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ORGANIZATION

HISTORICAL SKETCH

The University of Puerto Rico was created by an act of law of the Legislative Assembly on March 12, 1903. It emerged as an outgrowth of the Normal School at Fajardo, which had been established three years earlier with the purpose of training teachers for the Puerto Rican school system.

In 1908 the benefits of the Morrill-Nelson Act were declared applicable to the Island, thus fostering the rapid growth of the University. Evidence of that growth was the establishment of the College of Liberal Arts at Río Piedras in 1910 and of the College of Agriculture at Mayagüez in 1911.

It was in the College of Agriculture that 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 fifty years: the College of Agriculture and Mechanic Arts. The strengthening and diversification of the academic programs at Mayagüez was recognized years later when in 1942, as a result of university reform, the campus was organized into the colleges of agriculture, engineering, and science, under the direction of a vice chancellor. The expansion continued through the 1950's, when many programs flourished in the University. At Mayagüez, the College of Arts and Sciences and the Nuclear Center were established. At Río Piedras, the Colleges of Humanities, Natural Sciences, Social Sciences, and Business Administration emerged. At San Juan, the Schools of Medicine, Odontology, and Tropical Medicine were established.

The establishment of the Nuclear Center prompted the initiation of a graduate program at Mayagüez in 1957, since the latter provided an adequate climate for research. The program comprised the fields of nuclear science and technology, radiological physics, and mathematics. Initially the graduate program was directly under the Office of the Vice-Chancellor, but in 1965 it was transferred to the Office of the Dean of Studies. The Office of Graduate Studies was formally instituted in December 1967.

The Mayagüez Campus of the University of Puerto Rico continues its development in the best tradition of a land grant institution. It is a coeducational, bilingual, and nonsectarian school. It comprises the Colleges of Agricultural Sciences, Arts and Sciences, Business Administration, and Engineering. The College of Agricultural Sciences encompasses the Agricultural Experiment Station and the Agricultural Extension Service. Altogether the Campus gathers over 801 professors and researchers, 232 extensionists, and about 12,600 students. There are approximately 800 students enrolled in graduate programs.

ACCREDITATION AND AFFILIATION

The Mayagüez Campus of the University of Puerto Rico is fully accredited by the Middle States Association of Colleges and Schools, of which it is a member since 1946. It is also a member of the Association of Hispanic-American Universities.

In addition, the following programs are accredited by professional societies: Chemistry, by the American Chemical Society; associate and bachelor degrees in Nursing, by the National League of Nursing; and bachelor degrees in Chemical, Civil, Computer, Electrical, Industrial, and Mechanical Engineering, by the Accreditation Board of Engineering and Technology (ABET).

The University of Puerto Rico, Mayagüez Campus has been a sponsoring institution of Oak Ridge Associated Universities (ORAU) since 1966. ORAU is a private, not-for-profit consortium of 65 colleges and universities and a management and operating contractor for the U.S. Department of Energy (DOE) with principal offices located in Oak Ridge, Tennessee.

MISSION, AIMS, AND OBJECTIVES

Within the philosophical framework established by the University of Puerto Rico Act, the

Mayagüez campus directs its efforts towards the development of educated, cultured citizens, capable of critical thinking, and professionally qualified in the fields of agricultural, social, and natural sciences, engineering, humanities and business administration. They should be able to contribute in an efficient manner to the cultural, social, and economic development of the Puerto Rican and international community. This process is aimed at endowing our alumni with a strong technical and professional background and to instill a strong commitment to Puerto Rico and our hemisphere. Our alumni should have the necessary skills and knowledge to participate effectively in the search for solutions to the problems facing us, to promote the enrichment of the arts and culture, the development and transfer of technology as well as to uphold the essential attitudes and values of a democratic society.

To achieve the long-range goal mentioned above, the Mayagüez Campus strives to:

- Direct the efforts and initiatives of the Campus equally in three fundamental areas: instruction, research, and services to the community.
- Define the priorities and academic approaches of each college in such a way that they will provide opportunities to meet the needs of regular and continuing education.
- Direct the activities and initiatives of both the academic and research components of the Campus in such a way that they will not only share a common perspective but also constitute parts of the same effort and purpose.
- Provide a university education that will equip its graduates for fulfilling professional career and leadership training that will contribute to the enrichment of their spiritual and personal lives.
- Provide its students with the means to enable them to understand the changing social and economic problems and issues of our time.
- Develop in the students an ability to analyze, judge critically, summarize, formulate hypotheses, consider alternatives, distinguish between feelings and reasons, and reach valid conclusions.
- Encourage students to develop a personal philosophy of life that will make them feel a part of their community and also of the world. This will enable them to establish their own values, standards, and ideals, thereby making them active rather than passive members of the community.
- Develop in the students a positive attitude towards learning in order to encourage them to continue to improve and update their knowledge.
- Expedite the establishment of interdisciplinary programs to facilitate the full development of the intellectual potential of the students. This will enable them to function in a variety of areas of human endeavor.
- Develop programs that will create student awareness of the need to properly utilize and conserve natural, physical, and economic resources in order to ensure a better life for the people of Puerto Rico and for all humanity.
- Extend cooperative education to selected academic programs based on the needs of the community.
- Promote and encourage the professional and technical development of Campus employees based on their capabilities and interests as well as on the needs and realities of the institution.
- Provide students with services and facilities that create a favorable atmosphere for their full intellectual, social, and spiritual development.
- Develop educational technology resources and expand their effective use.
- Develop available library resources.
- Establish and define general criteria to guide the accreditation process of the Institution.
- Stimulate the participation of the total University community in the planning and

evaluation of academic programs and University agencies.

- Standardize procedures for the appointment, tenure, and promotion of academic personnel, without losing sight of the different needs of the academic departments.

- Assist government agencies and the private sector in the search for solutions to the problems that affect our times and the island.

In accordance with the aforementioned long-range goals and general objectives, each department and institutional unit directs its efforts and actions towards the common goal of preparing professionals with the scientific and technological backgrounds and the social awareness necessary to fulfill the needs of our constantly changing society.

STRUCTURE AND GOVERNMENT

Organization of the University of Puerto Rico

Presently the University of Puerto Rico is a well-established and mature institution, with a total enrollment of over 69,000 students. The Mayagüez Campus serves a student population of 12,800 students. It was organized as a result of the University Act (P.L.1), which was approved on January 20, 1966, and amended by Law No. 16 in 1993. 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 the Colleges at Aguadilla, Arecibo, Bayamón, Carolina, Cayey, Humacao, Ponce, and Utuado which are for undergraduate education. These institutional units are autonomous, each of them having a chancellor as chief administrative and academic officer.

Board of Trustees of the University of Puerto Rico

The Board of Trustees is the governing body of the University of Puerto Rico. Its membership consists of 10 private citizens who represent the public interest in higher education, two faculty members, and a student representative. The Governor of Puerto Rico, with the advice and consent of the Senate of Puerto Rico, appoints the representatives of the public interest. The faculty and student representatives are elected from among the non-university administration members of the University Board. Five of the public interest members are appointed to an eight-year term, three members to a six-year term, and the remaining two members to four-year terms. The faculty and student representatives are elected to one-year terms. Members representing the public interest may be reappointed to additional terms as long as the total time served does not exceed 8 years. The Board of Trustees elects its president from among its members.

The Board of Trustees, as the main authority of the University of Puerto Rico, is responsible for:

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

The Board of Trustees of the University of Puerto Rico meets in regular sessions according to an annual schedule which it approves and publishes each year. It may hold extraordinary meetings at other times when so directed by its president or required by five of its members.

President of the University of Puerto Rico

The President of the University is appointed to an indefinite term by the Board of Trustees, is the chief executive officer of the University system. Subject to the approval of the Board, he or she selects the chancellors of the various campuses and colleges. The President represents the University on corporate matters before the courts and government agencies. He or she is also an ex-officio member of all the faculties,

academic senates, and administrative boards of the University.

The President is responsible for the submission of the yearly budget for consideration by the Board of Trustees; the institutional development plan and its revisions; the regulations, contracts, and agreements that require university approval; and the annual report. He or she is also responsible for developing and maintaining relationships with other cultural and educational institutions that are local, national, or international.

University Board

The University Board consists of:

- the President of the University
- the chancellors of the 11 autonomous institutional units
- the Director of Finance
- three additional members appointed by the President with the approval of the Board of Trustees, one faculty representative from each Academic Senate, and one student representative from each unit

The Board is responsible for the preparation of:
- the general By-laws of the University
- the general By-laws of the student body
- the development plan of the University with the recommendations of the Academic Senates.

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

Chancellor of the Mayagüez Campus

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

1. presiding over the Administrative Board, the Academic Senate, and the faculty meetings;
2. appointing the deans, departmental directors and University personnel;
3. resolving, on appeal, controversial decisions of the 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.

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 budget proposal prepared by the Chancellor, and is responsible for granting tenure, promotions, and leaves of absence.

Academic Senate

The Academic Senate of Mayagüez is a body consisting of the members of the Administrative Board, the Director of the Library, the Director of the Counseling Office, representatives elected from the faculties whose number must not be less than twice the number of the ex-officio members, an elected member of the Library and Counseling Office, and 10 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 law structure.

