A. A minimum of 52 credits, of which no more than nine credits (9) can be at the 5000 level and no less than 34 credits at the 6000 level or higher. Of the previous 34 credits, 18 credits are assigned to the student's dissertation. Students are also required to take a minimum of nine credits hours of courses in an area other than their major.

B. The minimum grade point average required for graduation is 3.00.

***Course Distribution***

Departmental Core Courses (3 elective courses @ 3 credit hours) – 9 credit hours
Grade Requirements – 28 credit hours
Recommended Courses and Electives by Area of Specialty – 15 credit hours

**PROGRAM OF STUDY**

**PH.D. IN APPLIED CHEMISTRY CURRICULUM**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| | 3 | Core course 1 |
| | 3 | Core course 2 |
| | 3 | Elective course |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| | 3 | Core course 3 |
| | 3 | Specialty course 1 |
| | 3 | Elective |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| | 3 | Specialty course 2 |
| | 3 | Elective course |
| ADEM | 3 | Business Administration Graduate course |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| QUIM 8997 | 3 | RESEARCH AND DOCTORAL THESIS |
| QUIM 6705 | 3 | PRINCIPLES AND PRACTICE OF TEACHING CHEMISTRY AT THE UNIVERSITY LEVEL |
| QUIM 8008 | 3 | SCIENTIFIC COMMUNICATION IN CHEMISTRY |
| | 9 | |

**THIRD YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| *Practicum* | 0 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| QUIM 8997 | 9 | RESEARCH AND DOCTORAL THESIS |
| | 9 | |

**Total Credits 30**

**FOURTH YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| QUIM 8997 | 6 | RESEARCH AND DOCTORAL THESIS |
| | 6 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| QUIM 8980 | 1 | DOCTORAL RESEARCH SEMINAR |
| | 1 | |

**Total Credits 52**

## GRADUATE FACULTY INVOLVED IN RESEARCH AND THEIR RESEARCH INTERESTS

**JOSÉ A. CARMONA NEGRÓN**, *Assistant Professor*, Ph.D., 2023, University of Puerto Rico-Mayagüez Campus. Research interests: To develop new chemical-based tools for biomedical application in cancer and infection diseases at the interface of synthetic chemistry, cell biology, and medicine, to decipher cellular signaling networks with an emphasis on protein kinases. My research laboratory employs a comprehensive array of methodologies, including synthetic organic chemistry, structural biology, molecular modeling, and molecular biology techniques to develop exquisitely selective inhibitors of key signal transduction targets.

**ARNALDO CARRASQUILLO**, *Professor,* Ph.D., 1995, Texas A&M. Research interests: Understanding the role played by electrode surface composition and structure in determining and controlling the electrochemical reactivity of species present at the electrode-solution interfaces. Study of electrocatalysis and of biosensor technologies by using XPS, AES, LEDD, TDMS, thin layer and classical electrochemical method.

**MIGUEL E. CASTRO**, *Professor*, Ph.D., 1991, University of Texas at Austin. Research interests: Synthesis and characterization of electronic materials; application of heterogeneous catalysis to drug synthesis; time resolved mass and infrared spectroscopy; time-of-flight measurements of oriented molecules.

**JOSÉ E. CORTÉS**, *Professor*, Ph.D., 1989, University of North Texas. Research interests: Synthesis and characterization of fullerene-transition metal complexes. Electronic and geometric structure of fullerene-transition metal complexes and the relationship of their structure with the complexes chemical reactivities. Integration of high school biology, chemistry, mathematics, and physics using calculator-based laboratory technology.

**MARCO A. DE JESÚS**, *Professor*, Ph.D., 2004, University of Tennessee, Knoxville. Research interests: Study the potential health threats posed by exposure to trace aromatic pollutants, in particular pesticides, and PPCP's, in the environment. Use advanced air and water monitoring technologies in combination with information rich spectroscopies to evaluate the bioavailability of these chemicals in P.R.

**JOSELYN DEL PILAR ALBALADEJO**, *Assistant Professor*, Ph.D., 2014, The Ohio State University, Colombus, Ohio. Research interests The Del Pilar research laboratory is dedicated to advancing knowledge of the structure-property relationship of solid-state materials for environmental and energy applications. Through rigorous research, our laboratory develops synthetic methods that enhance material functionality, creating a significant impact in the field by utilizing inorganic synthesis and electrochemical techniques.

**AIKOMARI GUZMÁN,** *Associate Professor*, Ph.D., 2007, University of California, San Diego. Research interest: Methodology; synthesis of chiral ligands for the development of stereoselective metal-catalyzed reactions. Total synthesis of cyclic depsipeptides and other bioactive molecules.

**SAMUEL P. HERNÁNDEZ**, *Professor*, Ph.D., 1986, Johns Hopkins University. Research interests: Molecular spectroscopy of crossed molecular beams and jets; Laser Raman and surface enhanced Raman spectroscopy of biomolecules and their interactions with heavy metal ions and carcinogenic compounds; molecular spectroscopy of coordination compounds, superconductors and explosives; theoretical calculations correlating measured spectroscopy properties.

**MARTHA LAURA LÓPEZ**, *Professor*, Ph.D., 2007, University of Texas at El Paso. Research interests: Environmental chemistry. Toxicity of nanomaterials in plants. Method development and validation. Experimental design. Phytoremediation. Biochemical studies on metal induced stress in plants. Mechanisms of metal translocation in plants. Phytohormones in plants. Nanomaterials.

**ENRIQUE MELÉNDEZ**, *Professor*, Ph.D., 1990, University of Utah. Research interests: Bioinorganic/Bio-organometallic Chemistry. Design of metal-based drugs and biosensors. Metallocene-steroid conjugates as target specific drugs are developed for the treatment of hormone-dependent and -independent cancers. The mechanistic aspects of these species are studied by spectroscopic methods such as NMR, UV-Vis, Fluorescence spectroscopy, electrochemistry and Molecular Modeling techniques. Another area of interest is the development of electrochemical biosensors to detect diseases, pathogens and contaminants.

**ELSIE I. PARÉS MATOS**, *Professor*, Ph.D., 2000, Purdue University, Indiana. Research interest: Bioinformatics, Drug Design, Cellular Biology, Eukaryotic Gene Expression, Protein Expression, and Protein Characterization and Purification through Molecular Biology and Liquid Chromatography Methods.

**NILKA RIVERA-PORTALATÍN**, *Professor*, Ph.D., 2006, University of Florida. Research interests: Isolation, purification and characterization of natural products extracted from plants, and biological assays for the determination of medicinal properties and cytotoxicity. Synthesis, pharmacological and toxicological evaluation of estrogen derivatives and natural supplements used as substitutes of hormone replacement therapies.

**FÉLIX ROMÁN**, *Professor*, Ph.D., 1989, University of Nebraska. Research Interests: Development of analytical method for the determination of trace levels of metals and pesticides in biological and environmental matrices.

**RODOLFO ROMAÑACH**, *Professor*, Ph.D., 1986, University of Georgia. Research interests: Development of near infrared, spectroscopic methods for use in the pharmaceutical industry. Development of analytical methods to study interactions between excipients in solid oral dosage forms and tablet surfaces. Continuing education and professional/personal development of chemists. Use of polarized light microscopy in chemical education.

**WILDELIZ TORRES**, *Professor*, Ph.D., 2007, University of Puerto Rico. Research interests: Our research program focus on the development of robust metal-catalyzed methods for the synthesis of heterocyclic moieties from readily available starting materials. These methods should be user friendly, environmentally benign, and amenable to multi-gram scales. Synthetic efforts toward bioactive important compounds will be pursued to prove the synthetic value of our novel methodologies.

**CARMEN A. VEGA**, *Professor*, Ph.D., 1975, University of Florida. Research interests: Thermodynamics, electrochemistry and spectroscopy of solutions. HPLC studies of limits of detection of drugs in physiological fluids. Studies of the interaction of platinum drugs with amino acids and DNA.

**GRADUATE FACULTY INVOLVED IN ACADEMIC WORK AND THEIR INTERESTS**

**ASTRID J. CRUZ**, *Professor*, Ph.D., 1993, University of Massachusetts. Teaching interests: Theoretical studies of molecular scattering phenomena by means of wave packets and fast Fourier Transform techniques. Quantum finite temperature studies of molecule-surface energy transfer processes.

**AIDALÚ DE LOS A. JOUBERT-CASTRO**, *Associate Professor,* Ph.D*.,* 1998*,* Washington State University, Pullman. Research interests: Evaluation of liquid chromatography- particle beam mass spectrometry as a technique for the analysis of vanadyl geoporphyrins. Implementation and development of new teaching techniques that relate chemical concepts and the direct application of such concepts to the classroom.

**JORGE LABOY**, *Professor*, Ph.D., 1993, University of Cincinnati. Research interests: Mid-infrared FT-IR spectroscopy of transient species and reaction intermediates, mainly radicals using matrix-isolation. Photochemical reactions and reactions dealing with semiconductor materials.

**NAIRMEN MINA**, *Professor*, Ph.D., 1996, Baylor University. Research interests: FT-IR, Near IR, VIS and photoacustic spectroscopy of organic compounds at cryogenic temperatures. Chemical kinetics and spectroscopy of CFC's.

**LUIS A. MORELL**, *Professor*, Ph.D., 1993, University of California, Riverside. Research interests: Organic synthesis and development of hetero Diels-Alder reaction. Conformational analysis of sugar derivatives.

**FRANCIS PATRON**, *Professor,* Ph.D., 1997, Purdue University. Research interests: Chemistry education research on the teaching and learning of chemistry with particular interest in physical chemistry.

**ROBERT RIOS**, *Professor,* Ph.D., 1995, Rutgers University, New Jersey. Research interests: Chemotherapeutic approach to the treatment of tumors and the chemistry involved in the synthesis of ligands. Methodology development for the synthesis of useful-intermediates to be used in the construction of novel chemotherapeutic drugs.

**JORGE L. RIOS-STEINER**, *Professor*, Ph.D., 1991, University of Puerto Rico. Research interests: Analysis and structural studies of macromolecules, natural products, organic and inorganic molecules, utilizing X-ray crystallography as the main analytical tool.

**ALBERTO SANTANA-VARGAS**, *Professor*, Ph.D., 2003, University of Florida. Research interests: Our research deals with theoretical and computational aspects of molecular and materials science with particular emphasis on AbInitio and DFT calculations, quantum molecular dynamics, density matrix theory, and classical molecular dynamics. It includes photoinduced phenomena in the gas phase, clusters, and at solid or metallic surfaces. We use quantum and statistical mechanics, mathematical, and computational methods to describe time-dependent phenomena such as femtosecond dynamics, photochemistry, and quantum control in both simple and complex molecular systems.

**JESSICA TORRES**, *Professor*, Ph.D., 2004, John Hopkins University. Teaching interests: Surface chemistry, Solid State Chemistry, Atomic force microscopy, Chemical Education.

# DEPARTMENT OF ENGLISH

The Department of English Master's Program offers two masters and a curricular sequence: Master of Arts in English Education (MAEE), a Master of Arts in English Literatures (MAEL), and a Graduate Curricular Sequence in the Teaching of English to Speakers of Other Languages (TESOL).

## MASTER OF ARTS IN ENGLISH EDUCATION (MAEE)

In addition to the general requirements for admission to the Office of Graduate Studies of the University of Puerto Rico at Mayagüez, applicants to the program should satisfy the following conditions:

- Minimum 3.00 general and major grade point average. The Department Graduate Committee may consider applicants whose general and major GPA is 2.75-2.99 if compelling justification for the lower average is provided in the application.
- International students whose native language is not English must submit their TOEFL scores. The minimum score required is 550 for the paper-based test, 213 for the computer-based test, and 79 for the internet-based test.
- Applicants must submit a one-page, single spaced statement of purpose written in English with their online application.
- Applicants must also submit an academic writing sample (e.g., analytic essay).
- Three letters of recommendation from faculty who are familiar with the applicant's academic and/or professional work.
- Personal interview with a member of the Department Graduate Committee and/or Department Chair.
- Pre-requisites: Prospective students must take or have taken the following undergraduate courses (or equivalent courses).

INGL 3351. American Literature to 1860 *or* INGL 3352. American Literature 1860 to modern period.
INGL 3321. English Literature to 1798 *or* INGL 3322. English Literature 1798 to modern period
INGL 3225. Introduction to Linguistics
INGL 4205. Morphology and Syntax *or* INGL 4206. Structure of English

**All letters of recommendation and evidence of the above material should be submitted to the Office of Graduate Studies along with the regularly required material through their online platform.

Conditional Admission:

Students who lack up to 12 credits of coursework may be admitted to the program on a conditional basis. These students are required to make up the deficiencies by passing relevant coursework during their first year in the program.

Within the MAEE program, there are five core courses required for all students. Outside of the core, students may opt to tailor their programs to meet their individual interests, selecting from courses in linguistics, literature and pedagogy. Students in the MAEE Program choose from one of two options:

Option I: Thesis
Option III: Comprehensive Exam

The thesis option requires students to complete a thesis as the program requirement. The comprehensive exam option requires students to take two additional courses and to pass an exam that has a three-part written component and an oral defense.

Each option is defined clearly in the Graduate Handbook available on the Department of English website: https://www.uprm.edu/english/

## PROGRAM OF STUDY

## MAEE CURRICULUM

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| *INGL 6020 | 3 | Second Language Acquisition |
| **INGL 6996 | 1 | University Teaching Development |
| *INGL 6006 | 3 | Research Methods |
| INGL 5/6XXX | 3 | ***Elective |
| | 10 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| *INGL 6010 | 3 | TESL Materials and Testing |
| *EING 6005 | 3 | Foundations of English Education |
| **INGL 6996 | 1 | University Teaching Development |
| INGL 5/6XXX | 3 | ***Elective |
| | 10 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| INGL 5/6XXX | 3 | ***Elective |
| INGL 6XXX | 3 | Elective |
| INGL 6999 | 3 | Thesis (Option I) |
| **OR** | | |
| INTD 6015 | 0 | Comprehensive Exam |
| **AND** | | (Option III) |
| INGL 6XXX | 3 | Elective |
| **INGL 6996 | 1 | University Teaching Development |
| | 10 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| *INGL 6009 | 3 | Models for Teaching Literature |
| INGL 6999 | 3 | Thesis (Option I) |
| **OR** | | |
| INTD 6015 | 0 | Comprehensive Exam |
| **AND** | | (Option III) |
| INGL 6XXX | 3 | Elective |
| | 6 | |

**Total Credits: 30-36**

*Core Course
**If the student is receiving a graduate assistantship. Each class is valued at 1 credit per semester for a total of 3 credits.
***Nine (9) credits in electives can be at the 5000 level (INGL 5XXX)

## MASTER OF ARTS IN ENGLISH LITERATURES (MAEL)

For the Master of Arts in English Literatures (MAEL) (Academic Senate Certification 19-74). in addition to the general requirements for admission to the Office of Graduate Studies of the University of Puerto Rico at Mayagüez, applicants to the program should satisfy the following conditions:

- Hold a bachelor's degree with at least 9 credits in British literature and 6 in American literature from an accredited institution of higher learning. The department Graduate Committee will assess the applicants and can assign up to 4 undergraduate courses to be taken by applicants who have deficiencies.
- Have a GPA of at least 3.00 in English courses.
- Have mastery over written and spoken English (a criterion that will be evaluated by the Department Graduate Committee).
- Certification 09-09 provides for conditional admission to be granted to candidates who require pre-requisites.

For more information of the MAEL, visit: https://www.uprm.edu/english/graduate-program-m-a-e-l/

### PROGRAM OF STUDY

### MAEL CURRICULUM

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| *INGL 6605 | 3 | Research Methods Literature |
| INGL 6XXX | 3 | Period 1 Course |
| **OR** | | |
| INGL 6XXX | 3 | Period 6 Course |
| INGL 6XXX | 3 | **Elective |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| *INGL 5015 | 3 | English and American Literary Criticism |
| INGL 6XXX | 3 | Period 2 Course |
| **OR** | | |
| INGL 6XXX | 3 | Period 5 Course |
| INGL 6XXX | 3 | **Elective |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| INGL 6XXX | 3 | Period 3 Course |
| **OR** | | |
| INGL 6XXX | 3 | Period 4 Course |
| INGL 6XXX | 3 | **Elective |
| INGL 6999 | 3 | Thesis (Option I) |
| **OR** | | |
| INTD 6015 | 0 | Comprehensive Exam (Option III) |
| **AND** | | |
| INGL 6XXX | 3 | **Elective |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| INGL 6XXX | 3 | Period 2 Course |
| **OR** | | |
| INGL 6XXX | 3 | Period 5 Course |
| INGL 6XXX | 3 | **Elective |
| INGL 6999 | 3 | Thesis (Option I) |
| **OR** | | |
| INTD 6015 | 0 | Comprehensive Exam (Option III) |
| **AND** | | |
| INGL 6XXX | 3 | **Elective |
| | 9 | |

**Total Credits: 36**

*Core Course
**Review the MAEL Handbook for recommended electives.

| | | |
|---|---|---|
| Period 1: Old and Middle English | 6478 | Old English Language and Literature |
| | 6216 | Beowulf and Cynewulf |
| | 6207 | Chaucer and Chaucerians |
| | 6206 | Middle English Literature: Prose, Drama, and the Alliterative Revival |
| Period 2: Shakespeare and the Renaissance to 1660 | 6247 | Sixteenth Century British Literatures |
| | 6441 | Shakespeare: Texts and Contexts |
| | 6208 | British Poetry of the Seventeenth-Century |
| | 6215 | Seventeenth-Century Drama |
| Period 3: British Literature from 1660-1900 | 6479 | Neo-classical Poetry, Prose, & Drama |
| | 6218 | The Eighteenth-Century Novel |
| | 6487 | The Romantic Movement: The First Generation |
| | 6076 | The Romantic Movement: The Second Generation |
| | 6448 | The Victorian Novel |
| | 6477 | Victorian Poetry and Prose |
| Period 4: American Literature till 1900 | 6459 | Early American Literature to 1820 |
| | 6498 | US Literature 1820-1860 |
| | 6210 | US Literature 1860-1900 |

## GRADUATE CURRICULAR SEQUENCE

## TEACHING ENGLISH TO SPEAKERS OF OTHER LANGUAGES (TESOL)

The Department of English offers a Graduate Curricular Sequence in Teaching English to Speakers of Other Language (TESOL). Academic Senate Certification 21-42. This curricular sequence is conditioned to admission to the Masters in English Education (MAEE) offered by the Department of English. This curricular sequence complements and expands graduate students' education by providing them not only with the skills to teach English as a Second or Foreign Language, but also with a certificate that serves as evidence of meeting potential employment requirements for teaching English in a global society. It expands their options to teach both overseas and across the U.S. The objectives of this curricular sequence support and align with our institution's general education philosophy. This Curricular Sequence is also aligned with the curriculum for the English Department Masters in English Education (MAEE) Program at UPRM.

**Prerequisites:**
INGL 3225 Introduction to Linguistics

**Objectives:**

- Understand current research issues and concerns in Second and Foreign Language Teaching.
- Design a range of curriculum units, lesson plans, pedagogical materials and assessment tools to meet a range of second and foreign language learners' needs.
- Evaluate and critique syllabuses, curricula and pedagogical materials for second and foreign language learners.
- Analyze samples of language use from second language learners using phonological, lexical, and discourse approaches.
- Devise and implement appropriate strategies for their own ongoing professional development.
- Understand the role of the learners' context in second and foreign language learning.

**Required Courses and Options (18 credits):**

The Curricular Sequence option requires 18 credits in the following domains: language as a system (6), instruction and language acquisition (3), assessment (3), culture (3) and professionalism (3).

## PROGRAM OF STUDY

## GRADUATE CURRICULAR SEQUENCE

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| *INGL 6020 | 3 | Second Language Acquisition |
| **OR** | | |
| INGL 5010 | 3 | Perspectives of Teaching English |
| INGL 6996 | 1 | University Teaching Development |
| | 4 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| *INGL 6010 | 3 | TESL Materials and Testing |
| *EING 6005 | 3 | Foundations of English Education |
| INGL 6996 | 1 | University Teaching Development |
| | 7 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| INGL 5/6XXX | 3 | **Language as a System |
| INGL 6996 | 1 | University Teaching Development |
| | 4 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| INGL 5/6XXX | 3 | **Language as a System |
| | 3 | |

**Total Credits 18**

*Core Course
**See table below.

| Code | Title | Crds | Domain |
|---|---|---|---|
| INGL6008<br>INGL6016<br>INGL6018<br>INGL6028<br>INGL6030<br>INGL6040<br>INGL5019<br>INGL5025 | Bilingualism and Language Contact (3)<br>Topics in Sociolinguistics (3)<br>Topics in Psycholinguistics (3)<br>Psycholinguistics and the Reading Process (3)<br>Theory and Practice of Composition (3)<br>Practice in the Teaching of Composition (3)<br>Pragmatics (3)<br>Topics in Linguistics (3) | 6 | Language as a system |
| INGL5010<br>INGL6020* | Perspectives on Teaching English as a Second Language (3)<br>Second Language Acquisition (3) | 3 | Instruction Language Acquisition |
| INGL6010* | ESL Materials and Testing (3) | 3 | Assessment |
| EING6005* | Foundations of English Education (3) | 3 | Culture |
| INGL6996 | UTD- University Teaching Development (3) (Teaching practicum from an accredited institution or a one-year documented teaching experience in an ESL or EFL Context) | 3 | Professionalism |

*These three courses are also required in order to earn an MAEE

## DEPARTMENT OF ENGLISH FACULTY

A list of professors who engage in graduate activities in the department follows including highest degree earned, completion date, and degree-granting institution. Research and teaching interests are also included.

**NANDITA BATRA**, *Professor*, Ph.D., 1987, University of Rochester. Research and teaching interests: British Literature (1660 to the present), Postcolonial Studies, Gender Studies, Disability Studies, Anthrozoological Studies, Literary Theory.

**RAISA BONNET**, *Assistant Professor.* MFA, 2016, New York University. Research and teaching interests: Film Production, Directing, Screenwriting, Editing, Cinematography, Sound, Documentary, Production Design.

**RICIA A. CHANSKY**, *Professor*, Ph.D. 2009, Illinois State University. Research and teaching interests: oral history, autobiography, women's literature, gender studies, diasporic literature, decolonial theory, transnational studies, popular and visual culture, pedagogy, and the horror genre.

**CRISTOPHER B. FONT-SANTIAGO**, *Associate Professor*, Ph.D., 2021, University of Wisconsin-Madison. Research and teaching interests: TESOL, Bilingualism, Language Contact, Translanguaging, Natural Language Processing, World Englishes, Sociolinguistics, Perceptual Dialectology, Folk Linguistics, Phonology.

**JOCELYN A. GÉLIGA-VARGAS**, *Professor*, Ph.D. 1999, University of Massachusetts-Amherst. Research and teaching interests: Media Writing; Oral History; Social Justice in Education; Ethnography and Action Research; Afro-Puerto Rican Studies; Feminist Cultural Criticism and Activism.

**NICKOLAS HAYDOCK**, *Professor*, Ph.D. 1995, University of Iowa. Research and teaching interests: Middle English, Middle Scotts, Movie Medievalism, Film, Scottish Makkars, Robert Henryson, William Dunbar, Gavid Douglas, Epic, History of English.

**JOSÉ M. IRIZARRY**, *Professor*, Ph.D. 1999, Indiana University of Pennsylvania. Research and teaching interests: Early 20th Century Puerto Rican Writing in the US, African American Intellectual Discourse, Autobiographical Discourse.

**ERIC D. LAMORE**, *Professor,* Ph.D., 2007, Illinois State University. Research and teaching interests: Early American Literature, Early Black Atlantic Literature, African American Literature, Book History, Print Cultures, Textual Editing, and Pedagogy.

**BETSY MORALES CARO**, *Professor*, Ph.D. 1999, University of Texas at Austin. Research and teaching interests: Culture Studies, ESL, Linguistics, WID, English Education in Puerto Rico, Pedagogy.

**WALESKA F. MORCIGLIO**, *Assistant Professor*, MAEE. 1998, University of Puerto Rico at Mayagüez. Research and teaching interests: Second Language Writing, Basic Writing, and ESL.

**MARÍA DEL CARMEN QUINTERO AGUILÓ**, *Assistant Professor*, PhD, 2016, University of Puerto Rico at Río Piedras. Research and teaching interests: Metaphor Theory, Postcolonial Ecocriticism, The Human/Animal Divide, The Nature/Culture Divide, Tidalectics, The Island as Topos, Derek Walcott's Omeros, Blue Studies.

**HUGO RÍOS-CORDERO**, *Associate Professor*, Ph.D., 2014, Rutgers University, New Jersey. Research and teaching interests: Media Writing; Rhetoric of Power; Issues of Class, Race and Gender; Film and Media Studies; Visual Rhetoric; Post-Colonial and Critical Theory, and Creative Writing.

**ROSITA L. RIVERA**, *Professor,* Ph.D. 2006, The Pennsylvania State University. Research and teaching interests: curriculum development and assessment, ESL teacher education, Pragmatics, and discourse analysis, sociocultural aspects of ESL teaching and learning.

**ROSA I. ROMÁN PEREZ**, *Professor*, Ph.D. 2007. The Pennsylvania State University. Research and teaching interests: Critical Discourse Analysis; Critical Pedagogy and Teacher Education in Secondary Schools; Developmental Education and Student Retention; Media Literacy; ESL Writing, Disability Studies and Reading.

**MARY E. SEFRANEK,** *Professor,* Ed.D. 2006, Teachers College, Columbia University. Research and teaching interests: Bilingual/Bicultural Education, Emergent Bilingual Learners, English Education, K-12 Public Education in Puerto Rico, Latinx Studies in English Education, Multiliteracies and Multimodality Theorizing and Practice, and Queer Studies in Education.

**SANDRA L. SOTO SANTIAGO,** *Professor*, Ph.D. 2014. University of Arizona. Research and teaching interests: Social and Educational Justice, Transnationalism, Linguistic Anthropology, Language Acquisition, Language Policy, Sociocultural Theory, Teacher Education, Ethnography and Oral History.

**GREGORY K. STEPHENS**, *Associate Professor*, Ph.D. 1996, University of California-San Diego; 2nd M.A. in Spanish Literature, University of West Indies-Mona (2007). Research and teaching interests: Cultural analysis and ethnography; Creative Writing and literary nonfiction; rhetorical genre theory; romance of revolution in literature and film; Visual Narrative.

**NANCY V. VICENTE-VÉLEZ**, *Professor*, Ph.D. 2009, The Pennsylvania State University. Research and teaching interests: Decolonizing Methodologies: Narrative Inquiry, Testimonio, Auto-ethnography, Performance Studies, Latina/o Cultural Studies, Women's Studies, Popular Culture, Young Adult and Children's Literature, Fantasy and Science Fiction.

## DEPARTMENT OF GEOLOGY

The Department of Geology offers graduate study leading to a Master of Science degree. Applicants for admission should hold a Bachelor of Science degree in Geology or its equivalent from an accredited institution and have a minimum GPA of 2.80 (those with a GPA between 2.50 and 2.79 may be considered at the discretion of the Graduate Admission Committee), in addition to the requirements of the Graduate Studies Office. Students who do not meet these requirements may be admitted on a provisional basis until deficiencies are removed.

A student enrolled in the Master's Degree program in Geology needs to approve a minimum of thirty-two (32) credit hours subsequent to the bachelor's degree. Of these 32 credit hours, three (3) to six (6) credit hours are for research for the Master's thesis, two (2) credit hours are for a graduate seminar (1 credit hour per semester for two semesters) and three (3) credit hours are for the course GEOL 6107 Geology and Tectonics of the Caribbean. Of the remaining credit hours, fifteen (15) to eighteen (18) credit hours have to be approved in geology courses (amount depends on number of credits given for research), and six (6) credit hours in courses outside of their field of specialization. The latter courses may be taken outside of Geology, or in areas within Geology but in specializations distinct from that of the student's major. Students will not be permitted to take more than six (6) credit hours of Special Topics to satisfy their graduation requirements.

### PROGRAM OF STUDY

### GEOLOGY CURRICULUM

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| GEOL 6505 | 1 | GRADUATE SEMINAR I |
| GEOL XXXX | 3 | GEOL course |
| ELEC XXXX | 3 | Courses outside of field of specialization (can be |
| GEOL | | XXXX or other) |
| GEOL XXXX | 3 | GEOL course |
| | 10 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| GEOL 6506 | 1 | GRADUATE SEMINAR II |
| GEOL 6107 | 3 | GEOLOGY AND TECTONICS OF THE CARIBBEAN |
| ELEC XXXX | 3 | Courses outside of field of specialization (can be GEOL XXXX or other) |
| GEOL XXXX | 3 | GEOL course |
| | 10 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| GEOL 6999 | 3 | RESEARCH AND THESIS |
| GEOL XXXX | 3 | GEOL course |
| | 6 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| GEOL 6999 | 3 | RESEARCH AND THESIS |
| GEOL XXXX | 3 | GEOL course |
| | 6 | |

**Total Credits 32**

The aims of the academic program of the Department of Geology are to provide students with a firm understanding of the geological sciences, and advanced knowledge of techniques for data collection and analysis, and instruction at the forefront of their fields of specialization. Research emphasizes geological, geophysical, geochemical, and geobiological problems of the circum-Caribbean region with particular focus on surficial, tectonic, and volcanic processes and their associated hazards; the development of Cretaceous to Holocene reefs; carbonate petrology and stratigraphy; fluid history and hydrothermal mineralization; accessory mineral geochemistry; island arc formation and evolution; and accretionary and transcurrent plate boundary tectonics.

Funding for students is available in the form of teaching and research assistantships both from departmental funds and from research grants.

The Department of Geology occupies the northern third of the Physics Building, shared by Geology, Physics, and Marine Sciences, and has separate facilities available in two other buildings. Equipment is available for geochemical and geophysical measurements. Geochemical instrumentation includes a SIEMENS D5000 X-ray Diffractometer and other ancillary equipment, all purchased through a grant from the National Science Foundation Minority Research Center of Excellence program. Wet chemistry facilities are also available. Equipment is available to prepare petrographic thin sections.

The Department also hosts the UPRM Stable Isotope Laboratory, a facility funded through a grant from the National Science Foundation Major Research and Instrumentation program and the University of Puerto Rico Central Administration. The Stable Isotope Laboratory features a GV (Micromass) Isoprime magnetic sector isotope ratio mass spectrometer for measurement of the stable isotopes of H, C, N, O, and S in dual inlet or continuous flow operation. Peripheral attachments include a Eurovector 3000 elemental analyzer, and a New Wave Micromill device. The laboratory routinely measures the stable isotopes of carbon and oxygen in marine carbonates using the continuous flow method, and also the stable isotopes of O and H in water samples.

The Department has different types of geophysical equipment available for academic and research purposes. Computing facilities consist of an extensive networked array of PC and Macintosh microcomputers and several laser printers. The department hosts a computing facility with ~20 personal computers, a scanner and a printer for student use. It is used as teaching laboratory for courses in remote sensing, GIS, and seismology. It has installed ENVI, ArcGIS, and MATLAB, among other software.

**Seismic Network**

The Puerto Rico Seismic Network (PRSN, Red Sísmica de Puerto Rico) is under the administration of the Dept. of Geology. The mission of the PRSN is to produce high quality data and information to be able to respond to the needs of the emergency management, academic and research community and the general public. The network operates 25 digital real time broadband and short period seismic stations in Puerto Rico and the US and British Virgin Islands. Future plans include installing two stations in eastern Dominican Republic. The PRSN maintains a catalogue of earthquakes for the Puerto Rico region which extends from eastern Dominican Republic through the Virgin Islands. Continuous waveforms from all of its stations are also archived. As of 2007, the PRSN is also operating a network of 6 tsunami ready tide gauge stations. The data from these stations will be incorporated into the Tsunami Warning System for Puerto Rico and the Caribbean which has been under development at the PRSN since 2000. The information and data generated are distributed among the scientific and academic community, emergency management organizations, and the general public. It maintains an active education and outreach program which focuses on K-12 and emergency management. The PRSN is staffed by scientists, technicians, administrative personnel and students.

**Website:** https://www.uprm.edu/geology/

## GEOLOGY FACULTY

A list of professors who engage in graduate activities in the Department follows including the highest earned degree, and institution granting the degree. Research and teaching interests are also included**.**

**FERNANDO GILBES**, *Professor*, Ph.D., 1996, University of South Florida. Research interests: Environmental remote sensing, GIS. Teaching interests: Remote Sensing, GIS.

**THOMAS HUDGINS**, *Professor*, Ph.D., 2015, University of Michigan. Research interests: Igneous petrology, Formation of granites in island arcs, Economic Geology, Geochemistry. Teaching interests: Petrology, Geochemistry, Instrumental Analysis of Solid Materials, Economic Geology.

**VÍCTOR HUÉRFANO**, *Researcher*, Ph.D., 2003, University of Puerto Rico, Mayagüez. Research interests: Real Time Seismic Network Operations, Early Warning Systems (Tsunamis and Earthquakes), Tsunami Generation and Modeling, Crustal Structure and Local Field Seismic Inversion. Teaching interests: Earthquake Seismology, Physics of Tsunamis, Numerical methods in Real Time Seismology.

**K. STEPHEN HUGHES**, *Professor*, Ph.D., 2014, North Carolina State University. Research interests: Orogenic studies, field mapping, geochemistry, geochronology. Teaching interests: Structural geology, Tectonics.

**JAMES JOYCE**, *Professor*, Ph.D., 1985, Northwestern University, Illinois. Research interests: Caribbean geology, neo-tectonics, Quaternary geology, metamorphic petrology. Teaching interests: Caribbean geology, metamorphic petrology, structure and tectonics, Quaternary geology.

**ALBERTO M. LÓPEZ**, *Professor*, Ph.D., 2006, Northwestern University, Illinois. Research interests: Seismology, Plate Tectonics, Tsunami Earthquakes, Tsunami Modeling, GPS, Ocean bottom seismometers, and seismic instrumentation. Teaching interests: Seismology, Tectonics, Caribbean Tectonics, Geophysics, Geodesy.

**RAIZA QUINTERO**, *Assistant Professor*, Ph.D., 2023, Curtin University, Australia. Research and teaching interests: Planetary Geology, Meteorite impacts, Formation of the Solar System and Earth, Mineralogy, Geochemistry.

**WILSON RAMÍREZ**, *Professor*, Ph.D., 2000, Tulane University, Louisiana. Research interests: Carbonate petrology, low temperature geochemistry, Geology of reef systems, Coastal geology and erosion, Paleo-thermometry. Teaching interests: Carbonate Petrology, Marine Geology, Microfacies Analysis.

**LIZZETTE RODRÍGUEZ**, *Professor*, Ph.D., 2007, Michigan Technological University. Research interests: Volcanology, Volcanic hazards, Volcano monitoring (especially gas and deformation), Volcano-atmosphere interactions, Pyroclastic deposits. Teaching interests: Volcanology, Volcanic hazards, Natural hazards, Volcanic Processes and Deposits.

**HERNÁN SANTOS**, *Professor*, Ph.D., 1999, University of Colorado. Research interests: Carbonate sequence stratigraphy; biostratigraphy; paleontology. Teaching interests: Sedimentology; stratigraphy; paleontology.

**ELIZABETH VANACORE**, *Associate Researcher*, Ph.D., 2008, Rice University, Texas. Research interests: Distribution and nature of mantle heterogeneity, structure of the Deep Earth: D", ultra-low velocity zones (ULVZ's), inner/outer core structure, computational seismology, evolution and formation of continental lithosphere, array seismology. Teaching interests: Geodynamics, Geophysics, Seismotectonics.

# DEPARTMENT OF HISPANIC STUDIES

The Department of Hispanic Studies offers a program leading to the degree of Master of Arts in Hispanic Studies. All students enrolled in the M.A. program must choose one of two tracks:

- Hispanic Studies with concentration in Hispanic Linguistics; or
- Hispanic Studies with concentration in Spanish Literatures and Cultures

Students in the M.A. Program must also choose one of the program completion options:

- Option I: Thesis
- Option III: Comprehensive Exam or two research papers

The thesis option requires students to complete a thesis as the program requirement. The comprehensive exam or research papers option requires students to take an additional two courses. Each option is defined clearly in the Hispanic Studies Graduate Handbook.

In addition to the admission requirements of the Graduate Studies Office, the Hispanic Studies Department Graduate Program requires:

- A bachelor's degree in Hispanic Studies or its equivalent from an accredited institution.
- Minimum 2.75 general and 3.00 major grade point average in a scale of 0 to 4.00.
- An academic writing sample.
- Three recommendation letters from professionals who are familiar with the applicant's academic and/or professional work.

**Hispanic Literatures and Cultures track**

Applicants who choose the concentration in Spanish Literatures and Cultures must take or have taken the following undergraduate courses (or equivalent courses):

- ESPA 3211 or ESPA 3212 - Introduction to Spanish Literature I or II
- ESPA 4221 or ESPA 4222 – Spanish American Literature I or II
- ESPA 4231 or ESPA 4232 - Puerto Rican Literature I or II
- ESPA 4046 – Introduction to Critical Theory and Literary Analysis.

Students who do not meet these requirements may be admitted on a provisional basis until deficiencies are met.

In addition to the requirements of the Graduate Studies Office, the Hispanic Literatures and Cultures track requires approving the following courses:

- six credits of core courses: Contemporary Literary Theory and Criticism (ESHI 6605) and Seminar in Literary Criticism (ESHI 6606),
- from twelve to twenty-one credits in all areas of Hispanic Literatures and Cultures,
- six credits outside the major area, and
- three credits in Academic Writing (ESHI 6020)

Students also must either pass qualifying exams or papers in Literary criticism and theory, Spanish Literature, Spanish-American Literature, and Puerto Rican Literature, or else approve three thesis credits by successfully writing and defending a master's thesis.

**Hispanic Linguistics track**

Applicants who choose the concentration in Hispanic Linguistics must take or have taken the following undergraduate courses (or equivalent courses):

- LING 4010 or LING 5010 - Introduction to Linguistics
- LING 5030 - Introduction to Generative Syntax
- LING 5040 - Introduction to Generative Phonology
- LING 5060 - Compositional Semantics

Students who do not meet these requirements may be admitted on a provisional basis until deficiencies are met.

In addition to the requirements of the Graduate Studies Office, the Hispanic Linguistics track of the Master of Arts in Hispanic Studies requires completion of the following courses:

- twelve credits of core courses: Syntactic Theory I (LING 6130), Phonological Theory I (LING 6140) Semantic Theory (LING 6160), and Proseminar in Linguistic Research (LING 6700)
- from six to fifteen credits in Linguistics,
- six credits outside the major area, and
- three credits in Academic Writing (ESHI 6020)

Students also must either pass qualifying exams or papers in Syntax, Phonology, Semantics, and Linguistic Theory, or else approve three thesis

credits by successfully writing and defending a master's thesis.

**Website:**
https://www.uprm.edu/estudioshispanicos/

**PROGRAM OF STUDY**

**MASTER OF ARTS IN HISPANIC STUDIES**

**HISPANIC LITERATURES AND CULTURES CURRICULUM (WITH THESIS)**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| ESHI 6605 | 3 | Contemporary Literary Theory and Criticism |
| ESHI 6____ | 3 | Elective in Puerto Rican Literature |
| ESHI 6____ | 3 | Elective in Spanish American Literature |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| ESHI 6606 | 3 | Seminar in Literary Criticism |
| ESHI 6020 | 3 | Academic Writing |
| ESHI 6____ | 3 | Elective in Spanish Literature |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| ESHI 6____ | 3 | Elective in literature |
| INTD/HUMA/ LITE/FILO/INGL/ SOCI 5___ or 6___ | 3 | Elective in related fields |
| | 6 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| INTD/HUMA/ LITE/FILO/INGL/ SOCI 5___ or 6___ | 3 | Elective in related fields |
| ESHI 6045 | 3 | Research and thesis |
| | 6 | |

**Total Credits 30**

**PROGRAM OF STUDY**

**HISPANIC LITERATURES AND CULTURES CURRICULUM (WITH COMPREHENSIVE EXAMINATION OR TWO RESEARCH PAPERS)**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| ESHI 6605 | 3 | Contemporary Literary Theory and Criticism |
| ESHI 6____ | 3 | Elective in Puerto Rican Literature |
| ESHI 6____ | 3 | Elective in Spanish American Literature |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| ESHI 6606 | 3 | Seminar in Literary Criticism |
| ESHI 6020 | 3 | Academic Writing |
| ESHI 6____ | 3 | Spanish Literature |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| ESHI 6____ | 3 | Elective in literature |
| ESHI 6____ | 3 | Elective in literature |
| INTD/HUMA/ LITE/FILO/INGL/ SOCI 5___ or 6___ | 3 | Elective in related fields |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| ESHI 6____ | 3 | Elective in literature |
| ESHI 6____ | 3 | Elective in literature |
| INTD/HUMA/ LITE/FILO/INGL/ SOCI 5___ or 6___ | 3 | Elective in related fields |
| | 9 | |

**Total Credits 36**

**PROGRAM OF STUDY**

**HISPANIC LINGUISTICS TRACK CURRICULUM (WITH THESIS)**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| LING 6130 | 3 | Syntactic Theory |
| LING 5____ or 6____ | 3 | Elective in Linguistics |
| INTD/HUMA/ LITE/FILO/INGL/ SOCI/PSIC 5___ or 6___ | 3 | Elective in related fields |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| LING 6160 | 3 | Semantic Theory |
| ESHI 6020 | 3 | Academic Writing |
| LING 5____ or 6____ | 3 | Elective in Linguistics |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| LING 6140 | 3 | Phonological Theory I |
| LING 6700 | 3 | Proseminar in Linguistic Research |
| | 6 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| INTD/HUMA/ LITE/FILO/INGL/ SOCI/PSIC 5___ or 6___ | 3 | Elective in related fields |
| ESHI 6045 | 3 | Research and thesis |
| | 6 | |

**Total Credits 30**

**PROGRAM OF STUDY**

**HISPANIC LINGUISTICS TRACK CURRICULUM (WITH COMPREHENSIVE EXAMINATION OR TWO RESEARCH PAPERS)**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| LING 6130 | 3 | Syntactic Theory |
| LING 5____ or 6____ | 3 | Elective in Linguistics |
| INTD/HUMA/ LITE/FILO/INGL/ SOCI/PSIC 5___ or 6___ | 3 | Elective in related fields |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| LING 6160 | 3 | Semantic Theory |
| ESHI 6020 | 3 | Academic Writing |
| LING 5____ or 6____ | 3 | Elective in Linguistics |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| LING 6140 | 3 | Phonological Theory I |
| LING 6700 | 3 | Proseminar in Linguistic Research |

| | | |
|---|---|---|
| LING 5____ or 6____ | 3 | Elective in Linguistics |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| INTD/HUMA/ LITE/FILO/INGL/ SOCI/PSIC 5___ or 6___ | 3 | Elective in related fields |
| LING 5____ or 6____ | 3 | Elective in Linguistics |
| LING 5____ or 6____ | 3 | Elective in Linguistics |
| | 9 | |

**Total Credits 36**

## HISPANIC STUDIES FACULTY

A list of professors who engage in graduate activities in the Department follows, including the highest earned degree, date, and institution granting the degree. Research and teaching interests are also included.

**MARIBEL ACOSTA-LUGO**, *Professor*, Ph.D., 2004, University of Connecticut. Research and Teaching Interests: Spanish American Literature with emphasis on Puerto Rico and the Hispanic Caribbean; Novel, Theater and Short Story.

**HILTON ALERS-VALENTÍN**, *Professor,* Ph.D., 2000, University of Massachusetts at Amherst. Research and Teaching Interests: Generative Syntax, Phonological Theory, Formal Semantics, Mathematical and Computational Linguistics, Biolinguistics and Cognitive Science.

**AIDA L. CARRERO-VÉLEZ**, *Professor*, M.A., 1990, State University of New York at Albany. Research and Teaching Interests: Spanish American and Hispanic Caribbean Literatures. Short story, Poetry.

**CAMILLE CRUZ-MARTES**, *Professor,* Ph.D., 2001, Brown University. Research and Teaching Interests: Hispanic Caribbean and Latin American Colonial Literature.

**KATZMÍN FELICIANO-CRUZ**, *Professor,* Ph.D., 2004, University of Puerto Rico. Research and Teaching Interests: Spanish Literature.

**MANUEL FIGUEROA-MELÉNDEZ**, *Professor* Ph.D., 1997, University of Puerto Rico. Research and Teaching Interests: Spanish Literature, Novel, Poetry, Love in Literature, Theater. Poet, Essayist and Short Story Writer.

**LEILANI GARCÍA-TURULL**, *Associate Professor*, Ph.D., 2000, University of Wisconsin-Madison. Research and Teaching Interests: Latin American Literature with emphasis on Contemporary Chronicle in Puerto Rico and Mexico, Cultural Studies, Studies on Performance and Afro-Hispanic Literature.

**JACQUELINE GIRÓN-ALVARADO**, *Professor*, Ph.D., 1993, Pennsylvania State University. Research and Teaching Interests: Spanish American Poetry and Theater (20th Century), Puerto Rican Literature, Feminist Literature Criticism. Short Story Writer, Poet, Critic.

**MELVIN GONZÁLEZ-RIVERA**, *Professor*, Ph.D. 2011, Ohio State University. Research and Teaching Interests: Syntactic Theory, Semantics, Pragmatics, Caribbean Spanish.

**MAIRYM LLORENS MONTESERÍN**, *Assistant Professor*, Ph.D., 2022, University of Southern California. Research and Teaching Interests: Neurolinguistics, Phonetics, Clinical Linguistics, Cognitive Science.

**JAIME L. MARTELL-MORALES**, *Professor*, Ph.D., 2000, State University of New York-Stony Brook. Research and Teaching Interests: Puerto Rican and Spanish American Literature, Latin American Colonial Literature, Literary Theory, Novel and Poetry. Essayist and Critic.

**ALEXANDRA MORALES REYES**, *Professor*, Ph.D., 2013, University of Illinois-Urbana. Research and Teaching Interests: First and Second Language acquisition, Psycholinguistics, Phonology, Morphosyntax.

**CARMEN M. RIVERA-VILLEGAS**, *Professor,* Ph.D., 1997, Vanderbilt University. Research and Teaching Interests: Puerto Rican Poetry and Contemporary Mexican Literature.

**JOSÉ E. SANTOS-GUZMÁN**, *Professor*, Ph.D., 1999, Brown University. Research and Teaching Interests: Spanish Literatures of the 18th and 20th Centuries (Jovellanos, Olavide, Cadalso, Pérez Galdós, Generation of 1898, Spanish Novel from the Post-Civil War Era to the Present); Hispanic Linguistics (Language Variation).

**MARÍA M. SOLÁ-FERNÁNDEZ,** *Emeritus Professor*, Ph.D., 1977, University of Puerto Rico. Research and Teaching Interests: Spanish American Literature, Feminist Literature, Criticism, Puerto Rican Literature.

**ÁNGELA M. VALENTÍN RODRÍGUEZ**, *Assistant Professor*, Ph.D., 2012, Centro de Estudios Avanzados de Puerto Rico y el Caribe. Research and Teaching Interests: Puerto Rican Literature, Caribbean Literature, Speculative Fiction, Intersectionality, Women Studies.

## DEPARTMENT OF HUMANITIES

The Department of Humanities offers graduate study leading to the Master of Arts degrees in Cultural and Humanistic Studies. The aim of the Department is to promote a greater understanding of the liberal and expressive arts and advance cultural literacy and aesthetic sensibility. These goals are achieved through education and training within a broad range of disciplines drawing from the several undergraduate programs and sequences in the Department: Art Theory, Comparative Literature, French, Italian, Philosophy, Plastic Arts, Music and Theater.

### MASTER IN ARTS IN CULTURAL AND HUMANISTIC STUDIES

The graduate program in Cultural and Humanistic Studies pools the talents of the Department´s specialists in these variegated disciplines of the humanities to provide a rigorous graduate education and training within a fruitfully interdisciplinary field. The graduate program interweaves the classical orientation of humanistic studies in the liberal arts tradition with its critical, exploratory elaboration in the newer field of cultural studies.

While Cultural Studies researches literary texts, art, and popular culture in their contexts, the humanities explore foundational aspects of culture through canonical works of the Western tradition. The Program in Cultural and Humanistic Studies builds bridges between cultural and humanistic studies, integrating the Caribbean, Puerto Rican and Latin American experiences. It promotes the knowledge required for global citizenship and a transcultural sensibility through critical training in the interdisciplinary study of world cultures.

**Student Learning Outcomes**

Graduating students of the Master's degree will be educated to: 1) Think critically about culture and globalization, especially with reference to the Caribbean, Puerto Rican and Latin American experience; 2) Develop cultural literacy, especially with reference to the Caribbean, Puerto Rican and Latin American experience; 3) Foster a perspective of world citizenship in the domain of public debate, both within Puerto Rico and beyond; 4) Perform normative critique in the study of culture and globalization; and 5) Apply the methodologies of interdisciplinary studies in cultural studies and the humanities.

**Admission requirements**

Applicants for admission to the M.A. program entering with a B.A. should hold a Bachelor's degree from a properly accredited institution. Additionally, applicants must:

- have a minimum Bachelor´s degree GPA of 3.00 (those with a GPA between 2.75 and 2.99 may be considered at the discretion of the Graduate Admission Committee if compelling justification for the lower average is provided in the application).
- submit a one-page, single spaced statement of purpose with their on-line application.
- submit an academic writing sample (e.g. course paper).
- submit results of the GRE or EXADEP
- submit three recommendations from professionals who are familiar with the applicant's academic and/or professional work. Formal letters should be attached to the recommendation form provided with the application.
- complete a personal interview with a member of the Department Graduate Committee and/or the Chair of the Department.
- fulfill any additional requirements of the Graduate Studies Office Students who do not meet these requirements may be admitted on a provisional basis until deficiencies are removed.

**All letters of recommendation and evidence of the above material should be submitted to the Graduate School along with the regularly required material.

**Graduation Requirements**

To complete the Master's Degree in Cultural and Humanistic Studies students need to approve a minimum of thirty-three credits. Of these thirty-three credits, fifteen will be comprised of core courses and fifteen of elective courses. The remaining requirements vary depending on the M.A. exit option.

Three to six credits will be dedicated to thesis credits or to six additional credits of electives depending on the student´s choice of the two exit options, as described in the Graduate Students Office by-laws: Option I: Thesis, or Option III: Comprehensive Exam.

The thesis option requires students to complete, approve and defend a thesis as the program exit requirement. The comprehensive exam option requires students to take an additional two courses (six additional credits of electives) and to pass a comprehensive exam that has a three-part written component and an oral presentation.

Each option is defined clearly in the Humanities Department Graduate Handbook that is provided to students upon entry into the program.

**Website:** https://www.uprm.edu/humanidades/

## PROGRAM OF STUDY

### MASTER IN ARTS IN CULTURAL AND HUMANISTIC STUDIES (WITH THESIS)

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| ESCH 6001 | 3 | Cultural Studies I |
| ESCH 6011 | 3 | Humanistic Studies I |
| ESCH 6___ | 3 | Elective |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| ESCH 6002 | 3 | Cultural Studies II |
| ESCH 6012 | 3 | Humanistic Studies II |
| ESCH 6____ | 3 | Elective |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| ESCH 6005 | 3 | Research methods |
| ESCH 6____ | 3 | Elective |
| INTD/HUMA/ LITE/FILO/ ESHI/INGL/ SOCI 5___ or 6___ | 3 | Elective in related fields |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| INTD/HUMA/ LITE/FILO/ ESHI/INGL/ SOCI 5___ or 6___ | 3 | Elective in related fields |
| ESCH 6999 | 3 | Research and thesis |
| | 6 | |

**Total Credits 33**

### MASTER IN ARTS IN CULTURAL AND HUMANISTIC STUDIES (WITH COMPREHENSIVE EXAMINATION)

Same as above, except for:

**Second Year, Second Semester**

| Number | Credits | Course |
|---|---|---|
| ESCH 6____ | 3 | Elective |
| ESCH 6____ | 3 | Elective |
| INTD/HUMA/ LITE/FILO/ ESHI/INGL/ SOCI 5___ or 6___ | 3 | Elective in related fields |
| | 9 | |

Comprehensive exam

## FACULTY

A list of professors who engage in graduate activities in the department follows, including their highest earned degree, the date of completion, and the degree-granting institution. Research and teaching interests are also included.

**MARIAM COLÓN PIZARRO,** *Professor,* Ph.D., 2011, University of Michigan, Ann Arbor. Cultural Studies, Puerto Rican Studies, Cultural nationalism, Italian Language and Literature.

**SARA GAVRELL**, *Professor*, Ph.D., 2007, University of Wisconsin-Madison. Bioethics, Clinical and Medical Ethics, Ethical Theory.

**JEFFREY HERLIHY**, *Professor*, Ph.D. 2008, Universitat Pompeu Fabra. Literary Studies, Migration Studies, Transnational Literatures.

**MICHAEL HUFFMASTER**, *Professor*, Ph.D. 2010, University of California, Berkeley. Nineteenth- and Twentieth German Literature and Culture, Applied Linguistics.

**NOEMÍ MALDONADO CARDENALES,** *Professor*, Ph.D. 2008, State University of New York at Buffalo. Humanistic Studies, Drama Studies.

**CHRISTOPHER POWERS,** *Professor*, Ph.D. 2003, Johns Hopkins University. Comparative Literature, Cultural Studies, Critical Race Studies.

**EMILIA QUIÑONES-OTAL**, *Associate Professor*, Ph.D., 2014, Universidad de Valencia, España. Art History, History of Contemporary Latin American Art.

**FRANCES J. SANTIAGO-TORRES**, *Professor,* Ph.D., 1998, The City University of New York-Graduate Center. Cultural Studies, Comparative Literature, French Literature.

**JERRY TORRES-SANTIAGO**, *Professor*, Ph.D. 1998, Universidad de Puerto Rico. History, Architecture, Urban History, Humanistic Studies.

## DEPARTMENT OF KINESIOLOGY

The Department of Kinesiology offers a Master's in Art in Kinesiology (MAK), with three options; thesis (31 credits), project (34 credits), and academic courses (37 credits) in one of two study areas: Pedagogy in Teaching Physical Education (P) and Exercise Science (ES). Kinesiology is the study of human movement and physical activity in which the main objectives are:

1. The physiological, psychological responses, and mechanical qualities of movement;
2. The cultural, social, and historical perspectives of physical activity and sports;
3. The motor skill learning and performance processes to change behaviors towards healthy lifestyles;
4. The pedagogical content knowledge to teach high-quality physical education classes.

Our graduates can work efficiently in academic, governmental, and industrial endeavors or pursue doctoral studies.

Admission to the MAK Program is guided by the general regulations and requisites established by the Office of Graduate Studies. In addition to these requirements, applicants must have a 2.50 GPA overall or 3.00 specialization GPS or more in a bachelor's degree. Applicants who have not approved credit hours in the following areas: Exercise Physiology (3 crs.), Motor Learning (3 crs.), and Evaluation in Physical Education (3 crs.) or equivalent, if accepted to the program, will be assigned these courses as deficiencies. **Complying with the admission requisites does not guarantee automatic admission to the program.**

**Webpage:** https://www.uprm.edu/kinesiologia/

### PROGRAM OF STUDY

#### PLAN I: TESIS

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| KINE 6985 | 3 | Research Methods In Kinesiology |
| KINE 6105 | 3 | Current Topics In Kinesiology |
| KINE 6015 | 3 | Theories of Sports Training (ES) |
| or | | |
| EDFI 6005 | 3 | Analysis of Teaching Physical Education (P) |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| Statistics | 3 | Graduate Course in Statistics |
| KINE 6109 | 3 | Physiology of the Athlete in Sports (ES) |
| or | | |
| EDFI 6107 | 3 | Curricular Design in Physical Education (P) |
| Elective | 3 | Elective |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| Elective | 3 | Elective (ES) |
| or | | |
| EDFI 6105 | 3 | Learning and Control of Motor Skills (P) |
| EDFI 6209 | 3 | Evaluation and Prescription of Exercise (ES) |
| or | | |
| Elective | 3 | Elective (P) |
| KINE 6999 | 3 | Research and Thesis |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| KINE 6500 | 1 | Graduate Seminar |
| KINE 6999 | 3 | Research and Thesis |
| | 4 | |

**Total Credits 31**

**PLAN II: PROJECT**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| KINE 6985 | 3 | Research Methods In Kinesiology |
| KINE 6105 | 3 | Current Topics In Kinesiology |
| KINE 6015 | 3 | Theories of Sports Training (ES) |
| or | | |
| EDFI 6005 | 3 | Analysis of Teaching Physical Education (P) |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| Statistics | 3 | Graduate Course in Statistics |
| KINE 6109 | 3 | Physiology of the Athlete in Sports (ES) |
| or | | |
| EDFI 6107 | 3 | Curricular Design in Physical Education (P) |
| KINE 6107 | 3 | Anthropometry (ES) |
| or | | |
| Elective | 3 | Elective |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| EDFI 6105 | 3 | Learning and Control of Motor Skills (P) |
| or | | |
| Elective | 3 | Elective (ES) |
| EDFI 6046 | 3 | Safety in Physical Education (P) |
| or | | |
| EDFI 6209 | 3 | Evaluation and Prescription of Exercise (ES) |
| Elective | 3 | Elective |
| | 9 | |

**Second Semester**

| | | |
|---|---|---|
| KINE 6500 | 1 | Graduate Seminar |
| KINE 6905 | 3 | Project |
| Elective | 3 | Elective |
| | 7 | |

**Total Credits 34**

**Areas of Study: Exercise Science (ES) Pedagogy (P)**

**PLAN III: ACADEMIC COURSES**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| KINE 6985 | 3 | Research Methods in Kinesiology |
| KINE 6105 | 3 | Current Topics in Kinesiology |
| KINE 6015 | 3 | Theories of Sports Training (ES) |
| or | | |
| EDFI 6005 | 3 | Analysis of Teaching Physical Education (P) |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| Statistics | 3 | Graduate Course in Statistics |
| KINE 6109 | 3 | Physiology of the Athlete in Sports (ES) |
| or | | |
| EDFI 6107 | 3 | Curricular Design in Physical Education (P) |
| Elective | 3 | Elective |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| KINE 6107 | 3 | Anthropometry (ES) |
| or | | |
| EDFI 6105 | 3 | Learning and Control of Motor Skills (P) |
| EDFI 6209 | 3 | Evaluation and Prescription of Exercise (ES) |
| or | | |
| EDFI 6046 | 3 | Safety in Physical Education (P) |
| Elective | 3 | Elective |
| | 9 | |

**Second Semester**

| | | |
|---|---|---|
| KINE 6500 | 1 | Graduate Seminar |
| Elective | 3 | Elective |
| Elective | 3 | Elective |
| KINE 6017 | 3 | Inclusive Physical Activity for a Lifetime |
| | 10 | |

**Total Credits 37**

**Areas of Study: Exercise Science (ES) Pedagogy (P)**

## FACULTY

A list of professors who engage in graduate activities in the Department follows including their highest earned degree, date, institution granting the degree.

**RAMÓN L. ÁLVAREZ-FELICIANO**, *Associate Professor*, Ed.D., 2015, University of Puerto Rico-Rio Piedras.

**IBRAHIM M. CORDERO-MORALES**, *Professor*, Ph.D., 2002, Florida State University.

**LUIS O. DEL RÍO-PÉREZ**, *Professor*, Ph.D., 1989, University of Pittsburgh.

**MARGARITA FERNÁNDEZ-VIVÓ,** *Professor*, Ph.D., 2002, Florida State University.

**IRIS FIGUEROA-ROBLES**, *Professor*, Ph.D., 2010, Florida State University.

**EFRANK MENDOZA-MARTÍNEZ**, *Professor*, Ph.D., 1990, The University of New Mexico.

**CARLOS E. QUIÑONES-PADOVANI**, *Associate Professor*, Ph.D., 2009, Florida State University.

**ENID A. RODRÍGUEZ-NOGUERAS,** *Professor*, Ph.D., 2010, University of North Carolina at Greensboro.

**MANUEL SILVA**, *Professor*, Ph.D., 2014, Claremont Graduate University.

**EDUARDO SOLTERO-FLORES**, *Professor*, Ed.D., 1988, University of Houston.

**CARLOS TORRES RAMOS**, *Associate Professor*, Ph.D., 2018, University of Georgia.

# DEPARTMENT OF MARINE SCIENCES

The Department of Marine Sciences (DMS) is a graduate department of the University of Puerto Rico (UPR) at Mayagüez, offering instruction leading to a Master of Science Degree and a Doctor of Philosophy Degree in Marine Sciences. A second Program, a Professional Masters in Marine Sciences, is awaiting approval from the administration. The Master program was created in 1968 and the doctoral program of the DMS was established in 1972, both were the first masters and doctoral programs established at the Mayagüez Campus.

The Department had its origins in the Institute of Marine Biology, established at the Mayagüez Campus in 1954 to promote and conduct research in this discipline. With expansion in both its scope and capabilities, the Institute became in August 1968, the Department of Marine Sciences. It has continued to broaden and strengthen its academic and research activities and currently sponsors active programs of investigation and instruction in the fields of biological, physical, chemical. geological oceanography, and marine biotechnology. The faculty consists of 11 members offering approximately 60 courses which encompass a wide range of topics in marine sciences.

The aim of the Department is to promote a greater understanding of the marine environment. This is achieved primarily through the education and training of marine scientists, through basic and applied research, outreach and public education, and strategic alliances with Federal and local agencies and private institutions. Emphasis on excellence in academic and research programs has placed the DMS at the forefront of marine science and in a position to serve the needs of the maritime nations of Latin America and the Caribbean.

The aims of its academic programs are to provide students with a firm grounding in marine sciences, instruction at the forefront of their fields of specialization, advanced knowledge of experimental design, techniques for data and sample collection, preservation, processing and analyses. Students specialize in a particular discipline but are required to gain knowledge of other disciplines comprising the broad field of marine sciences. This is achieved by means of required core courses in biological, chemical, geological and physical oceanography, many elective courses, a seminar course in current topics and their thesis research.

Financial support to DMS students includes research assistantships from external sources (Federal-funded projects, Private companies, NGO's, etc.), teaching assistantships at other departments and activities related to outreach organized by the DMS. Assistantships from research funds are awarded at the discretion of the student advisor if he is involved as the principal and co-principal investigators of the project.

**Webpage:** https://www.uprm.edu/cima/

## PROGRAM OF STUDY

### MASTER IN MARINE SCIENCES
### PLAN I: WITH THESIS
### Total credits required = 32

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| CMOQ 6615 | 3 | Chemical Oceanography |
| CMOG 6616 | 3 | Geological Oceanography |
| Elective course | 3 | Variable credits |

Alternative courses are available in the DMS to complete the nine credits.

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| CMOB 6618 | 3 | Biological Oceanography |
| CMOF 6617 | 3 | Physical Oceanography |
| Elective | 3 | Variable credits |

Alternative courses are available to complete the nine credits.

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| CIMA 6999 | 3 | Research and Thesis |
| CIMA 8785 | 2 | Current Topics Seminar |
| Elective course | 3 | Variable credits |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| CIMA 6999 | 0 | Research and Thesis |
| Elective course | 3 | Variable credits |

**THIRD YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| CIMA 6999 | 0 | Research and Thesis |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| CIMA 6999 | 0 | Research and Thesis |

**Total Credits (required 32)**

**MASTER OF SCIENCES**
**IN MARINE SCIENCES**
**PLAN II: WITH PROJECT**
**32 credits required**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| CMOQ 6615 | 3 | Chemical Oceanography |
| CMOG 6616 | 3 | Geological Oceanography |
| Elective course | 3 | Variable credits |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| CMOB 6618 | 3 | Biological Oceanography |
| CMOF 6617 | 3 | Physical Oceanography |
| Elective course | 3 | Variable credits |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| CMOF6617 | 3 | Physical Oceanography, |
| CMOQ6615 | 3 | Chemical Oceanography |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| CIMA 6900 | 3 | Research Project |
| Elective course | 3 | Variable credits |

**THIRD YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| CIMA 6900 | 3 | Research Project |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| Elective course | 0 | Variable credits |

**Total Credits 32**

**MASTER OF SCIENCES**
**IN MARINE SCIENCES**
**PLAN III: WITH COURSES**
**Credits required = 36**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| CMOG 6616 | 3 | Geological Oceanography |
| CMOQ 6615 | 3 | Chemical Oceanography |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| CMOB 6618 | 3 | Biological Oceanography |
| CMOF 6617 | 3 | Physical Oceanography |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| Elective in CIMA | 3 | Variable credits |
| Elective in CIMA | 3 | Variable credits |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| Elective in CIMA | 3 | Variable credits |
| Elective in CIMA | 3 | Variable credits |

**THIRD YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| Elective course | 3 | Variable credits |
| Elective course | 3 | Variable credits |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| Elective course | 3 | Variable credits |
| Elective course | 3 | Variable credits |

**Total Credits 36**

**DOCTOR OF PHILOSOPHY IN MARINE SCIENCES (with MS)**
**Credits required = 48**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| CMOQ 6615 | 3 | Chemical Oceanography |
| CMOG 6616 | 3 | Geological Oceanography |
| CMOB 8665 | 3 | Morphology of Mar Invert |

Alternative courses to CMOB 8665 that the student can take: CMOB 6079, CIMA 5005, CIMA 5008

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| CMOB 6618 | 3 | Biological Oceanography |
| CMOF 6617 | 3 | Physical Oceanography |
| CMOB 8715 | 3 | Ecological Concepts |

Alternative courses to CMOB 8715 that the student can take: CMOQ 6617, CMOG 5001, CMOG 5002

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| CMOF 6445 | 4 | Remote Sensing in Ocean I |
| CIMA 8785 | 2 | Current Topics Seminar |
| CMOB 6635 | 3 | Research Meth in Mar Sc |

Alternative courses to CMOB 6635 that the student can take: CMOB 6079, CIMA 5005, CIMA 5008

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| CMOG 8706 | 3 | Structure of Coral Reef |
| CMOF 8619 | 3 | Coastal Oceanography |
| CIMA 8999 | 3 | Doctoral Dissertation |

Other alternative courses that the student can take: CMOB 8708, CMOB 8709, CMOF 8446

**THIRD YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| CMOF 8619 | 3 | Coastal Oceanography |
| CIMA 8999 | 5 | Doctoral Dissertation |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| CIMA 8999 | 4 | Doctoral Dissertation |

**Total Credits 48**

**DOCTOR OF PHILOSOPHY IN MARINE SCIENCES (with BS)**
**Credits required = 72**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| CMOQ 6615 | 3 | Chemical Oceanography |
| CMOG 6616 | 3 | Geological Oceanography |
| CMOB 8665 | 3 | Morphology of Mar Inver. |

Alternative courses to CMOB 8665 that the student can take: CMOB 6079, CIMA 5005, CIMA 5008

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| CMOB 6618 | 3 | Biological Oceanography |
| CMOF 6617 | 3 | Physical Oceanography |
| CMOB 8715 | 3 | Ecological Concepts |

Alternative courses to CMOB 8715 that the student can take: CMOQ 6617, CMOG 5001, CMOG 5002

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| CMOF 6445 | 4 | Remote Sensing in Ocean I |
| CIMA 8785 | 2 | Current Topics Seminar |
| CMOB 6635 | 3 | Research Meth in Mar Sc |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| CMOG 8706 | 3 | Structure of Coral Reef |
| CMOF 8619 | 3 | Coastal Oceanography |
| CIMA 8999 | 3 | Doctoral Dissertation |

**THIRD YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| CMOB-elective | 3 | Variable credits |
| CIMA 8999 | 2 | Doctoral Dissertation |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| CIMA 8999 | 4 | Doctoral Dissertation |
| Elective course | 5 | Variable credits |

**FOURTH YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| CIMA 8999 | 3 | Doctoral Dissertation |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| CIMA 8999 | 3 | Doctoral Dissertation |

**Total credits 56**

**The students have the alternative to take other courses available to complete the total of 72 credits.**

**Graduation Requirements**

- Approve a minimum of 32 credits for the Master in Marine Sciences Degree - Plan I, with Thesis.
- Approve a minimum of 32 credits for the Masters in Marine Sciences Degree - Plan II, with Project.
- Approve a minimum of 36 credits for the Masters in Marine Sciences Degree - Plan III, with courses only.
- Approve a minimum of 48 credits for the Doctor of Philosophy Degree in Marine Sciences when the student starts with a Master Degree.
- Approve 72 credits for the Doctor of Philosophy in Marine Sciences Degree when the students starts with a Bachelor Degree.
- Pass an Oral General Examination for the Master Plan I and Plan II Degree.
- Pass a Comprehensive Exam for the Master Degree Plan III
- Pass a Qualifying Exam and a Comprehensive Exam for the Doctor of Philosophy Degree.
- Successfully develop and defend a research thesis and submit a manuscript to a per-review journal for the Master Degree, Plan I
- Successfully develop and defend a Project for the Professional Master Degree, Plan II
- Successfully develop and defend a doctoral research dissertation, and submit at least two manuscripts to peer-reviewed journals for the Doctor of Philosophy Degree

**Facilities at Mayagüez**

The Department of Marine Sciences facilities on the main campus in Mayagüez are located in a wing of the Physics-Geology-Marine Sciences Building, built in 1972. These facilities include the main departmental administrative offices, a number of laboratories and faculty/student offices. Housed in this wing is the Marine Sciences Library Collection containing over 1,000 books, 17,000 serial volumes, 5,800 documents, plus numerous maps and reprints. It is one of the largest specialized collections in the Caribbean. The collection is complemented by additional holdings in the Mayagüez Campus General Library, and the Sea Grant Library.

Other Departments have state of the art instrumentation that is available for DMS students.

**Isla Magueyes Marine Laboratory**

The principal departmental facilities are located at the field station on Isla Magueyes. A complex of 7 buildings, with a combined area approaching 35,000 square feet, houses faculty and student offices, research laboratories, classrooms and laboratories for teaching and outreach activities, structural, services and boat maintenance shops, and diving facilities that allows faculty to execute the mission and goals of the Graduate program in Marine Sciences.

The DMS maintains a seawater system that is unique in Puerto Rico with submerged pumps supplying up to 85 gal/min. This system provides opportunity for research that depends on a constant supply of seawater to maintain specimens and to conduct experiments. Laboratories possess research instrumentation and dedicated equipment covering a wide spectrum of marine research topics. Instrumentation to conduct work on marine chemistry is available including, conductivity, temperature and depth (CTD's), fluorometers, spectrophotometers and pH meters either to use in the field or in the laboratory. The bio-optical laboratory field instrumentation to measure light profiles and optical properties of the water column and operates a NASA aerosol and radiation network (AERONET) station to characterize atmospheric aerosols. Two fully functional molecular biology laboratories are located on Magueyes as well.

A general use computer center houses computers for students and visitors. Isla Magueyes has 100% fiber-optic wifi service. All computers at Magueyes Island are linked to the UPR-network and all laboratories have internet connectivity.

The Department maintains a functional diving facility including a dive locker, maintenance shop, and a compressor room equipped with an electric compressor that provides compressed air and nitrox tanks. Tanks, are maintained and available for staff students and visitors. The DMS encourages divers to use their personal regulators, BCDs and dive computers. The DMS has some spare regulators and BCDs for emergencies. The department is at present a member of the American Academy for Underwater Sciences (AAUS). All diving from the DMS boats should comply with AAUS regulations, so divers must be approved by the DMS Dive Officer before they are allowed to dive with the DMS.

The DMS operates and maintains a fleet of small and medium sized open boats. This includes four (4) high-speed boats (21 – 24') and thirteen (13) smaller boats (17-20'), all for coastal inshore and shelf-edge water research and academics.

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Offshore work and heavy equipment deployment that needs larger boats could be accomplished by renting local boats or UNOL's large research Vessels. Our "medium-large" RVs, the Sultana (42') and the
*Gaviota* (35 ') were recently decommissioned.

Maintenance facilities are housed in four main buildings, which include workshops, a marine mechanic's shop, and a small boat and outboard motor maintenance-repair shop.

A 1,500 sq. ft. dormitory with five rooms, each with a bunker bed, small closet, AC and a chair, a social room area with fully equipped kitchen and a common bathroom with shower is located on the island.and can accommodate 20 people, Rooms are available to visitors, students, and researchers for a small fee. These should be booked well in advance through the DMS Visitors coordinator, Mrs. Lilivette Valle.(Lilivette.valle@upr.edu)

Two auxiliary diesel generators (250-300 KW each) provide electricity during power failures.

**Associated Centers and companies**

**The Caribbean Coastal Ocean Observing System (CariCOOS).**

CARICOOS (https://www.caricoos.org/) is the observing arm of the Caribbean Regional Association for Integrated Coastal Ocean Observing (CaRA) http://cara.uprm.edu/. This effort, funded by the NOAA IOOS office http://ioos.noaa.gov/, is one of eleven coastal observing systems and regional associations which along with federal agencies constitute the national coastal component of the US Integrated Ocean Observing System. For more information on the regional associations, please visit http://www.ioosassociation.org This web page brings together coastal ocean data and forecasts from a variety of sources including satellites, ocean instruments and numerical models to give the user an integrated view of past, present and forecasted ocean conditions in the US Caribbean region.

An MOU stablishes cooperation guidelines between CARICOOS and the UPRM system (the DMS) CARICOOS rents office and lab. space on Magueyes island for administrative personnel, researchers, student and to store and maintain the oceanographic instrumentation they use. CARICOOS supports a few of the DMS students with research assistantships, or through the DMS by negotiating rental fees.

**Contact:**
Dr. Julio Morell
Julio.morell@upr.edu

## EcoEléctrica Co.

The DMS provides laboratory space to the Power Company Eco-electrica as a base area for their coastal community impact monitoring program associated with their activities. Instruments are used and maintained by DMS students sponsored by the Company. The MOU establishes cooperation guidelines and funding for two graduate student assistantships a year and the availability of their equipment to be used by other students and professors of the DMS.

## Caribbean Coral Reef Institute (CCRI)

The Caribbean Coral Reef Institute (CCRI) was founded in 2003 under a cooperative agreement between the University of Puerto Rico at Mayagüez and the U.S. National Oceanographic and Atmospheric Administration. The goal was to enhance the application of science to the management of coral reef ecosystems. CCRI targets a wide range of topics related to coral reefs and associated marine habitats, their interactions and ecological services. The institute is localities in the facilities of the Magueyes Marine Laboratory.

This institute sponsor's competitive, peer reviewed scientific research and monitoring programs that address short and long-term management driven priorities for the understanding and managing of coral reef ecosystems in Puerto Rico and the US Caribbean.

- Develop, implement, and administer research and monitoring activities that improve the management of coral reef ecosystems and build management capability.
- Interact as appropriate with the Federal and Commonwealth agencies as well as other public and private organizations having a demonstrated capacity to assist in the management of coral reef ecosystems.
- Fully use the resource-base of the region to collaborate and conduct research and monitoring activities on coral reef ecosystems.

**Contact:**
Dr. Juan José Cruz-Motta
Director CCRI
Juan.cruz13@upr.edu

## Institute for Socio-Ecological Research (ISER)

ISER is an applied research and educational non-profit organization based in Cabo Rojo, Puerto Rico that engages and connects with communities across the Caribbean Sea and in coastal communities across the Americas on projects related to marine restoration and conservation, climate change, education, and social and environmental justice.

**Contact:**
Dr. Stacy Williams
Stacy.williams@isercaribe.org

## Bio-Optical Oceanography Laboratory

The Bio-optical Oceanography Laboratory at the Magueyes Island Field Station, southwestern Puerto Rico is a teaching and research facility that focuses

on the use of satellite remote sensing and field measurements of water optical properties in coastal areas of Puerto Rico.

Ongoing research includes 1) developing water optical and remote sensing proxies for inferring the condition and health of coral reefs, including measuring and monitoring spectral light penetration in SW Puerto Rico and relating these data to the status and community structure of coral reefs, 2) calibration/validation of NASA PACE hyperspectral satellite sensor and satellite multispectral data, and 3) assess the impacts of Sargassum intrusions and accumulation on seagrass beds and fringing mangroves in SW Puerto Rico using high-spatial resolution satellite data.

**Contact:**
Dr. Roy A. Armstrong
roy.armstrong@upr.edu
Phone: 787-899-2048, Ext. 249

**Collaborating Organizations**

The **University of Puerto Rico Sea Grant College Program (http://seagrantpr.org)** is an educational program dedicated to the conservation and sustainable use of coastal and marine resources in Puerto Rico, the US Virgin Islands, and the Caribbean region. Its mission is twofold: (1) to fund scientific research in the thematic areas of conservation and the use of coastal and marine resources; (2) to offer marine extension services by making use of its experience and by applying the scientific knowledge that is generated through their research to the problems and issues that the community of users face every day.

Since the beginning of the 1980's, Sea Grant has operated through the University of Puerto Rico, Mayagüez and Humacao Campuses. Sea Grant's work is based on collaborations with universities, industries, governmental agencies, and resource users. Its projects are carried out through research, education, and public service. The Sea Grant College Program has three components: Research, Education, and Marine Advisory; all of which are supported by their Communications section.

The DMS and the Sea Grant Program collaborate continuously with outreach educational activities and some minor research activities. Most of these activities are carried out by SG and DMS personnel with the help of students, faculty, administrative personnel and the physical planta personnel. The DMS provides office space for SeaGrant at the Magueyes Marine Station.

**The Maxwell-Hanrahan Foundation**

The Maxwell/Hanrahan Grants in Field Biology supports undergraduate and Graduate-level field research fellowships and internships for many US universities. The Department has received two years of Funding ($10,000 in 2024 and $25,000 in 2025) support field work of several DMS graduate students. Students can only use the funds to support field activities, materials and sample processing. This donation has been a big help for our students in the development and finishing of their required thesis for the Masters or Doctoral Degrees.

## MARINE SCIENCES FACULTY

The following is a list of professors engaged in academic and research activities in the Department, including the highest earned degree, date, institution granting the degree and research and teaching interests.

**ROY A. ARMSTRONG**, *Associate Director*, *Professor*, Ph.D., 1990, University of Puerto Rico. Research and Teaching interests: Remote Sensing, Water Optics, Underwater Robotics, Benthic Communities, water quality.

**MIGUEL CANALS SILANDER,** *Adjunct Associate Professor*, Ph.D., University of Hawaii at Manoa. Research and Teaching interests: Ocean Observing Systems, Coastal Engineering Applications; Physical Oceanography.

**TRAVIS COURTNEY,** *Assistant Professor*, Ph.D., 2019, University of California San Diego. Research and Teaching Interests: Biogeochemistry, Ecology, Coral Reefs, Water Quality, Climate Change, Environmental Impacts.

**JUAN J. CRUZ MOTTA**, *Assistant Professor,* Ph.D., 2005. University of Sydney, Australia. Research and Teaching interests: Quantitative Ecology, Environmental Impacts Detection, Biometry, Multivariate Methods.

**JUAN GONZALEZ LAGOA**, *Emeritus Professor,* Ph.D., 1973. University of Rhode Island. Research Training and Teaching Interests. Plankton, Bioluminescent Bays and Outreach.

**NOELLE LUCEY,** *Assistant professor*, Ph.D., Princeton University. Research and teaching experience: Wide experience with marine physiology, fisheries and aquaculture issues. Recently hired faculty.

**JOHANA ROTTEROVA**, *Assistant Professor*, Ph.D., 2020. Charles University, Prague, Czech Republic. Research and Teaching interests: Microbial interactions in Ciliates, Protists, Symbioses, Archaea, Bacteria, Metazoa.

**NIKOLAOS SCHIZAS***, Professor,* Ph.D., 1999, University of South Carolina. Research and Teaching interests: Evolution of Marine Invertebrates.

**WILFORD E. SCHMIDT**, *Professor*, Ph.D., 2003, University of California, San Diego. Research and Teaching interests: Physical Oceanography Applied Ocean Science.

**CLARK E. SHERMAN**, *Professor*, Ph.D., 2000, University of Hawaii. Research and Teaching interests: Marine Geology, Carbonite Sedimentology, Coral Reefs, Quaternary Geology.

**ERNESTO WEIL**, *Department Director, Professor*, Ph.D., 1992, University of Texas at Austin. Research and Teaching interests: Coral taxonomy, Systematics, and Evolution, coral reproductive biology and ecology, Coral reef ecology and decline associated with Climate Change.

# DEPARTMENT OF MATHEMATICAL SCIENCES

The department of Mathematical Sciences offers two programs leading to a Master of Science degree: one in Mathematics with tracks in 1) pure mathematics, 2) applied mathematics, 3) statistics mathematics or 4) Teaching Mathematics at Secondary Level and the other in Scientific Computing. The department of Mathematical Sciences also participates in an interdisciplinary program leading to a Ph.D. in Computing and Information Sciences and Engineering. Please refer to the Interdisciplinary Programs section for information on this doctoral program.

Students have access to the central Computing Center and to other equipment of the Mathematics Department. Two special purpose laboratories, the Scientific Computing and the Visualization Laboratory are available to students with research projects in computational mathematics.

## MASTER OF SCIENCE IN MATHEMATICS

Students entering this program may specialize in Pure or Applied Mathematics, Statistics Mathematics or Teaching Mathematics at Secondary Level.

**Applicants for applied mathematics** should have an undergraduate degree in Mathematics or its equivalent. Candidates are expected to have approved undergraduate courses in Multivariable Calculus, Linear Algebra, Ordinary Differential Equations, Numerical Analysis and Advanced Calculus. It is also recommended to have some programming experience using a high level language such as C\C++, and/or a mathematical package such as Matlab and Mathematica.

**Applicants for pure mathematics** should have an undergraduate degree in Mathematics or its equivalent. Candidates are expected to have approved undergraduate courses in Linear Algebra, Algebraic Structures, basic Topology and Advanced Calculus.

**Applicants for statistics mathematics** should have an undergraduate degree in Mathematics or its equivalent. Candidates are expected to have approved undergraduate courses in Linear Algebra, Multivariable Calculus and Statistics. Knowledge of computer programming is highly desirable.

Applicants for teaching mathematics at the secondary level should have an undergraduate degree or its equivalent. The applicant must have a Puerto Rico high school mathematics teacher certification or instead have 18 credits in mathematics, including advanced courses and 9 credits in education. Candidates are expected to have approved undergraduate courses in statistics, geometry, calculus, linear algebra, abstract algebra, or number theory.

In addition to the requirements of the Office of Graduate Studies, the Master of Science degree in Mathematics includes approving nine credits of core courses, two seminar credits, nine credits in the area of specialization, six credits outside the major area, and six thesis credits.

Specific course requirements for each area are available at http://math.uprm.edu

## MASTER OF SCIENCE IN SCIENTIFIC COMPUTING

Applicants for admission should have an undergraduate degree in Mathematics or its equivalent, or an undergraduate degree in Science or Engineering. Candidates are expected to have approved courses in multivariable calculus, differential equations, linear algebra, numerical analysis and data structures, as well as having programming experience using a high-level language such C\C++.

In addition to the requirements of the Office of Graduate Studies, the Master of Science degree in Scientific Computing includes approving the following core courses: Numerical Mathematical Analysis, MATE 6672, Numerical Linear Algebra, Mate 6025, Analysis of Algorithms, COMP 6785, and High Performance Computing COMP 6786, six credits outside the area, nine credits in the area of specialization, three thesis credits and two internship or seminar credits.

**Webpage:** http://math.uprm.edu

## MASTER IN PURE MATHEMATICS

The Department of Mathematical Sciences has a lively research group in the areas of complex and harmonic analysis, topology, category theory, abstract algebra, differential geometry and logic, leading to a Master degree in Science, M.S. Coursework and requirements are primarily aimed at preparing students for careers in research and teaching at the college level.

**Admission requirements**

- A bachelor's degree (BS), or an equivalent degree.
- Candidates are expected to have approved undergraduate courses in Linear Algebra, Algebraic Structures, basic Topology and Advanced Calculus.
- Fulfill requirements of the Office of Graduate Studies, including an average GPA of 2.50 on a four-point scale.

The Master of Science degree in Pure Mathematics, has three options of study, thesis (Plan I), project (Plan II), and thesis or project (Plan III).

### ACADEMIC PROGRAM
### PLAN I (Thesis)
### (4 SEMESTERS-32 CREDITS)

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| MATE 6201 | 3 | Abstract Algebra |
| MATE 6261 | 3 | Real Analysis I |
| MATE ---- | 3 | Elective* |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| MATE 6540 | 3 | Topology |
| MATE ---- | 3 | Elective* |
| MATE ---- | 3 | Elective* |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| MATE 6991 | 1 | Seminar I |
| MATE 6999 | 3 | Thesis |
| Elective | 3 | Elective ** |
| | 7 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| MATE 6992 | 1 | Seminar II |
| MATE 6999 | 3 | Thesis |
| Elective | 3 | Elective ** |
| | 7 | |

Elective* are courses MATE 5--- or MATE 6--- inside area of specialization.
Elective** are 5--- or 6--- level courses not listed in the area of specialization and could be from outside the math department.
It is recommended that student choose these courses with the help of their advisor.

### PLAN II (Project)
### (4 SEMESTERS-32 CREDITS)

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| MATE 6201 | 3 | Abstract Algebra |
| MATE 6261 | 3 | Real Analysis I |
| MATE ---- | 3 | Elective* |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| MATE 6540 | 3 | Topology |
| MATE ---- | 3 | Elective* |
| MATE ---- | 3 | Elective* |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| MATE 6991 | 1 | Seminar I |
| MATE 6705 | 3 | Project |
| Elective | 3 | Elective ** |
| | 7 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| MATE 6992 | 1 | Seminar II |
| MATE 6705 | 3 | Project |
| Elective | 3 | Elective ** |
| | 7 | |

Elective* are courses MATE 5--- or MATE 6--- inside area of specialization.
Elective** are 5--- or 6--- level courses not listed in the area of specialization and could be from outside the math department.
It is recommended that student choose these courses with the help of their advisor.

**PLAN III (No thesis or project)**
**(4 SEMESTERS-36 CREDITS)**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| MATE 6201 | 3 | Abstract Algebra |
| MATE 6261 | 3 | Real Analysis I |
| MATE ---- | 3 | Elective* |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| MATE 6540 | 3 | Topology |
| MATE ---- | 3 | Elective* |
| MATE ---- | 3 | Elective* |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| MATE ---- | 3 | Elective* |
| MATE ---- | 3 | Elective* |
| Elective | 3 | Elective ** |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| MATE ---- | 3 | Elective* |
| MATE ---- | 3 | Elective* |
| Elective | 3 | Elective ** |
| | 9 | |

Elective* are courses MATE 5--- or MATE 6--- inside area of specialization.
Elective** are 5--- or 6--- level courses not listed in the area of specialization and could be from outside the math department.
It is recommended that student choose these courses with the help of their advisor or Department Chair.

**MASTER IN APPLIED MATHEMATICS**

Applied mathematics involves applications of mathematical methods and techniques to explore, and describe behavior of scientific, industrial, and engineering phenomena. The applied mathematics program is interdisciplinary in spirit. It is based on principles of mathematical continuous modeling, computer simulation, linear programming, optimization, operations research, bioinformatics, numerical methods, etc. The applied mathematics program appeals to individuals who are interested in applying their mathematical interests and skills to real-world problems.

**Admission requirements**

- A bachelor's degree (BS), or an equivalent degree.
- Candidates are expected to have approved undergraduate courses in Multivariable calculus, Linear Algebra, Ordinary Differential Equations, Numerical Analysis and Advanced Calculus.

- It is also recommended to have some programming experience using a high level language such as C\C++, and/or a mathematical package such as Matlab and Mathematica.
- Fulfill requirements of the Office of Graduate Studies, including an average GPA of 2.50 on a four-point scale.

The Master of Science degree in Applied Mathematics, has three options of study, thesis (Plan I), project (Plan II), and thesis or project (Plan III).

**ACADEMIC PROGRAM**
**PLAN I (Thesis)**
**(4 SEMESTERS-32 CREDITS)**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| MATE 6672 | 3 | Numerical Analysis |
| MATE 6261 | 3 | Real Analysis I |
| MATE ---- | 3 | Elective* |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| MATE 6677 | 3 | Partial Diff. Equations |
| MATE ---- | 3 | Elective* |
| MATE ---- | 3 | Elective* |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| MATE 6991 | 1 | Seminar I |
| MATE 6999 | 3 | Thesis |
| Elective | 3 | Elective ** |
| | 7 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| MATE 6992 | 1 | Seminar II |
| MATE 6999 | 3 | Thesis |
| Elective | 3 | Elective ** |
| | 7 | |

Elective* are courses MATE 5--- or MATE 6--- inside area of specialization.
Elective** are 5--- or 6--- level courses not listed in the area of specialization and could be from outside the math department.
It is recommended that student choose these courses with the help of their advisor.

**PLAN II (Project)**
**(4 SEMESTERS-32 CREDITS)**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| MATE 6672 | 3 | Numerical Analysis |
| MATE 6261 | 3 | Real Analysis I |
| MATE ---- | 3 | Elective* |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| MATE 6677 | 3 | Partial Diff. Equations |
| MATE ---- | 3 | Elective* |
| MATE ---- | 3 | Elective* |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| MATE 6991 | 1 | Seminar I |
| MATE 6705 | 3 | Project |
| Elective | 3 | Elective ** |
| | 7 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| MATE 6992 | 1 | Seminar II |
| MATE 6705 | 3 | Project |
| Elective | 3 | Elective ** |
| | 7 | |

Elective* are courses MATE 5--- or MATE 6--- inside area of specialization.
Elective** are 5--- or 6--- level courses not listed in the area of specialization and could be from outside the math department.
It is recommended that student choose these courses with the help of their advisor.

**PLAN III (No thesis or project)**
**(4 SEMESTERS-36 CREDITS)**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| MATE 6672 | 3 | Numerical Analysis |
| MATE 6261 | 3 | Real Analysis I |
| MATE ---- | 3 | Elective* |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| MATE 6677 | 3 | Partial Diff. Equations |
| MATE ---- | 3 | Elective* |
| MATE ---- | 3 | Elective* |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| MATE ---- | 3 | Elective* |
| MATE ---- | 3 | Elective* |
| Elective | 3 | Elective ** |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| MATE ---- | 3 | Elective* |
| MATE ---- | 3 | Elective* |
| Elective | 3 | Elective ** |
| | 9 | |

Elective* are courses MATE 5--- or MATE 6--- inside area of specialization.
Elective** are 5--- or 6--- level courses not listed in the area of specialization and could be from outside the math department.
It is recommended that student choose these courses with the help of their advisor or Department Chair.

**MASTER IN MATHEMATICAL STATISTICS**

The use of statistical methodology is highly relevant for any person carrying research where data has been collected. Thus, Statistics is frequently used to validate research in fields such as engineering, biology, psychology, medicine, agriculture, etc. The main goal of this graduate program is to prepare students that will be able to apply statistical techniques to other fields in a correct way. The emphasis of the program is more in applied statistics than in theoretical statistics and probability. However, theoretical foundations of statistics and probability is considered in most of the courses. Students wishing to pursue a doctoral degree in statistics are encouraged to take more courses in theory of statistics, probability and stochastic processes.

**Admission requirements**

- A bachelor's degree (BS), or an equivalent degree.
- Candidates are expected to have approved undergraduate courses in Multivariable calculus, Linear Algebra, Multivariate Calculus, and Statistics.
- It is also highly recommended to have some programming experience.
- Fulfill requirements of the Office of Graduate Studies, including an average GPA of 2.50 on a four-point scale.

The Master of Science degree in Mathematical Statistics, has three options of study, thesis (Plan I), project (Plan II), and thesis or project (Plan III).

**ACADEMIC PROGRAM**
**PLAN I (Thesis)**
**(4 SEMESTERS-32 CREDITS)**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| ESMA 6600 | 3 | Probability Theory |
| ESMA 6661 | 3 | Theory of Statistics I |
| ESMA ---- | 3 | Elective* |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| ESMA 6305 | 3 | Statistical Methods |
| ESMA ---- | 3 | Elective* |
| ESMA ---- | 3 | Elective* |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| MATE 6991 | 1 | Seminar I |
| MATE 6999 | 3 | Thesis |
| Elective | 3 | Elective ** |
| | 7 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| MATE 6992 | 1 | Seminar II |
| MATE 6999 | 3 | Thesis |
| Elective | 3 | Elective ** |
| | 7 | |

Elective* are courses ESMA 5--- or ESMA 6--- inside area of specialization.
Elective** are 5--- or 6--- level courses not listed in the area of specialization and could be from outside the math department.
It is recommended that student choose these courses with the help of their advisor.

**PLAN II (Project)**
**(4 SEMESTRS-32 CREDITS)**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| ESMA 6600 | 3 | Probability Theory |
| ESMA 6661 | 3 | Theory of Statistics I |
| ESMA ---- | 3 | Elective* |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| ESMA 6305 | 3 | Statistical Methods |
| ESMA ---- | 3 | Elective* |
| ESMA ---- | 3 | Elective* |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| MATE 6991 | 1 | Seminar I |
| MATE 6705 | 3 | Project |
| Elective | 3 | Elective ** |
| | 7 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| MATE 6992 | 1 | Seminar II |
| MATE 6705 | 3 | Project |
| Elective | 3 | Elective ** |
| | 7 | |

Elective* are courses ESMA 5--- or ESMA 6--- inside area of specialization.
Elective** are 5--- or 6--- level courses not listed in the area of specialization and could be from outside the math department.
It is recommended that student choose these courses with the help of their advisor.

**PLAN III (No thesis or project)**
**(4 SEMESTERS-36 CREDITS)**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| ESMA 6600 | 3 | Probability Theory |
| ESMA 6661 | 3 | Theory of Statistics I |
| ESMA ---- | 3 | Elective* |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| ESMA 6305 | 3 | Statistical Methods |
| ESMA ---- | 3 | Elective* |
| ESMA ---- | 3 | Elective* |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| ESMA ---- | 3 | Elective* |
| ESMA ---- | 3 | Elective* |
| Elective | 3 | Elective ** |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| ESMA ---- | 3 | Elective* |
| ESMA ---- | 3 | Elective* |
| Elective | 3 | Elective ** |
| | 9 | |

Elective* are courses ESMA 5--- or ESMA 6--- inside area of specialization.
Elective** are 5--- or 6--- level courses not listed in the area of specialization and could be from outside the math department.
It is recommended that student choose these courses with the help of their advisor or Department Chair.

## MASTER IN MATH EDUCATION

### TEACHING MATHEMATICS AT SECONDARY LEVEL PROGRAM

The master degree (MS) in the Teaching of Mathematics at the Secondary Level is focused on the mathematical content and in its deep understanding. In the traditional programs of preparation of teachers, greater importance is given to the methodology of teaching than to the dominion of content. Our program is designed to provide a balance formation between Mathematics and Teaching and to incorporate as much mathematical theoretical knowledge as well as pedagogical aspects that will allow the teacher to be effective in teaching and knowledge. This program pretends to form leaders in Mathematics Education at the Secondary Level and to be an alternative for the professional improvement of active teachers.

The specific objective of the program is the formation of professionals, capable of teaching mathematics at the preuniversity level by using modern methodologies and technologies; capable of carrying out educational research that will allow them to participate in projects and improve continuously their teaching skills. The graduates from this program will be capable to work in projects and extracurricular activities that complement the teaching of mathematics, in agreement with technological and curriculum changes. One of the goals of the program is to form leaders in the teaching of mathematics in Puerto Rico and help current mathematics teachers keeping them updated about new technologies and methodologies.

**Admission requirements**

- A bachelor's degree (BS), or an equivalent degree.
- Have functional knowledge of Spanish and English language.
- The applicant must satisfy one of the following GPA criteria on studies (on a four-point scale):
    - Undergraduate grade-point average (GPA) of 2.50 or better.
    - Undergraduate specialization grade-point average (GPA) of 2.50 or better.
    - Have approved 60 credits in the last four semesters of the bachelor's degree.

- The applicant must have a Puerto Rico high school mathematics teacher certification or instead have 18 credits in mathematics, including advanced courses and 9 credits in education. Candidates are expected to have approved undergraduate courses in statistics, geometry, calculus, linear algebra, abstract algebra or number theory.

**ACADEMIC PROGRAM**
**(4 SEMESTERS-36 CREDITS)**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| EDMA 6005 | 3 | Geometry |
| EDMA 6015 | 3 | Set Theory and Logic |
| EDMA 6025 | 3 | Calculus Theory |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| EDMA 6105 | 3 | Problem Solving |
| EDMA 6991 | 3 | Topics in Mathematics Education |
| EDMA 6992 | 3 | Topics in Number Theory |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| EDMA 6205 | 3 | Statistics |
| EDMA 6215 | 3 | Technology in Mathematics Teaching |
| Elective | 3 | Course from outside of specialization area |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| EDMA 6225 | 3 | Modern Algebra |
| EDMA 6993 | 3 | Project in Mathematics Education |
| Elective | 3 | Course from outside of specialization area |
| | 9 | |

**MASTER IN SCIENTIFIC COMPUTING**

The graduate program in Scientific Computing is an interdisciplinary program in spirit which focuses on numerical methods and techniques relevant to the solution of scientific or engineering problems. It also includes computational experiments demonstrating the effectiveness of a proposed technique. Typically, research work includes numerical simulation of physical phenomena using state of the art numerical methods; efficient implementation of a new numerical scheme by using high performance computing techniques; analysis of theoretical aspects of a numerical method and its validation through numerical experimentation; design and analysis of efficient data structures to solve a scientific problems; development of mathematical software for solving scientific and engineering problems using modern techniques of software development. Although computation is one of the key components, this program is NOT a Computer Science program. The Scientific Computing program consists of three major components:

- Application: research focuses on solving numerically a practical problem or designing new methods or techniques for solving a specific problem.
- Theory: the work should include an analysis and discussion of theoretical aspects of the proposed techniques and/or the problem to be solved.
- Computation: research work should use efficient implementation by using high performance techniques such as parallel programming or modern techniques of software development, for example object oriented programming.

**Admission requirements**

- A bachelor's degree (BS) in Mathematics, Science, Engineering, or an equivalent degree.
- Candidates are expected to have approved undergraduate courses Multivariable calculus, Differential equations, Linear algebra, Numerical analysis and Data structures

- It is also recommended to have some programming experience using a high-level language such as C\C++
- Fulfill requirements of the Office of Graduate Studies, including an average GPA of 2.50 on a four-point scale.

The Master of Science degree in Scientific Computing, has three options of study, thesis (Plan I), project (Plan II), and thesis or project (Plan III).

**ACADEMIC PROGRAM**
**PLAN I (Thesis)**
**(4 SEMESTERS-32 CREDITS)**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| MATE 6672 | 3 | Numerical Analysis |
| MATE 6025 | 3 | Numerical Linear Alg. |
| Elective | 3 | Elective* |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| COMP 6785 | 3 | Analysis of Algorithms |
| COMP 6786 | 3 | High Performance Computing |
| Elective | 3 | Elective* |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| MATE 6991 | 1 | Seminar I |
| COMP 6998 | 3 | Thesis |
| Elective | 3 | Elective ** |
| | 7 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| MATE 6992 | 1 | Seminar II |
| COMP 6998 | 3 | Thesis |
| Elective | 3 | Elective ** |
| | 7 | |

Elective* are courses MATE/ESMA/COMP 5--- or MATE/ESMA/COMP/CIIC 6--- inside area of specialization.
Elective** are 5--- or 6--- level courses not listed in the area of specialization and could be from outside the math department.
It is recommended that student choose these courses with the help of their advisor.

**PLAN II (Project)**
**(4 SEMESTERS-32 CREDITS)**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| MATE 6672 | 3 | Numerical Analysis |
| MATE 6025 | 3 | Numerical Linear Alg. |
| Elective | 3 | Elective* |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| COMP 6785 | 3 | Analysis of Algorithms |
| COMP 6786 | 3 | High Performance Computing |
| Elective | 3 | Elective* |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| MATE 6991 | 1 | Seminar I |
| COMP 6998 | 3 | Thesis |
| Elective | 3 | Elective ** |
| | 7 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| MATE 6992 | 1 | Seminar II |
| COMP 6998 | 3 | Thesis |
| Elective | 3 | Elective ** |
| | 7 | |

Elective* are courses MATE/ESMA/COMP 5--- or MATE/ESMA/COMP/CIIC 6--- inside area of specialization.
Elective** are 5--- or 6--- level courses not listed in the area of specialization and could be from outside the math department.
It is recommended that student choose these courses with the help of their advisor.

**PLAN III (No thesis or project)**
**(4 SEMESTERS-36 CREDITS)**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| MATE 6672 | 3 | Numerical Analysis |
| MATE 6025 | 3 | Numerical Linear Alg. |
| Elective | 3 | Elective* |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| COMP 6785 | 3 | Analysis of Algorithms |
| COMP 6786 | 3 | High Performance Computing |
| Elective | 3 | Elective* |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| Elective | 3 | Elective* |
| Elective | 3 | Elective* |
| Elective | 3 | Elective ** |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| Elective | 3 | Elective* |
| Elective | 3 | Elective* |
| Elective | 3 | Elective ** |
| | 9 | |

Elective* are courses MATE/ESMA/COMP 5--- or MATE/ESMA/COMP/CIIC 6--- inside area of specialization.
Elective** are 5--- or 6--- level courses not listed in the area of specialization and could be from outside the math department.
It is recommended that student choose these courses with the help of their advisor or Department Chair.

## MATHEMATICAL SCIENCES FACULTY

A list of professors who engage in graduate activities in the Department follows including the highest earned degree, date, and institution granting the degree. Research and teaching interests are also included.

**ROBERT ACAR**, *Associate Professor*, Ph.D., 1987, University of Wisconsin-Madison. Research and Teaching interests: Numerical Analysis, Partial Differential Equations, Inverse Problems.

**ISRAEL A. ALMODÓVAR-RIVERA**, *Assistant Professor*, Ph.D., 2017, Iowa State University. Research and Teaching: Cluster Analysis, Public Health, Epidemiology, Biostatistical consulting, Data Mining, Data Science, Data Visualization, Analysis of Massive Datasets, Functional Magnetic Resonance Imaging, Statistical Computing, Statistical Learning, Statistical Education.

**DOROTHY BOLLMAN**, *Emeritus Professor*, Ph.D., 1964, University of Illinois, Urbana.

**ALCIBIADES BUSTILLO**, *Assistant Professor*, Ph.D., University of Puerto Rico, Mayagüez. Research and Teaching interests: Computer Sciences.

**LUIS F. CÁCERES-DUQUE**, *Professor*, Ph.D., 1998, University of Iowa, Iowa City, Iowa. Research and Teaching interests: geometry, problem solving, mathematics Olympiads.

**PAUL CASTILLO**, *Professor*, Ph.D., 2001, University of Minnesota. Research and Teaching interests: Finite Element and Numerical Analysis, Scientific computation and applications.

**OMAR COLÓN-REYES**, *Professor*, Ph.D., 2005, Virginia Polytechnic Institute and State University. Research and Teaching interests: Discrete Dynamical Systems, Algebra, Field theory and applications.

**ÁNGEL CRUZ-DELGADO**, *Professor*, Ph.D. 2000, Louisiana State University. Research and Teaching interests: Pure Mathematics, Differential Equations.

**STAN M. DZIOBIAK**, *Professor*, Ph.D., 2011, Louisiana State University. Research and Teaching interests: Graph Theory, Graph Minors, Combinatorics. Teaching interests: Discrete Mathematics, Number Theory, Abstract Algebra, Foundations of Mathematics, Algorithms, Calculus.

**LILIANA ESQUIVEL MORA**, *Assistant Professor*, Ph.D., 2016, National Autonomous University of Mexico-Michoacán, University of San Nicolas of Hidalgo, Morelia. Research and Teaching interests: Applied Mathematics.

**EDWIN FLÓREZ-GÓMEZ**, *Assistant Professor*, Ph.D., 2018, University of Puerto Rico at Mayaguez. Research and Teaching: Computer Science.

**EDGARDO LORENZO**, *Professor*, Ph.D., 2002, Wichita State University. Research and Teaching interest: Applied Statistics, Nonparametric Statistics, Survival Analysis.

**ISTVÁN MEZÓ**, *Assistant Professor*, Ph.D., 2010, University of Debrecen, Hungary. Research and Teaching interests: Combinatorial numbers, Number Theory.

**FLOR E. NARCISO FARIAS**, *Professor*, Ph.D., 1999, University of South Florida. Research interests: Human-Computer Interaction, Compilers.

**VICTOR A. OCASIO GONZALEZ**, *Professor*, Ph.D., 2014, Notre Dame University. Research interests: Logic and Computability, Computable Structure Theory. Teaching interests: Model Theory, Computability, Set Theory, Abstract Algebra.

**REYES M. ORTIZ-ALBINO**, *Professor*, Ph.D., 2008, The University of Iowa. Research and Teaching interests: Mathematics, Ideal Theory, Generalized Factorization.

**ARTURO PORTNOY**, *Professor*, Ph.D., 1997, Rensselaer Polytechnic Institute, Troy, NY. Research and Teaching interests: Analysis, Differential Equations, Applied Mathematics.

**WILFREDO QUIÑONES**, *Professor*, Ph.D., 1986, University of Massachusetts. Research and Teaching interests: Applied Mathematics and Analysis.

**KAREN RÍOS-SOTO**, *Professor*, Ph.D., 2008, Cornell University. Research and Teaching interests: Bio-mathematics, Mathematical Epidemiology and Ecology, Population and Social Dynamics; Mathematical Biology, Mathematical Modeling, Differential Equations, Linear Algebra, Stochastic Processes, Dynamical Systems and Calculus.

**ROBERTO RIVERA**, *Professor*, Ph.D., University of California, Santa Barbara. Research and Teaching interests: Statistics, Data Sciences.

**OLGAMARY RIVERA-MARRERO**, *Professor*, Ph.D., 2007, Virginia Tech Polytechnic Institute. Research and Teaching interests: Mathematics Education and Technology.

**JHOANA P. ROMERO LEITON**, *Assistant Professor*, PhD., 2017, Antioquia University, Colombia. Research and Teaching interests: Applied Statistics, Mathematical Biology, Data Sciences, Stability Theory, Optimal Control Theory, Bifurcations Theory, Applied Mathematics.

**JUAN ROMERO-OLIVERAS**, *Professor*, Ph.D., 2005, University of Maryland. Research and Teaching interests: Harmonic Analysis and Wavelet Theory and Applications to Biomedical Imaging, Calculus.

**DÁMARIS SANTANA**, *Professor*, Ph.D., 2005, University of Florida. Research and Teaching interests: Applied Statistics.

**FREDDIE SANTIAGO-HERNÁNDEZ**, *Professor*, Ph.D., 1988, State University of New York at Stony Brook. Research and Teaching interests: Differential Geometry.

**PEDRO M. VÁSQUEZ-URBANO**, *Professor*, D.Sc., 1997, George Washington University, Washington D.C. Research and Teaching interests: Linear and Non-linear Programming, Scheduling, Neural Networks.

**XUERONG YONG**, *Professor*, Ph.D., 2002, Hong Kong University of Science and Technology. Research and Teaching interests: Special Matrics and Graph theory with applications.

# DEPARTMENT OF PHYSICS

The Department of Physics offers a graduate program leading to a Master of Science degree. Applicants for admission should have a Bachelor's degree in Physics or related subject, and must meet the requirements of the Graduate Studies Office. Students not meeting these requirements may be admitted on a provisional basis until leveling courses are completed.

At the present, the Master of Science Degree of the Department of Physics follows Plan I. With Thesis Requirement. All students need to complete all courses in The Plan of Graduate Studies with a GPA of at least 3.00. The courses in the Plan of Graduate Studies are the following:

| | |
|---|---|
| FISI 6090 Introduction to Theoretical Physics 1 | 3crds. |
| FISI 6190 Introduction to Theoretical Physics II | 3 crds. |
| FISI 6431 Theory of Electricity and Magnetism | 3 crds. |
| FISI 6451 Introduction to Quantum Mechanics | 3 crds. |
| FISI 6280 Graduate Seminar I | 1 crds. |
| FISI 6380 Graduate Seminar II | 1 crds. |
| Electives in specialization | 6 crds. |
| Electives outside of specialization | 6 crds. |
| FISI 6991 Physics Research | 6 crds. |

All students are required to carry out a research project, as specified in the Plan of Graduate Studies, prepare a thesis, and pass an oral exam.

There are current research projects in the Department of Physics in fields such as Condensed Matter/Materials Science, Laser Spectroscopy, High Energy Physics, Astrophysics and Radioastronomy, Statistical Physics and Mathematical Modeling for Biological Applications, and Atmospheric Physics. Department facilities for research include well-developed laboratories for experimental research in laser spectroscopy and condensed matter/materials science, and facilities for computational work. For laser spectroscopy and nonlinear-optical studies, the Department of Physics research laboratories are equipped with a wide variety of laser sources producing beams from continuous wave to femtosecond pulses, and advanced spectroscopic equipment including double spectrometers and photon counting systems. Thin film and crystal growth facilities include systems for pulsed laser deposition, DC and RF sputtering, metal-organic chemical vapor deposition, and sol-gel techniques, high temperature furnaces and other sample preparation equipment. Materials characterization facilities include a high-resolution x-ray diffractometer specially equipped for thin film studies, atomic force/scanning tunneling microscope, systems for low-temperature electronic, optical, and magneto-optical studies of solids, multiple wavelength ellipsometer, and an electron spin resonance spectrometer. Additional facilities are available to researchers through other UPRM facilities and the UPR Materials Characterization Center.

Experimental research in high energy Physics is conducted in close collaboration with Fermilab, in Illinois, and advanced data analysis and transmission facilities to aid this effort are located in the Department of Physics. Distributed computational resources sustaining research are available through several laboratories, and the computer room for use by students and faculty, and through communication connections to campus and external facilities. The Department also has a precision machine shop supporting research activities. Additional facilities include an automated 16-inch reflector telescope, and a planetarium with capacity for 60 occupants.

**Webpage:** https://www.uprm.edu/fisica

## PROGRAM OF STUDY

## MASTER OF SCIENCE IN PHYSICS CURRICULUM

### FIRST YEAR

**First Semester**

| Number | Credits | Course |
|---|---|---|
| FISI 6090 | 3 | Introduction to Theoretical Physics I |
| FISI 6431 | 3 | Theory of Electricity and Magnetism |
| ELECTIVE* | 3 | Elective in specialization or outside of specialization |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| FISI 6190 | 3 | Introduction to Theoretical Physics II |
| FISI 6451 | 3 | Introduction to Quantum Mechanics |
| ELECTIVE* | 3 | Elective in specialization or outside of specialization |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| ELECTIVE* | 3 | Elective in specialization or outside of specialization |
| FISI 6280 | 1 | Graduate Seminar I |
| FISI 6991 | 2 | Physics Research |
| | 6 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| ELECTIVE* | 3 | Elective in specialization or outside of specialization |
| FISI 6380 | 1 | Graduate Seminar II |
| FISI 6991 | 2 | Physics Research |
| | 6 | |

**Total credits 30**

* **Only 6 credits in electives in specialization and 6 credits in electives outside specialization are required.**

## PHYSICS FACULTY

A list of professors who engage in graduate activities in the Department follows including their highest earned degree, date, institution granting the degree, and research interests.

**FRANCISO J. BEZARES-SALINAS,** *Assistant Professor,* Ph.D., 2009, Temple University, Philadelphia, PA. Research interests: Materials Characterization, Thin Films and Nanotechnology, Nanophotonics.

**HÉCTOR JIMÉNEZ-GONZÁLEZ**, *Professor*, Ph.D., 1992, Massachusetts Institute of Technology. Research interests: Experimental Solid State Physics, Magneto-optics.

**YONG-JIHN KIM**, *Professor*, Ph.D., 1989, Seoul National University. Research interests: Theoretical Solid State Physics, Superconductivity.

**MARK JURY**, *Professor*, Ph.D., 1984, University of Cape Town. Research interest: Meteorology.

**SERGIY LYSENKO**, *Professor*, Ph.D. 2001, Institute of Semiconductor Physics, NAS, Kiev, Ukraine. Research Interests: Solid State, Ultrafast Spectroscopy.

**SUDHIR MALIK,** *Professor*, Ph.D., 1997, University of Delhi, India. Research Interests: Experimental High Energy Physics.

**PABLO J. MARRERO-SOTO**, *Professor*, Ph.D., 2001, University of Massachusetts at Amherst. Research interests: Thin Film Physics, Quantum Theory.

**HÉCTOR MÉNDEZ-MELLA**, *Professor*, Ph.D., 1990, Centro de Investigación y Estudios Avanzados, Mexico City. Research interests: Experimental High Energy Physics.

**CARLOS U. PABÓN-ORTIZ**, *Professor*, Ph.D., 1994, City College of New York. Research interests: Atmospheric Physics.

**RAÚL PORTUONDO**, *Professor*, Ph.D., University of La Habana -UH-. Research interest: Pedagogy.

**HENRI A. RADOVAN,** *Professor*, Ph.D., 1998, University of Ulm, Germany. Research interests: Experimental Solid State Physics, Superconductivity.

**JUAN E. RAMÍREZ,** *Professor*, Ph.D., 2002, University of Colorado at Boulder. Research interests: Experimental High Energy Physics.

**RAFAEL A. RAMOS**, *Professo*r, Ph.D., 1994, Boston University. Research interests: Computational Materials Science, Statistical Physics.

**ERICK ROURA-DÁVILA**, *Professor*, Ph.D., 2001, University of Massachusetts at Amherst. Research interests: Quantum Theory.

**ARMANDO RÚA,** *Associate Professor***,** Ph.D., 2014, City University of New York. Research Interest: Condensed Matter Physics.

**SAMUEL SANTANA-COLÓN**, *Professor*, Ph.D., 2008, Indiana University. Research interests: Theoretical Physics.

**ALLISON J. SMITH**, *Assistant Professor*, Ph.D., 2018, University of Georgia. Research interests: Astronomy.

## DEPARTMENT OF PSYCHOLOGY

The Department of Psychology offers a Doctor of Philosophy (PhD) Program in School Psychology with two tracks: clinical and neuropsychology. The mission is to prepare school psychology practitioners and scholars whose activities promote the psychological and educational development and well-being of children and adolescents. This Program is grounded in a scientific-practitioner model focused on prevention and centered on an ecological vision of human development. As highly qualified scientific-practitioners, graduates will be able to apply extensive content knowledge and research skills to identify and solve psychological and educational problems in schools, clinics, and other environments relevant to children and adolescents. The vision of training and practice in school psychology is based on the accreditation standards of the American Psychological Association (APA) and the National Association of School Psychology's (NASP) standards for graduate preparation of school psychologists.

The PhD Program in School includes six (6) fundamental components: core courses, specialty areas, research, practical experiences, defense of a dissertation, and a one-year internship. Graduates will meet the requirements established by the Examining Board of Psychology in Puerto Rico to be licensed to practice school psychology in the Island (LPRA 96, Ley para Reglamentar el Ejercicio de la Psicología en Puerto Rico).

The curriculum includes 90 credits that may be completed in the span of five (5) years.

| **Courses** | **Credit Hours** |
|---|---|
| Core courses | 23 credit hours |
| School Psychology Courses | 24 credit hours |
| Specialized Strand. | 12 credit hours |
| Practicum Courses | 2 credit hours (500 hours of practice) |
| Advanced Practicum Courses | 6 credit hours (500 hours of practice) |
| Research Courses | 11 credit hours |
| Elective Courses | 6 credit hours |
| Dissertation | 3 credit hours |
| Internship (2000 clock hours) | 3 credit hours |
| **TOTAL** | **90 credit hours** |

**PROGRAM OF STUDY**

**DOCTOR OF PHILOSOPHY IN SCHOOL PSYCHOLOGY CURRICULUM**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| PSIC 6301 | 3 | Child & Adolescent Development |
| PSIC 6017 | 3 | Biological Basis of Behavior in Children and Adolescents |
| PSIC 6005 | 3 | Theories of Personality |
| PSIC 6016 | 2 | History and System of Psychology |
| ESMA 6206 | 4 | Statistics Applied to Psychology |
| | 15 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| PSIC 6318 | 3 | Learning and Cognition |
| PSIC 6035 | 3 | Diagnostic Models for Academic, Behavioral, And Emotional Disorders in Children and Adolescents |
| PSIC 6555 | 4 | Introduction to School Psychology: Roles -Functions and Ethical - LegalAspects |
| PSIC 6037 | 3 | Evaluation and Measurement |
| PSIC 6038 | 2 | Program Evaluation in School Contexts |
| | 15 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| PSIC 6300 | 3 | Educational Psychology |
| PSIC 6360 | 3 | Intervention Models for Behavioral, Academic, And Emotional Disorders in Children and Adolescents |
| PSIC 6310 | 3 | Human Diversity and Social Aspects of Behavior |
| PSIC 6320 | 4 | Cognitive Assessment (Integrated Practicum) |
| | 13 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| PSIC 6330 | 3 | Prevention, Consultation, And Intervention in School Psychology |
| PSIC 6335 | 4 | Advanced Research Methods in Psychology: Quantitative and Qualitative Approaches |
| PSIC 6340 | 4 | Psychoeducational Assessment (Integrated Practicum) |
| PSIC 8217 | 3 | **SPECIALIZED STRAND CLINICAL** Behavior Modification Techniques for ADHD and Disruptive Behavior Disorders |
| **OR** | | |
| PSIC 8227 | | **SPECIALIZED STRAND NEUROPSYCHOLOGY** Neuroanatomy |
| | 14 | |

**THIRD YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| PSIC 7501 | 1 | Practicum in School Psychology I |
| PSIC 6350 | 4 | Social-Emotional Assessment of Children and Adolescents (Integrated Practicum) |
| PSIC 8218 | 3 | **SPECIALIZED STRAND CLINICAL** |
| and | | Mood and Anxiety Disorders and Evidenced Based Treatments |
| PSIC 8226 | 3 | Projective Assessment Techniques for Children and Adolescents |
| **OR** | | |
| | | **SPECIALIZED STRAND NEUROPSYCHOLOGY** |
| PSIC 8228 | 3 | Principles of School Neuropsychology |
| and | | |
| PSIC 8235 | 3 | Neuropsychological Assessment |
| | 11 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| PSIC 7502 | 1 | Practicum in School Psychology II |
| PSIC 8225 | 3 | **SPECIALIZED STRAND CLINICAL** Play Therapy for Trauma and StressRelated Disorders |
| | | **SPECIALIZED STRAND NEUROPSYCHOLOGY** |
| PSIC 8236 | 3 | Neuropsychological Rehabilitation |
| XXX Elective | 3 | |
| | 10 | |

**FOURTH YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| PSIC 8521 | 3 | Advanced Practicum in School Psychology I |
| PSIC 8990 | 1 | Dissertation |
| | 4 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| PSIC 8522 | 3 | Advanced Practicum in School Psychology II |
| PSIC 8990 | 1 | Dissertation |
| | 4 | |

**FIFTH YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| PSIC 8950* | 3 | Internship in School Psychology |
| PSIC 8990 | 1 | Dissertation |
| | 4 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| PSIC 8950* | 0 | Internship in School Psychology |
| | 0 | |

* PSIC 8950 course is under review and starting in 2025 it will be two credits in the first semester of the fifth year, and one credit in the second semester of the fifth year.

**Total Credits M.S. 78**
**Total Credits Ph.D. 90**

Our graduates may be employed in diverse settings and roles: faculty in academic departments of school psychology, psychologists employed by public schools and psychologists in private practice, medical centers, residential treatment centers, and child guidance clinics among others.

**Admission Requirements**

In addition to the requirements established by the Office of Graduate Studies (OEG) and listed in ***Certification 09-09*** of the UPRM Academic Senate, applicants must comply with the following Program requirements:

- Complete the Application for Admission to Graduate School including all required documents.
- Have completed a bachelor's degree in psychology from an accredited college or university program with a 3.30 GPA and a specialization GPA of 3.30 and above.

**OR**

- Evidence of having completed the following courses-credits with an average of 3.30 and above:

| Course | Credits |
|---|---|
| Developmental Psychology. | 3 |
| Social Psychology | 3 |
| Physiological Psychology | 3 |
| Experimental Psychology or Research Methods | 3 |
| Estatistics | 3 |

- Interview with the Graduate Committee
- Official transcripts of completed undergraduate/graduate work
- Three (3) letters of recommendation
- Personal Statement
- Curriculum Vitae

Due to the systemic nature of the sequence of courses, the Program requires full-time studies.
This Program requires students to demonstrate the ability to speak, write, and understand Spanish and English. Corrective classes may be required for students who speak a language other than Spanish or English. Those courses will NOT be included in the student's plan of study.

**Graduation Requirements**

- Approve 90 credits
- Complete practice experiences (1,000 hours)
- Pass a comprehensive examination
- Successfully develop and defend a research proposal for the dissertation
- Attend a minimum of two (2) seminars for the duration of the program
- Complete a one-year internship (2,000 hours)
- Successfully develop and defend a dissertation based on an original piece of empirical research in School Psychology
- GPA of 3.0 or higher as required by **Certification 09-09** of the Academic Senate of UPRM

The Program is based in the Department of Psychology located at Celis Building, Office 303. Regular classrooms, each of approximately 800 square feet, are in the Chardon Building (CH). The Centro de Adiestramiento, Investigación y Servicios en Psicología Escolar (CAISPE) is a center that offer to the students a place to practice their knowledge and skills in intervention and evaluation.

**Webpage:** https://www.uprm.edu/psicologia/

## DEPARTMENTAL FACULTY

**JANET BONILLA MUJICA,** *Professor*, Ph.D., 1997, University of Puerto Rico, Río Piedras Campus.

**IRMARIE CRUZ LÓPEZ**, *Associate Professor*, Ph.D., 2021, Mississippi State University.

**BERNANDETTE M. DELGADO ACOSTA**, *Professor*, Ph.D., 1995, Texas A&M University.

**LIZZIE M. GARCIA PABÓN**, *Professor*, Ph.D., 2006, Pontifical Catholic University of Puerto Rico.

**MILAGRITOS GONZÁLEZ RIVERA**, *Professor*, Ph.D., 1992, Michigan State University.

**EDUARDO A. LUGO HERNÁNDEZ**, *Associate Professor*, Ph.D., 2003, De Paul University.

**MARY A. MORENO TORRES**, *Professor*, Ph.D., 2003, University of Puerto Rico, Río Piedras.

**ANA NIEVES ROSA,** *Professor*, Ph.D., 2001, University of Puerto Rico, Río Piedras.

**MARIO A. NÚÑEZ MOLINA**, *Professor*, Ed.D., 1987, Harvard University.

**CRISTINA PEREA NIEVES**, *Assistant Professor*, Ph.D., 2016, School Psychologist, Interamerican University of Puerto Rico, San Germán Campus.

**EFRAIN RIOS RUIZ,** *Associate Professor*, Psy.D., 2008, Ponce School of Medicine, Ponce.

**AXEL A. SANTOS FIGUEROA**, *Professor,* Ph.D., 2005, University of Puerto Rico, Río Piedras.

**DOUGLAS SANTOS SÁNCHEZ**, *Professor*, Ph.D., 1996, University of Puerto Rico, Río Piedras.

# *COLLEGE OF BUSINESS ADMINISTRATION*

**Mission**

Impact society by transforming students, professionals and organizations in the field of business through the offer of academic, practical, research and community service experiences.

**Vision**

To be Puerto Rico's best option in Business Administration with the best students, professors and recruiters.

**Culture**

With the purpose of creating a culture that supports our vision and mission, the College of Business Administration:

- Promotes pedagogical approaches that facilitate teaching and learning.
- Maintains undergraduate and graduate curricula that encourage practical experience and are up to date with technological and global changes, allowing for competitive differentiation.
- Sponsors active student organizations that encourage leadership and participative citizenship.
- Develops a learning community with common goals, willing to support and serve other faculties within the UPR system and the Caribbean.
- Encourages processes that promote effective communication with our stakeholders.
- Values honesty, service and quality
- Encourages an organizational culture that procures excellence through a responsive administration with minimum bureaucratic processes, with an environmental conscience for business.
- Supports teamwork.
- Encourages the continuous improvement of our faculty.

**Educational Objectives**

**STUDENT LEARNING OBJECTIVES**

1. Apply research to problems/issues encountered in a dynamic business environment.
2. Apply quantitative methods and related principles to problems/issues encountered in a dynamic world.
3. Apply business administration theory and related principles to problems and issues encountered in a dynamic business environment.
4. Identify and evaluate business opportunities and trends.

**Academic Programs**

The College of Business Administration offers a program leading to both, a Master of Business Administration degree and an MBA with specialization in Human Resources, Operation Management, or Finance.

Applicants for admission should have a Bachellor's degree from an accredited university and must meet the general requirements of the Graduate Studies Office (Certification #09-09).

Students admitted to the program are required to meet all requisites of the Graduate Studies Office and to approve 30-36 credit hours divided as follows:

**Plan I – Thesis**

The student must develop a research topic in a specific area of Business Administration. It receives the assistance and guidance of a Graduate Committee in the development of the topic and its hypothesis. To complete the degree, a student must submit and pass their research thesis. The student admitted to this Plan receives up to 6 academic credits for the approval of the research.

**Plan III - Course**

It allows the student to have the academic experience of taking an integrative Capstone-type course. This course provides the opportunity to integrate and apply the analytical concepts and tools of business functions studied during the MBA. In addition, competitive analysis will be exposed through the study and development of cases, as well as other active learning activities. The student admitted to this Plan receives 3 academic credits for the approval of this course.

**PROGRAM OF STUDY**

**Master of Business Administration - MBA**

**Plan I - Thesis**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| CONT 6005 | 3 | Managerial Accounting |
| ESTA 6005 | 3 | Management Statistics |
| GERE 6036 | 3 | International Management |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| FINA 6015 | 3 | Managerial Finance |
| MERC 6055 | 3 | Marketing Management |
| GEIN 6035 | 3 | Quantitative Managerial Methods |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| ECON 6027 | 3 | Managerial Economics |
| ELECTIVE | 3 | General Elective |
| ADMI 6996 | 3 | Thesis |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| ELECTIVE | 3 | General Elective |
| ADMI 6996 | 3 | Thesis |
| | 6 | |

**Total Credits 33**

**Master of Business Administration**

**Plan III - Course**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| CONT 6005 | 3 | Managerial Accounting |
| ESTA 6005 | 3 | Management Statistics |
| GERE 6036 | 3 | International Management |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| FINA 6015 | 3 | Managerial Finance |
| MERC 6055 | 3 | Marketing Management |
| GEIN 6035 | 3 | Quantitative Managerial Methods |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| ECON 6027 | 3 | Managerial Economics |
| ELECTIVE | 3 | General Elective |
| | 6 | |

**Second Semester**

| Number | Credits | Ω√ Number | Credits | Title |
|---|---|---|---|---|
| Number | Credits | Title | | |
| ◊V | Course | | | |
| ELECTIVE | 3 | General Elective | | |
| ADMI 6816 | 3 | MBA Integrational Experience | | |
| | 6 | | | |

**Total Credits 30**

Master of Business Administration with a specialization in **Industrial Management**

**Plan I - Thesis**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| CONT 6005 | 3 | Managerial Accounting |
| ESTA 6005 | 3 | Management Statistics |
| GERE 6036 | 3 | International Management |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| FINA 6015 | 3 | Managerial Finance |
| MERC 6055 | 3 | Marketing Management |
| ELECTIVE | 3 | General Elective |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| ELECTIVE | 3 | Specialty Elective |
| ELECTIVE | 3 | General Elective |
| ADMI 6996 | 3 | Thesis |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| ELECTIVE | 3 | Specialty Elective |
| ELECTIVE | 3 | Specialty Elective |
| ADMI 6996 | 3 | Thesis |
| | 9 | |

**Total Credits 36**

Master of Business Administration with a specialization in **Industrial Management**

**Plan III - Course**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| CONT 6005 | 3 | Managerial Accounting |
| ESTA 6005 | 3 | Management Statistics |
| GERE 6036 | 3 | International Management |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| FINA 6015 | 3 | Managerial Finance |
| MERC 6055 | 3 | Marketing Management |
| ELECTIVE | 3 | General Elective |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| ELECTIVE | 3 | Specialty Elective |
| ELECTIVE | 3 | Specialty Elective |
| ELECTIVE | 3 | General Elective |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| ELECTIVE | 3 | Specialty Elective |
| ELECTIVE | 3 | Specialty Elective |
| ADMI 6816 | 3 | MBA Integrational Experience |
| | 9 | |

**Total Credits 36**

Master of Business Administration with a specialization in **Finance**

**Plan I - Thesis**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| CONT 6005 | 3 | Managerial Accounting |
| ESTA 6005 | 3 | Management Statistics |
| GERE 6036 | 3 | International Management |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| FINA 6015 | 3 | Managerial Finance |
| MERC 6055 | 3 | Marketing Management |
| ELECTIVE | 3 | General Elective |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| ELECTIVE | 3 | Specialty Elective |
| ELECTIVE | 3 | General Elective |
| ADMI 6996 | 3 | Thesis |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| ELECTIVE | 3 | Specialty Elective |
| ELECTIVE | 3 | Specialty Elective |
| ADMI 6996 | 3 | Thesis |
| | 9 | |

**Total Credits 36**

Master of Business Administration with a specialization in **Finance**

**Plan III - Course**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| CONT 6005 | 3 | Managerial Accounting |
| ESTA 6005 | 3 | Management Statistics |
| GERE 6036 | 3 | International Management |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| FINA 6015 | 3 | Managerial Finance |
| MERC 6055 | 3 | Marketing Management |
| ELECTIVE | 3 | General Elective |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| ELECTIVE | 3 | Specialty Elective |
| ELECTIVE | 3 | Specialty Elective |
| ELECTIVE | 3 | General Elective |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| ELECTIVE | 3 | Specialty Elective |
| ELECTIVE | 3 | Specialty Elective |
| ADMI 6816 | 3 | MBA Integrational Experience |
| | 9 | |

**Total Credits 36**

Master of Business Administration with a specialization in **Human Resources**

**Plan I - Thesis**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| CONT 6005 | 3 | Managerial Accounting |
| ESTA 6005 | 3 | Management Statistics |
| GERE 6036 | 3 | International Management |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| FINA 6015 | 3 | Managerial Finance |
| MERC 6055 | 3 | Marketing Management |
| ELECTIVE | 3 | General Elective |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| ELECTIVE | 3 | Specialty Elective |
| ELECTIVE | 3 | General Elective |
| ADMI 6996 | 3 | Thesis |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| ELECTIVE | 3 | Specialty Elective |
| ELECTIVE | 3 | Specialty Elective |
| ADMI 6996 | 3 | Thesis |
| | 9 | |

**Total Credits 36**

Master of Business Administration with a specialization in **Human Resources**

**Plan III - Course**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| CONT 6005 | 3 | Managerial Accounting |
| ESTA 6005 | 3 | Management Statistics |
| GERE 6036 | 3 | International Management |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| FINA 6015 | 3 | Managerial Finance |
| MERC 6055 | 3 | Marketing Management |
| ELECTIVE | 3 | General Elective |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| ELECTIVE | 3 | Specialty Elective |
| ELECTIVE | 3 | Specialty Elective |
| ELECTIVE | 3 | General Elective |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| ELECTIVE | 3 | Specialty Elective |
| ELECTIVE | 3 | Specialty Elective |
| ADMI 6816 | 3 | MBA Integrational Experience |
| | 9 | |

**Total Credits 36**

**List of offerings for General MBA**

**Medullary**

| Number | Credits | Courses |
|---|---|---|
| CONT 6005 | 3 | Managerial Accounting |
| ECON 6027 | 3 | Managerial Economics |
| ESTA 6005 | 3 | Managerial Statistics |
| FINA 6015 | 3 | Managerial Finance |
| GEIN 6035 | 3 | Quantitative Managerial Methods |
| GERE 6036 | 3 | International Management |
| MERC 6055 | 3 | Marketing Management |

**General Electives**

| Number | Credits | Courses |
|---|---|---|
| ADMI 6005 | 3-6 | Special Topics |
| ADMI 6006 | 1-3 | Practice Under Coop Plan |
| ADMI 6008 | 3 | Development of Small and Medium-sized enterprises |
| ESTA 6006 | 3 | Design and Analysis of Experiments |
| FINA 6016 | 3 | Public Finance |
| FINA 6017 | 3 | Investment Analysis and Portfolio of Securities |
| FINA 6018 | 3 | Corporate Finance and Financial Policy |
| FINA 6019 | 3 | International Finance |
| FINA6025 | 3 | Administration of Financial Institutions |
| GEIN 6005 | 3 | Physical Distribution and Logistics |
| GEIN 6036 | 3 | Decisional Analysis |
| GEIN 6038 | 3 | Quality Control |
| GEIN 6039 | 3 | Prediction Models for the Enterprise |
| GEIN 6045 | 3 | Production Control |
| GEIN 6047 | 3 | Materials Management and Purchasing |
| GEIN 6048 | 3 | Manufacturing Strategies |
| GEIN 6065 | 3 | Project Management |
| GERE 6025 | 3 | Organizational Conduct |
| GERE 6026 | 3 | Organizational Design |
| GERE 6035 | 3 | Business Research Methods |
| GERE 6055 | 3 | Business Government and Society |
| GERE 6056 | 3 | Environmental Decision Management |
| GERE 6096 | 3 | Business Policy |
| GERH 6027 | 3 | Legal Aspects of the Company |
| GERH 6028 | 3 | Innovation and Organizational Change |
| GERH 6029 | 3 | Leadership in Formal Organizations |
| GERH 6030 | 3 | Supervisory Management |
| GERH 6037 | 3 | Wage and Day Administration |
| GERH 6040 | 3 | Fundamentals of Human Resource Management |
| MERC 6056 | 3 | Marketing Communication Strategies |
| MERC 6057 | 3 | Consumer Analysis |
| MERC 6065 | 3 | Market Research |
| SICI 6065 | 3 | Management Information Systems |

**List of offerings for with specialty**

**Medullary**

| Number | Credits | Courses |
|---|---|---|
| CONT 6005 | 3 | Managerial Accounting |
| ESTA 6005 | 3 | Managerial Statistics |
| FINA 6015 | 3 | Managerial Finance |
| GERE 6036 | 3 | International Management |
| MERC 6055 | 3 | Marketing Management |

**Elective Courses**

**Finance**

| Number | Credits | Courses |
|---|---|---|
| FINA 6016 | 3 | Public Finance |
| FINA 6017 | 3 | Investment Analysis and Portfolio of Securities |
| FINA 6018 | 3 | Corporate Finance and Financial Policy |
| FINA 6019 | 3 | International Finance |
| FINA 6025 | 3 | Financial Institution Administration |

**Industrial Management**

| Number | Credits | Courses |
|---|---|---|
| GEIN 6005 | 3 | Physical Distribution and Logistics |
| GEIN 6035 | 3 | Quantitative Managerial Methods |
| GEIN 6036 | 3 | Decisional Analysis |

| | | |
|---|---|---|
| GEIN 6038 | 3 | Quality Control |
| GEIN 6039 | 3 | Prediction Models for the Enterprise |
| GEIN 6045 | 3 | Production Control |
| GEIN 6047 | 3 | Materials Management and Purchasing |
| GEIN 6048 | 3 | Manufacturing Strategies |
| GEIN 6065 | 3 | Project Management |

**Human Resources Management**

| Number | Credits | Courses |
|---|---|---|
| GERH 6027 | 3 | Legal Aspects of the Company |
| GERH 6028 | 3 | Innovation and Organizational Change |
| GERH 6029 | 3 | Leadership in Formal Organizations |
| GERH 6030 | 3 | Supervisory Management |
| GERH 6037 | 3 | Wage and Day Administration |
| GERH 6040 | 3 | Fundamentals of Human Resource Management |

**Marketing**

| Number | Credits | Courses |
|---|---|---|
| MERC 6056 | 3 | Marketing Communication Strategies |
| MERC 6057 | 3 | Consumer Analysis |
| MERC 6065 | 3 | Market Research |

**General Electives**

| Number | Credits | Courses |
|---|---|---|
| ADMI 6005 | 3-6 | Special Topics |
| ADMI 6006 | 1-3 | Practice Under Coop Plan |
| ADMI 6008 | 3 | Development of Small and Medium-sized enterprises |
| ECON 6027 | 3 | Managerial Economics |
| ESTA 6006 | 3 | Experience Design & Analysis |
| GERE 6025 | 3 | Organizational Conduct |
| GERE 6026 | 3 | Organizational Design |
| GERE 6035 | 3 | Business Research Methods |
| GERE 6055 | 3 | Business Government and Society |
| GERE 6056 | 3 | Environmental Decision Management |
| GERE 6096 | 3 | Business Policy |
| SICI 6065 | 3 | Management Information Systems |

**Core courses (21 credit hours)**

- Managerial Accounting
- Managerial Economics
- Managerial Statistics
- Financial Management
- Organizational Behavior
- Managerial Quantitative Methods
- Marketing Management

**Elective Courses**

Six credits must be approved in elective courses. Courses vary according to the specialization areas.

**Thesis or Capstone Courses (3-6 credit hours)**

- Thesis
- MBA Capstone

**Courses identified as deficiencies**

The following codes have been assigned to the corresponding modules in Financial Accounting I and II, as well as in Statistics I and II. These modules replace the deficient courses in accounting (6 credits) and statistics (6 credits) with review modules, as detailed below:

- CONT 5001. Module in Financial Accounting I – Three credits.
- CONT 5002. Module in Financial Accounting II – Three credits.
- ESTA 5001. Module in Statistics I. – Three credits.
- ESTA 5002. Module in Statistics II – Three credits.

Note : This applies to students with conditional admission.

**Webpage :** https://www.uprm.edu/gradweb

## BUSINESS ADMINISTRATION FACULTY

A list of professors who engage in graduate activities in the Department follows including the highest earned degree, date obtained, and institution granting the degree. Research and teaching interests are also included.

**MARÍA A. AMADOR-DUMOIS**, *Professor*, Ph.D., 2005, George Washington University. Research and Teaching interest: International Business, Entrepreneurship, Project Management and Strategic Management.

**MONSERRATE CARDOZA-BONET**, *Associate Professor*, Ph.D., 2005, The Union Institute and University, Cincinnati, OH.

**MARIO CÓRDOVA-CLAUDIO**, *Professor*, Ph.D., JD, 1998, Rutgers - The State University of New Jersey. Research and Teaching interest: Operations Management, Operations Research.

**EVALUZ COTTO-QUIJANO**, *Associate Professor*, LL.M., 1996, Georgetown University, Ph.D, 2011, University of London. Research and Teaching interests: Financial Services Law.

**DARIK Y. CRUZ-MARTÍNEZ**, *Professor*, LL.M., 2008, Boston University. Research and Teaching interests: Corporate Finance, inancial Institutions Management, Business Law, and Corporate Governance.

**MORAIMA DE HOYOS-RUPERTO**, *Professor*, D.M., 2012, University Cleveland. Research of the College of Business School.

**DAVID GONZÁLEZ-LÓPEZ**, *Professor*, D.B.A., 2012, Pontifical Catholic University, CPA. Research and Teaching interests: Accounting.

**LUZ GRACIA-MORALES,** *Professor*, D.B.A., 2012, Pontifical Catholic University , CPA. Research and Teaching interests: Accountability and transparency in non profit organizations, Disclosure of functional expenses in the 990 Form (IRS return for non-profit organizations).

**LEILA M. MARCANO-NIEVES**, *Associate Professor*, D.B.A., 2020, Ana G. Méndez University.

**JOSE G. MARTINEZ-MARTINEZ,** *Professor*, D.B.A., Information Systems, 2001, University of Sarasota, Florida. Post-Doctoral Bridge to Business Program-Supply Chain Management, 2008, University of Toledo, Toledo, Ohio. Research and Teaching interests: Information Technologies, Operations Management and Human Resources.

**ROSARIO DE LOS A. ORTIZ-RODRÍGUEZ**, *Professor*, Ph.D. (2008), University of Illinois at Chicago. Research and Teaching interests: Statistics and Quantitative Methods.

**LUZ E. QUIÑONES-GONZÁLEZ**, *Professor*, Ph.D. (2014), Interamerican University of Puerto Rico, Metropolitan Campus. Research and Teaching interests: Human Resources, Organizational Behavior, Organizational Leadership and Organizational Change.

**YOLANDA RUIZ-VARGAS**, *Professor*, Ph.D., 2000, University of Texas-Pan American. Research and Teaching interests: Capital Structure, Corporate Finance, Financial Planning and Financial Education.

**ROBERTO L. SEIJO-VIDAL,** *Professor,* Ph.D. Industrial Engineering, 2009, Texas A&M University. Research and Teaching Interests: Supply Chain Management, Operations and Project Management.

**JAIME E. SEPÚLVEDA-RIVERA**, *Professor,* LL.M., 1994, Georgetown University; CPA. Research and Teaching interests: Business Law and Taxation.

**EDGAR SOTO-RODRÍGUEZ**, *Professor*, D.B.A., 2007, Argosy University at Sarasota, Florida. Research and Teaching interest: International Business, Entrepreneurship, Marketing and Strategic Management.

**JOHN VILLAVICENCIO-MATOS**, *Assistant Professor*, Ph.D., 2018, University of Puerto Rico.

**MARI LUZ ZAPATA-RAMOS**, *Professor*, Ph.D., 2012, University of Florida. Research and Teaching interests: Marketing and Communications.

# *COLLEGE OF ENGINEERING*

The graduate program of the College of Engineering is the key contributor to Research and Development (R&D) activities at the University of Puerto Rico at Mayagüez (UPRM). It provides graduate students with experiences in state-of-the-art developments. During the last two decades, the College of Engineering has evolved from a College with emphasis on traditional teaching and community service, to one with a balanced portfolio which also includes a strong research component. One of the most important components in the research structure at the College of Engineering is represented by the several centers which foster an interdisciplinary research culture between professors, students, and research support staff. These research hubs are described at the beginning of the catalog.

The College of Engineering offers Master of Science degrees and Master of Engineering degrees in:

- Chemical Engineering
- Civil Engineering
- Computer Engineering
- Electrical Engineering
- Industrial Engineering
- Materials Science and Engineering
- Mechanical Engineering
- Software Engineering

Doctor of Philosophy degrees (Ph.D.) are offered in the following disciplines:

- Bioengineering
- Chemical Engineering
- Civil Engineering
- Computer and Information Sciences and Engineering
- Mechanical Engineering
- Software Engineering

**Webpage:** https://www.uprm.edu/engineering/

# DEPARTMENT OF CHEMICAL ENGINEERING

The Department of Chemical Engineering offers programs leading to the Master of Sciences (MS), Master of Engineering, (ME), and Doctor of Philosophy (Ph. D.) degrees.

In addition to the admission requirements of the Graduate Studies Office, a Bachelor of Science degree in Chemical Engineering or its equivalent is required.

Academic graduation requirements for Master of Science and Master of Engineering Programs above those established by the Graduate Studies Office include approving the following four core courses: Advanced Thermodynamics, Transport Phenomena, Reactor Design, and Mathematical Methods in Chemical Engineering.

Research in the Department of Chemical Engineering spans the spectrum from fundamental work on chemical engineering science to applications development. Research projects broadly fall in the following categories:

- Bioprocess and Biomedical Engineering
- Catalysis and Surface Engineering
- Complex Fluids and Soft Matter
- Transport and Separations
- Pharmaceutical and Chemical Processes

Other research in traditional chemical engineering disciplines is also represented in the department.

**Webpage:** https://www.uprm.edu/inqu/

Candidates' specific study programs are developed between the student, advisor and graduate committee as established in UPRM Academic Senate Certification 09-09. Afterwards you will find general examples of program curricula for the doctoral and masters' degree options.

## PROGRAM OF STUDY

## MASTER OF SCIENCE (MS) in CHEMICAL ENGINEERING CURRICULUM

### FIRST YEAR

**First Semester**

| Number | Credits | Course |
|---|---|---|
| INQU 6005 | 3 | Reactor Design |
| INQU 6019 | 3 | Advanced Thermodynamics |
| INQU 6001 | 3 | Mathematical Methods |
| INQU 6029 | 1 | Graduate Seminar |
| | 10 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| INQU 6016 | 3 | Adv. Transport Phenomena |
| SPEC xxxx | 3 | *Specialization Area Elective |
| ELEC xxxx | 3 | **Non-Spec Area Elective |
| INQU 6029 | 0 | Graduate Seminar |
| | 9 | |

### SECOND YEAR

**First Semester**

| Number | Credits | Course |
|---|---|---|
| INQU 6037 | 3 | Masters Thesis |
| SPEC xxxx | 3 | *Specialization Area Elective |
| INQU 6029 | 0 | Graduate Seminar |
| | 6 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| INQU 6037 | 3 | Masters Thesis |
| ELEC xxxx | 3 | **Non-Spec Area Elective |
| INQU 6029 | 0 | Graduate Seminar |
| | 6 | |

**Total Credits 31**

*6 credits in area of specialization electives;
**6 credits in electives outside, but related, to the area of specialization

**PROGRAM OF STUDY**

**MASTER OF ENGINEERING (ME) in CHEMICAL ENGINEERING CURRICULUM**

**PROJECT OPTION**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| INQU 6005 | 3 | Reactor Design |
| INQU 6019 | 3 | Advanced Thermodynamics |
| INQU 6001 | 3 | Mathematical Methods |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| INQU 6016 | 3 | Adv. Transport Phenomena |
| SPEC xxxx | 3 | *Specialization Area Elective |
| ELEC xxxx | 3 | **Non-Spec Area Elective |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| INQU 6036 | 3 | Engineering Project |
| SPEC xxxx | 3 | *Specialization Area Elective |
| | 6 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| INQU 6036 | 3 | Engineering Project |
| ELEC xxxx | 3 | **Non-Spec Area Elective |
| | 6 | |

**Total Credits 30**

*6 credits in electives in the area of specialization;
**6 credits in electives outside, but related, to the area of specialization

**PROGRAM OF STUDY**

**MASTER OF ENGINEERING (ME) in CHEMICAL ENGINEERING CURRICULUM**

**COURSEWORK-ONLY OPTION**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| INQU 6005 | 3 | Reactor Design |
| INQU 6019 | 3 | Advanced Thermodynamics |
| INQU 6001 | 3 | Mathematical Methods |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| INQU 6016 | 3 | Adv. Transport Phenomena |
| SPEC xxxx | 3 | *Specialization Area Elective |
| ELEC xxxx | 3 | **Non-Spec Area Elective |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| SPEC xxxx | 3 | *Specialization Area Elective |
| ELEC xxxx | 3 | **Non-Spec Area Elective |
| FREE xxxx | 3 | *** Elective |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| FREE xxxx | 3 | *** Elective |
| | 9 | |

**Total Credits 36**

*minimum 6 credits in area of specialization electives;
**minimum 6 credits in electives outside, but related, to the area of specialization;
***12 credits can be in either area

**PROGRAM OF STUDY**

**DOCTOR OF PHILOSOPHY (PhD) in CHEMICAL ENGINEERING CURRICULUM**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| INQU 6005 | 3 | Reactor Design |
| INQU 6019 | 3 | Advanced Thermodynamics |
| INQU 6001 | 3 | Mathematical Methods |
| INQU 8996 | 1 | Doctoral Seminar |
| | 10 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| INQU 6016 | 3 | Adv. Transport Phenomena |
| SPEC xxxx | 3 | *Specialization Area Elective |
| ELEC xxxx | 3 | **Non-Spec Area Elective |
| INQU 8996 | 0 | Doctoral Seminar |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| INQU 8999 | 3 | Doctoral Dissertation |
| SPEC xxxx | 3 | *Specialization Area Elective |
| INQU 8996 | 0 | Doctoral Seminar |
| | 6 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| INQU 8999 | 3 | Doctoral Dissertation |
| SPEC xxxx | 3 | *Specialization Area Elective |
| INQU 8996 | 0 | Doctoral Seminar |
| | 6 | |

**THIRD YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| INQU 8999 | 3 | Doctoral Dissertation |
| ELEC xxxx | 3 | **Non-Spec Area Elective |
| INQU 8996 | 0 | Doctoral Seminar |
| | 6 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| INQU 8999 | 3 | Doctoral Dissertation |
| FREE xxxx | 3 | *** Elective |
| INQU 8996 | 0 | Doctoral Seminar |
| | 6 | |

**FOURTH YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| INQU 8999 | 3 | Doctoral Dissertation |
| FREE xxxx | 3 | *** Elective |
| INQU 8996 | 0 | Doctoral Seminar |
| | 6 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| INQU 8999 | 3 | Doctoral Dissertation |
| FREE xxxx | 3 | *** Elective |
| INQU 8996 | 0 | Doctoral Seminar |
| | 6 | |

**FIFTH YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| INQU 8999 | 0 | Doctoral Dissertation |
| FREE xxxx | 3 | *** Elective |
| INQU 8996 | 0 | Doctoral Seminar |
| | 3 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| INQU 8999 | 0 | Doctoral Dissertation |
| INQU 8996 | 0 | Doctoral Seminar |
| | 0 | |

**Total Credits 58**

*minimum 9 credits in area of specialization electives;
**minimum 6 credits in outside, but related, specialization electives
***12 credits can be in either area

## CHEMICAL ENGINEERING FACULTY

A list of professors who are engaged in graduate activities in the Department follows, including the highest earned degree, date, and institution granting the degree. Research and teaching interests are also included.

**ALDO ACEVEDO RULLAN**, *Professor*, Ph.D., 2006, University of Delaware. Research interests: Soft Matter; rheology. Teaching interests: Polymer Science and Engineering, Soft Matter, Rheology, Process Design, Transport Phenomena, Fluid Mechanics.

**CLARIBEL ACEVEDO VELEZ,** *Associate Professor*, Ph.D., 2011, University of Wisconsin, Madison. Research interest: Colloidal and Interfacial Phenomena, Surfactant Science, Nanoscale Science. Teaching interests: Momentum Transfer Operations, Colloids, & Interfaces, Process Design, Seminar.

**PAOLA A. BALDAGUEZ MEDINA**, *Assistant Professor*, Ph.D., 2024, University of Illinois, Urbana-Champaign. Research interests: eletroactive polymers, separations, biological and chemical sensors, electro-remediation.

**MOSES N. BOGERE**, *Professor*, Ph.D., 1993, University of Akron. Research interests: Multiphase Transport Phenomena in Dispersed Multiphase Systems, Control and Optimization, Applied Mathematics. Teaching interests: Multiphase Transport Phenomena, Process Control, Modeling and Instrumentation, Process Design.

**UBALDO M. CÓRDOVA-FIGUEROA**, *Professor*, Ph.D., 2008, California Institute of Technology. Research interests: Transport Phenomena, Physicochemical Hydrodynamics, Brownian Dynamics Simulations, Colloidal Dispersions, Microrheology, Synthesis of Selfpropelled Janus Particles. Teaching interests: Transport Phenomena, Colloidal Physics.

**MARÍA C. CURET ARANA**, *Professor*, Ph.D., 2006, Northwestern University, Northwestern University, Evanston, IL. Research interests: Kinetic modeling, Catalysis, First-principle calculations. Teaching interests: Undergraduate and Graduate Chemical Reaction Kinetics, Catalysis, Applied Molecular Modeling, Environmental Chemical Engineering.

**MARIBELLA DOMENECH GARCIA**, *Professor*, Ph.D., 2010, University of Wisconsin, Madison. Biomedical Engineering. Research interests: Microfluidics, Tumor Microenvironment, Stemcells, Breast Cancer, Nano-systems for Cell-targeted Drug Delivery. Teaching interests: Biomedical Engineering, Biotechnology, Quantitative Computational Biology, Biomaterials, Tissue Engineering, Chemical Engineering-Unit Operations.

**ARTURO J. HERNÁNDEZ-MALDONADO**, *Professor*, Ph.D., 2004, University of Michigan. Research interests: Synthesis and Characterization of Microporous and Mesoporous Materials, Zeolites, Zeolitic Crystallography, Adsorption. Teaching interests: Mass Transfer, Transport Phenomena, Adsorption Engineering.

**MAGDA LATORRE-ESTEVES**, *Associate Researcher*, Ph.D., 2006, Harvard Medical School. Research interests: Nanomaterials for Biomedical Applications, Molecular Mechanisms of Disease, Tissue Engineering. Teaching interests: Molecular Biology and Genetics, Nanomedicine Science and Technology, Quantitative Biology, Bioengineering.

**MARIA M. MARTINEZ IÑESTA**, *Professor*, Ph.D., 2005, University of Delaware. Research Interests: synthesis of metal nanostructures (nanowires and nanogrids), study of porous materials as templates, structural characterization of disordered materials, structural characterization of nanostructures, characterization of the properties of nanostructures and of the composite nanostructure + template for electronic and catalytic applications. Teaching Interests: Undergraduate and Graduate Kinetics, Diffraction, and Materials Characterization

**RAFAEL MENDEZ ROMAN**, *Professor*, Ph.D., 2005, University of Puerto Rico-Mayagüez. Research interests: Pharmaceutical Powder Properties, Continuous Mixing, Tablet Compaction. Teaching interests: Pharmaceutical Operations, Thermodynamics, Kinetics and Statistical Methods for Chemical Engineers.

**HANSEL A. MONTALVO-CASTRO**, Assistant *Professor*, Ph.D., 2024, University of Florida, Gainesville. Research interests: heterogeneous catalysis, materials design, and computation and simulations. Teaching interests: reactor design and catalysis, statistical mechanics, and quantum chemistry.

**CAMILO A. MORA NAVARRO**, *Associate Professor*, Ph.D., 2016, University of Puerto Rico-Mayagüez. Research interests: Tissue engineering, extracellular vesicles, biosensors development, and biomaterials. Teaching interests: Mass Transfer, Heat Transfer and Thermodynamics.

**PATRICIA ORTIZ BERMUDEZ**, *Professor*, PhD, 2005, UW-Madison, Microbiology. Research interests: Discovery and characterization of novel biocatalysts for lignocellulose degradation, and synthesis of antimicrobial nanoparticles and their interaction with microbial cell walls. Teaching interests: Bioengineering, Food Fermentation and Biotechnology, Biorefineries and Bioproducts.

**YOMAIRA J. PAGAN-TORRES**, *Professor*, PhD, 2011, UW-Madison, Chemical Engineering. Research interests: Heterogeneous Catalysis, Kinetic and Reaction Engineering, Catalytic Nanomaterial Synthesis and Characterization, Renewable Energy and Sustainability. Teaching interests: Chemical Engineering Kinetics and Catalysis, Chemical Process Safety and Economics, Chemical Engineering Seminar.

**LORENZO SALICETI-PIAZZA**, *Professor*, Ph.D., 1996, Purdue University. Research interests: Biochemical Engineering, Utilization of Renewable Resources. Teaching interests: Biochemical Engineering, Process Control and Applied Statistics.

**LAKSHMI N. SRIDHAR**, *Professor*, Ph.D., 1991, Clarkson University. Research interests: Analysis and Separation Processes, Process Optimization and Control Design, Synthesis and Control. Teaching interests: Applied Mathematics, Separation Processes, Reactions Engineering, and Transport Phenomena.

**DAVID SULEIMAN-ROSADO**, *Professor*, Ph.D., 1994, Georgia Institute of Technology. Research interests: Specialty Separations and Advanced Materials. Teaching interests: Material & Energy Balances, Thermodynamics, Kinetics and Transport Phenomena.

**MADELINE TORRES-LUGO**, *Professor*, Ph.D., 2001, Purdue University. Research interests: Biochemical Engineering, Biomedical Engineering, Materials, and Polymers. Teaching interests: Polymers, Thermodynamics.

**CARLOS VELÁZQUEZ-FIGUEROA**, *Professor,* Ph.D., 1997, University of Connecticut, Storrs, Connecticut. Research interests: Process Control, Application of Control Theory to Pharmaceutical Operations and Biotechnology, Supercritical Fluid for Pharmaceutical Applications, and Parameter Estimation. Teaching interests: Process Control, Instrumentation, Material and Energy Balances, Pharmaceutical Technologies.

# DEPARTMENT OF CIVIL ENGINEERING AND SURVEYING

The Department of Civil Engineering and Surveying offers programs leading to the degrees of Master of Science (M.S.), Master of Engineering (M.E.), and Doctor of Philosophy (Ph.D.) in Civil Engineering (C.E.).

## Vision

We provide society with people-serving problem-solvers in civil engineering and surveying.

## Mission

Provide our society with high quality professionals having a strong education in civil engineering and/or land surveying; with rich cultural, ethical, environmental, and social sensitivities; capacity for critical thinking; and the entrepreneurial skills to solve civil infrastructure problems. Search for and disseminate new knowledge. Provide services to solve engineering problems as members of interdisciplinary teams.

## SLOGAN

***CES = (PS)²*** (Civil Engineers and Surveyors = People-Serving, Problem Solvers)

**Webpage:** https://www.uprm.edu/inci/

### EDUCATIONAL OBJECTIVES

Our Civil Engineering graduates will address the challenges that they will face in their careers, pursue life-long learning, exhibit leadership, and provide quality service to the profession, our government, and our society. By the time of their graduation, our students should have developed:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. An ability to communicate effectively with a range of audiences.
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. An ability to develop and conduct appropriate experimentation, analyze, and interpret data, and use engineering judgment to draw conclusions.
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

## GRADUATE PROGRAMS

Students should comply with the admission requirements of the Office of Graduate Studies. Students in the Master of Science (Plan I) program are required to approve at least 24 course credits, carry out a research study and write and defend a thesis (6 credits). Students in the Master of Engineering (Plan II) program must approve at least 27 course credits, work on a design or development project and write and defend an engineering report (3 credits). Students in the Master of Engineering (Plan III) program must approve at least 30 credits in courses. There are no formal options, but students in the master's program can specialize in construction engineering and management, environmental and water resources, geotechnical, structures, or transportation.

## CIVIL ENGINEERING

### MASTER IN SCIENCE (MS) PLAN I CURRICULUM

This option requires taking thirty (30) credits in total to complete the Master's degree as well as write a proposal, carry out a research, write the thesis, and pass an oral examination. The requirements for the 30 credits are as follow:

- a maximum of nine (9) credits of advanced undergraduate level.
- a minimum of twenty-one (21) graduate-level credits, including up to six (6) thesis credits.
- a minimum of six (6) credits outside the study area, but in related areas.

The curriculum is a flexible one and major courses are associated with the student's research; therefore, courses from other departments can be considered major courses. An example of what the curriculum could look like is below.

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| INCI 6XXX | 3 | MAJOR |
| INCI 5XXX | 3 | MAJOR |
| ELEC 6XXX | 3 | ELECTIVE |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| INCI 6XXX | 3 | MAJOR |
| INCI 6XXX | 3 | MAJOR |
| ELEC 5XXX | 3 | ELECTIVE |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| INCI 6XXX | 3 | MAJOR |
| INCI 6066 | 3 | RESEARCH THESIS |
| | 6 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| INCI 6XXX | 3 | MAJOR |
| INCI 6066 | 3 | RESEARCH THESIS |
| | 6 | |

**Total Credits 30**

### MASTER IN ENGINEERING (ME) PLAN II CURRICULUM

This option requires taking at least twenty-seven (27) credits in courses plus three (3) credits in engineering projects. Students are required to write a proposal, carry out the project, write the project report, and pass an oral examination. Students are also required to take:

- a maximum of nine credits of advanced undergraduate level.
- a minimum of twenty-one graduate credits, including up to three project credits.
- a minimum of six credits outside the study area, but in related areas.

The curriculum is a flexible one and major courses are associated with the topic of the project that the student will work on; therefore, courses from other departments can be considered major courses. An example of what the curriculum could look like is below.

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| INCI 6XXX | 3 | MAJOR |
| INCI 5XXX | 3 | MAJOR |
| ELEC 6XXX | 3 | ELECTIVE |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| INCI 6XXX | 3 | MAJOR |
| INCI 6XXX | 3 | MAJOR |
| ELEC 5XXX | 3 | ELECTIVE |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| INCI 6XXX | 3 | MAJOR |
| INCI 6XXX | 3 | MAJOR |
| | 6 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| INCI 6XXX | 3 | MAJOR |
| INCI 6065 | 3 | ENGINEERING PROJECT |
| | 6 | |

**Total Credits 30**

**MASTER IN ENGINEERING (ME) PLAN III CURRICULUM**

This option requires taking thirty (30) credits in courses plus as follow:

- a maximum of nine (9) credits of advanced undergraduate level.
- a minimum of twenty-one (21) credits of graduate level.
- a minimum of six (6) credits outside the study area, but in related areas.
- a minimum of twenty-one (21) credits in the specialty area.

The curriculum is a flexible one and major courses are associated with the student's area of specialization (Structures, Transportation, Environmental Engineering and Water Resources, Construction Management, or Geotechnical Engineering). As such, courses from other departments can be considered major courses. An example of what the curriculum could look like is below.

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| INCI 6XXX | 3 | MAJOR |
| INCI 5XXX | 3 | MAJOR |
| ELEC 6XXX | 3 | ELECTIVE |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| INCI 6XXX | 3 | MAJOR |
| INCI 6XXX | 3 | MAJOR |
| ELEC 6XXX | 3 | ELECTIVE |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| INCI 6XXX | 3 | MAJOR |
| INCI 6XXX | 3 | MAJOR |
| | 6 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| INCI 6XXX | 3 | MAJOR |
| INCI 5XXX | 3 | MAJOR |
| | 6 | |

**Total Credits 30**

Students in the Ph.D. program must approve 42 course credits, pass a qualifying exam which includes a written and oral component, pass a comprehensive exam which includes a written and oral component, and prepare and defend a doctoral dissertation (18 credit-hours). The doctoral dissertation must be an original contribution to the state-of-the-art in the field of study. Up to 24 credit-hours of course work can be accredited for students who already have a master's degree before entering the Ph.D. program. Students in the Ph.D. program can select options in environmental and water resources, structures, or transportation.

**DOCTOR OF PHILOSOPHY IN CIVIL ENGINEERING CURRICULUM**

The program requires a minimum of 60 credits after their bachelor education. The student must complete successfully an exam that include written and oral components in the specialization area in Civil Engineering, and approve the final exam application when completed the credits number, excluding the corresponding theses, including a written and oral component. The distribution of the credits is as follow:

- Up to nine credits of advanced undergraduate level.
- Up to eighteen credits of thesis.
- A minimum of nine credits outside of specialization, but in related areas.

The curriculum is a flexible one and, just as the other programs, major courses are those associated with the student's area of specialization and research topic. Therefore, courses from other departments can be considered major courses. An example of what the curriculum could look like is below.

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| INCI 6XXX | 3 | MAJOR |
| INCI 6XXX | 3 | MAJOR |
| INCI 5XXX | 3 | MAJOR |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| INCI 6XXX | 3 | MAJOR |
| INCI 6XXX | 3 | MAJOR |
| ELEC 6XXX | 3 | ELECTIVE |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| INCI 6XXX | 3 | MAJOR |
| INCI 6XXX | 3 | MAJOR |
| ELEC 6XXX | 3 | ELECTIVE |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| INCI 6XXX | 3 | MAJOR |
| INCI 6XXX | 3 | MAJOR |
| INCI 8999 | 3 | DOCTORAL RESEARCH |
| | 9 | |

**THIRD YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| INCI 6XXX | 3 | MAJOR |
| ELEC 5XXX | 3 | ELECTIVE |
| INCI 8999 | 3 | DOCTORAL RESEARCH |
| | 9 | |

**Second Semester**

| | | |
|---|---|---|
| INCI 6XXX | 3 | MAJOR |
| INCI 8999 | 3 | DOCTORAL RESEARCH |
| | 6 | |

**FOURTH YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| INCI 8999 | 6 | DOCTORAL RESEARCH |
| | 6 | |

**Second Semester**

| | | |
|---|---|---|
| INCI 8999 | 3 | DOCTORAL RESEARCH |
| | 3 | |

**Total Credits 60**

A certificate in Resilience and Sustainability at the Coastal Zones is available for all students and professionals associated to hazard mitigation, first responders, and the community. Three levels of certificates are available. Core course work, seminars, workshops, and field trips are provided to complete the number of hours established for each certificate level.

## LABORATORY & RESEARCH CENTERS

The Department has over 52,000 square feet of facilities space for teaching and research activities. There are laboratory facilities for engineering materials, structures and structural models, soil mechanics, highway and traffic engineering, environmental engineering, and surveying and topography. A wind tunnel facility is available for modeling and simulation of wind effect on structures. A strong floor facility for testing full-scale structures is also available. A driving simulator and a pedestrian virtual reality simulator are used for studies focused on human performance and safety effects of road design decisions. Each laboratory has a faculty in charge and a trained laboratory technician.

Microcomputer laboratories are available to faculty and students around the clock, seven days a week. A systematic computer network infrastructure provides access to Internet to every classroom, computer center, laboratory, and every employee. An optic fiber network provides rapid external communication. There are three computer laboratories: 1) the Civil Engineering Infrastructure Research Center is equipped with microcomputers and work stations to assist students and professors in the development of their research projects; 2) the CAIREL (Computer Aided Instruction and Research Laboratory) facility is equipped with microcomputers and visual aids equipment; and 3) the Distance Learning Laboratory (DLL) equipped with long distance learning electronic equipment and work stations for students' meeting, classes and workshops.

The Department has strong basic and applied research components in resilient and sustainable civil infrastructure, hazard mitigation, climate change impacts on infrastructure of coastal communities, seismic resistance analysis of structures, environmental engineering, road design and safety analysis, multi-modal congestion reduction strategies, and construction materials. Our faculty is actively involved in research activities and services to agencies and organizations with significant external support from local and federal government, industry, and others. Our faculty was involved in research activities with about $4 million in funding during the past academic year, thus ranking among the top UPRM departments submitting proposals and receiving external funding.

Various centers provide administrative support to research initiatives: the Civil Infrastructure Research Center (CIRC), the UPRM Coastal Resilience Center (CRC), the Puerto Rico Strong Motion Program (PRSMP), the Puerto Rico Transportation Technology Transfer Center (also known as $T^2$) and the Puerto Rico Water Resources and Environmental Research Institute (PRWRERI). Graduate students are encouraged to participate in research experiences, both on-campus and off-campus. Students can also participate in summer internship programs in prestigious universities and research centers in the continental US.

## COURSES OFFERED

(I)= courses normally offered during the First Semester
(II)= courses normally offered during the Second Semester
(S)= courses normally offered during the Summer Session
(BD)= based on demand

## CIVIL ENGINEERING FACULTY

A list of professors who engage in graduate activities in the Department follows, including the highest earned degree, date, and institution granting the degree. Research and teaching interests are also included.

**FELIPE J. ACOSTA-COSTA**, *Professor,* Ph.D., 1999, Georgia Institute of Technology. Research interests: Experimental Material Characterization, Construction and Rehabilitation of Structures of Composite Materials. Teaching interests: Finite Element Analysis, Mechanics of Composite Materials, Construction Materials.

**LUIS D. APONTE-BERMÚDEZ**, *Professor*, Ph.D., 2006, University of Florida. Research interests: Wind Engineering. Teaching interests: Wind Engineering, Probabilistic Methods.

**ARSENIO CÁCERES-FERNÁNDEZ**, *Associate Professor*, Ph.D., 1998, West Virginia University. Research interests: Materials for Civil Engineering, Composite Materials Applications and Civil Engineering Infrastructure, Damage Mechanics, Construction Materials made from Recycled Products, Concrete Technology. Teaching interests: Civil Engineering Materials, Composite Materials, and Reinforced Concrete Design.

**BEATRIZ I. CAMACHO-PADRÓN**, *Associate Professor*, Ph.D., 2006, University of Texas at Austin. Research interests: Experimental Geotechnics, Geo-environmental Engineering, Foundation Engineering. Teaching interests: Geo-environmental Engineering, Foundation Engineering, Environmental Geotechnics, Structural Components in Construction.

**BENJAMÍN COLUCCI-RÍOS***, Professor*, Ph.D., 1984, Purdue University. Research interests: Pavement Evaluation, Bituminous Materials. Teaching interests: Highway Engineering, Transportation.

**IVETTE CRUZADO-VÉLEZ***, Professor*, Ph.D., 2009, Pennsylvania State University. Research interests: Transportation Systems Analysis, Public Transportation System, Urban Transportation Planning. Teaching interests: Transportation and Highway Engineering.

**EVI DE LA ROSA-RICCIARDI**, *Professor,* Ph.D., 2009, University of Florida. Teaching and Research Interests: Surveying, Topography, Geospatial Analysis, and Property Regulations.

**LUISA I. FELICIANO-CRUZ**, *Assistant Professor*, Ph.D., 2023, University of Puerto Rico-Mayagüez. Research interests: Flood Inundation Mapping, Hydrologic and Hydraulic Modeling, Climate and Big Data Analytics, GeoAl, and Machine Learning in Water Resources. Teaching interests: Environmental Engineering, Water Resources Engineering, Hydrology, Hydraulics, GIS, Groundwater Hydrology, Numerical Methods.

**ALBERTO M. FIGUEROA-MEDINA***, Professor*, Ph.D., 2005, Purdue University. Research interests: Effects of Highway Geometrics, Safety Analysis and Modeling, Driving Simulation and Virtual Reality Studies, Public Transportation, Micro-Mobility, Performance of Transportation Systems, Congestion Mitigation. Teaching interests: Highway Engineering and Design of Transportation Infrastructure.

**JOSÉ L. FLORES-MALAVÉ**, *Professor*, M.S.C.E., 1994, Purdue University. Teaching and Research Interests: Geospatial Analyses and Design (GIS/GPS), Surveying, Topography, and Cartography.

**MAGDA S. GALLOZA-CARRERO**, *Assistant Professor*, Ph.D., 2013, Purdue University. Research interests: Geographic Information Systems combined with Remote Sensing for Spatial Data Analysis and Data Management, Soil Erodibility, Land Management Practices Assessments in Soil Degradation for Predictive Capabilities. Teaching interests: Remote Sensing, GIS, Photogrammetry, Environmental Engineering, and Interdisciplinary Engineering.

**JOSÉ O. GUEVARA**, *Professor*, Ph.D., 1990, University of Florida. Research interests: Behavior of Reinforced Concrete Structures, Structural Design, Rehabilitation of Structures. Teaching interests: Reinforced Concrete Structures, Structural Design.

**CARLOS I. HUERTA-LÓPEZ,** *Associate Professor*, Ph.D., 2001, University of Texas at Austin. Research interests: Seismology, Exploration Geophysics, Engineering Seismology, Strong Motion Seismology, Oil Exploration. Teaching interests: Engineering Seismology.

**CARLA LÓPEZ DEL PUERTO**, *Professor*, Ph.D., 2009, Saint Louis University. Research interests: Construction Management, Design-Build Construction, Cost Estimation. Teaching interests: Construction Management, Design-Build Construction, Project Management, Construction Administration and Inspection.

**FRANCISCO MALDONADO-FORTUNET,** *Professor*, Ph.D., 2002, Georgia Institute of Technology. Research interests: Sustainable Construction, Construction Management. Teaching interests: Construction Management, Construction Projects Planning and Scheduling.

**JOSÉ A. MARTÍNEZ-CRUZADO**, *Professor*, Ph.D., 1993, University of California at Berkeley. Research interests: Earthquake Resistance Engineering, Concrete Behavior. Teaching interests: Reinforced Concrete, Structural Steel Design, Earthquake Resistance of Structures.

**OMAR I. MOLINA-BAS***, Professor*, Ph.D., 2008, "*Universidad Politécnica de Madrid"*. Research interests: Durability of Construction Materials, Precast Concrete Construction, Procurement of Infrastructure. Teaching interests: Construction Engineering and Management, Concrete Life Cycle, Public-Private Partnerships, Industrialized Construction.

**ALESANDRA C. MORALES-VÉLEZ**, *Professor*, Ph.D., 2015, University of Rhode Island. Research Interests: Liquefaction of Non-Plastic Soils, Shear Wave Velocity, Soil Behavior, Experimental Soil Characterization, Geotechnical Characterization of Calcareous Sands. Teaching Interests: Theory of 1D-Consolidation, Geotechnical Earthquake Engineering, Soil Behavior, Soil Mechanics and Foundations.

**JONATHAN MUÑOZ-BARRETO**, *Professor*, Ph.D., 2014, City College of New York. Research interests: Remote Sensing, Geographic Information

Systems. Teaching interests: Geodesy, Surveying, Geographic Information System.

**INGRID Y. PADILLA-CESTERO**, *Professor*, Ph.D., 1998, University of Arizona. Research interests: Subsurface Hydrology and Contaminant Transport, Soil and Ground-Water Remediation, Water Chemistry, Ground-Water/Surface-Water Interactions, and Ground-Water Flow and Contaminant Transport Modeling. Teaching interests: Groundwater Hydrology, Contaminant Transport, Water Chemistry.

**ISMAEL PAGÁN-TRINIDAD**, *Professor*, M.S.C.E. 1977, University of Puerto Rico at Mayagüez. Research interests: Natural Disasters, Coastal Resilient Infrastructure, Urban Drainage, Tropical Hydrology, Flash Floods, Water Infrastructure. Teaching interests: General Hydrology and Hydraulics, Applied Hydraulics, Groundwater Hydrology and Hydraulics, Water Resources Systems, Stochastic Hydrology, Flood Control, Disaster Mitigation.

**JOSÉ L. PERDOMO-RIVERA**, *Professor*, Ph.D, 2004, Virginia Polytechnic Institute and State University. Research interests: Materials Management in Construction, Information Technology for Construction, Handheld Devices Applied to Construction, Wireless Data Transmission, Business Practices Applies to Construction, Means and Methods for Building and Heavy Construction, Temporary Structures for Construction, Simulation and Modeling, Heavy Equipment Performance. Teaching interests: Construction Engineering.

**RICARDO RAMOS-CABEZA**, *Professor*, Ph.D., 1999, Rensselaer Polytechnic Institute. Research interests: Soil Dynamics, Soil-Structures Interaction, Earthquake Engineering. Teaching interests: Foundation Engineering, Steel Structures Design, Concrete Structures.

**DANIEL RODRÍGUEZ-ROMÁN**, *Professor*, Ph.D., 2015, University of California at Irvine. Research interests: Transportation Planning, Travel Demand Management, Metaheuristic Optimization. Teaching interests: Urban Transportation Planning, Discrete Choice Analysis, Public Transportation.

**ALI SAFFAR**, *Professor*, Ph.D., 1986, Worcester Polytechnic Institute. Research interests: Structural Fire Resistance, Stress Analysis, Gaussian Closure Techniques, Plastic Fire Design of Steel Structures. Teaching interests: Reinforced Concrete Structures, Building Design, Structural Analysis, and Design of Steel Structures.

**RAFAEL SEGARRA-GARCÍA**, *Professor,* Ph.D., 1988, Virginia Polytechnic Institute and State University. Research interests: Hydrology, Stochastic Processes, Water Resources Planning and Management. Teaching interests: Hydrology and Water Resources Engineering.

**WALTER F. SILVA-ARAYA**, *Professor*, Ph.D., 1993, Washington State University. Research interests: Erosion and Sedimentation, Vegetative Waterways, Unsteady Closed and Open Channel Flow, Rehabilitation of Hydraulic Structures, Environmental Hydraulics and Numerical Modeling of Hydraulic Systems. Teaching interests: Fluid Mechanics, Water Resources, Advanced Hydraulic Engineering.

**LUIS E. SUÁREZ-COLCHE**, *Professor*, Ph.D., 1986, Virginia Polytechnic Institute and State University. Research interests: Structural Dynamics, Computational Methods, Earthquake Engineering, Active and Passive Control. Teaching interests: Structural Dynamics, Structural Analysis, Structural Mechanics, Soil Dynamics.

**PEDRO J. TARAFA-VÉLEZ**, *Professor*, Ph.D., 2010, University of South Carolina. Research interests: Bio-molecular Engineering, Chemical Processes, Air Pollution, Water and Wastewater Treatment, Waste Disposal. Teaching interests: Water Treatment, Water and Wastewater Treatment, and Environmental Engineering.

**DIDIER M. VALDÉS-DÍAZ**, *Professor*, Ph.D., 1999, University of Texas at Austin. Research interests: Transportation Systems Modeling and Analysis, Intelligent Transportation Systems Applications, Network Modeling, Public Transportation System, Urban Transportation Planning, Geometric Design Applied to Urban and Rural Setting. Teaching interests: Transportation and Highway Engineering.

# DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

**General Information**

The Department of Computer Science and Engineering offers graduate degrees (master's and doctorate) in software engineering. The mission of the Graduate Program in Software Engineering (SWE) is to prepare highly skilled software engineering professionals that are capable of building complex mission-critical software systems and/or conducting research to create new, state-of-the-art software technologies that solve science, business, engineering, and technology challenges faced by our society, while observing the highest ethical standards and appropriate engineering practices.

In addition, the Department is the coordinator of the multidisciplinary doctoral program in Computing and Information Sciences and Engineering (CISE) offered jointly with the Department of Mathematical Sciences.

Detailed information on the graduate programs offered by the Department of Computer Science and Engineering can be found at https://www.uprm.edu/cse/inso-graduate/, and https://www.uprm.edu/cse/phd-computing-and-information-sciences-and-engineering-cise/.

**Degrees offered:**

1. Master of Science (MS) – The Master of Science degree comprises advanced coursework in software engineering (24 credits) and requires the preparation of an original research thesis (6 credits). The department offers a MS program in Software Engineering (MSSWE)
2. Master of Engineering (ME) – The Master of Engineering is a professional degree that comprises advanced coursework in software engineering. The ME program has two options, Plan II, where students take 24 to 27 credits in courses, and work on an engineering project (3-6 credits), and Plan III, where students take 30 credits in courses. The department offers a ME program in Software Engineering (MESWE).
3. Doctor of Philosophy (PhD) – The PhD in Software Engineering is a research training degree conceived as a research-oriented graduate experience when compared to the Master in SWE. The PhD in SWE has an emphasis on conducting *state-of-the-art research endeavors,* as opposed to completing extensive course sequences. The PhD program in Software Engineering requires the completion of 30 course credits above the BS, completion of the doctoral seminar (3 credits), completion of an Advanced Topics course (3 credits), the preparation of an original dissertation (18 credits), passing the qualifying and comprehensive examinations, and a successful dissertation defense.

## MASTER OF SCIENCE AND MASTER OF ENGINEERING IN SOFTWARE ENGINEERING

The Master in Software Engineering degree is intended for students who have earned a bachelor's degree in Software Engineering, Computer Science and Engineering, Computer Science, Computer Engineering, or closely related fields. It aims at providing students with advanced knowledge in Software Engineering in areas of program design, testing, maintenance, production deployment, monitoring, secure software engineering, software protection, and data engineering.
Students shall acquire high order skills for software analysis, and an ability to contribute effectively to the solution of complex problems through the development of software artifacts for production use.