The Faculty

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

The 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 in the Academic

Senate, the Administrative Board, University Board, and the Board of Trustees.

The Student Ombudsperson Office

This Office was created on November 10, 1999, as a result of the University's belief in dialogue and communication as the best way to pursue truth and thus enhance the quality of life for the students.

One of the University of Puerto Rico's fundamental objectives is to provide adequate and appropriate conditions to augment the development of its students. The mission of the Student Ombudsperson Office is to promote an effective though informal process to generate solutions to students' problems and conflicts.

In order to redress a grievance or complaint, the student has to initiate the pertinent procedure in the corresponding unit, according to the University's regulations. If such pursuit is not successful or ends up being onerous, the student will be able to seek the Student Ombudsperson's intervention. The complaints can be presented personally or by a written statement.

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 - Rights and duties in the academic relationship

A. The work involved in the subject under study constitutes the basis of the 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 he/she disagrees with them. 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 his/her 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 the 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 the 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 Mayagüez Campus Regulations (Reglamento de Estudiantes del Recinto Universitario de Mayagüez) available in the Office of the Dean of Students.

Regulations for Students of the Mayagüez Campus

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 the 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 of Students

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 the 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 right 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 at the Campus Office of the Dean of Students.)

INSTITUTIONAL POLICY ON THE PRIVACY OF EDUCATIONAL RECORDS

The University of Puerto Rico intends to comply fully with the clauses of the Buckley Amendment (Family Educational Rights and Privacy Act of 1974, as amended) of the United States Federal Government. This Act protects the private nature of students' educational files and establishes their right to inspect and examine said files. It also provides the guidelines to correct the accuracy of the information through informal and formal hearings. Students have the right to file complaints, if they so wish, with 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, in relation to alleged violations of the Act by the institution.

Copies of the institutional policy established by the University in compliance with the Act may be obtained in the Office of the Registrar, the General Library, the Office of the Dean of Students, the Financial Aid Offices, and at the Student Affairs Office of the colleges, schools, and programs. These offices maintain the student lists and the location of the students' educational records kept at the University. Questions related to the aforementioned Act should be addressed to the Office of the Registrar.

INSTITUTIONAL POLICY AS TO EQUALITY OF OPPORTUNITIES

The Mayagüez Campus of the University of Puerto Rico guarantees equal opportunities to its applicants for employment and academic admission. It also guarantees students and employees 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. The Campus does not exclude from participation nor deny benefits to nor discriminate against any person by reason of age, race, sex, color, place of birth, social origin or condition, physical or mental handicap, or political or religious beliefs.

Any applicant for academic admission or employment or any student or employee, who feels he or she has been 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 the Federal regulations for the implementation of Title IX, Educational Amendments of 1972, and Section 504 of the 1973 Rehabilitation Act.

FOREIGN NONIMMIGRANT STUDENTS

The Mayagüez Campus is authorized by law to admit foreign nonimmigrant students. (For additional information, refer to the section on Academic Regulations and to the section on Special Fees for Nonresident Students).

THE 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.

THE 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, Department of Health and Human Services, Title 45 (Public Welfare), Part 46: Protection of Human Subjects (revised March 8, 1983).

POLICY ON 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 thereof. The lack of integrity and the perpetration of academic and scientific fraud include plagiarism, falsification, false attribution, and all 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.

INSTITUTIONAL POLICY ON 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 the provision of services. Grievance procedures are spelled out in Circular Letter 88-07 (May 27, 1988) of the President of the University of Puerto Rico and the Administrative Board Certification #93-94-303 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. Smoking is permitted in public areas such as open hallways and other open spaces.

INSTITUTIONAL POLICY ON 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. 4 of June 23, 1971, and further treated in subsequent Federal and Commonwealth legislation. The policy and the means and procedures for its enforcement are detailed in Circular Letter 89-01 (June 6, 1989) of the President of the University of Puerto Rico.

GENERAL INFORMATION

Research

In addition to the numerous research laboratories under direct faculty supervision, the Mayagüez Campus has several research and development institutes which provide valuable support for research activities.

The Agricultural Experiment Station, originally established in 1910 by the Sugar Producers Association, 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 and to develop technology to 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 and six agricultural substations located at Adjuntas, Corozal, Juana Díaz, Gurabo, Isabela, and Lajas. The Station staff, laboratories, a specialized 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 Experiment Stations. This Association serves as a regional link to the U. S. Department of Agriculture, the National Association of State Universities and Land Grant Colleges (NASULGC), and the U. S. Congress.

The Bio-Optical Oceanography Laboratory (BIOL) of the University of Puerto Rico at Mayagüez, Department of Marine Sciences, has 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: (1) variability of inherent and apparent water optical properties, (2) effects of ultraviolet radiation on tropical marine organisms and on public health, (3) satellite data validation and algorithm development, and (4) estimation of oceanic primary production.

The Center for Applied Social Research (CISA), established in 1991, is an integral part of the Department of Social Sciences. CISA promotes and coordinates practical applications of faculty expertise to the analysis and mitigation of problems arising from or inextricably linked to social attitudes and behavior. The specific objectives of CISA are: 1) to provide strong research training and mentoring to undergraduate students; 2) to engage faculty and students in interdisciplinary research; 3) to develop collaborative research projects with other research centers, programs, and institutions; 4) to enhance the professional development of researchers and students through participation in a diverse number of seminars, workshops, and conferences; and 5) to increase the number of students pursuing a graduate degree in the social sciences.

Since CISA was established, a diverse number of research projects have been generated by researchers affiliated to the Center; such as: drug abuse, socioeconomic impact of resource management among fishermen, poverty and income inequality in the United States and Puerto Rico, public opinion and political participation, mitigation and preparedness regarding natural disasters, quantitative and qualitative aspects of urban rail transit systems, HIV/AIDS and mental health issues, female labor force participation in the tuna industry, comparative analysis of psychological depression in the Caribbean, and evaluation of the Minority Access to Research Careers (MARC) Program. A CISA research component that has been strongly developed during the previous focuses on outcome and process evaluation. Research projects in CISA have received funds from external (i.e., National Science Foundation, National Institute of Health, National Institute of Mental Health, National

Fisheries Service, U.S. Army Corps of Engineers, Ford Foundation/American Sociological Association, National Forest Service), state, and local sources as well as from the University of Puerto Rico. All the CISA projects involve direct student participation as research assistants, reflecting the center's commitment to undergraduate research training and mentoring.

The Center for Computing Research and Development (CECORD) was established to support the research activities of the National Science Foundation grant entitled Development of a Computer Engineering Research Environment at UPR-Mayagüez. The major goals of this grant are to develop the research environment needed to start a Ph.D. program in computer engineering and computer science and to increase minority participation in graduate school programs and research. The Center was conceived as an organization supported by research grants. Currently, the National Science Foundation, the Economic Development Administration of Puerto Rico, and the University of Puerto Rico fund it.

The Center for Hemispheric 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 maintains relationships with most of the hemisphere's ONCyT members through officially designated liaisons.

CoHemis publishes a free quarterly newsletter in English and Spanish distributed to persons and entities from Canada to Chile who are interested in science and technology (S&T) collaborations in such basic fields as energy, manufacturing, environment and natural resources, and infrastructure. This publication, *CoHemis*, reaches U. S. Congressional committees and educational and government R&D institutions as well as key members of the Latin American S&T community.

The Center for Internet Enhanced Education (CECI, by its Spanish initials), located at Chardón 217, is an innovative faculty-oriented computer center recently created by Dr. Mario Núñez Molina, professor of Psychology at the University of Puerto Rico at Mayagüez. CECI's main purpose is to aid the Faculty of the Department of Social Sciences in the process of integrating the use of the new information and communication technologies in the teaching of their respective courses. CECI also conducts research evaluating the effects that the Internet and other related technological advances have on the learning process.

CECI has desktop computers and laptops, connected to the Internet; a digital projector; a digital photo camera; a digital video camera; a printer; a photocopier, and a scanner. CECI also has different kinds of computer software, as well as journals, magazines and books related to the Internet and education. CECI has a web page which can be accessed at www.uprm.edu/ceci .

Besides having its resources available for faculty members, CECI currently provides the following services for the faculty of the Department of Social Sciences: 1) workshops about the development of online courses using WebCT and Internet Classroom Assistant (ICA); 2) workshops on web page design using Trellix Web; 3) individual assistance to faculty members regarding internet enhanced education; and 4) conferences and articles about the implications of the new education and communication technologies for education.

CECI also publishes *Hermes*, a newsletter which provides information regarding CECI's activities, and includes brief articles describing specific Internet and education related tools and software. It also serves the purpose of identifying and sharing with the faculty useful resources available on the WWW. Although Hermes is published in print, it is also available online at www.uprm.edu/ceci/hermes.htm.

The Center Research Instrumentation Laboratory (CRIL), founded in 1982 in the Department of Chemistry, has sophisticated instrumentation for inorganic, organic and environmental analysis. The staff includes a director and two instrumentation assistants. Available instrumentation include a 500 MHz Bruker and 300 MHz Varian NMR, a System 2000 FT-IR coupled to a Gas Chromatograph

and equipped with near and mid IR detectors, a Hewlett Packard Gas Chromatography/Mass Spectrometry system, a Perkin Elmer and Varian Atomic Absorption Spectrophotometers equipped with flame, cold vapor and graphite furnaces; a Leeman Labs Inductive Coupled Plasma-Optical Emission Spectrometry system, a Dionex Ion Chromatograph equipped with conductivity detector; and a Finnigan GC/MS/MS equipped with direct insertion probe, electron impact and chemical ionization sources. The CRIL staff provides service to undergraduate, graduate courses and research groups of the Chemistry Department as well as to other academic departments, the community, government agencies and local industry.