**Admission Requirements:**

1. General admission requirements set by the UPRM Office of Graduate Studies,
2. Applicants must possess a Bachelor's degree in Software Engineering, Computer Science and Engineering, Computer Science, Computer Engineering, or closely related field. UPRM students that have completed the UPRM Minor in Computer Science and Engineering might also apply. For admission consideration, the body of knowledge in the applicant's transcript shall at least include the following:
   - One semester college-level Calculus
   - Two semesters of college-level Physics
   - Two semesters of Computer Programming courses
   - One semester of Data Structures
3. The Department of Computer Science and Engineering Graduate Committee reviews all applications that the UPRM Office of Graduate Studies has judged complete and consistent with the general criteria established for

graduate studies at UPRM. The Graduate Committee evaluates:

- The applicant's coursework, academic history, and the appropriateness of her/his academic background;
- The degree of alignment of the applicant's interests and the program's graduate profile outcomes;
- The quality of the applicant's essay;
- The contents of the letters of recommendation in support of the applicant;
- The potential of the applicant for succeeding in the program within a reasonable period of time.

**Admission with Deficiencies**

Good applicants whose academic record lacks one or more of the following courses are considered to have deficiencies:

1. Introduction to Software Engineering (INSO 4101 or equivalent)
2. Introduction to Databases Systems (CIIC 4060 or equivalent)
3. Introduction to Operating Systems (CIIC 4050 or equivalent)
4. Introduction to Probability and Statistics (ININ 4010 or equivalent)

These applicants might be accepted into the program based on the strength their academic record, and might be required to take up to four of these undergraduate remedial courses upon acceptance into the program, as specified in section G.2.d. of Certification 09-09, amended by certification 20-94, of the Academic Senate at UPRM. All remedial courses must be approved during the first two years in the program.

**Graduation Requirements:**

The Master of Science program (Plan I) requires a minimum of 30 credits distributed as follows:

- 9 credits in core courses.
- 9 credits in electives within the area of specialization.
- 6 credits in electives out of the area of specialization.
- 6 credits of graduate thesis.

The Master of Engineering with project option (Plan II) requires a minimum of 30 credits distributed as follows:

- 9 credits in core courses
- 9-12 credits in electives within the area of specialization.
- 6 credits in electives out of the area of specialization.
- 3-6 credits of graduate project.

The Master of Engineering with courses option (Plan III) requires a minimum of 30 credits distributed as follows:

- 9 credits in core courses
- 15 credits in electives within the area of specialization.
- 6 credits in electives out of the area of specialization.

**PROGRAM OF STUDY**

**SOFTWARE ENGINEERING**
**MASTER OF SCIENCE (MS) CURRICULUM**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| INSO 6005 | 3 | Core Course |
| INSO 6006 | 3 | Core Course |
| ELECTIVE | 3 | Elective Course |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| INSO 6007 | 3 | Core Course |
| ELECTIVE | 3 | Elective Course |
| ELECTIVE | 3 | Elective Course |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| ELECTIVE | 3 | Elective Course |
| ELECTIVE | 3 | Elective Course |
| INSO 6999 | 3 | Master's Thesis |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| INSO 6999 | 3 | Master's Thesis |
| | 3 | |

**Total Credits 30**

Elective courses must be divided in 9 credits in electives within the area of specialization and 6 credits in electives out of the area of specialization.

**PROGRAM OF STUDY**

**SOFTWARE ENGINEERING**
**MASTER OF ENGINEERING (ME)**
**CURRICULUM**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| INSO 6005 | 3 | Core Course |
| INSO 6006 | 3 | Core Course |
| ELECTIVE | 3 | Elective Course |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| INSO 6007 | 3 | Core Course |
| ELECTIVE | 3 | Elective Course |
| ELECTIVE | 3 | Elective Course |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| ELECTIVE | 3 | Elective Course |
| ELECTIVE | 3 | Elective Course |
| INSO 6998 | | Master's Project or |
| ELECTIVE | 3 | Elective Course |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| INSO 6998 | | Master's Project or |
| ELECTIVE | 3 | Elective Course |
| | 3 | |

**Total Credits 30**

Elective courses must be divided in 9-15 credits in electives within the area of specialization and 6 credits in electives out of the area of specialization.

**Courses**

| Number | Credits | Course |
|---|---|---|
| INSO 6005 | 3 | Software Engineering Principles |
| INSO 6006 | 3 | Database Systems Engineering |
| INSO 6007 | 3 | Secure Software Systems |
| INSO 6010 | 3 | Development and Operations |
| INSO 6015 | 3 | Machine Learning and Operations |
| INSO 6030 | 3 | Web and Mobile Application Engineering |
| INSO 6040 | 3 | Health Related Application Engineering |
| INSO 6050 | 3 | Software Engineering for Edge Systems |
| INSO 6070 | 3 | Software-Defined Networks Engineering |
| INSO 6080 | 3 | Deep Learning Engineering |
| INSO 6998 | 3-6 | Master's Project |
| INSO 6999 | 6 | Master's Thesis |
| INSO 8995 | 3 | Advanced Topics |
| INSO 8999 | 18 | Doctoral Dissertation Research |

**DOCTORAL PROGRAM IN SOFTWARE ENGINEERING**

**Admission Requirements:**

1. Students without a MS/ME in SWE will have the same requirements as for the MS/ME program,
2. Students with a MS/ME in SWE are considered to have no deficiencies, and have an academic background appropriate for the PhD in SWE.
3. The Department of Computer Science and Engineering Graduate Committee reviews all applications that the UPRM Office of Graduate Studies has judged complete and consistent with the general criteria established for graduate

studies at UPRM. For these students, the Graduate Committee evaluates:

- The applicant's coursework, and academic history;
- The quality of the applicant's essay;
- The contents of the letters of recommendation in support of the applicant;
- The potential of the applicant for succeeding in the program within a reasonable period of time.

**Admission with Deficiencies**

As with the MS/ME programs in Software Engineering, the PhD program uses the same policies regarding admision to the program with deficiencies.

**Graduation Requirements:**

The PhD degree has a total of fifty-four (54) credits for students with a bachelor degree, and should be completed in four (4) years upon completion of a bachelor degree. For students with the MS/ME degree in SWE, the requirements may be completed in two (2) years upon completion of the MS/ME degree.

These are distributed as follows:

- 9 credits in core courses (Software Engineering Principles, Database Systems Engineering, Secure Software Systems)
- 15 credits in electives within the area of specialization
- 6 credits in electives out of the area of specialization
- 3 credits in Doctoral Seminar
- 3 credits in Advanced Topics
- 18 credits in Doctoral Dissertation

In addition, the student must pass the qualifying and comprehensive examinations and have a successful dissertation defense.

**PROGRAM OF STUDY**

**SOFTWARE ENGINEERING**
**DOCTOR OF PHILOSOPHY (PHD)**
**CURRICULUM**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| INSO 6005 | 3 | Core Course |
| INSO 6006 | 3 | Core Course |
| ELECTIVE | 3 | Elective Course |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| INSO 6007 | 3 | Core Course |
| ELECTIVE | 3 | Elective Course |
| ELECTIVE | 3 | Elective Course |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| ELECTIVE | 3 | Elective Course |
| ELECTIVE | 3 | Elective Course |
| INSO 8996 | 3 | Doctoral Seminar |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| INSO 8995 | 3 | Advanced Topics |
| ELECTIVE | 3 | Elective Course |
| ELECTIVE | 3 | Elective Course |
| | 9 | |

**THIRD YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| INSO 8999 | 6 | Doctoral Dissertation Research |
| | 6 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| INSO 8999 | 6 | Doctoral Dissertation Research |
| | 6 | |

**FOURTH YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| INSO 8999 | 3 | Doctoral Dissertation Research |
| | 3 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| INSO 8999 | 3 | Doctoral Dissertation Research |
| | 3 | |

**Total Credits 54**

Elective courses must be divided in 15 credits in electives within the area of specialization and 6 credits in electives out of the area of specialization.

## DOCTORAL PROGRAM IN COMPUTING AND INFORMATION SCIENCES AND ENGINEERING

The Department of Computer Science and Engineering coordinates the interdisciplinary doctoral program in Computing and Information Sciences and Engineering (CISE). Refer to the *Interdisciplinary Programs* section of this bulletin for information. Detailed program information is available at https://www.uprm.edu/cse/phd-computing-and-information-sciences-and-engineering-cise/.

## CONTACT INFORMATION

Department of Computer Science and Engineering
Graduate Studies
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**Phone**: 1-787-832-4040 ext. 5864, 5217
**Website:** https://cse.uprm.edu.

## COMPUTER SCIENCE AND ENGINEERING FACULTY

A list of professors who engage in graduate activities in the Department follows, including the highest earned degree, date, and institution granting the degree. Research and teaching interests are also included.

**EMMANUEL ARZUAGA**, *Professor*, Ph.D. 2012, Northeastern University. Research and Teaching interests: Virtualization, Cloud Computing, Pattern Recognition, Remote Sensing, Computer Vision.

**VENKATARAMANI KUMAR,** *Assistant Professor,* Ph.D. 2024, University of Dayton. Research and Teaching interests: Wireless Communications, Computer Networks, Wireless Security, Cryptography, Algorithm Design.

**KEJIE LU**, *Professor*, Ph.D. 2004, University of Texas at Dallas. Research and Teaching interests: Computer and Communications Networks: Architecture and Protocol Design, Performance Evaluation, Network Security, Wireless Communications: Space-time Coding, Channel Capacity.

**WILFREDO LUGO**, *Assistant Professor*, Ph.D. 2016, University of Puerto Rico Mayaguez. Research and Teaching interests: Edge Computing, Edge ML, Computer Vision, Data Science, Virtual Machines.

**JUAN F. MEDINA**, *Assistant Professor*, Ph.D. 2023, Polytechnic University of Madrid. Research and Teaching interests: Decision-Making and Human Factors in Autonomous Vehicles, Embedded Systems, and Mobile Robotics.

**JUAN F. PATARROYO**, *Assistant Professor*, Ph.D. 2019, University of Puerto Rico Mayaguez. Research and Teaching Interests: Embedded Systems, Robotics, Real-time Simulation, Automatic Control, Microgrid and Smart Grid Systems.

**ARTURO PONCE-ROMÁN,** *Professor,* Ph.D., 2015, Nova Southeastern University. Teaching and Research interests: Information Assurance, Human Computer Interaction

**WILSON RIVERA-GALLEGO**, *Professor*, Ph.D. 2000, Mississippi State University. Teaching and Research interests: Parallel and Distributed Computing, Big Data Analysis, Cybersecurity.

**MANUEL RODRÍGUEZ-MARTÍNEZ**, *Professor*, Ph.D. 2001, University of Maryland. Teaching and Research interests: Database Management Systems, Database Middleware Technology, WWW and Databases, Mobile Computing and Networking

**MARKO SCHUTZ,** *Professor*, Ph.D. 2001, Goethe University, Frankfurt, Germany. Teaching and Research interests: The intersection of operating systems, free/opensource software, and software development practices. Programming languages and their semantics, compiler technology, static semantic analysis, specification, verification, software quality assurance, software development practice.

**HEIDY SIERRA**, *Professor*, Ph.D. 2010, Northeastern University. Teaching and Research interests: Biomedical Imaging, Signal Processing, Computational Optics, Deep Learning.

**BIENVENIDO VÉLEZ,** *Professor*, Ph.D. 1999, Massachusetts Institute of Technology. Teaching and Research interests: Bioinformatics, Software Engineering and Quality, Web Applications.

# DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

**General Information**

The Department of Electrical and Computer Engineering offers graduate degrees (masters and doctorate) in electrical and computer engineering, with emphasis in the areas of Power and Energy Engineering, Telecommunications and Remote Sensing, and Electronics and Embedded Systems. In addition, the Department is involved in the multidisciplinary doctoral program in Computing and Information Sciences and Engineering (CISE) offered jointly by the School of Engineering, and the School of Arts and Sciences.

The ECE graduate program involves 25 faculty and 14 research laboratories, groups and centers, with grants from different federal agencies and collaborative projects with industry, that provide support to qualified graduate students. Detailed information on the ECE graduate programs can be found at https://ece.uprm.edu/graduates-programs/.

**Degrees offered:**

1. Master of Engineering (ME) – The master of engineering is a professional degree that comprises advanced coursework in electrical and computer engineering. The ME program has two options, Plan II, where students take 24 to 27 credits in courses, and work on an engineering project (3-6 credits), and Plan III, where students take 30 credits in courses. The department offers ME programs in Electrical Engineering (MEEE) and in Computer Engineering (MECpE).
2. Master of Science (MS) – The master of science degree comprises advanced coursework in electrical and computer engineering (24 credits) and requires the preparation of an original thesis (6 credits). The department offers MS programs in Electrical Engineering (MSEE) and in Computer Engineering (MSCpE)
3. Doctor of Philosophy (PhD) – This is the terminal degree for those seeking a technical or research career in electrical engineering. The PhD program in Electrical Engineering requires the completion of 36 course credits above the BS, completion of the doctoral seminar (1 credit), the preparation of an original dissertation (12 credits), passing the qualifying and comprehensive examinations, and a successful dissertation defense.

## MASTER OF SCIENCE AND MASTER OF ENGINEERING IN ELECTRICAL ENGINEERING

**Admission Requirements:**

1. A bachelor's degree in Electrical Engineering, Computer Engineering or their equivalents from an accredited institution of higher learning is required for the ECE graduate programs. Applicants with a degree in other engineering fields, science, mathematics, or in related areas, may be considered for admission.
2. A general grade point average of 3.0/4.0. Admission is possible for applicants with lower GPAs, but that have previous industrial or research experience.
3. A minimum mastery of both English and Spanish skills to understand technical literature and to write technical documents.
4. Three letters of recommendation from qualified referees.
5. A statement of purpose describing the applicant's goals and interests.

**Graduation Requirements:**

Students pursuing the degree of Master of Science (Plan I) or Master of Engineering (Plan II or III) in Electrical Engineering may specialize in the areas of (i) electronics and embedded systems, (ii) power and energy systems, and (iii) telecommunications and remote sensing.

For students enrolled in M.S. (Plan I) the program requires a minimum of 30 credits distributed as follows:

- 18 credits in core courses and technical electives in the selected area of specialization.
- 6 credits in electives outside the area of specialization.
- 6 credits of graduate thesis.

The Master of Engineering with project option (Plan II) requires a minimum of 30 credits distributed as follows:

- 18-21 credits in core courses and technical electives in the selected area of specialization.
- 6 credits in electives outside the area of specialization.
- 3-6 credits of graduate project.

The Master of Engineering with courses option (Plan III) requires a minimum of 30 credits distributed as follows:

- 24 credits in core courses and technical electives in the selected area of specialization.
- 6 credits in electives outside the area of specialization.

No more than 9 credits in advanced undergraduate level (5000 level) courses can be used to meet the degree requirements for any of the three plans.

## ELECTRICAL ENGINEERING

Student may specialize in: Electronics Engineering, Telecommunications and Remote Sensing, or Power and Energy Engineering.

### MASTER OF SCIENCE IN ELECTRICAL ENGINEERING (Plan I)

Students enrolled in MS (Plan I), must approve 30 credits distributed as follows:

- 18 credits in **core courses** and **technical electives in the area of specialization**
- 6 credits in electives outside the area of specialization
- 6 credits of graduate thesis

### MASTER OF ENGINEERING IN ELECTRICAL ENGINEERING (Plan II)

The Master of Engineering with project option (Plan II) requires a minimum of 30 credits distributed as follows:

- 18-21 credits in **core courses** and **technical electives** in the area of specialization
- 6 credits in electives outside the area of specialization
- 3-6 credits of graduate project

### MASTER OF ENGINEERING IN ELECTRICAL ENGINEERING (Plan III)

The Master of Engineering with project option (Plan III) requires a minimum of 30 credits distributed as follows:

- 24 credits in **core courses** and **technical electives** in in the area of specialization
- 6 credits in electives outside the area of specialization

### Courses Distributed by Area of Specialization

#### Analog Electronics and Embedded Systems Engineering

Core courses (6 credits): choose two courses in blue, at least one at 6000 level or above. Technical electives: choose as needed from the list below (12 credits for MS, 12-15 credits ME Plan II, 18 credits ME Plan III) Out of area electives: 6 credits on courses not on the list.

| Number | Credits | Course |
|---|---|---|
| INEL 8295 | 3 | Advanced Topics in Electronics |
| INEL 8296 | 3 | Advanced Topics in Computer Engineering |
| INEL 6009 | 3 | Computer Systems Architecture |
| INEL 6079 | 3 | Advanced IC Design Techniques |
| INEL 6080 | 3 | VLSI Systems Design |
| INEL 6615 | 3 | Active Microwave Circuits |
| INEL 6085 | 3 | Analysis and Design of Power Semiconductor Circuits |
| ICOM 5026 | 3 | Computer Networks |
| INEL 5206 | 3 | Digital Systems Design |
| INEL 5516 | 3 | Automation and Robotics |
| INEL 5208 | 3 | Principles of Biomedical Instrumentation |
| INEL 5265 | 3 | Analog Integrated Circuit Design |
| INEL 5205 | 3 | Instrumentation |
| INEL 5626 | 3 | Microwave Engineering II |
| INEL 5417 | 3 | Power Electronics Applied to Renewable Energy |
| INEL 5207 | 3 | Design with OpAmps and Analog ICs |

#### Telecommunications and Remote Sensing

Core courses (6 credits): choose one course of each of the 2 groups (DSP, RFS) at least one at 6000 level or above. Technical electives: choose as needed from the list below (12 credits for MS, 12-15 credits

ME Plan II, 18 credits ME Plan III) Out of area electives: 6 credits on courses not on the list.

| Number | Credits | Course |
|---|---|---|
| INEL 8395 | 3 | Advanced Topics in Digital Signal Processing |
| INEL 8396 | 3 | Advanced Topics in Communications |
| INEL 8695 | 3 | Advanced Topics in Applied Electromagnetics |
| INEL 6076 | 3 | Adaptive and Optimal Signal Processing |
| INEL 6078 | 3 | Estimation, Detection and Stochastic Processes |
| INEL 6049 | 3 | Multidimensional Signal Processing |
| INEL 6088 | 3 | Computer Vision |
| INEL 6015 | 3 | Neural Networks |
| INEL 6601 | 3 | Advanced Electromagnetics |
| INEL 6668 | 3 | Microwave Antenna Engineering |
| INEL 6669 | 3 | Microwave Remote Sensing |
| INEL 6615 | 3 | Active Microwave Circuits |
| INEL 6606 | 3 | Introduction to Radar Systems |
| INEL 5309 | 3 | Introduction to DSP |
| INEL 5046 | 3 | Pattern Recognition |
| INEL 5327 | 3 | Image Processing |
| INEL 5315 | 3 | Communication Theory II |
| INEL 5505 | 3 | Linear Systems Analysis |
| INEL 5307 | 3 | Optical Communications |
| INEL 5605 | 3 | Antenna Theory and Design |
| INEL 5627 | 3 | Antenna Theory and Design II |
| INEL 5606 | 3 | Microwave Engineering |
| INEL 5626 | 3 | Microwave Engineering II |
| INEL 5607 | 3 | Introduction to Radar Meteorology |
| INEL 5616 | 3 | Wireless Communications |

**Power and Energy Systems Engineering**

Core courses (6 credits): choose one course in red or blue at 6000 level or above. Technical electives: choose as needed from the list below (12 credits for MS, 12-15 credits ME Plan II, 18 credits ME Plan III) Out of area electives: 6 credits on courses not on the list.

| Number | Credits | Course |
|---|---|---|
| INEL 8495 | 3 | Advanced Topics in Power Engineering |
| INEL 8496 | 3 | Advanced Topics in Power Electronics |
| INEL 8595 | 3 | Advanced Topics in Control Systems |
| INEL 6027 | 3 | Power System Dynamics and Control |
| INEL 6028 | 3 | Economic Operation of Power Systems |
| INEL 6085 | 3 | Analysis and Design of Power Semiconductor Circuits |
| INEL 6025 | 3 | Surge Phenomena |
| INEL 6096 | 3 | Power Quality |
| INEL 6058 | 3 | High Frequency Power Converters |
| INEL 6000 | 3 | Introduction to Nonlinear Control Systems |
| INEL 6001 | 3 | Feedback Control Systems I |
| INEL 5415 | 3 | Power System Protection Design |
| INEL 5406 | 3 | Transmission and Distribution |
| INEL 5407 | 3 | Computer Aided Power System Design |
| INEL5408 | 3 | Electrical Motors Control |
| INEL 5417 | 3 | Power Electronics Applied to Renewable Energy |
| ICOM 5217 | 3 | Microprocessor Interfacing |
| INEL 5508 | 3 | Digital Control Systems |
| INEL 5505 | 3 | Linear Systems |

**MASTER OF SCIENCE AND MASTER OF ENGINEERING IN COMPUTER ENGINEERING**

**Admission Requirements:**

1. A bachelor's degree in Electrical Engineering, Computer Engineering or their equivalents from an accredited institution of higher learning is required for the ECE graduate programs. Applicants with a degree in other engineering fields, science, mathematics, or in related areas, may be considered for admission.
2. A general grade point average of 3.0/4.0. Admission is possible for applicants with lower GPAs, but that have previous industrial or research experience.
3. A minimum mastery of both English and Spanish skills to understand technical literature and to write technical documents.
4. Three letters of recommendation from qualified referees.
5. A statement of purpose describing the applicant's goals and interests.

**Graduation Requirements:**

The Master of Science program (Plan I) requires a minimum of 30 credits distributed as follows:

- 18 credits in core courses and technical electives in computer engineering (at least 12 credits at 6000 level or above).
- 6 credits in electives outside the computer engineering areas of emphasis.
- 6 credits of graduate thesis.

The Master of Engineering with project option (Plan II) requires a minimum of 30 credits distributed as follows:

- 18-21 credits in core courses and technical electives in computer engineering (at least 12 credits at 6000 level or above).
- 6 credits in electives outside the computer engineering areas of emphasis.
- 3-6 credits of graduate project.

The Master of Engineering with courses option (Plan III) requires a minimum of 30 credits distributed as follows:

- 24 credits in core courses and technical electives computer engineering (at least 12 credits at 6000 level or above).
- 6 credits in electives outside the computer engineering areas of emphasis.

No more than 9 credits in advanced undergraduate level (5000 level) courses can be used to meet the degree requirements for any of the three plans.

## MASTER OF SCIENCE IN COMPUTER ENGINEERING (Plan I)

Student may specialize in: Computing Systems (CS), Hardware and Embedded Systems (HES), or Digital Signal Processing (DSP).

Students enrolled in MS (Plan I), must approve 30 credits distributed as follows:

- 18 credits in **core courses** and **technical electives**
- 6 credits in electives outside computer engineering
- 6 credits graduate thesis

**Core Courses**: choose one course from at least 2 of the 3 specialization areas at 6000 level or above (6 credits)

**Technical Electives**. 12 credits to be chosen as needed

## MASTER OF ENGINEERING IN COMPUTER ENGINEERING (Plan II)

The Master of Engineering with project option (Plan II) requires a minimum of 30 credits distributed as follows:

- 18-21 credits in **core courses** and **technical electives** in computer engineering
- 6 credits in electives outside computer engineering
- 3-6 credits of graduate project

## MASTER OF ENGINEERING IN COMPUTER ENGINEERING (Plan III)

The Master of Engineering with project option (Plan III) requires a minimum of 30 credits distributed as follows:

- 24 credits in **core courses** and **technical electives** in computer engineering
- 6 credits in electives outside computer engineering

Note: No more than 9 credits in advanced undergraduate level (5000 level) courses can be used to meet the degree requirements for any of the three plans.

**Courses**

| Number | Credits | Course |
|---|---|---|
| INEL 8296 | 3 | Advanced Topics in Computer Engineering (grouping depends on the topic) |
| ICOM 6115 | 3 | Special Topics in Computer Engineering (grouping depends on the topic) |
| INEL 6078 | 3 | Estimation, Detection and Stochastic Processes |
| INEL 6049 | 3 | Multidimensional Signal Processing |
| INEL 6088 | 3 | Computer Vision |
| INEL 6080 | 3 | VLSI Systems Design |
| INEL 6009 | 3 | Computer Systems Architecture |
| INEL6079 | 3 | Advanced Integrated Circuit Design Techniques |
| ICOM 6025 | 3 | High Performance Computing |
| CIIC 6005 | 3 | Computing Foundations |
| ICOM 6087 | 3 | Artificial Intelligence: Techniques and Applications |
| ICOM 6095 | 3 | Human Computer Interaction |
| INEL 6015 | 3 | Neural Networks |
| INEL 5309 | 3 | Introduction to DSP |

| | | |
|---|---|---|
| INEL 5327 | 3 | Image Processing |
| INEL 5315 | 3 | Communication Theory II |
| INEL5307 | 3 | Optical Communications |
| INEL 5046 | 3 | Pattern Recognition |
| INEL 5206 | 3 | Digital Systems Design |
| INEL 5516 | 3 | Automation and Robotics |
| ICOM 5007 | 3 | Operating Systems |
| ICOM 5015 | 3 | Artificial Intelligence |
| ICOM 5016 | 3 | Database Systems |
| ICOM 5017 | 3 | Operating System and Network Administration and Security |
| ICOM 5018 | 3 | Network Security and Cryptography |
| ICOM 5026 | 3 | Computer Networks |

## DOCTORAL PROGRAM IN ELECTRICAL ENGINEERING

**Admission Requirements:**

1. A bachelor's or master's degree in Electrical Engineering, Computer Engineering or their equivalents from an accredited institution of higher learning. Applicants with a bachelor's or master's degree in other engineering fields, science, mathematics, or in related areas, may be considered for admission. Depending on the applicant's academic background, admission may be granted with deficiency courses, or a master's degree in Electrical or Computer Engineering may be recommended before admission into the doctoral program.
2. A general grade point average of 3.3/4.0 if the applicant holds a BS degree, or 3.5/4.0 if the applicant holds an MS or higher degree. Admission is possible for applicants with lower GPAs, but that have previous industrial or research experience.
3. A minimum mastery of both English and Spanish skills to understand technical literature and to write technical documents.
4. Three letters of recommendation from qualified referees.
5. A statement of purpose describing the applicant's goals and interests.

**Graduation Requirements:**

Students pursuing the degree of Doctor of Philosophy in Electrical Engineering may specialize in the areas of (i) electronics and embedded systems, (ii) power and energy systems, (iii) telecommunications and remote sensing, and (iv) computer engineering.

The program requires a minimum of 49 credits, above a bachelor's degree, distributed as follows:

- 24 credits in core courses and technical electives in the selected area of emphasis (at least 6 credits at 8000 level).
- 6 credits in electives outside the area of emphasis.
- 6 credits in advanced math courses (5000 level or above, at least 3 credits at 6000 level or above)
- 1 credit of doctoral seminar
- 12 credits of graduate thesis.

In addition, the student must pass the qualifying and comprehensive examinations, and have a successful dissertation defense.

## PhD PROGRAM IN ELECTRICAL ENGINEERING

The doctorate program in electrical engineering has emphasis areas in Power and Energy Engineering, Telecommunications and Remote Sensing, Electronics Engineering, and Computer Engineering. The program requires a minimum of 49 credits beyond the BS, distributed as follows:

- 24 credits in core courses and technical electives in the area of specialization, including 6 credits at 8000 level.
- 6 credits in electives outside the area of specialization
- 6 credits in advanced math courses (at least 3 credits should be 6000 level or above)
- 1 credit of doctoral seminar (INEL 8998)
- 12 credits of graduate tesis (INEL 8999)

In addition, the students must pass a qualifying exam, a comprehensive exam, and their dissertation defense.

## AREAS OF EMPHASIS

### Analog Electronics and Embedded Systems Engineering

Core courses (18 credits): choose two courses in blue, at least one at 6000 level, (6 credits), two courses at 8000 level (6 credits) and two courses in advanced math (5000 level and above, at least one

at 6000 level or above, 6 credits). Technical electives (12 credits): choose as needed from the list below. Out of area electives (6 credits): two courses not on the list.

| Number | Credits | Course |
|---|---|---|
| INEL 8295 | 3 | Advanced Topics in Electronics |
| INEL 8296 | 3 | Advanced Topics in Computer Engineering |
| INEL 6009 | 3 | Computer Systems Architecture |
| INEL 6079 | 3 | Advanced IC Design Techniques |
| INEL 6080 | 3 | VLSI Systems Design |
| INEL 6615 | 3 | Active Microwave Circuits |
| INEL 6085 | 3 | Analysis and Design of Power Semiconductor Circuits |
| ICOM 5026 | 3 | Computer Networks |
| INEL 5205 | 3 | Instrumentation |
| INEL 5206 | 3 | Digital Systems Design |
| INEL 5207 | 3 | Design with OpAmps and Analog ICs |
| INEL 5208 | 3 | Principles of Biomedical Instrumentation |
| INEL 5265 | 3 | Analog Integrated Circuit Design |
| INEL 5417 | 3 | Power Electronics Applied to Renewable Energy |
| INEL 5516 | 3 | Automation and Robotics |
| INEL 5626 | 3 | Microwave Engineering II |

**Power and Energy Systems Engineering**

Core courses (21 credits): choose two courses in red or black at least one at 6000 level, (9 credits), two courses at 8000 level (6 credits) and two courses in advanced math (5000 level and above, at least one at 6000 level or above, 6 credits). Technical electives (9 credits): choose as needed from the list below. Out of area electives (6 credits): two courses not on the list.

| Number | Credits | Course |
|---|---|---|
| INEL 8495 | 3 | Advanced Topics in Power Engineering |
| INEL 8496 | 3 | Advanced Topics in Power Electronics |
| INEL 8595 | 3 | Advanced Topics in Control Systems |
| INEL 6027 | 3 | Power System Dynamics and Control |
| INEL 6028 | 3 | Economic Operation of Power Systems |
| INEL 6085 | 3 | Analysis and Design of Power Semiconductor Circuits |
| INEL 6025 | 3 | Advanced Energy Conversion |
| INEL 6077 | 3 | Surge Phenomena |
| INEL 6096 | 3 | Power Quality |
| INEL 6058 | 3 | High Frequency Power Converters |
| INEL 6025 | 3 | Advanced Power Electronics |
| INEL 6000 | 3 | Introduction to Nonlinear Control Systems |
| INEL 6001 | 3 | Feedback Control Systems I |
| INEL 5415 | 3 | Power System Protection Design |
| INEL 5406 | 3 | Transmission and Distribution |
| INEL 5407 | 3 | Computer Aided Power System Design |
| INEL 5408 | 3 | Electrical Motors Control |
| INEL 5417 | 3 | Power Electronics Applied to Renewable Energy |
| ICOM 5217 | 3 | Microprocessor Interfacing |
| INEL 5508 | 3 | Digital Control Systems |
| INEL 5505 | 3 | Linear Systems Analysis |

**Telecommunications and Remote Sensing Engineering**

Core courses (18 credits): choose one course of each of the 2 groups (DSP, RFS), at least one at 6000 level (6 credits), two courses at 8000 level (6 credits) and two courses in advanced math (5000 level and above, at least one at 6000 level or above, 6 credits). Technical electives (12 credits): choose as needed from the list below. Out of area electives (6 credits): two courses not on the list.

| Number | Credits | Course |
|---|---|---|
| INEL 8395 | 3 | Advanced Topics in Digital Signal Processing |
| INEL 8396 | 3 | Advanced Topics in Digital Signal Processing |
| INEL 8695 | 3 | Advanced Topics in Electromagnetics |
| INEL 6007 | 3 | Introduction to Remote Sensing |
| INEL 6076 | 3 | Adaptive and Optimal Signal Processing |
| INEL 6078 | 3 | Estimation, Detection and Stochastic Processes |
| INEL 6049 | 3 | Multidimensional Signal Processing |
| INEL 6088 | 3 | Computer Vision |
| INEL 6015 | 3 | Neural Networks |
| INEL 6601 | 3 | Advanced Electromagnetics |

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|---|---|---|
| INEL 6668 | 3 | Microwave Antenna Engineering |
| INEL 6669 | 3 | Microwave Remote Sensing |
| INEL 6615 | 3 | Active Microwave Circuits |
| INEL 6606 | 3 | Introduction to Radar Systems |
| INEL 5309 | 3 | Introduction to DSP |
| INEL 5046 | 3 | Pattern Recognition |
| INEL 5327 | 3 | Image Processing |
| INEL 5315 | 3 | Communication Theory II |
| INEL 5505 | 3 | Linear Systems Analysis |
| INEL 5307 | 3 | Optical Communications |
| INEL 5605 | 3 | Antenna Theory and Design |
| INEL 5627 | 3 | Antenna Theory and Design II |
| INEL 5606 | 3 | Microwave Engineering |
| INEL 5626 | 3 | Microwave Engineering II |
| INEL 5607 | 3 | Introduction to Radar Meteorology |
| INEL 5616 | 3 | Wireless Communications |

**Computer Engineering**

Core courses: choose one course of each of the 3 groups (DSP, HES, CS), at least 2 at 6000 level (9 credits), two courses at 8000 level (6 credits) and two courses in advanced math (5000 level and above, at least one at 6000 level or above, 6 credits). Technical electives (9 credits): choose as needed from the list below. Out of area electives (6 credits): two courses not on the list.

| Number | Credits | Course |
|---|---|---|
| INEL 8296 | 3 | Advanced Topics in Computer Engineering |
| INEL 6078 | 3 | Estimation, Detection and Stochastic Processes |
| INEL 6049 | 3 | Multidimensional Signal Processing |
| INEL 6088 | 3 | Computer Vision |
| INEL 6080 | 3 | VLSI Systems Design |
| INEL 6009 | 3 | Computer Systems Architecture |
| INEL 6079 | 3 | Advanced Integrated Circuit Design Techniques |
| ICOM 6025 | 3 | High Performance Computing |
| CIIC 6005 | 3 | Computing Foundations |
| ICOM 6087 | 3 | Artificial Intelligence: Techniques and Applications |
| ICOM 6095 | 3 | Human Computer Interaction |
| INEL 6015 | 3 | Neural Networks |
| INEL 5309 | 3 | Introduction to DSP |
| INEL 5327 | 3 | Image Processing |
| INEL 5315 | 3 | Communication Theory II |
| INEL 5307 | 3 | Optical Communications |
| INEL 5046 | 3 | Pattern Recognition |
| INEL 5206 | 3 | Digital Systems Design |
| INEL 5516 | 3 | Automation and Robotics |
| ICOM 5007 | 3 | Operating Systems |
| ICOM 5015 | 3 | Artificial Intelligence |
| ICOM 5016 | 3 | Database Systems |
| ICOM 5017 | 3 | Operating System and Network Administration and Security |
| ICOM 5018 | 3 | Network Security and Cryptography |
| ICOM 5026 | 3 | Computer Networks |

## DOCTORAL PROGRAM IN COMPUTING AND INFORMATION SCIENCES AND ENGINEERING

The Department of Electrical and Computer Engineering participates in the interdisciplinary doctoral program in Computing and Information Sciences and Engineering. Refer to the *Interdisciplinary Programs* section of this bulletin for information. Detailed program information is available at http://phd.cise.uprm.edu.

**Research Infrastructure**

The ECE Department has over 8600 square foot of research laboratories. There are 6 shared use laboratories (graduate and undergraduate) and 11 research laboratories. The laboratories include state of the art computer network, instrumentation, and development and prototyping facilities. ECE facilities are located in the Stefani Building and at the UPRM Research and Development Center. Detailed information about the department laboratories can be obtained at the departmental web site, https://ece.uprm.edu/laboratories/.

**Website:** http://www.ece.uprm.edu

## ELECTRICAL AND COMPUTER ENGINEERING FACULTY

A list of professors who engage in graduate activities in the Department follows, including the highest earned degree, date, and institution granting the degree. Research and teaching interests are also included.

**FABIO ANDRADE-RENGIFO**, *Assistant Professor,* PhD, 2013, Universitat Politécnica de Catalunya. Research and Teaching interests: Microgrids, Renewable Energy Sources, Power Electronics.

**ERICK E. APONTE BEZARES**, *Associate Professor,* Ph.D. 2005, Rensselaer Polytechnic Institute. Research and Teaching interests: Distributed Generation, Islanding, DG Systems Dynamics, Optimization Techniques.

**EMMANUEL ARZUAGA**, *Assistant Professor*, Ph.D., 2012, Northeastern University. Research and Teaching Interests: Cybersecurity, Cloud Computing.

**MARCEL CASTRO-SITIRICHE**, *Associate Professor*, Ph.D., 2007, Howard University. Research interests: Appropriate Technology, Electric Drive Systems, Power Electronics, Intelligent Control, Education, Philosophy of Technology.

**JOSÉ R. CEDEÑO-MALDONADO**, *Professor*, Ph.D., 2002, Ohio State University. Research and Teaching interest: Power System Operation and Control, Optimization, Evolutionary Computation Techniques.

**ISIDORO COUVERTIER**, *Professor*, Ph.D., 1996, Louisiana State University. Research and Teaching interests: Computer Networks, Programming Languages, Operating Systems, Application Development.

**GLADYS O. DUCOUDRAY**, *Professor*, Ph.D., 2003, New Mexico State University. Research and Teaching interests: Low-Voltage low-power analog circuit design, Built-in self-test schemes for mixed signal circuits, Analog filters.

**SHAWN D. HUNT**, *Professor*, Ph.D., 1992, Michigan State University. Research and Teaching interests: Digital Signal Processing, Non-linear Dynamic Systems.

**AGUSTÍN A. IRIZARRY-RIVERA**, *Professor*, Ph.D., 1996, Iowa State University. Research and Teaching interests: Power Systems Dynamics, Control and Operation.

**MANUEL JIMÉNEZ-CEDEÑO**, *Professor*, Ph.D., 1999, Michigan State University. Research and Teaching interests: Low-Power VLSI Design, CAD Tools for VLSI Layout Design, Embedded Systems/Rapid.

**EDUARDO J. JUAN-GARCÍA**, *Professor*, Ph.D., 2001, Purdue University. Research and Teaching interests: Biomedical Acoustics, Medical Instrumentation.

**LEYDA LEÓN-COLÓN**, *Associate Professor*, Ph.D., 2010, Colorado State University. Research and Teaching interests: Radar Meteorology, Attenuation Correction, Applied Electromagnetic, Microwave Remote Sensing, Microwave Technology, Radar Systems, Atmospheric Sciences, Precipitation Microphysics.

**ADRIANA C. LUNA HERNÁNDEZ,** *Professor*, Ph.D., 2017, Aalborg University-Denmark.

**VIDYA MANIAN**, *Professor*, Ph.D., 2004, University of Puerto Rico, Mayagüez. Research and Teaching interests: Image Processing, Hyperspectral Image Classification, Computer Vision, Pattern Recognition and Algorithm Analysis.

**RAFAEL MEDINA-SÁNCHEZ**, *Associate Professor*, Ph.D., 2013, University of Massachusetts. Research and Teaching interests: Phased Array Antennas, Microwave Systems.

**EFRAÍN O'NEILL-CARRILLO**, *Professor*, Ph.D., 1999, Arizona State University. Research and Teaching interests: Power Quality, Distribution Systems, Power Electronics, Chaotic Dynamics, Load Modeling.

**LIONEL R. ORAMA EXCLUSA**, *Professor,* Ph.D. 1997, Rensselaer Polytechnic Institute. Research and Teaching interests: Electrical discharges in vacuum and gases, vacuum switching technology, fields stress analysis in electric power devices, power systems transients, alternative energy sources, distributed generation, power systems protection.

**EDUARDO ORTIZ**, *Professor*, Ph.D., 2006, Michigan State University. Research and Teaching interests: Photovoltaic Systems, Mathematical Modeling of Renewable Energies, Optimization, Power Electronics, Resonators, Nonlinear Control, Electric Drives.

**DOMINGO A. RODRÍGUEZ-RODRÍGUEZ**, *Professor*, Ph.D., 1988, City University of New York. Research and Teaching interests: Information Theory, Computational Signal Processing.

**RAFAEL A. RODRÍGUEZ-SOLÍS**, *Professor*, Ph.D., 1997, The Pennsylvania State University. Research and Teaching interests: Broadband and Tunable Microwave and Millimeter-wave Antennas and Circuits, Phased Array Antennas.

**NAYDA G. SANTIAGO-SANTIAGO**, *Professor*, Ph.D., 2003, Michigan State University. Teaching and Research interests: Performance Evaluation Methods and Instrumentation, HPC systems, and Parallel Processing.

**GUILLERMO J. SERRANO-RIVERA**, *Professor*, Ph.D., Georgia Institute of Technology, 2007. Research and Teaching interests: Analogic Integrated Circuits.

**MANUEL TOLEDO**, *Associate Professor*, Ph.D., 1995, Boston University. Research and Teaching interests: Machine Vision, Instrumentation, Embedded Systems, Semiconductor Process Control.

**RAÚL TORRES-MUNIZ**, *Professor*, Ph.D., 1998, University of Virginia. Research and Teaching interests: Neural Networks, Robotics, Intelligent Systems, Computer Vision, and Manufacturing.

# DEPARTMENT OF INDUSTRIAL ENGINEERING

The Department of Industrial Engineering offers two graduate programs: a Master of Science in Industrial Engineering and a Master of Engineering in Industrial Engineering.

## MISSION

To develop industrial engineering leaders known for their commitment, integrity, and respect and to serve the Puerto Rican and international communities with excellence by:

- providing an educational experience that nurtures industrial engineering professionals known for their solid technical capability, critical thinking skills, and social responsibility through a rigorous educational experience
- creating knowledge by performing basic and applied research
- stimulating and influencing the efficiency of governmental processes and services;
- supporting and improving manufacturing and service industries

## VISION

Strengthen our position as the preferred alternative for the Puerto Rican community and become recognized internationally for forming Industrial Engineering professionals of global impact. We aim to be a model of excellence in education, research, and administration.

## SLOGAN

Industrial Engineers make complex decisions simple.

**Webpage:** https://www.uprm.edu/inin/

## EDUCATIONAL OBJECTIVES

The graduate programs in industrial engineering at the University of Puerto Rico at Mayagüez provide a state-of-the-art curriculum committed to:

- **expand and deepen** students' *intellectual capabilities* and u*nderstanding* in the design, implementation, analysis, and improvement of industrial and service processes.
- **enable** students to pursue *advanced degrees*, attain *leadership roles*, and facilitate *career advancement.*
- **train** the *next-generation of industrial engineering professionals* with the capabilities to solve complex problems affecting our communities.
- **master** students' *communication skills* through dissemination of their work in written and oral form.

All graduate programs strive for these general objectives, nonetheless, each program has its unique features, which are listed below.

**MSIE Program: Specific Objectives**
The specific objectives of the MSIE program are to:

- **ignite** critical thinking skills by creating knowledge through fundamental and applied research.
- **seek** advanced degrees and academic careers.

**MEIE Program: Specific Objectives**
The MEIE program requires only coursework; however, it is flexible enough to accommodate an applied project as part of the degree requirements.

The MEIE program aims to:

- **deepen** students' understanding of current knowledge through the exploration of various IE disciplines.

**Graduation Requirements**

The **Master of Science in Industrial Engineering** degree with thesis requires a minimum of 30 credits of which a maximum of 9 credits may be at level 5000.

- Six (6) credits in thesis based on original research
- Nine (9) credits in core courses – ININ 6005, ININ 6019, ININ 6026
- Six (6) credits in courses required within the specialty area
- A minimum of 3 credits in elective courses of the specialty
- A minimum of 6 credits in elective courses related to, but outside the area of specialty
- INTD 6995 course cannot be used for master's degree.

The **Master of Engineering in Industrial Engineering** (Plan III) requires a minimum of 30 credits of which a maximum of 9 credits may be at level 5000.

- Nine (9) credits in core courses – ININ 6005, ININ 6019, ININ 6026
- Six (6) credits in courses required within the specialty area
- A minimum of 9 credits in elective courses of the specialty
- A minimum of 6 credits in elective courses related to, but outside the area of specialty
- Up to 6 credits in elective courses can be used towards an applied project
- INTD 6995 cannot be used for master's degree.

**PROGRAM OF STUDY**

**Master of Science in Industrial Engineering**
**CURRICULUM**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| ININ6026 | 3 | Systems Simulation |
| ININ6005 | 3 | Experimental Statistics |
| ININ6XXX/5XXX | 3 | Required course within specialty* |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| ININ 6019 | 3 | Advanced Production Control |
| ININ 6XXX/5XXX | 3 | Required course within specialty* |
| ININ 6XXX/5XXX | 3 | Elective within specialty |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| ININ6999 | 3 | Thesis |
| XXXX | 3 | Elective outside specialty* |
| | 6 | |

**Second Semester**

| | | |
|---|---|---|
| ININ 6999 | 3 | Thesis |
| XXXX | 3 | Elective outside specialty* |
| | 6 | |

**Total Credits 30**

**PROGRAM OF STUDY**

**Master of Engineering in Industrial Engineering**
**CURRICULUM**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| ININ6026 | 3 | Systems Simulation |
| ININ6005 | 3 | Experimental Statistics |
| ININ6XXX/5XXX | 3 | Required course within specialty* |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| ININ 6019 | 3 | Advanced Production Control |
| ININ 6XXX/5XXX | 3 | Required course within specialty* |
| ININ 6XXX/5XXX | 3 | Elective within specialty* |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| ININ 6XXX/5XXX | 3 | Elective within specialty* |
| ININ 6XXX/5XXX | 3 | Elective within specialty* |
| XXXX | 3 | Elective outside specialty* |
| | 9 | |

**Second Semester**

| | | |
|---|---|---|
| XXXX | 3 | Elective outside specialty* |
| | 3 | |

**Total Credits 30**

* Students must select specialty and outside of specialty courses in consultation with their advisors. The final study plan must be approved by the

student's graduate committee and Department Head.

Admission to our graduate program is guided by the general regulations and requisites established by the Office of Graduate Studies. This includes a written statement of purpose and three letters of recommendation, and working knowledge of Spanish language. In addition to the admission requirements established by the Office of Graduate Studies, a Bachelor's degree is required. Students with a background in an area other than engineering must have completed at least three courses of Calculus, two courses of Physics with Calculus as requisite, coursework in Linear Algebra, Differential Equations, Computer Programming, Probability, and Statistics. Applicants, who graduated from non-English speaking universities, must also present evidence of English as a Foreign Language (TOEFL iBT) results. An interview of the candidate may be required as part of the admission process.

## RESEARCH AND TEACHING LABORATORIES

### UPRM Model Factory

The UPRM Model Factory integrates modern equipment, materials, and people into a manufacturing system. Its mode of operation is through interdisciplinary working teams from several engineering and business disciplines. This is a coordinated effort between Industrial, Electrical & Computer, and Mechanical Engineering. The goals of these laboratory facilities are to provide the following:

- Basic training to students through course labs and project initiatives
- Practice-based experiences dealing with all aspects of an actual manufacturing system.
- A space where local manufacturing industry issues can be studied
- A place where modern production technology and techniques can be studied as they are applied in an integrated manufacturing system
- An opportunity to assist local manufacturers in the development of their production system
- A meeting place where people from various disciplines can meet and learn to work in teams, and get an appreciation for the technical aspects of the other's area of knowledge.

A recent addition to the Model Factory is the Additive Manufacturing Lab, which is a teaching, learning, and research lab that embraces the use and implementation of metal 3D printing. Currently, the lab houses a Renishaw AM 400 DMLS metal printer. The printer installation is available for both production builds as well as a site to research new materials and processes.

### Human Factors/Ergonomics and Work Measurement Lab

This laboratory has been designed to provide students with hands-on experience in the analysis and evaluation of humans and their working environment. Tasks are simulated and evaluated based on anthropometrics, cardiovascular, and force requirements. The laboratory is equipped with modern equipment for the analysis of work systems and computers with software for the analysis of manual material handling activities. The following is a list of some of the equipment available in the laboratory:

- Computers with licenses of ErgoIntelligence for analysis and evaluation of workstation design as well as the analysis of lifting tasks with the NIOSH lifting guide
- Chatillon digital force measurement gauges and equipment for the analysis of pushing and pulling tasks
- Hand dynamometers and pinch gauges to measure hand force
- Anthropometers and calipers for the collection o anthropometric data
- Heart rate meters and a treadmill for the evaluation of cardiovascular requirements of physical tasks
- Electromyography with data collection software for the analysis of muscular activity
- Goniometers and data collection software for the analysis of flexion, extension, and rotation of body members
- Heat stress monitors and wet-bulb globe temperature meter for the analysis of environmental variables,
- Dosimeters and sound level meters for the evaluation of noise levels
- Photometers for studies of illumination
- Stop watches and digital recording equipment for time studies and work measurement analysis, among many others

**Manufacturing Automation Lab**

This teaching-learning facility is the hands-on laboratory for the Automation and Process Control course. Students design, build, and control scaled models, mainly emulating real manufacturing operations. The emphasis is in the use of programmable logic controllers (PLC), industrial sensors and actuators, pneumatics, and computer-based human machine interfaces.

The lab is equipped with 20 workstations with all the necessary software and hardware. The facility is available for demonstration and custom trainings.

**Statistical Quality Control Lab**

The lab is equipped with statistical software for data analysis, design of experiments, and validation procedures. It can also provide hands-on demonstrations for applied statistics and simulation courses.

**Bio-Industrial Engineering Lab (Bio IE Lab)**

The Bio IE Lab focuses on the use of engineering analysis methods to extract biological knowledge from scientific in-silico, in-vitro and in-vivo experiments. The laboratory integrates high computing capabilities and state-of-the-art algorithms to lead data-based biological discovery. The lab work relates statistical, soft-computing and optimization techniques to biological data analysis. In particular, the search and discovery of biomarkers of cancer is a central line of work of the Bio IE lab. Located in the Industrial Engineering Department, the laboratory is equipped with four MacPro workstations and one iMac capable of running UNIX, Mac and Windows software.

**Lean Logistics (LELO) Lab**

The Lean Logistics (LELO) Lab is a student-centered lab seeking to provide hands-on experience while creating practical research-based solutions to contemporary logistics problems, particularly those of Latin American countries. Currently the lab has three main streams of research: facility logistics, humanitarian logistics, and supply chain networks security. Consulting and training at the supply chain, facility, or production line level are available through the lab.

**Socially Responsible Operations (SRO) Research Center**

Socially Responsible Operations Research Center (SRO) mission is to foster a new generation of innovative decision makers committed to issues that have a direct impact on the wellbeing of our society. The center strategy is to utilize the synergy created by the interaction and collaboration amongst research groups to create a culture of innovation and problem solving of societal issues.

**Center of Excellence in Transportation and Logistics (CETL)**

The Center of Excellence in Transportation and Logistics (CETL) was established in January 2025 through an agreement between UPR Mayagüez and Saltchuk Resources, to promote talent and innovation in Puerto Rico's logistics sector. CETL is built on three pillars: talent, innovation, and industry collaboration. Saltchuk and its subsidiaries in Puerto Rico contribute expertise and serve on a high-level advisory board. The center is led by Dr. Héctor J. Carlo, an industrial engineering professor and global logistics expert.

## INDUSTRIAL ENGINEERING FACULTY

A list of professors who engage in graduate activities in the Department follows, including the highest earned degree, date, and institution granting the degree. Research and teaching interests are also included.

**ROXANA APARICIO-CARRASCO**, A*ssistant Professor*, Ph.D., 2011, University of Puerto Rico, Mayagüez Campus. Teaching and research interests: Knowledge Discovery and Data Mining, Automatic Document Classification, Database Systems and Distributed Databases, Artificial Intelligence, and Machine Learning.

**SAMUEL A. BONET-OLIVENCIA**, A*ssistant Professor*, Ph.D., 2022, Texas A&M University. Teaching and research interests: Human Factors and Ergonomics, Human and Healthcare Systems Engineering, Telehealth and User-Center Design.

**MAURICIO CABRERA-RÍOS**, *Professor*, Ph.D., 2002, Ohio State University. Teaching and research interests: Manufacturing, Applied Statistics, Design of experiments, Identification of Biomaker genes, and Bioinformatics.

**HÉCTOR J. CARLO-COLÓN**, *Professor*, Ph.D., 2007, University of Michigan-Ann Arbor. Teaching and research interests: Production, Distribution, Logistics, Material Handling Systems, and Operations Research.

**VIVIANA I. CESANÍ-VÁZQUEZ**, *Professor,* Ph.D., 1998, University of Wisconsin, Madison. Teaching and research interests: Production Systems, Cellular Manufacturing, Engineering Economics, Risk Analysis, and Design and Management of Services Processes.

**MERCEDES FERRER-ALAMEDA**, *Professor*, MEMS, 1993, University of Puerto Rico at Mayagüez. Teaching and research interests: Applied Statistics, Statistical Process Control, Engineering Management, Process Improvement, Lean six Sigma Methodology, and Institutional Research.

**DAVID R. GONZÁLEZ-BARRETO,** *Professor,* Ph.D., 1996, Pennsylvania State University. Teaching and research interests: Statistical Quality Control, and Applied Statistics and Simulation.

**WILLIAM HERNÁNDEZ-RIVERA**, *Professor*, Ph.D., 1996, Texas A&M University. Teaching and research interests: Information Systems, Real Time Process Control, Optimization, and Genetic Algorithms.

**LOURDES A. MEDINA-AVILÉS,** *Professor,* Ph.D., 2012, Pennsylvania State University. Teaching and research interests: Product Design and Development, Medical Devices, Regulations, Healthcare Engineering, Decision Analysis, Automation and Real Time Process Control.

**MAYRA MÉNDEZ-PIÑERO**, *Professor*, Ph.D. 2009, Texas A&M University. Teaching and research interests: Cost Analysis and Control, Cost Modeling, and Engineering Economy.

**OMELL PAGÁN-PARÉS**, *Professor*, Doctor of Engineering, 1995, Universidad Politécnica de Madrid. Teaching and research interests: Production Systems, Total Quality Management, Layout, Logistics, and Design and Management of Services Processes.

**CRISTINA POMALES-GARCÍA**, *Professor*, Ph.D., 2006, University of Michigan-Ann Arbor. Teaching and research interests: Human Factors and Ergonomics, Web-based Distance Learning, and Engineering Education.

**PEDRO RESTO-BATALLA**, *Professor*, Ph.D., 1982, Texas A&M University. Teaching and research interests: Manufacturing, Automation, and Simulation.

**BETZABÉ RODRÍGUEZ-ÁLAMO**, *Professor*, Ph.D., 2010, University of Michigan-Ann Arbor. Teaching and research interests: Supply Chain, Production, Distribution and Logistics, Operations Research, and Simulation.

**AGUSTÍN RULLÁN-TORO**, *Professor*, Ph.D., 1990, Lehigh University. Teaching and research interests: Automation, Robotics, Facility Layout Planning, Modern Material Handling Systems, and Cost Modeling.

**WANDALIZ TORRES-GARCÍA,** *Professor*, Ph.D., 2011, Arizona State University. Teaching and research interests: Simulation, Applied Statistics, Probability, Data Mining, Bioinformatics, and Data Analytics.

# MATERIALS SCIENCE AND ENGINEERING

# MASTER'S PROGRAMS

## General Information:

The Materials Science and Engineering (MSE) graduate program was designed as an interdisciplinary venture to attract qualified graduate students. Although several UPRM departments are involved in MSE research, there is no appealing accretion program available in this area. Therefore, the program offers instruction pertinent to different fields of materials science, such as nanostructured materials, ceramic materials, electronic materials, biomaterials, materials characterization, and phase equilibria.

## Student Learning Outcomes

MSE graduates will successfully deal with the complex materials engineering problems that a person with a bachelor's degree cannot handle. In effect, the participant will be capable of:

- researching, designing, developing, and testing new materials;
- advising on the choice of materials for specific purposes and adaptability of processes;
- supervising fabrication of advanced materials in a plant production environment;
- optimizing materials used in manufacture;
- supervising the implementation of alternative, more economical materials;
- advising on materials inspection, maintenance, and repair procedures of materials;
- liaising with materials suppliers and the manufacturing and implementation teams.

## Degrees Offered:

The MSE program confers two degrees, depending on the study plan selected by the participating student: a) Master of Science and b) Master of Engineering. Accordingly, there are three plans of study available:

- **Plan I (Master of Science)**
  A minimum of 35 credit-hours that includes 8 credits of core courses in the area of specialization, up to 6 credits of master thesis, technical electives in the area of specialization, and technical electives outside the area of specialization.
- **Plan II (Master of Engineering):**
  A total of 35 credit hours includes eight credits of core courses in the area of specialization, up to 3 credits of the master project, technical electives in the area of specialization, and technical electives outside the area of specialization.
- **Plan III (Master of Engineering):**
  A total of 35 credit hours includes eight credits for core courses in the area of specialization, technical electives in the area of specialization, and technical electives outside the area of specialization.

### PROGRAM OF STUDY

### MATERIALS SCIENCE AND ENGINEERING CURRICULUM

**MASTER OF SCIENCE (PLAN I)**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| **CIIM 6005** | **4** | **Fundamentals of Advanced Materials** |
| CIIM 6018 | 3 | Nanostructured Materials |
| CIIM 6995 | 3 | Special Topics |
| | 10 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| **CIIM 6006** | **3** | **Structure and Properties of Materials** |
| CIIM 6007 | 3 | Kinetics and Phase Transformations |
| CIIM 6008 | 3 | Diffractometry and Complementary Techniques |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| **CIIM 6000** | **3** | **Thesis** |
| XXXX 6xxx | 3 | Graduate Elective 1 |

| | | |
|---|---|---|
| CIIM 6030 | 3 | Ceramic Materials |
| **CIIM 6027** | **1** | **Graduate Seminar** |
| | 10 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| **CIIM 6000** | **3** | **Thesis** |
| XXXX 6xxx | 3 | Graduate Elective 2 |
| | 6 | |

**Total Credits 35**

**MASTER OF ENGINEERING (PLAN II)**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| **CIIM 6005** | **4** | **Fundamentals of Advanced Materials** |
| CIIM 6018 | 3 | Nanostructured Materials |
| CIIM 6995 | 3 | Special Topics |
| | 10 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| **CIIM 6006** | **3** | **Structure and Properties of Materials** |
| CIIM 6007 | 3 | Kinetics and Phase Transformations |
| CIIM 6008 | 3 | Diffractometry and Complementary Techniques |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| XXXX 6xxx | 3 | Graduate Elective 1 |
| CIIM 6015 | 3 | Computational Materials Science |
| CIIM 6030 | 3 | Ceramic Materials |
| **CIIM 6027** | **1** | **Graduate Seminar** |
| | 10 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| **CIIM 6996** | **3** | **Master's Project** |
| XXXX 6xxx | 3 | Graduate Elective 2 |
| | 6 | |

**Total Credits 35**

**MASTER OF ENGINEERING (PLAN III)**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| **CIIM 6005** | **4** | **Fundamentals of Advanced Materials** |
| CIIM 6018 | 3 | Nanostructured Materials |
| CIIM 6995 | 3 | Special Topics |
| | 10 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| **CIIM 6006** | **3** | **Structure and Properties of Materials** |
| CIIM 6007 | 3 | Kinetics and Phase Transformations |
| CIIM 6008 | 3 | Diffractometry and Complementary Techniques |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| XXXX 6xxx | 3 | Graduate Elective 1 |
| CIIM 6015 | 3 | Computational Materials Science |
| CIIM 6030 | 3 | Ceramic Materials |
| **CIIM 6027** | **1** | **Graduate Seminar** |
| | 10 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| CIIM 6026 | 3 | Solidification Processes |
| XXXX 6xxx | 3 | Graduate Elective 2 |
| | 6 | |

**Total Credits 35**

For the three plans, all courses marked in bold are mandatory. The remaining MSE elective courses may be substituted by the program coordinator by other MSE ones (code CIIM) depending on the availability of the faculty involved in research projects. The graduate elective courses should be taken in a different program.

## Mission

The mission of this graduate program is to advance fundamental knowledge in Materials Science and Engineering applied to the creation, development, and optimization of materials, devices, and processes through innovative research. The program seeks to educate and train a highly competitive and resourceful cohort of professionals in this area. This program responds to current and anticipated technical and societal needs of Puerto Rico and the world.

This MSE graduate program is to benefit the industry and government of Puerto Rico and the world by offering their participants the following:

- Advanced technical skills and research experience in material selection, testing, design, materials engineering, device fabrication, and electronic materials.
- A flexible graduate program where professionals from the industry can customize their graduate studies, which can be completed within an attractive timeframe from the employers.
- An interdisciplinary program where faculty and students of various science and engineering departments can participate, conduct research, and learn from each other.
- Well-prepared MSE faculty, making UPRM even more effective in academic research and community service in a high-demand, high-profile, and well-funded field.

## Vision

This program will have considerable impact on the growth and development of Puerto Rican industry in the design, fabrication, characterization of materials, and product evaluation and, in achieving so, it will serve its community in vital areas, consistent with the University of Puerto Rico's mission.

## Admission Requirements:

1. A bachelor's degree in Mechanical, Chemical, Industrial, Electrical, or Civil Engineering or their equivalents from an accredited institution of higher learning is required for the MSE graduate programs. Applicants with a degree in Chemistry, Physics, Biology, and other engineering or science fields in related areas are also eligible for admission.
2. A general grade point average of 3.0/4.0. Admission is possible for applicants with lower GPAs who have demonstrated previous industrial or research experience.
3. A minimum mastery of English and Spanish skills to understand technical literature and write technical documents.
4. Three letters of recommendation from qualified referees.
5. A statement of purpose describing the applicant's goals and interests.

## Graduation Requirements:

For students enrolled in Plan 1, this Master of Science program requires a minimum of 35 credits distributed as follows:

1. A minimum of 29 credits with:
   - A minimum of 23 credits in the MSE program.
   - A minimum of 6 credits in courses related to MSE, but from another UPRM graduate program.
2. A six-credit graduate thesis, which concludes with the approval of a final examination.

The Master of Engineering with project option (Plan II) requires a minimum of 35 credits distributed as follows:

1. A minimum of 32 credits with:
   - A minimum of 26 credits in the MSE program.
   - A minimum of 6 credits in courses related to MSE, but from another UPRM graduate program.
2. Carry out an engineering project (3 credits).

The Master of Engineering with courses only (Plan III) requires a minimum of 35 credits distributed as follows:

- A minimum of 29 credits in core courses and technical electives offered by the MSE program.
- A minimum of 6 credits in courses related to MSE, but from another UPRM graduate program.

All students regardless of the plan selected can solicit up to nine credits of 5XXX level courses (advanced undergraduate) to be validated as part of the course requirement. The Graduate Committee will review and approve this solicitation, provided that those courses are adequate for the themes of the MSE program.

## Research Infrastructure:

The Department of Engineering Sciences and Materials manages more than 8,000 square feet of research space distributed in 10 laboratories in the Stéfani Building. Seven rooms are assigned for the MSE program. These laboratories host state–of–the–art instrumentation and robust standard equipment. The facilities are in the Stéfani Building, while shared ones are in the Industrial Engineering Building and the UPRM Research and Development Center's premises. The goals of these facilities are to provide the following:

- Practice-based experiences dealing with the synthesis of diverse materials
- Experiential learning on advanced characterization techniques for polymeric, metallic, and composite materials.
- A controlled environment for microfabrication of electronic devices
- A space for the design and synthesis of experimental nanomaterials

All these facilities serve students and researchers from various engineering and science disciplines working in interdisciplinary materials research and development.

**Biomaterials Laboratory (S-106)**
This 480 sq ft laboratory is equipped for bio-nanomaterials experiments. A laminar flow hood, incubators, and other equipment allow for the handling of microorganisms and the proper sterilization of materials. Additional instrumentation includes centrifuges and spectrophotometers.

**Materials Preparation Laboratory and Workshop (S-110)**
This laboratory houses sample preparation units, a high-energy ball mill, milling and drilling units as well as high-capacity tensile testing units.

**Materials Research Laboratory I (S-311)**
This laboratory houses the most expensive instrumentation obtained with federal grants: a nanoindentation unit and a physical property measurement unit as well atomic force microscopes, thermal analysis equipment and two x-ray diffractometers.

**Thermal Processing Laboratory (S-312 Annex)**
This is the most recent laboratory set up with US Dept. of Education funds and houses advanced and high temperature furnaces. A new ultra rapid quenching machine (UQR Edmund Bühler Gmbh) allows for extreme quenching of metallic samples from the liquid state, rendering a 1,000,000ºC/s cooling rate. Additionally, this laboratory houses a new Edmund Bühler melt spinner MSP 10 for max.10g of sample per run,

**Materials Research Laboratory II (S-313)**
This laboratory houses instrumentation for diverse types of characterization of materials: from cryogenic and room temperature magnetometers to optical microscopes as well as infrared spectrometers and thermal analysis units.

**Materials Research Laboratory III (S-313A)**
This laboratory is dedicated to thermos-mechanometric instrumentation, Mösbauer spectroscopy, and two low load mechanical testing units.

**Materials Research Laboratory IV (S-314)**
This space houses all necessary laboratory glassware and a fume hood for the synthesis of nanomaterials as well as a spin coater and a small and robust arc melter.

**Clean Room (R&D Center)**
This is a 600 sq ft Class 100 clean room built with federal monies. It houses instrumentation necessary for microfabrication: a three-gun magnetron sputtering unit, a mask aligner, a profilometer, and ancillary pieces of equipment.

**Model Factory and the Additive Manufacturing Unit**
UPRM Industrial Engineering (IE) Model Factory located on the ground floor of the IE building hosts the Renishaw AM 400 additive manufacturing unit.

The instrument was purchased as part of a Dept. of Defense contract Nº W911NF-17-1-0494 (Suarez, as PI). It has a build volume 248 mm × 248 mm × 285 mm and renders a build rate up to 20 $cm^3$/hr.

**Webpage:** https://www.uprm.edu/mateng/

**YouTube Channel:**
https://www.youtube.com/@materialsscienceandenginee6742

## FACULTY

**IVÁN J. BAIGÉS-VALENTÍN**, *Professor*, Ph.D., 1995, University of Florida - Gainesville.

**YANG LI**, *Professor,* Ph.D., 1993, Materials Physics, University of Science and Technology, Beijing, China.

**CARLOS MARÍN-MARTÍN**, *Professor*, Ph.D., 2002, Mechanical Engineering, Rensselaer Polytechnic Institute.

**AGNES PADOVANI-BLANCO**, *Professor*, Ph.D., 2002, Chemical Engineering, Georgia Institute of Technology.

**OSCAR MARCELO SUÁREZ**, *Professor and Coordinator of the program*, Ph.D., 2000, Metallurgical Engineering, University of Wisconsin-Madison.

**OSWALD UWAKWEH**, *Professor,* Ph.D., 1990, Materials Science and Engineering, Université de Nancy I, France.

# DEPARTMENT OF MECHANICAL ENGINEERING

The Mechanical Engineering Department offers graduate programs at the Master's and Doctorate of Philosophy level. At the Master's level, students may earn either a Master of Science (MS) or a Master of Engineering (ME) degree. The research facilities include state of the art laboratories that support activities for materials development, bioengineering device development, vehicle development, prototype manufacturing, controls and instrumentation, mechanical system response testing, alternative energy testing, fluid, heat and mass transfer analysis.

The program opened at the master's level in 1967. The PhD program began in 2016. Graduates from our program are expected to complete their master's work in 2-3 years. For the Ph.D. program, students entering the program with a Master's degree are expected to complete their studies in 3-4 years while students entering with a Bachelor's are expected to complete their degree in 4-6 years.

The Department of Mechanical Engineering has a diverse faculty performing research in various areas including: Thermodynamics; Heat transfer; Air conditioning; Manufacturing processes; Fluid mechanics; Mechanical metallurgy; Fracture mechanics; Transport phenomena; Gas dynamics; Mechanics of composite materials; Conservation and alternative energy systems; Control system design; Finite element analysis; Vibrations; Damage Detection; MEMS; Kinematics; Automatic assembly systems; Biosensors; Biomaterials; and Energy.

The program's structure is flexible enough to allow participants to specialize in one or more subject areas. Students can choose a concentration in thermal sciences, machine sciences, materials and manufacturing, or a program which combines courses from two concentration areas. The required courses depend on the area selected by the student and the research of project work.

## STUDENT PROFILE

| | Masters | Ph.D. |
|---|---|---|
| Students Enrolled/yr | 29 | 19 |
| Total Program Enrollment | 29 | 19 |
| Number of International Students | 15 | 11 |

## ADMISSION

Applicants to graduate study in Mechanical Engineering must have a Bachelor of Science degree in Mechanical Engineering from an accredited institution. Applicants with a bachelor degree from other fields related to Mechanical Engineering are also considered. During the evaluation process the academic record is analyzed and deficiencies may be assigned to compensate for the lack of essential coursework at the bachelor's level.

For the MS and ME programs, prospective students must comply with the general requirements imposed by the Office of Graduate Studies (OEG) to be able to apply. For the PhD program, prospective students must comply with the general requirements imposed by the OEG and must have a general 3.0 GPA (on a scale of 4.0) from a duly accredited institution to be able to apply. International applicants must provide evidence of available financial resources to cover educational and living expenses for at least the first year of study.

### Minimum English Requirements:

Students are expected to understand English and Spanish since courses may be taught in either language. The students are also expected to write effectively in English in a wide range of formats including business and personal letters, reports, book reviews, literature reviews and academic essays. If the first language of the prospective student is not Spanish or English (regardless of citizenship), the applicant must take the TOEFL iBT and obtain a minimum score of 80. If the score ranges from 70-79, the applicant may be considered based on an interview by members of the Graduate Committee. If admitted, we may require the student to approve a graduate-level English course.

## COURSE REQUIREMENTS

Students select a main research area to focus their coursework and research. The four focus areas are:

- Thermal sciences,
- Machine sciences,
- Materials and manufacturing
- Bio and Micro-scale Engineering

A detailed list of the requirements is available at: https://www.uprm.edu/inme/academic/grad/current-graduate-students/courses/list-inme-grad-courses/

Students in the Ph.D. program are required to take a minimum of sixty-one (61) credit hours if they enroll with a bachelors' degree. Eighteen (18) of these credits are in research/thesis work. Students entering the Ph.D. program with a master's degree may transfer up to twenty-four (24) credits taken for their master's pending the approval of their advisor and the Graduate Committee.

For the Master of Science (MS) program the requirements are a minimum of twenty-five (25) credit hours in coursework, work on a research project, and write a thesis for a total of thirty-one (31) credits (Plan I).

Students in the master of Engineering (ME) program could enroll in Plan II of Plan III. In Plan II they are required to take a minimum of twenty-seven (27) credit hours in coursework, work on a design or development project, and write an engineering report for a total of thirty (30) credits. In Plan III they are required to take a minimum of thirty (30) credit hours.

## PROGRAM OF STUDY

## MECHANICAL ENGINEERING MASTER OF SCIENCE (MS) CURRICULUM

### FIRST YEAR

**First Semester**

| Number | Credits | Course |
|---|---|---|
| +INME XXXX | 3 | Specialty Area Course |
| +INME XXXX | 3 | Specialty Area Course |
| &MATH XXXX | 3 | Advanced Math Course |
| #INME 6017 | 0 | Seminar |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| +INME XXXX | 3 | Specialty Area Course |
| +INME XXXX | 3 | Specialty Area Course |
| @Free Elective | 3 | Free elective course |
| #INME 6017 | 0 | Seminar |
| | 9 | |

### SECOND YEAR

**First Semester**

| Number | Credits | Course |
|---|---|---|
| @Free elective | 3 | Free elective course |
| @Free elective | 3 | Free elective course |
| INME 6099 | 3 | Research |
| #INME 6017 | 1 | Seminar |
| | 10 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| INME 6099 | 3 | Research |
| | 3 | |

**Total Credits 31**

* You can graduate earlier if you bring transfer credits from your BS degree at the graduate level with grades A or B (Cert. 09-09).

** The type of courses (specialty, math or free elective) can vary by semester based on course offering.

*** Graduate students are considered full-time students when enrolled in 9 credits or Research course (thesis).

Students in the Master of Science must enroll in:

\+ Twelve credits of **Specialty Area Courses**

& Three credits of **Advanced Math Course**

\# Three times in INME 6017 – Seminar course; twice with 0 credits; once with 1 credit. During their third enrollment, they are expected to present a seminar about their research project.

You can see the courses listed in the Mechanical Engineering website: https://www.uprm.edu/inme/academic/grad/current-graduate-students/courses/list-inme-grad-courses/

@ Students in the Master of Science must enroll in 9 credits of free elective upon discussion and selection of the courses with the student's advisor and/or graduate committee.

**Graduation Requirements**: Submit plan of study during first semester of studies, satisfy course credit requirements, submit Thesis proposal, submit final Thesis and approve Thesis defense. Students must maintain a minimum GPA of 3.0.

**PROGRAM OF STUDY**

**MECHANICAL ENGINEERING**
**MASTER OF ENGINEERING (ME)**
**CURRICULUM**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| +INME XXXX | 3 | Specialty Area Course |
| %INME XXXX | 3 | ME Elective Course |
| &MATH XXXX | 3 | Advanced Math Course |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| +INME XXXX | 3 | Specialty Area Course |
| %INME XXXX | 3 | ME Elective Course |
| @Free Elective | 3 | Free elective course |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| +INME XXXX | 3 | Specialty Area Course |
| %INME XXXX | 3 | ME Elective Course |
| @Free Elective | 3 | Free elective course |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| @Free Elective | 3 | Free elective course |
| | 3 | |

**Total Credits 30**

* You can graduate earlier if you bring transfer credits from your BS degree at the graduate level with grades A or B (Cert. 09-09).
** The type of courses (specialty, math, ME or free elective) can vary by semester based on course offering.
*** Graduate students are considered full-time students when enrolled in 9 credits.

Students in the Master of Engineering must enroll in:
\+ Nine credits of **Specialty Area Courses**
& Three credits of **Advanced Math Course**
% Nine credits of **ME Elective Courses**
You can see the courses listed in the Mechanical Engineering website: https://www.uprm.edu/inme/academic/grad/current-graduate-students/courses/list-inme-grad-courses/
@ Students in the Master of Science must enroll in 9 credits of free elective upon discussion and selection of the courses with the ME Graduate Program Coordinator.

**Graduation Requirements**: Submit plan of study during first semester of studies and satisfy course credit requirements. Students must maintain a minimum GPA of 3.0.

**PROGRAM OF STUDY**

**MECHANICAL ENGINEERING**
**DOCTOR OF PHILOSOPHY (PHD)**
**CURRICULUM**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| +INME XXXX | 3 | Specialty Area Course |
| %INME XXXX | 3 | ME Elective Course |
| &MATH XXXX | 3 | Advanced Math Course |
| #INME 8017 | 0 | Doctoral Seminar |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| +INME XXXX | 3 | Specialty Area Course |
| %INME XXXX | 3 | ME Elective Course |
| &MATH XXXX | 3 | Advanced Math Course |
| #INME 8017 | 0 | Doctoral Seminar |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| +INME XXXX | 3 | Specialty Area Course |
| %INME XXXX | 3 | ME Elective Course |

| | | |
|---|---|---|
| ‡INME 8000 | 3 | Doctoral Dissertation |
| #INME 8017 | 0 | Doctoral Seminar |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| +INME XXXX | 3 | Specialty Area Course |
| %INME XXXX | 3 | ME Elective Course |
| ‡ INME 8000 | 3 | Doctoral Dissertation |
| #INME 8017 | 1 | Doctoral Seminar |
| | 10 | |

**THIRD YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| %INME XXXX | 3 | ME Elective Course |
| @Free elective | 3 | Free elective course |
| ‡ INME 8000 | 3 | Doctoral Dissertation |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| @Free elective | 3 | Free elective course |
| @Free elective | 3 | Free elective course |
| ‡ INME 8000 | 3 | Doctoral Dissertation |
| | 9 | |

**FOURTH YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| ‡ INME 8000 | 3 | Doctoral Dissertation |
| | 3 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| ‡ INME 8000 | 3 | Doctoral Dissertation |
| | 3 | |

**Total Credits 61**

* You can graduate earlier if you bring transfer credits from your BS or MS or ME degree at the graduate level with grades A or B (Cert. 09-09).

** The type of courses (specialty, math, ME or free elective) can vary by semester based on course offering.

*** Graduate students are considered full-time students when enrolled in 9 credits or Research course (thesis).

Students in the PhD must enroll in:

\+ Twelve credits of **Specialty Area Courses**

& Six credits of **Advanced Math Course**

% Fifteen credits of **ME Elective Courses**

\# Four times in INME 8017 – Doctoral Seminar course; three times with 0 credits; once with 1 credit. During their fourth enrollment, they are expected to present a seminar about their research project. Students must approve Seminar with S at least four times, according to curriculum.

You can see the courses listed in the Mechanical Engineering website: https://www.uprm.edu/inme/academic/grad/current-graduate-students/courses/list-inme-grad-courses/

@ Students in the PhD must enroll in 9 credits of free elective upon discussion and selection of the courses with the student's advisor and/or graduate committee.

‡ Students may enroll in INME 8000 (Doctoral Dissertation) after passing the PhD Qualifying Exam.

**Qualifying examination**: Students must take a *Qualifying Examination* during the second semester of the first year of studies. If students approve the Qualifying Examination during the second semester of the first year, they may enroll in Doctoral Dissertation the following semester. If a student does not approve the Qualifying Examination during the second semester of the first year, they may repeat the Qualifying Examination for a second and final time during the first semester of the second year. Students cannot enroll in Doctoral Dissertation until they have approved the Qualifying Examination. Students cannot continue to be part of the doctoral program if they fail to pass the Qualifying Examination after the second attempt.

**Preliminary examination:** Students must take a *Preliminary Examination* during the first semester of their third year of study, before submitting a Doctoral thesis proposal to the Office of Graduate Studies. If student does not approve the Preliminary Examination during the first semester of the third year, they may repeat the Preliminary Examination for a second and final time during the second semester of the third year. Students cannot continue to be part of the doctoral program if they fail to pass

the Preliminary Examination after the second attempt.

**Graduation Requirements**: Submit plan of study during first semester of studies, satisfy course credit requirements, approve PhD Qualifying Exam, approve PhD Preliminary Exam, submit Dissertation proposal, submit final Dissertation and approve Dissertation defense, have at least one scientific article accepted for publication in a peer-reviewed journal. Students must maintain a minimum GPA of 3.0.

## CENTERS

Center for Aerospace and Unmanned Systems Engineering (CAUSE) provides a framework for broad-based, competitive, multi-institutional, multidisciplinary science and engineering research that will advance the aims of aeronautic, and astronautic Mission Directorates across the nation and world at large. The center will foster synergy between the following science and engineering directorates: (i) unmanned systems, (ii) aeronautics, and (iii) space. The center provides an interdisciplinary environment that enables and facilitates participants to carry out collaborative educational activities and research. The Center's overall mission is to leverage our strong theoretical, computational, and experimental programs to advance the frontiers of fundamental and applied research while educating a new cadre of STEM students. We intend to create strong collaborative relationships with the current aerospace industries, centers, institutes, schools and universities.

## BUILDINGS AND RESEARCH FACILITIES

The Mechanical Engineering Department maintains well-equipped research facilities which include laboratories for vehicle design, vibration control, material development and characterization, health monitoring and diagnostics, sensor development and applications, fatigue characterization from fluid structure interaction and development of computer aided engineering techniques.

The department has several computer facilities for research purposes. Workstations are connected to campus mainframes and are accessible to faculty and students on a continuous basis. A cluster with sisty-gour (64) cores is available for Fluid Mechanics studies. The nodes are connected with the master through an infiniband network. The Department has access to licensed engineering software such as ANSYS Multiphysics, Siemens NX, Siemens Star CCM+, Comsol Multiphysics, EES Solver and many others through the Virtual Computing Lab (VCL).

In the field of performance materials, **the New Materials Development Laboratory (NMDL)** is responsible for matching many new differentiated materials and technologies with market needs in the areas of bioengineering, alternative energy and electronics. The NMDL include a materialographic laboratory, a mechanical testing facility (including a 5000 lb Instron machine), thermal chambers, tribometers. Basic equipment for materialographic preparation including an automatic mounting press and various grinders/polishers, hardness testers, heat treatment furnaces and a various optical imaging systems are available. NMDL performs sponsored research from various government and private agencies.

The **Biosensing and Microfluidics Research Laboratory (BMRL)**, led by Dr. Rubén Díaz-Rivera and Dr. Pedro Resto is 900 sq. ft. facility located in the Department of Mechanical Engineering at UPRM. The purpose of this laboratory is to facilitate the design, construction and use of microfluidic systems for cell studies and biosensing applications. The laboratory houses a faraday-caged microscopy setup for electrical/optical characterization of microfluidic devices, a LabSmith Synchronized Video Microscope workstation with black & white and EPI-fluorescent optic modules, controlled with a Dell Precision T1700 desktop computer, for microfluidic visualization and data acquisition, and tools for performing PDMS soft lithography. The laboratory has access to a rapid prototyping facility having a 3D printer, a small scale CNC, an EPILOG Mini 60W Laser Cutter and an electronics workstation.

The **Mechatronics Laboratory** at the Mechanical Engineering (ME) Department is dedicated to study electromechanical systems. The laboratory offers training and support to existing ME courses while providing facilities and resources for research in the control of mechanical and electromechanical systems. The laboratory is equipped with PLC Pick-and-Place and Sorting. The laboratory has materials and equipment to perform experiments and projects using microcontrollers. The laboratory also includes a prototyping station with additional equipment to conduct independent research projects; a design center where students and researchers are able to share ideas and make

presentations; and a full-time technician to support the laboratory's activities. The laboratory also utilizes the equipment available in the Manufacturing Processes Laboratory to handle a wide variety of complex projects involving the fusion of mechanics, electronics, and software technologies.

In collaboration with the Department of Electrical and Computer Engineering and the Department of Engineering Sciences and Materials, the **Micro and Nano Devices Research Laboratory** is a Class 100 (ISO Class 5) cleanroom for photolithography located at the UPRM Research and Development Center. The facility houses a SUSS MicroTec Mask Aligner (MA-6) with backside alignment, a Reactive Ion Etcher with CF4 chemistry, a multiple target (AC/DC) Sputtering System (AJA Orion Thin Film Deposition System), a Stylus Profilometer (KLA Tencor P-6), a chemistry hood and photolithography peripherals.

The **Advanced Manufacturing Lab (AML)** focuses on cutting-edge research to investigate the Process-Structure-Property (PSP) relationships of advanced manufacturing technologies. Our focus lies on the hybrid and multi-material additive manufacturing of metallic components, with applications in aerospace propulsion and In Space Manufacturing & Assembly (ISAM). Our research integrates experimental design, advanced characterization techniques, and performance evaluation to study the microstructural evolution and their influence on material behavior in extreme environments.

**The Vehicle Design and Research Laboratory** is involved with research and development of high performance and alternate fueled vehicles for current and future transportation needs. It is equipped with a Design Center and a Machine Shop, two chassis dynamometers both and emissions measurement equipment. The Machine Shop includes 3D printers, CNC Router/Plasma Cutter and Laser Cutters. Data acquisition instrumentation is available for vehicle development and optimization. Current research projects include: energy management for solar powered vehicles, motorsport vehicle optimization, autonomous vehicles, intelligent transportation systems and remote control aircraft. Undergraduate student projects include Formula SAE, Solar Powered Vehicles (FSGP/ASC), SAE Mini Baja, Shell Eco-Marathon and SAE Aerodesign.

**The Mechanical Engineering Machine Science Laboratory (MEMSL)** is situated within in the Mechanical Engineering Building. This laboratory facilitates departmental research in Machine Science, focusing on mechanical and material component systems, including additive manufacturing for mechanical and aerospace applications with structural optimization and manufacturing constraints, vibration research for damage detection and material characterization (fatigue life), sensor design and anomaly detection, and composites involving sandwich core design and optimization. Computing facilitates for AI Generative Design and Machine Learning methodologies are accessible. MEMSL is equipped with two 3D printers, a laser vibrometer, electromagnetic shakers, amplifiers, data acquisition systems, software, transducer conditioning amplifiers, a power supply, an oscilloscope, and limited computing resources. MEMSL has received external financing from the National Science Foundation, the Department of Defense, Pratt & Whitney, and the Puerto Rico Science Technology and Research Trust.

At **The Bubble Dynamics Laboratory (BDL)**, cutting edge research is being conducted for understanding, producing and characterizing milli- micro- and nano-bubbles through the design of acoustic resonators. We develop experimental systems for validation and/or formulation of theoretical models involving the generation and collapse of bubbles with applications on the mechanical, naval, biomedical, agricultural and nuclear energy industry. The laboratory, located in the Mechanical Engineering Department at UPRM (Lucchetti Building), houses state of the art equipment including: a 3D stereoscopic PIV (Particle Image Velocimetry) system with the capability to perform shadow-sizing, micro-PIV and Laser Induced Fluorescence (LIF), a Dynamic Mechanical Analyzer (NTA) and a Static and dynamic light scattering (SLS-DLS) equipment. The BDL laboratory is also equipped with modern data acquisition and measuring devices and it is supported through research funded by the National Science Foundation, Department of Defense, Department of Energy, the US Nuclear Regulatory Commission and the Puerto Rico Science Technology and Research Trust.

**The Biomechanics and Biomaterials Laboratory** is dedicated to research and education principally in the area of characterization and testing of biomaterials. This Laboratory is equipped with a Tribometer, Minimat tensile tester,

Potentiostat/Galvanostat and an Analytical balance. Characterization of the wear resistance, tensile, compressive and fatigue properties are performed in this facility. Corrosion resistance and behavior through potentiodynamic polarization, cyclic voltammetry and electrochemical impedance spectroscopy are measured in this laboratory.

**The Human-Centered Design Research and Development Laboratory** purpose is to enhance quality of life by understanding human behavior and cognition to connect Design and Engineering for the development of knowledge and products for social well-being. Currently, the laboratory focuses in three areas: the intersection between Design and entrepreneurship, Design for aesthetics, and Virtual Reality for Engineering applications. The laboratory is equipped with various high performance computers and head mounted displays (e.g. Oculus Rift) for the virtual reality experiments. In addition, a range of input output devices is available for inclusion in virtual reality experiments. The laboratory offers visualization of complex engineering analysis and product assemblies in support of ME courses and other partnerships.

The goal of the **Computational Fluid Dynamics (CFD) Laboratory** is to model, understand and control fluid flows in engineering applications using numerical techniques. We develop numerical models and perform simulations of turbulent and atmospheric flows with applications in renewable energy and wind energy, heat transfer and gas turbine engines. The lab is equipped with two 8-cores 16GB workstations, several desktop workstations, and has access to supercomputers at high-performance computing centers in the Nation through NSF ACCESS network. The lab has developed an in-house parallel CFD code to perform direct numerical simulations and large-eddy simulations of turbulent flows. The lab research is funded by the Department of Energy, the National Science Foundation, and the Puerto Rico Science Technology and Research Trust.

The **TurboLab** is a Pratt and Whitney Center of Excellence is the first center of excellence in Puerto Rico and the Caribbean. The central objective of TurboLab, an ongoing initiative developed with funds committed from Pratt & Whitney Puerto Rico, is to enhance the curriculum and laboratory facilities with the purpose of reducing training time once graduates join the workforce. This will be accomplished by strengthening the capabilities in three main areas: (i) Gas Turbine Engines, (ii) Computational Design and Analysis and (iii) Controls and Embedded Systems, to cross-train students so that they have working knowledge in a broad range of disciplines to meet the current and future needs of the aerospace field. This effort also enables students, working under the guidance of UPRM faculty, to be provided with the knowledge (e.g., terminology, systems, technologies and tools), know-how and skills used in industry through project-based learning, expanding capabilities for conducting high-impact project-based training activities in areas of interest to the aerospace industry. The lab is equipped with two fully instrumented, scaled-down gas turbines (turbojet and turboshaft), a high-performance computer cluster, a performance real time target machine, module stations for embedded software development and prototyping, and software for computational design and optimization of systems, including simulation of propulsion systems.

## CONTACT INFORMATION

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**Internet**: http://www.uprm.edu/inme

## MECHANICAL ENGINEERING FACULTY

A list of professors who engage in graduate activities in the Department follows, including the highest earned degree, date, and institution granting the degree. Research and teaching interests are also included.

**ANDRÉ AMADOR**, *Assistant Professor,* Ph.D., 2020, University of California, San Diego. Research and Teaching interests: Fluid Mechanics, Applied Ocean Science, Coastal Resilience, Marine Renewable Energy.

**JAYANTA BANERJEE**, *Professor*, Ph.D., 1969, M.Ed., 1987, University of Waterloo, Canada. Research and Teaching interests: Manufacturing, Technology Transfer and Culture.

**PABLO CÁCERES**, *Professor*, Ph.D., 1984, University College Cardiff. Research and Teaching interest: Materials characterization using surface and electron microscopy techniques, Nanostructured materials synthesis and characterization, Thermoelectric Materials, Hydrides for Hydrogen Storage.

**SILVINA CANCELOS**, *Professor*, Ph.D., 2007, Rensselaer Polytechnic Institute. Research and Teaching interest: Two-phase flow and with applications on the biomedical industry and the nuclear energy industry.

**UMBERTO CIRI**, *Assistant Professor*, Ph.D., 2019, The University of Texas at Dallas. Research and Teaching interests: Renewable Energy, Wind Energy, Computational Fluid Dynamics, Turbulence, Aerodynamics.

**BRANDON COLÓN**, *Assistant Professor*, Ph.D., 2024, University of Texas at El Paso. Research and Teaching interests: Materials Science, Manufacturing, Spacecraft Propulsion.

**SANDRA COUTÍN**, *Professor*, Ph.D., 1996, Kansas State University. Research and Teaching interests: Numerical Heat Transfer and Fluid Flow in Manufacturing Processes and HVAC Systems.

**RUBÉN E. DÍAZ RIVERA**, *Professor*, Ph.D., 2005, University of California, Berkeley. Research and Teaching interest: Micro/Nano scale bioelectronic systems, Micro-electroporation, Biosensors and Microfluidic systems.