The Heat and Mass Transfer Research Laboratory (HMTRL) comprises research facilities dedicated to basic and applied theoretical and experimental research in heat and mass transfer phenomena. The facilities are administered by the Mechanical Engineering Department of the University of Puerto Rico at Mayagüez and are located on the first floor of the Luchetti Building.

Facilities associated with the HMTRL include several Pentium-based personal computers and silicon graphics CAD work stations, a solar collector testing facility, spray cooling experimental facilities, spray forming experimental facilities, and extensive instrumentation to measure flow, humidity, pressure, and temperature. Research in environmental flows, heat transfer in manufacturing of electronics components, metal sprays, solar energy, spray cooling, and two-phase flows is currently being conducted at the HMTRL. External agencies and companies sponsor most of the research projects.

Laboratory for Applied Remote Sensing and Image Processing (LARSIP) is a multidisciplinary laboratory located within the Department of Electrical and Computer Engineering at the University of Puerto Rico, Mayagüez Campus, and dedicated to the research and implementation of remote sensing, and the development of signal and image processing, geographical information systems (GIS), and emergency response system and Global Positioning System (GPS) technologies.

Additional services such as scanning, slide making, color plotting, and accessing aerial color and infrared photographs provided by NASA continue to be in high demand. The Space Information Laboratory receives, processes, and distributes images of the Caribbean and northern Amazon region for the purpose of investigation, planning, proposing, deciding upon and implementing studies of the infrastructure of the entire Caribbean Community of nations and a large portion of the Amazon region.

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 the NASA University Research Centers Program, (NASA-URC), the RAYTHEON Corporation, the Economic Development Administration of the Government of Puerto Rico (FOMENTO), and UPR through the Tropical Center for Earth and Space Studies (TCESS) established in 1995. TCESS complements and enhances LARSIP. Both LARSIP and TCESS function as training centers 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 Mayagüez and other UPR campuses. Universities and institutions in other countries are encouraged to form and establish liaisons with LARSIP and TCESS through Memoranda of Understanding or other similar arrangements.

The Learning Factory - The Manufacturing Engineering Education Partnership or MEEP (UPR-Mayagüez, Penn State University, and the University of Washington, in collaboration with Sandia National Laboratories and industry), has developed an undergraduate product realization/manufacturing engineering option which addresses various issues of the new ABET 2000 criteria, specifically Criteria 2 and 3 The result of this Program is the Learning Factory, an outcome-based undergraduate curriculum integrated with laboratory facilities and industry collaboration.

The Mechatronics Center at the Mechanical Engineering (ME) Department is the only training and research center in Puerto Rico dedicated to the study of the fundamentals of intelligent mechanical and electromechanical systems. The center offers training to industry and support for existing ME courses, while

providing facilities and resources for research in the field of modeling and computer control of mechanical and electromechanical systems.

The training facilities are equipped with eight laboratory workstations that will have the basic equipment to perform experiments and projects in mechatronics. The center also includes a prototyping laboratory 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 center's activities.

The prototyping laboratory provides students with access to specialized mechanical, electrical, and software tools for the design and realization of intelligent machines. The center also utilizes the equipment available in the Manufacturing Processes Laboratory, which empowers the center to handle a wide variety of complex projects involving the fusion of mechanics, electronics, and software technologies.

The Mechanical Systems Response Research Laboratory (MSRRL) at the Mechanical Engineering Department supports research efforts in various areas that focus on mechanical/material component systems in military and civil applications. Areas ranging from structural vibration control, material characterization, infrastructure health monitoring and diagnostics, to even Micro Electronic Mechanical Systems (MEMS) sensor development and applications is currently being perform. MSRRL is supported through research efforts from 5 faculty members from different departments.

MSRRL performs research from various government agencies such as DoD, NSF, NSF-EPSCoR, NASA, and private industry with funding currently approaching $2 million. Projects include topics such as:

- Characterization of Sandwich Composite Materials used in Civil and Military Stealth Applications
- Vibration Control using shape memory alloys
- Vibration Shaker Design
- Damage Detection and Health monitoring using Neural Networks
- Flow induced vibrations
- Acoustic Emission in Damage Detection and Material Characterization
- Novel Dynamic Material Characterization techniques

The MSRRL laboratory is equipped for research in mechanical/material component systems. The laboratory has a laser vibrometer for structural vibration response, several dynamic signal analyzers, acoustic emission equipment, data acquisition equipment, transducers (acceleration, force, and temperature), conditioning amplifiers, power supplies, oscilloscopes, computer facilities and a vacuum system for composite manufacture.

The Puerto Rico Commercial Aquaculture Research and Development Center (CIDACPR) of the University of Puerto Rico at Mayagüez, Department of Marine Sciences (DMS) was formed in 1994 to assist the Commonwealth of Puerto Rico with development of aquaculture in the Island. CIDACPR is funded by the Industrial Incentives Program (formerly the Science and Technology Board) of the Secretariat for Economic Development and Commerce of Puerto Rico, and the University of Puerto Rico. CIDACPR has specialist in economics and marketing, analysis of aquaculture enterprises, research facilities, and extension services, the latter in collaboration with the Agricultural Extension Service and the Sea Grant College Program.

CIDACPR has research and production facilities in Lajas and Sabana Grande in Southwest Puerto Rico. It offers key services to the Puerto Rican community, performs scientific research to support the local aquaculture industry, and provides fish fingerlings and postlarval prawns for these activities.

NASA PaSCoR, Partnership for Spatial & Computational Research, NASA Grant # NCC5-340, http://www.ece.uprm.edu/pascor
Lueny Morell, PI, lueny@ece.uprm.edu
Ramón Vásquez, Co-PI, reve@ece.uprm.edu
Jorge I. Vélez-Arocho, Outreach Coordinator
jvelez@ece.uprm.edu - The University of Puerto Rico at Mayagüez (UPRM) has established, through NASA Grant number NCC5-340, the Partnership for Spatial and Computational Research (PaSCoR). The main goal of this 5-year project is to strengthen academic programs and integrate research at the undergraduate level in various science, math and engineering/technology (SMET) disciplines, following the strategy of the Learning Factory

model implemented by the NSF Manufacturing Engineering Education Partnership. PaSCoR program is outcomes-based and student centered, focused on hands-on learning activities provided throughout the student's academic career.

The program's outcomes will be a SMET graduate that is knowledgeable of the technology and applications of remote sensing (RS) and geographical information systems (GIS), and, possesses the necessary skills either to enter graduate school or becomes a professional in these areas with success. The program also aims at developing values such as diversity, teamwork, global awareness and communication. PaSCoR goals will be achieved through five tasks, namely: 1) curriculum development, 2) undergraduate research & student mentoring, 3) industry collaboration, 4) outreach, and, 5) assessment.

Students from various SMET departments at UPRM (Agricultural Sciences, Biology, Geology, Electrical & Computer Engineering, Civil Engineering, and Mathematics) will be able to earn a certificate in RS/GIS upon completion of 12 credit-hours in course work, 6 credit-hours in undergraduate research and a summer internship. Courses and resources are open to all SMET student on Campus. Currently, there are eight (8) faculty members involved in student mentoring and course innovation/development, more than 30 students engaged in undergraduate research and more than 750 students taking RS/GIS interdisciplinary courses. NASA site visitors have recognized this project as a model program in the US. PaSCoR students have spent summers learning about RS-GIS and developing leadership skills in sites such as USGS, NASA, Caribbean Pictometry and the PR Planning Board. Due to her outstanding performance, undergraduate student, Fernmarie Rodríguez has been selected to NASA's Summer Academy. More than 20 publications and presentations in local, national and international forums have helped dissemminate this curriculum model.

The Office of the Associate Dean for Academic Affairs and Research of the College of Engineering serves as a coordinating and administrative unit of the College of Engineering, overseeing activities in research and technical services among the six departments within the College. In order to stimulate research, the Office distributes an External Funds Opportunities Bulletin, which contains information related to grant and fellowship opportunities. In addition, the Office provides support in proposal and report preparation. The Office of Academic Affairs and Research houses the Technical Information Center, which issues a monthly publication comprised of titles and abstracts of recently published articles and documents geared towards keeping teaching and research groups informed of new advances and developments in engineering and technology and related fields. The Office also houses the Water Resources Research Institute, which pursues research activities emphasizing the solution of water resources problems on the island.

The Puerto Rico and U. S. Virgin Island Climatology Center of the University of Puerto Rico at Mayagüez, Department of Marine Sciences provides the latest climate data and weather information available for the Caribbean. The Climate Office 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 obtained from many other organizations, foremost of which are the National Climate Center, Asheville, North Carolina, and the Climate Analysis Center, Washington, D. C. The Center receives journals on climate topics and has a large collection of climate data on CD-ROMS.