**DAVID B. DOONER**, *Professor*, Ph.D., 1991, University of Florida. Research and Teaching interests: Optimal Design of Mechanical Systems, Integrated Cap Cam, Geometric Modeling, Analysis and Synthesis of Mechanisms, gear systems, cam systems.

**J. GUSTAVO GUTIÉRREZ**, *Professor*, Ph.D., 2002, University of Wisconsin, Milwaukee. Research and Teaching interests: Heat and Mass Transfer, Fluid Flow, Computational Fluid Mechanics.

**YI JIA**, *Professor*, Ph.D., 1994, Harbin Institute of Technology. Research and Teaching interests: Micro Sensors, Micro Electronic Mechanical Systems (MEMS), Tribology, and Computer-aided Engineering Design.

**FREDERICK A. JUST**, *Professor*, Ph.D., 1997, Virginia Polytechnic Institute and State University. Research and Teaching interests: Damage, Detection, Vibration Control/Smart Structures, Alternative Vehicle Design.

**JOSE LUGO**, *Professor*, Ph.D., 2013, University of Notre Dame. Research and Teaching interest: Design Theory and Methodology, Optimization, CAE, VR, and Quantification of Product's Aesthetics.

**MARCO MENEGOZZO**, *Associate Professor,* Ph.D., 2015, University of Padova, Italy. Research and Teaching interest: Aerospace Structures, Reliability–Based Design Optimization and Aeroelasticity.

**NÉSTOR L. PÉREZ**, *Professor*, Ph.D., 1989, University of Idaho. Research and Teaching interests: Material Characterization, Alloy Development, Rapid Solidification, Corrosion, Fracture Mechanics and Non-destructive Evaluation.

**FERNANDO E. PLA-BARBY**, *Emeritus Professor*, Ph.D., 1978, University of Texas-Austin. Research and Teaching interests: Heat transfer, HVAC Systems, Design of Thermal and Energy System Sciences.

**PEDRO QUINTERO**, *Professor*, Ph.D., 2007, University of Maryland. Research and Teaching interest: Electronic Packaging for Power Electronics, Electronic packaging for High Temperature and Harsh Environments, Pb-Free Electronics: Materials and Manufacturing Processes, Transient Liquid Phase Sintering.

**PEDRO J. RESTO IRIZARRY**, *Professor*, Ph.D., 2012, University of Wisconsin, Madison. Research and Teaching Interests: Biomedical Engineering, Biomedical Micro-Electro-Mechanical Systems (BioMEMS), Biosensors, Mechatronics, System Dynamics.

**DAVID SERRANO**, *Professor*, Sc.D., 1987, Massachusetts Institute of Technology. Research and Teaching interests: Artificial Intelligence, CAE, Concentrating Based Systems.

**SHEILLA TORRES NIEVES**, *Professor*, Ph.D., 2011, Rensselaer Polytechnic Institute. Research and Teaching Interests: Experimental and Computational Fluid Dynamics, Turbulence, Boundary Layer, Applications: Aerospace, Turbomachinery, Wind Energy, Environmental and Atmospheric Flows.

**RICK VALENTÍN**, *Professor*, Ph.D., 2003, University of Maryland. Research and Teaching interest: Electronic Interconnects, Computer-Aided Engineering, Nano-templates, Fuel Cells, Porous media Manufacturing and Transport Analysis.

# INTERDISCIPLINARY PROGRAMS

The University of Puerto Rico at Mayagüez regards interdisciplinary programs as an important element of growth in its education and research missions.

Interdisciplinary programs involve a number of academic fields and are offered by faculty from many academic departments. These programs are designed to convey subjects which intersect more than one academic discipline, providing the flexibility and breath needed to undertake fast-moving research and technical innovations.

Interdisciplinary programs are administered by program directors or coordinators and draw their resources mainly from traditional academic departments. Students are encouraged to contact the directors of these programs to learn more about their range of courses, research and professional opportunities.

## DOCTORAL PROGRAM IN COMPUTING AND INFORMATION SCIENCES AND ENGINEERING

The University of Puerto Rico at Mayagüez offers an academic program leading to a Ph.D in Computing and Information Sciences and Engineering (CISE). The CISE doctorate covers a wide range of advanced studies and research problems of interdisciplinary nature in computing and information sciences and engineering organized around two concentrations, namely, Computer Science and Engineering, and Scientific Computing. The specialty in Computer Science and Engineering offers courses and research problems that involve the design, analysis, and development of software and digital information systems. The specialty in Scientific Computing focuses on the use of high-performance computing for the solution of problems in science and engineering.

The program aims at preparing leaders of information technology innovation for highly qualified careers in academia, government or industry. A student planning to enter the Ph.D. in CISE must be in possession of a B.S. in Engineering or Science, and have passed undergraduate courses in Data Structures, Introduction to Computing Foundations, Discrete Math, and Programming Languages; or their equivalents. Qualified students that are deficient in one or more of these courses can enter the program but shall remove these deficiencies during their first two years of study. All applicants must submit an essay explaining their personal vision of the discipline, and professional expectations.

The doctorate in CISE requires a minimum of 57 academic credits distributed as follows:

- Nine (9) credits in core courses,
- Twelve (12) credits in elective courses inside the selected specialty,
- Nine (9) credits in elective courses outside the student's specialty,
- Six (6) credits in advanced topics courses,
- Three (3) credits in seminars, and
- Eighteen (18) credits in a doctoral dissertation.

The core courses of the program are: Analysis of Algorithms, Foundations of Computing, and Computer Architectures. The elective courses for the specialty of Computer Science and Engineering may be selected from the elective courses of the Master in Science in Computer Engineering or the Master in Science in Software Engineering, while the electives for the specialty of Scientific Computing, from the Master in Science in Scientific Computing.

All students shall pass a Qualifying Exam that is based on the subjects covered in the core courses, and a Candidacy Exam, which is essentially the presentation before the student’s graduate committee of the student's research proposal leading to his or her doctoral dissertation.

Overall, the curriculum of the doctorate in CISE emphasizes research and creativity over passive learning. The main results of the student’s doctoral dissertation are expected to be published in a recognized journal before the Ph.D. is conferred.

**PROGRAM OF STUDY**

**DOCTORAL PROGRAM IN COMPUTING AND INFORMATION SCIENCES AND ENGINEERING CURRICULUM**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| CIIC 6005 | 3 | Computing Foundations |
| COMP 6785 | 3 | Algorithm Analysis |
| ELECTIVE | 3 | area of specialization |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| INEL 6009 | 3 | Computer Systems Architecture |
| ELECTIVE | 3 | out of area of specialization |
| ELECTIVE | 3 | area of specialization |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| ELECTIVE | 3 | area of specialization |
| ELECTIVE | 3 | out of area of specialization |
| ELECTIVE | 3 | out of area of specialization |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| ELECTIVE | 3 | area of specialization |
| CIIC 8995 | 3 | Advanced Topics |
| CIIC 9995 | 3 | Doctoral Dissertation |
| | 9 | |

**THIRD YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| CIIC 8996 | 1 | Doctoral Seminar |
| CIIC 9995 | 3 | Doctoral Dissertation |
| | 4 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| CIIC 8996 | 1 | Doctoral Seminar |
| CIIC 8995 | 3 | Advanced Topics |
| CIIC 9995 | 3 | Doctoral Dissertation |
| | 7 | |

**FOURTH YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| CIIC 8996 | 1 | Doctoral Seminar |
| CIIC 9995 | 3 | Doctoral Dissertation |
| | 4 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| CIIC 9995 | 6 | Doctoral Dissertation |
| | 6 | |

**Total Credits 57**

More information is available at: https://www.uprm.edu/cse/phd-computing-and-information-sciences-and-engineering-cise/

# BIOENGINEERING GRADUATE PROGRAM

## BIOENGINEERING MASTER'S PROGRAM

The Bioengineering Master's Program of the University of Puerto Rico – Mayagüez (UPRM) trains students in bioengineering by integrating the skills and competences of engineering, computational sciences, natural sciences, and medicine, while establishing an entrepreneurial culture within the students to focus on product-oriented research and development for future commercialization. Another program objective is to prepare graduates that are aware of the ethical and social responsibilities associated to the solution of technical problems in bioengineering.

The bioengineering program focuses on computational bioengineering and biomedical engineering research. It draws on internal areas of emphasis in order to guide students in their curriculum and maintain a flexible structure that is adaptable to technological evolutions.

Students graduating from the master's degrees will possess the following qualifications:

- In-depth knowledge in a specific area of bioengineering.
- Breadth of knowledge in the core areas of bioengineering and supporting disciplines.
- Ability to formulate a complex bioengineering problem and outline viable solution by integrating and applying basic principles of biology and engineering/physical sciences.
- Ability to work in a multidisciplinary environment.
- Ability to effectively communicate technical and scientific findings.
- Awareness of ethical and social issues.
- Entrepreneurial consciousness.

Two master's degrees are offered, which correspond to Plans I, II and III, as described in Certification 09-09 of the University of Puerto Rico-Mayagüez's Academic Senate.

**Master's of Science (Plan I - Thesis).** This program consists of a total of 31 credit-hours: nine credit-hours in bioengineering core courses, six credit-hours in bioengineering courses, six credit-hours in courses outside of bioengineering, three credit-hours in elective courses, six credit-hours in master's thesis, and one credit-hour in graduate seminar.

**Master's of Engineering (Plan II - Project).** This program consists of a total of 31 credit-hours: nine credit-hours in bioengineering core courses, six credit-hours in bioengineering courses, six credit-hours in courses outside of bioengineering, three credit-hours in elective courses, six credit-hours in engineering project, and one credit-hour in graduate seminar.

**Master's of Engineering (Plan III).** This program consists of a total of 31 credit-hours: nine credit hours in bioengineering core courses, twelve credit-hours in bioengineering courses, six credit-hours in courses outside of bioengineering, three credit-hours in elective courses, and one credit-hour in graduate seminar.

The degrees conferred will be Master of Science in Bioengineering to students that complete Plan I (thesis) and Master of Engineering in Bioengineering to students that complete Plan II (project) or Plan III (courses-only). The program's graduate committee will consider transfers from the doctoral program in bioengineering into the master's program, with previous recommendation from the student's thesis committee and from the program's executive director.

**Admission Requirements**

General requirements for admission into graduate programs at the University of Puerto Rico-Mayagüez are established in Certification 09-09 of the University of Puerto Rico-Mayagüez's Academic Senate. In addition, the Bioengineering Master's Program requires that applicants possess:

- A baccalaureate degree in engineering with a minimum grade point average (GPA) of **3.20** on a scale of **4.00**, from an accredited institution of higher learning. Depending on the applicant's academic background, admission may be granted with deficiency courses. Applicants will be encouraged, but not required, to have approved undergraduate courses in human anatomy and physiology, human cellular and molecular biology, or both.
- A baccalaureate degree in physics, chemistry, biology or related areas with a minimum grade point average (GPA) of **3.20** on a scale of **4.00**, from an accredited institution of higher learning, and with a mathematical background at the level of differential equations. Depending on the applicant's academic

background, admission may be granted with deficiency courses. Applicants will be encouraged, but not required, to have approved undergraduate courses in human anatomy and physiology, human cellular and molecular biology, or both.

- International students for whom English is not the first language are required to submit a Test of English as a Foreign Language (TOEFL) exam score.

**Graduation Requirements**

The general academic requirements for conferring the Master's of Science or Master's of Engineering degrees are established in Certification 09-09 of the University of Puerto Rico-Mayagüez's Academic Senate. Specific requirements for each degree in the graduate program in bioengineering are described below.

***Total Credit-Hour Requirement***

Students entering the **Master's of Science (Plan I - Thesis)** program are required to approve a minimum of thirty-one (31) credit-hours distributed in the following manner:

- 9 credit-hours in core courses
  - Principles of Biomedical Engineering (INME 6065)
  - Principles of Computational Bioengineering (BING 6004)
  - Molecular and Cellular Biology for Engineers (BING 6002)
- 6 credit-hours in bioengineering courses
- 6 credit-hours in courses outside of bioengineering
- 3 credit-hours in elective courses (either in bioengineering or outside)
- 1 credit-hour in graduate seminar (BING 8998)
  - The topics covered in the seminar will include:
    - Scientific issues
    - Social and ethical issues
    - Entrepreneurship
- 6 credit-hours in master's thesis (BING 6999)

**CURRICULUM FOR STUDENTS IN THE M.S. PROGRAM (Plan I)**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| BING 6002 | 3 | Molecular and Cellular Biology for Engineers |
| INME 6065 | 3 | Principles of Biomedical Engineering |
| Elective | 3 | Elective |
| BING 8998 | 0 | Graduate Seminar |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| BING 6004 | 3 | Principles of Computational Bioengineering |
| Technical Elective | 3 | Outside of bioengineering |
| Technical Elective | 3 | Outside of bioengineering |
| BING 8998 | 0 | Graduate Seminar |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| BING XXX | 3 | Bioengineering course |
| BING XXX | 3 | Bioengineering course |
| BING 6999 | 3 | Master's Thesis |
| BING 8998 | 0 | Graduate Seminar |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| BING 6999 | 3 | Doctoral Dissertation |
| BING 8998 | 1 | Graduate Seminar |
| | 4 | |

**Total Credits: 31**

Students entering the **Masters of Engineering (Plan II - Project)** program are required to approve a minimum of thirty-one (31) credit-hours distributed in the following manner:

- 9 credit-hours in core courses
  - Principles of Biomedical Engineering (INME6065)
  - Principles of Computational Bioengineering (BING 6004)
  - Molecular and Cellular Biology for Engineers (BING 6002)
- 6 credit-hours in bioengineering courses
- 6 credit-hours in courses outside of bioengineering
- 3 credit-hours in elective courses (either in bioengineering or outside)
- 1 credit-hour in seminar (BING 8998)
  - The topics covered in the seminar will include:
    - Scientific issues
    - Social and ethical issues
    - Entrepreneurship
- 6 credit-hours in engineering project (BING 6998)

**CURRICULUM FOR STUDENTS IN THE M.S. PROGRAM (Plan II)**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| BING 6002 | 3 | Molecular and Cellular Biology for Engineers |
| INME 6065 | 3 | Principles of Biomedical Engineering |
| Elective | 3 | Elective |
| BING 8998 | 0 | Graduate Seminar |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| BING 6004 | 3 | Principles of Computational Bioengineering |
| Technical Elective | 3 | Outside of bioengineering |
| Technical Elective | 3 | Outside of bioengineering |
| BING 8998 | 0 | Graduate Seminar |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| BING XXX | 3 | Bioengineering course |
| BING XXX | 3 | Bioengineering course |
| BING 6998 | 3 | Engineering Project |
| BING 8998 | 0 | Graduate Seminar |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| BING 6999 | 3 | Engineering Project |
| BING 8998 | 1 | Graduate Seminar |
| | 4 | |

**Total Credits: 31**

Students entering the **Master's of Engineering (Plan III – Courses Only)** program are required to approve a minimum of thirty-seven (37) credit-hours distributed in the following manner:

- 9 credit-hours in core courses
  - Principles of Biomedical Engineering (INME6065)
  - Principles of Computational Bioengineering (BING 6004)
  - Molecular and Cellular Biology for Engineers (BING 6002)
- 12 credit-hours in bioengineering courses
- 6 credit-hours in courses outside of bioengineering
- 3 credit-hours in elective courses (either in bioengineering or outside)
- 1 credit-hour in seminar (BING 8998)
  - The topics covered in the seminar will include:
    - Scientific issues
    - Social and ethical issues
    - Entrepreneurship

**CURRICULUM FOR STUDENTS IN THE M.S. PROGRAM (Plan III)**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| BING 6002 | 3 | Molecular and Cellular Biology for Engineers |
| INME 6065 | 3 | Principles of Biomedical Engineering |
| BING XXX | 3 | Bioengineering course |
| BING 8998 | 0 | Graduate Seminar |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| BING 6004 | 3 | Principles of Computational Bioengineering |
| Technical Elective | 3 | Outside of bioengineering |
| Technical Elective | 3 | Outside of bioengineering |
| BING 8998 | 0 | Graduate Seminar |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| BING XXX | 3 | Bioengineering course |
| BING XXX | 3 | Bioengineering course |
| BING XXX | 3 | Bioengineering course |
| BING 8998 | 0 | Graduate Seminar |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| Elective | 3 | Elective |
| BING 8998 | 1 | Graduate Seminar |
| | 4 | |

**Total Credits: 31**

Students will prepare a plan of study before the second month of their second semester of studies, and under the guidance of the student's graduate committee. The plan of study will be prepared taking into consideration: the student's academic and research interests, suitability of courses to prepare students for their research or project work, and academic offer. No more than 9 credit-hours of advanced undergraduate level courses can be used to complete degree requirements.

***Minimum Academic Index Requirements***

In order to complete the master's degree, each student must approve the required minimum credit-hours with a GPA of 3.0 or higher. Students enrolled in the graduate program may repeat a course with an earned grade of C or lower only once. Courses with a final grade of A or B cannot be repeated.

***Maximum Number of Transfer Credits Allowed***

Graduate courses taken at UPRM to fulfill requirements of another program may be utilized to fulfill the requirements of the bioengineering program. Courses taken at other institutions of higher learning may be utilized to fulfill master's program requirements, but are subject to residency requirements as specified in Certification 09-09 of the University of Puerto Rico-Mayagüez's Academic Senate. These norms stipulate that 60% of the courses in a student's plan of study must have been taken at UPRM. The program's graduate committee will determine which courses could be transferred. All transfer courses must be approved with a minimum grade of B. Under no conditions may thesis credits be transferred.

***Residency***

The "Norms that Regulate Graduate Studies at UPRM" stipulate the residency requirements as follows:
*"Residency requirements at the Master's level: a minimum of two semesters of study at UPRM and having completed sixty (60) percent of the course work for the program at UPRM."*

***Graduate Seminar***

Master's students will be required to register for the Graduate Seminar in Bioengineering course for the duration of their studies and will be awarded one credit-hour the end of their last semester of studies. Besides scientific and technical topics, the graduate seminar will also cover topics related to entrepreneurship, intellectual property, and social and ethical issues related to the field of bioengineering.

***Master's Thesis or Project (Plan I and Plan II only)***

Master's students enrolled in **Plan I (Master of Science degree)** are required to conduct a research project in bioengineering. Students are required to submit a thesis proposal for the approval of the student's graduate committee, complete the proposed research work, prepare a thesis and orally defend the thesis.

Master's students enrolled in **Plan II (Master of Engineering degree)** are required to develop an engineering project in bioengineering. Students are required to submit a project proposal for the approval of the student's graduate committee, complete the project, prepare a written project report, and orally defend this project.

## BIOENGINEERING DOCTORAL PROGRAM

The Bioengineering Doctoral Program of the University of Puerto Rico – Mayagüez (UPRM) trains students to become researchers in bioengineering by integrating the skills and competences of engineering, computational sciences, natural sciences, and medicine, while establishing an entrepreneurial culture within the students to focus on product-oriented research for future commercialization. Another program objective is to prepare graduates that are aware of the ethical and social responsibilities associated to the solution of technical problems in bioengineering.

Students graduating from the doctoral program will possess the following qualifications:

- In-depth knowledge in a specific area of bioengineering.
- Breadth of knowledge in the core areas of bioengineering and supporting disciplines.
- Ability to independently conduct research.
- Ability to formulate a complex bioengineering problem and outline viable solution by integrating and applying basic principles of biology and engineering/physical sciences.
- Ability to work in a multidisciplinary environment.
- Ability to effectively communicate technical and scientific findings.
- Awareness of ethical and social issues.
- Entrepreneurial consciousness.

The program draws on internal areas of emphasis in order to guide students in their curriculum and research and to maintain a flexible structure that will allow the program to adapt itself to technological evolutions. The bioengineering program focuses on:

**Bioinformatics/Computing**
**Nano-medicine**
**Neuro-engineering**
**Microfluidics**
**Medical ultrasound**
**Applied biology**
**Assistive technologies**
**Biomaterials**

research, and consists of a total of **forty nine (49) credit-hours** for students entering the program with a **B.S. degree**, and **thirty-four (34) credit-hours** for students entering the program with an **M.S. or M.E. degree**. Of the forty-nine credit-hours, nine credit-hours will be in bioengineering core courses, six credit-hours in bioengineering courses, nine credit-hours in courses outside of bioengineering, six credit hours in elective courses, one credit-hour in graduate seminar, and eighteen credit-hours in doctoral dissertation. For students entering with an M.S. degree, 34 credit-hours will be required in the following manner: nine credit-hours in core courses, three credit-hours in bioengineering courses, three credit-hours in courses outside of bioengineering, one credit-hour in graduate seminar, and eighteen credit-hours in doctoral dissertation. Each doctoral student will be required to participate in the graduate seminar each semester and will receive one credit at the conclusion of his dissertation. Students will also be required to pass a qualifying exam, prepare a dissertation proposal and complete a dissertation research project that will demonstrate the scope of acquired knowledge and the student's creativity and scientific rigor. The dissertation must be an original contribution to the existing scientific and/or technical body of knowledge in the field of bioengineering.

**Admission Requirements**

General academic requirements for admission to the Ph.D. are included in Certification 09-09 issued by the UPRM Academic Senate. Additional specific program requirements are:

**Students entering the program with a B.S. degree**

- A baccalaureate degree in engineering with a minimum grade point average (GPA) of 3.20 on a scale of 4.00, from an accredited institution of higher learning. Depending on the applicant's academic background, admission may be granted with deficiency courses. Applicants will be encouraged, but not required, to have approved undergraduate courses in human anatomy and physiology, human cellular and molecular biology, or both.
- A baccalaureate degree in physics, chemistry, biology or related areas with a minimum grade point average (GPA) of 3.20 on a scale of 4.00, from an accredited institution of higher learning, and with a mathematical background at the level of differential equations. Depending on the applicant's academic background, admission may be granted with deficiency courses. Applicants will be encouraged, but not required, to have approved undergraduate courses in human anatomy and physiology, human cellular and molecular biology, or both.
- International students for whom English is not the first language are required submit a Test of English as a Second Language (TOEFL) exam score.

**Student entering the program with an M.S. or M.E. degree**

- A master's degree in engineering from an accredited institution of higher learning. Depending on the applicant's academic background, admission may be granted with deficiency courses. Applicants will be encouraged, but not required, to have approved undergraduate or graduate courses in human anatomy and physiology, human cellular and molecular biology, or both.
- A master's degree in physics, chemistry, biology or related areas from an accredited institution of higher learning, and with a mathematical background at the level of differential equations. Depending on the applicant's academic background, admission may be granted with deficiency courses. Applicants will be encouraged, but not required, to have approved undergraduate or graduate courses in human anatomy and physiology, human cellular and molecular biology, or both.
- International students for whom English is not the first language are required submit a Test of English as a Second Language (TOEFL) exam score.

The same norms established by the UPRM's Academic Senate as well as all previously described admission guidelines to the doctoral program are applicable to transfer students. The program's graduate committee will consider transfers from the doctoral program into the master's program, with previous recommendation from the student's thesis committee and from the program's executive director.

**Graduation Requirements**

The general academic requirements for conferring the doctoral degree are stated in Certification 09-09 of the UPRM's Academic Senate. Specific requirements for the Doctoral Program in Bioengineering are described below.

Students entering the program with a **B.S. degree** are required to approve a minimum of **forty-nine (49) credit-hours** distributed in the following manner:

- 9 credit-hours in core courses
  - Principles of Biomedical Engineering (INME6065)
  - Principles of Computational Bioengineering (BING 6004)
  - Molecular and Cellular Biology for Engineers (BING 6002)
- 6 credit-hours in bioengineering courses
- 9 credit-hours in courses outside of bioengineering
- 6 credit-hours in elective courses (either in bioengineering or outside)
- 1 credit-hour in seminar (BING 8998)
  - The topics covered in the seminar will include:
    - Scientific issues
    - Social and ethical issues
    - Entrepreneurship
- 18 credit-hours in doctoral dissertation (BING 8999)

**CURRICULUM FOR STUDENTS ENTERING THE PROGRAM WITH A B.S. DEGREE**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| BING 6002 | 3 | Molecular and Cellular Biology for Engineers |
| INME 6065 | 3 | Principles of Biomedical Engineering |
| Elective | 3 | Elective |
| BING 8998 | 0 | Graduate Seminar |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| BING 6004 | 3 | Principles of Computational Bioengineering |
| Technical Elective | 3 | Outside of bioengineering |
| Technical Elective | 3 | Outside of bioengineering |
| BING 8998 | 0 | Graduate Seminar |
| | 9 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| BING XXX | 3 | Bioengineering course |
| BING XXX | 3 | Bioengineering course |
| Technical Elective | 3 | Outside of bioengineering |
| BING 8998 | 0 | Graduate Seminar |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| Elective | 3 | Elective |
| BING 8999 | 3 | Doctoral Dissertation |
| BING 8998 | 0 | Graduate Seminar |
| | 6 | |

**THIRD YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| BING 8999 | 3 | Doctoral Dissertation |
| BING 8998 | 0 | Graduate Seminar |
| | 3 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| BING 8999 | 3 | Doctoral Dissertation |
| BING 8998 | 0 | Graduate Seminar |
| | 3 | |

**FOURTH YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| BING 8999 | 6 | Doctoral Dissertation |
| BING 8998 | 0 | Graduate Seminar |
| | 6 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| BING 8999 | 3 | Doctoral Dissertation |
| BING 8998 | 1 | Graduate Seminar |
| | 4 | |

**Total Credits: 49**

Students entering the program with an **M.S. or M.E. degree** are required to approve a minimum of **thirty-four (34) credit-hours** distributed in the following manner:

- 9 credit-hours in core courses
  - Principles of Biomedical Engineering (INME6065)
  - Principles of Computational Bioengineering (BING 6004)
  - Molecular and Cellular Biology for Engineers (BING 6002)
- 3 credit-hours in bioengineering courses
- 3 credit-hours in courses outside of bioengineering
- 1 credit-hour in seminar (BING 8998)
  - The topics covered in the seminar will include:
    - Scientific issues
    - Social and ethical issues
    - Entrepreneurship
- 18 credit-hours in doctoral dissertation (BING 8999)

**CURRICULUM FOR STUDENTS ENTERING THE PROGRAM WITH AN M.S. or M.E. DEGREE**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| BING 6002 | 3 | Molecular and Cellular Biology for Engineers |
| INME 6065 | 3 | Principles of Biomedical Engineering |
| BING XXX | 3 | Bioengineering course |
| BING 8998 | 0 | Graduate Seminar |
| | 9 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| BING 6004 | 3 | Principles of Computational Bioengineering |
| Technical Elective | 3 | Outside of bioengineering |
| BING 8998 | 0 | Graduate Seminar |
| | 6 | |

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| BING 8999 | 6 | Doctoral Dissertation |
| BING 8998 | 0 | Graduate Seminar |
| | 6 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| BING 8999 | 6 | Doctoral Dissertation |
| BING 8998 | 0 | Graduate Seminar |
| | 6 | |

**THIRD YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| BING 8999 | 3 | Doctoral Dissertation |
| BING 8998 | 0 | Graduate Seminar |
| | 3 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| BING 8999 | 3 | Doctoral Dissertation |
| BING 8998 | 1 | Graduate Seminar |
| | 4 | |

**Total Credits: 34**

Students will prepare a plan of study before the second month of their second semester of studies, and under the guidance of the student's graduate committee. The plan of study will be prepared taking into consideration: the student's academic and research interests, suitability of courses to prepare students for their research work, and academic offer. No more than 9 credit-hours of advanced undergraduate level courses can be used to complete doctoral degree requirements.

***Minimum Academic Index Requirements***

In order to complete the doctoral degree, each student must approve a minimum of 49 credit-hours with a GPA of 3.0 or higher. Students enrolled in the doctoral program may repeat a course with an earned grade of C or lower only once. Courses with a final grade of A or B cannot be repeated.

***Maximum Number of Transfer Credits to be Allowed***

Courses taken at UPRM in fulfillment of requirements of another graduate program may be utilized to fulfill the requirements of the proposed program. Courses taken at other institutions of higher learning may be utilized to fulfill doctoral program requirements, but are subject to residency requirements as specified in Certification 09-09 which establishes that 60% of the courses in a student's plan of study must have been taken at UPRM. The program's graduate committee will determine which courses could be transferred. All transfer courses must be approved with a minimum grade of B. Under no conditions may thesis credits be transferred.

***Residency***

The "Norms that Regulate Graduate Studies at UPRM" stipulate the residency requirements as follows:
*"Residency requirements at the Doctoral level: a minimum of four semesters for students entering*

*with a Bachelors degree, and a minimum of two semesters for students entering with a Master's degree. In both cases the student will complete sixty (60) percent of the course work for the program at UPRM."*

***Graduate Seminar***

Doctoral students will be required to register for the Graduate Seminar in Bioengineering course for the duration of their doctoral studies and will be awarded one credit-hour the semester the dissertation is turned in. Besides scientific and technical topics, the graduate seminar will also cover topics related to entrepreneurship, intellectual property, and social and ethical issues related to the field of bioengineering.

***Qualifying Exam***

All doctoral students will be required to take a doctoral qualifying examination in order to evaluate the candidate's competency in bioengineering core areas. The examination consists of three written parts, which will be prepared, supervised and evaluated by the program's Graduate Studies Committee in coordination with its faculty.

A student who has passed the examination will be allowed to register in BING 8999 – Doctoral Dissertation. This student is henceforth regarded as a doctoral degree candidate in the Bioengineering Program at UPRM.

A student who has failed the qualifying examination the first time may retake it a second and final time within one semester of the first attempt. According to UPRM regulations, a second failure will result in the student's dismissal from the graduate program. If the student does not hold a Master's degree in Bioengineering, the student will be given the opportunity to transfer to the Bioengineering's Master of Science or Master of Engineering programs. If none of these options is selected, the student will be suspended from the Bioengineering graduate program. After one year of suspension, the student may apply for a second and final admission to the same program or to another UPRM graduate program.

***Dissertation Proposal***

After successfully passing the qualifying examination, the doctoral student is required to submit a research proposal regarding his/her project of interest. Following the acceptance of the research proposal, the student is given a comprehensive examination to determine initiative, originality, breadth, and high level of professional commitment to the problem selected for investigation. This dissertation proposal exam consists of a written part (the proposal) and an oral defense of the proposal.

***Dissertation***

All Ph.D. candidates must undertake an independent research project that becomes a significant contribution to the advancement of knowledge in a particular area of bioengineering. All doctoral candidates must pass the oral exam in defense of his/her dissertation. Students must have passed the qualifying examination in order to register for the doctoral dissertation course, and have passed the preliminary exam before defending his/her thesis.

***Publication in Peer-Reviewed Journals***

All students should have at least one (1) scientific article related to the dissertation submitted in a peer-reviewed journal before the thesis defense.

## FACULTY

The UPRM Bioengineering Graduate Program has a very active interdisciplinary group of faculty members. Faculty members come from various academic departments within the Colleges of Engineering and Arts and Sciences.

**MAURICIO CABRERA-RÍOS**, *Professor*, Ph.D., 2002, Ohio State University. Research areas: Bioinformatics, Probability and Statistics.

**SILVINA CANCELOS**, *Assistant Professor*, Ph.D., 2007, Rensselaer Polytechnic Institute. Research areas: Biomedical Acoustics, Bubble Dynamics.

**MIGUEL E. CASTRO**, *Professor*, Ph.D., 1991, University of Texas. Research areas: Nanoscaled Sensors.

**UBALDO CÓRDOBA,** *Professor*, Ph.D., 2008, California Institute of Technology. Research areas: Transport phenomena, applied mathematics.

**SAYLISSE DÁVILA,** *Professor*, Ph.D., 2010, Arizona State University. Research areas: Applied statistics, multivariate data analysis, healthcare.

**RUBÉN DÍAZ**, *Professor*, Ph.D., 2005,University of California, Berkeley. Research areas: Transport Phenomena in Biological Systems, Micro/Nano Fabrication Technologies.

**MARIBELLA DOMENECH-GARCÍA,** *Professor*, Ph.D., 2010, University of Wisconsin, Madison. Research areas: Tumor cell Signaling, Microfluidic Systems for 3D Cell Culture.

**DAVID R. GONZÁLEZ-BARRETO,** *Professor,* Ph.D., 1996, Pennsylvania State University. Research area: Experimental Design.

**SAMUEL P. HERNÁNDEZ-RIVERA**, *Professor*, Ph.D., 1986, Johns Hopkins University. Research area: Spectroscopy.

**CLARA E. ISAZA,** *Assistant Professor,* Ph.D., 2005, Ohio State University. Research areas: BioOptimatics, Biochemistry, Public Health.

**EDUARDO J. JUAN-GARCÍA,** *Professor*, Ph.D., 2001, Purdue University. Research areas: Biomedical Acoustics, Bioinstrumentation.

**MAGDA LATORRE-ESTEVES**, *Associate Researcher*, Ph.D., 2006, Harvard Medical School. Research area: Nanoparticle-cell interactions.

**JUAN LÓPEZ-GARRIGA**, *Professor*, Ph.D., 1986, Michigan State University. Research areas: Structure and Function Relationships in Hemeproteins.

**VIDYA MANIAN**, *Professor*, Ph.D., 2004, University of Puerto Rico – Mayagüez. Research areas: Brain Computer Interfaces, Brain Imaging, Image Processing, Biosensory Data Fusion.

**LOURDES A. MEDINA-AVILÉS,** *Professor,* Ph.D., 2012, Pennsylvania State University. Research areas: Medical Device Development and Manufacturing.

**JUAN C. MARTÍNEZ-CRUZADO**, *Professor*, Ph.D., 1988, Harvard University. Research area: Molecular Biology.

**ENRIQUE MELÉNDEZ,** *Professor,* Ph.D., 1990, University of Utah. Research areas: Metal-based Drugs and Biosensors.

**PATRICIA ORTIZ-BERMUDEZ**, *Professor*, Ph.D., 2005, University of Wisconsin, Madison. Research areas: Biotechnology, Microbiology.

**PEDRO J. RESTO IRIZARRY**, *Professor*, Ph.D., 2012, University of Wisconsin, Madison. Research area: Microfluidic Devices.

**KAREN RÍOS-SOTO**, *Professor*, Ph.D., 2008, Biometry/Computational Biology Cornell University. Research area: Biological Statistics and Computational Biology.

**MANUEL RODRÍGUEZ-MARTÍNEZ**, *Professor*, Ph.D., 2001, Computer Science University of Maryland. Research area: Database Management Systems.

**FÉLIX R. ROMÁN VELÁZQUEZ**, *Professor*, Ph.D., 1989, University of Nebraska-Lincoln. Research and Teaching interest: Pesticides in biological and environmental matrices; Determination of heavy metals, antioxidants and other compounds in food samples.

**DAVID SERRANO**, *Professor*, Sc.D., 1987, Massachusetts Institute of Technology. Research area: Rehabilitative Medical Devices.

**HEIDY SIERRA,** *Assistant Professor*, Ph.D., 2010, Northeastern University. Research areas: Biophotonics.

**OSCAR MARCELO SUÁREZ,** *Professor*, Ph.D., 2000, University of Wisconsin-Madison. Research areas: Multifunctional biopolymer-matrix composites.

**PAUL A. SUNDARAM**, *Professor*, Ph.D., 1988, The Ohio State University. Research area: Biomaterials.

**WANDALIZ TORRES GARCÍA,** *Associate Professor*, Ph.D., 2011, Arizona State University. Research areas: Data mining, Applied Statistics, Big data, Cancer Genomics, Bioinformatics, Simulation.

**MADELINE TORRES-LUGO,** *Professor*, Ph.D., 2001, Purdue University. Research areas: Polymers, Biomaterials, Hydrogel-Based Drug Delivery.

**BIENVENIDO VÉLEZ,** *Professor*, Ph.D., 1999, Massachusetts Institute of Technology. Research areas: Distributed Systems, Information Discovery and Retrieval.

# FOOD SCIENCE AND TECHNOLOGY PROGRAM

**Mission**

Contribute to food safety assurance and the availability of a high nutritional quality food supply through the preparation of capable Food Science and Technology professionals, scientific research, agile and accessible information dissemination, and new technology transfer and development.

**Vision**

To be leaders in formal education, knowledge dissemination, scientific research and technology transfer in the area of Food Science and Technology.

**Program Description**

The Mayagüez Campus of the University of Puerto Rico offers a program of study leading to the Master of Science degree in Food Science and Technology. Subject areas cover a wide range of basic and applied approaches in a multidisciplinary setting, including chemistry, engineering, microbiology, and food processing. The program is designed to prepare individuals for technical careers in the food and allied industries, government agencies, academia, and international agencies.

**General Requirements**

A student planning to enter the program should have a B.S. degree in a recognized branch of agriculture, biology, chemistry, engineering, microbiology, physics, or nutrition. Applicants should have the following courses or their equivalent: Food Microbiology (BIOL 4366), Calculus for Biological Sciences II (MATE 3022) or Engineering Calculus I (MATE 3031), Biochemistry (QUIM 5071), and Introductory Physics with Laboratory (FISI 3091 and FISI 3092). Candidates lacking any of the abovementioned courses will be expected to remove deficiencies during the first year of study.

**Program Educational Objectives**

The students completing the academic program of Food Science and Technology will be able to:

1. Integrate, apply and incorporate the principles of food science (chemistry, microbiology, engineering, and food processing) to the development and improvement of processes and products that guarantee food quality and safety.
2. Apply the knowledge and skills acquired to develop solutions to problems, situations and challenges in the food industry.

**Programs Goals**

- Prepare ethical, competent and entrepreneur professionals capable of contributing to the food industry
- Disseminate the necessary scientific knowledge and technology for food industry's growth and improvement
- Promote entrepreneurship

**Webpage:** https://www.uprm.edu/ciag/cita/

## PROGRAM OF STUDY

### CURRICULUM
### MASTER OF SCIENCE
### (PLAN I - with THESIS)

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| CITA 6010 | 0 | FST Orientation |
| QUIM 6001 | 3 | Advanced Food Chemistry |
| QUIM 6003 | 1 | Advanced Food Chemistry Lab |
| CITA 6601 | 3 | Food Processing I |
| | 3 | Professional Elective |
| | 10 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| BIOL 6705 | 3 | Advanced Food Microbiology |
| CITA 6615 | 3 | Food Technology |
| CITA 6999 | 2 | Thesis |
| | 8 | |

**Summer**

Students are strongly encouraged to dedicate this summer term to advance their research, participate in an internship experience or take food industry related certifications (e.g., GMP, HACCP, PCQI).

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| CITA 6603 | 1 | Food Processing Lab |
| CITA 6999 | 2 | Thesis |
| | 3 | Professional Elective |
| | 6 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| CITA 6655 | 1 | Seminar |
| CITA 6999 | 2 | Thesis |
| | 3 | Professional Elective |
| | 6 | |

**Total Credits 30**

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| CITA 6603 | 1 | Food Processing Lab |
| CITA 6992 | 3 | Final Project |
| | 3 | Professional Elective |
| | 7 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| CITA 6655 | 1 | Seminar |
| CITA 6992 | 2 | Final Project |
| | 3 | Professional Elective |
| | 6 | |

**Total Credits 30**

**CURRICULUM**
**PROFESSIONAL MASTER**
**(PLAN II - with PROJECT)**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| CITA 6010 | 0 | FST Orientation |
| QUIM 6001 | 3 | Advanced Food Chemistry |
| QUIM 6003 | 1 | Advanced Food Chemistry Lab |
| CITA 6601 | 3 | Food Processing I |
| CITA 6992 | 1 | Final Project |
| | 8 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| BIOL 6705 | 3 | Advanced Food Microbiology |
| CITA 6615 | 3 | Food Technology |
| | 3 | Professional Elective |
| | 9 | |

**Summer**

Students are strongly encouraged to dedicate this summer term to advance their research, participate in an internship experience or take food industry related certifications (e.g., GMP, HACCP, PCQI).

**CURRICULUM**
**PROFESSIONAL MASTER**
**(PLAN III - without THESIS OR PROJECT)**

**FIRST YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| CITA 6010 | 0 | FST Orientation |
| QUIM 6001 | 3 | Advanced Food Chemistry |
| QUIM 6003 | 1 | Advanced Food Chemistry Lab |
| CITA 6601 | 3 | Food Processing I |
| | 3 | Professional Elective |
| | 10 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| BIOL 6705 | 3 | Advanced Food Microbiology |
| CITA 6615 | 3 | Food Technology |
| AGRO 6600 | 3 | Advanced Biometry |
| | 9 | |

**Summer**

Students are strongly encouraged to dedicate this summer term to advance their research, participate in an internship experience or take food industry related certifications (e.g., GMP, HACCP, PCQI).

**SECOND YEAR**

**First Semester**

| Number | Credits | Course |
|---|---|---|
| CITA 6603 | 1 | Food Processing Lab |
| CITA 6006 | 3 | Food Safety |
| | 3 | Professional Elective |
| | 3 | Professional Elective |
| | 10 | |

**Second Semester**

| Number | Credits | Course |
|---|---|---|
| CITA 6655 | 1 | Seminar |
| CITA 6605 | 3 | Quality Management in the Food Industry |
| | 3 | Professional Elective |
| INTD 6015 | 0 | Comprehensive Exam Review |
| | 7 | |

**Total Credits 36**

## RECOMMENDED PROFESSIONAL ELECTIVES

| Number | Credits | Course |
|---|---|---|
| AGRO 5005 | 3 | Agricultural Biometrics |
| AGRO 6600 | 3 | Advanced Biometrics |
| CITA 5005 | 3 | Food Quality Control |
| CITA 5006 | 3 | Food Quality & Safety in Processing |
| CITA 5007 | 3 | Food Ind. Laws and Regulations |
| CITA 5010 | 3 | Culinology |
| CITA 6005 | 3 | Food Packaging |
| CITA 6006 | 3 | Food Safety |
| CITA 6007 | 3 | Safety of Fruit and Veg. Products |
| CITA 6015 | 3 | Antimicrobial Food Packaging |
| CITA 6017 | 3 | Food Toxicology |
| CITA 6018 | 3 | Microbial Adapt. and Food Safety |
| CITA 6019 | 3 | Food Sensory Analysis |
| CITA 6605 | 3 | Food Quality Management |
| CITA 6990 | 3 | Prof. Occupational Experience |
| HORT 6650 | 3 | Post Harvest of Horticultural Crops |
| CIAN 5346 | 3 | Dairy Products |
| CIAN 5357 | 3 | Science & Tech. of Fresh Meats |
| CIAN 6609 | 3 | Advanced Dairy Bacteriology |
| INQU 8025 | 3 | Food Fermentation and Biotech. |
| QUIM 6335 | 4 | Food Analysis |
| QUIM 6919 | 3 | Enzymes |

## FOOD SCIENCE AND TECHNOLOGY PROGRAM FACULTY

**MATÍAS J. CAFARO**, *Professor*, Ph.D., 2003, University of Kansas, Lawrence. Research and Teaching interests: Mycology, Molecular Systematics, Food Microbiology and Food Safety.

**ANGEL O. CUSTODIO-GONZALEZ**, *Associate Professor*, PhD., 2005, Harvard University. Research and Teaching interests: Molecular Genetics, Food Safety, Product Development and Culinology.

**ROSA N. CHAVES-JÁUREGUI**, *Assistant Professor*, Ph.D., 1999, University of São Paulo, Brazil. Research and Teaching interests: Food Science, Food Sensory, Nutrition.

**MARCO A. DE JESÚS**, *Associate Professor*, Ph.D., 2004. UT, Knoxville. Research and Teaching interests: Analytical chemical separations, Chemical Sensing and Raman Spectroscopy.

**KATHERINE DOMENECH PÉREZ**, *Assistant Professor*, University of Nebraska-Lincoln. Research interests: Meat quality, Meat science.

**JOSE A. DUMAS**, *Professor*, Ph.D., 1999, University of Puerto Rico. Research and Teaching interests: Food Chemistry, Analytical Chemistry.

**JAVIER HUERTAS MIRANDA**, *Associate Professor*, Ph.D., 2012. University of Puerto Rico at Mayagüez. Research and Teaching interests: Fermentation, Computer Process Control.

**JOSÉ PABLO MORALES-PAYÁN**, *Professor*, Ph.D., 1999, University of Florida, Gainesville. Research and Teaching interests: Organic horticulture, fruit crops, post-harvest handling.

**LYNETTE E. ORELLANA FELICIANO**, *Professor*, Ph.D., 2004, Washington State University. Research and Teaching interests: Food Microbiology, Food Processing Food Safety, and Product Development.

**FERNANDO PÉREZ-MUÑOZ**, *Associate Professor*, Ph.D., 1996, Iowa State University. Research and Teaching interests: Food Processing, Process Improvement Engineering. Post-harvest Handling, Physical Properties of Food, Food Sensory and Product Development.

**MARÍA L. PLAZA**, *Assistant Professor*, Ph.D., 2010, University of Florida, Gainesville. Research and Teaching interests: Food Chemistry, Food Processing and Product Development.

**LEYDA PONCE DE LEÓN**, *Professor*, Ph.D., 1999, University of Wisconsin. Research and Teaching interests: Manufacture of Dairy Products, Dairy Microbiology.

**ELIDE VALENCIA**, *Professor*, Ph.D., 1997, University of Florida. Research and Teaching interest: Agronomy and Soils.

# *COURSES OF INSTRUCTION*

# *OFFICE OF THE DEAN OF ACADEMIC AFFAIRS*

**Graduate Interdisciplinary Courses**

**INTD 5001**. MULTIDISCIPLINARY ARCHAEOLOGY I. Three credit hours. Two hours of lecture and two hours of laboratory per week.

Introduction to the systematic description of archaeological data, their recording procedures, analysis, and methodical synthesis of the information obtained. Includes the analysis of material remains using approaches and techniques from diverse disciplines of the natural sciences and engineering. Organized in modules of archaeometry, analysis of archaeological materials, and synthesis of archaeological data.

**INTD 5002**. MULTIDISCIPLINARY ARCHAEOLOGY II. Three credit hours. Two hours of lecture and two hours of laboratory per week. Prerequisite: INTD 5001 or authorization of the Director of the Department.

Introduction to archaeological research in Puerto Rico and the Caribbean from a multidisciplinary perspective. Includes the study of archaeological sites and regions using approaches and techniques from diverse disciplines of the natural sciences and engineering. Organized in modules of introduction to archaeological theory; survey and remote sensing; excavation and geoarchaeology.

**INTD 5010**. INTRODUCTION TO NEUROSCIENCE. Three credit hours. Two hours of lecture and one hour of discussion per week.

Survey study of the nervous system, with emphasis on the structure, function and development of the human brain. Exploration of basic neuroanatomy, propagation of nerve impulses, and transfer of information between nerve cells. Analysis of cognitive and neural processes that support sensory systems, movement, emotions, memory, learning, and other domains such as language, number, music, navigation, and facial recognition. Discussion about the importance of evidence from brain pathologies and imaging techniques in cognitive science research.

**INTD 5095.** APPROPRIATE TECHNOLOGY. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

General overview of technology from historical and philosophical viewpoints. Critical examination of choice inherent in technology. Traditional and new definitions of appropriate technology. Challenges and best practices to apply engineering and technology to underserved, under-funded, or wrong-development communities.

**INTD 5500**. ADVANCED TOPICS IN COGNITIVE SCIENCE. One to six credit hours. The discussion and seminar contact hours will be according to the number of credits assigned to the course. This course may be taken several times. Prerequisite: authorization of the Director of the Department.

Exploratory course in a cognitive science advanced topic.

**INTD 5900**. RESEARCH SEMINAR IN COGNITIVE SCIENCE. One to six credit hours. The discussion and seminar contact hours will be according to the number of credits assigned to the course. This course may be taken several times. Prerequisites: (INTD 4110 and INTD 5010 and LING 4010) or authorization of the Director of the Department.

Exploration of a field of study in cognitive science. Literature search, reading and discussion of primary sources from the chosen subject. Identification and delimitation of a research problem, as well as the design of an original research project.

**INTD 6005**. THE PRACTICE OF TEACHING IN HIGHER EDUCATION. Three credit hours. Three hours of lecture per week.

Theoretical and practical issues regarding the teaching process at the university level. Study of the fundamentals of the teaching-learning process which includes: teaching and learning theories, instructional objectives, teaching planning, preparation, adaptation and use of educational materials, strategies, methods and techniques for effective teaching; and fundamentals in testing, evaluation, and assessment. All students are required to demonstrate proficiency in the areas studied by making a formal presentation.

**INTD 6006**. PROPOSAL AND THESIS WRITING. One credit hour. One hour of lecture per week.

Application of the principles of precise, clear, concise, formal writing in the preparation of research proposals, masters theses and doctoral dissertations.

**INTD 6015**. COMPREHENSIVE EXAMINATION PREPARATION. Zero credit hours. Prerequisite: to be an Option III graduate student and have completed all the courses in his program.

Study period to prepare for the comprehensive examination, which allows students to maintain their regular-student status.

**INTD 6017.** PHILOSOPHIC ASPECTS OF TECHNOLOGICAL CHANGE. Three credit hours. Three hours of lecture per week.

Study of non-technical aspects of the design and use of technologies with emphasis on the critical analysis of the idea of progress. Consideration of the political, cultural, and quality of life implications of current technological tendencies.

**INTD 6995**. INSTITUTIONAL COOP PLAN. Zero to three credit hours. Six to ten weeks during the summer or twelve to fifteen during the semester, depending on the required duration of the internship. Requisites: be a regular graduate student. To have applied to the government agency, private enterprise or foundation of his (her) choice, and to have complied with the requisites established by it. To have been selected by the host government agency, private enterprise of foundation.

Work experience supervised and evaluated by a faculty member in coordination with a government agency, private enterprise or foundation, according to the student's academic background and work requirements.

# *OFFICE OF THE DEAN OF STUDENTS*

## DEPARTMENT OF COUNSELING AND PSYCHOLOGICAL SERVICES

**UNIV 3005**. INTRODUCTION TO UNIVERSITY WAY OF LIFE. Zero credit hour. One hour of lecture per week.

Course directed towards a better understanding of the fundamental aspects that affect student life and adequate adjustments to the campus environment. Designed to enhance the academic and social integration in order to help students during their college years. Includes topics such as: study and communication skills, career planning, personal development, computer literacy, academic regulations, and institutional resources.

# *COLLEGE OF AGRICULTURAL SCIENCES*

**CIAG 6010**. PRECISION AGRICULTURE SYSTEMS. Three credit hours. Three hours of lecture per week.

Study of precision agriculture systems, including agricultural variability, global positioning systems (GPS), and geographic information systems (GIS). The course covers technologies for yield monitoring, the use of unmanned aerial vehicles (UAVs), and remote and proximal sensing techniques. It also addresses electronic control systems and the environmental and economic implications of these technologies.

**CIAG 6601**. SEMINAR I. One credit hour. One hour of seminar per week. Prerequisite: authorization of the Director of the Department.

Discussion, preparation and presentation of a research proposal. Assignments will emphasize skills in literature review, study and analysis of scientific articles, and management and compilation of information.

**CIAG 6602**. SEMINAR II. One credit hour. One hour of seminar per week. Prerequisite: authorization of the Director of the Department.

Discussion of current research focused on solving problems in agronomy, horticulture, crop protection, plant-biosecurity, soil, water and other natural resources, or other agro-environmental issues. Students will report findings of their research or a previously selected topic.

**CIAG 6995**. AGRICULTURAL SCIENCES GRADUATE INTERNSHIP. One to six credit hours. Prerequisite: authorization of the Director of the Department.

Work experience in Agricultural Sciences supervised and evaluated by a faculty member in coordination with a government agency, academic or research institution, private enterprise or foundation based on the student's academic background and work requirements.

**CIAG 8000**. ANALYSIS OF AGRICULTURE IN THE CARIBBEAN TROPICS. Three credit hours. Three hours of lecture per week.

Analysis of the importance of the Caribbean tropics in food production from the climatic, socioeconomic, technological, and bioethical perspectives that characterize the world at present. Study of the relevance of the tropics as a source of biodiversity and in the maintenance of ecological equilibrium, and of concepts of sustainable agriculture.

**CIAG 8005**. APPLIED STATISTICAL MODELS IN AGRICULTURAL RESEARCH. Three credit hours. Three hours of lecture per week.

Study and application of statistical models in the agricultural sciences, including linear and nonlinear regression, factorial analysis of variance, mixed models, and generalized linear models. Design of experiments, analysis of data, and use of statistical software. Previous knowledge of biometry or statistics is required.

**CIAG 8925**. DOCTORAL SEMINAR. Zero to three credit hours. One hour of seminar per week.

Oral presentation and discussion of current research topics, including the doctoral proposal and thesis research.

**CIAG 8999**. DOCTORAL RESEARCH AND THESIS. Zero to fifteen credit hours.

A research that constitutes a significant contribution to the student's area of specialization. Writing and defense of the doctoral dissertation is required.

**AGRICULTURAL ECONOMICS**

**Advanced Undergraduate Courses**

**ECAG 5006**. FEASIBILITY STUDIES AGRICULTURAL ENTERPRISES. Three credit hours. Three hours of lecture per week. Prerequisites: ECAG 4019 or authorization of the Director of the Department.

Use and application of feasibility studies for the establishment and development of agricultural enterprises, considering sustainability of the resources.

**Graduate Courses**

**ECAG 6006.** CONSUMER ECONOMICS. Three credit hours. Three hours of lecture per week.

Study of the rol of consumers in the economy of a nation and decision making in the market place. Analysis of economic principles of consumer behavior that affect consumer and producers decisions in the market of goods and services.

**ECAG 6601**. RESOURCE ECONOMICS. Three credit hours. Three hours of lecture per week.

Analysis of problems in the development and management of natural resources. Emphasis on natural resources in agriculture and their impact in economic development. Economic principles involved in efficient utilization of natural resources, such as water, land, sea and forest.

**ECAG 6604**. ADVANCED FARM MANAGEMENT (On demand). Three credit hours. Three hours of lecture per week.

Analysis of situations and problems related with management of farm businesses. Includes study and analysis of methods of collecting and analyzing farm data; marginal analysis and budgeting techniques; and managerial concepts as they apply to all levels of decision-making.

**ECAG 6605.** COMPUTER PROGRAMS FOR ECONOMETRICS. Two credit hours. Two hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Use of computer programs for data analysis and estimation of econometric models.

**ECAG 6611**. ECONOMICS OF AGRICULTURAL PRODUCTION (On demand). Three credit hours. Three hours of lecture per week.

Economic analysis of agricultural production. Includes the study of production and cost functions; input-output analysis; and the decision-making process necessary for a proper utilization of resources.

**ECAG 6631**. ADVANCED AGRICULTURAL MARKETING (I) (Even numbered years). Three credit hours. Three hours of lecture per week.

A comprehensive advanced study of the field of agricultural marketing.

**ECAG 6635.** GLOBAL AGRIBUSINESS MARKETING. Three credit hours. Three hours of lecture per week.

Analysis of the different marketing strategies used by agribusiness organizations in the global market.

**ECAG 6641**. AGRICULTURAL DEVELOPMENT (On demand). Three credit hours. Three hours of lecture per week.

Study and analysis of the factors that influence the process of transformation and development of the agricultural sector of the economy, emphasizing those of an economic nature. Emphasis is given to the situation presented by an economy in full process of development. The interrelationships of the agricultural sector with other sectors of the economy are examined and analyzed.

**ECAG 6650.** ECONOMICS OF AGRICULTURAL POLICY. Three credit hours. Three lectures per week.

General comprehensive study of the formulation and implementation of policy for the agricultural sector of the economy, with major emphasis on the economic aspects. Reference is made to specific aspects of policy, especially in Puerto Rico and the United States.

**ECAG 6651**. ELEMENTS OF APPLIED MATHEMATICAL ECONOMICS I. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

We will study concepts about algebra, functions, matrices and differential calculus to better understand the economic phenomena in the field of Agricultural Economics.

**ECAG 6654.** RURAL SOCIOLOGY PROBLEMS. Three credit hours. Three lectures per week.

The application of sociological theories to the analysis of rural social problems; investigation of factors detrimental to community development and human welfare.

**ECAG 6660**. AGRICULTURAL PRICES. Three credit hours. Three hours of lecture per week.

A cross-sectional analysis of the factors affecting demand and product prices, study of empirical techniques of economic model building and interpretation and of forecasting.

**ECAG 6665**. APPLIED ECONOMETRICS I. Three credit hours. Three hours of lecture per week.

Use of econometrics in the agricultural economics problems and its application in production, price and consumption models.

**ECAG 6666**. APPLIED ECONOMETRICS II. Three credit hours. Three hours of lecture per week. Prerequisite: ECAG 6665 or authorization of the Director of the Department.

Study, application, and evaluation of econometric models with limited dependent variables, panel and time series data. Analysis and interpretation of results based on regression models.

**ECAG 6990**. SUPERVISED PROFESSIONAL OCCUPATIONAL EXPERIENCE FOR COOP STUDENTS. Three to six credit hours. Prerequisite: Authorization of the Director of the Department.

Practical experience in Agricultural Economics and Agribusiness Management in cooperation with the private sector or government. To be jointly supervised by the academic department, the Coop program coordinator, and an official from the cooperating entity. A written report will be required upon completion of each work period.

**ECAG 6991**. AGRICULTURAL ECONOMIC INTERNSHIP. One to six credit hours. Prerequisite: authorization of the Director of the Department.

Work experience in Agricultural Economics supervised and evaluated by a faculty member in coordination with a government agency, academic or research institution, private enterprise or foundation, in accordance with the student's academic background and work requirements.

**ECAG 6995.** SPECIAL PROBLEMS IN AGRICULTURAL ECONOMICS. Two to six credit hours. One to three research periods per week.

This course provides for study in any phase of Agricultural Economics in which the student is especially interested. Individual problem method.

**ECAG 6997**. SELECTED TOPICS (On demand). One to three credit hours. Prerequisite: authorization of the Director of the Department.

Selected topics in agricultural economics such as economic evaluation of agricultural projects, agricultural law, environmental economics, agricultural finance and others.

**ECAG 6998**. SELECTED TOPICS (On demand). One to three credit hours. Prerequisite: authorization of the Director of the Department.

Selected topics in agricultural economics such as economic evaluation of agricultural projects, agricultural law, environmental economics, agricultural finance and others.

**ECAG 6999**. RESEARCH IN AGRICULTURAL ECONOMICS (I, II, S). One to six credit hours. One to six research periods per week.

Organized research in Agricultural Economics on a Master's thesis level, including thesis presentation and discussion as part of the requirements for a Master of Science degree with a major in Agricultural Economics.

## AGRICULTURAL EDUCATION

### Graduate Courses

**EDAG 6601**. ADVANCED METHODS IN TEACHING VOCATIONAL AGRICULTURE. Three credit hours. Three hours of lecture per week.

A comparative study of teaching methods and techniques.

**EDAG 6602**. FARMING PROGRAMS. Three credit hours. Three hours of lecture per week.

Study of farming programs at the all-day, young and adult farmer's level, with special emphasis on farm management, financing, recording and evaluating.

**EDAG 6603**. EVALUATION. Three credit hours. Three hours of lecture per week.

Study of the fundamentals of tests and measurements. Emphasis will be given to measures of central tendency and dispersion, measures for comparing differences and the significance of the difference at various confidence levels, interpretation of results, and formulation of plans of action.

**EDAG 6605**. TEACHER TRAINING. Three credit hours. Three hours of lecture per week.

Study of the problems of the rural farm population, with emphasis on youth and adult organizations, such as 4-H Clubs, Future Farmers, and Advisory Councils.

**EDAG 6607**. INVESTIGATION PROCEDURES. Three credit hours. Two hours of lecture and one three-hour laboratory per week.

Assembling, selecting, organizing, interpreting and reporting data pertinent to investigation made in the fields of education and related sciences.

**EDAG 6608**. PREPARATION OF TEACHING MATERIAL. Three credit hours. Three hours of work per week.

The preparation by the students of teaching materials such as samples, specimens, charts, graphs, pictures, slides, job analysis, lesson plans, basic units and enterprise units.

**EDAG 6610**. SEMINAR IN AGRICULTURAL EDUCATION. Three credit hours. Three hours of lecture per week.

A critical study of selected problems in vocational agriculture. Students are requested to make individual investigations and to report on their findings. Some aspects of the work will be conducted through committees.

**EDAG 6611**. CURRICULUM DEVELOPMENT. Three credit hours. Three hours of lecture per week.

The planning of course of study for young and adult farmer groups at a functional level.

**EDAG 6612**. ADULT EDUCATION IN VOCATIONAL AGRICULTURE. Three credit hours. Three hours of lecture per week.

A comprehensive study of the philosophy of this type of instruction, with emphasis on the organization of course content on a long-term basis. Teaching techniques, supervision, evaluation and reporting will be discussed.

**EDAG 6631**. ORGANIZATION AND ADMINISTRATION IN VOCATIONAL AGRICULTURE. Three credit hours. Three hours of lecture per week.

Study of the laws affecting agricultural education, criteria for selection of students, classroom management, farm management, Future Farmers of America and other phases of the vocational agriculture program.

**EDAG 6671**. PROGRAM PLANNING. Three credit hours. Three hours of lecture per week.

A detailed analysis of the job of the teacher of vocational agriculture, with special emphasis on the development of a sound philosophy of the program of instruction and the work.

**EDAG 6999**. RESEARCH IN AGRICULTURAL EDUCATION. Three to six credit hours. Three to six research periods per week.

The selection by students of topics in agricultural education for individual study; the preparation of designs; the determination of the adequate statistics to use; and the completion of the project.

## AGRICULTURAL EXTENSION

### Graduate Courses

**EXAG 6601**. COMMUNITY ORGANIZATION AND LEADERSHIP. Three credit hours. Three hours of lecture per week.

A study of how the community is organized and how it changes, the relationship of organization and change to work in adult education, community development and Extension work. Special attention will be given to the role of professional leadership in organization and change.

**EXAG 6603**. ORAL AND WRITTEN COMMUNICATION. Three credit hours. One hour of lecture and two three-hour laboratory periods per week.

The learning process and the principles involved in written and oral communication. The course is especially designed for Extension Agents, teachers of Vocational Agriculture, and others interested in improving their teaching abilities. Laboratory practice in the arts of communication is provided.

**EXAG 6610**. PRINCIPLES OF EXTENSION TEACHING. Three credit hours. Three hours of lecture per week.

The theories and principles of teaching and learning, and their application to Agricultural Extension.

**EXAG 6612**. PSYCHOLOGY IN EXTENSION EDUCATION. Three credit hours. Three hours of lecture per week.

The scientific study and interpretation of human behavior; basic psychological principles applied to Extension Education.

**EXAG 6614**. ADMINISTRATION AND SUPERVISION IN EXTENSION EDUCATION. Three credit hours. Three hours of lecture per week.

Theory and principles of personnel administration and supervision in Extension Education.

**EXAG 6620**. EXTENSION EVALUATION. Three credit hours. Three hours of lecture per week.

A study of the principles involved in Extension evaluation, and of adequate methods and processes for measuring and evaluating Extension work according to the results obtained. Questionnaire construction, sampling, interviewing, and analysis and interpretation of data will be discussed.

**EXAG 6622**. PROGRAM DEVELOPMENT IN EXTENSION. Three credit hours. Three hours of lecture per week.

The basic principles, procedures and problems in the process of Extension program development in both agriculture and homemaking.

**EXAG 6628**. ADVANCED SEMINAR IN EXTENSION PROBLEMS. Three credit hours. Three hours of lecture per week.

Study of problems from such fields as administration, supervision, personnel recruitment and training, and scope of programs. Selection will be made in the light of the special interest of seminar members.

**EXAG 6630**. PRINCIPLES AND PHILOSOPHY OF ADULT EDUCATION. Three credit hours. Three hours of lecture per week.

Critical comparison of present day schools of thought on the philosophy and principles of adult education programs; the nature, objectives, and functions of such programs. A term paper is required.

**EXAG 6640**. SOCIAL RESEARCH METHODS. Three credit hours. Three hours of lecture per week.

Methods and theory of investigation as applied to the social sciences. Emphasis is given to the collection, analysis and interpretation of information in connection with special problems of research. The student is required to plan research in his field of interest.

**EXAG 6642.** RURAL YOUTH PROBLEMS. Three credit hours. Three lectures per week.

Study of problems faced during adolescence, such as the adolescent value system, interests, and group life; the relationship of adolescent culture to adult culture; the relationship of the sociology of adolescence to educational programs such as the 4-H Clubs, Vocational Agriculture and the school.

**AGROENVIRONMENTAL SCIENCES**

**Advanced Undergraduate Courses in Agronomy and Soils**

**AGRO 5005**. BIOMETRICS (I, S). Three credit hours. Two hours of lecture and three hours of laboratory per week. Prerequisites: authorization of the Director of the Department.

Basic concepts of statistical reasoning applied to problems in agricultural, biological and environmental sciences. Data gathering, graphical description and numerical summarization. Concepts of probability and sampling. Estimation and hypothesis testing, analysis of variance, linear regression and correlation. Students describe and analyze real data sets and use statistical computing programs.

**AGRO 5006**. GENESIS, MORPHOLOGY AND CLASSIFICATION OF SOILS (I). Three credit hours. Three hours of lecture per week. Prerequisites: (AGRO 3011 and AGRO 3013) or authorization of the Director of the Department.

Historical development of concepts of soil and systems of soil classification; principles and nomenclature of "Soil Taxonomy"; environmental factors and processes of soil formation; and field study of soil profiles. Field trips are required.

**AGRO 5007**. SOIL PHYSICS (I) (Even numbered years). Three credit hours. Two lectures and one three-hour laboratory per week.

Physical properties of soils, and factors affecting them; soil consistency, structure, water, air, temperature, tillage; evaluation and influence in determination of soil productivity.

**AGRO 5008**. SOILS OF PUERTO RICO (II). Three credit hours. Two hours of lecture and three hours of laboratory per week. Prerequisites: AGRO 5006 or authorization of the Director of the Department.

Study of the genesis and distribution of the soils of Puerto Rico, based on environmental conditions; classification of soils using the "Soil Taxonomy" system; evaluation of the morphological, chemical, physical, and mineralogical properties of soils with respect to agricultural and not agricultural uses. Representative soil profiles are studied during field trips.

**AGRO 5010.** MANAGEMENT OF NATURAL FORESTS. Three credit hours. Two hours of lecture and one three hour laboratory per week. Prerequisites: BIOL 3435 or CFIT 3005 or BIOL 3051 or (BIOL 3061 and BIOL 3063) or authorization of the Director of the Department.

Study of the composition and structure of the different forest systems of the tropics, such as wet forest, deciduous forest, dry forest, conifer forest and mangrove from the stand point of their multiple use and sustainability. Field trips required.

**AGRO 5015**. CONSERVATION, MANAGEMENT AND DEVELOPMENT OF NATURAL RESOURCES (I) (Even numbered years). Three credit hours. Three hours of lecture per week. Prerequisite: AGRO 4035 or authorization of the Director of the Department.

Study of concepts, methods and techniques in the conservation, management and development of natural resources, and their effects on environmental quality. Contemporary issues and problems in the management and allocation of natural resources will be discussed.

**AGRO 5501**. AGRICULTURAL BIOTECHNOLOGY (II) (Even numbered years). Three credit hours. Three hours of lecture per week. Prerequisites: QUIM 3062 and (BIOL 3015 or BIOL 3300) and (BIOL 3770 or PROC 4016) or authorization of the Director of the Department.

Biological concepts for biotechnology: enzymes, nucleic acids, genetic transfer mechanisms, operons, plasmids, vectors, cloning, DNA sequencing, monoclonal antibodies, clonal production and hybridization.

**AGRO 5502.** AGRICULTURAL BIOTECHNOLOGY LABORATORY (II) (Even numbered years). One credit hour. One three-hour laboratory per week. Corequisite: AGRO 5501.

Experiments or demonstrations on microbial growth, DNA isolation, embryo transfer, protoplast isolation, tissue culture, plant hybridization, mutagenesis, plasmid isolation, and DNA electrophoresis. Restriction enzymes and other DNA techniques.

**Graduate Courses in Agronomy and Soils**

**AGRO 6005**. USE OF STATISTICAL COMPUTER PACKAGES IN BIOMETRY. Two credit hours. Two hours of lecture per week.

Use of statistical computer packages in the analysis of experimental data.

**AGRO 6017**. ADVANCED AGROCLIMATOLOGY. Three credit hours. Two hours of lecture and three hours of laboratory per week.

Study of the use of sensors to measure and collect climatological data. Use of mathematical models to process climatological data to estimate such variables as evapotranspiration, sensible heat flux and crop canopy energy balance.

**AGRO 6300**. SIMULATION OF AGRICULTURAL SYSTEMS. Three credit hours. Three hours of lecture per week.

Study of the principles of simulation of agricultural systems. The dynamics between crop growth and development in relation to soil water and nitrogen will be discussed. The use of models to simulate crop production and management practices will be emphasized.

**AGRO 6505.** ADVANCED SOIL FERTILITY. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Discussion of advanced topics in soil fertility including nutritional diagnosis, nutrient availability, limiting factors, recommendations for fertilization, soil management, and environmental impact.

**AGRO 6600**. ADVANCED BIOMETRICS (II). Three credit hours. Two hours of lecture and three hours of laboratory per week.

Advanced study of analysis of variance, covariance and multiple regression, design and analysis of experiments applied to research problems in agricultural, biological and environmental sciences. Students design experiments, analyze data and use statistical computing programs. Previous knowledge of basic statistics is required.

**AGRO 6602.** PASTURE CROPS AND MANAGEMENT. Three credit hours. Two lectures and one three-hour laboratory per week.

The relationship of pasture crops to types of rainfall, soils and other environmental factors as they affect the production, conservation, and utilization of forages.

**AGRO 6604**. SOIL-PLANT RELATIONSHIPS (I) (Odd numbered years). Three credit hours. Three hours of lecture per week.

Study of the processes that affect root growth and development, methods of study of such processes, availability of nutrients and factors that affect their movement and absorption; growth as a function of dry matter accumulation, root proliferation and nutrient uptake.

**AGRO 6607**. SOIL CHEMISTRY (I) (Odd numbered years). Three credit hours. Two hours of lecture and one three-hour laboratory per week.

Chemical composition and properties of soils, chemical processes of weathering, soil solution reaction, chemical properties of clays, and ionic exchanges in soils.

**AGRO 6612**. MANAGEMENT OF TROPICAL SOILS (I) (Odd numbered years). Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Application of principles of soil science in the interpretation and use of recent research relating to problems in the management and production of tropical soils.

**AGRO 6624**. SOIL MINERALOGY (I) (Even numbered years). Three credit hours. Two hours of lecture and one three-hour laboratory per week.

Identification of the constituent minerals of soils, and their relation to soil classification and agricultural practices.

**AGRO 6995-6996**. SPECIAL PROBLEMS (I, II, S)-(I, II, S). One to three credit hours per semester. One to three research periods per week each semester.

Advanced studies, investigations and special problems in Agronomy or related fields. Problems or topics will be assigned according to the interests and needs of the individual student.

**AGRO 6997**. SPECIAL TOPICS IN AGRONOMY (I, II, S). One to three credit hours. Prerequisite: authorization of the Director of the Department.

Topics not covered in other courses or specialized studies in the areas of crops and soil sciences.

**AGRO 6998**. SPECIAL TOPICS IN AGRONOMY (I, II, S). One to three credit hours. Prerequisite: authorization of the Director of the Department.

Topics not covered in other courses or specialized studies in the areas of crops and soil sciences.

**AGRO 6999**. RESEARCH (I, II, S). One to six credit hours. One to six research periods per week.

Organized research in crops at the Master's thesis level, including thesis presentation and discussion as part of the requirement for a Master of Science degree with a major in Crops.

**CFIT 5006.** PHYTOREMEDIATION. Three credit hours. Three hours of lecture per week. Prerequisites: ((BIOL 3435 or BIOL 3051 or (BIOL 3061 and BIOL 3063)) and (QUIM 3002 or (QUIM 3132 and QUIM 3134))) or authorization of the Director of the Department.

Discussion of the relevant concepts used in phytoremediation. Study of the principles used in phytoremediation such as the use of vascular plants for the phytoextraction, rhyzofiltration, phytostabilization and phytovolatilization of organic and inorganic contaminants from the soils and water resources.

**CFIT 6009**. ADVANCED PLANT GENETICS. Three credit hours. Three hours of lecture per week.

Discussion of advanced concepts in classical and molecular genetics and their application to the study of genome structure, expression, and manipulation in cultivated plants.

**CFIT 6105**. PLANT BREEDING METHODS. Three credit hours. Three hours of lecture per week.

Study of crop domestication and sources of genetic diversity. Application of the principles of genetics in crop improvement. Study of breeding techniques in self-pollinated, cross-pollinated, And asexually propagated crops, as well as breeding for disease and pest resistance. Analysis of the impact of biotechnology and genetic engineering on crop improvement.

**CFIT 6611**. ADVANCED PLANT BREEDING (II) (Even numbered years). Three credit hours. Three hours of lecture per week.

Types of genetic action in plant breeding, use of the principle of population genetics and quantitative genetics in the improvement of crops; relationship of population structure to the induction of genetic variation and selectivity processes. Application of cytogenetics and polyploid concept to plant improvement.

**CFIT 6644**. ENVIRONMENTAL PHYSIOLOGY (On demand). Three credit hours. Three hours of lecture per week.

Environmental aspects of phytophysiology, including energy, nutrition cycles, pollution, and others.

**CFIT 6645**. ADVANCES IN BIOLOGICAL NITROGEN FIXATION (I) (Odd numbered years). Three credit hours. Two hours of lecture and one hour of seminar per week.

Mechanism by which atmospheric nitrogen is incorporated into plant proteins and modern techniques utilized for its study, organisms capable of fixing nitrogen in a free-living state or in symbiosis with plants, methodology to take advantage of this process in agriculture.

**CFIT 8007**. PLANT BREEDING FOR BIOTIC AND ABIOTIC STRESS. Three credit hours. Three hours of lecture per week.

Study of biotic and abiotic factors that limit the production of crops. Application of techniques and methods of plant breeding that increase the efficiency of selection for tolerance or resistance to stress.

**CFIT 8009**. PLANT BREEDING LABORATORY AND FIELD TECHNIQUES. Two credit hours. One hour of lecture and three hours of laboratory per week.

Observation of methods and techniques used in autogamous, allogamous, and asexually propagated crops in plant breeding programs. Analysis of phenotypic and molecular data using computer programs. Application of laboratory and field evaluation techniques for breeding of resistance to pathogens, insects, and environmental stress. Field trips are required.

**Advanced Undergraduate Courses**

**PROC 5005**. PHYTOPATHOGENIC FUNGI (I) (Even numbered years). Three credit hours. Two hours of lecture and one three-hour laboratory per week. Prerequisite: PROC 4006 or authorization of the Department Director.

Examination of the most interesting groups of fungi from the phytopathogenic point of view: their taxonomy, nomenclature, morphology, genetics, host-parasite relationship, physiology, and ecology. Distinctive characteristic of specific pathogens. Field trips for collection and observation are required.

**PROC 5006**. INSECTS OF TROPICAL CROPS. Three credit hours. Two hours of lectures and one three-hour laboratory per week. Prerequisite: PROC 4008 or CFIT 4008 or authorization of the Director of the Department.

Major insects affecting tropical crops, their biology and taxonomy; identification of damages in the field as well as in the laboratory; appropriate measures of control.

**Graduate Courses**

**PROC 6008.** CROP PROTECTION II. Three credit hours. Two hours of lecture and three hours of laboratory per week. Prerequisite: authorization of the Director of the Department.

Study of the morphology, taxonomy, ecology, physiology, and control of the most important pathogens of tropical crops including fungi, nematodes, bacteria, viruses and mycoplasms. Discussion of abiotic agents which cause diseases on plants.

**PROC 6015.** MOLECULAR ASPECTS IN PLANT PATHOLOGY. Three credit hours. Three hours of lecture per week.

Study of the biochemistry, physiology, and molecular biology of plant-pathogen interactions. Discussion of molecular mechanisms involved in the development of plant diseases caused by biotic agents such as fungi, bacteria, nematodes and viruses.

**PROC 6601**. PROPERTIES AND ACTIONS OF HERBICIDES. Three credit hours. Two hours of lectures and one three hour laboratory per week.

Classification and structure of chemicals used in weed control; the action of herbicides and their effects on the morphology and internal mechanisms of plants; physiological processes affected by herbicides, and edaphic and climatic factors influencing the performance of weed killers.

**PROC 6603**. METHODS OF RESEARCH IN PATHOLOGY (II) (Odd numbered years). Four credit hours. Two hours of lecture and two three hours laboratories per week. Prerequisite: Authorization of the Director of the Department.

A course intended to give the graduate student practice and skill in methods of laboratory and field research in Plant Pathology.

**PROC 6604**. DIAGNOSIS AND CONTROL OF PLANT DISEASES (II) (Even numbered years). Three credit hours. One hour of lecture and two three-hour laboratory periods per week.

Techniques used in diagnosis of plant diseases. Sources of descriptive information on phytopathogens, fungi identification, and control measures.

**PROC 6605**. URBAN PESTS. Three credit hours. Two hours of lecture and one three-hour laboratory per week.

Study of urban pests of major economic impact that infest residential, industrial and commercial structures. Methods for the control of urban pests, with emphasis on arthropods.

**PROC 6606.** CROP EPIDEMIOLOGY. Three credit hours. Two hours of lecture and three hours of laboratory per week. Prerequisite: authorization of the Director of the Department.

Application of mathematical analysis to the field study of plant disease epidemics. Use of forecast and methods to detect and quantify the effects of epidemics on the yield and quality of crops.

**PROC 6608**. ADVANCED TROPICAL PHYTOPATHOLOGY (I) (Even numbered years). Four credit hours. Four hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Study and anlysis of the etiology, pathology, epiphytology, and control of major plant diseases of the most important economic tropical crops.

**PROC 6609**. INTEGRATED PEST MANAGEMENT (I). Three credit hours. Two hours of lecture and one three-hour laboratory per week.

Integrated management of agricultural pests based on the understanding of basic ecological principles and through the use of environmentally compatible pest management tactics and strategies which include ecological management, and the biological, mechanical, genetic, chemical and legal factors.

**PROC 6620**. TOXICOLOGY OF PESTICIDES (II) (Odd numbered years). Three credit hours. Two hours of lecture and one three-hour laboratory per week.

Classification, analysis, uses and toxicity of pesticides used in agriculture; methods in toxicology research; residual effects of pesticides on the environment, and on public health.

**PROC 6624**. MORPHOLOGY AND TAXONOMY OF PHYTOPARASITIC NEMATODES. Three credit hours. Two hours of lecture and one three-hour laboratory per week. Prerequisite: PROC 4018 or CIFI 4018.

Morphology, anatomy, and taxonomy of phytoparasitic nematodes; rules and problems of nomenclature.

**PROC 6625.** TAXONOMY AND MORPHOLOGY OF ENTOMOPHAGOUS INSECTS. Four credit hours. Three hours of lecture and three hours of laboratory per week.

Analysis, application, and evaluation of the methods used in the morphology, taxonomy and systematics of entomophagous insects with emphasis on hymenopterans. Includes character differentiation, the construction and evaluation of keys, cladograms and phenograms, analysis of the literature, and the taxonomy and morphology to family level.

**PROC 6630**. CONTROL OF PHYTOPARASITIC NEMATODES (I) (Even numbered years). Three credit hours. Two hours of lecture and one three-hour laboratory per week.

Study and evaluation of the physical, biological and chemical control of phytoparasitic nematodes.

**PROC 6635**. TROPICAL AGRONEMATOLOGY (I) (Odd numbered years). Three credit hours. Two hours of lecture and one three-hour laboratory per week.

A detailed study covering the most important aspects of plant nematodes in the tropics, especially those concerned with sugar cane, coffee, tobacco, citrus fruits, pineapples, plantains, bananas, rice, and vegetables.

**PROC 6645**. BIOLOGICAL CONTROL: CONCEPTS AND THEORIES (I) (Odd numbered years). Three credit hours. Two hours of lecture and one three-hour laboratory per week. Prerequisite: authorization of the Director of the Department.

Ecological theories that study the use of beneficial organisms for the population density regulation of organisms noxious to crops of economic importance. Other topics to be studied are: the structure of the agroecosystem community, predator-prey ecological relations, types and components of predation, post-introduction programs and aspects of integration, perspectives and development of biological control strategies, with emphasis on insect control.

**PROC 6650**. PHYTOVIROLOGY (II) (Odd numbered years). Three credit hours. Two hours of lecture and one three-hour laboratory per week.

Fundamental concepts of plant viruses including transmission, vector identification, their effects on insect vectors, host range, classification, serology, and physical properties and methods of control. Research methods are emphasized in the laboratory.

**PROC 6993**. SELECTED TOPICS (On demand). One to three credit hours. Prerequisite: authorization of the Director of the Department.

Study of selected topics in Crop Protection not covered in existing courses.

**PROC 6994**. SELECTED TOPICS (On demand). One to three credit hours. Prerequisite: authorization of the Director of the Department.

Study of selected topics in Crop Protection not covered in existing courses.

**PROC 6995-6996**. SPECIAL PROBLEMS (I, II, S)-(I, II, S). One to three credit hours per semester. One to three study and research periods per week.

Study or investigation of a special problem in the field of crop protection.

**PROC 6999**. RESEARCH AND THESIS (I,II,S). Three to six credit hours.

Thesis research.

**PROC 8006**. INSECT BEHAVIOR. Three credit hours. Two hours of lecture and three hours of laboratory per week.

Study of the terminology and concepts of insect behavior, operating mechanisms, and its ecological and evolutionary significance. Evaluation of insect behavior and its impact on management of other populations.

**PROC 8007**. INSECT ECOLOGY. Three credit hours. Two hours of lecture and three hours of laboratory per week.

Study and discussion of advanced concepts of insect ecology and evolution, analysis of pertinent factors at the population and community levels, and insects' interaction with the environment. Study of plant-insect, insect-insect, and parasite-insect dynamics under laboratory and field conditions.

**PROC 8016**. ADVANCED PLANT BACTERIOLOGY. Three credit hours. Two hours of lecture and three hours of laboratory per week.

Discussion and application of principles and methods of detection, isolation, identification, and characterization of plant pathogenic bacteria. Study of pathogenesis, virulence factors, interactions, resistance, and control.

## PROGRAM OF HORTICULTURE

### Advanced Undergraduate Courses

**HORT 5005**. ADVANCED FLORICULTURE. Three credit hours. Two hours of lecture and one three-hour laboratory per week. Prerequisite: HORT 4025 or authorization of the Director of the Department.

A comprehensive review of scientific literature and research on the ecology, physiology, propagation, improvement, and other growth processes of important flowering and foliage plants.

**HORT 5006**. ADVANCED VEGETABLE GARDENING. Two credit hours. One hour of lecture and one three-hour laboratory per week. Prerequisite: HORT 4008 or authorization of the Director of the Department.

This course aims to review the different phases of experimental work in vegetable growing with assigned field problems. Field trips required.

**HORT 5015.** HORTICULTURE OF TEMPERATE ZONES. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Study of the basic and applied concepts in horticulture in temperate zones. Study of the effects of environmental factors on agricultural production and how they affect plant growth and development of fruits, vegetables and ornamental crops, and urban forests. Emphasis will be given to different marketing systems for agricultural products and their postharvest physiology. The course consists of lectures and a ten-day trip to a temperate zone country.

### Graduate Courses

**HORT 6007/CITA 6007**. SAFETY OF FRUIT AND VEGETABLE PRODUCTS. Three credit hours. Two hours of lecture and one three-hour laboratory per week.

Advanced study of intrinsic and extrinsic factors that determine the growth of microorganisms, during post-harvest, processing, storage, and transportation of fruits and vegetables that may affect public health.

**HORT 6601**. FOOD PROCESSING I (I). Three credit hours. Three hours of lecture per week.

Fundamentals and commercial practice of food preservation by heat treatment, drying, freezing, canning, irradiation and microwaves. Topics included are selection of raw material, preparation, unit of operations and processing, packaging and storage. Processes covered will include aseptic packaging of juice and milk as well as canning of fruits and vegetables.

**HORT 6611**. ADVANCED PLANT PROPAGATION (II). Three credit hours. Two hours of lecture and one three-hour laboratory per week.

Techniques in plant propagation through embryo culture, meristematic culture in vegetative propagation, culture of explants, and other advanced methods; review of recent findings in this field.

**HORT 6616**. ADVANCED TROPICAL FRUITS (II) (On demand). Three credit hours. Three hours of lecture per week.

A study of the problems encountered in the production of fruits of major economic importance, with special emphasis on tropical conditions. The influence of stocks, varieties, planting sites, soils and ecological factors will be stressed.

**HORT 6620**. PRODUCTION OF HORTICULTURAL CROPS IN PROTECTED STRUCTURES. Three credit hours. Three hours of lecture per week.

Study of the effect of environmental factors such as light, water, humidity, temperature, carbon dioxide concentration and various nutrients sources on the growth, development and yield of horticultural crops under different protected structures.

**HORT 6650**. POST HARVEST PHYSIOLOGY AND MANIPULATION OF HORTICULTURAL CROPS (On demand). Three credit hours. Two hours of lecture and one three-hour laboratory per week.

The physiology of maturation and ripening, and the handling of horticultural crops to preserve quality and ensure storage life.

**HORT 6652**. PHYSIOLOGY OF VEGETABLE CROPS (II) (On demand). Three credit hours. Three hours of lecture per week.

The study of photoperiodism, thermoperiodism, deficiencies, growth substances, rooting, germination and fruit setting in each of the major vegetable crops.

**HORT 6653**. PHYSIOLOGY OF FRUIT PRODUCTION (I) (On demand). Three credit hours. Three hours of lecture per week.

The study of fruit production, including water, light, soil and nutrition relationships; pruning, fruit setting, and other growth and productivity factors.

**HORT 6665**. PLANT GENETIC TRANSFORMATION (I) (On demand). Four credit hours. Three hours of lecture and one four-hour laboratory per week.

Theory and practice of the concepts in the genetic transformation of plants by direct and indirect methods. Emphasis will be given to Agrobacterium tumefaciens mediated transformation.

**HORT 6669**. GROWTH REGULATORS IN HORTICULTURE (I). Three credit hours. Two hours of lecture and one three-hour laboratory per week.

The use of growth regulators and other chemicals in the modification and alteration of natural plant processes; the application of these substances in the commercial production of fruits, vegetables, and ornamentals.

**HORT 6990**. SUPERVISED PROFESSIONAL OCCUPATIONAL EXPERIENCE FOR COOP STUDENTS. From three to six credit hours. Only 3 credits will be considered within the minimum of the required 30 credits for the graduate program.

Practical experience in Horticulture in cooperation with the private sector or government. To be jointly supervised by the academic department, the Coop program coordinator and an official from the cooperating entity. A written report will be required upon completion of each work period.

**HORT 6995-6996** (On demand). RESEARCH IN HORTICULTURE. One to three credit hours per semester. One to two research periods per week for a total of three to six hours each semester.

Research on an important horticultural problem. A thesis presentation is not required, but a report of the investigation should be made.

**HORT 6997**. SELECTED TOPICS (On demand). One to three credit hours. Prerequisite: authorization of the Director of the Department.

Selected topics in plant propagation, production, management, physiology, genetic engineering, molecular biology, and other areas of interest in horticulture.

**HORT 6998**. SELECTED TOPICS (On demand). One to three credit hours. Prerequisite: authorization of the Director of the Department.

Selected topics in plant propagation, production, management, physiology, genetic engineering, molecular biology, and other areas in horticulture.

**HORT 6999.** RESEARCH AND MASTER THESIS. Zero to six credit hours. Zero to six hours of research per week.

Organized research in horticulture at the master's thesis level, including thesis presentation and discussion as part of the requirements for a Master of Science degree with a major in Horticulture.

**HORT 8030**. METHODOLOGY AND INSTRUMENTATION APPLIED TO HORTICULTURE. Three credit hours. Two hours of lecture and three hours of laboratory per week.

Study of the use and applications of methodologies and instrumentation utilized in biotechnology, hydroponics and post-harvest technology.

**HORT 8040**. MOLECULAR MARKERS IN CROPS. Three credit hours. Two hours of lecture and three hours of laboratory per week.

Study of the most important molecular markers and their use in crops, with emphasis on their historical development, theoretical basis, and practical applications.

## ANIMAL SCIENCE

### Advanced Undergraduate Courses

**CIAN 5005**. USE OF ORGANIC BY-PRODUCTS IN ANIMAL NUTRITION. Three credit hours. Three hours of lecture per week. Prerequisite: CIAN 4010 or authorization of the Director of the Department.

Theory, concepts, and applications of the process of conversion of organic by-products into ingredients for animal use and their utilization in commercial feeds for livestock.

**CIAN 5045**. ENVIRONMENT AND MANAGEMENT OF FARM ANIMALS. Three credit hours. Three hours of lecture per week. Prerequisite: CIAN 4005 or authorization of the Director of the Department.

Study of the effects of the environment on the physiology and behavior of farm animals. Evaluation of management alternatives to minimize adverse environmental effects and to improve the productivity of livestock enterprises.

**CIAN 5346**. DAIRY BY-PRODUCTS (On demand). Three credit hours. Two lectures and one three-hour laboratory per week. Prerequisite: CIAN 4008 or authorization of the Director of the Department.

The manufacture of ice cream, cheese, and butter.

**CIAN 5350.** VETERINARY CLINICAL PARASITOLOGY. Three credit hours. Two hours of lecture and three hours of laboratory per week. Prerequisites: (CIAN 4005 and CIAN 4036) or authorization of the Director of the Department.