The Puerto Rico Water Resources Research Institute (PRWRRI) is one of 54 water research centers established throughout the United States and its territories by an act of Congress in 1964 and presently operates under Section 104 of the Water Research and Development Act of 1984 (P.L. 98-242).

Since its creation, the Puerto Rico Water Resources Research Institute has sponsored a substantial number of research projects supported jointly by Federal and University of Puerto Rico funds.

The PRWRRI is a component of the Research and Development Center of the University of Puerto Rico at Mayagüez. As such, it acts as the official liaison of the University of Puerto Rico with industry and government for all water resources 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 research program the Institute supports.

By virtue of the local relevance of its research and the prestige and leadership of the investigators it has supported, the Institute has become the focal point for water-related research in Puerto Rico. Meetings, seminars, technical reports, and a quarterly newsletter are used by the Institute to keep the water resources community and 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 of these activities facilitate the translation of the research sponsored by the Institute into practical applications of direct benefit to industry, government, and the general public.

The Research and Development Center of the Office of External Resources (ORE) at the Mayagüez Campus was established in 1986 to encourage and manage research and development activities in the areas of engineering, technology, and science, creating a technological basis to serve the Puerto Rican community. The R&D Center manages several research programs which include basic and applied research, research substations 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 industry, public and private organizations, and government agencies. The Center has its own Advisory Board Committee composed of seven renowned professionals, experts in the fields of science and engineering, to provide counseling and advice on its plans and activities. All the 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 industry sponsors include AT&T, Avon, Bacardi, Digital, Martin Marietta, Raytheon, Upjohn Pharmaceuticals, and White Westinghouse.

The R&D Center offers technical and administrative assistance to the UPRMC research community through its Accounting and Finance, Budget, Purchasing, Receiving, and External Resources Offices, among others. The Center has its own reference library, of the General Library of the UPRMC, which boasts a specialized collection of materials 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 the researchers on academic and administrative forums; plans and establishes the research policy of UPRMC 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 performance excellence.

The Center of Research Excellence in Science and Technology (CREST) began in 1988 through the sponsorship of the National Science Foundation as a Minority Research Center of Excellence. This initiative was an effort to increase participation of underrepresented groups in the areas of science and engineering. The original program consisted of three research segments: Marine Natural Products, Tropical Terrestrial Ecology, and Caribbean Geology, utilizing scientists from the Mayagüez and Río Piedras Campuses. The primary focus of the Program continues to be the development and support of students in undergraduate and graduate programs.

Some of the Center’s objectives are to provide research that will enable underrepresented minority students to choose careers in science and engineering, develop the infrastructure necessary to establish collaboration with other institutions, develop a competitive group of scientists, and provide educational improvement activities for professors, teachers, and graduate and undergraduate students.

Student research activities assist them in developing skills in areas where they can gain a broader understanding of possible alternatives

for the future. Student participation in national and international symposia is also encouraged at the Center. Center students have the opportunity to meet international and national leaders in their research fields, develop leadership skills and share information at different levels.

The Civil Infrastructure Research Center (CIRC), created in 1991, began operating within the Civil Engineering Department in January, 1992. The CIRC received funds from the National Science Foundation through the PR office of the Experimental Program to Stimulate Cooperative Research (PR-EPSCoR) until the year. The Center also received funds from the University of Puerto Rico and the Department of Transportation and Public Works. The Center has also participated in the organization of international conferences and workshops.

The CIRC's mission is to help government and industry maintain, manage, and improve Puerto Rico's infrastructure while contributing to the expansion and improvement of the College of Engineering's undergraduate and graduate programs in infrastructure-related disciplines. The CIRC developed a comprehensive strategic plan which is contained in our website at http://ce.uprm.edu.

The research program of the Civil Infrastructure Research Center was originally organized into two principal thrust areas and a developing thrust area. These thrust areas have been defined by the intersection of Puerto Rico's most pressing infrastructure problems and the UPR Mayagüez Civil Engineering Department's strongest areas of expertise. The principal thrusts are: (I) Transportation and, (II) Structural and Geotechnical Systems; the developing thrust is in Water Resources.

Presently, the Center has projects with the Federal Emergency Management Agency, the Sloan Foundation, the National Science Foundation, the USAERDC, the USDOT, and the Puerto Rico Department of Transportation and Public Works.

The Civil Infrastructure Research Center has a computer center. The computer center was developed with funds from Puerto Rico EPSCoR, The Puerto Rico Legislature, the National Science Foundation, and the Civil Engineering Department. Our computer center exists to support all CIRC researchers and it is used by all our graduate students as well as undergraduate students doing research under the CIRC's sponsorship.

Since our foundation, the Center has administered $5,125,352 in completed projects. Presently, our Center is managing $2,384,396 in on-going projects. The Center actively participates in developing new proposals to support our goals. For more information please contact us at http://ce.uprm.edu.

PRSN– The Puerto Rican **Seismic Network** is administered by the Department of Geology. The staff oversees a network of short-period and broadband seismometers installed in Puerto Rico and nearby islands. The main objective of the PRSN is to process and analyze local, regional, and teleseismic earthquakes. The data generated are distributed among the scientific and academic communities, civil defense organizations, and are available to the general public.

The Tropical Center for Earth and Space Studies (TCESS) of the University of Puerto Rico at Mayaguez is funded by NASA's University Research Centers (URC) Program. It is divided administratively into five components:

1. Space Information Laboratory (SIL)
2. Earth Systems Studies (ESS)
3. Advanced Automated Image Analysis (AAIA) for Remotely Sensed Data
4. Sensor Materials and Electronics for Space Applications (SMESA)
5. Outreach and Education

The Space Information Laboratory is built on the foundations of LARSIP and is funded by the contributions from NASA, UPR, and Fomento. UPRMC installed and operates Synthetic Aperture Radar (SAR) and HRPT tracking stations. These are national facilities available by invitation to other NASA and U. S. university researchers. SIL is a training center for scientists and engineers in a bilingual environment. The Laboratory provides opportunities for research applicable to the problems of the Caribbean area.

The Earth Systems Studies component contains two working groups, both of which have participated in other NASA programs. The Geology group investigates surface deformations and hazards of Lesser Antilles island arc volcanoes. The Marine Sciences group

investigates the effects of the thinning of the ozone layer and related surface UV radiation modulation on the development of plant screening pigments.

The Advanced Analysis Information Systems group from Electrical and Computer Engineering investigates new image-processing algorithms and techniques for storage, processing, and dissemination of remotely- sensed data using high-speed streams with implications for SAR processing.

The Sensor Materials and Electronics for Space Applications component investigates a number of materials with special properties suitable for space sensors. Techniques and materials for power conversion electronics for spacecraft are also studied.

An Outreach and Education component works in concert with TCESS. An extension of the successful "Science on Wheels" project, a "Space Communications on Wheels" van brings space and earth studies to high school students in Puerto Rico. A Technology Transfer Internship Program is being developed that will allow professors and students to visit U. S. National Laboratories, universities, and NASA field centers to facilitate technology transfer and encourage advanced studies.

SPECIAL PROGRAMS

Several comprehensive programs on the campus have a special impact on research and education as a whole. Of outstanding importance are the Sea Grant College Program and the Resource Center for Science and Engineering.

The 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, the Inter- American University, the Ana G. Méndez University System, the Sacred Heart University, and the Pontifical Catholic University of Puerto Rico in partnership with the Puerto Rico Department of Education. The RCSE's mission is to achieve excellence in science, engineering, and mathematics (SEM) education in order to promote the 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, the 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 of the RCSE is in great part due to its development as a consortium based on a collaborative network among the major institutions of higher education, thus providing access to a broad pool of resources and promoting the optimization of efforts. Its goals range from efforts to improve the 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, the RCSE was established as an administrative unit of the University's Central Administration and is directly under the supervision of the President of the University. As a special institute which is not identified with any particular academic program, level, or unit, the RCSE has effectively promoted the maximum collaboration of all institutions, thus facilitating a synergistic effect on the improvement of SEM education throughout the island. The RCSE has acted as an intermediary among the consortium institutions, bringing them together to identify the major problems and needs in SEM education on the Island and to develop jointly innovative programs to address these needs. Key academic and administrative officials from all member institutions participate fully in the planning and implementation of the RCSE programs. Offices for the RCSE are located on both the Río Piedras and Mayagüez Campuses.

The Puerto Rico Transportation Technology Transfer Center. In order to promote research and development in highway related activities in Puerto Rico and the Virgin Islands, the Transportation Technology Transfer Center was created on April 1, 1986 in the Civil Engineering Department of the University of Puerto Rico, Mayagüez Campus.

The Center is one of 57 centers throughout the United States under the Local Technical Assistance Program. The Puerto Rico Transportation Technology Transfer Center program provides service and technical

information to local officials of the 78 municipalities, Department of Transportation and Public Works of Puerto Rico and the Virgin Islands Department of Public Works.

The Center activities and operation expenses are funded by several sources: Federal Highway Administration, Department of Transportation of Puerto Rico and the US Virgin Islands Department of Public Works. Moving towards the next millennium, the Puerto Rico Transportation Technology Transfer Center is evolving with new ideas and initiatives such as sponsoring the following student research programs: the Entrepreneurial Training and Technical Assistance Program (ETTAP) and the Tren Urbano UPR/MIT Human Resources Development Program. The Center is committed to start and support distance learning programs and have our first group of graduates from our new Road Scholar Program.

PRVISMP – The Puerto Rico & Virgin Islands Strong Motion Program is under the administration of the Civil Engineering and Surveying Department. The main objective of the program is to determine, as accurate as possible, the critical earthquake ground motion for which the structures in Puerto Rico should be designed. The program includes 39 free field stations with digital accelerographs which are distritubed in a local strong motion network for the San Juan Metropolitan Area (13 stations), another strong motion network for the Mayagüez Metropolitan Area (10 stations), and others 16 strong motion stations around the Island. The program also includes 6 joint stations where an accelerograph and a broadband seismograph from the PRSN are working together. Finally, two buildings are seismically instrumented. Within the next two years 21 more strong motion stations will be established, a concrete dam and two bridges will be instrumented. Strong motion records are available upon request.

The UPR Sea Grant College Program. Since 1980 the University of Puerto Rico Sea Grant College Program (UPR Sea Grant) 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 that 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 stake holders producing a better understanding of marine technologies, seafood production (including marine aquaculture), coastal ecosystem health, and coastal economic development (including the human environmental impacts, and public safety). Sea Grant provides research and educational opportunities to graduate and undergraduates students in 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.

The Pre-College Engineering Program (PCEP) is a two-week summer-residential program designed to introduce talented high school students to the engineering profession. The main objective of the program is to motivate participants to select and pursue careers in engineering. The program is designed to assist participants in making an informed career selection. This is accomplished by exposing them thoroughly to the engineering profession through a series of enhancing activities. Upon completion of the program, participants are able to decide if they really want to study engineering, and if so, which specific engineering discipline they prefer and why. The program has served a total of 590 students. The success of the program is evidenced by the fact that 94% of the students served that went on to pursue careers in engineering have either completed their degree or are still active students in an engineering program. Funding for the program is provided mostly by corporate institutions.

PUBLICATIONS

The principal publications of the Mayagüez Campus are:

Atenea-- An academic journal published twice a year by the College of Arts and Sciences. It contains literary articles in Spanish and English.

Boletín de Avances Técnicos--A monthly publication of The Technical Information Center. It comprises titles and abstracts of recently published articles and documents geared to keep business and industry segments as well as teaching and research groups informed of new advances and developments in the areas of engineering, technology, and related fields. The bulletin is distributed free of charge.

Boletín Informativo de la Facultad de Artes y Ciencias-- The College of Arts and Sciences with information related to faculty members, departmental activities, achievements, and other useful information. The publication serves as a link between the faculty and students of the College.

Boletín Marino-- A monthly publication of the Sea Grant Program with information about the activities of the Program.

Boletines Técnicos-- Published by The Agricultural Experiment Station. Technical and informative bulletins about research in agriculture and related areas.

The Caribbean Journal of Science -- A scientific journal published twice a year by the College of Arts and Sciences highlighting research work related to the Caribbean area.

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

Departmental Publications—Occasional publications produced by various departments (such as "Contributions" the University of Puerto Rico-Mayagüez, Department of Marine Sciences) with information about their achievements and activities and publications.

El Puente--A bilingual newsletter (English/ Spanish) of The Transportation Technology Transfer Center published three times a year. Its purpose is to serve as a bridge of information between the Center and local transportation officials and as a vehicle for reader response. It consists of brief articles about the latest transportation-related technology as original research related to local transportation problems. It also keeps the reader informed about the latest technical publications and audiovisual materials available from the Center and provides the topics and dates of the training opportunities sponsored by it.

Revista Internacional de Desastres Naturales, Accidentes e Infraestructura Civil--This International Journal is published in Spanish and covers the areas of natural hazards, accidents and civil infrastructure problems. The scope of the journal includes fundamental as well as applied research and case studies in the areas mentioned above. All papers submitted to the journal are considered through a peer-review process, and the editorial board is formed by researchers from Puerto Rico, the US, Latin America, and Spain. It is published twice a year at the Department of Civil Engineering, University of Puerto Rico at Mayagüez. The editors-in chief are Dr. Luis A. Godoy and Dr. Luis E. Suarez.

The Journal of Agriculture of the University of Puerto Rico--A scientific periodical published three times a year by the Agricultural Experiment Station. It includes technical and scientific articles related to the agriculture of Puerto Rico and the Caribbean. Papers are considered through a peer-review process and the editorial board is formed by members of the University, and other specialists.

Agricultural Experiment Station Publications-- A series of publications of interest to farmers and housekeepers which include bulletins and leaflets about livestock, agriculture, agricultural engineering, health and hygiene, nutrition, child care, home economics, clothing and textiles, 4-H Clubs, and other subjects.

MUSEUM

An Art Gallery in the Carlos Chardón Building of the Mayagüez Campus was inaugurated in 1959 with a Salvador Dalí exhibition. Works by both local and foreign artists are frequently exhibited. The Department of Humanities also

has a permanent collection of copies of some of the great paintings and sculptures of the past.

A Natural History Collection located in the Celis Hall and collections in the Departments of Geology and Marine Sciences serve as a nucleus for an expanding museum in the near future. The Geology Museum is located in this same building in room F-202. The museum displays a collection of fossils, minerals, and rocks, including those representative of the Geology of Puerto Rico. The museum is open to the public.

Housed in the Physics, Geology, and Marine Sciences Building are the facilities of the Planetarium and the Astronomical Observatory. These are open to the students and the general public, the latter invited for monthly evening shows.

ACADEMIC SERVICES

OFFICE OF THE DEAN OF ACADEMIC AFFAIRS

The Office of the Dean of Academic Affairs is responsible for coordinating and supervising all academic matters and activities of the four academic colleges and the Division of Continuing Education and Professional Studies. These include graduate programs, academic institutional research, continuing education programs, and the professional enhancement of the academic personnel. In addition, the Office is responsible for the assessment, planning, and analysis of new curriculum proposals or changes; updating these curriculum innovations; and developing projects for research that might contribute to academic excellence. Other auxiliary services like the enforcement of academic procedures and regulations are provided to sustain an efficient teaching and academic research system. The Office also maintains a link with other academic institutions in Puerto Rico, the U. S., and other countries in order to promote a dynamic development with a global vision.

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

1) Admissions Office
2) Center for Professional Enhancement
3) Department of Aerospace Studies
4) Department of Military Sciences
5) Distance Learning
6) Division of Continuing Education and Professional Studies
7) Library System
8) Office of Graduate Studies
9) Registrar's Office

GRADUATE INTERDISCIPLINARY COURSES

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 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 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: To be a regular graduate student with full admission. Cannot be

a graduating senior. Apply to the government agency, private enterprise or foundation of his (her) choice, and comply with the requisites established by it. Be selected by the host government agency, private enterprise or 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.

1. ADMISSIONS OFFICE

General Objectives

The Admissions Office is in charge of the following activities:

1. To receive and process all undergraduate applications according to the eligibility criteria.
2. Give orientation regarding the eligibility criteria.
3. Compile, maintain and update statistical data regarding admissions and serve as a facilitator to the academic community who needs this information for tuition and other processes.
4. Reinforce university admissions regulations.
5. Serve as a consultant to the Administrative Board regarding admissions indexes.
6. Receive and process all undergraduate applications according to the eligibility criteria.
7. Give orientation regarding the eligibility criteria.
8. Compile, maintain, and update statistical data regarding admissions and serve as a facilitator to the academic community that needs this information for tuition evaluation and other procedures.
9. Enforce University admissions regulations.
10. Serve as a consultant to the Administrative Board regarding admissions indexes.

2. CENTER FOR PROFESSIONAL ENHANCEMENT

The Center for Professional Enhancement (**CPE**) was established in July 1996, with matching, non-recurrent funds from the Central Administration. The concept for the Center began in the Extension and Community Services Division under the Dean of Academic Affairs in coordination with the Project Pro-Excellence in Teaching and Learning (PEEA in Spanish), which began in 1990. The PEEA initiative arose mainly because of a petition, expressed as a resolution, from the Parents Association to the Campus Chancellor.

The CPE mission is to expose faculty members to diverse educational strategies in order to promote academic excellence, thereby ensure high-caliber student performance. New faculty, permanent faculty, librarians, counselors, graduate students, and academic management personnel are all considered in the Center's mission. The Center covers all aspects of professional development including teaching, learning, evaluation, technology, and research. Its goal is to create a community of well-prepared and motivated individuals who will contribute to the academic excellence of our institution.

Services include annual orientation for new faculty and graduate teaching assistants, annual training 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. The seminars are tailored to fit the needs of the audience. They involve theory along with hands-on activities. Services also include workshops for academic management, taping of classes for self-evaluation, educational research activities, and individual assistance for departments and faculty.

The CPE was created in 96-97 by the Administrative Board, through the Certification number 596, which mandates a teaching preparation workshop for all faculty personnel dedicated to teaching who have been hired since August 1997. The workshop consists of 29 contact hours that every professor must comply with during his/her first year of service. The professor's participation will go on his/her record and will be taken into consideration for the various personnel actions at the institutional level.

For more information, call 787-832-4040, extension 3829, 3050, 787-265-3829, Fax 787-831-5249, or E-mail cep_rum@rumac.uprm.edu.