Study of the interaction of the most common parasites of veterinary importance in domestic animals and the impact animal production. Discussion and analysis of parasite pathology, clinical manifestations, life cycles and control methods.

**CIAN 5355**. ADVANCED BEEKEEPING (On demand). Three credit hours. Two hours of conference and three hours of laboratory per week. Prerequisite: CIAN 4016 and authorization of the Director of the Department.

Commercial Management of apiaries. Including the bees, and the various methods used to obtain honey and wax.

**CIAN 5357**. SCIENCE AND TECHNOLOGY OF FRESH MEATS (I) (On demand). Three credit hours. Two hours of lecture and one four-hour laboratory per week. Prerequisite: CIAN 4005 or authorization of the Director of the Department.

Principles and practices in the handling, processing and preservation of beef, pork, and poultry meats.

**CIAN 5359**. BIOSECURITY AND DISEASE CONTROL (II). Three credit hours. Three hours of lecture per week. Prerequisites: CIAN 4005 or authorization of the Director of the Department.

Theory about practices in sanitary and management for the control and prevention of farm animal diseases. Discussion of management practices to prevent the transmission of zoonotic diseases.

**CIAN 5365**. GASTROINTESTINAL MICROBIOLOGY OF DOMESTIC ANIMALS (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: (CIAN 4010 and BIOL 3770 and QUIM 3062) or authorization of the Director of the Department.

Discussion of theory related to the microbial ecology of the gastrointestinal tract of domestic animals. Analysis of the role of intestinal microbes in the nutrition, health, and productivity of animals with emphasis on farm animals.

**Graduate Courses**

**CIAN 6025**. MINERAL NUTRITION AND METABOLISM (On demand). Three credit hours. Three hours of lecture per week.

Study of nutritional implications and metabolic roles of mineral in animal nutrition. Forms and location in the body, metabolic function, deficiencies, toxicity, interactions, and requirements of minerals in animal nutrition.

**CIAN 6055**. ANIMAL MOLECULAR BIOTECHNOLOGY. Four credit hours. Three hours of lecture and four hours of laboratory per week. Prerequisite: authorization of the Director of the Department.

Study and application of the principles and practice of molecular biology to the production and improvement of domestic animals. Discussion of transgenic animal production, molecular genetics, and marker assisted selection.

**CIAN 6600**. DAIRY CATTLE MANAGEMENT (II). Three credit hours. Two hours of lecture and one three-hour laboratory per week.

Care and management of dairy cattle.

**INPE 6601**. ADVANCED ANIMAL BREEDING (On demand). Three credit hours. Two hours of lecture and one three-hour laboratory per week.

Advanced course in population genetics, with special emphasis on quantitative characteristics, breeding and selection of farm animals.

**CIAN 6603**. MEAT ANIMAL PRODUCTION (I). Three credit hours. Two hours of lecture and one three-hour laboratory per week.

A comprehensive review of recent advances in the research of various phases of meat animal production.

**CIAN 6604**. ANIMAL NUTRITION (I). Three credit hours. Two hours of lecture and one three-hour laboratory per week.

Physiological mechanisms involved in thirst and appetite; digestion, absorption and utilization of nutrients; respiration and body temperature regulation.

**CIAN 6606.** EXPERIMENTAL NUTRITION (I, II)(On demand). Three credit hours. Two hours of lecture and one three-hour laboratory per week.

Study and application of the methodology used in animal nutrition research. Practice in *in vivo, in vitro,* and *in situ* digestibility trials and mathematical models to determine ruminal degradability and fermentation rates. Evaluation of experimental design for nutrition research.

**CIAN 6607-6608**. GRADUATE SEMINAR (I, II) (On demand). One credit hour. One meeting per week per semester.

Lectures, discussions and reports on selected topics in animal science.

**CIAN 6609**. ADVANCED DAIRY BACTERIOLOGY (On demand). Three credit hours. Two hours of lecture and one three-hour laboratory per week.

The microbiology of milk and milk products.

**CIAN 6611**. RUMINANT NUTRITION (II). Three credit hours. Two hours of lecture and one three-hour laboratory per week.

Physiological and biochemical processes of digestion; relation of rumen function to animal response; chemical analyses and nutrient composition and requirements of feedstuffs, primarily forages; in vitro methodology for determining nutrient digestibility.

**CIAN 6614.** ADVANCED POULTRY PRODUCTION (II). Three credit hours. Two hours of lecture and one three-hour laboratory per week.

Commercial poultry farm operation, processing and marketing of poultry products.

**CIAN 6615**. ADVANCED SWINE PRODUCTION (I). Three credit hours. Three hours of lecture per week.

Study of the problems of modern swine production and on going research to solve them.

**CIAN 6617**. ADVANCED REPRODUCTION (I). Three credit hours. Three hours of lecture per week.

Anatomical, physiological, and pathological processes of reproduction in farm animals. Current concepts in endocrinology and their application in management and control of reproduction. Effect of tropical environment on reproduction.

**CIAN 6618.** PHYSIOLOGY OF LACTATION. Three credit hours. Three hours of lecture per week.

Study of the origin and evolution of mammals. Analysis of the similarities and differences in development, morphology and physiology of the mammary gland among species. Analysis of processes associated with synthesis of milk components and their relationship with commercial milk production. Discussion of the biological and chemical properties of milk and its significance on the neonate and human nutrition. Application of the basic processes associated with immunology of the mammary gland, methods of mastitis detection and management practices associated with its control in dairy herds.

**CIAN 6625.** ANIMAL ENERGY METABOLISM (On demand). Three credit hours. Three hours of lecture per week.

Study of energy metabolism and its relationship to cell structure; the concept and types of energy; laws of thermodynamics and their relationship to animal metabolism; energy utilization and requirements in animals; environmental effects and control systems in energy metabolism, as well as techniques utilized for its study.

**CIAN 6626**. ANIMAL PROTEIN METABOLISM (I). Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Nutritional and biochemical aspects of animal protein metabolism; digestion and absorption; metabolism of free aminoacids; protein synthesis and turnover; excretion of nitrogenous products; nutritional value of proteins; protein requirements; general features of metabolic and hormonal control.

**CIAN 6637**. NEUROENDOCRINE AND CIRCULATORY PHYSIOLOGY(I). Three credit hours. Three hours of lecture per week.

Study of the processes of the nervous, endocrine and cardiovascular functions with emphasis on cellular control mechanisms in domestic animals.

**CIAN 6638**. RENAL, RESPIRATORY AND DIGESTIVE PHYSIOLOGY(II). Three credit hours. Three hours of lecture per week.

Study of the processes of the renal respiratory and gastrointestinal functions with emphasis in the cellular control mechanisms in domestic animals.

**CIAN 6990**. SUPERVISED PROFESSIONAL OCCUPATIONAL EXPERIENCE FOR CO-OP STUDENTS. From three to six credit hours. Prerequisites: authorization of the Director of the Department.

Practical experience in animal management and production and/or animal products in cooperation with the private sector or government. To be jointly supervised by the academic department, the Coop program coordinator and an official from the cooperating entity. A written report will be required upon completion of each work period.

**CIAN 6995-6996**. SPECIAL PROBLEMS (I, II, S)-(I, II, S). One to five credit hours. One to five research periods per week each semester.

Advanced studies in animal science problems and procedures. Problems will be assigned according to experience, interests and needs of the individual student.

**CIAN 6997**. SELECTED TOPICS (I,II). One to three credit hours. Prerequisite: authorization of the Director of the Department.

Selected topics in biotechnology, physiology, nutrition, reproduction, animal health and management of domestic species.

**CIAN 6998**. SELECTED TOPICS (On demand). One to three credit hours. Prerequisite: authorization of the Director of the Department.

Selected topics in biotechnology, physiology, nutrition, reproduction, animal health and management of domestic species.

**CIAN 6999**. RESEARCH AND THESIS (I,II,S). One to six credit hours. One to six research periods per week.

Organized research in animal science at the master's thesis level, including thesis presentation and discussion as a part of requirements for a Master of Science degree with a major in animal science.

**CIAN 8020**. NON-RUMINANT FARM ANIMAL NUTRITION. Three credit hours. Three hours of lecture per week.

Study of the digestive physiology of poultry, swine, equines, and lagomorphs to develop the analytical capacity for research in nutrition and its practical application. Analysis of the nutritional value of the most utilized feeds and discussion of their chemical composition, voluntary intake, digestibility, and metabolism as well as the most common feed additives.

**CIAN 8025**. VITAMIN METABOLISM IN ANIMALS. Three credit hours. Three hours of lecture per week.

Study of vitamins and their specific functions in animal cell metabolism. Analysis of vitamin requirements for different animal functions, the need for vitamin supplementation, and vitaminmineral interactions.

**CIAN 8040**. ENVIRONMENTAL INTERACTIONS IN FARM ANIMALS. Three credit hours. Two hours of lecture and one hour of discussion per week.

Physiological, biochemical and behavioral response of domestic animals to a variety of environmental factor such as biological, physical, chemical and social.

**CIAN 8630**. ANIMAL ENDOCRINOLOGY. Three credit hours. Two hours of lecture and one hour of discussion per week.

Study of the organization and function of the endocrine glands. Analysis of the structure, synthesis, release, transport, and metabolism of their hormonal products and their effects on target cells.

# *COLLEGE OF ARTS AND SCIENCES*

## BIOLOGY

### Advanced Undergraduate Courses

**BIOL 5005**. ELEMENTARY PLANT ANATOMY. Three credit hours. Two hours of lecture and one three-hour laboratory per week. Prerequisite: BIOL 3435 or BIOL 3417 or authorization of the Director of the Department.

The study of simple and complex tissues of the organs of vascular plants; the study of the characteristics of parenchyma, sclerenchyma and collenchyma cells, as well as the elements composing the xylem and phloem tissues.

**BIOL 5007**. GENERAL PLANT MORPHOLOGY. Three credit hours. Two hours of lecture and one three-hour laboratory per week. Prerequisite: BIOL 3417 or BIOL 3435 or authorization of the Director of the Department.

The general principles of plant morphology, including evolutionary tendencies, phylogenetic lines and the life cycles of the principal groups of plants.

**BIOL 5016**. PLANT EVOLUTION. Two credit hours. Two hours of lecture per week. Prerequisite: BIOL 3417 or BIOL 3435 or authorization of the Director of the Department.

Analysis of the geological, morphological, anatomical, physiological, and geographical evidence showing how the different plant phyla have evolved, with emphasis on the evolution of tracheophytes. Assigned reading reports.

**BIOL 5018**. PLANT PHYSIOLOGY. Four credit hours. Three hours of lecture and one laboratory of three hours per week. Prerequisites: BIOL 3417 or BIOL 3435 or authorization of the Director of the Department. Co-requisite: QUIM 3032 or QUIM 3062 or QUIM 3463 or authorization of the Director of the Department.

Plant physiology: diffusion, transpiration, absorption and transport, mineral nutrition, metabolism, growth and development, hormones, effects of environmental factors.

**BIOL 5038.** BIOLOGICAL APPLICATIONS OF REMOTE SENSING AND GEOGRAPHICAL INFORMATION SYSTEMS. Three credit hours. Two hours of lecture and one three-hour laboratory per week. Prerequisite: MATE 3172 or MATE 3005 or authorization of the Director of the Department.

Students will learn the theory of extracting information from remotely sensed data, its integration into geographical information system (GIS) databases, and its use for the study and management of biological systems. Students will extract information of biological interest from remotely sensed data and other types of geographic data, will assemble at least one geographic database, and use that geographic database to study the relationships between one or several organisms and several environmental variables.

**BIOL 5045**. SCANNING ELECTRON MICROSCOPY (SEM). Three credit hours. Two hours of lecture and one three-hour laboratory per week. Prerequisite: authorization of the Director of the Department.

Theoretical and practical aspects of the scanning electron microscope (SEM) with emphasis on sample preparation for SEM, detection of the different types of signals emitted by the specimen, and image analysis.

**BIOL 5055**. EUKARYOTIC MOLECULAR GENETICS. Three credit hours. Three hours of lecture per week. Prerequisites: BIOL 3300 and QUIM 5071.

The eukaryotic genome, gene structure, transposable elements, regulation of transcription, mRNA processing, signal transduction and the genetics of development the cell cycle, and cancer. Discussion of research techniques in molecular genetics.

**BIOL 5056**. EUKARYOTIC MOLECULAR GENETICS LABORATORY. Two credit hours. Eight hours of laboratory per week. Prerequisites: (BIOL 3300 and QUIM 5071) or authorization of the Director of the Department. Corequisite: BIOL 5055.

Techniques used in eukaryotic molecular genetics such as: DNA preparation, polymerase chain reaction, restriction mapping, gene cloning, DNA sequencing, and construction of genomic and CDNA libraries.

**BIOL 5057.** INTRODUCTION TO BIOLOGICAL SEQUENCE ANALYSIS. Three credit hours. Two hours of lecture and three hours of laboratory per week. Prerequisites: BIOL 3300 or authorization of the Director of the Department.

Use of bioinformatics programs for the retrieval manipulation, and analysis of DNA and protein sequences. The subjects include: description of sequence data editing software, sequence database searches (nucleotide, proteins and genomes), comparative sequence alignments, applications for the design of specific or degenerate oligonucleotides for the detection of DNA sequences via PCR, and construction of phylogenetic trees using distance, parsimony and maximum likelihood methods.

**BIOL 5116.** MOLECULAR BASIS OF EUKARYOTIC CELL SIGNALING. Three credit hours. Three hours of lecture per week. Prerequisites: BIOL 3010 or BIOL 4008 or QUIM 5071 or authorization of the Director of the Department.

Principles of molecular signaling regulating membrane, cytoplasmic and nuclear events in eukaryotic cells. Emphasis on contemporary research methods and the principles of identifying and solving problems related to cellular signal transduction.

**BIOL 5117.** CELLULAR AND MOLECULAR BIOLOGY OF CANCER. Three credit hours. Three hours of lecture per week. Prerequisite: BIOL 3010 or authorization of the Director of the Department.

Discussion of topics related to cancer research and its clinical application. Emphasis on molecular mechanisms that lead to cancer development and tumor progression and how they relate to the clinical course of the disease. Discussion of recent discoveries in the area.

**BIOL 5226.** GENETICS AND EVOLUTION OF HUMAN POPULATIONS. Three credit hours. Three hours of lecture per week. Prerequisites: (BIOL 3300 or (CIBI 3032 and ANTR 3015)) or authorization of the Director of the Department.

Study of the biology of human populations, mainly from a genetic and evolutionary perspective. Includes the study of genetic elements, their evolution and their use in studies of the evolution and dispersal of human populations and domesticated species.

**BIOL 5399.** EUKARYOTIC GENOME ANNOTATION. Two credit hours. One hour of lecture and three hours of research per week. Prerequisite: BIOL 3300 or authorization of the Director of the Department.

Practical course covering the annotation of genomic fragments in different eukaryotic species, using the genome of an evolutionarily closely related species as a reference sequence. Includes the detailed study of the structure of diverse genetic elements, molecular evolution processes, and the use of applications and computer programs useful for studies in genomics. A final report is required.

**BIOL 5416**. HERPETOLOGY. Three credit hours. Two hours of lecture and one three-hour laboratory per week.

A study of the biology, classification and morphology of amphibians and reptiles, with emphasis on local species. Field trips.

**BIOL 5417**. ICHTHYOLOGY. Three credit hours. Two hours of lecture and one three-hour laboratory per week.

A study of the biology, classification and morphology of fishes, with emphasis on local species. Field trips.

**BIOL 5585**. MEDICAL AND VETERINARY ENTOMOLOGY. Three credit hours. Two hours of lecture and one three-hour laboratory per week.

This course offers the student interested in entomology, animal husbandry or veterinary science, an opportunity to become familiar with the recognition, characteristics, habits and control of insects, ticks, mites, and other arthropods that attack man and domestic animals.

**BIOL 5755**. VIROLOGY. Three credit hours. Two hours of lecture and one three-hour laboratory per week. Prerequisite: BIOL 3770 or authorization of the Director of the Department.

The classification, structure, physiology and biochemical activities of viruses.

**BIOL 5758**. BACTERIAL GENETICS. Two credit hours. Two hours of lecture per week. Prerequisites: BIOL 3300 or BIOL 3770 or authorization of the Director of the Department.

DNA replication and expression in the prokaryotic cell; transfer of genetic information; the impact of genetic processes on the physiology and ecology of bacteria.

**BIOL 5760**. BACTERIAL GENETICS LABORATORY. One credit hour. One four hour laboratory per week. Corequisite: BIOL 5758.

Molecular techniques for the study of the genetics of bacteria and bacteriophages. Practical experiences in the processes of recombination, complementation, the control of genetic expression, and the transmission of genetic information among microorganisms.

**BIOL 5765**. MYCOLOGY. Three credit hours. Two hours of lecture and one three-hour laboratory per week. Prerequisite: BIOL 3770 or authorization of the Director of the Department.

A study of the morphology, physiology, classification and relation of fungi to man. Emphasis is given to the isolation and identification of the different groups.

**BIOL 5815**. ANIMAL BEHAVIOR. Three credit hours. Two hours of lecture and one three-hour laboratory per week.

A study of activities and responses of animals in meeting their life requirements. Field trips.

**BIOL 5955**. INTRODUCTION TO RESEARCH METHODS IN ECOLOGY. Three credit hours. One hour of lecture and two three-hour laboratory periods per week. Prerequisite: BIOL 3125 or authorization of the Director of the Department.

Field and laboratory exercises serve to introduce the student to the basic methods used in ecological research. The student is trained in the use of computers for the analysis of ecological data.

**BIOL 5990**. FIELD BIOLOGY WORKSHOP. One to three credit hours. Thirty to sixty hours of workshop/practice per credit. Prerequisite: authorization of the Director of the Department.

Intensive practical experience in selected areas of field biology, in or outside of Puerto Rico. A final written report will be required.

**Graduate Courses**

**BIOL 6003**. BIOLOGY AND TECHNOLOGY OF PLASMIDS. Two credit hours. Two hours of lecture per week.

Study of the fundamental concepts of the biology, structure, and diversity of plasmids. Discussion of the processes of replication and their role as a tool in genetic engineering and biotechnology.

**BIOL 6004**. BIOLOGY AND TECHNOLOGY OF PLASMIDS LABORATORY. One credit hour. Four hours of laboratory per week. Corequisite: BIOL 6003.

Discussion, experimentation, and application of techniques and strategies for the isolation and study of plasmids from physiological, genetic, and biotechnological perspectives.

**BIOL 6008**. PROKARYOTIC MOLECULAR GENETICS AND GENE REGULATION. Three credit hours. Three hours of lecture per week.

Presentation, description, and analysis of nucleic acid and chromosomal architecture of prokaryotes; the structure and function of biological components involved in the processes of replication, transcription, and translation. Discussion of the different levels and mechanisms of gene expression and regulation with emphasis on their genetic and physiological consequences.

**BIOL 6011**. PRINCIPLES OF METAGENOMICS. Two credit hours. Two hours of lecture per week.

Discussion of fundamental principles for the study of prokaryotic genes and genomes with emphasis in functional genomics. Study of basic principles of emerging disciplines and their impact in problem solving in biology. Description of processes and techniques used for the generation, analysis and application of metagenomics libraries.

**BIOL 6012**. PRINCIPLES OF METAGENOMICS LABORATORY. One credit hour. Four hours of laboratory per week. Corequisite: BIOL 6011.

Application of techniques for the generation and study of metagenomic libraries. Discussion and use of processes such as genetic material extraction, library generation, library screening for diversity and functional studies will also be discussed.

**BIOL 6015**. INSECT MORPHOLOGY. Four credit hours. Two hours of lecture and two two-hour laboratories per week.

A study of the general internal and external morphology of insects.

**BIOL 6017**. PHYSIOLOGY OF BACTERIA. Three credit hours. Two hours of lecture and three hours of laboratory per week.

The physiology of bacteria and the biochemistry of microbic processes.

**BIOL 6018**. PRINCIPLES AND APPLICATIONS OF SYNTHETIC. Three credit hours. Three hours of lecture per week.

Discussion of the fundamentals of Synthetic Biology, its importance, applications, aspects in the development of parts, prototypes, and systems, genetic regulation, and its use for problem solving.

**BIOL 6019**. PRINCIPLES AND APPLICATIONS OF SYNTHETIC BIOLOGY LABORATORY. Two credit hours. Four hours of laboratory per week. Corequisite: BIOL 6018.

Discussion and application of techniques for generation, development, and study of genetic prototypes focusing on Synthetic Biology and the International Genetic Engineered Machines (iGEM). Practical experiences in processes such as extraction and manipulation of different types of genetic material, DNA recombination technology, in silico analysis, prototype functionality and expression control measurements.

**BIOL 6040.** BIOGEOGRAPHY. Three credit hours. Three hours of lecture per week.

A study of the principles governing the distribution of organisms. Examples of the Caribbean area are used.

**BIOL 6155**. PLANT ECOLOGY. Four credit hours. Two hours of lecture and two three-hour laboratories per week. Prerequisite: authorization of the Director of the Department.

The interrelations of plants and environment; climatic, edaphic, and biotic factors in their relation to origin, development, and structures of vegetation; introduction to ecological fieldwork and the methods of ecological research. Practice is given in the recognition of associations, determination, and description of their structure, and relationships and measurements of environmental factors. Reports required.

**BIOL 6199**. BEHAVIORAL ECOLOGY. Three credit hours. Three hours of lecture per week.

Recent developments in behavioral ecology. Evolutionary and ecological models applied to the behavioral problems of survival and reproduction. Integration of theory with field and laboratory evidences. Field trips required.

**BIOL 6369**. POPULATION GENETICS. Three credit hours. Three hours of lecture per week.

Genetic variation in natural populations of both plants and animals in different communities, covering selection, migration, mutations, mating systems, and the effect of population size on the maintenance of genetic variation.

**BIOL 6605**. ENVIRONMENTAL POLLUTION AND DISTURBANCE. Three credit hours. Two hours of lecture and one three-hour laboratory per week. Prerequisite: authorization of the Director of the Department.

An ecological consideration of pollution and disturbance of the environment; the effects of industrial, domestic and other pollutants of the ecosystem; the physical, chemical and biological parameters used in pollution control and abatement. Field trips.

**BIOL 6607**. POPULATION ECOLOGY. Three credit hours. Two hours of lecture and one three-hour laboratory per week.

Study of populations for analysis of the control and interaction among them. Topics such as mortality, fertility, population growth, competition and predator-prey interaction will be discussed.

**BIOL 6610**. LIMNOLOGY. Three credit hours. Two hours of lecture and one three-hour laboratory per week.

A study of the physical, chemical and biological characteristics and interrelations of these factors in aquatic situations; community structure in still and running water; studies of local streams and ponds.

**BIOL 6617**. ADVANCED GENETICS. Three credit hours. Two hours of lecture and one three-hour laboratory per week. Prerequisite: authorization of the Director of the Department.

Discussion of selected topics in genetics.

**BIOL 6631**. CELLULAR BIOCHEMISTRY AND PHYSIOLOGY. Four credit hours. Three hours of lecture and one three-hour laboratory per week.

The interconversions of energy in living cells; photosynthesis and carbohydrate metabolism as energy sources; the utilization of metabolic energy for protein synthesis; solute and solvent movements; nerve and muscle phenomena. Emphasis on metabolic regulation and enzyme action.

**BIOL 6635**. MEDICAL MYCOLOGY. Three credit hours. Two hours of lecture and one three-hour laboratory per week. Prerequisite: authorization of the Director of the Department.

A study of the fungi pathogenic to man.

**BIOL 6637**. TAXONOMY AND MORPHOLOGY OF FUNGI. Three credit hours. Two hours of lecture and one three-hour laboratory per week.

A thorough coverage of the phycomycetes, ascomycetes, deuteromycetes and basidiomycetes from a taxonomical and morphological approach, with emphasis on saprophytes, zoopathogens and phytopathogens.

**BIOL 6642**. ADVANCED MYCOLOGY. Three credit hours. Two hours of lecture and one three-hour laboratory per week.

A study of fungi with emphasis on current literature and methods of research.

**BIOL 6645.** SYSTEMATIC MYCOLOGY. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Study of fungal systematics including historical aspects of classification, taxonomy, and nomenclature. Critical reading and analysis of historical and modern works that gave rise to the current classification of fungi and associated groups. Discussion of the phylogenetic relationships of fungi and other groups that are traditionally studied by micologists, as well as the characteristics used to establish such relationships.

**BIOL 6650**. BACTERIAL DIVERSITY. Three credit hours. Two hours of lecture and three hours of laboratory per week. Prerequisite: consent of the Director of the Department.

The diversity of prokaryotic organisms in relation to ecophysiological and evolutionary perspectives, emphasizing their isolation, identification, and application.

**BIOL 6688**. SCIENTIFIC PHOTOGRAPHY FOR BIOLOGISTS. Two credit hours. Two three-hour laboratories per week. Prerequisite: authorization of the Director of the Department.

Photographic techniques in biological research. A presentation and a portfolio of the student's work are required.

**BIOL 6689**. BIOLOGICAL RESEARCH METHODS. Two credit hours. Two hours of lecture per week.

Methods and theory of investigation in the biological field, including a study of the biological literature and of sources of information from major institutions active in this field. The student is required to write a research proposal in his area of interest.

**BIOL 6690**. GRADUATE SEMINAR. One credit hour. Two hours of lecture per week.

Discussion of recent literature in biology and related fields. Students will discuss principal topics in their special fields.

**BIOL 6705**. ADVANCED FOOD MICROBIOLOGY. Three credit hours. Two hours of lecture and one three-hour laboratory per week.

Microbiology of food commodities. The nature and function of beneficial and harmful microorganisms. Foodborne diseases. Effects of food processing and storage on microorganisms.

**BIOL 6805.** SYMBIOSIS. Three credit hours. Three hours of lecture per week.

Study of common and unusual biological associations between distinct organisms, such as parasites, endosymbiotic bacteria, pollinators, and others. Analysis of organism interactions, from the endosymbiotic theory on the origin of eukaryotic cells to the ecological interactions between organisms and their evolution. A final oral presentation will be required.

**BIOL 6806.** BIOLOGICAL SYSTEMATICS. Three credit hours. Two hours of lecture and three hours of laboratory per week.

Study of the theory and practice of biological systematics, including parsimony analysis of morphological and molecular characters. Discussion of concepts and methods pertinent to the generation and evaluation of phylogenetic trees, and their application using current software packages. A course project on the phylogeny of a particular group or organisms is required.

**BIOL 6990**. RESEARCH . One to six credit hour periods per week.

Research for a thesis.

**BIOL 6991-6992**. SPECIAL STUDIES IN BIOLOGY. One to three credit hours per semester. One to three research periods per week each semester.

Supervised research in some special topics of biology other than a thesis problem, but designed to provide experience and training in scientific investigation.

**BIOL 6993**. SPECIAL TOPICS IN BIOLOGY I. One to three credit hours. One to six hours of lecture or seminar per week.

Selected topics in biology, botany, microbiology, or zoology.

**BIOL 6994**. SPECIAL TOPICS IN BIOLOGY II. One to six credit hours. One to six hours of lecture per week.

Selected topics in biology, botany, microbiology, and zoology.

**BIOL 6997**. SELECTED TOPICS IN BIOLOGY: LABORATORY. One to six credit hours. One to six two-to four-hour laboratories per week.

Laboratory practice of selected topics in biology, botany, microbiology, or zoology.

## ZOOLOGY

### Advanced Undergraduate Course

**ZOOL 5005**. INVERTEBRATES OF PUERTO RICO. Three credit hours. Two hours of lecture and one-three hour laboratory per week.

Taxonomy and ecology of the most common invertebrates of Puerto Rico, especially Arthropoda (exclusive of insects and marine forms) and Mollusca. Field trips.

### Graduate Courses

**ZOOL 6019**. ADVANCED PARASITOLOGY. Four credit hours. Three lectures and one three-hour laboratory per week. Prerequisite: authorization of the Director of the Department.

Lectures, conferences, reading and laboratory work dealing with practical problems of classification, morphology and host relations of animal parasites.

**ZOOL 6058**. INSECT TAXONOMY. Three credit hours. One hour of lecture and two two-hour laboratory periods per week.

The classification of the hexapoda. Construction of keys, preparation of description, nomenclatural problems, faunistic and monographic studies, catalogs and bibliographies.

## CHEMISTRY

### Advanced Undergraduate Courses

**QUIM 5005**. METHODOLOGY OF ENVIRONMENTAL CHEMICAL ANALYSIS. Three credit hours. Three hours of lecture per week. Prerequisites: ((QUIM 3055 or QUIM 3065) and (QUIM 3461 or QUIM 3450 or QUIM 3071 or QUIM 3061)) or authorization of the Director of the Department.

Methods of chemical analysis used for environmental studies in monitoring air, water, and soil, including the methodology required by federal, state, and local agencies. Discussion of sampling techninques for air, surface and waste water, soil, and other matrices. Practical description of analytical instrumentation, quality control, and data analysis.

**QUIM 5065**. CHEMISTRY OF SYNTHETIC DRUGS (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: QUIM 3032 or QUIM 3072 or QUIM 3450 or QUIM 3463 or authorization of the Director of the Department.

The chemistry of synthetic organic compounds of medical and physiological interest. Topics to be covered will include anesthetics, antispasmodics, antipyretics, analgesics, hypnotics, sedatives, anticonvulsants, anticoagulants, antihistamines, tranquilizers, antimalarials, and anthelmintics.

**QUIM 5066**. TOXICOLOGICAL CHEMISTRY (II). Three credit hours. Three hours of lecture per week. Prerequisite: QUIM 3032 or QUIM 3072 or QUIM 3450 or QUIM 3062 or QUIM 3463 or QUIM 3464 or authorization of the Director of the Department.

Chemical properties, reactions, origin, and use of toxic substances, including chemical aspects of their effects upon biological systems, and their transformation and elimination.

**QUIM 5071**. GENERAL BIOCHEMISTRY I. Three credit hours. Three hours of lecture per week. Prerequisite: QUIM 3463 or QUIM 3072 or QUIM 3450 or QUIM 3062 or authorization of the Director of the Department.

Chemical characterization of proteins, carbohydrates, lipids, and nucleic acids; principles of enzymology and bioenergetics; biological membranes and transport; recombinant DNA techniques; biological oxidations.

**QUIM 5072**. GENERAL BIOCHEMISTRY II. Three credit hours. Three hours of lecture per week. Prerequisite: QUIM 5071 or authorization of the Director of the Department.

Biosynthesis and biodegradation of carbohydrates, lipids, amino acids, and nucleic acids; integration and regulation of animal metabolism; chemistry of genetic expression and regulation.

**QUIM 5073**. GENERAL BIOCHEMISTRY LABORATORY I. One credit hour. One four-hour laboratory per week. Corequisite: QUIM 5071.

Isolation and characterization of proteins, lipids, and nucleic acids; enzymatic processes; the use of recombinant DNA techniques.

**QUIM 5074**. GENERAL BIOCHEMISTRY LABORATORY II. One credit hour. Four hours of laboratory per week. Corequisite: MATE 3021 or MATE 3031 or MATE 3144 or MATE 3183.

The use of bioinformatics, structural genomics, and the molecular modeling in the spectroscopic characterization analysis of biological molecules.

**QUIM 5085**. FOOD CHEMISTRY (On demand). Four credit hours. Three hours of lecture and four hours of laboratory per week. Prerequisite: (QUIM 3072 and (QUIM 3463 or QUIM 3062)) or authorization of the Director of the Department.

A study of the chemistry of the principal food resources and food additives, their role in nutrition, and the effect of processing treatment on their chemical composition.

**QUIM 5095**. NUCLEAR CHEMISTRY (II). Three credit hours. Three hours of lecture per week. Prerequisites: (((QUIM 3042 or QUIM 3002) or (QUIM 3132 and QUIM 3134)) and (MATE 3183 or MATE 3031 or MATE 3144)) or authorization of the Director of the Department.

A course describing the fundamental concepts of nuclear science. Selected topics on nuclear properties, nuclear forces and structure, radioactivity, mathematical relations of radioactive decay, statistics, nuclear reactions, effects of nuclear radiations and transitions, application of nuclear phenomena of chemistry and other related fields.

**QUIM 5105**. PRINCIPLES OF QUANTUM CHEMISTRY. Three credit hours. Three hours of lecture per week. Prerequisite: QUIM 4042 or authorization of the Director of the Department.

Conceptual development, postulates, and models of quantum mechanics. Approximation methods to the solution of the time-independent Schrödinger equation.

**QUIM 5125**. CHEMICAL THERMODYNAMICS (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: QUIM 4042 or authorization of the Director of the Department.

Systematic analysis of the fundamental concepts of chemical thermodynamics and their applications.

**QUIM 5135**. PHYSICAL ORGANIC CHEMISTRY (On demand). Three credit hours. Three hours of lecture per week. Prerequisites: (QUIM 4042 and (QUIM 3450 or QUIM 3032 or QUIM 3072 or QUIM 3463)) or authorization of the Director of the Department.

A mathematical and quantitative study of organic chemical phenomena. Applications of modern theoretical concepts to the chemical and physical properties of organic compounds, and to the kinetics and mechanisms of organic reactions.

**QUIM 5145**. HETEROCYCLIC COMPOUNDS (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: QUIM 3032 or QUIM 3072 or QUIM 3450 or QUIM 3463 or authorization of the Director of the Department.

Structure, synthesis, and reactions of ring systems containing other atoms besides carbon. Alkaloids will be given special consideration.

**QUIM 5150**. SPECTROSCOPIC IDENTIFICATION OF ORGANIC COMPOUNDS (I). Three credit hours. Three hours of lecture per week. Prerequisite: QUIM 3032 or QUIM 3072 or QUIM 3450 or QUIM 3463 or authorization of the Director of the Department.

Elucidation of the structure of organic compounds by spectroscopic methods, including infrared, ultraviolet, nuclear magnetic resonance, and mass spectrometry techniques.

**QUIM 5175**. EXPLOSIVES DETECTION AND ANALYSIS. Four credit hours. Three hours of lecture and one four-hour laboratory period per week. Prerequisites: (QUIM 4041 and (QUIM 3065 or QUIM 3055)) or authorization of the Director of the Department.

General aspects, chemical and physical properties, and analytical techniques for the detection and analysis of explosives.

**QUIM 5205.** PHARMACEUTICAL ANALYTICAL CHEMISTRY. Three credit hours. Three hours of lecture per week. Prerequisites: ((QUIM 3065 or QUIM 3055) and (QUIM 3072 or QUIM 3450) and QUIM 4041) or authorization of the Director of the Department.

Application of analytical methods and validation requirements oriented to pharmaceutical processes, materials, and regulations that apply to the pharmaceutical industry.

**Graduate Courses**

**QUIM 6005-6006**. GRADUATE SEMINAR (I, II)-(I, II). One credit hour per semester. One hour of lecture per week each semester.

Lectures, discussions, and reports on selected topics in chemistry.

**QUIM 6007**. SPECIAL TOPICS I. One to six credit hours. One to six hours of lecture per week.

Selected topics in inorganic organic, and analytical chemistry, and biochemistry.

**QUIM 6008**. SPECIAL TOPICS II. From one to three credit hours. From one to three hours of lecture per week.

Selected topics in inorganic chemistry, organic chemistry, analytical chemistry, physical chemistry, and biochemistry.

**QUIM 6010**. ADVANCED ENVIRONMENTAL CHEMISTRY. Three credit hours. Three hours of lecture per week.

Chemistry of the environment with emphasis in water, soil, and atmosphere; analysis and treatment of contaminants; environmental policy.

**QUIM 6011**. ADVANCED INORGANIC CHEMISTRY I (I). Three credit hours. Three hours of lecture per week.

Electronic properties; theories of bonding and structures of inorganic compounds, including metals and their complexes; reactions and applications of acid-base, coordination, and bioinorganic systems.

**QUIM 6012**. ADVANCED INORGANIC CHEMISTRY II (II). Three credit hours. Three hours of lecture per week.

Physical and chemical properties of elements; kinetics and reaction mechanisms of coordination compounds; organometallic chemistry.

**QUIM 6016**. BIOPHYSICAL CHEMISTRY. Three credit hours. Three credit hours of lecture per week.

Spectroscopic methods, molecular simulation, bioenergetics, reaction kinetics, and solution thermodynamics applied to nucleic acids, protein and other biological molecules.

**QUIM 6017.** APPLICATIONS OF RAMAN SPECTROSCOPY FOR ENVIRONMENTAL ANALYSIS. Three credit hours. Three hours of lecture per week.

Discussion of theory, methodology, implementation, and analytical aspects of Raman Spectroscopy, and its recent applications with an emphasis on environmental analysis. Includes topics related to techniques used in research in the areas of biophysics, chemistry and materials science.

**QUIM 6026**. SPECIAL TOPICS IN INORGANIC CHEMISTRY (On demand). Three credit hours. Three hours of lecture per week. Corequisite: QUIM 6011 or authorization of the Department Director.

Discussions of areas of inorganic chemistry that are expanding very rapidly or that have developed recently, including newly developing areas of inorganic chemical research.

**QUIM 6028**. CRISTALLOGRAPHY. Three credit hours. Three lectures per week. Prerequisite: QUIM 4042.

A study of X-rays, crystal geometry, symmetry group diffraction by lattices, the reciprocal lattice, powder and single crystal patterns, structure factors, the phase problem and structure determinations, and refinements including Fourier, Patterson and least square methods.

**QUIM 6035**. NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Department Director.

Fundamental concepts and practice of high-resolution nuclear magnetic resonance (NMR) spectroscopy emphasizing instrumentation with Fourier transform, pulse methods, and the information these provide.

**QUIM 6036**. CHEMICAL ASPECTS OF ENVIRONMENTAL PROBLEMS. Three credit hours. Three hours of lecture per week.

Chemical aspects of environmental problems with emphasis on those occurring in Puerto Rico such as those involving heavy metals, volatile organic compounds, pesticides, and solid wastes. Critical analysis on their effects on public health and the design of new technology for the solution and prevention of these problems will be conducted.

**QUIM 6045**. COMPUTATIONAL SIMULATION APPLIED TO MATERIALS. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Use of molecular simulation to solve problems in materials science. Deterministic and stochastic methods such as molecular dynamics and Monte Carlo. Classical quantum energetic models.

**QUIM 6055**. TRACE ANALYSIS OF ENVIRONMENTAL CONTAMINANTS. Three credit hours. Three hours of lecture per week.

Sampling techniques and instrumental methods of analysis at trace levels of contaminants in water, air, and soil.

**QUIM 6215**. ADVANCED ANALYTICAL CHEMISTRY (On demand). Three credit hours. Three hours of lecture per week.

Advanced topics in chemical analysis including various electrochemical, chromatographic, and complexometric methods.

**QUIM 6216**. SURFACE ANALYTICAL CHEMISTRY. Three credit hours. Three hours of lecture per week.

Analytical and spectroscopic methods for characterization of surfaces and of chemical and electrochemical reactions on surfaces.

**QUIM 6218**. CHEMICAL SEPARATIONS. Three credit hours. Three hours of lecture per week.

Advanced techniques of chemical separations, and their analytical and preparative applications, recent methods of extraction, chromatography, electrophoresis and sedimentation.

**QUIM 6335**. FOOD ANALYSIS (II) (On demand). Four credit hours. Two hours of lecture and eight hours of laboratory per week.

Theory and practice of methods used in food analysis.

**QUIM 6395**. INFRARED SPECTROSCOPY AND MICROSCOPY. Three credit hours. Three hours of lecture per week.

Instrumentation and recent applications of infrared spectroscopy and microscopy.

**QUIM 6401**. ADVANCED ORGANIC CHEMISTRY (I). Three credit hours. Three hours of lecture per week.

Electronic theory, condensation reactions, molecular rearrangements, stereochemistry, reaction mechanisms, and free radicals.

**QUIM 6605**. ADVANCED PHYSICAL CHEMISTRY (II). Three credit hours. Three hours of lecture per week.

Chemical applications of statistical thermodynamics, selected topics in kinetic theory of gases, quantum chemistry and chemical thermodynamics.

**QUIM 6606**. ELECTROCHEMISTRY (On demand). Three credit hours. Three hours of lecture per week.

Theory of weak and strong electrolytes, activity coefficients, potentials, reference electrodes, electrochemical cells, etc. Consideration is also given to ionic transport phenomena and electro-deposition of metals.

**QUIM 6705.** PRINCIPLES AND PRACTICE OF TEACHING CHEMISTRY AT THE UNIVERSITY LEVEL. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

The teaching-learning process in chemistry: theories, teaching methods, and techniques applied to the teaching of chemistry. Study of the fundamentals of measurement, evaluation and assessment.

**QUIM 6707.** SOLID STATE CHEMISTRY. Three credit hours. Three hours of lecture per week.

Discussion of the structure and properties of solid materials such as metals, semiconductors, and inorganic solids.

**QUIM 6715.** ADVANCED BIOCHEMISTRY. Three credit hours. Three hours of lecture per week.

Study of the structure and function of biological macromolecules, such as nucleic acids and proteins. Discussion of biological membranes as fundamental components in cellular function. Analysis of macromolecules by advanced instrumental techniques.

**QUIM 6815**. PLANT BIOCHEMISTRY. Three credit hours. Three hours of lecture per week.

Chemistry of plant constituents. Chemical processes occurring during the growth and development of plants; biochemistry of photosynthesis.

**QUIM 6835.** CHEMOMETRICS. Four credit hours. Three hours of lecture and four hours of laboratory per week.

Application of statistical methods to chemometrics. Quality analysis for the improvement of industrial processes. Design of experiments that optimize the information needed in order to understand and analyze chemical systems.

**QUIM 6915**. ENZYMES (On demand). Three credit hours. Three hours of lecture per week.

Fundamental principles of enzymatic reactions, including topics such as: mechanisms, kinetics, inhibitors, and activators.

**QUIM 6998**. CHEMISTRY RESEARCH (I, II, S). Six credit hours.

The student will choose a member of the faculty as his adviser. Presentation of a thesis is required for credit.

**QUIM 8008**. SCIENTIFIC COMMUNICATION IN CHEMISTRY. Three credit hours. Three hours of lecture per week. Prerequisite: twelve credits in chemistry graduate courses.

Topics related to the preparation and organization of an effective presentation, and to the writing of proposals, scientific articles, and technical reports. Development, presentation and defense of an original research proposal required.

**QUIM 8615**. CHEMICAL KINETICS (On demand). Three credit hours. Three hours of lecture per week.

The discussion of measurements of reaction rates and theories of chemical reactions, study of gas phase and solution kinetics, and rates of biochemical, inorganic and organic reactions.

**QUIM 8616.** NUCLEIC ACIDS. Three credit hours. Three hours of lecture per week.

Study of nucleic acid structures and properties with emphasis on structure-function relationships. Discussion of instrumental techniques for structural analysis and selected applications.

**QUIM 8980**. DOCTORAL RESEARCH SEMINAR. One credit hour. One hour of seminar per week. Prerequisite: authorization of the President of the Graduate Committee (Research Counselor).

Oral presentation and discussion of the doctoral thesis work.

**QUIM 8995**. SPECIAL TOPICS IN APPLIED CHEMISTRY. One to nine credit hours. One to nine hours of lecture per week.

Selected topics in Applied Chemistry.

**QUIM 8997**. RESEARCH AND DOCTORAL THESIS. One to eighteen credit hours. Three to eighteen hours of research or thesis per week. Prerequisite: authorization of the President of the Graduate Committee.

Research that constitutes a significant contribution to the student's field of specialization. Preparation and defense of the dissertation is required.

## DEPARTMENT OF ENGLISH

### Advanced Undergraduate Courses

**INGL 5007.** ORAL COMMUNICATION. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Communication theory and speaking techniques, including enunciation, intonation, phrasing, projecting the voice, and holding audience attention. Varieties of formal oral interpretation are studied and practiced, including drama and poetry reading, public speaking, and debate.

**INGL 5009**. CONTRASTIVE GRAMMAR (II) (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: Authorization of the Director of the Department.

Analysis of the descriptive grammars of English and Spanish to identify areas of divergences and to achieve an understanding of linguistic universals.

**INGL 5010**. PERSPECTIVES ON TEACHING ENGLISH AS A SECOND LANGUAGE (I) (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: Authorization of the Director of the Department. Co-requisite: EDPE 4245 or authorization of the Director of the Department.

Historical overview of language teaching methods from grammar-translation to the most recent approaches; students will develop applications for teaching English as a second language.

**INGL 5015**. ENGLISH AND AMERICAN LITERARY CRITICISM (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: Authorization of the Director of the Department.

Theory and practice of literary criticism within the tradition of English and American literature. A research paper will be required.

**INGL 5018.** STUDY IN THE BRITISH ISLES. Three credit hours. Twenty two point five (22.5) hours of lecture and twenty five hours of seminar per summer. Prerequisite: authorization of the Director of the Department.

Selected courses on various topics in English literature and culture, offered by international summer school programs in universities in the British Isles, such as the university of Cambridge, Oxford University, or University of Edinburgh. Includes plenary lectures on special topics in English literature and excursions to sites of historical and cultural interest.

**INGL 5025**. CURRENT APPROACHES IN LINGUISTIC THEORY (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: Authorization of the Director of the Department.

Recent developments in linguistic theory and their application to related issues.

### Graduate Courses

**INGL 6006**. RESEARCH METHODS (I). Three credit hours. Three hours of seminar per week.

Research techniques in language study with emphasis on English.

**INGL 6008**. BILINGUALISM AND LANGUAGE-CONTACT. Three credit hours. Three hours of lecture per week.

The linguistic and social-psychological aspects of bilingualism; the sociology of language-contact.

**INGL 6009**. MODELS FOR TEACHING LITERATURE(I). Three credit hours. Three hours of seminar per week.

The teaching of literature in English: explication of texts, literary theory and its value in the classroom, the establishment of historical context; problems of teaching literature to speakers of English as a second language.

**INGL 6010**. TESL MATERIALS AND TESTING (II). Three credit hours. Three hours of lecture per week.

Study and development of materials and techniques for the teaching and evaluation of English as a second language, with emphasis on oral communication skills.

**INGL 6016**. TOPICS IN SOCIOLINGUISTICS. Three credit hours. Three hours of lecture per week.

Selected topics based on current research interests in sociolinguistics.

**INGL 6018**. TOPICS IN PSYCHOLINGUISTICS. Three credit hours. Three hours of lecture per week.

Selected topics based on current research interests in psycholinguistics.

**INGL 6020**. SECOND LANGUAGE ACQUISITION (I). Three credit hours. Three hours of lecture per week.

An overview of research topics in second language acquisition, and an in-depth study of one of these topics.

**INGL 6025.** STUDIES IN AMERICAN LITERATURE. Three credit hours. Three hours of lecture per week.

Study of selected themes and movements in American literature.

**INGL 6028**. PSYCHOLINGUISTICS AND THE READING PROCESS. Three credit hours. Three hours of lecture per week.

The reading process and the measurement of reading skills and comprehension in native and second languages; degree of transfer of reading skills from native to second language; current psycholinguistics research in the field of reading.

**INGL 6030**. THEORY AND PRACTICE OF COMPOSITION . Three credit hours. Three hours of lecture per week.

Practice in the techniques of writing. Study of its research and theory.

**INGL 6040**. PRACTICE IN THE TEACHING OF COMPOSITION . Three credit hours. Three hours of lecture per week.

Development and demonstration of materials and methods for the teaching of writing. Study of recent theory, research, and pedagogy.

**INGL 6048.** POETRY SINCE 1945. Three credit hours. One and a half hours of lecture and one and a half hours of seminar per week.

Discussion of the main poetic traditions that characterize the works of the major poets since the second half of the Twentieth Century, including a distinction between modern and postmodern poetry. Examination of movements, themes, and conventions associated with poetry of this period and identification of the common elements in poetry from 1945 to the present. Study of the relationship between primary sources taking into account their historical and cultural contexts. Development of a research project using literary critical theory.

**INGL 6055**. STUDIES IN LITERATURE I. Three credit hours. Three hours of lecture per week.

Study of selected authors, themes, or movements in the literature of the English language.

**INGL 6056**. STUDIES IN LITERATURE II. Three credit hours. Three hours of lecture per week.

Study of selected authors, themes, or movements in the literature of the English language.

**INGL 6058**. STUDIES IN LITERATURE III. Three credit hours. Three hours of lecture per week.

Study of selected authors, themes, and movements in the literature of the English language.

**INGL 6075.** DRAMA 1880-1945. Three credit hours. One and a half hours of lecture and one and a half hours of seminar per week.

Identification and analysis of the themes, elements, conventions and contexts of dramatic works of representative writers from the period 1880-1945, such as Oscar Wilde, John Synge, W.B. Yeats, Lillian Hellman, Bernard Shaw, Sean O'Casey, Clifford Odets, Christopher Isherwood, Maxwell Anderson, T.S. Eliot and Eugene O'Neill. Discussion of the relationship between the primary texts and their historical period through the use of critical theory. An original research project will be required.

**INGL 6076.** THE ROMANTIC MOVEMENT: THE SECOND GENERATION. Three credit hours. One and a half hours of lecture and one and a half hours of seminar per week.

Identification and analysis of the themes, elements, and conventions of the representative writers of the Second Generation of the Romantic Movement born after 1775, also known as the "Younger Generation." Development of analytical skills and use of critical theory through a historical perspective of the primary texts and their historical period. Development of a research project using secondary sources to analyze texts from the period.

**INGL 6206**. MIDDLE ENGLISH LITERATURE: PROSE, DRAMA AND THE ALLITERATIVE REVIVAL. Three credit hours. One hour of lecture, one hour of discussion and one hour of seminar per week.

Identification and analysis of the themes, elements, and conventions of medieval prose, drama and the Alliterative Revival. Development of analytical skills and use of critical theory through a historical perspective of the primary texts and their historical period. Development of a research project using secondary sources to analyze texts from the period.

**INGL 6207**. CHAUCER AND CHAUCERIANS. Three credit hours. One hour of lecture, one hour of discussion and one hour of seminar per week.

Identification and analysis of the themes, elements, and conventions of representative works of Geoffrey Chaucer, such as The Canterbury Tales, Troilus and Criseyde and The Dream Visions coupled with selected works by the English and Scottish Chaucerians, such as John Lydgate and Robert Henryson. Development of analytical skills and use of critical theory through a historical perspective of the primary texts and their historical period. Development of a research project using secondary sources to analyze texts from the period.

**INGL 6208**. SEVENTEENTH CENTURY BRITISH POETRY. Three credit hours. One hour of lecture, one hour of discussion and one hour of seminar per week.

Identification and analysis of the themes, elements and conventions of representative poets in seventeenth century Britain, such as John Donne, George Herbert, Robert Herrick, Andrew Marvell, John Dryden, John Milton, Aemilia Lanyer, Mary Wroth, Margaret Cavendish, and Katherine Philips. Students will refine their analytical skills and acquire an historical perspective of the relationship of the texts to their historical contexts through the use of literary theory.

**INGL 6210**. UNITED STATES LITERATURE FROM 1860 TO 1900. Three credit hours. One hour of lecture, one hour of discussion and one hour of seminar per week.

Identification and analysis of the themes, elements, and conventions of U.S. literature from 1860-1900 by representative writers from diverse genders, ethnic, and racial groups during this period. Development of analytical skills and use of critical theory through a historical perspective of the primary texts and their historical period. Development of a research project using secondary sources to analyze texts from the period.

**INGL 6215**. SEVENTEENTH-CENTURY DRAMA. Three credit hours. One hour of lecture, one hour of discussion and one hour of seminar per week.

Identification and analysis of the themes, elements, and conventions of plays by representative dramatists of the 17th Century, such as Ben Jonson, John Webster, Beaumont and Fletcher, William Shakespeare, George Chapman, Thomas Middleton, Philip Massinger, William Rowley, and John Milton. Students will refine their analytical skills and acquire an historical perspective of the relationship of the primary texts to their historical period through the use of literary theory. They will develop a research project that requires the use of secondary sources to analyze texts from the period.

**INGL 6216**. BEOWULF AND CYNEWULF. Three credit hours. One hour of lecture, one hour of discussion and one hour of seminar per week.

Identification and analysis of the themes, elements, and conventions of the Old English poem Beowulf and the works of the poet Cynewulf, such as Juliana and Elene. Development of analytical skills and use of literary theory through a historical perspective of the primary texts and their historical period.

**INGL 6217**. POETRY 1900-1945. Three credit hours. One hour of lecture, one hour of discussion and one hour of seminar per week.

Identification and analysis of the themes, elements and conventions of representative poets of the Modern period (1900-1945), such as Ezra Pound, T. S. Eliot, William Butler Yeats, Marianne Moore, H. D., Gertrude Stein, Amy Lowell, Mina Loy, Robert Graves, Siegfried Sassoon, Robert Frost, William Carlos Williams, Carl Sandburg, E. E. Cummings, Wallace Stevens, Claude McKay, Langston Hughes, Edith Sitwell, Edwin Muir, Patrick Kavanagh, and W. H. Auden.

**INGL 6218**. THE EIGHTEENTH-CENTURY BRITISH NOVEL Three credit hours. One hour of lecture, one hour of discussion and one hour of seminar per week.

Identification and analysis of the themes, elements, and conventions of representative British novelists of the 18th Century, such as Daniel Defoe, Samuel Richardson, Henry Fielding, Charlotte Lennox, Horace Walpole, Matthew Lewis, Oliver Goldsmith, Fanny Burney, Mary Wollstonecraft, William Godwin, Tobias Smollett, and Laurence Sterne. Students will refine their analytical skills and acquire an historical perspective of the relationship of the texts to their historical contexts through the use of literary theory.

**INGL 6240**. DRAMA SINCE 1945. Three credit hours. One hour of lecture, one hour of discussion and one hour of seminar per week.

Identification and analysis of the themes, elements and conventions of representative dramatists since 1945, such as Tennessee Williams, Harold Pinter, Samuel Beckett, John Osborne, Lorraine Hansberry, Arthur Miller, Caryl Churchill, Tom Stoppard, David Mamet, David Hare, Sam Shepard, Amiri Baraka, and Wole Soyinka. Students will refine their analytical skills and acquire an historical perspective of the relationship of the texts to their historical contexts through the use of literary theory.

**INGL 6245**. FICTION SINCE 1945. Three credit hours. One hour of lecture, one hour of discussion and one hour of seminar per week.

Identification and analysis of the themes, elements and conventions of representative fiction writers since 1945. Readings will reflect diversity and focus mainly on British and American writers of the period, such as George Orwell,

Graham Greene, Iris Murdoch, Doris Lessing, John Fowles, John Updike, William Burroughs, Jack Kerouac, Anthony Burgess, Maxine Hong Kingston, Alice Walker, Salman Rushdie, JM Coetzee, JRR Tolkien, Chinua Achebe, and Toni Morrison. Students will refine their analytical skills and acquire an historical perspective of the relationship of the texts to their historical contexts through the use of literary theory.

**INGL 6441.** SHAKESPEARE: TEXTS AND CONTEXTS. Three credit hours. One and a half hours of lecture and one and a half hours of seminar per week.

Identification and analysis of the themes, elements, and conventions of Shakespeare's texts and contexts at an advanced level, including a study of the critical, textual, and scholarly traditions. Students will refine their critical reading and writing skills, acquire an understanding of the relationship between the primary texts and their cultural/historical contexts, comprehend the critical theory pertinent to studying Shakespeare's texts, and apply critical theory in the reading of primary texts.

**INGL 6448.** THE VICTORIAN NOVEL. Three credit hours. Three hours of lecture and discussion per week.

Identification and analysis of the themes, elements, conventions, and authors of the novels of the Victorian period (1837-1901). A research project including the use of secondary sources to analyze texts is required.

**INGL 6459.** AMERICAN LITERATURE UNTIL 1820. Three credit hours. One and a half hours of lecture and one and a half hours of discussion per week.

Identification and analysis of the themes, elements, and conventions of American literature until 1820. Analysis of the relationship between the primary texts read in the course and their cultural/historical contexts. Application of critical theory in the analysis of Early American literature. A research project will be required.

**INGL 6476.** FICTION FROM 1900 TO 1945. Three credit hours. One and a half hours of lecture and one and a half hours of discussion per week.

A study of the main themes including a distinction between 'modernity' and 'modernism' that characterize the novels and short fiction of the major writers of the first half of the twentieth century, with emphasis on British and North American writers. Discussion of the conventions and themes associated with the fiction of this period and identification of common elements. Analysis of the texts and study of their relationship to their historical contexts through the use of critical theory.

**INGL 6477.** VICTORIAN POETRY AND PROSE. Three credit hours. One and a half hours of conference, one and a half hours of seminar per week.

Identification and analysis of the themes, elements and conventions of representative poets and non-fictional prose-writers of the Victorian period (1837-1901). Development of analytical skills and acquisition of a historical perspective of the relationship of the texts to their historical contexts through the use of critical theory.

**INGL 6478.** OLD ENGLISH LANGUAGE AND LITERATURE. Three credit hours. One and a half hours of lecture and one and a half hours of seminar per week.

An introduction to Old English, coupled with a study of Old English prose and lyric. Readings of representative texts such as the prose works of Bede, Aelfric, Wulfstan, the Anglo-Saxon Chronicle, and anonymous prose works, as well as poetry from the Anglo-Saxon verse anthology, *The Exeter Book.*

**INGL 6479.** NEOCLASSICAL POETRY, PROSE, DRAMA. Three credit hours. One and a half hour of lecture and one and a half hour of seminar per week.

Identification and analysis of the themes, elements, and conventions of the Works of the Restoration and Neoclassical periods with attention to poets, prose writers, and dramatists such as Congreve, Wycherley, Behn, Addison & Steele, Johnson, Sheridan, Dryden, Pope, Finch, Cowper, Gray, and Thompson. Development of analytical skills and a

historical perspective of the relationship between the primary texts and their historical period through the use of literary critical theory. Development of a research project is required.

**INGL 6487.** THE BRITISH ROMANTIC MOVEMENT: THE FIRST GENERATION. Three credit hours. One and a half hours of lecture and one and a half hours of seminar per week.

Identification and analysis of the themes, elements, and conventions of the representative writers born between 1743 and 1775 of the First Generation of the Romantic Movement. Historical analysis of the relationship of the primary texts to their period through the use of critical theory. A research project that includes the use of secondary sources to analyze texts from the period is required.

**INGL 6498**. UNITED STATES LITERATURE 1820 TO 1860. Three credit hours. One hour of lecture, one hour of discussion and one hour of seminar per week.

Identification and analysis of the themes, elements, and conventions of U.S. literature 1820- 1860 by representative writers from diverse genders and ethnic groups during this period. Development of analytical skills and use of critical theory through a historical perspective of the primary texts and their historic period.

**INGL 6516.** PUERTO RICAN LITERATURE IN ENGLISH. Three credit hours. Three hours of lecture per week.

Identification and analysis of the themes, elements, and conventions of Puerto Rican literature in English since 1898. Discussion of the relationship between the primary texts read in the course and the cultural/historical contexts. Application of critical theory in the reading of primary texts. An original research project will be required.

**INGL 6518**. LITERATURE OF THE ANGLOPHONE CARIBBEAN. Three credit hours. One and a half hours of lecture and one and a half hours of discussion per week.

Identification and analysis of the themes, elements, and conventions of anglophone Caribbean literature. Discussion of the relationship between the primary texts and their cultural/historical contexts. Comprehension of the critical theory pertinent to the study of anglophone Caribbean literary texts, and its application to the analysis of primary texts.

**INGL 6526.** POSTCOLONIAL THEORY AND LITERATURE FROM BRITISH POSTCOLONIES. Three credit hours. One and a half hours of lecture and one and a half hours of seminar per week.

Identification and analysis of the themes, elements, and conventions of Anglophone postcolonial literary texts, by writers from former colonies or dependencies of the British empire and their diaspora. Text analysis from a historical perspective through the use of critical literary theory. A research project which includes the use of secondary sources to analyze the primary texts is required.

**INGL 6527.** NOVELS FROM THE BRITISH ISLES. Three credit hours. One and a half hours of lecture and one and a half hours of seminar per week.

Identification and analysis of the themes, elements and conventions of representative novelists from the British Isles such as Daniel Defoe, Henry Fielding, Jane Austen, Sir Walter Scott, William Thackeray, Charles Dickens, Emily Bronte, James Joyce, Virginia Woolf, John Banville, Zadie Smith, Hanif Kureishi, and Julian Barnes, among others. Students will refine their analytical skills and acquire an historical perspective of the relationship of the texts to their historical contexts through the use of critical theory. A research project which requires the use of secondary sources to analyze the primary texts will be developed.

**INGL 6605.** RESEARCH METHODS IN LITERATURE. Three credit hours. One and a half hour of lecture and one and a half hour of seminar per week. Prerequisite: six credits in English Literature at the 3000 level or above.

Study of the materials and methodologies used in literary research. Development, documentation, and defense of a thesis proposal on a literary topic. Preparation of a paper suitable for a professional symposium or academic publication.

**INGL 6910**. CREATIVE PROJECT. Three credit hours. Prerequisite: 30 credits approved.

Creative projects that may include: literary projects, film and communication media projects, electronic teaching materials, interdisciplinary e-courses designed for online platforms, annotated bibliographies, textbooks, and other projects.

**INGL 6981**. SPECIAL TOPICS IN ENGLISH STUDIES I. Three credit hours. Three hours of lecture per week.

A course that falls under the umbrella of the field of English Studies, which includes, but is not limited to, pedagogy, linguistics, communication, and literature.

**INGL 6982.** SPECIAL TOPICS IN ENGLISH STUDIES II. Three credit hours. Three hours of lecture per week.

A course that falls under the umbrella of the field of English Studies, which includes, but is not limited to, pedagogy, linguistics, communications, and literature.

**INGL 6985**. SPECIAL TOPICS I. Three credit hours. Three hours of seminar per week.

Selected topics in linguistics, literature, or pedagogy.

**INGL 6986**. SPECIAL TOPICS II. Three credit hours. Three hours of seminar per week.

Selected topics in linguistics, literature, or pedagogy.

**INGL 6995**. RESEARCH. One to three credit hours. Three to nine hours per week of research.

Research on a topic, which focus and breadth of study will be designed by the student and approved by the supervising professor prior to registration in the course.

**INGL 6996.** UNIVERSITY TEACHING DEVELOPMENT. One to three credit hours. One hour of discussion per week per credit.

Application of instructional theories and strategies to the teaching of English as a Second Language at the university level. A teaching portfolio is required.

**INGL 6997.** TOPICS IN A LITERARY GENRE. Three credit hours. One and a half hours of lecture and one and a half hours of seminar per week.

A variable content course offering a detailed examination of a specific literary genre or mode, such as Science Fiction, Comedy, The Gothic and Magical Realism, among others.

**INGL 6999**. THESIS. Three to six credit hours.

Research in the fields of English language and applied linguistics, and presentation of a thesis.

**English Education (EING)**

**EING 6005**. FOUNDATIONS OF ENGLISH
EDUCATION (I). Three credit hours. Three hours of lecture per week.

Foundations of English education emphasizing an analysis of the social, economic, and political issues which affect the teaching of the language in Puerto Rico.

**GEOLOGY**

**Advanced Undergraduate Courses**

**GEOL 5005.** MARINE GEOLOGY. Three credit hours. Two hours of lecture and two hours of laboratory per week. Prerequisite: GEOL 4046 or authorization of the Director of the Department.

Discussion of the broad morphotectonic features of the sea floor and of coastal zones. Sediments, their origin, mode of formation, methods of study and interpretation. Reefs. Sea bottom topography and geomorphology. Study of changes of the level of the sea. Emphasis on the Caribbean region.

**GEOL 5006**. SEDIMENTATION. Three credit hours. Two hours of lecture and one two-hour laboratory per week. Prerequisite: GEOL 4046 or authorization of the Director of the Department.

Erosion, transportation, and deposition of sediments; classification of sediments; sedimentary environment; sedimentary history of depositional sites; significance of grain size in the sedimentary environment.

**GEOL 5008**. MICROPALEONTOLOGY. Three credit hours. Two hours of lecture and two hours of laboratory per week. Prerequisite: GEOL 4003 or authorization of the Director of the Department.

Foraminifers, structure and morphology of the test, stratifraphy and paleoecology, fundamentals of classification, tintinnids, radiolarians, conodonts, ostracods, dicoasterids.

**GEOL 5011**. PRINCIPLES OF PALEONTOLOGY I (I, Odd numbered years) (On demand). Three credit hours. Two hours of lecture and one two-hour laboratory per week. Prerequisite: authorization of the Director of the Department.

Morphology and classification of fossils with emphasis on the invertebrates. General stratigraphic distribution. The most significant fossil groups will be studied in the laboratory.

**GEOL 5015**. OPTICAL MINERALOGY. Three credit hours. Two hours of lecture and one three hour laboratory per week. Prerequisite: GEOL 3056 or authorization of the Director of the Department.

Optical crystallography, detailed microscopic study of rock forming minerals.

**GEOL 5020**. ADVANCED GEOPHYSICS (Odd numbered years) (On demand). Three credit hours. Three hours of lecture per week. Prerequisites: GEOL 4057 or authorization of the Director of the Department.

The principal physical processes related to the dynamics and evolution of the earth, including energetic activity, gravitational and magnetic fields, heat flow, tectonics, and convection.

**GEOL 5025**. GEOLOGY OF THE CARIBBEAN (Every year). Three credit hours. Three hours of lecture per week. Prerequisite: GEOL 4009 or authorization of the Director of the Department.

The geological and geophysical history and evolution of the Caribbean region, with special emphasis on Puerto Rico; mineral resources; geological hazards; relation of the region to global tectonics.

**GEOL 5026**. TECTONICS (Odd numbered years) (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: GEOL 4009 or authorization of the Director of the Department.

Theory of global plate tectonics as a synthesis of diverse geological themes, with emphasis on the Caribbean region.

**GEOL 5027**. METALLOGENESIS AND GLOBAL TECTONICS (Even numbered years) (On demand). Three credit hours. Three hours of lecture per week.

The relationship of the genesis and distribution of ore deposits to the tectonic environments.

**GEOL 5565**. EARTHQUAKE SEISMOLOGY. Three credit hours. Three hours of lecture per week. Prerequisites: (GEOL 4057 and MATE 3032 and FISI 3152) or authorization of the Director of the Department.

The use of local and global networks to determine the location, magnitude, and source parameters of earthquakes; global seismicity; theory of wave propagation; point sources; inversion of the Earth's structure; source properties.

**GEOL 5575**. SEISMOTECTONICS. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Description of the relationship between seismology and plate tectonics. Recognize how earthquakes are used to identify the forces that act along active plate boundaries. Catalog earthquake types occurring at convergent, divergent and shear plate boundaries. Apply the concepts of Physics to explain the seismic processes occurring on the fault plane. Distinguish between slow-slip and stick-slip fault movements. Relate the signal obtained from modern seismic and geodetic instruments with seismic processes to infer plate boundary kinematics.

**GEOL 5605**. GEOLOGICAL HAZARDS. Three credit hours. Two hours of lecture and three hours of laboratory per week. Prerequisites: GEOL 3025 or GEOL 4015 or authorization of the Director of the Department.

Mechanisms, distribution, and mitigation of geological hazards, including earthquakes, surface fault ruptures, volcanoes, landslides, floods, and ground subsidence. Analysis of case histories. Field trips are required.

**GEOL 5985**. SPECIAL TOPICS IN PALEONTOLOGY. One to three credit hours. Prerequisite: authorization of the Director of the Department.

Recent developments in paleontologic principles. Field trips required.

**GEOL 5993**. ADVANCED GEOCHEMISTRY. One to three credit hours. One to three hours of lecture per week.

Advanced topics in geochemistry. Field trips required.

**GEOL 5994.** SPECIAL TOPICS IN PALEONTOLOGY WITH LABORATORY. One to three credit hours. Prerequisite: authorization of the Director of the Department.

Special topics in paleontology. Field trips required.

**GEOL 5996**. APPLIED GEOLOGY I. One to three credit hours. One to three hours of lecture per week.

Recent development in applied geology, stressing interchange of information between geoscientists and professionals in other fields. Course content –such as hydrogeology, erosion and sedimentation, environmental geology – will vary from semester to semester. Field trips are required.

**GEOL 5998**. ADVANCED PETROLOGY I. One to three credit hours. One to three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Advanced topics on the origin of volcanic, plutonic, and metamorphic rocks. Course content will vary depending on the interests of the professor and students. Field trips required.

**Graduate Courses**

**GEOL 6105**. GROUND FAILURE IN THE TROPICS (Even numbered years) (On demand). Three credit hours. Two hours of lecture and one three-hour laboratory per week.

Modes and mechanisms of ground failure including landslides, sinkholes collapse, and soils expansion; slope stability analysis; aerial photos interpretation and their use in mapping of landslides and sinkholes. Analysis of case histories. Field trips are required.

**GEOL 6106.** ADVANCED GEOMORPHOLOGY. Three credit hours. One hour of lecture, one hour of discussion and one hour of laboratory per week.

In-depth investigation into geomorphologic processes and landforms. Targeted studies of landscape evolution, hillslopes, rivers, drainage basins, tectonic geomorphology and biogeomorphology. Analysis of interactions between climate and geomorphology. Identification of special geomorphologic concerns in Puerto Rico. Application of the concepts discussed and employed in class or field trips for the development of class projects. Integration of geographical information systems (GIS) data and geomorphologic processes.

**GEOL 6107**. GEOLOGY AND TECTONICS OF THE CARIBBEAN (Every year). Three credit hours. Three hours of lecture per week.

The geologic and tectonic evolution of the Caribbean plate and adjacent areas.

**GEOL 6115**. VOLCANIC HAZARDS (Odd numbered years) (On demand). Three credit hours. Three hours of lecture per week.

Volcanic hazards: causes, effects, assessment, mitigation, prediction, and management. Analysis of case histories.

**GEOL 6116**. SEISMIC REFLECTION EXPLORATION. Four credit hours. Three hours of lecture and three hours of laboratory per week.

Use of active seismic methods to determine the subsurface structure. Study of the upper crust through the use of seismic waves reflected through layers of the crust and registered at the surface using geophysical instrumentation. Emphasis on research projects planning and deployment of seismic reflection equipment. Application of acquisition, processing, visualization and interpretation techniques relevant to reflection seismic data in both two and three dimensions.

**GEOL 6117**. VOLCANIC PROCESSES AND DEPOSITS (I, Even numbered years) (On demand). Three credit hours. Two hours of lecture and one three-hour laboratory per week.

Volcanic processes and the deposits they produce.

**GEOL 6119**. VOLCANIC PETROGENESIS (II, Even numbered years) (On demand). Three credit hours. Two hours of lecture and one three-hour laboratory per week.

Mineralogy and geochemistry of volcanic rocks in relation to their petrogenesis.

**GEOL 6120**. GNSS AND ITS APPLICATIONS IN THE GEOSCIENCES. Three credit hours. Two hours of lecture and three hours of laboratory per week.

Explanation of how the Global Navigation Satellite System (GNSS) works, and its applications to the Geosciences. Explanation of the orbit and signal coming from satellites and the mathematical models applied to the observed data in order to determine positions in defined reference frames. Description and comparison of the current GNSS systems (GPS, GLONASS, Galileo, etc.). Use of GNSS instrumentation to acquire data and its subsequent processing. Application of the technology to the fields of tectonics, seismology, volcanology, oceanography, meteorology and others.

**GEOL 6125**. PROBLEMS IN ENGINEERING GEOLOGY. Three credit hours. Two hours of lecture and three hours of laboratory per week.

The application of geology to engineering problems in tropical regions soil and rock description for engineering purposes, geophysical instrumentation, and techniques. Analysis of case histories. Field trips are required.

**GEOL 6135**. INSTRUMENTAL ANALYSIS OF SOLID MATERIALS (Odd numbered years) (On demand). Four credit hours. Two hours of lecture and two three-hour laboratories per week.

Modern instruments used in the analysis of solid materials: theoretical background, training in their use, and interpretation of the measurements.

**GEOL 6145**. MICROFACIES ANALYSIS (Odd numbered years) (On demand). Three credit hours. Two hours of lecture and one three-hour laboratory per week.

Paleontological and sedimentary criteria for the recognition of environments of limestone deposits. Field trips are required.

**GEOL 6147**. CARBONATE GEOLOGY (Even numbered years) (On demand). Three credit hours. Two hours of lecture and one three-hour laboratory per week.

Identification and classification of carbonate sediments and rocks; environments of deposition; variations in styles of accumulation through time; diagenetic modifications. Field trips are required.

**GEOL 6155**. HYDROGEOLOGY (Even- numbered years). Three credit hours. Three hours of lecture per week.

Principles of hydrogeology: chemical and physical properties of surface and subsurface water; rock-water interaction; effects and behavior of contaminants; water resources management.

**GEOL 6157**. BASIN ANALYSIS (Odd numbered years) (On demand). Three credit hours. Three hours of lecture per week.

Origin and evolution of sedimentary basins; mechanisms, controls, and mathematical models of their subsidence.

**GEOL 6185**. ORE DEPOSITS. Three credit hours. Three hours of lecture per week.

Ore deposits: nature, mode of occurrence, origin, and their host rocks. Field trips are required.

**GEOL 6187**. ORE PETROLOGY. Three credit hours. Two hours of lectura and three hours of laboratory per week.

Identification and classification of ore minerals and their host rocks; analysis of texture and composition. Field trips are required.

**GEOL 6195**. IGNEOUS PETROLOGICAL SYSTEMS (Odd numbered years) (On demand). Three credit hours. Two hours of lecture and one three-hour laboratory per week.

Theory and methodology of igneous petrology.

**GEOL 6205**. ADVANCED SEISMOLOGY (Even numbered years) (On demand). Three credit hours. Three hours of lecture per week.

Modern aspects of seismology including wave propagation in an inhomogeneous medium, attenuation and scattering, and source theory; recent contributions to the understanding of the physical processes of the Earth's interior.

**GEOL 6207.** GEOPHYSICAL TIME SERIES ANALYSIS. Three credit hours. Three hours of lecture per week. Prerequisites: Authorization of the Director of the Department.

Study of the use of digital signal processing as applied in geophysical studies. Application of the fundamental principles and analysis of the consequences of sampling theorem, waveform convolution and deconvolution, the Z and Fourier transforms, windowing and filters in geophysical analysis.

**GEOL 6208.** GEODYNAMICS. Three credit hours. Three hours of lecture per week. Prerequisites: authorization of the Director of the Department.

Advanced study of the Earth's plate tectonics and mantle convection and how the forces generated by the Earth's heat engine govern geologic surface processes including earthquakes, volcanism and mountain building. Application of fundamental concepts used for quantitative analysis of mantle convection, lithospheric flexure and fracture, heat transfer within the Earth, the geodynamo and deformation mechanisms.

**GEOL 6215**. ENVIRONMENTAL GEOLOGY (On demand). Three credit hours. Two hours of lecture and one three-hour laboratory per week.

Geology and its relationship to the environment: internal and surface processes, resources, pollution and waste disposal, medical geology, environmental laws, and land use planning. Analysis of case histories. Field trips are required.

**GEOL 6225**. ADVANCED GEOLOGICAL REMOTE SENSING. Three credit hours. Two hours of lecture and one two-hour laboratory per week.

Theory and techniques of remote sensing for the geosciences with an emphasis on quantitative analysis, error estimation, and image enhancement; digital processing, analysis, and interpretation of image data from a variety of operational platforms.

**GEOL 6228**. STRUCTURAL ANALYSIS OF DEFORMED TERRAINS. Three credit hours. Two hours of lecture and one three-hour laboratory per week.

Advanced methods of structural analysis with an emphasis on microcrystalline deformation, foliation development, and rheological models; techniques for measuring strain, differentiation between simple and complex fabrics on the stereographic projection, and balancing cross sections. Examples from the geology of Puerto Rico and the Caribbean will be used.

**GEOL 6505**. GRADUATE SEMINAR I (On demand). One credit hour. One hour of seminar per week.

Oral presentation and discussion of recent developments or classical works in the geosciences.

**GEOL 6506**. GRADUATE SEMINAR II (On demand). One credit hour. One hour of seminar per week.

Oral presentation and discussion of recent developments or classical works in the geosciences.

**GEOL 6991**. SPECIAL PROBLEMS IN APPLIED GEOLOGY (On demand). One to three credit hours.

Individual research on selected topics in applied geology with special emphasis on the Caribbean.

**GEOL 6992**. SPECIAL PROBLEMS IN STRATIGRAPHY (On demand). One to three credit hours.

Individual research on selected topics in stratigraphy with special emphasis on the geology of the Caribbean.

**GEOL 6993**. SPECIAL PROBLEMS IN GEOPHYSICS (On demand). One to three credit hours.

Individual research on selected topics in geophysics with special emphasis on the geology of the Caribbean.

**GEOL 6994**. SPECIAL PROBLEMS IN PETROLOGY (On demand). One to three credit hours.

Individual research on selected topics in petrology with special emphasis on the geology of the Caribbean.

**GEOL 6995.** SPECIAL PROBLEMS IN EARTHQUAKE SEISMOLOGY. One to three credit hours. One to three hours of discussion and research per week.

Reading and discussion of topics related to earthquake seismology. Course themes will be selected according to the objective delineated by the professor. Students will present a final project related to a specific problem in earthquake seismology.

**GEOL 6996.** SPECIAL PROBLEMS IN SEISMIC EXPLORATION. One to three credit hours. One to three hours of discussion and research per week. Prerequisites: GEOL 6116 or authorization of the Director of the Department.

Reading and discussion of topics related to seismic exploration seismology. Course themes will be selected according to the objective delineated by the professor.

**GEOL 6997.** SPECIAL PROBLEMS IN GEOPHYSICAL COMPUTATION. One to three credit hours. One to three hours of discussion and research per week.

Reading and discussion of topics related to computational geophysics. Course themes will be selected according to the objective delineated by the professor. Students will present a final project related to a specific problem in computational geophysics.

**GEOL 6998.** SPECIAL PROBLEMS IN GEOLOGICAL NATURAL HAZARDS. One to three credit hours. One to three hours of discussion per week.

Discussion of topics related to geological natural hazards.

**GEOL 6999**. RESEARCH AND THESIS (I, II).
Three to six credit hours.

Research in geology and presentation of a thesis.

**HISPANIC STUDIES**

*** Graduate Courses**
(* Graduate courses do not require prerequisites.)

**ESHI 6006**. DON QUIJOTE (On demand). Three credit hours. Three hours of lecture per week.

A critical reading of the immortal novel of the Golden Age, and analysis of Cervantes' style and themes, with special attention to research.

**ESHI 6007**. POETIC CREATION FROM RUBEN DARIO TO GARCIA LORCA (On demand). Three credit hours. Three hours of lecture per week.

Study and appreciation of the aesthetics embodied in Modernism and the poetic world of García Lorca.

**ESHI 6008**. THEATER OF THE GOLDEN AGE (On demand). Three credit hours. Three hours of lecture per week.

Critical reading of the great works of the dramatists of the Golden Age, with emphasis on the criticism of Spanish Classical Drama.

**ESHI 6016**. SPANISH NOVEL OF THE 19th CENTURY (On demand). Three credit hours. Three hours of lecture per week.

A study of the works of Galdós as the main figure of the renaissance in the Spanish novel of the 19th Century.

**ESHI 6017**. THE CONTEMPORARY SPANISH ESSAY (On demand). Three credit hours. Three hours of lecture per week.

A critical study of the Spanish essay of the twentieth century through the reading and discussion of texts representative of the contemporary Spanish thought.

**ESHI 6018**. ROMANTICISM AND MODERNISM IN THE LITERATURE OF PUERTO RICO (I). Three credit hours. Three hours of lecture per week.

A study and analysis of the most significant aspects of Puerto Rican Romanticism and Modernism.

**ESHI 6020**. ACADEMIC WRITING. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Practice in strategies of scholarly writing in Spanish for graduate students in literary and linguistics.

**ESHI 6027**. GENERAL LINGUISTICS (On demand). Three credit hours. Three hours of lecture per week.

A study of the development of linguistics, analysis of schools, fundamental methods and fields in which modern linguistics operate. Discussion of new trends.

**ESHI 6028**. THE NOVEL OF THE HISPANIC ANTILLES (On demand). Three credit hours. Three hours of lecture per week.

A study of the origin and development of the novel in Cuba, Puerto Rico and the Dominican Republic, analysis of the outstanding works of each country, with special attention to their common characteristics and differences.

**ESHI 6029**. THE LITERARY GENERATION OF THE THIRTIES IN PUERTO RICO (On demand). Three credit hours. Three hours of lecture per week.

A study of the artistic tendencies and literary forms in the works of the main authors of the Generation of the Thirties in Puerto Rico.

**ESHI 6035**. PUERTO RICAN LITERATURE OF THE GENERATION OF 45 (On demand). Three credit hours. Three hours of lecture per week.

Reading and analysis of various forms of poetry, short story, novel, drama, and the essay whose roots evolve from the generation of 1930 to form the so called generation of 1945.

**ESHI 6037**. EVOLUTION OF GRAMMAR IN THE SPANISH LANGUAGE. Three credit hours. Three hours of lecture per week.

Study of the morphology and syntax of the Spanish language from its origin up to the present; diachronic study of Spanish grammar. Discussion and analysis.

**ESHI 6045**. THESIS RESEARCH. Six credit hours.

A study of the methods and techniques in linguistic and literary research in Hispanic Studies. Full accreditation of this course is given upon completion and approval of the Master´s thesis.

**ESHI 6047**. MEDIEVAL SPANISH LITERATURE. Three credit hours. Three hours of lecture per week.

The popular anonymous creations and the works of learned poets with special attention given to XV Century literature, already influenced by the Renaissance and culminating in La Celestina.

**ESHI 6059**. EIGHTEENTH-CENTURY SPANISH LITERATURE. (On-demand) Three credit hours. Three hours of lecture per week.

Study of the literary development in Spain from 1726 to 1816. Description and analysis of the discourses, stylistic tendencies, and literary genres, emphasizing the interaction between the aesthetic, social, and political aspects of the time, in light of current theoretical approaches.

**ESHI 6067**. CONTEMPORARY SPANISH AMERICAN SHORT-STORY (On demand). Three credit hours. Three hours of lecture per week.

The Spanish American short story from the decade of 1940 to the present; tendencies and techniques; most representative authors: Borges, Cortázar, Arreola, Rulfo, Roa Bastos, Fuentes, Carpentier, Paz, Di Benedetto, García Márquez, Yáñez, Vargas Llosa, Donoso.

**ESHI 6070.** PUERTO RICAN FOLKTALE. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Discussion on folklore and folktale as an expressive manifestation. Identification and description of the different types and characteristics of the genre in Puerto Rico. Analysis of the meanings construed by these texts and study of their possible uses in the classroom.

**ESHI 6079.** CONTEMPORARY PUERTO RICAN SHORT STORY. Three credit hours. Three hours of lecture per week.

Study of short story development in Puerto Rico from the generation of 1945-1950 until the 21st century, with emphasis on writers who have emerged since the 1970's. Analysis of the generations in relation to their ideologies, stylistic tendencies, and the manner in which each continues or breaks with the previous tradition.

**ESHI 6096**. DIALECTOLOGY AND SOCIOLINGUISTICS IN THE CARIBBEAN SPANISH. (On demand) Three credit hours. One-and-one-half hours of lecture and one-and-one-half hours of seminar per week.

Explore linguistic and extra-linguistic aspects of the regional and social variety of Caribbean Spanish, from both a diachronic and synchronal perspective.

**ESHI 6405**. THE SPANISH LANGUAGE IN AMERICA. (On demand) Three credit hours. Three hours of lecture per week.

A comparative study and analysis of the characteristics that define the unity and the variety of our vernacular language in Puerto Rico, in the rest of the Spanish American countries, and in Spain.

**ESHI 6406**. SPANISH LANGUAGE IN PUERTO RICO. (On demand) Three credit hours. Three hours of lecture per week.

A comparative study and analysis of the characteristics that define the unity and the variety of our vernacular language in Puerto Rico, in the rest of the Spanish American countries, and in Spain.

**ESHI 6407.** SPECIAL TOPICS IN HISPANIC LANGUAGE AND LITERATURE. One to six credit hours. One to six hours of lecture per week.

Selected topics in Hispanic language and literatures.

**ESHI 6561** (On demand). THE NOVEL IN SPANISH AMERICA. Three credit hours. Three hours of lecture per week.

Lectures with textual analysis of the major works in the history of the Spanish-American novel, from its beginnings in the 19th Century to the present.

**ESHI 6562** (On demand). THE NOVEL IN SPANISH AMERICA. Three credit hours. Three hours of lecture per week.

Lectures with textual analysis of the major works in the history of the Spanish-American novel, from its beginnings in the 19th Century to the present.

**ESHI 6605.** CONTEMPORARY THEORY AND LITERARY CRITICISM. Three credit hours. Three hours of lecture per week.

Study of the theoretical-critical main currents in the literary study from the beginning of the 20th Century to the present. Examination of the theoretical concepts and the fundamental critical methodologies, mainly from the reading of primary sources. Evaluation of critical essays and practical application of methods of analysis. Writing of a bibliographical or critical essay from one of the studied approaches. The course may be updated as new theories, tendencies or methodologies of analysis arise.

**ESHI 6606.** SEMINAR IN LITERARY CRITICISM. Three credit hours. Three hours of seminar per week.

Study of a particular critical approach chosen by the professor who teaches it. Reading, discussion of primary sources, and application of this critical approach to texts of Hispanic Literature. Writing of a theoretical critical article that applies this approach to a text.

**ESHI 6607.** "RAÍZ Y ALAS": CONTEMPORARY SPANISH AMERICAN POETRY. Three credit hours. Three hours of lecture per week.

Analysis of the Literary Works of the Spanish American Poetry Masters during the 20th and 21st Centuries.

**ESHI 6609.** HISPANIC AMERICAN LITERATURE AND POST-COLONIAL STUDIES. Three credit hours. Three hours of lecture per week.

Application of the postcolonial theory to the diachronic study of representative Hispanic American literary texts from the independence from Spain to the end of the 20th century.

**ESPA 5006**. THE QUEERCARESQUE: QUEER INHERITOR OF THE PICARESQUE NOVEL. Three credit hours. One hour of lecture, one and a half hours of discussion and half hour of research per week. Prerequisite: ESPA 3102 or authorization of the Director of the Department.

Discussion of The Life of Lazarillo de Tormes as the groundbreaking picaresque novel as well as excerpts of other classics of this genre. A transatlantic approach among queer literatures focused on the evolution or reappropriation of the genre, narratology, technologies linked to each book according to their historicity, and the marginalized sexualities that can be traced starting with the foundational Lazarillo. Analysis and critique of how language reveals the relationship between the authors and their countries in a particular moment in time.

**ESPA 6005**. THE MULTIPLE UNIVERSES OF RENÉ MARQUÉS: SCHOLAR, WRITER, IDEOLOGIST AND READER. Three credit hours. Two hours of lecture and one hour of discussion per week.

Study and analysis of the literary work of René Marqués. Development of skills in bibliographical research, application of processes to analyze literary texts, current methods in literature critical studies, and writing of monographic works.

**LING 5010**. PRAGMATICS. Three credit hours. Three hours of lecture per week. Prerequisites: LING 4010 or authorization of the Director of the Department.

Study of how context influences the interpretation of meaning in linguistic expressions. Discussion of how speakers use language to perform communicative acts and achieve specific goals. Analysis of extralinguistic factors affecting comprehension, such as speaker intention, situational context, and interpersonal relationships. Formulation of the rules and principles underlying the interpretation of contextual meaning.

**LING 5030**. INTRODUCTION TO GENERATIVE SYNTAX. Three credit hours. Two hours of lecture and two hours of laboratory per week. Four credit hours equivalency for the profesor.

Study of syntactic structures in natural languages, with particular attention to spanish. Description and classification of syntactic features, categories, functions and operations. Representation of subordinate clauses, clitics, negation, and sentence informational structure. Analysis of phrase and sentence constituents through the application of recent generative syntactic theoretical models.

**LING 5040**. INTRODUCTION TO GENERATIVE PHONOLOGY. Three credit hours. Two hours of lecture and two hours of laboratory per week. Four credit hours equivalency for the profesor.

Study of phonological structures in natural languages using formal methods. Description, classification and representation of articulate sounds, prosodic structures and distinctive features. Formulation of phonological rules and ordering relations, feature geometry, tone, intonation, and metrical stress. Data analysis for the identification of phonological patterns and processes in segments and suprasegmentals through the application of recent generative phonological theories.

**LING 5050.** MORPHOLOGICAL THEORY. Three credit hours. Three hours of lecture per week. Prerequisites: LING 4010 or ESPA 4201 or INGL 3225 or authorization of the Director of the Department.

Representation of morphological structures, processes, and operations in natural languages through models proposed in generative morphology. Study of the nature of the lexicon, morphology as an autonomous module of grammar, and the interface of morphology with phonology and syntax. Revision of theories of Lexical Morphology, Prosodic Morphology, and Optimality. Application of linguistic theory to the analysis of morphological data in natural languages.

**LING 5060**. COMPOSITIONAL SEMANTICS. Three credit hours. Two hours of lecture and two hours of laboratory per week. Four credit hours equivalency for the profesor.

Introduction to the study of linguistic meaning and its relationship with syntactic structure according to the principles of truth-conditional compositional semantics. Application of formal methods, model theory, and type theory to semantic analysis. Exploration of the categories of informational content, classes and relations of meaning, predication, quantification, modification, events, presuppositions, and conversational implicatures.

**LING 5075.** LANGUAGE ACQUISITION AND DEVELOPMENT. Three credit hours. One and a half hours of lectures and one and a half hours of seminar per week. Prerequisites: LING 4010 or ESPA 4201 or INGL 3225 or authorization of the Director of the Department.