3. DEPARTMENT OF AEROSPACE STUDIES – AIR FORCE ROTC

Program Objectives

The objectives of the Air Force ROTC program at the Mayagüez Campus of the University of Puerto Rico are as follows:

1. To identify, select, and motivate qualified students who will participate in the Program of Aerospace Studies.
2. To provide university-level education that will prepare the students to be officers in the United States Air Force.
3. To enhance students' basic appreciation of and dedication to democratic principles.
4. To provide the students with an understanding of the role of the Air Force in support of the national interest of the U.S.
5. To develop in the student his or her potential as a leader and manager.
6. To commission Second Lieutenants dedicated to their tasks that will accept their responsibilities eagerly, think creatively, and speak and write English fluently.

There are two types of Air Force ROTC Programs offered at the Mayagüez Campus: the four-year program and the two-year program. These programs are available to male and female students. The four-year program consists of the Basic Course (General Military Course: GMC) and the Advanced Course (Professional Officer Course: POC). Each of these courses lasts two years. The Basic Course includes Aerospace Studies 3001-3002 and Aerospace Studies 3011-3012. These courses provide two credit hours per semester and count towards the general graduation academic index. Students enrolled in the Basic Course participate weekly in two hours of Leadership Laboratory (Corps Training) in addition to the one-hour of classroom work. After completing the Basic Course, students may request admission into the Air Force ROTC Advanced Course, which prepares them to be officers in the U. S. Air Force. The Advanced Course consists of Aerospace Studies 4001-4002 and Aerospace Studies 4011-4012, which provide the equivalent of four credit hours per semester. The students of the Advanced Course (POC) attend three hours of class and two hours of Leadership Laboratory (Supervision of Corps Training) weekly. The College Deans may consider these courses as general electives for academic credit to a maximum of 12 credit hours. Students enrolled in the Air Force ROTC Program receive all the required textbooks, uniforms, and equipment. Those students enrolled in the POC receive a monthly allowance of $200. The two-year program consists of the POC only, and it is designed for those students who did not have the opportunity to participate in the Basic Course (GMC). The curriculum of the two-year program is the same as that of the four-year POC program. We have a 1-5 year program.

FIELD TRAINING

Students in the four-year program who apply for the Advanced Course (POC) attend a four-week Field training Program at an Air Force base in the U. S. during the summer between their second and third academic years or before they enter the POC. The students in the two-year program have to attend a similar field training for five weeks as a prerequisite for entering the Advanced Course. The major areas of study in the Field Training Program include junior officer training, aircraft and aircrew orientation, career orientation, survival training, base functions and Air Force environment, and physical training. The major areas of study included in the five-week Field Training Program are essentially the same as those in the four-week Field Training and in the General Military Course including Corps Training. While in field training, the cadets receive approximately $450 for the four-week program and $670 for the five-week program and are provided with transportation, lodging, meals, medical services, uniforms and equipment.

ORGANIZATIONS

Arnold Air Society*:* This student organization of outstanding cadets has as its main goals maintaining Air Force traditions and ideals and serving the cause of aerospace age citizenship. The Society participates in many Air Force promotional activities, service projects, and social gatherings. Membership in this organization is voluntary.

Silver Wings: This is the auxiliary unit of the Arnold Air Society; it is composed of dedicated civilian or cadet students who are interested in promoting the Air Force and the ROTC Program on campus and in the community. These individuals have a distinct uniform and take part in many interesting activities and events, including parades, where they are the pride of the Cadet Corps, banquets, dining-outs, and acting as official hosts for the Cadet Corps social activities.

SCHOLARSHIPS

The Air Force offers scholarships in Bachelor/Master degree to outstanding students selected for admission to the four-year program and the two-year program. These scholarships pay for the cost of tuition, laboratories, and books, in addition to providing a monthly allowance of $200 while the minimum requirements for the program are maintained. Cadets accepted in the Advanced Course who did not receive a scholarship before are offered a $3,000 scholarship yearly ($1,500 per semester).

REQUIREMENTS FOR THE ADVANCED COURSE (POC)

To be admitted into the POC, a student must satisfy the following requirements:

1. Be a United States citizen.
2. Have good moral character.
3. Be at least 17 years old with parent/legal guardian consent and have two academic years remaining (undergraduate, graduate, or a combination of both).
4. Able to pass the Air Force medical examination.
5. Be interviewed and selected by a board of Air Force officers.
6. Able to successfully complete a four-week field training course if a Four-Year Program cadet, or a five-week field training course if a Two-Year Program cadet.
7. Able to qualify on the Air Force Officer Qualifying Test.
8. Able to meet the age limitations before being commissioned.
9. Demonstrate proficiency in the English language by test and interview.

LEADERSHIP LABORATORY

The first two years of the Leadership Laboratory (Llab) include studying Air Force protocol and courtesies, drills and ceremonies, issuing military commands, instructing, directing, and evaluating the preceding skills, studying the aspects of an Air Force officer's environment and learning about areas of opportunities available to commissioned officers. The last two years of Llab consist of activities classified as advanced leadership experiences. They involve the planning and controlling of military activities of the cadet corps; the preparation and presentation of briefings and other oral and written communications; and the providing of interviews, guidance, and information which will increase the understanding, motivation, and performance of other cadets.

FACULTY

LIEUTENANT COLONEL RAMON CORTES, *Professor of Aerospace Studies*, Master's Degree: Operations Research, Air Force Institute of Technology.

CAPTAIN CHRISTOPHER CARROLL, *Assistant Professor of Aerospace Studies*, M.B.A., University of California at Davis.

CAPTAIN MARTIN SIPULA, *Assistant Professor of Aerospace Studies*, Master of Arts in Management, National University, San Diego, California.

4. DEPARTMENT OF MILITARY SCIENCE – ARMY ROTC

DESCRIPTION OF AIMS

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 Officer's Training Corps (ROTC) Program at colleges and university throughout the Nation.

The mission of the 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; 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 Corps. In the future, the Army ROTC Program will continue to be the major source of newly commissioned officers for the Active Army and the Reserve Components.

The Army ROTC offers college students a choice of two programs: a four-year program and a two-year advanced program. The four-year program consists of a 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 are figured in the general grade point average. The college deans may consider these courses for academic credit as general electives to a maximum of 12 credit hours.

A Basic Course is conducted on a voluntary basis for male and female undergraduate who are physically and mentally qualified. A student must satisfactorily complete both years of studies to be eligible for the Advanced Course. The Advanced Course is optional and selective. The United States Government furnishes all the necessary uniforms, shoes, and any special articles of equipment required to carry out the ROTC program for both the Basic and Advanced Courses. All Government property must be returned to the Military Science Department at the end of classes or prior to a cadet dropping the course. Students enrolled in the Advanced Course receive a living allowance of up to $1,500.00 each year during the Advanced Course and approximately $700.00 for attendance at Advanced Camp at Fort Bragg, North Carolina.

Under the two-year advanced program, the student is required to attend two summer camps. The first will earn credit for the two-year basic course ($700.00 for attendance) required in the four-year program. The second summer camp is the normal requirement for the four-year program.

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.

Requirements for eligibility are:

A. Basic Course:

1. Be in a Baccalaureate or graduate degree program full time (12 credits or more).
2. Have a 2.00 or better GPA to enter second year of Basic course.

* 3. Must enroll in the ROTC English program or test out of it.

Note: Cadets will not fail the Basic Courses for lack of English skills.

B. Advanced Course:

1. Have a GPA 2.00 or better.
2. Be medically qualified (free exam).
3. Be a full time student (12 credits or more).

**4. Score 70 or more on the English Comprehension Level Test (ECL)

5. Have "Junior" in college status (negotiable).

* Have applied for accreditation of ROTC English courses.

** We will prepare you to pass the English exam.

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 four years, include full tuition and laboratory fees, approximately $300.00 a year for textbooks, and a living allowance of up to $1,000.00 for each academic year the scholarship is in effect. In addition, ROTC scholarship students receive approximately $700.00 for attendance at the Advanced Camp.

ORGANIZATIONS

Pershing Rifle Society: This military society was organized at this University during the school year 1958-59. It is a national society that takes pride in its membership; and strives for leadership, sharpness, neatness, and individual as well as unit achievements. Its members are carefully elected by a Board of senior members. The Precision Drill Team is an integral part of the Society. The Pershing Rifle Society is recognized nation-wide with the designation of Company P-16 of the 16th Regiment.

Association of the United States Army (AUSA): This Society was organized at this University in 1959 and is open to all cadets. AUSA has assumed the basic task of enhancing the public image of the ROTC with a program of civil activities and public information campaigns. AUSA participates in annual Blood and Cancer Funds Drives, High School Orientations, and other civic action projects. The Sponsor Platoon is responsible for civil activities, public information, and recruiting. The Bulldog Platoon is responsible for operational plans and training. The AUSA Society is recognized nation-wide with the designation of Bulldog Company.

FACULTY

LIEUTENANT COLONEL ISRAEL REYES, *Professor of Military Science*, M.S., North Carolina State University, 1992.

MAJOR RAUL PADILLA**,** *Assistant Professor of Military Science*, B.A., University of Puerto Rico, Mayagüez, 1989.

MAJOR FRANK G. SOKOL, *Assistant Professor of Military Science,* M.S., Central Michigan University, 1990.

MAJOR LESTER TORRES**,** *Assistant Professor of Military Science,* B.A., University of Puerto Rico, Mayagüez, 1981.

MAJOR GREGROY L. WHITE*, Assistant Professor of Military Science*, M.S., University of Alabama, 2000.

CAPTAIN RENE DIAZ**,** *Assistant Professor of Military Science*, B.A., University of Puerto Rico, Cayey, 1989.

CAPTAIN LUIS A. DUPERON, *Assistant Professor of Military Science*, B.A., University of South Florida, 1995.

CAPTAIN RAFAEL A. MEDINA**,** *Assistant Professor of Military Science,* B.A., Polytechnic University of Puerto Rico, 1992.

CAPTAIN EDWIN REYES, *Assistant Professor of Military Science*, B.A.

CAPTAIN CARLOS I. SANTANA, *Assistant Professor of Military Science*, B.S., Interamerican University, San Germán, Puerto Rico, 1986.

MAJOR SERGEANT JAIME MATOS, *Operations Sergeant*.

MASTER SERGEANT ANTHONY RODRIGUEZ, *Drill Instructor*.

SERGEANT FIRST CLASS RICHARD CAMPOS, *Drill Instructor*.

SERGEANT FIRST CLASS ARVENTO COLLINS, Drill Instructor.

SERGEANT JAMES MYERS, S*upply Sergeant.*

MR. BOLIVAR BERNIER, *English Instructor Supervisor,* Training Specialist (Language), B.A. University of Puerto Rico, Cayey, 1973.

MRS. DOROTHY GRAHAM, *English Instructor*, Training Specialist (Language), B.S., Tuskegee University, Alabama, 1961.

MRS. OMAYRA VEDBRAATEN, *English Instructor*, Training Specialist (Language), M.A., Interamerican University, San Germán, Puerto Rico, 1996.

5. DISTANCE LEARNING

The Distance Learning Program is coordinated from the Office of the Dean of Academic Affairs. This program has coordinated eight graduate courses in the past two years for Business Administration, Chemical Engineering, Electrical and Computer Engineering, and Nursing through videoconferencing. The present projects include the addition of three videoconference courses and four on-line courses. More information about Distance Learning can be obtained at the following Internet address: http://academic.uprm.edu/ed.

6. DIVISION OF CONTINUING EDUCATION AND PROFESSIONAL STUDIES

HISTORY

The Division of Continuing Education and Professional Studies was created in the 1958-59 academic year. It was established in order to integrate under a unit, several programs existing in the Campus, but not administered unitarily. These were: the summer program, the evening program and the Saturday courses program. The inclusion of these three areas into a new academic unit served as a basis for innovative and extended services in non-traditional fields.

GOALS AND OBJECTIVES

A. *General Goal*

To attend the special educational needs of university level or related to university work that are not being taken care by the traditional offerings of the university and to link the physical and human resources of the university to the problems and needs of the community, fostering closer collaboration with it.

B. *Objectives*

1. To provide educational opportunities for the adult working population.
2. To provide educational opportunities to those adults who have interrupted their studies and need new and special alternatives to complete them.
3. To provide educational opportunities to disadvantaged groups, minorities and other social sectors not benefiting from traditional offerings.
4. To initiate educational programs and credit courses in response to educational needs that have not been attended by traditional offerings.
5. To create continuing education offerings for professional groups.
6. To identify continuing education needs of the community at large and provide the courses and educational experiences to meet these needs.
7. To provide the community at large and groups within the community with information and orientation services.
8. To promote the development of awareness and sensitivity in the University toward the needs of the community and undertake initiatives to have University human and physical resources aid in meeting those needs.

PROGRAMS

The Division of Continuing Education and Professional Studies addresses its goals and objectives through initiatives that change throughout the years. Most of these involve the creation of projects, educational offerings, and programs, which are transitory in nature and short in duration.

At present the work of the Division is subdivided under the following programs:

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

1. EDUCATION PROGRAM

The Education Program was originated as, and still has as one of its main concerns, an extension program providing courses for in-service teachers. At present, besides fulfilling this continuing education service to teachers in both private and public school system it includes a teacher's training program for regular students of the College of Arts and Sciences and others. It is not a degree program.

A. Teacher's Certificate Program

The Education Program offers the credit courses necessary to complete the requirements for a teacher's license as stipulated by the Department of Education of Puerto Rico. We offer the credit courses required in several areas of certification. The students, however, obtain their license from the Department of Education of Puerto Rico upon presenting evidence of having completed the credits required. The actual offerings include all courses required for the license in secondary education.

B. Teacher-Training Program in Secondary Education

This intensive training program is for students pursuing the bachelor degree in the College of Arts and Sciences and others. The program includes, in addition to education courses, observation and practice in the classroom under the direct supervision of experienced teachers. All participants who successfully complete this training, besides obtaining the degree, have complied with the requirements for the teacher's certificate from the Department of Education of Puerto Rico.

2. CONTINUING EDUCATION PROGRAM

Continuing Education is recognized as a growing need for adults who have obtained a university education and for those who have not. The Division offers educational options at irregular hours (weekdays, evenings, and Saturdays) in order to provide an opportunity for working adults to further their education. It also fulfills different needs for children, adolescents, and elderly people who are interested in developing their knowledge, talents or abilities.

This non-traditional service offers continuing education hours/credits required to renew the licenses and/or certifications for different professions, and provides educational alternatives in special areas such as business administration, microcomputer applications, technical skills, arts, language, handcrafts, and sports in which professional and cultural growth can be obtained independently of traditional programs leading to a degree. 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, and/or special projects.

3. SPECIAL TRAINING PROGRAMS

Non-traditional needs in the areas of technology and career skills can be met with short-term training programs. The Division of Continuing Education and Professional Studies collaborates with other community institutions 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. The courses in these programs do not carry college credits, and therefore cannot be used to fulfill degree requirements. The completion of the program, however, entails obtaining a certificate as a credential for the job market.

4. COMMUNITY SERVICES

The University of Puerto Rico at Mayagüez Campus has several administrative units that relate to the community. The Division of Continuing Education and Professional Studies, however, has as one of its important tasks to offer education services to the community and to do so with the collaboration of the other colleges in the University. Interrelation with the community through civic and professional groups is promoted in order to respond to real needs within the community.

Typical activities oriented towards the community are rendered through:

a. Conferences
b. Seminars
c. Workshops
d. Group meetings
e. Continuing education courses
f. Short-term special training.
g. Others

FACULTY

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ANTONIO SANTOS-CABRERA, *Assistant Professor*, M.A.Ed., 1976, Interamerican University of Puerto Rico.

7. LIBRARY SYSTEM

The Mayagüez Campus General Library consists of a Main Library, a special departmental collection and an Educational Technology Unit. The Main Library has an area of approximately 124,335 squared feet. The Library has a seating capacity of 1,278. It also has 19 closed study carrels for graduate students and faculty, 10 study rooms for group discussion, two library instruction classrooms and a microform room.

The Library serves students, faculty, researchers, extension service officers, the administrative staff and other members of the academic community. It fully supports the educational and research mission and objectives of the Institution by providing the necessary library and information resources, facilities and services. To fulfill its purpose, the Library is divided into three major areas: Technical Services, Public Services and Educational Technology. The special collection of Marine Sciences is located in the corresponding academic department.

Technical Services is in charge of all the technical processes involved in the acquisitions of library materials and the preparation of these materials for the users. This includes selection, ordering, invoicing, bookkeeping, labeling, and cataloging and classification. Technical Services is also responsible for library automation, staff training, binding and preservation of materials, and the gift and exchange program.

Public Services is in charge of the reference and research services of the following collections:

- Álvarez-Nazario Collection
- Collection for the Visually Impaired
- Electronic Resources Center
- General Circulation and Reserve
- Government Documents and Maps
- Interlibrary Loans
- Manuel María Sama y Auger Collection (Puerto Rican Collection)
- Music and Oral History Collection
- Patent and Trademark Depository Library (PTDL).
- Puerto Rico Census Data Center
- Reference
- Serials and Periodicals

The Educational Technology Area consists of an Audiovisual Services Department located on the second floor of the Sánchez Hidalgo Building and the Closed Circuit Television Department located in the Nursing Building. Audiovisual Services includes the following units: graphic arts, audio studio, an audiovisual equipment-lending and repair center, and a Film Library. Closed Circuit Television (CCTV) produces instructional and educational TV programs and provides videotape-recording services for various campus activities. Other services include multi-channel broadcasting of video programs to classrooms and assembly halls, teleconferencing, satellite downlinks, television studio, and a video library.

The Library's holdings includes: 221,490 volumes of books, 5,435 journal titles, 258,243 microfiches, 12,719 microcards, 19,232 microfilms, 584,206 government documents, 714 films, 8,214 maps, 8,460 sound recordings, 605 musical scores, 916 sound magnetic tapes, 24,632 slides, 4,177 videocassettes, 687 filmstrips, 4,767 CD-ROMs, 2,432 theses, 6 million patents and 2.5 million U.S. issued trademarks.

The Library is a selective depository for U.S. Government Publications; for the Interamerican Institute for Agricultural Cooperation (IICA) in San José, Costa Rica; and for the Service Center for Aging Information (SCAN). It is one of the Coordinating Agencies of the Puerto Rico Census Data Center, under the Planning Board of Puerto Rico and is also a depository of the U.S. Bureau of the Census publications.