Survey of research and theoretical perspectives in natural language acquisition and development in children. Discussion and examination of child language data from Spanish and other languages. Exploration of universal principles and biological aspects of language acquisition and development, the logical problem of language acquisition, infant speech perception and production, development of phonology, morphology, syntax, semantics and the lexicon, Universal Grammar and the language bioprogram, and child creation of creole languages.

**LING 5080**. COMPUTATIONAL LINGUISTICS. Three credit hours. Two hours of lecture and two hours of laboratory per week. Prerequisites: LING 4010 or ESPA 4201 or INGL 3225 or authorization of the Director of the Department.

Introduction to the study and modeling of the computational properties of human language in order to develop linguistic models that may be used to test theoretical constructs about this faculty. Application of aspects of linguistic theory and formal language theory in analyzing structures in natural language and evaluating complexity and generative adequacy in models of language competence, processing and acquisition. Design and implementation of rule systems as well as phonological, morphological, syntactic and semantic representations for natural language parsers. Survey of some on-line tools, such as tagged corpora, parsers and semantic webs. Discussion of the interdisciplinary relationships between computational linguistics, natural language processing, and artificial intelligence.

**LING 5090**. FORMAL FOUNDATIONS OF LINGUISTIC THEORY. Three credit hours. Three hours of lecture per week. Prerequisites: LING 4010 or ESPA 4201 or INGL 3225 or MATE 3171 or authorization of the Director of the Department.

Study of the logical and mathematical foundations needed to formulate linguistic theory and formally describe properties of languages. Introduction to formal tools and basic concepts of set theory, relations and functions; infinites; propositional calculus and predicate logic; Model Theory; algebras, lattices, and automata. Application of formal methods to the analysis of the syntax and semantics of quantifiers, natural and formal languages, and types of grammars.

**LING 5100.** PHILOSOPHICAL FOUNDATIONS OF LINGUISTIC THEORY. Three credit hours. One and a half hours of lecture and one and a half hours of seminar per week. Prerequisites: (LING 4010 and (INGL 3225 or ESPA 4202 or ESHI 6027)) or authorization of the Director of the Department.

Critical-historic reconstruction of the fundamental concepts in linguistic theory, such as levels of adequacy in a theory of grammar; rules, representations and derivations; restrictions and locality; principles and parameters of Universal Grammar; hierarchy of formal languages and automata; the relation between thought, language and reality; I-language, meaning, truth, sense and reference, virtual conceptual necessity, dualism and methodological minimalism. Discussion of the development of linguistic theory from Cartesian rationalism to the biocognitive approach within modern and contemporary scientific thinking.

**LING 5110.** FOUNDATIONAL ISSUES IN BIOLINGUISTICS. Three credit hours. One and a half hours of lecture and one and a half hours of seminar per week. Prerequisites: ((LING 4010 and ESPA 4202) or ESHI 6027 or INGL 3225) or authorization of the Director of the Department.

Critical review and analysis of the canonical issues and debates in biolinguistics such as the biological factors in language design; the architecture of the language faculty; universal grammar, recursion and innatism in language adquisition and development; linguistic competence within a comparative ethological context; the nature of the genetic endowment and evolution of the language faculty; the neurological implementation and computational models of the language components and interfaces. Discussion of the contributions of anthropology, psychology, molecular and evolutionary biology, neuroscience, and computational sciences to problems in theoretical linguistics, as well as the implications of findings in biolinguistics for some controversies in these disciplines.

**LING 5120.** PSYCHOLINGUISTICS. Three credit hours. One and a half hours of lectures and one and a half hours of seminar per week. Prerequisites: LING 4010 or ESPA 4201 or INGL 3225 or authorization of the Director of the Department.

Introduction to the study of the mental representations and processes involved in language implementation, including the comprehension, production and storage of spoken and written linguistic information. Survey of sentential, discursive and conversational structure processing models. Exploration of the psychological reality of linguistic representations. Discussion of the contributions of psychology, computational sciences and Artificial Intelligence to problems in the design of models of natural language processing, as well as the implications of findings in psycholinguistics for some controversies in these disciplines.

**LING 5170.** BILINGUALISM AND SECOND LANGUAGE ACQUISITION IN CHILDREN. Three credit hours. Three hours of lecture per week. Prerequisites: LING 4010 and INGL 3225 or authorization of the Director of the Department.

Exploration of language development in bilingual and second language acquisition in children. Survey of research and theoretical perspectives in bilingualism, second language acquisition, heritage language, and foreign language learning. Analysis of children's language data in the different linguistic components: lexicon, phonology, morphology, syntax, and semantics. Discussion of existing myths about bilingual acquisition in children. Examination of the possible effects of bilingualism on a child's academic achievement, cognitive development, and first language development.

**LING 5180**. NATURAL LANGUAGE PROCESSING. Three credit hours. One hour of lecture, one hour of discussion and one hour of computation per week. Prerequisites: LING 4010 and (COMP 3010 or CIIC 3011 or CIIC 3015 or INGE 3016) and (ESMA 3016 or ININ 4010).

Introduction to the study of search and learning methods in designing and analyzing computational representations and algorithms for natural language processing. Implementation of linear and non-linear learning algorithms, with special attention to neural networks. Use of language models in sequence labeling and classification. Application of concepts in syntax and formal language theory to natural language parsing. Meaning representation, denotation and computation by means of compositional formalisms. Survey of on-line tools and human language technologies. Discussion of the interdisciplinary relationships between natural language processing, computational linguistics and artificial intelligence.

**LING 5980**. RESEARCH SEMINAR IN COMPUTATIONAL LINGUISTICS AND NATURAL LANGUAGE PROCESSING. Credits vary from zero to six credit hours. Prerequisites: (LING 5030 or LING 5080 or LING 5180) and authorization of the Director of the Department.

Development of a research project in computational linguistics or natural language processing under the supervision of a faculty member.

**LING 5990**. SEMINAR IN LINGUISTICS. Zero to six credit hours. One hour of discussion and two hours of seminar per week. Prerequisites: Two from LING 5030, LING 5040 or LING 5060 or authorization of the Director of the Department.

Exploration of a field of study in contemporary linguistics. Search, reading and discussion of primary sources from the chosen subject. Identification and specification of a linguistic inquiry and design of an original research project. Project completion and presentation of a technical report and/or research poster will be requiered.

**LING 6130.** SYNTACTIC THEORY I. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Study of the universal principles and parameters of variation that explain the formation and structure of syntactic constituents. Analysis of syntactic structures and the relations and operations that occur between lexical items during the derivation leading to different levels of syntactic representation. Description of the syntactic interfaces with the phonological and semantic component. Application of generative syntactic theory to problems in natural languages.

**LING 6140.** PHONOLOGICAL THEORY I. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Analysis of segmental and suprasegmental structures of natural languages according to the different theories proposed in generative grammar. Formulation of phonological rules and representations using derivational and non-derivational models. Application of theoretical models to data analysis in the phonology and morphology of natural languages.

**LING 6160.** SEMANTIC THEORY. Three credit hours. Three hours of lecture per week. Prerequisites authorization of the Director of the Department.

Study of denotation and meaning composition in natural languages. Application of formal tools and models, such as set theory, propositional and predicate logic, semantic type theory, and lambada calculus, to compute the meaning of linguistic expressions. Formal representation of semantic rules and principles. Extensional analysis of predicates, modifiers, definite descriptions, relative clauses, pronouns, and quantificational determiners. Comparison and evaluation of restrictions in convert movement versus type-shifting rules in the interpretation of variables and generalized quantifiers.

**LING 6180**. NATURAL LANGUAGE PROCESSING. Three credit hours. One hour of lecture, one hour of discussion and one hour of computation per week. Prerequisite: authorization of the Director of the Department.

Theory and practice of search and learning methods in designing and analyzing computational representations and algorithms for natural language processing. Implementation of linear and non-linear learning algorithms, with special attention to neural networks. Use of language models in sequence labeling and classification. Application of concepts in syntax and formal language theory to natural language parsing. Meaning representation, denotation, and computation by means of compositional formalisms. Survey of on-line tools and human language technologies. Discussion of the interdisciplinary relationships between natural language processing, computational linguistics, cognitive science, and artificial intelligence.

**LING 6240**. PHONOLOGICAL THEORY II. Three credit hours. Prerequisite: LING 6140.

Advanced study of non-linear and non-derivational models in contemporary phonological theory. Critical examination of the architecture and components of Optimality Theory and its comparison with Principles and Parameters based phonological theories. Analysis of suprasegmental and prosodic aspects of natural languages, such as syllabification, metrical stress, tone, and intonation, in both derivational and non-derivational theoretical frameworks. Typological approach to stress and tone systems in natural language. Review of phonological interfaces with morphological and syntactic structures.

**LING 6250**. SYNTACTIC THEORY II. Three credit hours. Prerequisite: LING 6130.

Advanced comparative study of the most recent generative models in contemporary syntactic theory. Examination of the architecture and modules of the computational system, phrase structure and levels of syntactic representation, binding, and restrictions of movement and derivational economy, as proposed in the Principles and Parameters Theory and the Minimalist Program. Critical analysis of theoretical implications in syntactic representation and derivation from both theoretically-internal and empirical perspectives. Problem formulation in aspects of the syntax of natural languages and application of syntactic theory to explain problematic data.

**LING 6260**. FORMAL SEMANTICS. Three credit hours. One hour of lecture, one hour of discussion and one hour of seminar per week. Prerequisite: LING 6160 or authorization of the Director of the Department.

Advanced study of foundational issues and findings in formal semantics in order to develop a deeper understanding of the methods of natural language semantics and the ways in which they can yield new insights into linguistic meanings. Exploration of the phenomenon of intentionality in natural language, as well as the core techniques and results of intentional or possible-word semantics. In depth examination of sentential complements of propositional attitude verbs, modality and conditionals. Application of analytic tools developed through these studies to explore other relevant topics such as the de *rel de dicto* distinction, the semantics of plurals and e-type anaphora. Exposure to primary literature in the field of formal semantics. Formulation of problems and analysis of linguistics data to explain aspects of the semantics of natural languages.

**LING 6280**. FORMAL COMPUTATIONAL LINGUISTICS. Three credit hours. One hour of lecture, one hour of discussion and one hour of seminar per week. Prerequisite: authorization of the Director of the Department.

Study of the theoretical foundations of computational linguistics, with an emphasis on the importance of algorithms, algebra, logic, and formal language theory in the understanding and modeling of human language. Analysis of empirical phenomena in phonology and syntax from a variety of natural languages to motivate and illustrate the use of formal concepts and methods. Discussion of issues in theoretical linguistics from a computational perspective and its possible impact in the development of new applications and technologies.

**LING 6700**. PROSEMINAR IN LINGUISTIC RESEARCH. Three credit hours. One and a half hours of seminar and one and a half hours of workshop per week. Corequisites: (LING 6130 and LING 6140 and LING 6160) or authorization of the Director of the Department.

Workshop in the theory and application of scientific research methods in theoretical, experimental or field linguistics. Identification, formulation and development of a linguistic research problem. Search and study of relevant primary literature; data collection and research design.

**LING 6710**. BIOLINGUITICS SEMINAR. Three credit hours. Three credit hours. One and a half hours of seminar and one and a half hours of workshop per week. Prerequisite: authorization of the Director of the Department. Corequisite: LING 6700.

Research workshop in the evolution, genetics, neurobiology, structural design, and functional architecture of the human language faculty. Identification, formulation and development of a research problem in biolinguistics. Search and study of relevant primary literature; data collection and research design.

**LING 6720**. NEURO AND PSYCHOLINGUISTICS SEMINAR. Three credit hours. One and a half hour of seminar and one and a half hour of workshop per week. Prerequisite: authorization of the Director of the Department. Corequisite: LING 6700.

Research workshop in language comprehension, production and development, and the neural mechanisms in the brain that control the implementation of human language. Identification, formulation and exploration of a research problem in psycholinguistics or neurolinguistics. Search and study of relevant primary literature; data collection and research design.

**LING 6730**. SYNTAX SEMINAR. Three credit hours. One and a half hour of seminar and one and a half hour of workshop per week. Prerequisite: LING 6250 or authorization of the Director of the Department. Corequisite: LING 6700.

Research workshop in theoretical or experimental syntax. Identification, formulation and development of a research problem in syntactic theory. Search and study of relevant primary literature; data collection and research design.

**LING 6740**. PHONOLOGY SEMINAR. Three credit hours. One and a half hour of seminar and one and a half hour of workshop per week. Prerequisite: LING 6240 or authorization of the Director of the Department. Corequisite: LING 6700.

Research workshop in theoretical or experimental phonology. Identification, formulation and development of a research problem in phonological theory. Search and study of relevant primary literature; data collection and research design.

**LING 6750**. SEMINAR OF MORPHOLOGY AND THE LEXICON. Three credit hours. One and a half hour of seminar and one and a half hour of workshop per week. Corequisite: LING 6700 or authorization of the Director of the Department.

Research workshop on the structure and storage of lexical items, processes and operations in word formation, and the representation of the mental lexicon. Identification, formulation and exploration of a research problem in morphological theory and interfaces. Search and study of relevant primary literature; data collection and research design.

**LING 6760**. SEMANTICS SEMINAR. Three credit hours. One and a half hour of seminar and one and a half hour of workshop per week. Prerequisite: LING 6260 or authorization of the Director of the Department. Corequisite: LING 6700.

Research workshop in theoretical or experimental semantics. Identification, formulation and development of a research problem in formal semantics. Search and study of relevant primary literature; data collection and research design.

**LING 6770**. LANGUAGE ACQUISITION SEMINAR. Three credit hours. One and a half hour of seminar and one and a half hour of workshop per week. Prerequisite: authorization of the Director of the Department. Corequisite: LING 6700.

Research workshop in first and second language acquisition and development. Identification, formulation and exploration of a research problem in language acquisition. Search and study of relevant primary literature; data collection and research design.

**LING 6780**. COMPUTATIONAL LINGUISTICS SEMINAR. Three credit hours. One and a half hour of seminar and one and a half hour of workshop per week. Prerequisite: authorization of the Director of the Department. Corequisite: LING 6700.

Research workshop in the implementation of computational models of linguistic competence or automated natural language processing. Identification, formulation and development of a research problem in computational linguistics. Search and study of relevant primary literature; exploration of existing computational tools, and research design.

**LING 6795**. SEMINAR IN METHODS OF LINGUISTIC RESEARCH. Three credit hours. One hour of discussion and two hours of seminar per week. Prerequisite: authorization of the Director of the Department.

Theory and practice of methods and strategies for research in contemporary Hispanic linguistics. Formulation and investigation of a research topic. Different procedures for the collection of data and research design will be studied. A written and oral presentation of an original thesis proposal will be required.

**DEPARTMENT OF HUMANITIES**

**ESCH 6001**. CULTURAL STUDIES: THEORETICAL APPROACHES. Three credit hours. One and a half hours of lecture and one and a half hours of discussion per week.

Study of history, themes, and methodological aspects of cultural studies with an emphasis on its major theoretical tendencies and schools from its pre-cursors to its most recent articulations. Cultural studies in Puerto Rico, the Caribbean and Latin America will be included.

**ESCH 6002**. CULTURAL STUDIES: PRACTICAL APPROACHES. Three credit hours. One and a half hours of lecture and one and a half hours of discussion per week.

Review of the history, themes, and methodological aspects of cultural studies and their application to various disciplinary frameworks such as media studies, comparative literature, art theory, critical race theory, and gender and sexuality studies. Cultural studies of Puerto Rico, the Caribbean and Latin America will be included.

**ESCH 6005**. RESEARCH METHODS. Three credit hours. One and a half hours of lecture and one and a half hours of discussion per week.

Introduction to the methods of research in the fields of Cultural and Humanistic Studies.

**ESCH 6006**. GENDER AND SEXUALITY THEORY. Three credit hours. One and a half hours of lecture and one and a half hours of discussion per week.

Critical analysis of modern and contemporary theories of gender and sexuality as they relate to cultural phenomena. Interdisciplinary consideration of the historical articulations of gender and sexuality, including perspectives from literary theory, art theory and popular culture studies, with emphasis on the United States, the Caribbean and Latin America.

**ESCH 6007**. CRITICAL RACE THEORY. Three credit hours. One and a half hours of lecture and one and a half hours of discussion per week.

Study of contemporary theories of race and their relation to social and cultural phenomena, with interdisciplinary consideration of the history of practices of racial distinction in the United States, the Caribbean and Latin America. Interdisciplinary study of the cultural articulation of race from the perspectives of literary theory, art theory and popular cultural studies.

**ESCH 6008**. POPULAR CULTURE AND MASS MEDIA. Three credit hours. One and a half hours of lecture and one and a half hours of discussion per week.

Critical and practical investigation of popular culture and mass media. Examination of the conceptual frameworks adopted by cultural studies to understand popular cultures and mass media. Survey of approaches utilized by various disciplines in order to study and participate in the spheres of popular culture and mass media.

**ESCH 6010**. ART AND POWER. Three credit hours. One and a half hours of lecture and one and a half hours of discussion per week.

Study of the relationship between art and power throughout history, as influenced by political, economic, religious and mass media institutions. Analysis of the purpose of works of art as well as the design and the signification of the forms and materials of which they are made.

**ESCH 6011**. CLASSIC HUMANISTIC STUDIES. Three credit hours. One and a half hours of lecture and one and a half hours of discussion per week.

Survey of philosophical, theoretical, aesthetic, literary, historical and scientific works representative of humanistic tradition of the liberal arts from classical antiquity to the Renaissance, with an emphasis on advanced critical readings of pivotal texts.

**ESCH 6012**. MODERN HUMANISTIC STUDIES. Three credit hours. One and a half hours of lecture and one and a half hours of discussion per week.

Survey of philosophical, theoretical, aesthetic, literary, historical and scientific works representative of humanistic tradition of the liberal arts from the Renaissance to the present, with an emphasis on advanced critical readings of pivotal texts.

**ESCH 6015**. COMPOSITION, EDITING AND PUBLISHING. Three credit hours. One and a half hours of lecture and one and a half hours of discussion per week.

Analysis of principles, practices, and application of skills used in the composition, editing and publishing of academic texts within the fields of Cultural and Humanistic Studies.

**ESCH 6016**. MULTILINGUAL RESEARCH. Three credit hours. One and a half hours of lecture and one and a half hours of discussion per week.

Study of critical theories and practices of translation in research including documentation, intertextuality, and issues arising from translation in colonial and postcolonial contexts. Research in the fields of Cultural and Humanistic Studies using sources retrieved from different languages.

**ESCH 6017**. UNIVERSITY TEACHING DEVELOPMENT. One credit hour. Three hours of workshop per week.

Application of instructional theories and strategies to teaching courses in Cultural and Humanistic Studies at the university level.

**ESCH 6993**. SPECIAL TOPICS I. Three credit hours. One and a half hours of lecture and one and a half hours of discussion per week.

Special topics in Cultural and Humanistic Studies I.

**ESCH 6994**. SPECIAL TOPICS II. Three credit hours. One and a half hours of lecture and one and a half hours of discussion per week.

Special topics in Cultural and Humanistic Studies II.

**ESCH 6999**. RESEARCH AND THESIS. Zero to six credit hours. Zero to six hours of thesis per week. Prerequisites: ESCH 6002 and ESCH 6012 and ESCH 6005.

Research in cultural and humanistic studies and the presentation of a thesis representing an original contribution to the field.

**Advanced Undergraduate and Graduate Courses**

**HUMA 5991**. SPECIAL TOPICS. One to nine credit hours. One to nine hours of lecture per week. Prerequisites: HUMA 3112 or authorization of the Director of the Department.

Selected topics in the area of the Humanities.

**HUMA 5992**. SPECIAL TOPICS. One to nine credit hours. One to nine hours of lecture per week. Prerequisite: HUMA 3112 or authorization of the Director of the Department.

Selected topics in the area of the Humanities.

**LITE/FILO 5001**. LITERATURE AND PHILOSOPHY I. Three credit hours. Three hours of lecture per week.

Critical examination of the major philosophical theories of literary genres; analysis of the epistemological, metaphysical, and ethical meaning of literary texts from the ancient Greeks to the early Spanish Golden Age.

**LITE/FILO 5002**. LITERATURE AND PHILOSOPHY II. Three credit hours. Three hours of lecture per week.

Critical examination of the major philosophical theories of literary genres; analysis of the epistemological, metaphysical, and ethical meaning of literary texts from the end of the Spanish Golden Age to the present.

**LITE 5035**. THEORY OF THE NOVEL. Three credit hours. Three hours of lecture per week. Prerequisite: 9 credits in LITE, ESPA or INGL or authorization of the Director of the Department.

The development of the novel as a literary genre, emphasizing texts from the baroque to the present; a comparative analysis of narratology theories and representative novels.

**LITE 5050**. CONTEMPORARY LITERARY CRITICISM. Three credit hours. Three hours of lecture per week. Prerequisite: 9 credits in LITE, ESPA or INGL or authorization of the Director of the Department.

Principles and methodologies of contemporary schools of criticism; analysis of critics and texts from various literatures.

**LITE 5057**. MAGICAL REALISM. Three credit hours. Three hours of lecture per week. Prerequisites: Nine credits in LITE or ESPA or INGL or authorization of the Director of the Department.

Magical realism in the context of world literature. Analysis of its distinguishing characteristics in the genre of fantasy through readings of its main authors, texts, and critics.

**LITE 5336.** WORLD LITERATURE BY WOMEN. Three credit hours. One and a half hours of lecture and one and a half hours of discussion per week. Prerequisites: Nine credits in LITE or ESPA or INGL or authorization of the Director of the Department.

The study of the themes, problems, and theories of the female gender as represented in the poetry, prose, and drama of world literature by women. Analysis of gender theory and its relation to contexts both local and global. Discussion of the relationship between gender and themes such as race, class, community, stereotypes, representation, myth and the abject in women's literature from diverse cultures.

**LITE 5615**. THE SYMBOLIST MOVEMENT IN LITERATURE. Three credit hours. Three hours of lecture per week. Prerequisites: Nine credits in LITE or ESPA or INGL or authorization of the Director of the Department.

The development of the symbolist movement and its influence in Europe and in America, with special emphasis on poetry and the theater.

**LITE 5715**. METHODS IN THE STUDY OF LITERARY TEXTS. Three credit hours. Three hours of lecture per week. Prerequisites: Nine credits in LITE or ESPA or INGL or authorization of the Director of the Department.

Analysis of the most important methods used in the study of literary texts, from rhetoric's, to structuralism, with emphasis on the techniques used in comparative literature.

**LITE 5995**. SPECIAL TOPICS IN COMPARATIVE LITERATURE I. One to nine credit hours. Prerequisites: Nine credits in LITE or ESPA or INGL or authorization of the Director of the Department.

Critical analysis of authors, movements, genres, or interdisciplinary topics in comparative literature.

**LITE 5996**. SPECIAL TOPICS IN COMPARATIVE LITERATURE II. One to nine credit hours. Prerequisites: Nine credits in LITE or ESPA or INGL or authorization of the Director of the Department.

Critical analysis of authors, movements, genres, or interdisciplinary topics in comparative literature.

## DEPARTMENT OF KINESIOLOGY

### Advanced Undergraduate Course

**EDFI 5005**. HEALTH ASSESSMENT. Three credit hours. Two hours of lecture and three hours of laboratory per week. Prerequisites: (BIOL 3715 and BIOL 3716) or authorization of the Director of the Department.

The application of the laws of mechanics to the analysis of sport techniques. A research project will be required.

### Graduate Courses

**EDFI 6005.** ANALYSIS OF TEACHING PHYSICAL EDUCATION. Three credit hours. Three hours of lecture per week.

Analysis of teacher behavior, decisions and actions as the director of the teaching and learning process. Experiences in the performance and analysis of teaching skills through demonstrative classes are included. The student is expected to identify and apply the teacher behavior, decisions and actions that have proven to be effective, in their own teaching. Conferences, discussion, group work, observations and practice are included. A research project is required.

**EDFI 6046.** SAFETY IN PHYSICAL EDUCATION. Three credit hours. Three hours of lecture per week.

Risk management and prevention of accidents in physical education and sport programs; safety considerations and legal aspects. At the end of the course students must be able to recognize inherent risks and elaborate solutions for the prevention of accidents in different activities and in facilities for recreation and sport. Conferences, discussions, critical analysis of articles, and a research project are included.

**EDFI 6105.** LEARNING AND CONTROL OF MOTOR SKILLS. Three credit hours. Three hours of lecture per week.

Research methods and study of the factors influencing learning and control of motor skills such of memory systems, information processing, attention and performance, motor programming, individual differences and capabilities, practice conditions, feedback and knowledge of results, and motor memory. Students are expected to do research to determine how different variables influence motor learning and/or performance. Students are also expected to apply the learning and motor control concepts in the teaching and performance of motor skills. Conference, discussion and critical analysis of articles, and a research project are included.

**EDFI 6107.** CURRICULAR DESIGN IN PHYSICAL EDUCATION. Three credit hours. Three hours of lecture per week.

Analysis of traditional and innovative curricular designs in Physical Education, including the present curricular framework and the Physical Education Program Standards of Puerto Rico. The adaptation of the curricular design in accordance with school context is discussed. The student is expected to identify, select and design the implementation of a curricular design that best attends to the needs of the student population in becoming physically educated. Conferences, discussion and demonstrative classes are included. A research project is required.

**EDFI 6209.** EVALUATION AND PRESCRIPTION OF EXERCISE. Three credit hours. Three hours of lecture per week.

Scientific principles applied to the evaluation of physical fitness and health with emphasis on the interpretation and application of results. A combination of conferences and practical experiences to teach the skills related to the evaluation of physical components and health used in the preparation of the prescription of exercise regimes, are included. Communication skills for interview, and the performance and interpretation of physical fitness test will be discussed. The student is expected to evaluate physical fitness groups in the population and apply it in the preparation of exercise programs. A research project is required.

**KINE 6015.** THEORIES OF SPORTS TRAINING. Three credit hours. Three hours of lecture per week.

Study of the sports training theories and its application. Emphasis on the psysiological, technical, and psychological aspects of the athlete and the training planning. The student is expected to plan the design and supervision of the training cycle of an athlete in any sport. Conference and critical review of related literature will be used. A project is included.

**KINE 6017**. LIFETIME INCLUSIVE PHYSICAL ACTIVITY. Three credit hours. Two hours of lecture and one hour of discussion per week. Prerequisite: authorization of the Director of the Department.

Analysis of physical, social, psychological, and emotional needs of individuals with functional diversity in inclusive physical activity environments across their life stages and transitions.

**KINE 6105.** CURRENT TOPICS IN KINESIOLOGY. Three credit hours. Three hours of lecture per week.

Trends and research of current topics in kinesiology, physical education, and sports. The student is expected to critically analyze, prepare reports and develop a research project related to a contemporary topic. Conferences, discussion, critical analysis of articles and oral presentations are included. A research project is required.

**KINE 6107.** ANTHROPOMETRY. Three credit hours. Three hours of lecture per week.

Measurements of the structure of the human body with emphasis in the athlete's performance in different sports. The student is expected to measure, evaluate, analyze and interpret anthropometric data in relation to the athlete's performance in sports. Conference, practice, reports, laboratories, discussion, and research report are included.

**KINE 6109.** PHYSIOLOGY OF THE ATHLETE IN SPORTS. Three credit hours. Three hours of lecture per week.

Study of the physiological changes in the athlete during performance of different sports and in the training requirements. Emphasis on the activities used for improving the performance of the cardio-respiratory and muscular-skeletal systems and the metabolism of the athletes who practice individual group sports. The student is expected to apply in the design of the athlete training the adequate activities that will attain the adaptations necessary for the different sports. Conference, group discussion and critical analysis of literature in the field of sport physiology will be used. A research project is required.

**KINE 6115.** SPORTS FACILITIES MANAGEMENT. Three credit hours. Three hours of lecture per week.

Planning, design, and operation of facilities for instruction, recreation and sport activities. Field trips required.

**KINE 6125.** LEGAL ASPECTS IN THE ADMINISTRATION OF KINESIOLOGY, SPORTS AND RECREATION. Three credit hours. Three hours of lecture per week.

Legal considerations in the administration of Kinesiology, athletics, and Recreation. The students will discuss legal aspects and responsibilities as they relate to the administration of programs in these areas. It includes lectures, critical analysis of articles, and an individual research project.

**KINE 6155.** PHYSICAL ACTIVITY FOR SENIOR CITIZENS. Three credit hours. Three hours of lecture per week.

The role of physical activity in the maintenance of the physical, mental, and social health of senior citizens. The student is expected to design and develop programs in physical activity directed to improve and maintain the health of senior citizens. Conference, discussion and critical analysis of articles, reports, and research project are included. Field trips are required.

**KINE 6205.** ANALYSIS OF HUMAN MOVEMENT. Three credit hours. Three hours of lecture per week.

The analysis of human movement using video images in two dimensions and the quantitative methods of kinematics. The student is expected to acquire a video of the execution of a sport or exercise skill and analyze quantitative aspects of the kinematics of it. Conference, discussion, some laboratories, and a movement analysis project are included.

**KINE 6500.** GRADUATE SEMINAR. One credit hour. One hour of seminar per week.

Discussion, oral presentations, and written reports performed by the student in topics of kinesiology and physical education. The student is expected to create a written report in topics of kinesiology and physical education and present it to an audience for its discussion.

**KINE 6905.** PROJECT. Three credit hours. Nine hours of research per week.

Comprehensive study of a concrete and practical problem in kinesiology or physical education with the purpose of integrating the acquired knowledge in the graduate program. It includes the formulation of a problem, the review of literature, collection of data, analysis, conclusion, the presentation of a defense of the project. It is expected that the student be capable of presenting a project to solve a problem in one of the subareas of kinesiology or physical education and of approving an oral exam before the Examiner Committee.

**KINE 6985**. RESEARCH METHODS IN KINESIOLOGY. Three credit hours. Three hours of lecture per week.

Research methodology in human movement and sports.

**KINE 6991.** INDEPENDENT STUDY. One to three credit hours. Three to nine hours of research per week.

Elaboration of a supervised pilot investigative project on a Kinesiology, Physical Education or sports topic. The formulation of the problem, review of literature, data collection, analysis and conclusion may be included. The student is expected to make a presentation and a written report of the investigation.

**KINE 6992.** SPECIAL TOPIC. One to three credit hours. One to three hours of lecture per week.

Special topic in kinesiology, not offered in courses in the university catalogue. Discussion of a specialized topic of interest for students or offered by a visiting professor. The student is expected to discuss and present reports related to the special topic. Conferences, discussion, presentations and laboratory are included. A research project is required.

**KINE 6999.** RESEARCH AND THESIS. Three to six credit hours. Nine to eighteen hours of research per week.

Supervised research in kinesiology (includes teaching or physical education). Review of literature, data collection, analysis, presentation, and defense of a master's thesis are included. Students are expected to complete a research in kinesiology (includes teaching or physical education) and defend it in front of a graduate committee.

**MARINE SCIENCES**

**Advanced Undergraduate Course**

**CIMA 5005**. INTRODUCTION TO OCEANOGRAPHY (I, II) (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Basic knowledge, techniques, and areas of interest of the different disciplines of marine sciences. The interaction and research aims in Physical, Geological, Chemical and Biological Oceanography.

**CIMA 5007**. INTRODUCTION TO OCEAN OBSERVATION. Three credit hours. Three hours of lecture per week.

Discussion of the scientific and practical applications of ocean observation. Evaluation of the different types of observation platforms from the most traditional such as buoys and ships to the modern autonomous submersible vehicles and satellites in polar and geostationary orbits. Investigation of the different types of physical, chemical, and biological sensors installed on these platforms, as well as their principles of operation, limitations and environmental and energy requirements. Evaluation of telemetry protocols and data storage in the operation of the observation system.

**CIMA 5008**. LABORATORY OF INTRODUCTION TO OCEANOGRAPHY. One credit hour. Three hours of laboratory per week. Corequisite: CIMA 5005.

Application of basic knowledge and techniques in different areas and disciplines of interest within marine sciences. The application exercises present the research aims, scopes, and interaction between Physical, Geological, Chemical, and Biological Oceanography.

**Graduate Courses**

**CIMA 6007**. PROFESSIONAL RESEARCH CONDUCT IN OCEAN SCIENCES. Two credit hours. Two hours of discussion per week.

Discussion of responsible research conduct and training for graduate students. Additional emphasis on Justice, Equity, Diversity, and Inclusion (JEDI) in ocean sciences research.

**CIMA 6900**. GRADUATE RESEARCH PROJECT IN MARINE SCIENCES. Zero to six credit hours. One hour of discussion and eight hours of research per week. Prerequisites: Approve three of four core courses: (CMOB 6618 and CMOF 6617 and CMOG 6616 and CMOQ 6615) or authorization of the Director of the Department.

Comprehensive study of a problem related to any of the marine sciences disciplines, biological, physical, geological and /or chemical oceanography, which integrates the knowledge acquired in the program. The project could be done in house (CIMA) or in any other institution (public or private) and the selected topic will depend on the student's interest. At the end of the project, the student must submit a final report that shows main results, acquired experience and applications. This report will be evaluated by the student's graduate committee.

**CIMA 6999**. RESEARCH AND THESIS (I, II, S). One to six credit hours.

Up to a maximum of six credits representing the research and thesis may be granted towards the master of science degree.

**CIMA 8785**. CURRENT TOPICS SEMINAR (II). Two credit hours. Two hours of lecture per week.

Recent topics in marine sciences and related fields.

**CIMA 8998**. SPECIAL PROBLEMS (I, II, S). One to three credit hours. One to three sessions per week.

Tutorial discussion and/or laboratory and library research on a special topic.

**CIMA 8999**. DOCTORAL RESEARCH AND DISSERTATION (I, II, S). Up to twelve credit hours.

Up to a maximum of twelve credits representing the dissertation may be granted toward the Doctor of Philosophy degree.

**MARINE SCIENCES BIOLOGICAL OCEANOGRAPHY (CMOB)**

**Advanced Undergraduate Courses**

**CMOB 5007**. FUNDAMENTALS OF AQUACULTURE. Three credit hours. Three hours of lecture per week.

The culture of animals and plants in fresh, brackish, or saline water. Field trips required.

**CMOB 5015**. FISHERIES BIOLOGY (I, II). Three credit hours. Three hours of lecture per week.

A study of the principles and methods of fisheries investigation with emphasis on the fisheries of North America and the Caribbean. Field trips.

**CMOB 5017**. MARINE ECOLOGY AND RESOURCE MANAGEMENT. Five credit hours. Three hours of lecture and two three-hour laboratories per week. Prerequisite: authorization of the Director of the Department.

Description of the marine environment and familiarization with the major tropical marine communities; data-gathering and biological sampling techniques; human impact on the marine environment from the standpoint of pollution, exploitation, protection, and regulation; jurisprudence in major litigation involving marine resources; management practices.

**CMOB 5087**. AQUACULTURE AND THE ENVIRONMENT. Three credit hours. Three hours of lecture per week.

Impact of aquaculture on the environment and the mitigation of its effects. Field trips required.

**Graduate Courses**

**CMOB 6010**. MARINE SIMBIOSIS. Four credit hours. Three hours of lecture and three hours of laboratory per week.

Study of symbioses and interactions among animals, plants, fungi, bacteria, archaea, and protists (including algae) in diverse marine environments, with emphasis on evolutionary and physiological adaptations of symbiotic partners in their genetics and metabolism and other types of interactions.

**CMOB 6018**. MARINE ECOLOGY (I, II) (On demand). Four credit hours. Three hours of lecture and one three-hour laboratory per week.

Structure and function of marine ecosystems; flux of energy and materials in biogeochemical cycles.

**CMOB 6077**. ZOOPLANKTON ECOLOGY (On demand). Three credit hours. Two hours of lecture and one three-hour laboratory per week. Prerequisite: authorization of the Director of the Department.

Aspects of zooplankton ecology in relation to oceanographic processes in estuarine, neritic, and oceanic ecosystems. Includes experiences in sampling techniques and experimental design.

**CMOB 6078.** ANALYSIS OF SPATIAL DATA IN MARINE ECOLOGY. Three credit hours. Three hours of lecture per week.

Collection and analysis of spatial data in marine ecology within a geographic information system and landscape ecological context with applications to ecological problems. Emphasis on ecological issues in the marine environment and their application to marine resources management. A research project is required.

**CMOB 6079.** DNA DATA ANALYSIS OF MARINE ORGANISMS. Six credit hours. Three hours of lecture and six hours of laboratory per week.

Introduction to modern marine population genetics and phylogenetics of marine species. Study of the different types of molecular data and their collection; phylogeny reconstruction by parsimony, distance, and likelihood methods; tests of the molecular clock for dating speciation events; Darwinian selection at the molecular level, interspecies variation, detection of population structure; and genomic evolution. Analysis of real data from the marine scientific literature with computer software in population genetics and phylogenetics.

**CMOB 6618**. BIOLOGICAL OCEANOGRAPHY (I). Three credit hours. Two hours of lecture and one three-hour laboratory per week.

Marine life and its relationship to geological, physical and chemical aspects of the ocean; basic techniques fundamental to marine research. Demonstrations and field trips.

**CMOB 6619**. BIO-OPTICAL OCEANOGRAPHY (I) (On demand). Four credit hours. Three hours of lecture and one three-hour laboratory per week. Prerequisite: Authorization of the Director of the Department.

Integrated study of the role of light in aquatic ecosystems including the physics of light transmission within water, the biochemistry and physiology of aquatic photosynthesis, and the ecological relationships that depend on the underwater light environment. Field trips required.

**CMOB 6635**. RESEARCH METHODS IN MARINE SCIENCES (II). Three credit hours. Three hours of lecture per week.

Techniques of data collection, analysis, and interpretation with emphasis on research problems relevant to the marine ecosystems of Puerto Rico.

**CMOB 6645**. MARINE PLANKTON BIOLOGY (I, II) (On demand). Two credit hours. One hour of lecture and one three-hour laboratory per week.

Study of the marine plankton with emphasis on systematics, morphology, life histories, physiology, feeding, and reproduction. Importance of plankton on the economy of the sea, particularly in their role as primary and secondary producers. Field trips required.

**CMOB 6655**. MOLECULAR MARINE BIOLOGY (I, II) (On demand). Four credit hours. Two hours of lecture and two three-hour laboratories per week. Prerequisite: Authorization of the Director of the Department.

Theory, practice, and applications of molecular marine biology.

**CMOB 8635**. MARINE MICROBIOLOGY. Three credit hours. Two hours of lecture and three hours of laboratory per week.

Analysis of marine microorganisms with emphasis on their functions in nutrient cycling in the ocean, and the role of algae, bacteria, protozoans, fungi and viruses. Emphasis on the presence of non-culturable microorganisms in the marine environment and their research methods.

**CMOB 8636**. MARINE PARASITOLOGY. Four credit hours. Two hours of lecture and six hours of laboratory per week.

Parasitology of marine organisms with emphasis on local fauna, collecting methods, preparation for the study and identification of parasites.

**CMOB 8649**. CRITICAL ANALYSIS OF READINGS IN MARINE ECOLOGY (II) (On demand). Two credit hours. Four hours of seminar per week.

Study of classical and recent readings in marine ecology. Analysis of authors' aims, methods, results, and interpretations.

**CMOB 8657**. ACUACULTURE. Four credit hours. Three hours of lecture and three hours of laboratory per week.

Principles underlying food production by efficient utilization of various aquatic environments and organisms to include fresh, brackish, and marine environments, and the lotic and lentic systems of the culture of fish and other aquatic crops, such as algae, molluscs, and crustaceans.

**CMOB 8659**. INVERTEBRATE AQUACULTURE. Three credit hours. Three hours of lecture per week.

Study of the cultivation of invertebrates such as shrimps, oysters, clams, mussels, gastropods, and octopi. Emphasis on modern techniques,feasibility and economic aspects.

**CMOB 8665**. MORPHOLOGY OF MARINE INVERTEBRATES (II) (On demand). Three credit hours. Two hours of lecture and one three-hour laboratory per week.

Form, structure and function of representative marine invertebrates.

**CMOB 8667**. ADVANCED FISHERIES BIOLOGY (I, II) (On demand). Three credit hours. Two hours of lecture and one three-hour laboratory per week. Prerequisites: authorization of the Director of the Department.

Population dynamics of exploited species, management and conservation principles for commercial fisheries.

**CMOB 8676**. SYSTEMATICS OF MARINE INVERTEBRATES (I) (On demand). Four credit hours. Three hours of lecture and one four-hour laboratory per week.

Taxonomy, phylogeny and distribution of marine invertebrates with special attention to local forms.

**CMOB 8679**. MARINE BOTANY (I, II). Three credit hours. Two hours of lecture and one three-hour laboratory per week.

A study of the flora of the sea, with emphasis on the morphology, ecology and taxonomy of algae.

**CMOB 8686**. ICHTHYOLOGY I (II) (On demand). Three credit hours. Two hours of lecture and one three hour laboratory per week.

Study of the morphology, physiology and ecology of fishes, with emphasis on marine forms.

**CMOB 8687**. ICHTHYOLOGY II (I) (On demand). Three credit hours. Two hours of lecture and one three hour laboratory per week.

Study of the systematic, evolution and distribution of fishes, with emphasis on marine forms.

**CMOB 8708**. BIOLOGY OF THE CORAL REEF. Five credit hours. Three hours of lecture and five hours of laboratory per week. Prerequisite: CMOB 8676.

Exploration of the systematic, evolution, and biological characteristics (structure, modularity, life cycles, reproduction, etc.) of the main organisms forming coral reef communities. Field trips to coral reef communities and laboratory work are required.

**CMOB 8709**. ECOLOGY AND ZOOGEOGRAPHY OF CORAL REEFS. Five credit hours. Three hours of lecture and one six-hour laboratory per week. Prerequisite: CMOB 8708 or authorization of the Director of the Department.

Study of the ecology and geographical distribution of corals and coral reefs. Field trips are required.

**CMOB 8715**. ECOLOGICAL CONCEPTS IN MARINE RESEARCH (I, II) (On demand). Three credit hours. Two hours of lecture and one three-hour laboratory per week.

Advanced ecological concepts with special emphasis on the marine environment; energy relationships in ecological systems; application of quantitative biology and experimental methods in ecological research.

**CMOB 8716**. ECOLOGY OF MARINE COMMUNITIES SEMINAR (II) (On demand). Two credit hours. Two sessions per week.

Composition and quantitative structure of selected marine assemblages, and their energetic and tropic relationships.

**CMOB 8993**. SPECIAL TOPICS IN AQUACULTURE. One to three credit hours. One to three sessions per week.

Studies under staff supervision on projects specifically concerned with aquaculture. Topics will be selected by agreement between the student and the professor.

**CMOB 8994**. A, B, C. SPECIAL PROBLEMS IN MARINE INVERTEBRATES (I, II) (On demand). One to three credit hours. One to three sessions per week.

Supervised study or research on specific selected aspects of marine invertebrates, or techniques pertaining to their study.

**MARINE SCIENCES CHEMICAL OCEANOGRAPHY (CMOQ)**

**Graduate Courses**

**CMOQ 6008**. OPEN DATA SCIENCE IN CHEMICAL OCEANOGRAPHY. One credit hour. Three hours of laboratoy per week.

Study of chemical oceanography through the description of patterns in publicly available data of ocean time series, satellite remote sensing, and Earth system climate model output. Practice in downloading and managing publicly available data, chemical oceanography toolboxes, scientific visualizations, and description of oceanographic processes.

**CMOQ 6615**. CHEMICAL OCEANOGRAPHY (II). Three credit hours. Three hours of lecture per week.

General survey of chemical oceanography, including application of basic concepts of physical and analytical chemistry to the marine environments, chemical interactions of major and minor constituents of seawater, the influence of chemical processes on physical, biological, and geological processes.

**CMOQ 6617**. MARINE POLLUTION (II) (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: CMOQ 6615 or CIMA 6615.

Deleterious effects on living resources, human health, marine activities, and water quality caused by the anthropogenic introduction of substances or energy into the marine environment.

**CMOQ 8638**. CHEMICAL OCEANOGRAPHY LABORATORY (I). Three credit hours. One hour of lecture and six hours of laboratory per week.

Laboratory experience in techniques of sampling and handling of marine samples, and the analyses of these samples for major, minor and trace constituents.

**CMOQ 8991**. A, B, C. SPECIAL PROBLEMS IN CHEMICAL OCEANOGRAPHY (I, II) (On demand). One to three credit hours. One to three sessions per week.

Laboratory studies of specific problems in chemical oceanography. Topics to be chosen by the student and approved by the professor.

## MARINE SCIENCES GEOLOGICAL OCEANOGRAPHY (CMOG)

### Advanced Undergraduate Course

**CMOG 5001.** INTRODUCTION TO CLIMATE CHANGE. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Overview of the principles of Earth's climate covering a broad range of phenomena that influence climate at various regional and global time scales and resolutions. Discussion of climate forced by external controls. Description of the effects of internal forces and their variability, and human-induced climate change. Emphasis on the role of greenhouse gases and rates of change of these processes. Discussion of the future climate change scenarios and possible mitigating steps.

**CMOG 5002**. LABORATORY OF INTRODUCTION TO CLIMATE CHANGE. One credit hour. Three hours of laboratory per week. Corequisite: CMOG 5001.

Application and analyses of the principles of Earth's climate covering a broad range of phenomena forced by external controls. Laboratory exercises include the use of proxy data, climate modeling, and analysis of climate change impacts.

### Graduate Courses

**CMOG 6616**. GEOLOGICAL OCEANOGRAPHY (II). Three credit hours. Two hours of lecture and one three-hour laboratory per week. For students not majoring in Geological Oceanography.

A review of the basic concepts of geology; geomorphology and structure of the ocean basins and continental shelves; techniques of marine exploration and research; study of the tectonic theories on the origin of marine basins and structural processes; the distribution of sediments, and marine sedimentary processes.

**CMOG 8606**. COASTAL GEOMORPHOLOGY (II) (On demand). Three credit hours. Two hours of lecture and one three-hour laboratory per week.

The origin of coastal features and their relationships with shore problems relative to the basic sciences; presentation of the forces that modify the shores. Discussion and field trips.

**CMOG 8618**. MARINE GEOLOGY OF THE CARIBBEAN (I, II) (On demand). Four credit hours. Two hours of lecture and two three-hour laboratory periods per week. Prerequisite: 15 credit hours in Geology.

Synthesis and analysis of the marine geology of the Caribbean, using published data and cruise information; survey of our present knowledge of bathymetry, and of the structure, sediments and stratigraphy of the Caribbean.

**CMOG 8655**. MARINE BIOGEOGRAPHY (I, II) (On demand). Three credit hours. Three hours of lecture per week.

The origin, speciation and distribution of marine plants and animals in relation to the physical, chemical and physiological aspects of the ocean, with special emphasis on tropical biota.

**CMOG 8675**. ADVANCED GEOLOGICAL OCEANOGRAPHY (I, II) (On demand). Three credit hours. Two hours of lecture and one three-hour laboratory per week.

A comprehensive review of the geomorphology and structure of the ocean basins; analysis of tectonic theories and structural processes operating in the marine environment; distribution of marine sediments.

**CMOG 8698**. BIOGEOLOGY SEMINAR (II) (On demand). Three credit hours. Three one-hour sessions per week.

Introduction to the problems of biota-sediment interaction; influence of biological factors on geological processes. Guest lecturers will be invited. Each student will be required to make an oral presentation of at least one topic during the semester.

**CMOG 8706**. STRUCTURE OF CORAL REEF. Three credit hours. One hour of lecture and two three-hour laboratories per week.

Structure, development, and methods of study of coral reefs. Field trips required.

**CMOG 8717**. SPECIAL PROBLEMS IN MARINE GEOLOGY (II) (On demand). One to three credit hours. One to three hours of lecture and one three-hour laboratory per week.

Supervised study or research on specific aspects in marine geology.

**MARINE SCIENCES PHYSICAL OCEANOGRAPHY (CMOF)**

**Advanced Undergraduate Courses**

**CMOF 5005**. COASTAL STRUCTURES. Three credit hours. Three hours of lecture per week.

Types of coastal structures; their purpose, design, construction, and environmental impact.

**CMOF 5015**. PHYSICAL OCEANOGRAPHY FOR ATMOSPHERIC SCIENCES. Three credit hours. Three hours of lecture per week. Prerequisites: (MATE 4009 and (FISI 3172 or FISI 3162)) or authorization of the Director of the Department.

Introduction to topics in physical oceanography such as heat budget, physical properties of seawater, oceanic mixing processes, and equations of conservation of heat, salt, and momentum. Analysis of the origin of marine currents by applying the concepts of potential vorticity conservation and Sverdrup circulation. Description of the mechanics of surface and deep currents.

**Graduate Courses**

**CMOF 6005**. METHODS OF OCEANOGRAPHIC DATA ANALYSIS (II) (On demand). Three credit hours. Three hours of lecture per week.

Oceanographic data analysis emphasizing computer techniques: exploratory data analysis, regression analysis, scalar and vector spectral analysis, maximum entropy spectral analysis, empirical orthogonal eigen functions, filters, complex demodulation.

**CMOF 6006**. ATMOSPHERIC AND OCEANIC TURBULENCE (I, II) (On demand). Three credit hours. Three hours of lecture per week.

Fundamental concepts of turbulence and their application to the study of geophysical fluids.

**CMOF 6445**. REMOTE SENSING IN OCEANOGRAPHY I. Four credit hours. Two hours of lecture and two three-hour laboratories per week. Prerequisite: Authorization of the Director of the Department.

Remote sensing and its application in oceanography, including comparison with field data. Field trips are required.

**CMOF 6617**. PHYSICAL OCEANOGRAPHY (I). Three credit hours. Three hours of lecture per week.

General introduction to the study of physical processes in the sea; physical properties of sea water, heat budget, water budget, temperature-salinity relationships, light in the sea, equations of motion, vertical stability, Coriolis effect geostrophic motion, general oceanic circulation, waves and tides.

**CMOF 6631-6632**. GEOPHYSICAL FLUID DYNAMICS I-II. Three credit hours. Three hours of lecture per week each semester. Prerequisite: authorization of the Director of the Department.

The dynamics of large-scale motions in the ocean and the atmosphere. Theories of stratified fluids in rotation and of geophysical waves.

**CMOF 6655**. OCEAN SURFACE WAVE MECHANICS. Three credit hours. Three hours of lecture per week.

Study of the mechanics of ocean surface gravity waves, including theory, kinematical properties, statistics, spectra, and forces.

**CMOF 6665**. MATHEMATICAL MODELING OF MARINE SYSTEMS. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Theory and practice of the modeling of biological, chemical, and physical marine systems, emphasizing multidisciplinary ecological problems. Programming skills required.

**CMOF 8446**. REMOTE SENSING IN OCEANOGRAPHY II. Four credit hours. Two hours of lecture and one six-hour laboratory per week. Prerequisite: CMOF 6445.

Advanced concepts of remote sensing and their application in oceanography, including comparison with field data. Field trips are required.

**CMOF 8607**. ESTUARINE CIRCULATION (I) (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: CIMA 6617.

Definition, classification, and description of estuaries; estuarine circulation patterns; physical oceanography of adjacent waters; the dynamics of circulation and its relation to the environment.

**CMOF 8619**. COASTAL OCEANOGRAPHY. Three credit hours. Three hours of lecture per week.

Interactions between long and short period waves and the shore; tides, storm surges, seiches, shoaling wave theories, wave refraction and diffraction, breakers, run-up, longshore currents, nearshore sediment transportation, foreshore processes.

**CMOF 8625**. DYNAMICAL OCEANOGRAPHY (On demand). Three credit hours. Three hours of lecture per week.

Introduction to the dynamical processes in the sea; geopotential axes, Lagrangian and Eulerian Kinematics, Eulerian expansion, equation of continuity, circulation and vorticity. Navier-Stokes equations, vertical stability, inertial motion, Coriolis effect, geostrophic motion, diffusion and turbulent processes, Ekman motion, small amplitude wave theory, open and closed basin resonance.

**CMOF 8659**. COMPUTER MODELING IN OCEANOGRAPHY AND METEOROLOGY (I, II) (On demand). Three credit hours. Three hours of lecture per week.

Finite difference methods for the solution of the hydrodynamic equations that appear in numerical models of the atmosphere and the ocean, emphasizing the solution of the linear and non-linear advection equation, numerical filtering techniques, and mesh systems.

**CMOF 8669**. PHYSICAL OCEANOGRAPHY LABORATORY (II) (On demand). One credit hour. One three-hour laboratory per week.

Map projections, use of charts and oceanographic atlases, preparation of diagrams, instrumentation at sea and ashore; observation aboard an oceanographic vessel.

**CMOF 8990**. A, B, C. SPECIAL PROBLEMS IN PHYSICAL OCEANOGRAPHY (I, II) (On demand). One to three credit hours. One to three sessions per week.

Selected topics in physical oceanography.

## MATHEMATICAL SCIENCES

## MATHEMATICS (MATE)

### Advanced Undergraduate Courses

**MATE 5016**. GAME THEORY (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Mathematical theory and solution of different classes of games, such as two-person, rectangular or matrix, and multipersonal games.

**MATE 5047**. INTERMEDIATE DIFFERENTIAL EQUATIONS (I) (Odd numbered years). Three credit hours. Three hours of lecture per week. Prerequisites: (MATE 4009 and MATE 4031) or authorization of the Director of the Department.

Existence, continuity and differentiability of solutions; stability and Lyapunov’s theorem.

**MATE 5049**. CALCULUS OF VARIATIONS (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: MATE 4009 or authorization of the Director of the Department.

Origin and historical development of the calculus of variations; first variation of a functional; canonical forms of Euler's equations; second variation: sufficient conditions for weak and strong extremals; applications to problems in geometry, mechanisms and physics.

**MATE 5055**. VECTOR ANALYSIS (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: MATE 3063 or authorization of the Director of the Department.

Introduction to vector analysis as a tool for mathematicians. The algebra and calculus of vectors, including gradient, divergence and curl, Stokes' and Green's Theorems, curvilinear coordinates, and simple N-Dimensional space. Applications in physics and geometry.

**MATE 5056**. TENSOR ANALYSIS (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: MATE 3063 or authorization of the Director of the Department.

Cartesian tensors, Cartesian tensor fields, gradient vector, Laplacian, covariant and contravariant tensor fields, the differential line-element and the fundamental tensors, covariant differentiation and the Riemann-Christoffel tensor.

**MATE 5150**. LINEAR ALGEBRA (I). Three credit hours. Three hours of lecture per week. Prerequisite: MATE 4008 or authorization of the Director of the Department.

Study of the essentials of linear algebra, including finite dimensional vector spaces. Linear equations, matrices, determinants, bilinear forms, inner products, Spectral Theorem for normal operators, and linear transformations.

**Graduate Courses**

**MATE 6005**. COMBINATORICS (On demand). Three credit hours. Three hours of lecture per week.

Enumerative analysis and optimization techniques: permutations and combinations, generating functions, recurrence relations, the principle of inclusion and exclusion, rudiments of graph theory, transport network, and linear programming.

**MATE 6006.** THE MATHEMATICS OF CONTINUOUS MEDIA MODELS. Three credit hours. Three hours of lecture per week.

Presentation of the mathematical foundations of the mechanics of continuous media, which allows the development of new mathematical models and the understanding of existing ones in related areas of science and engineering. Description of mathematical methods based on principles of invariance and determinism. Discussion of general theorems that interconnect various formal theories of continuous media.

**MATE 6025**. NUMERICAL LINEAR ALGEBRA. Three credit hours. Three hours of lecture per week.

Matrix analysis techniques fundamental to problem solving and the development of optimization methods and numerical solution of differential equations. Topics include: eigenvalue and eigenvector problems, numerical methods, singular value decomposition, special problems, and applications.

**MATE 6026**. NUMERICAL OPTIMIZATION. Three credit hours. Three hours of lecture per week.

Modern optimization methods and their application to various problems in science and engineering. Topics include: optimization on convex sets, minimization methods of nonlinear problems, nonlinear equations, conjugate methods, and special structure problems.

**MATE 6035**. TOPICS IN OPERATIONS RESEARCH I (II) (Odd numbered years). Three credit hours. Three hours of lecture per week.

Selected topics in operations research.

**MATE 6036**. TOPICS IN OPERATIONS RESEARCH II (I) (Odd numbered years). Three credit hours. Three hours of lecture per week.

Selected topics in operations research.

**MATE 6045**. OPTIMIZATION THEORY (II) (Odd numbered years). Three credit hours. Three hours of lecture per week.

Classical optimization techniques: linear, non-linear, geometric programming, dynamic programming, the path method.

**MATE 6101.** NUMBER THEORY I. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Fundamental non-analytic theory. Theory of congruences. Wilson and Euler theorems and applications. Sums of two squares. Primitive roots. Quadratic reciprocity law.

**MATE 6201**. ABSTRACT ALGEBRA (II)-(I). Three credit hours per semester. Three hours of lecture per week each semester. Prerequisite: authorization of Director of the Department.

A survey of abstract algebra. Algebraic systems studied include groups, ring, fields, Galois theory, modules over rings, partially ordered algebraic systems and theory of categories.

**MATE 6202**. ABSTRACT ALGEBRA (II)-(I). Three credit hours per semester. Three hours of lecture per week each semester. Prerequisite: authorization of Director of the Department.

A survey of abstract algebra. Algebraic systems studied include groups, ring, fields, Galois theory, modules over rings, partially ordered algebraic systems and theory of categories.

**MATE 6261**. THEORY OF FUNCTIONS OF A REAL VARIABLE I (I). Three credit hours. Three hours of lecture per week.

Set theory, the axiom of choice and Zorn's lemma, structure of the real number system, metric and topological spaces, Borel sets and Baire functions, limit theorems, properties of continuous and semicontinuous functions, derivatives and sequences of functions, functions of bounded variation, Riemann-Stieltjes integration.

**MATE 6262**. THEORY OF FUNCTIONS OF A REAL VARIABLE II (II). Three credit hours. Three hours of lecture per week.

An introduction to measure theory and Lebesque integration, covering the following topics: inner and outer measure, measurable sets, Lebesque measurable sets, Vitali's covering theorem, measurable functions, convergence in measure, the Lebesque integral for real functions of a real variable, the Radon-Nykodym theorem, multiple integrals, Fubini's theorem, L spaces, convergence in the mean.

**MATE 6301**. THEORY OF FUNCTIONS OF A COMPLEX VARIABLE (II) (Even numbered years). Three credit hours. Three hours of lecture per week.

This course provides a rigorous foundation in the theory of functions of a complex variable. Topics include theory of analytic functions, contour integration and infinite series.

**MATE 6460**. INTRODUCTION TO FUNCTIONAL ANALYSIS. Three credit hours. Three hours of lecture per week. Prerequisites: authorization of the Director of the Department.

Fundamental concepts of normed spaces and Banach spaces. Hilbert spaces. Weak convergence and closed transformations. Riesz-Schauder theory. Functions in Banach algebras. Spectral Analysis in Hilbert spaces.

**MATE 6530**. DIFFERENTIAL GEOMETRY I (II) (Even numbered years). Three credit hours. Three hours of lecture per week. Prerequisite: MATE 6670.

Study of Riemannian metrics, affine and Riemannian connections, geodesics, curvatures, Jacobi fields, immersions.

**MATE 6531**. DIFFERENTIAL GEOMETRY II (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: MATE 6530.

Study of complete manifolds, spaces of constant curvature, variations of energy, Rauch comparison theorem, Morse index theorem, fundamental group of manifolds of negative curvature, sphere theorem.

**MATE 6540**. TOPOLOGY (II). Three credit hours. Three hours of lecture per week.

An introductory course devoted to set-theoretic topology. Properties of topological spaces, including connectedness, compactness, bases, sub-bases, product spaces, quotient spaces, and the separation axioms.

**MATE 6551**. ALGEBRAIC TOPOLOGY (On demand). Three credit hours. Three hours of lecture per week.

Homotopy and homology groups associated with a topological space.

**MATE 6622**. TOPICS IN THE THEORY OF FUNCTIONS OF A COMPLEX VARIABLE (I) (Even numbered years). Three credit hours. Three hours of lecture per week. Prerequisite: MATE 6301.

Conformal mapping. Riemann surfaces, harmonic functions, the Dirichlet problem.

**MATE 6627**. TOPICS IN ANALYSIS (I)-(II on demand). Three credit hours per semester. Three hours of lecture per week. Prerequisite: authorization of Director of the Department.

The content of this course will vary according to interest and demand. In any given semester the course may deal with one of the following topics: Functional Analysis, Harmonic Analysis, Theory of complete normed algebras, Theory of uniform algebras, Integral Equations, Spectral Theory of Differential Operators from Physics, advanced topics in ordinary differential equations or other analogous topics.

**MATE 6628**. TOPICS IN ANALYSIS (I)-(II on demand). Three credit hours per semester. Three hours of lecture per week. Prerequisite: authorization of Director of the Department.

The content of this course will vary according to interest and demand. In any given semester the course may deal with one of the following topics: Functional Analysis, Harmonic Analysis, Theory of complete normed algebras, Theory of uniform algebras, Integral Equations, Spectral Theory of Differential Operators from Physics, advanced topics in ordinary differential equations or other analogous topics.

**MATE 6631**. TOPICS IN MATHEMATICAL LOGIC (I)- (On demand). Three credit hours per semester. Three hours of lecture per week each semester. Prerequisite: authorization of the Director of the Department.

The content of this course will vary from time to time, depending on demand and interest. In any given semester, the course would be devoted to a topic such as one of the following: theory of formal systems, axiomatic set theory, model theory, theory of computability and decidability, theory of finite automata, mathematical linguistics, and others.

**MATE 6651-6652**. INTRODUCTION TO HIGHER GEOMETRY (I, Even numbered years)-(On demand). Three credit hours per semester. Three hours of lecture per week each semester.

Homogeneous Cartesian coordinates, linear dependence of points and lines, harmonic division, line coordinates, cross-ratio; transformation; metric, affine, and projective geometries; points and line curves, space geometry.

**MATE 6670**. DIFFERENTIABLE MANIFOLDS (I, Every two years) (On demand). Three credit hours. Three hours of lecture per week.

Differentiable manifolds, vector fields, the Frobenius theorem, differential forms and tensor fields, Lie groups, homogeneous spaces, integration on manifolds.

**MATE 6672**. NUMERICAL MATHEMATICAL ANALYSIS (I). Three credit hours. Three hours of lecture per week.

Mathematical methods of computation applicable to automatic digital computers, choice and use of tables, finite differences, roots of equations, numerical differentiation and integration, curve fitting, least squares, harmonic analysis.

**MATE 6673**. NUMERICAL MATHEMATICAL ANALYSIS LABORATORY (I). One credit hour. One three-hour laboratory per week. Corequisite: MATE 6672.

Each student will prepare and run the solution of assigned problems on a digital computer.

**MATE 6674**. NUMERICAL METHODS FOR DIFFERENTIAL EQUATIONS. Three credit hours. Three hours of lecture per week.

Fundamentals of mathematical modeling with partial differential equations and numerical methods for their solution with the computer. Convergence and stability of distinct schemes of finite differences or finite elements for various types of partial differential equations.

**MATE 6675**. MATHEMATICS OF MODERN SCIENCE I (I). Three credit hours. Three hours of lecture per week.

A more advanced study of some topics covered in Mathematics of Modern Science. Complex variables, partial differential equations, special functions, and transform calculus.

**MATE 6676**. MATHEMATICS OF MODERN SCIENCE II (II). Three credit hours. Three lectures per week. Prerequisite: MATE 6675.

A more advanced study of some topics covered in MATE 4071-4072. Sturm-Liouville systems, calculus of variations, integral equations, tensors, and finite differences.

**MATE 6677**. ELEMENTARY PARTIAL DIFFERENTIAL EQUATIONS (I) (Even numbered years). Three credit hours. Three hours of lecture per week.

General theory of partial differential equations of the first and second order, linear partial differential equations, study of some of the important types of differential equations of mathematical physics.

**MATE 6678**. SPECIAL TOPICS IN PARTIAL DIFFERENTIAL EQUATIONS (II) (Odd numbered years). Three credit hours. Three hours of lecture per week. Prerequisite: MATE 6677.

Solution of boundary value problems, using integral transform methods, such as Laplace, Fourier, Mellin, etc.; introduction to integral and integro-differential equations.

**MATE 6693-6694**. TOPICS IN ALGEBRA (II odd numbered years)-(On demand). Three credit hours per semester. Three hours of lecture per week each semester. Prerequisite: authorization of the Director of the Department.

Selected topics from algebra. Varied content to be offered from time to time as need exists and as faculty interests and time permit.

**MATE 6705**. PROJECT. Cero to three credit hours.

Application of mathematics to the solution of a specific problem. A final written report is required.

**MATE 6991-6992**. SEMINAR (I, II)-(I, II). One to three credit hours per semester. One to three one-and-one-half-hour lectures per week each semester.

Discussions and reports of special topics in mathematics.

**MATE 6993**. TOPICS IN DIFFERENTIAL GEOMETRY I (II) (Odd numbered years). One to three credit hours. One to three hours of lecture per week.

Selected topics in differential geometry.

**MATE 6994**. TOPICS IN DIFFERENTIAL GEOMETRY II (On demand). One to three credit hours. One to three hours of lecture per week.

Selected topics in differential geometry.

**MATE 6995**. SPECIAL TOPICS (On demand). One to three credit hours. One to three hours of lecture per week. Prerequisite: authorization of Department Director.

Selected topics in Mathematics. Themes will vary according to the needs and interests of students and faculty.

**MATE 6999**. THESIS (I, II). Zero to six credit hour.

Every student working towards the degree of Master of Science in Mathematics is required to write a thesis on a topic selected in consultation with his advisor.

## COMPUTER SCIENCE (COMP)

### Advanced Undergraduate Courses

**ICOM/COMP 5015**. ARTIFICIAL INTELLIGENCE. Three credit hours. Three hours of conference per week. Prerequisite: ICOM 4035 or authorization of the Director of the Department.

An introduction to the field of artificial intelligence: Lisp language, search techniques, games, vision, representation of knowledge, inference and process of proving theorems, natural language understanding.

**COMP 5045**. AUTOMATA AND FORMAL LANGUAGES (I). Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Finite automata and regular languages; pushdown automata and context-free languages; Turing machines and recursively enumerable sets; linearly bounded automata and context-sensitive languages; computability and the halting problem; undecidable problems.

**COMP 5055**. PARALLEL COMPUTATION (II). Three credit hours. Three hours of lecture per week. Prerequisite: MATE 4061 and authorization of the Director of the Department.

The use of supercomputers: parallel architecture, design of algorithms for scientific computation and their implementation with parallel multiprocessors, and performance analysis.

**INEL/ICOM/SICI/COMP 5318**. INTERMEDIATE ROUTING, SWITCHING AND WIDE AREA NETWORKS. Three credit hours. Three hours of lecture per week. Prerequisite: INEL/ICOM/SICI/COMP 4308 or authorization of the Director of the Department.

Study and configuration of link state protocols. Study of intermediate level concepts such as switching, wide area network or WAN standards, virtual local area networks or VLAN, network design, and redundancy. Presentation and study of strategies for managing and saving address space such as variable length subnet masks and network address translation.

### Graduate Courses

**COMP 6025**. SCIENTIFIC VISUALIZATION. Three credit hours. Three hours of lecture per week.

Use of computer graphics technology to aid the understanding of data acquired by physical measurement, numerical computation or simulation.

**COMP 6315/ESMA 6315**. DATA MINING. Three credit hours. Three hours of lecture per week. Prerequisite: ESMA 6305 or authorization of the Director of the Department.

Concepts and techniques of data mining, based on statistical methodology. Study and application of diverse data-preprocessing techniques. Application of data visualization techniques in two and three dimensions, linear and non-linear supervised classifiers, clustering methods, and outlier detention. Application of association rule and text mining techniques.

**COMP 6785**. ANALYSIS OF ALGORITHMS (II). Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Analysis of algorithms: graph algorithms, algorithms for classical problems in linear algebra. Integer and polynomial arithmetic, complexity, and NP-completeness.

**COMP 6786**. HIGH-PERFORMANCE COMPUTING. Three credit hours. Three hours of lecture per week. Prerequisite: COMP 6785.

Concepts and methods for the design, implementation, and evaluation of high-performance algorithms for large-scale scientific and technological problems in a multiprocessing environment.

**COMP 6787**. INTERNSHIP. Two credit hours. One hundred and twenty hours of practice during the summer. Prerequisites: MATE 6672, MATE 6025 and COMP 6786.

Participation in a research project at a scientific computing center, to be selected in consultation with the Graduate Committee, preferably in a National Laboratory, NASA or DOD. A final oral and written presentation is required.

**COMP 6838**. TOPICS IN COMPUTER SCIENCE (I). Three credit hours. Three hours of lecture per week.

Selected topics in Computer Science.

**COMP 6839**. TOPICS IN COMPUTER SCIENCE (II). Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Selected topics in Computer Science.

**COMP 6995**. PROJECT IN SCIENTIFIC COMPUTING. Zero to three credit hours.

Development of a project in scientific computing. Presentation and approval of a written report is required.

**COMP 6998**. THESIS. Zero to three credit hours.

Research in scientific computing. Presentation and approval of a thesis is required.

## STATISTICS MATHEMATICS (ESMA)

### Advanced Undergraduate Course

**ESMA 5015**. STOCHASTIC SIMULATION. Three credit hours. Three hours of lecture per week. Prerequisite: ESMA 4001 or authorization of the Director of the Department.

Basic methods of simulation, modeling of complex systems, simulation languages, generation of random numbers, model validity, analysis of solutions, variance reduction techniques, and the design of experiments.

### Graduate Courses

**ESMA 6205**. APPLIED REGRESSION (II). Three credit hours. Three hours of lecture per week.

Simple linear regression, multiple linear regression, robust regression methods and analysis of residuals. Problems and remedial measures in the design of regression models. Selection of independent variables. Non-linear regression.

**ESMA 6206**. STATISTICS APPLIED TO PSYCHOLOGY. Four credit hours. Three hours of lecture and two hours of laboratory per week.

Study and application of the main statistical methods used in psychology and education. Discussion of the concept of probability and its role in the process of making statistical decisions. Emphasis on statistical methods for the resolution

of research problems. The course includes a laboratory for the development of skills in the use of statistical software for data analysis.

**ESMA 6305**. STATISTICAL METHODS (I). Three credit hours. Three hours of lecture per week.

Populations and samples, probability distributions, sampling distributions, statistical inference, linear and multiple regression and correlation, analysis of variance and covariance. Use of statistical computer package.

**COMP 6315/ESMA 6315**. DATA MINING. Three credit hours. Three hours of lecture per week. Prerequisite: ESMA 6305 or authorization of the Director of the Department.

Concepts and techniques of data mining, based on statistical methodology. Study and application of diverse data-preprocessing techniques. Application of data visualization techniques in two and three dimensions, linear and non-linear supervised classifiers, clustering methods, and outlier detention. Application of association rule and text mining techniques.

**ESMA 6600**. PROBABILITY THEORY (I). Three credit hours. Three hours of lecture per week.

Sample spaces and events, conditional probability and independence, discrete and continuous random variables, moment generating functions, and limit theorems.

**ESMA 6607**. ADVANCED SAMPLING THEORY (II) (Even numbered years). Three credit hours. Three hours of lecture per week.

Advanced theory and techniques of statistical sampling, including simple, stratified, systematic, and conglomerate sampling; comparison among these and corresponding problems of estimation; allocation problems.

**ESMA 6616**. LINEAR MODELS (I) (Odd numbered years). Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Multivariate normal distribution; distribution of quadratic forms; theory of least squares; estimation and hypothesis testing in the general linear model, analysis of multiple classifications; components of variance models.

**ESMA 6660**. BIOSTATISTICAL ANALYSIS (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Descriptive and inferential statistical techniques, design of experiments, construction of biomathematical models, bio-essays and probit analysis.

**ESMA 6661**. THEORY OF STATISTICS I (II). Three credit hours. Three hours of lecture per week.

Sampling distributions, point and interval estimation, optimal properties of estimators, tests of simple and composite hypotheses, likelihood ratio tests, tests of goodness of fit, and analysis of contingency tables.

**ESMA 6662**. THEORY OF STATISTICS II (I). Three credit hours. Three hours of lecture per week. Prerequisite: ESMA 6661.

Nonparametric tests, multivariate distributions, introduction to linear models, estimation and hypothesis testing in linear models, Bayesian methods, and statistical decision theory.

**ESMA 6665**. STATISTICAL COMPUTING (II) (Odd numbered years). Three credit hours. Three hours of lecture per week. Prerequisite: ESMA 6205 or authorization of the Director of the Department.

Exploratory data analysis techniques; probability approximation; matrix computation applied to linear regression; computational methods for optimization, nonlinear regression, and multivariate analysis.

**ESMA 6787**. EXPERIMENTAL DESIGN (I) (Even numbered years). Three credit hours. Three hours of lecture per week.

Principles of experimental design and hypothesis testing: randomized blocks, latin squares, $2^n$, $3^n$, and other factorial experiments; confounding, fractional factorials, response surface methodology, split plot and incomplete block designs.

**ESMA 6788**. ADVANCED PROBABILITY THEORY (On demand). Three credit hours. Three hours of lecture per week.

Fundamentals of integration and measure theory; basic concepts of probability in the context of measure theory; conditional probability and conditional expectation; strong law of large numbers; theory of martingales and central limit theorem.

**ESMA 6789**. STOCHASTIC PROCESSES (II) (Odd numbered years). Three credit hours. Three hours of lecture per week.

Probability spaces and convergence concepts; random walk; Markov chains; Poisson processes and purely discontinuous Markov processes; stationary processes; martingales; Brownian motion and diffusion stochastic processes.

**ESMA 6835**. TOPICS IN STATISTICS (II) (Odd numbered years). Three credit hours. Three hours of lecture per week.

Selected topics in theoretical and applied statistics. The content will vary according to the interests of students and professors.

**ESMA 6836**. TOPICS IN STATISTICS (On demand). Three credit hours. Three hours of lecture per week.

Selected topics in theoretical and applied statistics. The content will vary according to the interests of students and professors.

## TEACHING MATHEMATICS AT SECONDARY LEVEL

### Graduate Courses

**EDMA 6005.** GEOMETRY. Three credit hours. Three hours of lecture per week.

Discussion of topics in plane, analytical, and transformational geometry using a constructivist approach with emphasis on the development of problem-solving abilities. Discussion of methodologies for the teaching of these topics in the classroom will be included.

**EDMA 6015.** SET THEORY AND LOGIC. Three credit hours. Three hours of lecture per week.

Study of set theory and logic including propositional calculus, algebra of finite, infinite and countable sets, well-ordered sets, and number systems. Emphasis on the development of abilities to do mathematical proofs.

**EDMA 6025.** CALCULUS THEORY. Three credit hours. Three hours of lecture per week.

Detailed study of the fundamental concepts of the theory of calculus of functions of one variable. Discussion of limits, continuity, derivatives and its applications, and integrals and their applications. The theory and its relevance to the teaching of mathematics at the high school level will be emphasized.

**EDMA 6105.** PROBLEM SOLVING. Three credit hours. Three hours of lecture per week.

Formulation and comparison of strategies and techniques for problem-solving in diverse areas of mathematics. Problems will be selected in order to introduce important mathematical concepts and motivate high school students.

**EDMA 6205.** STATISTICS. Three credit hours. Three hours of lecture per week.

Study of the fundamental concepts of probability, random variables, sampling distributions, inferential statistics, and simple and multiple linear regression. The statistical principles that guide the planning, design, and analysis of an experiment will be discussed. The design of an experiment in the area of mathematics education is required.

**EDMA 6215.** TECHNOLOGY IN MATHEMATICS TEACHING. Three credit hours. Three hours of lecture per week.

Study of the use of technology in the mathematics curriculum at the high school level and its impact in the classroom. The relation between the integration of technology and the student's mathematical achievement will be analyzed.

**EDMA 6225.** MODERN ALGEBRA. Three credit hours. Three hours of lecture per week.

Rigorous study of the algebraic structure of number systems and algebras of polynomials. Generalization of numerical systems to structure to structure of groups, rings and fields. Emphasis on the application and relevance of algebraic structures in the teaching of mathematics at the high school level.

**EDMA 6991.** TOPICS IN MATHEMATICS EDUCATION. One to three credit hours. One to three hours of lecture per week.

Selected topics in mathematics education and related areas in the mathematics curriculum at the high school level.

**EDMA 6992.** TOPICS IN NUMBER THEORY. Three credit hours. Three hours of lecture per week.

Special topics oriented toward the exploration of problems and techniques of number theory that will be used for projects of high school students.

**EDMA 6993.** PROJECT IN MATHEMATICS EDUCATION. One to three credit hours. One to three hours of research per week.

Development of a project in mathematics education. Oral and written presentation of a report is required.

**PHYSICS**

**Advanced Undergraduate Courses**

**FISI 5025**. INTRODUCTION TO SOLID STATE PHYSICS. Three credit hours per semester. Three hours of lecture per week each semester. Prerequisites: FISI 5037 or authorization of the Director of the Department.

An introduction to X-ray diffraction, crystal structures, elastic constant of crystals, lattice energy and vibrations; thermal properties of solids, dielectric properties, ferroelectric crystals; diamagnetism, paramagnetism, ferromagnetism, antiferromagnetism; free electron model of metals, superconductivity, excitons, photoconductivity and luminescense.

**FISI 5037**. INTRODUCTION TO SOLID STATE PHYSICS (On demand). Three credit hours per semester. Three hours of lecture per week each semester.

An introduction to X-ray diffraction, crystal structures, elastic constant of crystals, lattice energy and vibrations; thermal properties of solids, dielectric properties, ferroelectric crystals; diamagnetism, paramagnetism, ferromagnetism, antiferromagnetism; free electron model of metals, superconductivity, excitons, photoconductivity and luminescence.

**FISI 5045.** PHYSICS OF FLUIDS. Three credit hours. Three hours of lecture per week. Prerequisites: MATE 4009, FISI 3152 and authorization of the Director of the Department.

Hydrostatics, mathematical models of fluid dynamics, dimensional analysis and similitude, boundary layer flow in pipes and ducts, incompressible potential flow.

**FISI 5047**. LASER PHYSICS. Three credit hours. Three hours of lecture per week. Prerequisites: (FISI 4105 and FISI 4068) or authorization of the Director of the Department.

Semiclassical theory of laser operation. Analysis of laser light characteristics, interaction of radiation with matter, optical resonators, pumping schemes, common laser systems, and non-linear optics.

**METE 5065**. ADVANCED DYNAMIC METEOROLOGY. Three credit hours. Three hours of lecture. Prerequisites: (METE 4061 and MATE 4009) or authorization of the Director of the Department.

Discussion of the quasi-geostrophic approximation, linear perturbation theory, and baroclinic instability to describe atmospheric motion in middle latitudes. Mesoscale phenomena and the general circulation of the atmosphere, variability over tropical latitudes, and principles of numerical modeling for atmospheric motion will be studied.

**Graduate Courses**

**FISI 6051-6052**. MATHEMATICAL PHYSICS (On demand). Three credit hours. Three hours of lecture per week each semester.

Calculus of variations, Lagrange's equations of motion, Hamilton's equations, contact transformation, introduction to quantum theory and special theory of relativity; mathematical theory of vibrations, statistical mechanics, introduction to theory of elasticity, electrodynamics and other related topics.

**FISI 6060**. NUCLEAR PHYSICS (On demand). Four credit hours. Four hours of lecture per week.

Fundamentals of quantum theory of the nucleus; mathematical theory of scattering, neutron-proton scattering; theory of nuclear reactions, theory of beta decay, and other related topics.

**FISI 6090**. INTRODUCTION TO THEORETICAL PHYSICS. Three credit hours per semester. Three lectures per week each semester.

Introduction to the problems and methods of theoretical physics; dynamics, electrodynamics, statistical mechanics, quantum mechanics, hydrodynamics and elasticity.

**FISI 6190.** INTRODUCTION TO THEORETICAL PHYSICS II. Three credit hours. Three hours of lecture per week. Prerequisites: authorization of the Director of the Department.

Introduction to the problems and methods of theoretical physics, dynamics, electrodynamics, statistical mechanics, quantum mechanics, hydrodynamics and elasticity.

**FISI 6280-6380**. GRADUATE SEMINAR (I)-(II). One credit hour per semester. Two hours of lecture per week each semester.

Discussions and reports on special topics in physics.

**FISI 6431-6432**. THEORY OF ELECTRICITY AND MAGNETISM (I)-(On demand). Three credit hours per semester. Three hours of lecture per week each semester.

Discussion of problems in electrostatics, magnetostatics and stationary currents; formulation of Maxwell's equations, electromagnetic wave theory, and radiation from moving charges, etc.

**FISI 6451-6452**. INTRODUCTION TO QUANTUM THEORY (II)-(On demand). Three credit hours per semester. Three hours of lecture per week each semester.

Introductory background to Quantum Theory; wave mechanical method and some of its applications to one-particle problem; linear oscillators and spatial oscillators; radiation and fields; approximate methods; perturbation theory; introductory general formulation of Quantum Theory.

**FISI 6477**. ELEMENTARY PARTICLES. Three credit hours. Three hours of lecture per week.

The physics of elementary particles and their interactions.

**FISI 6510**. SPECIAL TOPICS IN PHYSICS (I, II). One to nine credit hours. One to nine hours of lecture per week. Prerequisite: authorization of Director of Department.

Specialized topics in physics such as high-energy physics, nuclear reaction physics, plasma physics, low temperature physics, cosmology and others.

**FISI 6991**. PHYSICS RESEARCH (I, II, S). One to six credit hours.

The student will choose a member of the faculty as his adviser. Presentation of a thesis is required for credit.

**ASTRONOMY (ASTR)**

**ASTR 5005**. FORMATION AND EVOLUTION OF GALAXIES. Three credit hours. Three hours of lecture per week.

Formation, types, structures, evolution, and interaction of galaxies.

**ASTR 5007**. PLANETARY ASTRONOMY. Three credit hours. Three hours of lecture per week. Prerequisite: ASTR 4005 or authorization of the Director of the Department.

The study of the properties, physical formation, and evolution of the planets and the solar system.

**ASTR 6001-6002**. INTRODUCTION TO CELESTIAL MECHANICS (On demand). Three credit hours per semester. Three hours of lecture per week each semester.

Fundamental principles of astronomy and dynamics, with emphasis on the theoretical aspect: general equations of motions for bodies in an isolated system; integrals of motion, orbits, planetary equations, perturbations, canonic equations, contact transformations, lunar theory and the satellite problems.

**ASTR 6991**. SPECIAL TOPICS IN ASTRONOMY AND ASTROPHYSICS. One to six credit hours. One to six hours of lecture per week.

Selected topics in astronomy and astrophysics.

**DEPARTMENT OF PSYCHOLOGY**

**Graduate Courses**

**PSIC 6005**. THEORIES OF PERSONALITY. Three credit hours. One and a half hours of lecture and one and a half hours of discussion per week.

Study of personality from the perspective of trait theory and biological, psychodynamical, learning based, cognitive, humanistic and cultural approaches. Detailed discussion and application of theories of personality, with particular attention to the stages of childhood and adolescence.

**PSIC 6016**. HISTORY AND SYSTEMS OF PSYCHOLOGY. Two credit hours. One hour of lecture and one hour of discussion per week.

History, philosophical foundations, and major events that formed psychology as a scientific discipline. Study of the schools and systems prevailing in the discipline since the second half of the 19th century to the present.

**PSIC 6017**. BIOLOGICAL BASES OF BEHAVIOR IN CHILDREN AND ADOLESCENTS. Three credit hours. One and a half hours of lecture and one and a half hours of discussion per week.

Study of the fundamentals of neuroanatomy, brain structures and their key functions related to behavior and mental processes of children and adolescents. Discussion of psychopharmacological interventions available to treat a variety of neuropsychiatric disorders.

**PSIC 6035**. DIAGNOSTIC MODELS FOR ACADEMIC, BEHAVIORAL, AND EMOTIONAL DISORDERS IN CHILDREN AND ADOLESCENTS. Three credit hours. One and a half hours of lecture and one and a half hours of discussion per week.

Study of historical and current perspectives on childhood psychopathology, its diagnosis and systems of classification with emphasis on disorders that are typically observed in schools and other applied settings. Discussion and analysis of child and adolescent mental disorders. Emphasis on etiology, epidemiology, phenomenology, nosology and diagnosis of mental disorders.

**PSIC 6037**. EVALUATION AND MEASUREMENT. Three credit hours. Three hours of lecture per week. Prerequisite: ESMA 6206.

Study of principles and concepts underlying advanced measurement applications. Classical test theory, generalizability theory, scales construction concepts, test bias, standard setting techniques, and item response theory are discussed.

**PSIC 6038**. PROGRAM EVALUATION IN SCHOOL CONTEXTS. Two credit hours. One hour of lecture and one hour of discussion per week.

Principles and processes involved in the evaluation of programs within a school context. Development of skills for the design and implementation of an evaluation that is viable and useful to decision making in the school context.

**PSIC 6300**. EDUCATIONAL PSYCHOLOGY. Three credit hours. Three hours of lecture per week. Prerequisite: PSIC 6318.

Introduction to the principles of cognitive and learning processes applied to the educational context. Analysis of the educational objectives, student characteristics, teaching methods, and evaluation of the learning process.

**PSIC 6301**. CHILD AND ADOLESCENT DEVELOPMENT. Three credit hours. One and a half hours of lecture and one and a half hours of discussion per week.

Discussion and analysis of theories, processes and issues related to physical, cognitive, and psychological development from conception to 21 years of age. Study of key themes in the development of infants, children, and adolescents, such as brain development, attachment, self regulation, and socialization, within diverse individual, family, school, and community contexts.

**PSIC 6310**. HUMAN DIVERSITY AND SOCIAL ASPECTS OF BEHAVIOR. Three credit hours. One hour of lecture, one hour of discussion and one hour of seminar per week.

Study of the concept of human diversity from a psychosocial perspective as well as in the understanding of what it means to be "different" in terms of race, socioeconomic status, ethnicity, gender, sexual orientation and diverse disabilities. Discussion of the effects of both prejudice and discrimination within the social, legal and educational context. Study of strategies to combat prejudice and discrimination within the social, legal and educational context.

Application of principles of social psychology related to the development of the social self and the interpersonal dynamics of the child in the school system.

**PSIC 6318**. LEARNING AND COGNITION**.** Three credit hours. One and a half hours of lecture and one and a half hours of discussion per week.

Analysis and discussion of diverse theoretical perspectives related to learning, cognition, and social processes in children and adolescents. Analysis of teaching and learning processes considering biological, educational, and systemic factors.

**PSIC 6320**. COGNITIVE ASSESSMENT. Four credit hours. Four hours of lecture per week. Prerequisite: PSIC 6037.

Development of basic skills in the administration, correction and interpretation of intelligence tests. Writing reports, development of effective interventions, and communicating the results to parents, teachers and other professionals. Emphasis on the theory, research and contemporary topics related to the measurement of intelligence, with attention to topics related to ethics and the evaluation of intellectual ability. Discussion and review of the eligibility criteria for providing special educational services. Analysis of the implications of the paradigm change to the RTI model and solutions to problems, supervised progress and evaluation based on the curriculum.

**PSIC 6330**. PREVENTION, CONSULTATION, AND INTERVENTION IN SCHOOL PSYCHOLOGY. Three credit hours. Three hours of lecture per week. Prerequisite: PSIC 6555.

Study of key topics and concepts in school-based prevention, consultation and intervention. Application of models and strategies in the consultation process. Discussion of legal and ethical issues, diversity, planning and effective assessment of consultation.

**PSIC 6335**. ADVANCED RESEARCH METHODS IN PSYCHOLOGY: QUANTITATIVE AND QUALITATIVE APPROACHES. Four credit hours. Four hours of lecture per week. Prerequisite: ESMA 6206.

Comprehensive discussion and analysis of the foundations and principal techniques of quantitative and qualitative research in psychology. Emphasizes the integration of theory, research, and practice. The development of a research proposal is required.

**PSIC 6340**. PSYCHOEDUCATIONAL ASSESSMENT. Four credit hours. One hour of lecture, two hours of discussion and one hour of seminar per week. Prerequisite: PSIC 6320 and PSIC 6037.

Theoretical and practical study of strategies and basic statistical and psychometric concepts in psychoeducational assessment. Discussion of aspects related to standardized, criteria referenced, and curriculum-based evaluation, as well as informal measurements. Administration, scoring and interpretation of commonly used instruments for academic and behavioral assessment. Use of instruments for the diagnosis of basic academic skills. Emphasis on the communication of results for instruction and placement decisions for students in special programs.

**PSIC 6350**. SOCIO-EMOTIONAL ASSESSMENT OF CHILDREN AND ADOLESCENTS. Four credit hours. Four hours of lecture per week. Prerequisites: PSIC 6320 and PSIC 6035.

Study of the theoretical and applied aspects of techniques used in evaluating the social and emotional functioning of children and adolescents with socioemotional disorders. Emphasis on the discussion of the conceptual and clinical application of the socioemotional assessment process.

**PSIC 6360**. INTERVENTION MODELS FOR BEHAVIORAL, ACADEMIC AND EMOTIONAL DISORDERS IN CHILDREN AND ADOLESCENTS. Three credit hours. One and a half hours of lecture and one and a half hours of discussion per week. Prerequisite: PSIC 6035.

Development and implementation of psychoeducational interventions based on data-driven, evidence-based, and an ecological preventive model. Emphasis on interventions for academic, behavioral, and emotional difficulties and their applications in individual, educational, and clinical contexts.

**PSIC 6555**. INTRODUCTION TO SCHOOL PSYCHOLOGY: ROLES, FUNCTIONS AND ETHICAL-LEGAL ASPECTS. Four credit hours. Four hours of lecture per week.

Introduction to the historical and theoretical bases of the development of school psychology and the various roles and key functions exercised by school psychologists. Review of the provision of direct and indirect services in Puerto Rico. Investigation and application of ethical and legal aspects relevant to the practice of school psychology. Examination of key topics in the profession and their relationship with the school organizational system.

**PSIC 7501**. PRACTICUM IN SCHOOL PSYCHOLOGY I. One credit hour. One hour of supervised practice per week. Prerequisites: PSIC 6035 and PSIC 6360 and PSIC 6320.

Supervised practicum designed to expose students to field experiences in school psychology, school culture, regular and special education, and the specific roles and functions school psychologists perform in schools. Two hundred and fifty (250) hours of practicum in a school supervised by a program faculty member are required, as evidenced by a work log.

**PSIC 7502**. PRACTICUM IN SCHOOL PSYCHOLOGY II. One credit hour. One hour of supervised practice per week. Prerequisite: PSIC 7501.

Supervised practicum designed to expose students to field experiences in school psychology, school culture, regular and special education, and the specific roles and functions school psychologists perform in schools. Two hundred and fifty (250) hours of practicum in a school supervised by a program faculty member are required, as evidenced by a work log.

**PSIC 8217**. BEHAVIOR MODIFICATION TECHNIQUES FOR ADHD AND DISRUPTIVE BEHAVIOR DISORDERS. Three credit hours. One and a half hours of lecture and one and a half hours of discussion per week. Prerequisite: PSIC 6360.

Principles and methods of learning theories applied to the treatment of disruptive behavioral disorders and attention deficit disorder with hyperactivity. Study of the multiple ways in which behavior may be altered through interactions with the environment.

**PSIC 8218**. MOOD AND ANXIETY DISORDERS AND EVIDENCED–BASED TREATMENTS. Three credit hours. Three hours of lecture per week. Prerequisite: PSIC 6360.

Study of mood disorders, anxiety disorders and their multiple clinical manifestations. Discussion of the most effective and empirically validated treatment modalities.

**PSIC 8225**. PLAY THERAPY FOR TRAUMA AND STRESS RELATED DISORDERS. Three credit hours. Three hours of lecture per week. Prerequisite: PSIC 6360.

Study of the history, theories, techniques, and appropriate uses of play therapy in different stages of development, particularly in cases of exposure to traumatic life events that threaten to cause injury, physical integrity or death. Development of a program of play therapy activities in accordance with the student's area of interest.

**PSIC 8226**. PROJECTIVE ASSESSMENT TECHNIQUES FOR CHILDREN AND ADOLESCENTS. Three credit hours. Three hours of lecture per week. Prerequisite: PSIC 6360.

Introduction to the administration, scoring, and interpretation of tests used to assess the emotional and behavioral functioning of children and adolescents. Assessment includes the integration of a complex clinical history, behavioral observations and the use of projective assessment techniques.

**PSIC 8227**. NEUROANATOMY. Three credit hours. Three hours of lecture per week. Prerequisite: PSIC 6017.

Study of the anatomical and physiological bases of the nervous system emphasizing the chemical processes which influence human behavior.

**PSIC 8228**. PRINCIPLES OF SCHOOL NEUROPSYCHOLOGY. Three credit hours. One and a half hour of lecture and one and a half hour of discussion per week. Prerequisites: PSIC 6017.

Study of the relationship between the brain, behavior, childhood and adolescence development. Comparison of approaches between school neuropsychology and clinical neuropsychology, as well as related disciplines. Neurodevelopmental disorders will also be applied.

**PSIC 8235**. NEUROPSYCHOLOGICAL ASSESSMENT. Three credit hours. Three hours of lecture per week. Prerequisites: PSIC 6320. Corequisite: PSIC 8228.

Critical analysis of the different focuses of neuropsychological evaluation of children. Review of clinical literature and research of neuro-psychological tests and other methods of evaluating children and adolescents. Study of tools for neuro-psychological assessment in school-age children, as well as their administration and interpretation.

**PSIC 8236**. NEUROPSYCHOLOGICAL REHABILITATION. Three credit hours. Three hours of lecture per week. Prerequisite: PSIC 8228 and PSIC 8235.

Application of neuropsychological assessment and intervention plans for children and adolescents with cognitive dysfunction. Emphasis will be directed towards orientation, attention/executive function, problem solving, reasoning, memory, visual perception and behavioral sequels.

**PSIC 8521**. ADVANCED PRACTICUM IN SCHOOL PSYCHOLOGY I. Three credit hours. Three hours of supervised practice per week. Prerequisites: PSIC 7502.

Development of skills in the areas of assessment, consultation, intervention and outcome assessment. Students will offer psychological and educational services to clients under the direct supervision of a licensed school psychologist. Exploration of issues related to counseling and development of these skills and the presentation of case studies. Two hundred and fifty (250) supervised practicum hours in session planning and treatment interventions with clients are required, either individually or in-group. Practicum hours are evidenced by a work log.

**PSIC 8522**. ADVANCED PRACTICUM IN SCHOOL PSYCHOLOGY II. Three credit hours. Three hours of supervised practice per week. Prerequisite: PSIC 8521.

In-depth development of skills in the areas of assessment, consultation, intervention and outcome assessment. Students will offer psychological and educational services to clients under the direct supervision of a licensed school psychologist. Exploration of issues related to counseling and development of these skills and the presentation of case studies. Two hundred and fifty (250) supervised practicum hours in session planning and treatment interventions with clients are required, either individually or in-group. Practicum hours are evidenced by a work log.

**PSIC 8950**. INTERNSHIP IN SCHOOL PSYCHOLOGY. Three credit hours. Three hours of internship per week. Prerequisites: PSIC 8522.

Fieldwork in a school under the supervision of a university professor and a licensed school psychologist. The student will be exposed to school organization and operation, program evaluation, assessment, prevention, intervention, counseling and professional ethics in a school context. Interns are required to complete a minimum of 2,000 work hours in a calendar year. Preparation of a portfolio and a work log are required.

**PSIC 8990**. DISSERTATION. Three credit hours. Prerequisites: ESMA 6206 and PSIC 6038 and PSIC 6335.

Development and preparation of a doctoral dissertation, based on a research project in School Psychology, which represents an original and relevant contribution to the discipline.

**ACCOUNTING (CONT)**

**CONT 5006**. TAX LIABILITIES FOR BUSINESSES IN PUERTO RICO. Three credit hours. Three hours of lecture per week.

A comprehensive study of business tax liabilities in Puerto Rico under local or federal laws. Includes topics such as property, municipal, labor-related and excise taxes as well as tax exemptions under the Industrial Incentives Act.

**CONT 5007**. ADVANCED ACCOUNTING RESEARCH. Three credit hours. Three hours of lecture, discussion and research per week. Prerequisites: CONT 3008 or CONT 4019 or authorization of the Director of the Department.

Application of various research methodologies in accounting topics. Development of skills to identify, compile, measure, summarize, verify, and interpret financial and non financial data for decision making purposes.

**CONT 5016**. CYBERSECURITY FOR ACCOUNTING PROFESSIONALS. Three credit hours. Three hours of lecture per week. Prerequisites: CONT 3012 or authorization of the Director of the Department.

Study of the assurance and security of data in information systems. It includes cybersecurity risks in an organization or business. In addition, topics of digital transformation, cyberattacks, data breaches, privacy, governance frameworks, and regulations are discussed.

**CONT 5017**. PYTHON PROGRAMMING FOR ACCOUNTANTS. Three credit hours. Three hours of lecture per week. Prerequisites: CONT 3012 or authorization of the Director of the Department.

Study of coding and logical programming thinking using Python to complete common financial and managerial accounting tasks. Topics include use of the Python programming language to work with tables and several data wrangling projects using accounting datasets.

**CONT 6005**. MANAGERIAL ACCOUNTING. Three credit hours. Three hours of lecture per week.

Fundamental accounting concepts and techniques and their application to all types and functions of organizations. Study of the relationships between accounting techniques and business operations control through the case solution approach. Financial statement analysis and their relevance in the decision making process. Tax effects on business decisions. Emphasis on planning and control.

**ADMINISTRATION (ADMI)**

**ADMI 5005**. BUSINESS AND ENTREPRENEURIAL EDUCATIONAL TRAVEL. Three credit hours. 11.25 hours of lecture per week (9 hours befor the educational travel and 36 hours during the educational travel).

Introduction to international business and entrepreneurial experiences, including goals and concepts developed by the United Nations related to economic development and sustainable enterprises. They will examine the balance between the needs of enterprises and the interests of workers as a whole with society. Students will investigate the development and creation of enterprises, in addition to sustainable companies and how they promote the economic development through social dialogue, decent work in balance with the environment. The course includes an educational travel experience outside of Puerto Rico.

**ADMI 5996**. SELECTED TOPICS IN BUSINESS ADMINISTRATION. Three credit hours. Three hours of lecture per week.

Selected topics in Business Administration.

**ADMI 6005**. SPECIAL TOPICS. Three to six credit hours. Three to six hours of lecture per week.

Selected topics in Business Administration.

**ADMI 6006**. COOP PLAN PRACTICE. One to three credit hours. Prerequisite: 18 credits approved in the graduate program.

Supervised work experience in a government agency, a private enterprise or foundation, in accordance with the student's academic background and the job requirements.

**ADMI 6008**. DEVELOPMENT OF MEDIUM AND SMALL BUSINESS. Three credit hours. Three hours of lecture per week.

Study and analysis of the development of small and medium size business in manufacturing, service and retailing sectors. Study of legal aspects in the establishment of a business, development of appropriate record keeping and accounting systems, identification and servicing of appropriate markets, financing and uses of funds and concepts of human resources management needed for an efficient business operation.

**ADMI 6097**. PROJECT. Zero to three credit hours. Zero to three hours of lecture per week.

Comprehensive study of a business problem with the purpose of integrating the knowledge acquired in the graduate program.

**ADMI 6816**. MBA CAPSTONE EXPERIENCE. Three credit hours. Three hours of discussion per week. Prerequisites: CONT 6005 and ESTA 6005 and GERE 6036 and FINA 6015 and MERC 6055.

Integration and application of concepts and analytical tools of business functions studied during MBA course work. Competitive analysis of case studies and active learning activities. The emphasis of the cases and activities are on curriculum integration, critical thinking skills, quantitative analysis, and communication skills.

**ADMI 6996**. THESIS. Zero to six credit hours.

Research in Business Administration. Presentation and approval of a thesis is required.

**COMPUTERIZED INFORMATION SYSTEMS (SICI)**

**INEL/ICOM/SICI/COMP 5318.** INTERMEDIATE ROUTING, SWITCHING AND WIDE AREA NETWORKS. Three credit hours. Three hours of lecture per week. Prerequisite: INEL/ICOM/SICI/COMP 4308 or authorization of the Director of the Department.

Study and configuration of link state protocols. Study of intermediate level concepts such as switching, wide area network or WAN standards, virtual local area networks or VLAN, network design, and redundancy. Presentation and study of strategies for managing and saving address space such as variable length subnet masks and network address translation.

**SICI 6065**. MANAGEMENT INFORMATION SYSTEMS. Three credit hours. Three hours of lecture per week.

This course provides a general understanding of information systems and information technology (IS/IT), planning and development, information resources management and social impacts of informatics. It discusses how information is used for decision support in organizations and how information systems enable competitive advantage.

**ECONOMICS (ECON)**

**ECON 6027**. MANAGERIAL ECONOMICS. Three credit hours. Three hours of lecture per week.

Study of several economic concepts and their applications to managerial problems in different markets. Analysis of the economic system in the aggregate level and of production cost; price setting under different market structures, demand and supply, elasticity and capital cost.

**FINANCE (FINA)**

**FINA 5015.** PRINCIPLES OF FINANCIAL ENGINEERING. Three credit hours. Three hours of lecture per week. Prerequisites: (ESTA 3002 and MATE 3049) or authorization of the Director of the Department.

Introduction to the development of financial strategies and financial instruments according to the efficient market hypothesis.

**FINA 5016**. INTRODUCTION TO VENTURE CAPITAL. Three credit hours. Three hours of lecture per week. Prerequisite: ADOF 3017.

Introduction to available innovative software tools in conducting office administrative tasks.

**FINA 6015**. FINANCIAL MANAGEMENT. Three credit hours. Three hours of lecture per week.

Management decisions concerning the acquisition, distribution and control of funds; role of money and capital markets in decision making; short-term financing policies and the various considerations taken in developing financial strategies. Cases are used to demonstrate the process of financial decision-making.

**FINA 6016**. PUBLIC FINANCE. Three credit hours. Three hours of lecture per week. Prerequisites: FINA 6015.

Theoretical and applied aspects of the allocation of resources and economic stabilization policies in modern states. Theory on public expenditures, tax collection and its outcomes; effect of public debt financing.

**FINA 6017**. INVESTMENT ANALYSIS AND PORTFOLIO THEORY. Three credit hours. Three hours of lecture per week. Prerequisite: FINA 6015.

Analysis of an investment opportunity within the context of the most recent theories on risk diversification and balance on investment portfolios; investment strategy on portfolio management.

**FINA 6018**. CORPORATE FINANCIAL STRATEGIES AND POLICIES. Three credit hours. Three hours of lecture per week. Prerequisite: FINA 6015.

Problems related to management of assets, liabilities and capital. Emphasis on financial decisions and the formulation of financial policies in two basic areas: working capital management and capital budgeting decisions.

**FINA 6019.** INTERNATIONAL FINANCE. Three credit hours. Three hours of lecture per week. Prerequisite: FINA 6015.

Theoretical and empirical aspects of the financial management of enterprises that operate in an international business environment, emphasizing multinational enterprises (MNE's). Development of knowledge, attitudes, and skills needed to make financial decisions for organizations such as multinational enterprises.

**FINA 6025**. ADMINISTRATION OF FINANCIAL INSTITUTIONS. Three credit hours. Three hours of lecture per week.

A study of the economic, legal and tax environment in which financial institutions operate. Assets and liabilities management for depositary and non-depositary institutions. Risk management on changes in interest rate, credit risk and planning the liquidity of long and short term investment.

**FINA 6997**. FINANCE PRACTICE FOR GRADUATE STUDENTS AT COOP. Three to nine credit hours (three credits per period up to 9 credits/ Full- time work for an equivalent of the semester or summer). Prerequisite: authorization of the Director of the Department.

Practical full-time experience in Finance in cooperation with a private enterprise, government, or non-profit organizations jointly supervised by the faculty member, the coop program coordinator, and the immediate supervisor at the workplace.

**HUMAN RESOURCES MANAGEMENT (GERH)**

**GERH 6027**. LEGAL ASPECTS OF BUSINESS ORGANIZATION. Three credit hours. Three hours of lecture per week.

Social and philosophical aspects of the law; its systems, functions, processes and limits, applied to business organization in its internal and external issues.

**GERH 6028**. INNOVATION AND ORGANIZATIONAL CHANGE. Three credit hours. Three hours of lecture per week.

Different approaches for planned change in organizations from long-range viewpoint. Structural, technological, and behavioral changes; models of change; methods of intervention; behavior of the change agent; measurement of change. Innovation processes, theories of creativity, technological innovations, and organizational change are explored in terms of their implications for managerial action.

**GERH 6029**. LEADERSHIP IN FORMAL ORGANIZATIONS. Three credit hours. Three hours of lecture per week.

Identification of effective managerial styles within a contingency perspective. Present orientation in leadership theories, the nature of managerial work, and major roles performed by leaders in different types of organizations. Measurement instruments, simulations and analysis of vocational interest of manager, and their applications to managerial functions.

**GERH 6030**. SUPERVISORY MANAGEMENT. Three credit hours. Three hours of lecture per week.

Supervision as a managerial function, emphasizing those personal, administrative, and human relation skills needed for an effective supervision. Legal aspects, at the state and federal levels, which supervisors face on a daily basis.

**GERH 6037**. WAGE AND SALARY ADMINISTRATION. Three credit hours. Three hours of lecture per week.

Development and maintenance of internally equitable and externally competitive compensation programs. The role of compensation in the recruitment, retention, and motivation of employees. Topics include: compensation as an exchange process, compensation and behavioral concepts, job analysis and evaluation, salary structures, incentive plans, employee benefits, legal aspects and executive compensation.

**GERH 6040**. FOUNDATIONS OF HUMAN RESOURCES MANAGEMENT. Three credit hours. Three hours of lecture per week.

An in-depth study of the major functions of human resources administration. Emphasis is given to recruitment, performance appraisal and fringe benefits. Consideration is given to the impact of current legislation on these areas.

**REHU 6997**. HUMAN RESOURCES MANAGEMENT PRACTICE FOR GRADUATE STUDENTS AT COOP. Three to nine credit hours (three credits per period up to 9 credits/ Full- time work for an equivalent of the semester or summer). Prerequisite: authorization of the Director of the Department.

Practical full-time experience in Human Resources Management in cooperation with a private enterprise, government, or non-profit organizations jointly supervised by the faculty member, the coop program coordinator, and the immediate supervisor at the workplace.

**INDUSTRIAL MANAGEMENT (GEIN)**

**GEIN 6005**. PHYSICAL DISTRIBUTION AND LOGISTICS. Three credit hours. Three hours of lecture per week.

Study of physical distribution systems; an examination of the costs involved in physically moving and storing the product from its production point to the point it is purchased; an analysis of the efforts to coordinate physical distribution and materials management in order to reduce costs and improve services.

**GEIN 6035**. MANAGERIAL QUANTITATIVE METHODS. Three credit hours. Three hours of lecture per week. Prerequisite: ESTA 6005.

Mathematical approach to analysis and solution of complex business problems with special emphasis on their formulation and solution procedures in areas such as: inventory control, linear programming, integer programming, queuing, and decision theories.

**GEIN 6036**. DECISION ANALYSIS. Three credit hours. Three hours of lecture per week. Prerequisite: GEIN 6035 or MECU 6035 or authorization of the Director of the Department.

Strategies used in the decision making process and their applications in long range planning. Use of decision trees and probabilistic analysis in decision making.

**GEIN 6038**. QUALITY CONTROL. Three credit hours. Three hours of lecture per week. Prerequisite: ESTA 6005.

Assumptions and technical postulates that support quality control: sampling, control charts, estimation of the characteristics of industrial processes, hypothesis testing and analysis of variance. Emphasis on the integration of the quality control function to the decision making process.

**GEIN 6039**. FORECASTING MODELS FOR THE FIRM. Three credit hours. Three hours of lecture per week. Prerequisite: ESTA 6005.

Forecasting methods, their essential characteristics, and their application. Forecasting within the firm, acquisition of data, planning of the forecasting process, maintenance of systems in use and identification and implementation of new developments.

**GEIN 6045**. PRODUCTION CONTROL. Three credit hours. Three hours of lecture per week. Prerequisite: ESTA 6005.

New developments in the area of production control. Analysis of techniques and models in recent literature in areas such as: inventory control, production planning, scheduling, forecasting and control models. Application of these techniques to current problems.

**GEIN 6047**. MATERIALS MANAGEMENT AND PURCHASING. Three credit hours. Three hours of lecture per week. Prerequisite: ESTA 6005.

Functions and contributions of purchasing and materials management in the organization. Management of transportation, traffic and purchasing activities. Analysis and control techniques in purchasing and materials management.

**GEIN 6048**. MANUFACTURING STRATEGIES. Three credit hours. Three hours of lecture per week.

Basic links between manufacturing processes and the corporate infrastructure. Study of the contribution of the manufacturing function to the development of corporate strategies.

**GEIN 6065**. PROJECT MANAGEMENT. Three credit hours. Three hours of lecture per week.

Study of the concepts and applications of project management, its evolution, importance, and the managerial implications for contemporary organizations. The planning, management and control of projects including the different phases in its life cycle will be studied in detail.

**MANAGEMENT (GERE)**

**GERE 6025**. ORGANIZATIONAL BEHAVIOR. Three credit hours. Three hours of lecture per week.

Study of the social and psychological aspects needed to understand the behavior of individuals within an organization. Management strategies for organizational effectiveness. Topics such as individual and small group behavior, goal definition, organizational structure, and leadership will be considered.

**GERE 6026**. ORGANIZATIONAL DESIGN. Three credit hours. Three hours of lecture per week. Prerequisite: GERE 6025.

Evaluation of organizational design structures, measurements of system performance, and problems in the design of adaptive systems. Job specialization, behavior formalization, units grouping, unit size, lateral relationships, and vertical and horizontal decentralization are some of the parameters of design to be considered.

**GERE 6035**. BUSINESS RESEARCH METHODS. Three credit hours. Three hours of lecture per week. Prerequisite: ESTA 6005.

Management research formats; study design; study sampling and reliability; techniques on how to report and register behavior.

**GERE 6036**. INTERNATIONAL MANAGEMENT. Three credit hours. Three hours of lecture per week.

The multinational enterprise, its activities, environment and limitations, including external aspects like the legal area, cultural environment and social responsibility and control. Internal aspects such as strategies aimed at attaining the enterprise's objectives, information systems, cost transfer, management performance evaluation, and risk management in foreign investment projects.

**GERE 6055**. BUSINESS, GOVERNMENT AND SOCIETY. Three credit hours. Three hours of lecture per week.

Study of the interrelationships between profit or non-profit organizations and their external environments; consideration of the public policy process.

**GERE 6056.** ENVIRONMENTAL DECISION MANAGEMENT. Three credit hours. Three hours of lecture per week.

Study of environmental issues and programs from the managerial decision-making perspective with emphasis on the design and implementation of environmental management systems; the industrial ecology approach as an alternative to the traditional approach to environmental management.

**GERE 6096.** BUSINESS POLICY. Three credit hours. Three hours of lecture per week.

Analysis and interpretation of the formulation and implementation of policies that integrate different functional areas of a business. The study of managerial complex cases will be emphasized.

**GERE 6997**. OPERATIONS MANAGEMENT PRACTICE FOR GRADUATE STUDENTS AT COOP. Three to nine credit hours (three credits per period up to 9 credits/ Full- time work for an equivalent of the semester or summer). Prerequisite: authorization of the Director of the Department.

Practical full-time experience in Operations Management in cooperation with a private enterprise, government, or non-profit organizations jointly supervised by the faculty member, the coop program coordinator, and the immediate supervisor at the workplace.

**MARKETING (MERC)**

**MERC 6055**. MARKETING MANAGEMENT. Three credit hours. Three hours of lecture per week.

Fundamental elements and the decision making process in management and planning of marketing activities.

**MERC 6056**. MARKETING COMMUNICATION STRATEGY. Three credit hours. Three hours of lecture per week. Prerequisite: MERC 6055.

Communication as an integral part of marketing strategy. The essential role of the various components of communication in the total marketing strategy examined under different marketing conditions. Design and implementation of a marketing communication strategy.

**MERC 6057**. CONSUMER ANALYSIS. Three credit hours. Three hours of lecture per week. Prerequisite: MERC 6055.

Behavior of the final consumer and the processes directly related to the acquisition and consumption of goods and services. Use of models of behavior to illustrate the decisional process, and the concepts involved in establishing strategies for new products, distribution systems and pricing decisions.

**MERC 6065**. MARKETING RESEARCH. Three credit hours. Three hours of lecture per week. Prerequisites: MERC 6055.

Applied research in the area of marketing: identification and solution of marketing problems; research design, measurement, data collection and analysis in consumer behavior, product, advertising and sales estimates; analytical methods commonly used in these areas; development of solutions and action recommendations.

**STATISTICS (ESTA)**

**ESTA 6005**. MANAGERIAL STATISTICS. Three credit hours. Three hours of lecture per week.

Probability theory, statistical inference, and decision theory applied to managerial decision problems. Basic theoretical concepts that support the statistical methods. Analysis and discussion of cases with statistical background.

**ESTA 6006**. EXPERIMENTAL DESIGN AND ANALYSIS. Three credit hours. Three hours of lecture per week. Prerequisite: ESTA 6005.

Fundamental concepts in the design of experiments: principles of inferential statistics, statistical linear models, block models, factorial models, and analysis of variance. Use of computer software for the solution of statistical problems related to business.

# *COLLEGE OF ENGINEERING*

## CHEMICAL ENGINEERING

### Advanced Undergraduate and Graduate Courses

**INQU 5006**. STATISTICAL METHODS FOR CHEMICAL ENGINEERS. Three credit hours. Three hours of lecture per week. Prerequisites: (INQU 4005 and (MATE 4009 or MATE 3048)) or authorization of the Director of the Department.

Statistical analysis of experimental data, curve fitting, and sampling theory; nomography; problem solving with digital computers. Emphasis is given to chemical engineering applications.

**INQU 5015**. FUNDAMENTALS OF AIR POLLUTION (I). Three credit hours. Three hours of lecture per week. Prerequisite: INCI 4008 or authorization of the Director of the Department. Corequisite: INQU 4002.

Classification and extent of air pollution problems; meteorology and air pollution; dispersion from effluents; the effect of air pollution on plants and animals; visibility problems; socioeconomic impact of pollution problems; analytical and experimental sampling methods; equipment and process for abating air pollution; governmental regulations for air pollution control.

**INQU 5018**. AIR POLLUTION CONTROL (II). Three credit hours. Three hours of lecture per week. Prerequisite: INQU 4010 or INCI 4008 or authorization of the Director of the Department.

A discussion of the theory, principles, and practices related to engineering control of particulate and gaseous emissions from natural, industrial, agricultural, commercial, and municipal sources of atmospheric pollution.

**INQU 5019**. INDUSTRIAL WASTE CONTROL (I). Three credit hours. Three hours of lecture per week. Prerequisite: INCI 4008 or authorization of the Director of the Department. Corequisite: INQU 4002.

The minimization of industrial wastes through the proper design and operation of manufacturing plants; treatment and disposal of industrial wastes, with emphasis on the chemical industries in Puerto Rico.

**INQU 5020.** CHEMICAL PROCESS SAFETY AND ECONOMICS. Three credit hours. Three hours of lecture per week. Prerequisite: INQU 4001 or authorization of the Director of the Department.

Process safety and economic engineering analysis of chemical engineering unit operations and processes. Estimation of capital and manufacturing costs for engineering economic analysis and profitability analysis of chemical processes. Evaluation of the impact of chemical processing on the health and safety of people, and damage to the environment. Understanding of potential hazards and risk assessment associated with chemical processes and equipment. Analysis of process design and optimization.

**INQU 5021**. CHEMICAL ENGINEERING PROCESS DESIGN I. Three credit hours. Three hours of lecture per week. Corequisites: INQU 4002 and INQU 4017.

Analysis and design of chemical and biochemical process units, in particular, chemical reactors, mixers, separation units, heat exchangers, and transport of fluids.

**INQU 5022**. CHEMICAL ENGINEERING PROCESS DESIGN II. Three credit hours. Three hours of lecture per week. Prerequisites: (INQU 4017 and INQU 4002 and INQU 5021) or authorization of the Director of the Department.

Integration of chemical engineering concepts, economics, safety, ethics, and environmental considerations to plant and/or chemical process design.

**INQU 5025**. ANALYSIS AND CONTROL OF PROCESSES. Three credit hours. Three hours of lecture per week. Prerequisites: (INQU 4017 and INQU 4002) or authorization of the Director of the Department.

Mathematical simulation of chemical and physical processes. Analysis of first and second order systems; control modes; control hardware; roots locus and frequency response analysis; optimum control settings; applications to the design of control systems.

**INQU 5026**. MICROCLIMATE AND DISPERSION OF AIR POLLUTANTS (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: INQU 4002 or INCI 4008 or authorization of the Director of the Department.

Discussion of the elements of microclimate in urban, rural, and valley environments. Dispersion of air pollutants in these environments.

**INQU 5029.** BIOPROCESS ENGINEERING LABORATORY. Two credit hours. One hour of lecture and three hours of laboratory per week. Prerequisites: INQU 4207 or INQU 4003 or authorization of the Director of the Department.

Hands-on experiences in upstream and downstream bioprocess unit operations. Experiments in the areas of bioreactor cultures, cell and protein separation, as well as application of bioanalytical methods.

**INQU 5030**. CHEMICAL ENGINEERING LABORATORY II (I, II). Two credit hours. Two threehour laboratory periods per week. Prerequisite: (INQU 4002 and INQU 4017) or authorization of the Director of the Department. Corequisite: INQU 5025.

Experimental studies on mass transfer, process control, fermentation, kinetics and catalysis using pilot plant equipment at the Unit Operations Laboratory.

**INQU 5035**. BIOREACTOR ENGINEERING. Three credit hours. Three hours of lecture per week. Prerequisite: INQU 4005 or authorization of the Director of the Department.

Fundamentals of biochemistry. Kinetics of enzyme reactors; growth kinetics of suspended cell cultures; consideration of transport phenomena in bioreactors; operation and control strategies of bioreactors; culture of genetically engineered cells to produce recombinant proteins of therapeutic value.

**INQU 5036**. PARTICULATE SYSTEMS. Three credit hours. Three hours of lecture per week. Prerequisite: INQU 4002 or authorization of the Director of the Department.

Creation, characterization, separation and agglomeration of particles. Sizing fractionation of powders, surface area and pore size determinations. Pulverization, crystallization, agglomeration, tableting and granulation.

**INQU 5050**. HAZARDOUS WASTE TREATMENT. Three credit hours. Three hours of lecture per week. Prerequisite: INQU 4012 or INCI 4008 or authorization of the Director of the Department.

Introduction to the application of traditional and innovative technologies for the treatment of hazardous wastes in water and soil. Discussion of aspects such as: environmental regulations, design and operating parameters, and cost analysis. Use of computer software for the simulation and design of the different technologies.

**INQU 5075.** POLYMER ENGINEERING. Three credit hours. Three hours of lecture per week. Prerequisites: ((QUIM 3042 or QUIM 3132) and (INQU 4010 or INGE4010 or INGE4015)) or authorization of the Director of the Department.

Application of the principles of fluid mechanics, and heat and mass transfer to describe the production and processing of polymeric materials. Application of engineering principles to the analysis of polymer processes such as extrusion, molding and other industrially relevant unit operations. Emphasis on the effects of processing on structure and physical properties of polymers, and vice versa.

**INQU 5076.** POLYMER SCIENCE. Three credit hours. Three hours of lecture per week. Prerequisites: QUIM 3042 or QUIM 3132 or authorization of the Director of the Department.

Analysis of the fundamental physical and chemical properties of polymers and their relevance in the synthesis, production and characterization of polymer-based materials. Discussion of polymerization and reaction kinetics of polymers and copolymers, structure and morphology in solution, melt, and solid phases, thermodynamics of polymers, solutions and blends, and molecular weight characterization.

**INQU 5995**. SPECIAL PROBLEMS (I, II, S). One to three credit hours. One to three laboratory, library or independent work periods per week. Prerequisite: authorization of the Director of the Department.

Undergraduate research problems in chemical engineering or related field. Topics vary with interest of student and instructor. Open only to outstanding chemical engineering students.

**Graduate Courses**

**INQU 6001**. MATHEMATICAL METHODS IN CHEMICAL ENGINEERING (I). Three credit hours. Three hours of lecture per week. Prerequisite: authorization of Department Director.

Mathematical formulation and analysis of chemical engineering problems: application of linear algebra, vector analysis, and advanced ordinary differential equations.

**INQU 6002**. NUMERICAL METHODS IN CHEMICAL ENGINEERING (II). Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Formulation and numerical analysis of chemical engineering problems: application of partial differential equations, boundary value problems, orthogonal functions, and error analysis.

**INQU 6005**. REACTOR DESIGN (I). Three credit hours. Three hours of lecture per week.

Analysis and design of batch and continuous chemical reactors for homogeneous, heterogeneous, catalytic and non-catalytic reactions; residence time distribution; influence of mass and heat transport on yield and product distributions; stability and optimization of reactors.

**INQU 6009**. COLLOIDS AND INTERFACES. Three credit hours. Three hours of lecture per week.

Study of the principles of colloid science and interphases and their applications. Development of the fundamental understanding of how various properties of colloids and their interactions at a microstructural level lead to the observed bulk behavior of the material under study.

**INQU 6010**. APPLIED MOLECULAR BIOLOGY FOR ENGINEERS. Three credit hours. Three hours of lecture per week.

Study of the fundamentals of cell composition, structure, and function, cellular signal transduction, and the relationship of defects in these areas to human diseases. Discussion of commonly used molecular biology techniques and the primary literature in which these techniques are applied to the solution of biomedical engineering problems.

**INQU 6016**. ADVANCED TRANSPORT PHENOMENA (II). Three credit hours. Three hours of lecture per week.

Advanced analysis of momentum, energy and mass transport of continuous media. Analytical and numerical solutions to the equations of change, transport coefficients, boundary layer theory, relationship between microscopic and macroscopic balances, and dimensional analysis.

**INQU 6019**. ADVANCED THERMODYNAMICS (I). Three credit hours. Three hours of lecture per week.

A study of thermodynamics, emphasizing thermodynamic potential functions, fugacities in gas and liquid mixtures, thermodynamic properties, and phase equilibria.

**INQU 6020.** RHEOLOGY OF COMPLEX FLUIDS. Three credit hours. Three hours of lecture per week.

Study of the mechanical and flow properties of complex fluids, and the relationship with their microstructure. Discussion of fundamentals of rheological measurements, including flow kinematics, material functions, rheometry, and structural probes. Overview of rheological properties of colloids, liquid crystals, and polymer solutions and melts, amongst others.

**INQU 6025**. CATALYSIS (II). Three credit hours. Three hours of lecture per week.

A study of heterogeneous reactions, reaction rate, catalysis, activity and selectivity of catalytic agents, and surface chemistry; an analysis of industrial catalysts.

**INQU 6028**. INSTRUMENTATION AND CONTROL PROCESS (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: INQU 5025.

Application of advanced control techniques to chemical engineering processes. Emphasis on feedback/feedforward control, ratio control, multi-variable process control, interacting control loops, and sampled-data systems.

**INQU 6029**. GRADUATE SEMINAR (I,II). From zero to one credit hour. From zero to one one-hour session per week.

Research presentation by graduate students and faculty members.

**INQU 6035**. SELECTED TOPICS IN BIOCHEMICAL ENGINEERING (On demand). Three credit hours. Three hours of lecture per week.

Advanced topics in biochemical engineering: kinetics of enzymatic reactions, transport phenomena in microbial systems, deviation from ideal flow patterns, design and analysis of biological reactors.

**INQU 6036**. ENGINEERING PROJECT (I, II, S). Three to six credit hours.

Comprehensive study of a specified chemical engineering problem selected so as to integrate the knowledge acquired in the graduate program of study. This project fulfills one of the terminal requirements of the Master of Engineering program, and will be governed by the norms established for this purpose.

**INQU 6037**. MASTER'S THESIS (I, II, S). Six credit hours.

Research in chemical engineering, and presentation of a thesis.

**INQU 6038**. X-RAY CHARACTERIZATION OF MATERIALS. Three credit hours. Three hours of lecture per week.

Study of the use of X-rays for the characterization of materials. Study of the fundamentals of space groups and the theory, applications, and experimental considerations of diverse techniques such as: single crystal and powder X-ray

diffraction, small angle scattering, amorphous scattering, X-ray fluorescence, and X-ray absorption. Discussion of the relation between these techniques and other materials characterization techniques.

**INQU 6995**. SPECIAL PROBLEMS (On demand). One to three credit hours. One to three hours of lecture per week.

Investigations and special problems in chemical engineering.

**INQU 8007**. TRANSPORT PHENOMENA IN BIOLOGICAL SYSTEMS. Three credit hours. Three hours of lecture per week. Prerequisites: Authorization of the Director of the Department.

Integrated study of momentum, heat, and mass transfer, thermodynamics, and reaction kinetics to provide a mechanistic understanding of such processes as the physiological and cellular level in the human body. Formulation and solution of mathematical expressions to describe artificial organs, analyze biological systems characteristics, and evaluate their implication in biological transport.

**INQU 8010**. SPECIAL TOPICS IN TRANSPORT PHENOMENA. Three credit hours. Three hours of lecture per week. Prerequisite: Authorization of the Director of the Department.

Special topics in transport phenomena and related areas.

**INQU 8016**. SPECIAL TOPICS IN HETEROGENEOUS CATALYSIS. Three credit hours. Three hours of lecture per week.

Selected topics in heterogeneous catalysis. Includes a catalyst design project or a seminar on recent research.

**INQU 8025**. FOOD FERMENTATION AND BIOTECHNOLOGY. Three credit hours. Three hours of lecture per week.

A study of the chemistry, microbiology and technology in fermentation processes in the food industry. Includes topics such as: kinetics of biological processes, optimal conditions for the design of fermentors, thermodynamic and stoichiometric limitations, and production of industrial microorganisms by genetic engineering processes.

**INQU 8027**. CHEMICAL ENGINEERING PRINCIPLES APPLIED TO DRUG THERAPY. Three credit hours. Three hours of lecture per week. Prerequisites: Authorization of the Director of the Department.

Application of chemical engineering principles to drug therapy. Topics include: pharmacokinetic and pharmacodynamic concepts, design of therapeutic regiments, and the application of transport phenomena in the design and modeling of drug delivery devices.

**INQU 8036**. ADSORPTION IN NANOSTRUCTURED MATERIALS. Three credit hours. Three hours of lecture per week.

Study of the principles and phenomena of surface adsorption of molecular scale materials. Design of nano-scale materials, including potential energy calculations considering the composition and surface geometry. Methods of adsorbent synthesis, adsorption techniques and methods for performance analysis, and simulation of molecular dynamics will also be included.

**INQU 8103.** NANOPARTICLE SCIENCE AND ENGINEERING. Three credit hours. Three hours of lecture per week.

Study of the theory, fabrication techniques, and applications of metallic and magnetic nanoparticles. Topics include: synthesis and derivatization methods, physical and chemical properties, and particle-particle and particle-surface interactions.

**INQU 8995**. SPECIAL PROBLEMS. One to six credit hours.

Research and special problems in Chemical Engineering.

**INQU 8996**. DOCTORAL SEMINAR. Cero to one credit hour.

Oral presentations and discussions in areas of interest.

**INQU 8997**. SPECIAL TOPICS IN COMPLEX FLUIDS. One to six credit hours. One to six hours of lecture per week.

Special topics in rheology, structure, characterization, modeling, and processing of complex fluids. Application of engineering concepts to novel and classical research areas of complex fluids.

**INQU 8999**. DOCTORAL DISSERTATION. Eighteen credit hours.

Development, preparation and defense of a thesis or dissertation based on an original research project in Chemical Engineering, which represents a significant contribution to the state of knowledge of this discipline.

## CIVIL ENGINEERING AND SURVEYING

### Advanced Undergraduate Courses

**INCI 5006**. APPLIED HYDRAULICS (I). Three credit hours. Three hours of lecture per week. Prerequisite: INCI 4138 or authorization of the Director of the Department.

Dimensional analysis and modeling; hydraulic machinery and structures; steady conduit and open channel flow; pipe network system.

**INCI 5007**. SOLID WASTE MANAGEMENT. Three credit hours. Three hours of lecture per week. Prerequisite: INCI 4008 or authorization of the Director of the Department.

The solid waste problem: volume reduction and storage of solid wastes, design and optimization of collection systems, recycling, integrated treatment and disposal systems.

**INCI 5008**. INTRODUCTION TO HYDROLOGY. Three credit hours. Three hours of lecture per week. Prerequisite: INCI 4138 or authorization of the Director of the Department.

The elements of the hydrologic cycle; probability theory and commonly used probability distributions in hydrology: hydrologic and hydraulic flood routing analysis; use of hydrologic concepts in design.

**INCI 5009**. FUNDAMENTALS OF AIR POLLUTION (II). Three credit hours. Three hours of lecture per week. Prerequisite: INCI 4008 or authorization of the Director of the Department.

Classification and extent of air pollution problems, its effects on plants, animals, visibility, and its socio-economic impact; dispersion of effluents; analytical and experimental sampling methods.

**INCI 5010.** SUSTAINABLE AND RESILIENT DESIGN AND CONSTRUCTION. Three credit hours. Three hours of lecture per week. Prerequisites: Fifth year student or authorization of the Director of the Department.

Discussion of sustainable development. Application of sustainability and resiliency to engineering design and construction. Discussion of the engineering and ethical principles needed to support green and resilient design and construction. Discussion of the process to deliver and assess green and resilient construction, the construction system for resource optimization, the reduction of environmental impact, and the use of the integrated building design to achieve sustainability and resiliency.

**INCI 5012**. APPLIED SANITARY ENGINEERING CHEMISTRY (II). Four credit hours. Three hours of lecture and one three-hour laboratory per week. Prerequisite: INCI 4008 or authorization of the Director of the Department.

The application of chemical principles to the sanitary engineering field. Physical, chemical, and biochemical analysis of water and wastewater. Interpretation of analytical data. Integration of experimental data into the design process. The preparation of laboratory reports in the form of engineering reports is emphasized.

**INCI 5015**. WATER TREATMENT AND POLLUTION CONTROL. Three credit hours. Two lectures and one three-hour laboratory per week. Prerequisite: INCI 4008 or authorization of the Director of the Department.

Study of water and wastewater treatment processes in terms of the underlying physical, chemical, and biological principles; the application of the principles to the study of unit treatment processes and to the design, operation, and analysis of performance of integrated treatment plants; the influence of the self-purification of natural bodies of water and of the planned use of the resources on the type and degree of treatment of waste and its disposal; wastewater reclamation.

**INCI 5017**. PRESTRESSED CONCRETE STRUCTURES (I). Three credit hours. Three hours of lecture per week. Prerequisite: INCI 4012 or authorization of the Director of the Department. Corequisite: INCI 4022.

Prestressing systems and materials; stress losses, design of beams of flexure, bond, shear and bearing; specifications and economics of design.

**INCI 5018**. MATRIX ANALYSIS OF STRUCTURES I (I). Three credit hours. Three hours of lecture per week. Prerequisites: INCI 4022 and authorization of the Director of the Department.

Use of matrix methods in the analysis of structures; flexibility and stiffness methods.

**INCI 5019.** DESIGN OF REINFORCED MASONRY STRUCTURES. Three credit hours. Three hours of lecture per week. Prerequisite: INCI 4012 or authorization of the Director of the Department.

Analysis and design of reinforced and unreinforced masonry structures using advanced analytical techniques and design philosophies. Includes topics such as: material properties, stability, and buckling of unreinforced masonry; flexural strength, stiffness, and ductility of reinforced masonry elements; and seismic and wind load design provisions.

**INCI 5021.** INTRODUCTION TO DYNAMICS OF STRUCTURES. Three credit hours. Three hours of lecture per week. Prerequisite: INCI 4022 or authorization of the Director of the Department.

Study of the modeling of structures as systems of single and multiple degrees of freedom. Explanation of the calculation of natural frequencies and vibration modes. Use of computer programs for the dynamic analysis of structures. Introduction of the concept of response and design spectra along with their use for the calculation of the response to earthquake loads.

**INCI 5026**. BRIDGE DESIGN (II). Three credit hours. Three hours of lecture per week. Prerequisites: (INCI 4012 and INCI 4022) or authorization of the Director of the Department.

Bridge analysis and design; bridge types, characteristics; design problems.

**INCI 5027**. MODEL ANALYSIS OF STRUCTURE (BD). Three credit hours. Two hours of lecture and one three-hour laboratory per week. Prerequisite: INCI 4022 or authorization of the Director of the Department.

Model analysis in structural engineering; similarity of structures; theory of models of trussed and framed structures and shells; direct and indirect model analysis of structures.

**INCI 5029**. PRINCIPLES OF CITY PLANNING. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

The scope of and legislative bases for planning, organization of planning agencies, basic studies for studies for planning, public utilities and related service facilities, transit and transportation systems, recreation and related service facilities, transit and transportation systems, recreation and public spaces, land use planning, zoning, land subdivision regulations, economic and social aspects of planning, local, regional and national levels of planning.

**INCI 5036**. DESIGN-BUILD PROJECT DELIVERY. Three credit hours. Three hours of lecture per week.

Discussion of the design-build project delivery process. Analysis of the dynamics of the Design-Build process for the development of resilient and sustainable infrastructure. Use of management techniques to capitalize on Design-Build's potential. Application of procurement methods that require interdisciplinary, resilient, and sustainable approaches.

**INCI 5037**. MANAGEMENT OF CONSTRUCTION ENGINEERING PROJECTS. Three credit hours. Three hours of lecture per week. Prerequisites: INCI 4056 or authorization of the Director of the Department.

Study of the project management knowledge areas required to effectively manage construction engineering projects. Discussion of tools and best practices used in the construction industry for successful project management.

**INCI 5047**. INTRODUCTION TO ROCK MECHANICS (BD). Three credit hours. Three hours of lecture per week. Prerequisite: INCI 4139 or INCI 4031 or authorization of the Director of the Department.

Fundamentals of rock mechanics: properties of rocks; strength and deformation characteristics of intact and *in-situ* rocks, computation of internal stresses in a rock mass; methods of rock exploration; application of rock mechanics.

**INCI 5049**. GEOSYNTHETICS IN CIVIL ENGINEERING (II). Three credit hours. Three hours of lecture per week. Prerequisite: INCI 4139 or authorization of the Director of the Department.

Manufacture, properties and test methods of the different products that comprise the geosynthetics. Applications in: drainage and filtration, design of pavements, earth retaining structures, systems of pollution control, sanitary landfills and other environmental projects.

**INCI 5055**. DESIGN OF TIMBER STRUCTURES (II). Three credit hours. Three hours of lecture per week. Prerequisite: INCI 4021 or authorization of the Director of the Department.

Physical and mechanical properties of solid and laminated wood; design and behavior of flexural, tension, and compression members; design of timber connections and mechanical fasteners; special problems in the design of wood trusses, shear walls, diaphragms and plywood composite beams.

**INCI 5056**. STRUCTURAL ANALYSIS III. Three credit hours. Three hours of lecture per week. Prerequisite: INCI 4022 or authorization of the Director of the Department.

Application of methods for analysis of statically indeterminate structures. Moment distribution. Slope deflection and energy theorems.

**INCI 5057.** DESIGN OF REINFORCED CONCRETE STRUCTURES. Three credit hours. Two hours of conference and one hour of computation per week. Prerequisites: (INCI 4012 and INCI 4022) or authorization of the Director of the Department.

Design of concrete buildings, review of the design of slabs, beams and columns applied to buildings using the new seismic design codes, design of two-way slab systems, shear walls, typical foundations, retaining walls and design for torsion. Discussion of examples related to a complete structural design of a multistory building including the preparation of construction drawings.

**INCI 5065**. PRODUCTION OF BITUMINOUS MATERIALS. Three credit hours. Two hours of lecture and three hours of laboratory per week. Prerequisites: INCI 4035-Civil Engineering Materials or INCI 4231 or authorization of the director of the Department.

Study of the production of bituminous materials, the distillation process, raw materials, different types of asphalt mixtures used in the construction and rehabilitation of flexible pavements. Laboratory tests and trials for the characterization of such materials according to current standards and performance requirements. Volumetric mix design for different levels of traffic, climatic and durability considerations; principles of production, quality control and quality assurance.

**INCI 5146**. INTRODUCTION TO TRAFFIC ENGINEERING (I). Three credit hours. Three hours of lecture per week. Prerequisite: INCI 4137 or authorization of the Director of the Department.

Operation and geometric analysis and design of intersections. Interrupted traffic flow theory, queuing theory, capacity and level of service, traffic studies, service models for signalized intersections and traffic simulation models.

**INCI 5995**. SPECIAL TOPICS (II). One to six credit hours. The contact will vary according to the topic to be presented. Prerequisite: authorization of the Director of the Department.

The topics will be presented by visiting professors and members of the department who are specialists in the field to be covered. The selection and scope of the topics shall be in accordance with the interests and needs of the students.

**INCI 5996**. SPECIAL PROBLEMS (BD). One to six credit hours. The contact will vary according to the topic to be presented. Prerequisite: authorization of the Director of the Department.

Research and special problems in Civil Engineering and related fields. Open to outstanding students in the field of Civil Engineering.

**Graduate Courses**

**INCI 6005**. WATER AND WASTEWATER TREATMENT (II). Three credit hours. Three hours of lecture per week. Prerequisite: authorization of Department Director.

The process of treating water and wastewater; design of facilities for treatment of water for municipal and industrial use; principles for treatment of municipal and industrial wastewater; application of unitary processes in the design of treatment plants to meet industrial effluents guidelines.

**INCI 6006**. GROUNDWATER HYDROLOGY (II). Three credit hours. Three hours of lecture per week. Prerequisite: authorization of Department Director.

Fundamentals of groundwater hydrology: well hydraulics, groundwater quality, surface and subsurface factors affecting groundwater, and seawater intrusion.

**INCI 6008**. WATER RESOURCES SYSTEMS (II). Three credit hours. Three hours of lecture per week. Prerequisite: authorization of Department Director.

Systems theory and operation research for solving typical water resources problems quantitatively and qualitatively; aspects of engineering economics, the concepts of the discount rate, methods of project evaluation, stochastic and deterministic simulation.

**INCI 6009**. WATER AND WASTEWATER TREATMENT LABORATORY (II). Three credit hours. One hour of lecture and six hours of laboratory per week.

Physical, chemical and biological processes in the treatment of water and waste water. Waste analysis, biodegradation, and waste water characterization.

**INCI 6015**. SANITARY ENGINEERING MICROBIOLOGY (BD). Three credit hours. Two hours of lecture and one three-hour laboratory per week.

Biochemical reactions induced by microorganisms, emphasizing microbiological processes related to water and wastewater treatment and to environmental pollution control.

**INCI 6016**. STOCHASTIC HYDROLOGY (BD). Three credit hours. Three hours of lecture per week. Prerequisite: authorization of Department Director.

Probability theory applied to hydrology; extreme value distribution; recurrence and frequency analysis; stochastic simulation of the hydrological process; hydrological models.

**INCI 6017**. STRUCTURAL MECHANICS (I). Three credit hours. Three hours of lecture per week.

Advanced theories of mechanics of materials are discussed with emphasis on topics most relevant to the civil engineering structures. The selection includes thin-walled cross sections subject to unsymmetrical bending and torsion, Mohr's circle for second moments of area, shear center of monosymmetric and unsymmetric sections, beams on elastic foundation, curved beams, thin shells of revolution subject to axisymmetric loading, and the limit states associated with fatigue, fracture and creep. Case studies on metal roof systems, long span beams, and liquid storage tanks are used to augment the theory.

**INCI 6018**. FINITE ELEMENT ANALYSIS OF STRUCTURES (II). Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

The finite element method and its application in the analysis of structures with elastic and non-linear behavior and in the determination of buckling loads, element development for the solution of unitary stress and strain problems in flexion of plates, thin and thick shells, axisymmetric shells, and solids.

**INCI 6019**. DESIGN OF STEEL STRUCTURES (I). Three credit hours. Three hours of lecture per week.

Evaluation of current specifications for the design of structural members under axial, flexure, torsional, and combined axial and flexural loadings; design of plate girders and rigid frames; plastic design of gable and multistory frames; design of connections for fatigue loading.

**INCI 6020**. OPTIMIZATION IN STRUCTURAL DESIGN (II). Three credit hours. Three hours of lecture per week.

Application of linear programming to the optimization of the design of steel and reinforced concrete frames subject to gravitational and lateral loads.

**INCI 6021**. THEORY OF ELASTICITY. Three credit hours. Three hours of lecture per week. Prerequisites: INCI 6017 or authorization of the Director of the Department.

Presentation of the theory to analyze stresses and strains in three-dimensional elastic solids presuming constitutive elastic equations. Formulation of models based on differential equations for the explicit solution of simple problems in the classic literature. Study of alternate formulations of virtual work and its changes due to variations in displacements and forces, small and large deformations, and fundamentals of thermoelasticity.

**INCI 6022**. DESIGN OF EARTHQUAKE RESISTANT STRUCTURES. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Study of the parameters used for the selection of a Design Earthquake, development of ground spectra, elastic and inelastic design spectra. Design of structures using the capacity method. Introduction to base isolation systems.

**INCI 6023**. ANALYSIS OF STRUCTURES OF COMPOSITE MATERIALS. Three credit hours. Three hours of lecture per week.

Analysis of the mechanical and physical properties of composite materials from the micromechanical to the macromechanical level. Laminate analysis including failure theories. Analysis, design, and optimization of structural

elements and of concrete reinforced with composite materials. Study of the manufacture of components and analysis of connections between elements.

**INCI 6025**. PLAIN AND REINFORCED CONCRETE (II). Three credit hours. Three hours of lecture per week.

Brief review of the theories used in the design of concrete and the factors affecting the properties and behavior of the material and of the test specimen; behavior of plain concrete under different types of environment and of loading; critical review of ultimate strength; behavior of reinforced concrete members and relation between results of research and current specifications for design.

**INCI 6026**. REINFORCED CONCRETE STRUCTURES (I). Three credit hours. Three hours of lecture per week. Prerequisite: INCI 6025.

Continuation of INCI 6025. Ultimate strength and behavior of statically indeterminate reinforced concrete structures; floors, slabs; specifications.

**INCI 6027**. ADVANCED STRUCTURAL PROBLEMS (BD). Three credit hours. Three hours of lecture per week.

Advanced design of complex structural projects.

**INCI 6029**. DESIGN OF STRUCTURES FOR DYNAMIC LOADS (II). Three credit hours. Three hours of lecture per week.

Free vibrations; forced vibrations and transient response of structures having one or more degrees of freedom; damping and inelastic action; nature of dynamic loading from earthquakes and bomb blasts; methods of analysis and criteria for designing earthquake-resistant and blast-resistant structures.

**INCI 6030**. ANALYSIS OF STRUCTURAL SYSTEMS IN THE NON-LINEAR REGIME (BD). Three credit hours. Three hours of lecture per week.

Nature of the problem of non-linear behavior. Tangent stiffness method. Structures on elastic foundations. Soil and structure interaction.

**INCI 6031**. ADVANCED SOIL MECHANICS I (II). Three credit hours. Three hours of lecture per week.

One-dimensional consolidation; advances in consolidation theories; secondary consolidation; precompression; three-dimensional consolidation; sand drains; distribution of stresses in a soil mass; computation of settlements.

**INCI 6032**. MEASUREMENT OF SOIL PROPERTIES. Two hours of lecture and one three-hour laboratory per week.

Study and practice of the measurement of stress-strain and consolidation properties of soils including tests such as one-dimensional consolidation, direct shear, and triaxial tests. Practice in sample preparation, testing details, sources of error, analysis and interpretation of results, and report preparation is included.

**INCI 6045**. PAVEMENT DESIGN (I). Three credit hours. Three lectures per week.

Traffic loads, climatic effects, stresses in pavements, flexible pavement design, rigid pavement design, skid resistance, construction practices and maintenance.

**INCI 6046**. URBAN TRANSPORTATION PLANNING (II). Three credit hours. Three hours of lecture per week.

Urban travel characteristics and trends; basic urban transportation studies, including origin, destination surveys, inventory, use studies, parking studies, and transit surveys; application of transportation, economic, land use data in estimating future travel; planning arterial street and expressway systems, off street parking, and transit systems; coordination of city planning and transportation engineering; metropolitan transportation administration and finance.

**INCI 6047**. TRAFFIC ENGINEERING (I). Three credit hours. Two hours of lecture and one two-hour discussion, computation or field period per week.

City and highway traffic surveys and designs; accidents, congestion, delay, speed, volume density, parking, channelization, lighting, traffic control and routing, signs, signals and markings, urban traffic consideration in city planning; driver reactions and habit patterns.

**INCI 6048**. TRANSPORTATION SYSTEMS ANALYSIS (II). Three credit hours. Three hours of lecture per week.

Principles and techniques of systems analysis and mathematical programming are presented and applied to economic, physical planning, and the evaluation and operation of transportation facilities. Mathematical models are used to examine problems related to optimum efficiency of transportation systems and modes. Operations research methods of linear programming, non-linear programming, network analysis, queueing theory, and simulation are studied.

**INCI 6049**. TRANSPORTATION SYSTEMS EVALUATION (II). Three credit hours. Three hours of conference per week.

The course is designed to provide graduate students with knowledge of evaluation studies and methods employed in planning the proper function and character of transportation facilities, and of the broad administrative policies such as transportation needs, finance, and economics that affect the planning, design, and programming of transportation systems. The course contents give attention to the application of basic techniques in engineering economic evaluation and the assessment of user and non-user impacts of transportation improvements.

**INCI 6050.** ADVANCED TRANSPORTATION SYSTEMS ANALYSIS (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: INCI 6048.

Advanced topics in transportation and demand analysis; transportation economy; resource models; techniques for the design and generation of alternatives in transportation systems.

**INCI 6051**. MASS TRANSPORTATION SYSTEMS. Three credit hours. Three hours of lecture per week.

Study of concepts related to the planning and operation of mass transportation systems in urban areas. Discussion and comparison of diverse modes of mass transport. Detailed study of urban rail systems.

**INCI 6055**. CONSTRUCTION COSTS ESTIMATES. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Study of construction cost-estimating techniques during the different phases of the construction process. Development and application of knowledge and skills necessary to estimate costs in a construction project.

**INCI 6057**. THEORY OF ELASTIC STABILITY (II). Three credit hours. Three hours of lecture per week.

Bending of prismatic bars subjected to axial and lateral loads; buckling of compression members on the elastic and inelastic ranges; lateral buckling of beams, and torsional buckling.

**INCI 6059**. MODELING OF URBAN STORM DRAINAGE (I). Three credit hours. Three hours of lecture per week.

Application of hydrologic and hydraulic principles to the analysis, design, and management of urban drainage and small watersheds; computer modeling and simulation; effects of spatial and temporal rainfall variabilities; overland flow; runoff from highways; stormsewers, culverts, and other related drainage structures.

**INCI 6060**. POLLUTANT TRANSPORT (I). Three credit hours. Three hours of lecture per week.

Point and non-point source pollutants; the Streeter-Phelps equation; analysis of the transport problem in streams and estuaries; finite element approach to system analysis; ocean outfalls; pollutographs and loadgraphs; universal equation of soil conservation, mathematical model for pollutants handling.

**INCI 6061**. SEDIMENT TRANSPORT I. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Introduction to sediment transport. Hydrodynamics of fluid-particle systems. Initiation of particle motion. Relation of bedforms to flow regime. Design of stable channels and live bed stable channels. Bedload and suspended sediment transport. Local scour in channels measurement of sediment transport.

**INCI 6063**. COMPUTER HYDROLOGIC MODELING (II). Three credit hours. Three hours of lecture per week.

Emphasis on computer hydrologic modeling. Application of the Hydrologic Cycle's components to the development of precipitation-runoff models. Individual watershed processes are analyzed and their integration to computer models studied. Model selection and calibration techniques, with special attention to error analysis, are also studied. Students are exposed to actual problems of using Hydrologic Models. Class projects include applications to real cases.

**INCI 6064**. ADVANCED CONCRETE TECHNOLOGY (BD). Three credit hours. Three hours of lecture per week.

Microstructure, physical and mechanical properties of concrete; strength-porosity relation, failure modes, and behavior of concrete under various stress states; fiber reinforced cementitious composites: types, mechanical properties, applications, and mixture proportions; fiber-reinforced shotcrete: applications and field performance; fiber reinforced plastics (FRPs): applications for repair, rehabilitation, and reinforcement.

**INCI 6065**. ENGINEERING PROJECT (I, II). Three to six credit hours.

Comprehensive study of a specific civil engineering problem selected so as to integrate the knowledge acquired in the graduate program of study. This project fulfills one of the terminal requirements of the Master of Engineering Program and will be governed by the norms established for this purpose.

**INCI 6066**. RESEARCH THESIS (I, II). One to six credit hours.

Research in the field of civil engineering and presentation of a thesis.

**INCI 6068**. PAVEMENT MANAGEMENT. Three credit hours. Three hours of lecture per week.

Development of systematic methods to evaluate and administer existing pavements for highways and airports. Analysis of existing pavement defects, structural capacity, safety, and geometry. Development and application of statistical models, optimization techniques, and analysis of rehabilitation techniques for existing pavements. Field project required.

**INCI 6069**. SOIL DYNAMICS (BD). Three credit hours. Three hours of lecture per week.

Introduction to the terminology and notation used in the analysis of dynamic systems. Discussion of dynamic soil properties and wave propagation theories in soils. Design of foundations in seismic regions, theory of machine vibrations, and the problem of soil liquefaction in granular soils. Description of laboratory dynamic tests and analysis of the data obtained from them.

**INCI 6070**. CONSTRUCTION ADMINISTRATION AND INSPECTION. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Study of the concepts and processes related to the administration and inspection of construction projects. Discussion of the organization and scheduling of a project, applicable laws and regulations, specifications, quality control, safety, and other administrative aspects.

**INCI 6076**. PHYSICO-CHEMICAL TREATMENT OF WATER (I). Three credit hours. Three hours of lecture per week.

Theory and application of physico-chemical unit processes for the removal of pollutants from water and wastewater; substitution of biological treatment by physico-chemical processes; problems and technology of wastewater reuse for drinking purposes.

**INCI 6077**. PLANNING AND SCHEDULING CONSTRUCTION PROJECTS. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Study of the concepts of planning and scheduling construction projects. Emphasis on division of the project into activities and the estimation of their duration; bar charts; development of networks by CPM and PM and their analysis using PERT. Scheduling with limited resources and resource leveling and the use of the schedule as a project control mechanism.

**INCI 6078**. SHEAR STRENGTH OF SOILS. Three credit hour. Three hours of lecture per week.

Studies of the physic-chemical properties of soils and the mechanisms of shearing resistance. Discussion of residual shear strength, Hvorslev's parameters, drained and undrained shear strength, and long-term shear strength.

**INCI 6080.** ANALYSIS AND DESIGN OF DEEP FOUNDATIONS. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Analysis and design of single and grouped piles subjected to axial and lateral forces, drivability analysis, and practical recommendations for pile driving. Design and interpretation of load test considering negative skin friction effects, and design of drilled shafts.

**INCI 6085**. ADVANCED MATHEMATICAL METHODS IN CIVIL ENGINEERING. (BD). Three credit hour. Three hours of lecture per week.

Advanced calculus; optimization methods, estimation theory; sampling theory; queuing theory; application of spread sheet and data base programs in microcomputers.

**INCI 6086.** STATISTICAL METHODS IN WATER RESOURCES. Three credit hours. Three hours of lecture per week.

Application of probabilistic methods to problems in water resources. Study of the probability distributions of rainfall and runoff processes. Analysis of random variables and hypothesis testing; frequency analysis of extreme events; correlation and regression analysis in water resources; fundamentals of uncertainty and risk analysis.

**INCI 6087**. CONSTRUCTION COST ENGINEERING AND FINANCIAL MANAGEMENT. Three credit hours. Three hours of lecture per week.

Study of techniques and technologies required to achieve success in construction projects through improved cost control. Fundamental concepts related to cost control, financial management, advanced engineering economics, accounting, project control systems, and cash flow analysis applied to construction. The use of computer software for cost control and accounting will be explained.

**INCI 6088**. ENGINEERING GROUND IMPROVEMENT. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Study of the methods of ground and site improvement to mitigate construction problems under poor engineering conditions. Description of design techniques for dewatering systems and ground improvement techniques applied to diverse systems including: compaction, preloading, vertical drains, admixtures, grouting, reinforced earth, in-situ densification, stone columns, slurry trenches, and relevant uses of geotextiles.

**INCI 6089**. ADVANCED STRUCTURAL DYNAMICS. Three credit hours. Three hours of lecture per week. Prerequisite: INCI 6029 or authorization of the Director of the Department.

Variational formulation of the equations of motion and of the equations of motion in state space, including the use of complex eigenvalues and eigenvectors. Study of free and forced vibrations of continuous systems using the frequency response method. Introduction to nonlinear vibrations and to wave propagation in unidimensional finite, semi-infinite, and infinite media.

**INCI 6090.** GEOMETRIC DESIGN OF HIGHWAYS. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Study of geometric design concepts and policies used to design highways and streets, at-grade intersections, grade separations, interchanges, and other ground transportation facilities. Application of design control and criteria and consideration of the safety and operational effects of the roadway and roadside elements, the sight distance, the horizontal and vertical alignment, and other elements of the design of roads of different functional classification.

**INCI 6098**. REHABILITATION OF REINFORCED CONCRETE STRUCTURES (BD). Three credit hours. Three hours of lecture per week.

Discussion of the available techniques to compute the maximum load capacity of a structure, estimates of expected gravity and lateral loads, and determination of the actual safety factor of the structure under the imposed load. Reinforced concrete pathology and prognosis of the problems caused by materials' defects, construction problems, and inadequate design. Techniques for strengthening structural elements. Presentation and discussion of typical cases.

**INCI 6099**. CONSTRUCTION METHODS AND EQUIPMENT. Three credit hours. Three hours of lecture per week.

Study of construction methods and equipment for civil engineering projects. Selection, layout, and organization of construction installations, equipment, and resources. Analysis of cost, operation, and productivity of equipment and construction methods. Field trips are required.

**INCI 6100**. STRUCTURAL COMPONENTS IN GEOTECHNICAL ENGINEERING. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Analysis and design of individual and combined foundations, mat foundations, cantilever retaining walls, and pile caps. Rigid and flexible method of analysis of combined and mat foundations will also be studied.

**INCI 6105**. EARTH PRESSURES AND SHALLOW FOUNDATIONS. Three credit hours. Three hours of lecture per week.

Application of soil mechanics concepts to earth pressure and retaining structures, foundations of buildings, sheet piles, braced cuts, settlement, and contact pressures. Analysis and design of shallow foundations, retaining structures, sheet piles, and braced cuts.

**INCI 6106**. TEMPORARY STRUCTURES IN CONSTRUCTION. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Study of the fundamental concepts related to the selection, design, and layout of temporary structures needed in construction. Safety issues, prefabricated and customized structures, use of pumps during construction, ramps, runways, and scaffolding, and design and analysis of frameworks for concrete structures will also be discussed.

**INCI 6107.** DURABILITY OF CONSTRUCTION MATERIALS. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Development of the analysis and design skills necessary to build public work in challenging environments. Study of the construction materials' lifecycle to provide a high level of expertise in areas such as: cement chemistry, aggregate science, binder technology, microstructure, and transportation mechanisms in concrete, concrete durability, alternative materials, durability of non-cement based materials, and material's performance.

**INCI 6108**. ROAD SAFETY ANALYSIS. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Study of the analytical methods used to estimate and analyze the safety effects and the relationships between different elements and characteristics of drivers, vehicles, traffic flow, and highway design. Analysis of crash, traffic and roadway inventory databases, the consideration of human factors and driver responses to risk perception. Application of conventional safety modeling techniques and methods for identifying hazardous locations, and recognize causes for different crash types.

**INCI 6109**. PRODUCTIVITY ANALYSIS AND SIMULATION IN CONSTRUCTION. Three credit hours. Three hours of lecture per week.

Study of the techniques and technologies used to manage productivity and methods of improvement in construction. Study of productivity measurement including work sampling, crew balance charts, process charts, and flow diagrams. Application of simulation to construction to illustrate how discrete event simulation can be used for productivity studies and for the design of complex and dynamic operations.

**INCI 6110**. ENGINEERING SEISMOLOGY. Three credit hours. Three hours of lecture per week. Prerequisites: authorization of the Director of the Department.

Application of concepts in seismology specific to civil engineering for the solution of problems regarding site characterization, ground response upon vibrations, and engineering structures.

**INCI 6115**. PROGRAMMING METHODS IN CIVIL ENGINEERING (BD). Three credit hours. Three hours of lecture per week.

Implementation of numerical methods and algorithms for the solution of linear and non-linear systems of equations. Development and implementation of design systems and computer graphics (CAE/CAD). A comprehensive programming project will be required.

**INCI 6116**. HYDROLOGICAL AND HYDRAULIC MEASUREMENT METHODS. Three credit hours. One hour of lecture and one six-hour workshop per week.

Utilization of field equipment, sampling techniques, and data analysis for hydrological and hydraulic applications. Field work is required.

**INCI 6118**. BIOREMEDIATION: PRINCIPLES AND APPLICATIONS. Three credit hours. Three hours of lecture per week.

Design and management of bioremediation projects. Topics in bioremediation include: site characterization, project management, subsoil microbial systems, biotransformation pathways of hazardous contaminants, and bioremediation technologies to solve environmental problems. The relationship among the physiological traits of microorganisms, the physicochemical properties of the contaminants, and the nature of the remediation environment will be emphasized.

**INCI 6119.** DATA ANALYSIS AND MODELING OF TRANSPORTATION SYSTEMS. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Study of the variety of analytical tools that are regularly applied to data collected for transportation research studies. Emphasis on the use of model estimation methods as well as software packages helpful in the analysis of data for improving research in transportation engineering.

**INCI 6125.** UNSTEADY FLOW IN CLOSED CONDUITS. Three credit hours. Three hours of lecture per week.

Study of the principles of unsteady flow in closed-conduits, wave propagation and its causes. Derivation of the equations that describe unsteady flow and its limitations. Discussion of the numerical methods for computer solution of unsteady flow problems. Consideration of boundary conditions and methods for controlling unsteady flow. Development of computer programs for transient unsteady flow simulation.

**INCI 6127.** UNSTEADY FLOW IN OPEN CHANNELS. Three credit hours. Three hours of lecture per week.

Detailed study of the St. Venant equations for unsteady open channel flow. Derivation of the differential of shallow-water equations. Modern methodologies to solve unsteady open-channel flow problems using computers. Applications to surge problems and dam breaks and introduction to methods of flow routing. Development of computer programs and use of well-known software to solve real life applications.

**INCI 6130.** PEDESTRIAN AND BICYCLE TRANSPORTATION. Three credit hours. Three hours of lecture per week.

Study and analysis of current practices related to the planning, design, operation, and maintenance of pedestrian and bicycle facilities. Identification of access and mobility needs and challenges of pedestrians and cyclists and their integration in the development of safe and sustainable transportation infrastructure systems.

**INCI 6135**. HUMAN FACTORS IN ROADWAY SAFETY. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the director of the Department.

Influence of human factors in the design and operation of highway systems with emphasis on the analysis of safety and crash events. Perception and processing of information, response time, fatigue, alcohol and drugs effect, differences by gender and age, understanding of traffic control devices, visibility and lighting, and factors related to the site context.

**INCI 6150**. SLOPE STABILITY. Three credit hours. Three hours of lecture per week.

Study and analysis of soil and rock slope stability including the aspects of design and stabilization within a geotechnical framework.

**INCI 6205.** CONSTRUCTION CONTRACTING FOR ENGINEERS AND CONSTRUCTION PROFESSIONALS. Three credit hours. Three hours of lecture per week.

Study of the fundamental principles for contracting in the construction industry including topics such as: legal obligations for the parties, formation principles, contracts for architectural and design services, construction contracts, subcontractor agreements, description of commercial terms.

**INCI 6206.** PRECAST CONCRETE CONSTRUCTION. Three credit hours. Three hours of lecture per week.

Study of precast concrete, the benefits of prefabrication and its applications. Emphasis of the use of precast concrete for innovative and modern designs. Development of expertise in precast construction philosophy, principles, and systems. Study of precast detailing, stability, and key issues such as fire resistance and sustainability.

**INCI 6207.** PROCUREMENT OF INFRASTRUCTURES. Three credit hours. Three hours of lecture per week.

Study of the engineering, technical and organizational issues related to the procurement of infrastructure. Analysis of the scientific principles, practical information, decision-making, pecuniary as well as socio-economic aspects of civil

engineering infrastructures. Discussion of sector profiles and developments, issues and options, planning principles, as well as practices, funding and cost recovery of public works.

**INCI 6208.** BUILDING CONSTRUCTION SYSTEMS. Three credit hours. Three hours of lecture per week.

Study of the general characteristics of building materials, codes and standards, and construction methods pertaining to soils, foundations, wood, masonry, concrete, steel, and cladding and roofing systems. Discussion of the fundamental aspects of mechanical and electrical systems for buildings.

**INCI 6209.** ENVIRONMENTAL IMPACT ANALYSIS. Three credit hours. Three hours of lecture per week.

Description of environmental assessment fundamentals. Planning of the environmental assessment process including impact identification, environmental assessment indicators, prediction and assessment of impacts on environmental, social, economic, and cultural settings. Evaluation of alternatives including methods of decision making and preparation of environmental documents.

**INCI 6305**. WIND ENGINEERING. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Advance study of the formation, history, probability of occurence, and geographic distribution of extreme wind events, with a primary focus on tropical cyclones, design wind loads for structures, structural response to wind loading, and experimental and product evaluation methods specific to wind engineering practice.

**INCI 6306.** SEEPAGE AND CONSOLIDATION. Three credit hours. Three hours of lecture per week. Prerequisites: authorization of the Director of the Department.

Principles of steady state and transient seepage flow in soils, governing differential equations for unconfined and confined seepage flow problems. Graphical, analytical, and numerical solutions of seepage flow in homogeneous and layered soils with both isotropic and anisotropic permeability. Classical one-dimensional consolidation theory; the use of consolidation theory to analyze and interpret laboratory and field tests; analysis and design considerations. Extended theories of consolidation, nonlinear finite strain, Biot's consolidation theory, and generalized consolidation theory.

**INCI 6335**. GRADUATE SEMINAR (BD). One credit hour. One hour of seminar per week.

Presentations and discussions in the areas of graduate studies and research. Faculty members, graduate students, and visiting lecturers will participate in this course.

**INCI 6555.** STORMWATER RUNOFF MANAGEMENT. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Study of the hydrologic, environmental, and economic aspects of stormwater runoff management systems design. Volume determination for the design, study of quality and pollutant loading, and treatment of this stormwater runoff. Design of swales and detention ponds, financial planning of stormwater management systems, and rural area storm water management.

**INCI 6995**. SPECIAL PROBLEMS (I, II). One to six credit hours.

Research and special problems in Civil Engineering.

**INCI 6996.** PRACTICE IN CIVIL ENGINEERING. Zero to three credit hours. Zero to three hours of internship per week.

Practical experience in civil engineering jointly planned between the department and the collaborating organization.

**INCI 6997**. SPECIAL TOPICS. One to six credit hours. One to six hours of lecture per week.

Special topics in Civil Engineering and related areas.

**INCI 8024**. STRUCTURAL RELIABILITY. Three credit hours. Three hours of lecture per week.

Study of reliability theory and its applications in structural design, risk and sensibility analysis, and code revision. Detailed presentation of level I and level II reliability analysis and an introduction to level III analysis. Discussion of the fundamentals of stochastic processes and load modeling.

**INCI 8080**. ADVANCED ANALYSIS OF STEEL STRUCTURES. Three credit hours. Three hours of lecture per week.

Study of advanced design theories for steel structures. Analysis of current design specifications for structural members and connections in rigid and semi-rigid frames.

**INCI 8999**. DOCTORAL RESEARCH AND THESIS. Nine to eighteen credit hours.

Research and presentation of a thesis which constitutes a significant contribution to the field of specialization of the student.

## COMPUTER SCIENCE AND ENGINEERING

### Graduate Courses

**INSO 6005**. SOFTWARE ENGINEERING PRINCIPLES. Three credit hours. Three hours of lecture per week.

Comprehensive study of modern software engineering principles and techniques for the efficient delivery and maintenance of correct, scalable, and secure software systems for production use. Specification, design, and implementation of software systems using cloud technologies, agile methods, SCRUM, design patterns, refactoring, continuous integration, continuous delivery, logging systems, and software quality assurance.

**INSO 6006**. DATABASE SYSTEMS ENGINEERING. Three credit hours. Three hours of lecture per week.

Comprehensive study of engineering principles to build the internals of modern database management systems. Design and implementation of row-oriented systems, columnoriented systems, in-memory engines, multi-core data engines, vectorized query executors, and RDMA systems.

**INSO 6007**. SECURE SOFTWARE SYSTEMS. Three credit hours. Three hours of lecture per week.

Concepts of secure software development in the context of secure operating system design principles, protection methods, access control, authentication, vulnerability analysis and case studies. Case studies will focus on secure software systems for applications such as securing data at rest, smart devices and autonomous systems.

**INSO 6010**. DEVELOPMENT AND OPERATIONS Three credit hours. Three hours of lecture per week.

Comprehensive study of DevOps software engineering principles and techniques for the rapid and continuous development, integration, and delivery of software systems for production use. Design and implementation of DevOps infrastructure using software containers, microservices, continuous integration, continuous delivery, logging systems, and collaborations tools.

**INSO 6015**. MACHINE LEARNING AND OPERATIONS. Three credit hours. Three hours of lecture per week.

Comprehensive study of MLOps software engineering principles and techniques for the rapid and continuous development, integration, and delivery of Machine Learning production systems. Design and implementation of data

processing pipelines, effective data labeling and validation, data augmentation, model search, model analysis, resource management, model serving, model management and delivery, and monitoring and logging.

**INSO 6030**. WEB AND MOBILE APPLICATION ENGINEERING. Three credit hours. Three hours of lecture per week.

Comprehensive study of software engineering principles and techniques for the development of mobile and web applications in production systems. Design and implementation of multitier applications, REST APIs, distributed data persistence layers, secure web sockets APIs, web-based user interfaces, hybrid and native mobile apps, APIs to manage phone hardware, instrumentation, and monitoring systems.

**INSO 6040**. HEALTH-RELATED APPLICATION ENGINEERING. Three credit hours. Three hours of lecture per week.

Analysis of health-related data in different domains, such as images, time series analysis of physiological data, text in medical documents, and electronic health records. The challenges and advantages of using artificial intelligence (AI) to solve problems in the area of medicine will be discussed. Discussion of fundamental concepts in deep learning systems, machine learning, supervised learning, distributed learning, image analysis, text data representation, problem solving strategies involving multimodal data, and interdisciplinary projects using AI.

**INSO 6050**. SOFTWARE ENGINEERING FOR EDGE SYSTEMS. Three credit hours. Three hours of lecture per week.

Comprehensive study of existing frameworks and applications in Edge Computing, with a focus on big data analytics and distributed computing. Design and implementation of computing systems over edge devices and the cloud including synchronization, resource management, fault tolerance, services, multi-sensor data analytics, and their applications.

**INSO 6070**. SOFTWARE-DEFINED NETWORKS ENGINEERING. Three credit hours. Three hours of lecture per week.

Comprehensive study of engineering principles to develop modern software-defined networking (SDN) systems. Analysis, design and implementation of functions running on SDN controllers, SDN switches, and SDN applications.

**INSO 6080**. DEEP LEARNING ENGINEERING. Three credit hours. Three hours of lecture per week.

Engineering Principles of deep learning with deep neural network architectures. Study of algorithms and implementation techniques for fully connected neural networks, convolutional networks, recurrent networks, word embeddings, attention methods, generative adversarial networks, and transformers. Analysis of gradient descent optimization, hyperparameters selection, overfitting, and probabilistic modeling. Use of software libraries and frameworks using computational models of directed graphs in distributed systems and graphical processing units ("GPU").

**INSO 6998**. MASTER'S PROJECT. Zero to six credit hours. One to six hours of thesis or dissertation per week. Prerequisite: authorization of the Director of the Department.

Supervised production of scholarly work that makes an original contribution to an application and development problem in Software Engineering.

**INSO 6999**. MASTER'S THESIS. Zero to six credit hours. One to six hours of thesis or dissertation per week. Prerequisite: authorization of the Director of the Department.

Supervised production of scholarly work that makes an original contribution to a research problem in Software Engineering.

**INSO 8995**. ADVANCED TOPICS. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Discussion of advanced topics in an active research field within Software Engineering.

**INSO 8996**. DOCTORAL SEMINAR. Three credit hours. Three hours of seminar per week. Prerequisite: authorization of the Director of the Department.

Discussion and exercise of skills for technical or scientific writing. Assessment of research papers and proposals, write scientific critiques and survey papers, and participate in research review panels.

**INSO 8999**. DOCTORAL DISSERTATION. Zero to eighteen credit hours. One to eighteen hours of thesis or dissertation per week. Prerequisite: authorization of the Director of the Department.

Supervised production of an academic dissertation that makes an original contribution to a research problem in Software Engineering.

## ELECTRICAL AND COMPUTER ENGINEERING

### ELECTRICAL ENGINEERING (INEL)

#### Advanced Undergraduate Courses

**INEL 5046**. MACHINE LEARNING AND PATTERN RECOGNITION. Three credit hours. Three hours of lecture per week. Prerequisites: (INEL 4095 or INEL 4301) and (ININ 4010 or ININ 4011) or authorization of the Director of the Department.

Introduction to the field of pattern recognition, including statistical decision making, nonparametric decision making, clustering techniques, artificial neural networks, learning techniques, evaluation of classification rules, and image analysis.

**INEL 5205**. INSTRUMENTATION (I). Three credit hours. Three hours of lecture per week. Prerequisites: (INEL 4201 and INEL 4206) or authorization of the Director of the Department.

Signals from transducers; signal conditioning, data conversion and transmission; effects of noise. Data storage and display; use of microprocessors in instrumentation.

**INEL 5206**. DIGITAL SYSTEMS DESIGN. Three credit hours. Three hours of lecture per week. Prerequisite: INEL 4207 or authorization of the Director of the Department.

Design methods in combinational and sequential systems. Use of programmable logic devices in digital systems design. Analysis and design of system controllers.

**INEL 5207.** ANALOG SYSTEMS DESIGN. Three credit hours. Three hours of lecture per week. Prerequisite: (INEL 4201 and INEL 4205) or authorization of the Director of the Department.

This course covers the design of applications using analog integrated circuits. A discussion on the characteristics of operational amplifiers is followed with a detailed overview of applications.

**INEL 5208.** PRINCIPLES OF BIOMEDICAL INSTRUMENTS. Four credit hours. Three hours of lecture and two hours of laboratory per week. Prerequisite: INEL 4202 or authorization of the Director of the Department.

Theoretical and practical aspects of the methods used to measure physiological events with emphasis in the cardiovascular, pulmonary, and nervous systems.

**INEL 5209.** INTRODUCTION TO SOLID STATE ELECTRONICS. Three credit hours. Three hours of conference per week. Prerequisite: authorization of the Director of the Department.

Basic operation principles of solid state electronic devices, physical fenomena and properties of solid materials involved in the analysis and design of such devices, detailed treatment of the most common elements used as diodes, transitor and controlled rectifiers.

**INEL 5218.** INTRODUCTION TO MIXED-SIGNAL TESTING. Three credit hours. Three hours of lecture per week. Prerequisite: INEL 4201 or authorization of the Director of the Department.

Description and analysis of tester hardware, sampling theory for Digital Signal Processing (DSP), analog channels and sample channel testing, including testing for mixed signal circuits focused on A/D and D/A converters, focused calibration and test economics.

**INEL 5265.** ANALOG INTEGRATED CIRCUIT DESIGN. Three credit hours. Three hours of lecture per week. Prerequisites: INEL 4201 or authorization of the Director of the Department.

Analysis and design of analog and mixed-technology (analog-digital) circuits through the use of advanced computer-assisted design (CAD) techniques. Discussion of functional tests of analog integrated circuits.

**INEL 5307**. OPTICAL COMMUNICATIONS (I). Three credit hours. Three hours of lecture per week. Prerequisites: INEL 4301 or authorization of the Director of the Department.

Optical communication principles; transmitter and receiver design; fiber optic channels.

**INEL 5309.** DIGITAL SIGNAL PROCESSING. Three credit hours. Three hours of lecture per week. Prerequisite: INEL 4095 or authorization of the Director of the Department.

Signal classification, Z-Transform and discrete Fourier transform; matrix representation of digital filters and digital systems; digital filter design; discrete Fourier transform algorithms.

**INEL 5315**. THEORY OF COMMUNICATIONS II. Three credit hours. Three hours of lecture per week. Prerequisite: (INEL 4301 and (ININ 4011 or ININ 4010)) or authorization of the Director of the Department.

Information theory; coding theory; signal design; noise and probability of error.

**INEL/ICOM/SICI/COMP 5318**. INTERMEDIATE ROUTING, SWITCHING AND WIDE AREA NETWORKS. Three credit hours. Three hours of lecture per week. Prerequisite: INEL/ICOM/SICI/COMP 4308 or authorization of the Director of the Department.

Study and configuration of link state protocols. Study of intermediate level concepts such as switching, wide area network or WAN standards, virtual local area networks or VLAN, network design, and redundancy. Presentation and study of strategies for managing and saving address space such as variable length subnet masks and network address translation.

**INEL 5327**. IMAGE PROCESSING. Three credit hours. Three hours of lecture per week. Prerequisite: INEL 4095 or INEL 5309 or ICOM 4045 or authorization of the Director of the Department.

Mathematical representation of two dimensional digital signals. Two-dimensional filter design, image coding, image filtering, enhancement, and compression.

**INEL 5406**. DESIGN OF TRANSMISSION AND DISTRIBUTION SYSTEMS. Three credit hours. Three hours of lecture per week. Prerequisite: INEL 4415 or authorization of the Director of the Department.

Generation, transmission, and distribution of electric power. Reliability consumer services; overhead and underground lines.

**INEL 5407**. COMPUTER AIDED POWER SYSTEM DESIGN (II). Three credit hours. Three hours of lecture per week. Prerequisite: INEL 4415 or authorization of the Director of the Department.

Design of power systems using digital computers; load flow, economic load dispatch, symmetrical and unsymmetrical faults. Selection of breakers.

**INEL 5408**. ELECTRICAL MOTORS CONTROL (I). Three credit hours. Three hours of lecture per week. Prerequisites: (INEL 4405 and INEL 4416 and INEL 4505) or authorization of the Director of the Department.

Characteristics and selection criteria of alternating current (A.C.) and direct current (D.C.) motors; design and control of solid state drive systems; braking methods; heating and duty cycle calculations. Performance calculations and design of closed loop controllers.

**INEL 5415**. PROTECTION DESIGN FOR ELECTRICAL SYSTEMS. Three credit hours. Three hours of lecture per week. Prerequisite: INEL 4415 or authorization of the Director of the Department.

Design and selection of protective devices used in electrical generation, transmission, and distribution systems such as: relays, fuses, breakers, reclosers, and arresters. Selection of other system components such as sectionalizers and throwovers. Protection and insulation coordination.

**INEL 5417.** POWER ELECTRONICS APPLIED TO RENEWABLE ENERGY SYSTEM. Thee credit hours. Three hours of lecture per week. Prerequisite: INEL 4416 or authorization of the Director of the Department.

Design of interfaces using topologies based on power electronics for photovoltaic and wind applications. Use of algorithms for maximum power point tracking; control of photovoltaic and wind systems, and its applications.

**INEL 5505**. LINEAR SYSTEM ANALYSIS (II). Three credit hours. Three hours of lecture per week. Prerequisite: INEL 4505 or authorization of the Director of the Department.

Linear spaces and matrices; state variables representations for linear continuous and discrete systems; the Z-transform and its application; controllability and observability; state estimators; stability.

**INEL 5506**. PROCESS INSTRUMENTATION AND CONTROL ENGINEERING (II). Three credit hours. Three hours of lecture per week. Prerequisite: (INEL 4505 and INEL 4206) or authorization of the Director of the Department.

Design of process instrumentation and control systems, based on analog and digital instruments and mini or microcomputers. Standards and practical considerations emphasized.

**INEL 5508**. DIGITAL CONTROL SYSTEMS (I). Three credit hours. Three hours of lecture per week. Prerequisites: INEL 4505 or authorization of the Director of the Department.

Analysis and design of digital control systems; stability, controllability and observability of discrete systems. Practical considerations when implementing a digital control system.

**INEL 5516**. AUTOMATION AND ROBOTICS (I). Three credit hours. Three hours of lecture per week. Prerequisite: INEL 4206 or ININ 4057 or authorization of the Director of the Department.

Analysis and design of automated pneumatic systems using programmable controllers. Programming of industrial robots.

**INEL 5605**. ANTENNA THEORY AND DESIGN. Three credit hours. Three hours of lecture per week. Prerequisites: ((INEL 4155 or INEL 4152) and (INEL 4095 or INEL 4301)) or authorization of the Director of the Department.

Radiation mechanism. Types of antennas; impedance; radiation patterns; antenna arrays. Antenna measurements.

**INEL 5606.** MICROWAVE ENGINEERING. Three credit hours. Three hours of lecture per week. Prerequisites: ((INEL 4155 or INEL 4152) and (INEL 4095 or INEL 4301)) or authorization of the Director of the Department.

Rectangular and circular waveguides; passive components, tubes, and solid-state devices components, tubes, and solid-state devices used in microwave systems.

**INEL 5608.** RADIO FREQUENCIES (RF) SPECTRUM MANAGEMENT. Three credit hours. Three hours of lecture per week. Prerequisite: INEL 4151 or authorization of the Director of the Department.

Analysis of the most relevant issues related to the RF spectrum management, including regulations at national and international levels, the geophysical fundamentals of wave propagation, the power budget equation, engineering aspects about antennas and active and passive sensors, introduction to the services that use the spectrum (satellite communications, radio astronomy, Earth exploration) and the agencies that regulate them.

**INEL 5616.** WIRELESS COMMUNICATION. Three credit hours. Three hours of lecture per week. Prerequisites: ((INEL 4155 or INEL 4152) and (INEL 4095 or INEL 4301)) or authorization of the Director of the Department.

Study of cellular radio and personal wireless communications, multiple access techniques for the efficient use of the radio spectrum, and wide-area wireless systems. Description of some wireless systems and their standards. Effects of EM radiation on health. Development of modulation and diversity methods to facilitate signal transmission and to improve quality of reception.

**INEL 5995**. SPECIAL PROBLEMS (On demand). One to six credit hours. Prerequisite: Authorization of the Director of the Department.

Investigations and special problems in Electrical Engineering or related fields. Open to outstanding Electrical Engineering students.

**Graduate Courses**

**INEL 6000**. INTRODUCTION TO NONLINEAR CONTROL SYSTEMS (I). Three credit hours. Three hours of lecture per week.

Analysis and synthesis of nonlinear control systems; phase plane and describing function techniques; Lyapunov's second method and its application in the design and stability determination of nonlinear systems.

**INEL 6001**. FEEDBACK CONTROL SYSTEMS I (II). Three credit hours. Three hours of lecture per week.

The Z-transform and its application to sampled-data control systems; analysis of automatic control systems, using state variable concepts; stability criteria; introduction to parameter optimization techniques.

**INEL 6002**. FEEDBACK CONTROL SYSTEMS II. Three credit hours. Three lectures per week.

Selected topics in advanced control theory from such areas as adaptive control systems, optimal control theory, statistical design, and system identification.

**INEL 6005**. ANALYSIS, DESIGN AND PARASITIC EFFECT OF INTEGRATED CIRCUITS (On demand). Three credit hours. Three hours of lecture per week.

Analysis and design of integrated circuits. Study of linear and non-linear models, and parasitic effects. Analog and digital circuits.

**INEL 6006**. SPEECH AND IMAGE COMMUNICATION (I) (Odd numbered years). Three credit hours. Three hours of lecture per week.

Digital coding of waveforms including pulse code modulation (PCM), differential pulse code modulation (DPCM), tree/trellis coding, run-length coding, sub-band coding, transform coding; quadrature mirror filters; vector quantization; rate distortion theoretic performance bounds.

**INEL 6007**. INTRODUCTION TO REMOTE SENSING (I). Three credit hours. Three hours of lecture per week.

History, principles, and applications of remote sensing. Electromagnetic radiation; aerial photography; image interpretation; land observation satellite systems; image resolution; preprocessing and classification of images; geographic information systems.

**INEL 6009**. COMPUTER SYSTEM ARCHITECTURE. Three credit hours. Three hours of lecture per week.

Fundamentals of the architecture and organization of computers. Concepts of high-level languages. Architectural support to the compilation process and to operating systems.

**INEL 6025**. ADVANCED ENERGY CONVERSION (I) (Odd numbered years). Three credit hours. Three hours of lecture per week.

Theory and design of processes for direct energy conversion. Thermoelectric, thermionic, and photovoltaic conversion. Fuel cells. Introduction to irreversible thermodynamics and its application to describe operations. MHD equations and generators. Conversion efficiency and electrical losses.

**INEL 6026**. COMPUTATIONAL METHODS FOR POWER SYSTEMS ANALYSIS II. Three credit hours. Three lectures per week. Prerequisite: INEL 5027.

Application of numerical techniques and computer methods to the solution of a variety of problems related to the planning, design and operation of large interconnected electric power systems.

**INEL 6027**. DYNAMICS AND CONTROL OF INTEGRATED POWER SYSTEMS (I). Three credit hours. Three hours of lecture per week.

Discussion of a variety of transient and control problems associated with interconnected power systems, and techniques for their analysis and solution. Methods for dynamic analysis of large systems are stressed.

**INEL 6028**. OPTIMIZATION AND ECONOMIC OPERATION OF INTEGRATED POWER SYSTEMS (II). Three credit hours. Three hours of lecture per week.

Theory of optimization under equality and inequality constraints; computational methods and application to generation scheduling in integrated power systems.

**INEL 6045**. ENGINEERING PROJECT (I, II). Zero to six credit hours.

Comprehensive study of a specific electrical engineering problem selected so as to integrate the knowledge acquired in the graduate program of study. This project fulfills one of the terminal requirements of the Master of Engineering Program, and will be governed by the norms for this purpose.

**INEL 6046**. MASTER'S THESIS (I, II). Zero to six credit hours.

Research in the field of Electrical Engineering and presentation of a thesis.

**INEL 6047**. ADVANCED CONTROL SYSTEM THEORY (II). Three credit hours. Three hours of lecture per week.

Advanced problems in linear and non-linear control systems. The use of linear algebra for the analysis and design of linear systems is emphasized. The implementation of linear systems via analog and digital simulation diagrams is also studied.

**INEL 6048**. ADVANCED MICROPROCESSOR INTERFACING. Three credit hours. Three hours of lecture per week.

Architecture of 8, 16, and 32 bits microprocessors; bus, input/output and memory interfacing; parallel processing architecture; configuration and interfacing of multiprocessors; applications of the multiprocessor system.

**INEL 6049**. MULTIDIMENSIONAL DIGITAL SIGNAL PROCESSING (II) (Odd numbered years). Three credit hours. Three hours of lecture per week.

Representation of multidimensional signals and systems; Fourier analysis of multidimensional signals; design and implementation of two-dimensional digital filters; applications of digital filtering techniques to beam forming and image analysis.

**INEL 6050**. ADVANCED DIGITAL SIGNAL PROCESSING ALGORITHMS. Three credit hours. Three hours of lecture per week. Prerequisite: INEL 5309.

Theoretical foundations, fast algorithms for the Discrete Fourier Transform. Fast convolution algorithms, multidimensional techniques, fast filtering computations, architecture of filters and transforms, fast algorithms in VLSI. Application studies in transmission error controlling codes, sonar, radar, speech, image processing, and other engineering areas. Study of software implementations on vector and parallel architectures. Algorithms and symbolic computation.

**INEL 6055.** SOLID STATE ELECTRONICS. Three credit hours. Three hours of lecture per week.

This course deals with solid state electronic devices that utilize the conductive, dielectric, magnetic and optical properties of materials. Some of the topics included are atomic structure, interatomic forces and crystal structures, conduction mechanisms, transport phenomena, and application of these theories to semiconductor devices.

**INEL 6057.** REGULATORY ISSUES IN ELECTRICAL ENGINEERING. Three credit hours. Three hours of lecture per week.

Study of the regulatory entities or agencies and their regulations related to areas relevant to electrical engineering. Emphasis on telecommunications, energy, biomedical and electronic applications.

**INEL 6058**. HIGH FREQUENCY POWER CONVERTERS. Three credit hours. Three hours of lecture per week. Prerequisite: INEL 6085.

Simulation, analysis, modeling, design, and control of high frequency power converters. Study of unidirectional and bidirectional soft-switching topologies for dc to dc and dc to single-phase or three-phase power converters. Discussion of applications such as traditional and uninterruptible power supplies, electronic ballasts for fluorescent lamps, inverters for motor drives, and rectifiers with power factor correction.

**INEL 6059.** INTELLIGENT SYSTEMS AND CONTROLS. Three credit hours. Three hours of lecture per week.

Engineered intelligent systems and their application to complex decision, modeling, and control processes.

**INEL 6066**. CONTROL OF ELECTRIC DRIVE SYSTEMS (I) (Odd numbered years). Three credit hours. Three hours of lecture per week.

Theory and operation of phase and chopper controlled direct current (d.c.) drives, closed loop d.c. drives and their analysis, phase locked loop d.c. drives; design of controllers for optimal performance. Speed control and control schemes for induction and synchronous motors; inverters and cycloconverters; closed loop alternating current (a.c.) drives; stability and performance analysis.

**INEL 6067**. DISTRIBUTED PROCESSING AND ADVANCED COMPUTER ARCHITECTURES. Three credit hours. Three hours of lecture per week.

Advanced topics in computer architecture and distributed processing, including: vector processors, multi-processors, pipeline computers, data flow computers.

**INEL 6070**. ADVANCED INTEGRATED CIRCUIT DESIGN TECHNIQUES. Three credit hours. Three hours of lecture per week.

Study of contemporary circuit design optimization techniques with emphasis on power management and power reduction in both analog and digital integrated circuits. Analysis of problems related to performance optimization and noise reduction.

**INEL 6075**. INTEGRATED CIRCUITS FABRICATION. Three credit hours. Three hours of lecture per week.

Basic principles underlying the fabrication of circuits with emphasis in very large scale integrated systems (VLSI). Properties of materials like silicon and gallium arsenide; phase diagrams; solid solubility; crystal growth; doping; evaporation; sputtering epitaxy; diffusion; ion implantation; oxidation; lithographic process; device and circuit fabrication. Thin and thick film circuits, assembly, packaging processing, yield and reliability.

**INEL 6076.** ADAPTIVE AND OPTIMAL SIGNAL PROCESSING. Three credit hours. Three hours of lecture per week. Prerequisite: INEL 6078.

Signal and system modeling, power spectrum estimation, optimum linear filtering, and linear and nonlinear adaptive filtering.

**INEL 6077.** SURGE PHENOMENA IN POWER SYSTEMS. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Power system analysis under transient conditions due to breaker operation, lighting strikes, or sudden changes in loads. Design of power systems with emphasis on surge protection equipment, insulation level selection, and effects of ground resistance.

**INEL 6078**. ESTIMATION, DETECTION, AND STOCHASTIC PROCESSES. Three credit hours. Three hours of lecture per week. Prerequisite: Authorization of the Director of the Department.

Fundamentals of estimation, detection, and random process theory relevant to signal processing, communications, and control. Parameter estimation; signal detection and estimation from wave form observations.

**INEL 6079**. ADVANCED INTEGRATED CIRCUIT DESIGN TECHNIQUES. Three credit hours. Three hours of lecture per week. Prerequisite: Authorization of the Director of the Department.

Study of contemporary circuit design optimization techniques with emphasis on power management and power reduction in both analog and digital integrated circuits. Analysis of problems related to performance optimization and noise reduction.

**INEL 6080**. VLSI SYSTEMS DESIGN (II). Three credit hours. Three hours of lecture per week.

MOS (metal-oxide-semiconductor) devices and circuits. Design, implementation and fabrication of integrated systems at a very large scale (VLSI). System timing analysis. Physical implementation of several computational systems.

**INEL 6085**. ANALYSIS AND DESIGN OF POWER SEMICONDUCTOR CIRCUITS (II). Three credit hours. Three hours of lecture per week.

Analysis and design of single phase and three phase controlled rectifiers, dual converters, A.C. voltage controllers, PWM converters, for power supplies, four quadrant choppers, voltage and current source inverters with modulation techniques, A.C. to A.C. converters.

**INEL 6086**. INTRODUCTION TO MICRO-ELECTRO-MECHANICAL SYSTEMS. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Discussion of the basic principles of MEMS design, fabrication, and testing. Includes topics such as: the theory behind microfabrication techniques, material deposition techniques, lumped modeling of MEMS structures, static and dynamic behavior of MEMS, and MEMS integration into systems.

**INEL 6088**. COMPUTER VISION. Three credit hours. Three hours of lecture per week.

Introduction to computer vision. Computer vision systems. Biological vision system and biological signal processing; early image processing; boundary detection; region growing; texture and shape analysis.

**INEL 6096**. ELECTRIC POWER QUALITY. Three credit hours. Three hours of lecture per week.

Analysis, modeling, and mitigation of the difficulties related to the distortion of voltages and current on power systems. Special emphasis in harmonics and sources of power quality problems. Study of voltage sags and swells, impulses, and other transient events.

**INEL 6207**. HIGH PERFORMANCE COMPUTERS. Three credit hours. Three hours of lecture per week.

Study of architectural and organizational aspects of processors that result in high performance. Study of contemporary high performance computers. Discussion of future trends in computer design.

**INEL 6209**. DIGITAL IMAGE PROCESSING. Three credit hours. Three hours of lecture per week.

Image representation and compression. Image enhancement by filtering and removal of existing degradations. Image transformation; image models; image restoration.

**INEL 6601**. ADVANCED ELECTROMAGNETICS. Three credit hours. Three hours of lecture per week.

Advanced theory and techniques for the analysis of electromagnetic systems applied to electrical engineering problems. Advanced study of Maxwell's equations, electrical properties of matter, and wave propagation, polarization, reflection, and transmission in diverse media. Use of Green's functions for the solution of electromagnetism problems.

**INEL 6605**. RADAR THEORY AND PRACTICE. Three credit hours. Three hours of lecture per week.

Discussion of the theory underlying radar and lidar techniques. Topics include: wave propagation and polarization, cross section of targets, matched filters, ambiguity functions, coded radar signals, signal processing and interpretation of radar and lidar returns, and their applications.

**INEL 6606.** INTRODUCTION TO RADAR SYSTEMS. Three credit hours. Three hours of lecture per week.

Study of the basic theory underlying radar systems and their construction. Use of the radar equation for diverse applications. Discussion of different types of radar such as FM, FM-CW and pulse, their strengths and weaknesses as well as their applications. Study of calibration and signal detection in noise as well as different types of transmitters and receivers.

**INEL 6615**. MICROWAVE ACTIVE CIRCUITS. Three credit hours. Three hours of lecture per week.

Study and design of microwave frequency amplifiers and oscillators taking into consideration parameters such as noise, bandwidth, gain, and output power. Discussion of transistor amplifiers and oscillation that use dielectric resonators.

**INEL 6668**. MICROWAVE ANTENNA ENGINEERING. Three credit hours. Three hours of lecture per week.

Analysis and design of microwave and millimeter-wave antennas.

**INEL 6669.** MICROWAVE REMOTE SENSING. Three credit hours. Three hours of lecture per week.

Study of the interaction of electromagnetic waves with natural and artificial objects. Introduction to radiometry theory and to the operational principles of active and passive instrumentation used in remote sensing.

**INEL 6995**. SPECIAL TOPICS IN ELECTRICAL ENGINEERING (I, II). One to six credit hours. One to six hours of lecture per week.

Study of selected topics in Electrical Engineering.

**INEL 6997**. INDEPENDENT STUDIES. One to three credit hours. Three hours per credit of independent study. Prerequisite: to be a graduate student and authorization of the Director of the Department.

Independent studies in electrical engineering or related areas under supervision of a member of the faculty.

**INEL 6998**. PREPARATION FOR COMPREHENSIVE EXAM. Zero credit hours. One to twelve hours of independent study. Prerequisite: to be an option III graduate student from the Master in Electrical Engineering Program and have completed at least 30 credits in his program or authorization of the Director of the Department.

Independent studies in preparation for the comprehensive exam.

**INEL 8295.** ADVANCED TOPICS IN ELECTRONICS. One to six credit hours. One to six hours of lecture per week.

Study of selected topics in electronics or related fields.

**INEL 8296.** ADVANCED TOPICS IN COMPUTER ENGINEERING. One to six credit hours. One to six hours of lecture per week.

Study of selected topics in computer engineering or related fields.

**INEL 8395.** ADVANCED TOPICS IN SIGNAL PROCESSING. One to six credit hours. One to six hours of lecture per week.

Study of selected topics in signal processing or related fields.

**INEL 8396.** ADVANCED TOPICS IN COMMUNICATIONS SYSTEMS. One to six credit hours. One to six hours of lecture per week.

Study of selected topics in communications systems or related fields.

**INEL 8495.** ADVANCED TOPICS IN ELECTRIC POWER ENGINEERING. One to six credit hours. One to six hours of lecture per week.

Study of selected topics in electric power engineering or related fields.

**INEL 8496.** SELECTED TOPICS IN POWER ELECTRONICS. One to three credit hours per semester up to a maximum of six credit hours. Prerequisite: authorization of the Director of the Department.

Study of selected topics in power electronics or related fields.

**INEL 8595.** ADVANCED TOPICS IN CONTROL SYSTEMS. One to six credit hours. One to six hours of lecture per week.

Study of selected topics in control systems or related fields.

**INEL 8695.** ADVANCED TOPICS IN APPLIED ELECTROMAGNETICS. One to six credit hours. One to six hours of lecture per week.

Study of selected topics in applied electromagnetics or related fields.

**INEL 8995.** ADVANCED TOPICS. One to six credit hours. One to six hours of lecture per week.

Study of selected topics in electrical engineering or related fields.

**INEL 8997.** INDEPENDENT STUDY. One to three credit hours.

Individual student research in electrical engineering and related fields.

**INEL 8998.** DOCTORAL SEMINAR. Zero to one credit hour. One hour of seminar per week.

Oral presentations in research topics in electrical engineering.

**INEL 8999.** DOCTORAL DISSERTATION. Three to twelve credit hours.

Development, preparation, and defense of a dissertation based on an original research project in electrical engineering that represents a significant contribution in the area of specialization.

## COMPUTER ENGINEERING (ICOM)

### Advanced Undergraduate Courses

**ICOM 5007**. OPERATING SYSTEMS PROGRAMMING. Four credit hours. Three hours of lecture and one-three hour laboratory per week. Prerequisites: (ICOM 4035 and INEL 4206) or authorization of the Director of the Department.

Concepts of operating systems, multiprogramming, multiprocessing, batch, partitioned, and real time. Organizational and processing of file systems. Study of queuing theory and information flow control.

**ICOM/COMP 5015**. ARTIFICIAL INTELLIGENCE. Three credit hours. Three hours of conference per week. Prerequisite: ICOM 4035.

An introduction to the field of artificial intelligence: Lisp language, search techniques, games, vision, representation of knowledge, inference and process of proving theorems, natural language understanding.

**ICOM 5016**. DATABASE SYSTEMS. Three credit hours. Three hours of lecture per week. Prerequisite: ICOM 4035 or authorization of the Director of the Department.

Study of database system architectures; design and implementation of database applications; conceptual and representational models; SQL and the relational model; functional dependencies and normalization; transaction processing.

**ICOM 5017**. OPERATING SYSTEM AND NETWORK ADMINISTRATION AND SECURITY. Three credit hours. Two hours of lectrure and one three-hour laboratory per week. Prerequisite: (INEL 4307 and ICOM 5007) or authorization of the Director of the Department.

Practical experience in the administration and security of operating systems and networks. Design and development of measures for the detection of and response to attacks on such systems.

**ICOM 5018**. CRYPTOGRAPHY AND NETWORK SECURITY. Three credit hours. Three hours of lecture per week. Prerequisite: ICOM 5007 or authorization of the Director of the Department.

Study of the theoretical and practical aspects of computer systems and network security. Threat modles and vulnerabilities of computer systems and networks to attacks such as: hackers, malicious code, Trojan horses, viruses, and worms. Methods and techniques to defend against attacks and minimize their damage. Cryptographic techniques, physical and operational security policies, and management-related issues.

**ICOM 5025**. OBJECT-ORIENTED SOFTWARE DEVELOPMENT. Three credit hours. Three hours of lecture per week. Prerequisites: ICOM 4035 or authorization of the Director of the Department.

Discussion of the fundamental concepts of object-oriented programming. Analysis, design, and development of object-oriented software. Study of object-oriented languages.

**ICOM 5026**. COMPUTER NETWORKS. Three credit hours. Three hours of lecture per week. Prerequisite: ICOM 5007 or authorization of the Director of the Department.

Study of computer communication including the OSI and Internet layering models and networking protocols at subnetwork, network, transport, and application layers. Analysis of media and standards applied to computer networks as well as the software, hardware, and terminology associated with data communications.

**ICOM 5035.** COMPUTER GRAPHICS. Four credit hours. Three hours of lecture and two hours of laboratory per week. Prerequisites: ICOM 4035 or authorization of the Director of the Department.

The analysis, creation and rendering of 3D models and animations using computer graphics: geometric modeling and transformations, rendering algorithms, animation, illumination models, image formation, antialiasing, and ray tracing.

**ICOM 5047.** COMPUTER ENGINEERING DESIGN. Three credit hours. One hour of lecture and four hours of laboratory per week. Prerequisites: ((ICOM 4009 or ICOM 5016) and (ICOM 4217 or INEL 5206 or INEL 5265) and ICOM 4215 and ICOM 5007 and INEL 4301 and INEL 4207) or authorization of the Director of the Department.

Capstone course in which student teams design a project to solve a complete computer engineering problem considering engineering standards and realistic constraints. The project should integrate both hardware and software concepts.

**ICOM 5104.** COMPUTATIONAL SYSTEMS BIOLOGY. Three credit hours. Three hours of lecture per week. Prerequisites: (ICOM 5016 and INGE 5036) or authorization of the Director of the Department.

Study of fundamental concepts, models and computational methods for the analysis of biological networks. Discussion of theoretical foundations of networks and their use in biology systems modeling and simulation. Construction of networks from data and qualitative methods for their dynamic simulations and systems analysis.

**INEL/ICOM/SICI/COMP 5318**. INTERMEDIATE ROUTING, SWITCHING AND WIDE AREA NETWORKS. Three credit hours. Three hours of lecture per week. Prerequisite: INEL/ICOM/SICI/COMP 4308 or authorization of the Director of the Department.

Study and configuration of link state protocols. Study of intermediate level concepts such as switching, wide area network or WAN standards, virtual local area networks or VLAN, network design, and redundancy. Presentation and study of strategies for managing and saving address space such as variable length subnet masks and network address translation.

**ICOM 5995**. SPECIAL PROBLEMS. One to six credit hours. Two to four hours of research per week per credit. Prerequisite: authorization of the Director of the Department.

Research and problem-solving in computer engineering or related fields.

**Graduate Courses**

**ICOM 6005**. DATABASE SYSTEM DESIGN. Three credit hours. Three hours of lecture per week.

Issues on design and implementation of database systems. Database system architectures and conceptual models, including a comparative study of hierarchical systems, networks, relational and object-oriented systems. Storage, index, query processing and optimization, transaction processing, fault tolerance, and crash recovery techniques. Design and implementation of a prototype database management system.

**ICOM 6006**. DISTRIBUTED OPERATING SYSTEMS. Three credit hours. Three hours of lecture per week.

Advanced topics in operating systems, with emphasis in distributed systems. Operating system architectures, including conventional, network, distributed, and cooperative-autonomous systems. Issues in design, concurrent programming, client/server models, synchronization, distributed process communication, time and resource scheduling, distributed/shared files and memory, and security.

**ICOM 6015**. ARTIFICIAL NEURAL NETWORKS. Three credit hours. Three hours of lecture per week.

Artificial neural network architectures and their learning algorithms.

**ICOM 6025.** HIGH PERFORMANCE COMPUTING. Three credit hours. Three hours of lecture per week.

Study of topics in high-performance computing including interconnection topologies, memory access and programming models, shared memory and message-passing systems, clusters, latency tolerance, load balancing, fault tolerance, commodity software technologies, and performance profiling.

**ICOM 6087**. ARTIFICIAL INTELLIGENCE: TECHNIQUES AND APPLICATIONS (I) (Odd numbered years). Three credit hours. Three hours of lecture per week.

Special-purpose programming languages and their support systems used by researchers in the area of artificial intelligence. Techniques used in constructing psychological models. Mathematical methods for robot design. Applications such as language processing, computer vision, robotics, text processing, planning, and expert systems.

**ICOM 6089**. OBJECT-ORIENTED SOFTWARE DESIGN. Three credit hours. Three hours of lecture per week.

Fundamental concepts of object-oriented programming and its use in the design and development of software. Study and implementation of object-oriented languages and architectures.

**ICOM 6095.** HUMAN-COMPUTER INTERACTION. Three credit hours. Three hours of lecture per week.

Software engineering and human factors for the design, implementation and evaluation of effective user interface for computing systems.

**ICOM 6115.** TOPICS IN COMPUTER ENGINEERING. Three credit hours. Three hours of lecture per week.

Development of advanced topics in computer engineering of academic and research interest.

**ICOM 6117**. USABILITY ENGINEERING. Three credit hours. Three hours of lecture per week.

Fundamental concepts of usability. Usability components and attributes: learning-ability, efficiency, memory-ability, error reduction, and satisfaction. Study of usability evaluation techniques and methods. Design and implementation of usability tests.

**ICOM 6205.** ADVANCED SOFTWARE ENGINEERING. Three credit hours. Three hours of lecture per week.

Software design practices and techniques. Study of design representations and comparison of design methods. CASE tools methodologies for software development.

**ICOM 6215.** EXPERT SYSTEMS. Three credit hours. Three hours of lecture per week.

The study of the history and foundation of Expert Systems; its use in the analysis and solution of problems.

**ICOM 6505**. WIRELESS NETWORKS. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Study of the theoretical issues related to wireless networking and practical systems for design and performance evaluation of both wireless data networks and cellular wireless telecommunication systems. Topics include: wireless access technologies, QoS, location management in mobile environments, and impact of mobility on performance.

**ICOM 6506**. NETWORK PERFORMANCE ANALYSIS. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Study of the analytical modeling and simulations techniques needed to evaluate the performance of a computer network system. Topics include: probability review, Markov chains, queuing theory, network traffic modeling, QoS, traffic engineering and MPLS.

**ICOM 6994.** PREPARATION FOR COMPREHENSIVE EXAM. Zero credit hours. One to twelve hours of independent study. Prerequisite: to be an option III graduate student from the Master in Computer Engineering Program and have completed at least 30 credits in his program or authorization of the Director of the Department.

Study period to allow graduates students in option III of the Master of Engineering in Computer Engineering Program to maintain regular student status, while preparing to take the comprehensive exam.

**ICOM 6995**. INDEPENDENT STUDIES IN COMPUTER ENGINEERING. One to three credit hours. Three to nine hours of independent study per week.

Individual study of advanced topics in computer engineering of academic and research interest.

**ICOM 6998**. MASTER'S PROJECT. Zero to six credit hours. Three to eighteen hours of project per week.

Design and development project in computer engineering.

**ICOM 6999**. MASTER'S THESIS. Zero to six credit hours. Three to eighteen hours of thesis per week.

Research project in computer engineering.

## COMPUTER SCIENCE AND ENGINEERING (CIIC)

### Advanced Undergraduate Courses

**CIIC 5015.** ARTIFICIAL INTELLIGENCE. Three credit hours. Three hours of lecture per week. Prerequisites: ICOM 4035 or CIIC 4020.

An introduction to the field of artificial intelligence: Lisp language, search techniques, games, vision, representation of knowledge, inference and process of proving theorems, natural language understanding.

**CIIC 5017.** OPERATING SYSTEM AND NETWORK ADMINISTRATION AND SECURITY. Three credit hours. Two hours of lecture and three hours of laboratory per week. Prerequisites: CIIC 4070 or ICOM 5026.

Practical experience in the administration and security of operating systems and networks. Design and development of measures for the detection and response to attacks on such systems.

**CIIC 5018.** CRYPTOGRAPHY AND NETWORK SECURITY. Three credit hours. Three hours of lecture per week. Prerequisites: CIIC 4050 or ICOM 5007.

Theoretical and practical aspects of computing system and network security, threat models, system vulnerability to attacks such as: hackers, malicious code, Trojan horses, viruses, and worms, cryptographic techniques used to defend systems from such attacks.

**CIIC 5019**. HIGH PERFORMANCE COMPUTING. Three credit hours. Three hours of lecture per week. Prerequisites: ICOM 4035 or CIIC 4020 or authorization of the Director of the Department.

Study of the fundamentals concepts associated with the performance of a computing systems. Discussion of techniques for the reduction of operations with the aim of minimizing the response time of a system to problems whose solution poses a high demand of computational resources. Study of parallelization, and concurrency strategies, and practical experiences with the use of systems and tools implementing them.

**CIIC 5029.** COMPILERS DEVELOPMENT. Three credit hours. Two hours of lecture and three hours of laboratory per week. Prerequisites: CIIC 4082 or INEL 4206. Corequisites: CIIC 4030 or ICOM 4036.

Study and application of techniques associated with the analysis of source languages and the generation of efficient object codes with emphasis on the components of a compiler.

**CIIC 5045**. AUTOMATA AND FORMAL LANGUAGES. Three credit hours. Three hours of lecture per week. Prerequisites: CIIC 4020 or ICOM 4035 or authorization of the Director of the Department.

Study of theoretical computational models, languages, and machines. Introduction to the theory of intractable and un-decidable problems. Topics include: finite automata, regular languages, context-free languages, pushdown automata, turing machine, halting problem, undecidability, and intractable problems.

**CIIC 5130**. CLOUD COMPUTING INFRASTRUCTURES. Three credit hours. Three hours of lecture per week. Prerequisites: ((CIIC 4060 or ICOM 5016- Database Systems) and (CIIC 4070 or ICOM 5026- Computer Networks)) or authorization of the Director of the Department.

Description of the principles of cloud computing. Discussion of the virtualization, load balancing in the system, scalability and elasticity, replication and deployment. Design and programming of applications in the cloud. Discussion of advanced aspects of cloud computing including security and software performance evaluation. Discussion of the use of cloud infrastructure for areas such as health, transportation, energy and education.

**CIIC 5140**. BIG DATA ANALYTICS. Three credit hours. Three hours of lecture per week. Prerequisites: ININ 4010- Probability and Statistics for Engineers and ((CIIC 4060 or ICOM 5016- Database Systems) or authorization of the Director of the Department).

Description of the principles of big data systems and analysis techniques for the design of cloud computing processes. Discussion of the implementation of parallel algorithms to process data on cloud-resident storage and memory-based file systems.

**CIIC 5150**. MACHINE LEARNING ALGORITHMS. Three credit hours. Three hours of lecture per week. Prerequisites: (ININ 4010 and CIIC 4020) or authorization of the Director of the Department.

Development of machine learning algorithms and programs using supervised and unsupervised learning methods following different strategies. Use of software libraries and frameworks by implementing computational models of directed graphs in distributed systems and graphical processing units ("GPU"). Graphical visualization of data and results using data manipulation tools and their respective data sources. Discussion of recent research publications in machine learning and their application in industry and academia.

**CIIC 5995**. SELECTED TOPICS. One to three credit hours. Prerequisite: authorization of the Director of the Department.

Selected topics in computer science and engineering.

**DEPARTMENT OF INDUSTRIAL ENGINEERING**

**Advanced Undergraduate Courses**

**ININ 5005.** MODERN OPTIMIZATION METHODS. Three credit hours. Three hours of lecture per week. Prerequisites: ININ 4021 or ININ 4150 or authorization of the Director of the Department.

Advanced undergraduate course addressed to industrial engineering students to studies the most common heuristic search methods. Topics such as simulated annealing, genetic algorithms, tabu search, and combinatorial and continuous optimization problems are discussed. The main techniques and their variations presented and are critically discussed. Key papers from the literature, including applications, are discussed.

**ININ 5006.** SYSTEMS ENGINEERING AND ANALYSIS. Three credit hours. Three hours of lecture per week. Prerequisites: ININ 4015 or ININ 4007 or INCI 4055 or INCI 4026 or authorization of the Director of the Department.

Introduction to the design of systems considering their lifecycle from conceptualization until disposal, including the basic theory of systems lifecycle management. Study of techniques to evaluate the design of systems that could be industrial, mechanical, electronic, or organizational, with application to multiple disciplines.

**ININ 5007.** COMPLEX SYSTEMS MODELING AND SYSTEM DYNAMICS. Three credit hours. Two hours of lecture and two hours of laboratory per week. Prerequisites: ININ 4021 or ININ 4150 or authorization of the Director of the Department.

Introduction to modeling of system dynamics for the analysis of business decisions with a focus on industrial, service and public policy applications, particularly those decisions forced by structural changes , policies and strategies that affect how the system behaves. Includes the conceptual tools to understand the structure and dynamics of complex systems.

**ININ 5009.** LEAN SIX SIGMA METHODOLOGY. Three credit hours. Three hours of lecture per week. Prerequisites: (ININ 4078 and (ININ 4039 or ININ 4155)) or authorization of the Director of the Department.

Discussion of the basic principles of lean and six sigma methodologies to maximize the value of a product or service focusing primarily on customer satisfaction. Use of the DMAIC methodology as a structured way to integrate the tools of industrial engineering to solve problems related to processes and systems improvement.

**ININ 5025**. QUEUEING SYSTEMS AND SIMULATION. Four credit hours. Four hours of lecture per week. Prerequisites: (ININ 4020 and (ININ 4021 or ININ 4150) and (ININ 4072 or ININ 4009)) or authorization of the Director of the Department.

Analysis of stochastic systems using the theoretical foundation of basic queuing networks and discrete-event simulation. Modeling of the interrelationship between system's components through the generation of random variables, input/output analysis, and experimental design and optimization. Emphasis on modeling industrial systems using computer simulation packages.

**ININ 5105.** INTRODUCTION TO MEDICAL DEVICE DESIGN METHODS. Three credit hours. Three hours of lecture per week. Prerequisites: ININ 4020 or INME 4055 or INEL 4205 or INQU 4008 or authorization of the Director of the Department.

Discussion of fundamental methods for medical device development. Study of the process of medical device development, from concept to marketing. Analysis of procedures of product definition, design, risk management, production planning and market introduction, FDA (Food and Drug Administration) regulations, and intellectual property protection. Case studies illustrating important considerations to manage the complexities of the development process are included.

**ININ 5200**. INTRODUCTION TO ENGINEERING MANAGEMENT. Three credit hours. One and a half hour of lecture and one and a half hour of discussion per week. Prerequisites: ININ 4015 or ININ 4007.

Study and application of the fundamentals of management concepts to multidisciplinary engineering teams.

**ININ 5405.** STATISTICAL METHODS IN BIOINFORMATICS. Three credit hours. Three hours of lecture per week. Prerequisites: ININ 4010 or ININ 5559 or INCI 4136 or AGRO 5005 or ESMA 3101 or ESMA 4001 or ESMA 4006 or ESTA 3002 or authorization of the Director of the Department.

Study and application of statistical methods related to bioinformatics analysis including sequence analysis, gene expression and phylogenetic trees. Use of methods such as inferential statistics, statistical modeling, clustering analysis and Markovian processes.

**ININ 5505**. TOTAL QUALITY MANAGEMENT. Three credit hours. Three hours of lecture per week. Prerequisite: ININ 4078 or authorization of the Director of the Department.

Introduction to innovative philosophies in total quality control. The impact of leadership, organizational infrastructure and client satisfaction on quality management. Utilization and management of information, personnel, processes and product design for continuous quality improvement.

**ININ 5555**. INTRODUCTION TO NONLINEAR OPTIMIZATION AND NEURAL NETWORKS. Three credit hours. Three hours of lecture per week. Prerequisites: (MATE 3063 and (INGE 3016 or CIIC 3011 or CIIC 3015 or COMP 3010)) or authorization of the Director of the Department.

Optimization techniques in the context of problems with or without restrictions in industrial engineering. Multivariate search methods with or without derivatives. Description of artificial neural networks as a nonlinear optimization technique. Analysis and design of artificial neural networks, using supervised and unsupervised algorithms. Applications of nonlinear optimization and neural networks in the field of industrial engineering.

**ININ 5559**. ENGINEERING STATISTICS. Three credit hours. Three hours of lecture per week. Prerequisites: (MATE 3032 and INGE 3016) or authorization of the Director of the Department.

Development of probability theory for scientific and engineering inference. Discrete and continuous random variables and distributions and their applications in engineering. Hypothesis testing and confidence intervals. Regression analysis. Applications to engineering problem solving.

**ININ 5565**. MEASUREMENT AND PREDICTION OF PRODUCT RELIABILITY. Three credit hours. Three hours of lecture per week. Prerequisite: ININ 4020 or authorization of the Director of the Department.

Introduction to reliability theory; system analysis; constant failure rate models; time dependent failure rate models; state dependent systems; availability; maintainability; complete and censored data analysis (parameter estimation and distribution fitting); prediction of reliability.

**ININ 5575**. SEQUENCING AND SCHEDULING OF RESOURCES. Three credit hours. Three hours of lecture per week. Prerequisites: ININ 4021 or ININ 4150 or authorization of the Director of the Department.

Conceptual and practical aspects involved in the scheduling of resources. Examples and applications drawn from areas such manpower, computer, and transportation.

**ININ 5595**. DESIGN AND MANAGEMENT OF SERVICES PROCESSES. Three credit hours. Three hours of lecture per week. Prerequisites: ININ 4009 and (ININ 4039 or ININ 4155 or authorization of the Director of the Department).

Industrial engineering techniques and models to design and manage the operations of service organizations or services processes in manufacturing enterprises. Development, evaluation, and implementation of alternative solutions to the operational problems of service organizations. Use of models and techniques in marketing, quality assurance and

management, work measurement and design, operations research, production planning and control, engineering economics, human resources, management information systems, and facilities layout.

**ININ 5997.** SELECTED TOPICS IN INDUSTRIAL ENGINEERING. One to six credit hours. One to six hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Discussion of selected topics in Industrial Engineering or related fields.

**Graduate Courses**

**ININ 6005**. EXPERIMENTAL STATISTICS. Three credit hours. Three hours of lecture and/or discussion per week. Prerequisite: authorization of the Director of the Department.

Applications of multiple regression to analysis of variance and experimental designs. Analysis of multiple classifications involving fixed, random, and mixed effects, including crossed and nested variables of classification. Emphasis on computer model applications.

**ININ 6008**. NETWORK FLOWS AND GRAPHS IN MANAGEMENT SCIENCE. Three credit hours. Three hours of lecture and discussion per week. Prerequisite: authorization of the Director of the Department.

Principles of network flows and graphs theory and their applications in management science. Classical network flow problem formulations including maximal flow-minimal cut, assignment, transportation and others. Representation of optimization problems as network formulations, and the use of the out of kilter algorithm for their solution. Single versus multicommodity flow, as well as the relation of graphs and networks to combination problems.

**ININ 6010**. MULTIPLE REGRESSION ANALYSIS. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Analysis of unplanned experimental data to develop models for predicting complex systems behavior. Topics include: matrix formulation and properties of least squares estimators in multiple linear regression; analysis of residuals; diagnostics for influential data; strategies for variable selection; diagnostics, effects, and corrective measures for problems with correlated predictor variables; biased regression and other estimation criteria; autocorrelated residuals; simultaneous inference, model validation; use of computer programs to analyze real data and to develop a model.

**ININ 6016**. HUMAN FACTORS ENGINEERING. Three credit hours. Three hours of lecture and discussion per week. Prerequisite: authorization of the Director of the Department.

Human factors applications in the design of equipment and work environment. Methods for the analysis of human errors and skills and their utilization in the design of control systems and information displays.

**ININ 6019**. ADVANCED PRODUCTION CONTROL. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Assessment of production control systems and examination for improvements in the systems performance and supply chains, where the techniques of optimization, mathematical modeling simulation and case studies are employed.

**ININ 6020**. QUEUEING THEORY AND APPLICATIONS. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Development and use of analytical models for the design of queuing systems. Introduction to stochastic-process models. Applications to analysis, design, and optimization of queuing systems in service and manufacturing organizations.

**ININ 6025**. LINEAR AND DISCRETE OPTIMIZATION. Three credit hours. Three hours of lecture and discussion per week. Prerequisite: authorization of the Director of the Department.

Basic theory and development of the simplex method for solving linear programming problems with discrete variables. Dual problems and sensitivity analysis. Formulation of problems with discrete variables. Developments of implicit enumeration and related methods for integer problems. Application of linear and discrete optimization methods to problems of industry and government. Use of computer programs.

**ININ 6026.** SYSTEMS SIMULATION. Three credit hours. Three hours of lecture and discussion per week. Prerequisite: authorization of the Director of the Department.

Principles of feedback dynamics; levels; rates, delays. Simulation languages and their applications in industrial and service systems. Analysis and interpretation of results. Recommendation and justification of proposed alternatives.

**ININ 6030**. ADVANCED ECONOMICS FOR ENGINEERS. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Formulation of economic problems in terms of quantifiable models. Use of deterministic, probabilistic, risk and multiattribute techniques to evaluate design alternatives and to select an acceptable solution.

**ININ 6036**. INTRODUCTION TO TIME SERIES ANALYSIS. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Univariate and bivariate time series in frequency and time domain, use of autocorrelation and spectral analysis for model identification. Uses of model diagnostic and forecasting techniques, dynamic systems modeling and stochasting estimation by means of the Kalman filter.

**ININ 6045**. MATERIAL HANDLING SYSTEMS. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Fundamentals of material handling systems including types of equipment and their applications, relationship between material handling and design of facilities, computer control, and automation. A project will be required.

**ININ 6046**. ADVANCED INDUSTRIAL EXPERIMENTATION. Three credit hours. Three hours of conference per week. Prerequisite: ININ 6005 or authorization of the Director of the Department.

Applications, analogies and differences among confidence intervals, prediction intervals, and tolerance intervals. Fundamental concepts and applications of response surface methodology and evolutionary operations to manufacturing processes. Case study of manufacturing experiments with dichotomous or polytomous response variables. Use of logistic regression for modeling the relationship between a categorical variable and a set of covariates. Effective modeling strategies and the interpretation of results are emphasized. Fundamental concepts in the design and analysis of experiments with mixtures. Statistical techniques and methods for designing, modeling, and analyzing mixture data. Extensive use of software packages for statistical data analysis.

**ININ 6048.** KNOWLEDGE DISCOVERY IN ENGINEERING MULTIVARIATE DATA. Three credit hours. Three hours of lecture per week. Prerequisites: authorization of the Director of the Department.

Development of empirical linear and non-linear model building skills using a variety of tools from multivariate statistics and data mining. Development of skills to identify the model that best represents the natural relationship between a numerical and/or categorical response, and a high-dimensional set of explanatory variables. Special attention is given to data pre-processing, missing value imputation, outlier detection, feature extraction/selection, and models validation. Introduction to unsupervised learning and modeling techniques for multiple response variables.

**ININ 6055.** MATHEMATICAL MODELS IN DISTRIBUTION LOGISTICS. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Study on the logistics involved in transporting finished goods from manufacturers to customers. Particular emphasis is given to the design and operation of container terminals, cross-docks, and distribution centers, as well as the

management of freight transportation modes. Emphasis will be given on mathematical models for the optimization of distribution systems and their implementation.

**ININ 6078**. QUALITY CONTROL SYSTEMS. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Advanced topics in statistical process control. Design of control charts. EWMA charts. The SPRT and its applications in quality engineering: CUSUM and continuous sampling plans. Multivariate control charts. Principles of quality engineering and Taguchi methods. The loss function and its applications to multiresponse experiments.

**ININ 6995**. SPECIAL PROGRAMS. One to three credit hours. One to three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Study of previous work and literature on a selected topic of the industrial engineering field.

**ININ 6998**. ENGINEERING PROJECT. Three to six credit hours.

Comprehensive study of a special industrial engineering problem selected so as to integrate the knowledge acquired in the graduate program study. This project fulfills one of the terminal requirements of the Master of Engineering program, and will be governed by the norms established for this purpose.

**ININ 6999**. THESIS. One to six credit hours.

Research in the Industrial Engineering field leading to the presentation and approval of a thesis.

**MATERIALS SCIENCE AND ENGINEERING**

**CIIM 6000.** MASTER'S THESIS. One to six credit hours.

Research and preparation of a thesis under the supervision of a faculty member.

**CIIM 6005**. FUNDAMENTALS OF ADVANCED MATERIALS. Four credit hours. Three hours of lecture and one hour of seminar per week.

Integrated study of the fundamental concepts of advanced materials necessary to understand the development of their structures and properties, as well as their engineering applications. Analysis of the structure and properties of ceramic, composite, electronic, metallic, and polymer materials; atomic- and nanometer-scale microstructures, including long-range and short-range order atomic arrangements, as well as the development of microstructures and their transformations. Case studies on the design of materials and their synthetic pathways.

**CIIM 6006.** STRUCTURE AND PROPERTIES OF MATERIALS. Three credit hours. Three hours of lecture per week.

Study of solid-state physics applied to functional materials, which will allow the explanation of the synthesis-structure-properties relationship and its application to materials processing. Discussion of the relationship between crystal structure and the phenomenon of diffraction, structural defects, lattice vibration, and their relationship with the thermal properties of materials. In addition, the principles of the semiconducting and superconducting behavior of materials will be studied, as well as the mechanistic bases of high- and low-temperature materials synthesis options, including nucleation and diffusion processes.

**CIIM 6007**. KINETICS AND PHASE TRANSFORMATION. Three credit hours. Three hours of lecture per week.

Study of thermodynamic and diffusion concepts applied to the kinetics of phase transformations, which will permit the development of skills necessary for the analysis of such transformations in diverse systems. Nucleation and growth

phenomena applied to the processes of recovery, recrystallization, precipitation, and solidification will be studied, as well as spinoidal, order-disorder, and athermal transformations.

**CIIM 6008.** DIFFRACTOMETRY AND COMPLEMENTARY TECHNIQUES. Three credit hours. Two hours of lecture and one two-hour laboratory per week.

Study of the theory, practice, and applications of X-ray diffraction and other complementary techniques, which will allow the identification of the most suitable characterization techniques for the type of information (morphological, structural, qualitative, and quantitative) required for materials of interest. Discussion of experimental methods and applications of electron and neutron diffraction techniques, as well as electron microscopy. Presentation of the principles of complementary techniques such as SPM, XPS, Auger, Mossbauer, solid-state nuclear magnetic resonance, and SIMMS and their application to structural problems in the solid state.

**CIIM 6010.** MATERIALS MICROPROCESSING AND ENGINEERING. Three credit hours. Three hours of lecture per week.

Discussion of synthesis routes applied to the microprocessing of engineering materials, including epitaxial growth in ion beam processing. The processing conditions for thin films of semiconductors and other functional materials for superconducting, magnetic, and tribological applications are also discussed. The students will be able to propose and explain the most suitable microprocessing route for a specific engineering application.

**CIIM 6015.** COMPUTATIONAL MATERIALS SCIENCE. Three credit hours. Two hours of lecture and one two-hour laboratory per week.

Study of the concepts of computer-assisted modeling and their applications to atomistic processes, which will permit the development of skills necessary for the computational analysis of processes such as kinetics and diffusion phenomena. The behaviors governed by isotropic or anisotropic properties (e.g., texture development) and phase transformation processes (e.g., segregation, precipitation, quenching), are also covered.

**CIIM 6016.** POLYMER SCIENCE AND ENGINEERING. Three credit hours. Three hours of lecture per week.

Discussion of the concepts related to the structure, properties, synthesis, and selection of polymeric materials, which will permit the explanation and prediction of the behavior of such materials. Application of these concepts to the study of the mechanical behavior of polymers, viscosity, and creep, as well as to processing issues, including copolymerization in blends and alloys.

**CIIM 6017**. FUNDAMENTALS OF MATERIALS CHEMISTRY. Three credit hours. Three hours of lecture per week.

Study of the scientific foundations of the chemical origin of materials properties and the structure of solids, in order to apply these concepts in the analysis of homogeneous and heterogeneous systems. The physicochemical principles of dissolution, precipitation, and crystal growth processes are presented and discussed on mechanistic and practical application bases. The theory and applications of mechanochemistry and mechanoactivation of materials, as well as the chemistry of surfaces and interfaces in sols, gels, colloids, and nanoparticle systems, self-assembly and film formation, will be discussed.

**CIIM 6018.** NANOSTRUCTURED MATERIALS. Three credit hours. Three hours of lecture per week.

Study of the dependence of materials properties on crystal size at the nanoscale. Nanotechnology is discussed from the perspectives of characterization techniques, processing, and applications of nanostructures composed of functional materials. After completing the course, the students will be able to analyze, debate, and suggest synthesis, characterization, and application alternatives for nanostructures of different materials.

**CIIM 6019.** THERMODYNAMICS AND PHASE EQUILIBRIA. Three credit hours. Three hours of lecture per week.

Study of the thermodynamic principles and concepts applied to materials science, which will permit the analysis of the stability of the phases of a material based on thermodynamic considerations. The thermodynamics of solutions, fusion and vaporization processes, and surfaces and interfaces will be studied. Discussion of thermodynamic concepts applied to the study of binary and pseudo-binary systems with corresponding phase diagrams, including metastable phases. Analysis and application of ternary phase diagrams.

**CIIM 6020.** DIFFUSION PHENOMENA IN MATERIALS. Three credit hours. Three hours of lecture per week.

Study of the bases of atomic transport phenomena and diffusion mechanisms in solids, Fick's laws and the Kirkendall effect. Discussion of the characteristics of diffusion in ionic solids. Mathematical analysis of diffusion phenomena and the application of Green's function. The students will be able to analyze multi-component diffusion processes as well as other forms of diffusion in materials processing.

**CIIM 6026.** SOLIDIFICATION PROCESSES. Three credit hours. Three hours of lecture per week.

Study of heat and mass transfer concepts applied to solidification processes. The properties of crucibles and molds as well as the metallurgy of molten alloys and cast metal matrix composites will be studied. Computational simulation of solidification processes to analyze them from a mechanistic and practical viewpoint.

**CIIM 6027.** GRADUATE SEMINAR. One credit hour. One hour of seminar per week.

Oral presentation on a research topic in materials science and engineering.

**CIIM 6030**. CERAMIC MATERIALS. Three credit hours. Three hours of lecture per week.

Comprehensive study of ceramic materials including their crystalline structure, electronic and ionic defects and derivative transport phenomena, microstructure, mechanical properties, processing and characterization techniques. Study of related topics such as glass formation and applications of ceramic materials.

**CIIM 6995.** SELECTED TOPICS. One to six credit hours. One to six hours of lecture per week.

Selected topics in materials sicence and engineering.

**CIIM 6996.** MASTER'S PROJECT. One to three credit hours.

Design and development of a project in materials science and engineering. A final written report is required.

**INGE 5005**. STABILITY AND PROCESSING OF MATERIALS. Three credit hours. Three hours of lecture per week. Prerequisites: INGE 4001 or INGE 3045 or INME 4107 or authorization of the Director of the Department.

Discussion of materials' stability driven by thermodynamics and kinetics considerations such as microstructural evolution and interparticle interactions. Discussion of interfaces and their roles during materials syntheses and processing at different stages. Discussion of governing and operational phenomena at multi-length scales during synthesis and processing (ranging from nanomaterials to bulk materials processing) such as diffusion, sintering, and solidification.

**INGE 5015**. THEORY AND MANAGEMENT OF SYSTEMS. Three credit hours. Three hours of lecture per week. Prerequisite: third year standing or higher or authorization of the Director of the Department.

Introduction to the systems approach and to systems analysis. Analytical methods applicable to interactive contexts, such as economic and ecological systems and to organizations. Topics include: Problem formulation, information management, evaluation and selection of alternatives, implementation and monitoring of solutions.

**INGE 5016.** INTRODUCTION TO MATERIALS CHARACTERIZATION. Three credit hours. Three hours of lecture per week. Prerequisites: INGE 4001 or INGE 3045 or INME 4107 or authorization of the Director of the Department.

Discussion of the theory and practice of micro-characterization techniques, including optical microscopy, thermal analysis, electron beam diffraction, and x-ray and photon-induced interactions. Explanation of the complementary surface analysis techniques as experimental methods for design and selection of metals, polymers, composites and biological materials.

**INGE 5020.** INTRODUCTION TO CERAMIC MATERIALS. Three credit hours. Three hours of lecture per week. Prerequisites: INGE 4001 or INGE 3045 or INME 4107 or authorization of the Director of the Department.

Introduction to the fundamental principles of ceramic materials including their crystalline structure, electronic and ionic defects and subsequent transport phenomena, microstructure, mechanical properties, processing and diverse modern applications. Study of related topics such as glass formation and applications of nanostructured ceramic materials.

**INGE 5027**. OCEAN WAVE DYNAMICS FOR ENGINEERS. Three credit hours. Three hours of lecture per week. Prerequisites: INGE 4015 or authorization of the Director of the Department.

Analysis of surface waves focused on the engineering applications of ocean wave dynamics. Discussion and application of the physical and mathematical fundamentals which govern the behavior of ocean waves. Application of statistics and extreme wave analysis to develop design wave criteria.

**INGE 5028**. ENGINEERING VIBRATIONS. Three credit hours. Three hours of lecture per week. Prerequisites: INGE-INME 4046- Fundamentals of Vibrations and (INGE 4019-Introduction to Mechanics of Materials or INGE 4012-Mechanics of Materials II or authorization of the Director of the Department.

Discussion of the vibration theory of discrete and continuous systems. Use of techniques, principles and methodology to solve practical problems of engineering vibrations with an emphasis on analytical tools and computational approaches. Analysis of modeling and response of discrete and continuous systems; use of matrix methods for the solution of discrete systems; use of eigenvalue problem analysis for discrete and continuous systems; use of numerical methods in vibration analysis; applications of finite element methods for the analysis of vibrations of systems and nonlinear vibrations.

**INGE 5037.** APPLIED SIGNAL PROCESSING FOR ENGINEERING MECHANICS. Three credit hours. Three hours of lecture per week. Prerequisites: (INGE 3016 and MATE 3063) or authorization of the Director of the Department.

Practical introduction to signal processing, including time-domain, frequency-domain, and time-frequency domain approaches. Development of skills to manipulate, analyze, and extract useful and reliable information from different types of signals. Practical applications of methods and principles including signal de-noising, outlier analysis, vibration based system identification, irregularities detection, system health monitoring and non-stationary signals characterization.

**INGE 5040.** ENGINEERING ACOUSTICS. Three credit hours. Three hours of lecture per week. Prerequisites: (MATE 4009 and (INGE 3032 or INGE 3035)) or authorization of the Director of the Department.

Basic acoustics theory and practice, modeling of acoustic sources, sound propagation and transmission, acoustics measurements, sound in enclosed spaces, design of sound enclosures and barriers and design of muffling devices.

**INGE 5065**. MATERIALS SELECTION. Three credit hours. Two hour of lecture and two hours of laboratory per week. Prerequisites: INGE 3045- Materials Science for Electrical Engineers or INGE 4001- Engineering Materials or INME 4107- Materials Science and Engineering or authorization of the Director of the Department.

Discussion of the concepts, tools, and procedures related to the materials selection process to provide the conceptual basis needed for the decision-making process in the selection of materials in engineering applications. Use of materials selection software. Discussion of engineering materials and their structure-property-performance relationship. Use of case studies for the application of basic concepts in materials selection and the application of materials selection charts.

Discussion of multiple constraints and compound objectives. The concepts of process selection as well as aesthetics and industrial design will also be discussed.

**INGE 5066**. RECYCLING OF MATERIALS. Three credit hours. Three hours of lecture per week. Prerequisite: INGE 4001 or INGE 3045 or INME 4007 or authorization of the Director of the Department.

Analysis of the recycling situation in the global context and its laws and regulations. Design of separation and collection centers for recyclable waste materials including electronic devices, aluminum cans, bottles, plastics, steel, tires, construction debris, and hazardous wastes. Planning of processing facilities.

**INGE 5075**. NANOMATERIALS AND FINE PARTICLES PROCESSING. Three credit hours. Three hours of lecture per week. Prerequisite: INGE 4001 or INGE 3045 or INME 4007 or authorization of the Director of the Department.

Study of the nanoscale and the perspective of nanotechnology, nanomaterials, and their properties. Fundamentals and practice of particle nucleation and growth. Analysis of conditions leading to particle stability and the formation of solid solutions at the micro- and nanosize scale. Fundamental and industrial applications such as ceramics, magnetic materials, semiconductors, ferroelectrics, optical materials, catalysts, pigments, and biological and medical devices. Study of nanotechnology and its relation with the environment.

**INGE 5085**. MATERIAL SCIENCE AND ENGINEERING SEMINAR. One credit hour. One hour of lecture per week. Prerequisites: INGE 4001 or INGE 3045 or INME 4107 or authorization of the Director of the Department.

Oral and written presentations about materials science and engineering topics.

**INGE 5095.** BIOMECHANICS OF THE MUSCULOSKELETAL SYSTEM. Three credit hours. Three hours of lecture per week. Prerequisites: INGE 3032 or INGE 3035 or authorization of the Director of the Department.

Study of the mechanisms of human musculoskeletal system. Analysis of the highly complex and intricate movements of various joints in the body. Study of the mechanical properties of bones, cartilages, tendons, ligaments and muscles that comprise a joint. Analysis techniques of static and dynamic equilibrium that explain the musculoskeletal interactions which causes joint movement.

**INGE 5104**. NANOMEDICINE FUNDAMENTALS. Three credit hours. Three hours of lecture per week. Prerequisites: INGE 4001 or INGE 3045 or INME 4107 or authorization of the Director of the Department.

Overview of the distinctive features of nanotechnology and their application to biomedical problems. Contrasts among macro/micro/nano to bring out the unique properties of nanotechnology in medicine. Introduction to cutting-edge of nanomedical technologies for sensing and imaging, drug delivery, and therapeutic applications will be addressed.

**INGE 5185**. INTRODUCTION TO COASTAL ENGINEERING. Three credit hours. Three hours of lecture per week. Prerequisites: INGE 4015-Fluid Mechanics or authorization of the Director of the Department.

Analysis of waves, including linear wave theory, wave transformation, wave statistics, and wave-induced flows. Analysis of the dynamics of tides, currents, and sea level variations and extreme events, the effects of coastal processes on cross-shore and alongshore sediment transport, on coastal morphology, and on the different types of coastal engineering stabilization measures. Design of beach nourishment and inlet stabilization. Discussion of the fundamental design considerations for coastal engineering structures.

**INGE 5996.** SPECIAL TOPICS. One to six credit hours. One to six hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Study of selected topics in general engineering. The selection and scope of the topics shall be in accordance with the interests and needs of the students.

**MECHANICAL ENGINEERING**

**Advanced Undergraduate Courses**

**INME 5005**. LUBRICATION (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Fundamental principles and concepts of lubrication theory; hydrostatic and hydrodynamic lubrication; examples of journal and thrust bearing design, using both the hydrostatic and hydrodynamic principles; considerations in boundary lubrication.

**INME 5007**. SOLAR ENERGY APPLICATIONS (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: INME 4015 or INQU 4001 or authorization of the Director of the Department.

Fundamentals of solar radiation, its measurement, and methods of estimation. Selected topics on heat transfer relevant to systems design applications of solar energy such as flat plate and focusing collectors, energy storage systems, heating and cooling systems, power systems, and distillation processes.

**INME 5008**. CORROSION. Three credit hours. Three hours of lecture per week. Prerequisite: INME 4007 or INME 4107 or authorization of the Director of the Department.

Electrochemical principles and corrosion mechanisms; protection and prevention of corrosion in metals; the effects of temperature, environment, and metallurgical factors.

**INME 5010**. DESIGN THINKING. Three credit hours. Three hours of lecture per week. Prerequisite: 30 credits approved or more in their discipline.

A study of the design thinking methodology in the context of a project-based course. Investigation of user needs, problem identification, creation of possible solutions, analysis and selection of solutions. Creation of a functional prototype demonstrating the usability and viability of the product.

**INME 5015**. SELECTED TOPICS IN MECHANICAL ENGINEERING. One to six credit hours. One to six hours of lecture per week. Prerequisite: authorization of the Director of the Department.

A study of certain selected topics in Mechanical Engineering not covered by other existing courses.

**INME 5018**. MATERIALS FAILURE ANALYSIS. Three credit hours. Three hours of lecture per week. Prerequisites: ((INME 4012 and INME 4007) or (INME 4012 and INME 4107)) or authorization of the Director of the Department.

Materials science concepts used to identify, correct and prevent failure due to the improper use of materials or to problems in manufacturing processes. In depth study of failure mechanisms such as fatigue, wear, creep, and corrosion.

**INME 5025**. METALS FATIGUE (II) (Odd numbered years). Three credit hours. Three hours of lecture per week. Prerequisite: INME 4007 or INME 4107 or authorization of the Director of the Department.

Nature of metal fatigue; modern approaches to design of mechanical components for repeated loadings; importance of residual stresses and stress concentrations; analysis of cumulative damage and life prediction; cycle counting and sequence of events.

**INME 5105**. FUNDAMENTALS OF NUCLEAR SCIENCE AND ENGINEERING. Three credit hours. Three hours of lecture per week. Prerequisites: FISI 3172 and (MATE 4009 or MATE 4145).

Principles of nuclear science and engineering for electric power generation. Discussion of principles such as radiation, nuclear fission and chain reactions, neutron interaction with matter, neutron diffusion and moderation, criticality of steady state systems, reactor kinetics, and radiation protection.

**INME 5106**. NUCLEAR POWER PLANT ENGINEERING. Three credit hours. Three hours of lecture per week. Prerequisites: FISI 3172 and (MATE 4009 or MATE 4145).

Principles of utilization of fission energy to generate electric power, including topics such as: thermodynamic and power plant cycle analysis, nuclear reactor technologies, design principles and operational characteristics, nuclear fuel cycle, waste treatment, instrumentation and control systems, and plant electrical systems.

**INME 5107**. RADIOLOGICAL SAFETY AND RADIOACTIVE WASTE MANAGEMENT. Three credit hours. Three hours of lecture per week. Prerequisites: FISI 3172 and (MATE 4009 or MATE 4145).

General principles of radiation and radioactivity and their interaction with matter and biological systems. Specific topics include: protection methodology, radiation dosimetry, systems for personnel monitoring, radioactive waste disposal procedures, regulations, and long-term risk analysis.

**INME 5510**. INTRODUCTION TO FINITE ELEMENT MODELING. Three credit hours. Two hours of lecture and two hours of laboratory per week. Prerequisites: (INME 4011 and INGE 3016) or authorization of the Director of the Department.

Study of the foundations, methods and techniques used in Finite Element Modeling (FEM). Use of FEM codes to analyze solids in problems of practical engineering interest. Emphasis on the use of FEM as a tool and means to obtain engineering solutions.

**INME 5520**. INTRODUCTION TO COMPUTATIONAL FLUID DYNAMICS. Three credit hours. Two hours of lecture and two hours of laboratory per week. Prerequisites: INME 4015 or authorization of the Director of the Department.

Study of the foundations, methods and techniques used in computational fluid dynamics (CFD). Use of CFD codes to analyze solids in problems of practical engineering interest. Emphasis on the use of CFD as a tool and means to obtain engineering solutions.

**INME 5530**. INTRODUCTION TO MULTIBODY DYNAMICS MODELING (MBD). Three credit hours. Two hours of lecture and two hours of laboratory per week. Prerequisites: INME 4005 or authorization of the Director of the Department.

Study of the foundations, methods and techniques used in Multibody Dynamics (MBD). Use of MBD codes, solid modeling, and dynamic methods for kinematic-kinetic analysis and design of rigid and flexible multi-body assemblies in two and three dimensions with applications to machinery.

**INME 5701.** GAS TURBINE PERFORMANCE ANALYSIS I. Three credit hours. Three hours of lecture per week. Prerequisites: (INME 4001 and INGE 4015) or authorization of the Director of the Department. Corequisite: INME 4002 or authorization of the Director of the Department.

Application of concepts in thermodynamics, fluid mechanics, aerodynamics, and compressible flow theory to analysis and design of jet engines. Study of jet engine performance by means of thermodynamic analysis, measurement of pressure, temperature, and velocity parameters and their relation to fuel consumption and thrust output.

**INME 5702**. GAS TURBINE PERFORMANCE ANALYSIS II. Three credit hours. Three hours of lecture per week. Prerequisites: INME 5701 and (INME 4002 or authorization of the Director of the Department).

Identification and optimization of jet engine components for a well integrated system. Principles of overall system design applied to both design and off-design behavior of turbomachinery, combustion and emissions, acoustics, and operationally stable throttle response. Advanced thermodynamic concepts applied to turbofan optimization.

**INME 5707.** GAS TURBINE SYSTEM OPERATION. Three credit hours. Three hours of lecture per week. Prerequisites: ((INME 4002 or INME 4045 or INQU 4012) and INGE 3016 and INME 4707) or authorization of the Director of the Department.

Study of jet engine performance using energy budgets and its optimization in the jet engine cycle. Study of turbomachine components, such as compressors, combustors, turbines and nozzles, as integrated into a system that produces power aircrafts. Development of a thermodynamic model for a turbofan engine to investigate design and off-design behavior, and the response to external and internal parameters. Study the influence of design criteria such as structural integrity, emissions, acoustics, and operationally-stable throttle response on the integration process.

**INME 5717.** AIRCRAFT STRUCTURAL ANALYSIS AND DESIGN. Three credit hours. Three hours of lecture per week. Prerequisites: (INME 4717 and (INGE 4019 or INGE 4012)) or authorization of the Director of the Department.

Application of work and energy principles, and numerical methods, to the design of flight vehicles. Study of deflection and load analysis using the principle of virtual work, principle of contemporary virtual work, analytical weak form solutions, and the finite element formulation. Wing design considering: fatigue, aeroelasticity, divergence, environmental loads, aerospace materials, dynamic stability of thin-walled compression members, and structural dynamics.

**INME 5995**. SPECIAL PROBLEMS. One to six credit hours. One to six hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Researches and special problems in Mechanical Engineering and related fields.

**INME 5996**. SPECIAL PROBLEMS II. One to six credit hours. One hour of lecture per week per credit. Prerequisite: authorization of the Director of the Department.

Study of special problems in Mechanical Engineering and related fields.

**INME 5997**. SELECTED TOPICS II. One to six credit hours. One to six hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Study of selected topics in mechanical engineering or related fields.

**Graduate Courses**

**INME 6001**. ADVANCED THERMODYNAMICS I (I) (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Critical study of thermodynamics laws; property relationships; statistical thermodynamics; thermodynamics design of power plants and refrigeration plants.

**INME 6002**. ADVANCED THERMODYNAMICS II (II) (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: INME 6001 or authorization of the Director of the Department.

Advanced applications of thermodynamics to energy systems; chemical reaction kinetics; combustion; modeling of intermolecular forces and transport properties; solid phase thermodynamics.

**INME 6005**. HEAT CONDUCTION (Every third semester). Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Analytical methods for the solution of heat conduction problems in Cartesian, cylindrical, and spherical geometries, separation of variables superposition., Laplace transforms, variational formulation; numerical methods to include finite differences and finite elements.

**INME 6006**. RADIATION HEAT TRANSFER (Every third semester). Three credit hours. Three hours of lecture per week.

The nature of thermal radiation and radiative characteristics of surfaces. Application of fundamentals to the analysis of evacuated enclosures and of systems containing a thermal radiation absorbing and emitting media. Study of the combined effects of radiation conduction and convection of thermal energy. Applications.

**INME 6007**. ADVANCED AIR CONDITIONING (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: INME 6001 or authorization of Department Director.

Advanced study of psychometrics, dynamic models for buildings, simultaneous heat and mass transfer processes. Energy efficient cooling and heating of building using annual energy consumption criterion and conventional and non-conventional air conditioning systems.

**INME 6008**. ADVANCED METAL CUTTING Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Mechanics of machining process including friction and temperature. Tools wear analysis, cutting fluids and surface finish. Economics of machining processes. Flexible manufacturing and group technology process design.

**INME 6009**. ADVANCED MANUFACTURING PROCESSES (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Developments in the removal and deforming processes of materials. Applications of these processes to hard, brittle, conducting and non-conducting materials. Use of the computer in the analysis of these processes.

**INME 6010**. ADVANCED CONCEPTS IN FLUID MECHANICS AND CONVECTIVE HEAT TRANSFER (Every third semester). Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Fluid properties, equations of mass, momentum and energy for viscous flows, exact solutions, low and high Reynolds number flows, velocity and thermal boundary layers, flow in tubes, approximate methods, compressible flows, momentum and energy transfer in turbulent flows.

**INME 6015**. DISLOCATION THEORY (Every third semester). Three credit hours. Three hours of lecture per week. Prerequisite: INME 4007 or authorization of Department Director.

Theory of dislocations in isotropic and anisotropic continua; dislocation reactions; the relation of theory to observed dislocation configurations.

**INME 6016**. MECHANICAL METALLURGY (Every third semester). Three credit hours. Three hours of lecture per week. Prerequisite: INME 6015 or authorization of Department Director.

Dislocation theory applied to the deformation of metals; including the mechanisms of glide; fatigue; creep, and fracture.

**INME 6017**. SEMINAR. Zero to one credit hour. Zero to one hour of lecture per week.

Discussions and presentations on topics related to mechanical engineering and research projects developed by students of the graduate program.

**INME 6019**. FRACTURE MECHANICS (Every third semester). Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Application of fracture mechanics to structural integrity of engineering materials; prevention of fracture, relationship between material toughness, design stress and flaw size, microstructural and environmental effects; transition temperature; fatigue and failure analysis.

**INME 6021**. ENGINEERING SYSTEMS DESIGN I (Every third semester). Three credit hours. Three hours of lecture per week. Prerequisites or Corequisites: INME 6001 and INME 6011 or authorization of the Director of the Department.

An introduction to the philosophy of problem recognition and design project formulation; practice in this activity through the actual formulation and completion of several small design projects or one large one.

**INME 6022**. ENGINEERING SYSTEMS DESIGN II (Every third semester). Three credit hours. Three hours of lecture per week. Prerequisite: INME 6021.

A continuation of INME 6021.

**INME 6024**. NUMERICAL ANALYSIS OF TRANSPORT PHENOMENA (Every third semester). Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Numerical solution of governing equations stemming from heat and mass transfer and fluid flow phenomena.

**INME 6025**. GAS DYNAMICS (Every third semester). Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Fluid properties, equations of mass, momentum and energy, one-dimensional gas dynamics, normal and oblique shocks, expansion fans, flows in ducts and nozzles, flow with friction and heat transfer, small perturbation theory, introduction to characteristic method.

**INME 6026**. BOILING AND CONDENSATION HEAT TRANSFER. Three credit hours. Three hours of lecture per week.

Fundamentals of boiling and condensation including interface and wetting phenomena, drop and film condensation, pool and flow boiling and instabilities in two-phase flows.

**INME 6030**. MECHANICS OF COMPOSITE MATERIALS (Every third semester). Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Analysis of mechanical behavior of composite materials; fiber reinforced composites, and laminated beams and plates; environmental effects; prediction of properties; theories of strength, stiffness, design.

**INME 6035**. CONSERVATION AND ALTERNATE ENERGY SYSTEMS (On demand). Three credit hours. Three hours of lecture per week.

Technology of energy conservation and of systems for production of electricity which do not use fossil fuels. Case studies of conservation schemes, and of the technology of wind, ocean energy, direct solar, nuclear and biofuels. Energy sources, conversion processes, transportation and storage, supply systems, and socio-economic and ecological assessment. Individual, in depth, term papers are required on two of the topics covered.

**INME 6036**. CONTROL SYSTEM DESIGN AND APPLICATIONS (Every third semester, on demand). Three credit hours. Three hours of lecture per week.

Design of electromechanical products; use of electronic parts in design. Applications of logic design. Selection and construction of control loop parts such as sensors and actuators. Design, build, and test of a miniature controlled system.

**INME 6037**. FINITE ELEMENT ANALYSIS (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Application of energy and variational principles to approximate ordinary and partial differential equations. Application of weak and strong formulations. Application to structural and heat transfer problems with static and

dynamic loading. Computer programming of finite element analysis code to solve one-and two-dimensional problems using isoparametric formulation. Comparison of finite element results with exact and semi-analytical solutions.

**INME 6039**. VIBRATIONS (Every third semester). Three credit hours. Three hours of lecture per week.

Systems with multiple degrees of freedom, principal modes and coordinates, modal analysis, influence coefficients, transfer matrix. Lagrange's equations. Continuous system, longitudinal, torsional and lateral vibrations. Simulation of vibrational problems on analog and digital computers.

**INME 6040**. ADVANCED KINEMATICS (Every third semester). Three credit hours. Three hours of lecture per week. Prerequisite: Graduate state.

Kinematic synthesis by analytical and computer assisted methods. Advanced topics in kinematic synthesis of linkages. Computerized design for function, path and motion generation. Spatial mechanisms and robotics.

**INME 6045**. AUTOMATIC ASSEMBLY SYSTEMS (Every third semester). Three credit hours. Three hours of lecture per week.

Introduction to assembly systems; mechanics of vibratory and non vibratory feeders; parts feeding and orienting devices; natural resting aspects of parts; performance and economics of automatic assembly and robotic assembly systems; product design improvement for ease of assembly.

**INME 6046**. DESIGN FOR MANUFACTURE (Every third semester). Three credit hours. Three hours of lecture per week.

Methods to assist in the design of products for manufacture. Guidelines and design rules for quality control and to ease the fabrication of assemblies and products with casting and molding processes, material removal, and deforming.

**INME 6047.** INTERMEDIATE FLUID MECHANICS. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Analysis of fluid flow around a rigid body by applying equations for continuity, momentum and energy, and two-dimensional potential flow. Introduction and application of compressibility effects to analyze fluid flow around transonic wings. Analysis of friction and heat transfer in duct flows. Nozzles, diffusers and propulsion devices will be discussed.

**INME 6048.** CONTINUUM MECHANICS. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Study of continuum mechanics covering algebra and calculus of tensors, analysis of stress and deformation at a point. Development of the basic equations of a continuous medium by applying the basic laws of conservation of mass, linear momentum, moment of momentum, and the first and second law of thermodynamics. Study of constitutive axioms and constitutive relations for solids and fluids, application to problems of solid mechanics and/or fluid mechanics.

**INME 6055.** CONDUCTION AND RADIATION HEAT TRANSFER. Three credit hours. Three hours of lecture per week.

Discussion and use of methods for the analytical solution of heat conduction and heat radiation problems including Bessel's functions, separation of variables, superposition, and the Laplace transform. Numerical solution of combined heat conduction and radiation problems using the methods of finite difference and discrete ordinates for radiatively participating and non-participating media.

**INME 6065.** PRINCIPLES OF BIOMEDICAL ENGINEERING. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Study of advanced general topics as applied to biomedical systems. Brief history of medicine, including human anatomy, physiology, and the rise of modern molecular biology. Description of the development of quantitative methods in biology, and the role of engineering in understanding complex biological systems. Description of relevant laws, professional ethics and regulatory environment.

**INME 6099**. RESEARCH (I, II). Six credit hours.

Research in the field of Mechanical Engineering. The presentation and approval of a thesis is required in order to obtain the six credits.

**INME 6107.** SMART MATERIALS AND DEVICES. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Study of smart materials and their classification according to their response and stimuli ability. Discussion of the effect of crystalline structure on the properties of piezoelectric materials, magnetostrictive alloys, shape memory alloys and others. Application of smart materials in actuators and sensors.

**INME 6115.** BIOMATERIALS. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Study of advanced materials as applied to biomedical systems. Integration of materials science and engineering concepts with biology for the design of successful interfaces between living cells and organic and inorganic materials as well as medical devices.

**INME 6135.** TISSUE ENGINEERING. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Study of tissue engineering applied to biomedical systems. Review of quantitative cell and tissue biology, cell and tissue characterization, engineering methods and design, and clinical implementation. Discussion of cells and their behavior, followed by the effect of external stimuli on cells. The properties of the extracellular matrix will be studied. Specific cases of vascular tissue engineering, cartilage tissue engineering and bone engineering will be studied. The implications of using stem cells for tissue engineering will be discussed.

**INME 6160.** FUNDAMENTALS OF MICRO AND NANOFABRICATION. Four credit hours. Three hours of lecture and three hours of laboratory per week. Prerequisite: authorization of the Director of the Department.

Discussion and application of micro and nanofabrication techniques as applied to micro-electro-mechanical systems (MEMS) and nano-electro-mechanical systems (NEMS), such as photolithography, subtractive and additive techniques, surface and bulk micromachining, soft lithography and non-conventional fabrication techniques. Hands-on laboratory experience on mask design, photolithography, surface micromachining and soft lithography.

**INME 6165.** DESIGN OF MICROFLUIDIC SYSTEMS. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Discussion of advanced concepts and technologies of micro-scale flows. Analysis of microfabrication techniques, special cases of the Navier-Stokes equations, inertial microfluidics, capillary effects, droplet microfluidics, electrokinetics, acoustofluidics, optofluidics, nanofluidics, and transport phenomena in micro-scale flows. Determination of design parameters and optimization of micro-scale fluidic structures based on analytical and computational solutions of the Navier-Stokes, energy and mass transport equations.

**INME 6170.** BIOMEDICAL MICRO-ELECTRO-MECHANICAL SYSTEMS (BIOMEMS). Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Discussion of advanced topics in biomedical micro-electro-mechanical systems (BioMEMS). Analysis of the underlying physical, chemical and biological phenomena in BioMEMS as applied to medical and biological sciences. Design of BioMEMS based on the current trends in the field of biomedical science and engineering.

**INME 6748**. ENERGY AND VARIATIONAL PRINCIPLES IN APPLIED MECHANICS. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Application of energy and variational principles in applied mechanics using fundamental theorems from variational calculus and solid mechanics. Derivation of equations of mechanics from energy and variational principles. Formulation and solution of initial-, boundary-, and eigen-value problems using direct variational methods.

**INME 6810**. MECHANICAL FUNDAMENTALS OF ELECTRONIC PACKAGING. Three credit hours. Three hours of lecture per week. Prerequisite: authorización of the Director of the Department.

Discussion of the fundamental mechanical principles used in the design of electronic devices and their integration into electronic systems. Analysis of the manufacturing processes related to the integration levels with focus on the effect of materials compatibility, thermo/mechanical stresses, solder interconnections, and reliability. Discussion of electronic packaging at the device and assembly level.

**INME 6995**. SELECTED TOPICS (On demand). One to six credit hours. One to six hours of lecture per week.

Study of selected topics in Mechanical Engineering and related fields.

**INME 6998**. ENGINEERING PROJECT (On demand). Three to six credit hours.

Comprehensive study of a mechanical engineering problem selected to integrate the knowledge acquired in the graduate program of study. This project fulfills one of the requirements of the Master of Engineering Degree (ME) and will be governed by the norms established for the Graduate School for this purpose.

**INME 8000.** DOCTORAL DISSERTATION. Zero to six credit hours.

Academic research and dissertation development based on an original research project in Mechanical Engineering.

**INME 8017.** DOCTORAL SEMINAR. Zero to one credit hour.

Discussions and presentations on advanced topics related to Mechanical Engineering and research projects developed by students of the doctoral program.

**INME 8995.** ADVANCED PROBLEMS IN MECHANICAL ENGINEERING. One to six credit hours.

Research and special problems at and advanced level in Mechanical Engineering and/or related fields.

**INME 8997.** ADVANCED TOPICS IN MECHANICAL ENGINEERING. One to three credit hours.

Advanced fundamentals and research topics not covered by existing graduate courses in Mechanical Engineering and/or related fields.

# *INTERDISCIPLINARY PROGRAMS*

## DOCTORAL PROGRAM IN COMPUTING AND INFORMATION SCIENCES AND ENGINEERING

### Graduate Courses

**CIIC 6005**. COMPUTING FOUNDATIONS. Three credit hours. Three hours of lecture per week.

Concepts and formal definitions of algorithmically solvable problems. Classification of problems by their computability in terms of the time and space required to solve them.

**CIIC 8995**. ADVANCED TOPICS. One to six credit hours. One to six hours of lecture per week.

Study of advanced topics in science and engineering of information and computing.

**CIIC 8996**. DOCTORAL SEMINAR. Zero to three credit hours.

Study and dissemination of current research topics in sciences and engineering of information and computing. Each student will select a research topic for which he/she will make a formal and public presentation.

**CIIC 8997**. INDEPENDENT STUDY. Zero to six credit hours.

Independent studies in sciences and engineering of information and computing.

**CIIC 9995**. DOCTORAL DISSERTATION. Zero to eighteen credit hours.

Research work leading to a significant and original contribution in sciences and engineering of information and computing.

## BIOENGINEERING GRADUATE PROGRAM

### Graduate Courses

**BING 6002**. MOLECULAR AND CELLULAR BIOLOGY FOR ENGINEERS. Three credit hours. Three hours of lecture per week.

Study of the biology of cells, emphasizing examples relevant to bioengineering. Topics such as protein structure and function, cellular membranes and organelles, cell growth and oncogenic transformation, cellular transport, receptors and cell signaling, the cytoskeleton, the extracellular matrix, and cell movement will be included.

**BING 6004**. PRINCIPLES OF COMPUTATIONAL BIOENGINEERING. Three credit hours. Three hours of lecture per week.

Study of computational issues and methods employed in molecular biology. Biological data sources available on the internet will be introduced and analyzed.

**BING 6016**. ERGONOMICS FOR ENGINEERS AND BIOMEDICAL SCIENTIST. Three credit hours. Three hours of lecture per week.

Study of anatomical and physiological concepts that describe and predict human motor capabilities, with particular emphasis on the evaluation and design of manual activities in diverse occupations. Use of quantitative and simulation models to explain muscle strength performance, cumulative and acute musculoskeletal injuries, physical fatigue, and human motion control.

**BING 6017.** ADVANCED BIOSTATISTICS APPLICATIONS. Three credit hours. Three hours of lecture per week.

Application of statistical methods to solve biomedical and bioengineering problems. Use of generalize linear models, including logistic, Poisson, and binomial regressions. Design of experiments under biological process constraints and appropriate data analysis. Use of artificial neural network techniques to model nonlinear relationships among qualitative and quantitative variables of a biomedical system.

**BING 6097**. BIOMEDICAL ACOUSTICS. Three credit hours. Three hours of lecture per week.

Application of acoustics principles toward the design of diagnostic and therapeutic medical devices. Use of computer tools to simulate the acoustic response of systems composed of biological tissues.

**BING 6998**. ENGINEERING PROJECT. Zero to six credits.

Comprehensive study of a specific bioengineering problem selected to integrate the knowledge acquired in the graduate program of study.

**BING 6999**. MASTER THESIS. Zero to six credit hours.

Research in the field of Bioengineering and presentation of a thesis.

**BING 8202**. STRUCTURAL BIOINFORMATICS. Three credit hours. Three hours of lecture per week.

Analysis and prediction of the conformation of biological macromolecules. Study of the relation between macromolecular structure and function, with emphasis on proteins.

**BING 8995**. ADVANCED TOPICS IN BIOENGINEERING. One to six credit hours. One to six hours of lecture per week.

Study of advanced topics in bioengineering and related areas.

**BING 8997**. INDEPENDENT STUDIES. One to three credit hours. Three to nine hours of independent study per week.

Independent studies in bioengineering and related fields.

**BING 8998**. GRADUATE SEMINAR. Zero to one credit hour. One hour of seminar per week.

Oral presentations and discussions in areas of interests in bioengineering.

***BING 8999**. DOCTORAL DISSERTATION. Zero to eighteen credit hours.

Development, preparation and defense of a dissertation based on an original research work in bioengineering.

*Doctoral Program

## FOOD SCIENCE AND TECHNOLOGY PROGRAM

### Advanced Undergraduate Courses

**CITA 5005.** QUALITY CONTROL IN THE FOOD INDUSTRY. Three credit hours. Three hours of lecture per week. Prerequisite: MATE 3172 or authorization of the Director of the Department.

Study of quality control tools and the processes of continuous improvement applied to the food industry.

**CITA 5006.** QUALITY AND SAFETY MANAGEMENT IN FOOD PROCESSING. Three credit hours. Two hours of lecture and three hours of laboratory per week.

Safety and quality principles of the management of a food processing plant in Puerto Rico.

**CITA 5007**. FOOD INDUSTRY LAWS AND REGULATIONS. Three credit hours. Three hours of lecture per week. Prerequisite: authorization of the Director of the Department.

Identify key topics and core concepts so that food scientists recognize the laws and regulations that govern the production and handling of foods in the United States and around the world.

**CITA 5010**. CULINOLOGY. Three credit hours. Two hours of lecture and four hours of laboratory per week. Prerequisites: CIBI 3032 or BIOL 3052 or (BIOL 3062 and BIOL 3064) or BIOL 4015 or QUIM 3335 or QUIM 5071.

Study of science concepts underlying physical and chemical transformations when cooking or processing food. Comparison of cooking methods, functional ingredients and processing conditions affecting flavor, aroma, and texture properties. Food preparation principles with emphasis on requirements, challenges and trends informulation and food product development.

**CITA 5995**. SPECIAL PROBLEMS IN FOOD SCIENCE AND TECHNOLOGY. One to three credit hours. One hour of lecture per week per credit.

Study and research of a specific problem in the area of Food Science and Technology selected by the student and the professor.

**CITA 5996.** SPECIAL PROBLEMS IN FOOD SCIENCE AND TECHNOLOGY II. One to three credit hours. One hour of lecture per week per credit.

Study and research of a specific problem in the area of Food Science and Technology selected by the student and the professor.

**CITA 5997**. SELECTED TOPICS I (On demand). One to three credit hours. One to three hours of lecture per week.

Selected topics in food science and technology and related areas.

**CITA 5998**. SELECTED TOPICS II (On demand). One to three credit hours. One to three hours of lecture per week.

Selected topics in food science and technology and related areas.

**Graduate Courses**

**SAGA 5125/CITA 6005.** FOOD PACKAGING. Three credit hours. Three hours of lecture per week.

Study of food packaging and its multiple roles in protecting packaged food and beverage products and facilitating distribution and communication with retailers, consumers and users. Study of the relationship between food packaging and health, safety and economic well being. Use of technology and its integration with products, distribution, and marketing.

**SAGA 5126/CITA 6006.** FOOD SAFETY. Three credit hours. Three hours of lecture per week.

Practices and methods to guarantee food safety and product integrity. Topics such as laws and regulations, good manufacturing practices (GMP's), hazard analysis and critical control points (HACCP), and food labeling will be discussed.

**HORT 6007/CITA 6007**. SAFETY OF FRUIT AND VEGETABLE PRODUCTS (On demand, I). Three credit hours. Two hours of lecture and one three-hour laboratory per week.

Advanced study of intrinsic and extrinsic factors that determine the growth of microorganisms, during post-harvest, processing, storage, and transportation of fruits and vegetables that may affect public health.

**CITA 6010**. FOOD SCIENCE AND TECHNOLOGY ORIENTATION. Zero credit hours. Ten hours of conference a week before the beginning of classes during the first semester of the academic year.

Orientation to university life as a master student of the FST Program. Good laboratory practices. Adequate disposal of chemical and biological wastes. The course meets for a total of 10 hours the week before starting classes during the first semester of the academic year.

**CITA 6015**. ANTIMICROBIAL FOOD PACKAGING (On demand). Three credit hours. Three hours of lecture per week.

Identification of state-of-the-art packaging strategies aimed at inhibiting microbial growth in raw and processed foods from meats, fruits, vegetables, poultry, seafood, and beverages. Analysis of the use of natural antimicrobial agents, nanoparticles, biosensors, DNA arrays, and MALDI-TOF spectrophotometry in applications of biodegradable packaging, films, and antimicrobial coatings.

**CITA 6017**. FOOD TOXICOLOGY (II). Three credit hours. Three hours of lecture per week.

Study of the formation, characteristics, and control of potentially toxic components that occur naturally or are induced during food processing.

**CITA 6018**. MICROBIAL ADAPTATION AND FOOD SAFETY (On demand). Three credit hours. Three hours of lecture per week.

Evaluation of the implications of stress adaptation and its consequences for food safety in kinetics, mechanisms, assessment, and control of stress adaptation and its impact on the safety of processed foods. Description of the responses of pathogens to physical and chemical stresses encountered during food processing that may increase a pathogen's tenacity and resistance to processing. Analysis of the strategies to overcome stress adaptation in foodborne pathogens.

**CITA 6019**. FOOD SENSORY ANALYSIS (On demand). Three credit hours. Three hours of lecture per week.

Discussion of quantitative and qualitative aspects of food sensory analysis. Demonstration and application of the methodology of data gathering and analysis for sensory testing. Design, practice and analysis of three group projects using discrimination, attribute difference and consumer tests, respectively.

**CITA 6601**. FOOD PROCESSING I (I). Three credit hours. Three hours of lecture per week.

Fundamentals and commercial practice of food preservation by heat treatment, drying, freezing, canning, irradiation, and microwaves. Topics included are selection of raw material, preparation, unit operations, packaging, and storage. Processes covered will include aseptic packaging of juice and milk as well as canning of fruits and vegetables.

**CITA 6603**. FOOD PROCESSING LABORATORY I (I). One credit hour. One four-hour laboratory per week. Co requisites: HORT 6601 or CITA 6601.

The topics in the laboratory will include tray drying, freeze drying, freezing, canning, heat penetration process studies in canned products, and fermentation.

**CITA 6605.** QUALITY MANAGEMENT IN THE FOOD INDUSTRY. Three credit hours. Three hours of lecture per week.

Study of quality management systems applicable to the food industry: components and implementation, compliance with the specifications and requirements of customers and regulatory agencies.

**CITA 6615**. FOOD TECHNOLOGY (II). Three credit hours. Two hours of lecture and one three-hour laboratory per week.

Units of operations: filling and packaging, reverse osmosis, ultrafiltration, electrodialysis, evaporation, freeze concentration. Quality control of raw materials and finished products; laws and regulations that apply to food industry.

**CITA 6655**. SEMINAR (II). One credit hour. One hour of seminar per week.

Lectures, discussions, and reports on selected topics that may include results of research work.

**CITA 6990**. SUPERVISED PROFESSIONAL OCCUPATIONAL EXPERIENCE FOR COOP STUDENTS (On demand). From three to six credit hours. Only three credits will be considered within the minimum of the required 30 credits for the graduate program. Prerequisite: Authorization of the Director of the Department.

Practical experience in Food Science and Technology in cooperation with the private sector or government. To be jointly supervised by the academic department, the Coop program coordinator, and an official from the cooperating entity. A written report will be required upon completion of each work period.

**CITA 6992**. FINAL PROJECT. Cero to six credit hours. Twenty hours of independent study per week.

Comprehensive study of a specific problem in the field of Food Science and Technology selected to integrate the knowledge acquired throughout the program.

**CITA 6995**. SPECIAL PROBLEMS IN FOOD SCIENCE AND TECHNOLOGY (On demand). One to three credit hours. One to three research periods per week.

Study and research of a specific problem in the field of food science and technology, selected by the professor and the student.

**CITA 6996**. SPECIAL PROBLEMS IN FOOD SCIENCE AND TECHNOLOGY (On demand). One to three credit hours. Three to nine hours of laboratory per week. Prerequisite: authorization of the Director of the Department.

Study and research of a specific problem in the field of food science and technology, selected by the professor and the student.

**CITA 6997**. SELECTED TOPICS. One to six credit hours. One to six hours of lecture.

Selected topics in Food Science and Technology. Themes will vary according to the needs and interests of students and faculty.

**CITA 6998**. SELECTED TOPICS (On demand). One to three credit hours. Prerequisite: authorization of the Director of the Department.

Selected topics in Food Science and Technology. Themes will vary according to the needs and interests of students and faculty.

**CITA 6999**. THESIS (On demand). Three to six credit hours.

Preparation and presentation of a thesis.