On March 1995, the Library became a member of the Patent and Trademark Depository Library Program of the U.S. Patent and Trademark Office. This is the only participating library outside the United States and the only one of its kind in Puerto Rico, the Caribbean and Latin America.

The Library's main subject interests are in agriculture, animal industries, engineering, natural and applied sciences, technology, marine and environmental sciences, energy, economics, business administration, nursing, humanities, behavioral sciences, and geology.

Among the various services offered by the Library are: book loans; document and journal loans; interlibrary loans; reference and information services; access to electronic indexes and abstracts; online catalog; homepage (http://www.uprm.edu//library); library orientations and tours of facilities; library research and instruction courses; document delivery; fax delivery; photocopying machines; sale of photocopying cards; duplication of materials in microforms; loans of audiovisual equipment; online retrieval services; selective dissemination of information; access to Web-based and CD-ROM full-text databases; Internet access; and access to remote government and commercial databases.

Librarians assist students and faculty in their study and research endeavors. An information desk service is provided to answer questions and assist patrons in the effective use of the online catalog and of the resources, facilities and services that are available. The information desk is located in the lobby at the main entrance and is open Monday through Friday from 9:00 a.m. to 11:30 noon and from 1:30 to 4:00 p.m.

Members of the Library's staff offer the following formal courses: AGRO 4019–Seminar on Horticulture; BIOL 3055–Bibliography and Library Research in Biological Sciences; CISO 3145–Bibliography and Library Research in the Social Sciences; and INTD 3355–Research Methods in Libraries.

Library services are fully automated and the online catalog can be accessed from terminals and computers installed in the Library, everywhere on Campus and through the Internet. A local area network (LAN) allows for the use of databases in CD-ROM from various collections. Cataloging and classification is done online using the bibliographic utility of the Online Computer Library Center (OCLC). The Library is also a member of the Southeastern Library Network (SOLINET) and the United States Agricultural Information Network (USAIN).

The Library's rules and regulations are included in the Bylaws. Copies are available at the Administrative Office of the Library.

General Library Faculty

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NORMA SOJO-RAMOS, *Associate Professor* (Librarian III), M.S.L.S. (1984), Florida State University at Tallahassee.

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ELSIE TORRES-NEGRON**,** *Assistant Professor* (Librarian II), M.L.S. (1986), University of Puerto Rico at Río Piedras.

JEANETTE VALENTIN-MARTY, *Professor* (Librarian IV), M.A.L.S. (1983), University of Michigan.

8. OFFICE OF GRADUATE STUDIES

The graduate program 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 Civil Engineering, Chemical Engineering and Computing and Information Sciences and Engineering have been also established, and programs in Biology, Applied Chemistry, Biotechnology, and Mechanical Engineering have been proposed. The Mayagüez Campus currently hosts 32 masters and 4 PhD programs.

According to the Certification 97-21 of the Mayagüez Campus Academic Senate, this Office has to supervise and enforce the rules and regulations related to graduate studies. This Office deals with two main areas: graduate admissions and active students. The Office is directed by the Associate Dean of Academic Affairs and Director of Graduate Studies, and the Associate Director of Graduate Studies. The Office is currently located in **303 Monzón Hall**, and can be reached through extensions **3442** or **3598**, or, from outside Campus, through its phone number **787-265-3809**. Most of the information in this Bulletin of Information of Graduate Studies is available, in English and Spanish, in the Office's Internet site **http://grad.uprm.edu**.

9. REGISTRAR'S OFFICE

The Office of the Registrar provides information in an accurate manner with consistent quality service that is responsive to the needs of the University community.

The Office has the responsibility of maintaining academic records of students, both current and former, graduate and undergraduate, and ensuring the privacy and security of those records.

The Office also provides registration services to departments and students; records and reports grades; certifies attendance, grade point averages and degrees; issues transcripts; and schedules final exams.

The Office of the Registrar seeks to provide the highest quality services using innovative procedures and advanced technology.

Veterans Service Office

The Office of the Veteran Services is part of the Registrar's Office. It serves veterans, dependents of veterans, servicemen, and servicewomen in matters pertaining to the Veterans Administration such as: educational benefits, registration, and study at the University. All beneficiaries must complete their programs of study within the normal time required for completion of programs. If a veteran exceeds these time specifications, the Office of Veterans Affairs will suspend benefit payments.

STUDENT SERVICES

Office of the Dean of Students

The Office of the Dean of Students aims to assure and maintain an optimal learning environment by providing a variety of services and activities that are support systems of the 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.

Financial Aid

The Department of Financial Aid administers financial aid programs to assist students who need help in meeting their cost of education. Even though costs at the University are considered to be low, each year approximately 72 percent 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 where students work and are paid for services, and loans that require repayment.

The philosophy followed in rendering financial assistance is based on the principle that parents are the ones primarily responsible, to the best of their ability, for providing the 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.

In general, to be eligible for financial aid, the student must:
- be a U.S. citizen or eligible non-citizen,
- be registered with the Selective Service System (if required),
- be working toward a degree,
- be making satisfactory academic progress,
- not owe a refund on a Federal Grant or be in default on a Federal educational loan,
- have financial need (except for Unsubsidized Stafford Loans),
- not owe a refund in a Title IV Program.

Financial need is the difference between the cost of education and the amount the parents and the student can provide. The types and amount of aid a student may receive are determined by evaluating the financial need, and the availability of funds. To be considered for all financial aid programs, the student must complete and submit each academic year, the Application for Federal Student Aid and an institutional application form together with required documents.

Funding is available from the programs listed below:

Grants and Scholarships

The ***Institutional Supplemental Assistance Program*** is funded by the University to provide grants to undergraduate and graduate students enrolled on at least a half time basis.

Private Scholarships and Grants are funds received by the University for student assistance, which are conveyed according to the criteria and guidelines specified by each donor.

Loans

The ***Federal Perkins Loan Program*** allows undergraduate and graduate students to borrow low-interest federally subsidized funds through lending institutions such as banks, based on determined financial need. Students can also get an unsubsidized loan regardless of need. Repayment begins six months after the student graduates or ceases to be enrolled on at least a half-time basis.

The ***William D. Ford, Federal Direct Loan Program*** allows undergraduate and graduate students to borrow low-interest federally subsidized funds through lending institutions such as banks, based on determined financial need. Students can also get an unsubsidized loan regardless of need. Repayment begins six months after the student graduates or ceases to be enrolled on at least a half-time basis.

The ***Geer Loan Program*** is funded through a private trust donation to the Mayagüez Campus. It provides five percent interest loans of up to a maximum yearly award of $1,000, based on financial need. Repayment begins forty-six days after the loan proceeds are disbursed.

Federal Work-Study Program

The ***Federal Work-Study Program*** provides employment opportunities for undergraduate and graduate students with financial need. Most jobs are on campus and the students are paid according to the number of hours worked, up to the amount awarded.

Health Services

The Health Services Department offers primary health care, free of charge, for all students. Among the services provided are medical consultation, dental care, emergency and short-stay recuperation care, ambulance services, clinical laboratory tests, psychology service**,** counseling on addiction**,** health education program and coordination and referrals to off-campus health providers for students under the University health insurance plan or personal health insurance**.** Family Planning services are offered for a nominal cost to all members of the university community. These services are classified in two areas: preventive medicine with emphasis on primary and secondary prevention and therapeutic medicine. Services are offered during regular working hours, except ambulance transportation service, which is provided on a twenty-four hour daily basis.

Medical consultation and emergency services are offered by general physicians and professional nurses. These services are offered from 7:00am to 9:00pm, Monday to Thursday and from 7:00am to 4:30pm Friday. A clinical laboratory complements these services during regular working hours.

Dental services are offered to students by appointments. Services include oral examinations, X-rays, prophylactic treatment, control of infections and cavities, and orientation on dental hygiene. Senior year students of the School of Dentistry of the University of Puerto Rico also provide primary dental care under the supervision of our dentists.

All students entering the University for the first time are required to complete and submit a medical history form that includes a complete physical examination and laboratory tests. Evidence of immunizations is also required and failure to comply will result in a medical hold on registration.

The University, through a private company, offers the students an insurance health plan in order to provide a more comprehensive health coverage. The plan is required, unless the student provides evidence of other health insurance coverage. Among the services covered by the university plan are referrals to specialists, X-rays and laboratory tests recommended by physicians, hospital emergency room care, hospitalization, surgical procedures, prescription medicines, and maternity services that include prenatal and postnatal care.

Psychological services are also part of the services offered. This includes psychotherapy, crisis intervention, group therapy and consultation to other health departmental professionals. Workshops on various mental health topics are also available.

Preventive medicine pursues the prevention, detection, screening and control of medical conditions among students that may need immediate attention, observation or special care. Through a Health Promotion and Prevention Program, individual and group orientations are

offered. Some of the areas covered are: nutrition, sexual health, eating disorders, sexually transmitted diseases including AIDS, alcohol and other drug abuse prevention, counseling and referral. Secondary prevention for chronic illness such as heart diseases, diabetes, asthma and epilepsy, as well as other health related areas with emphasis in the promotion of healthy lifestyles and health maintenance are also included in the program. A resource library with books and printed educational and information material is available to the community.

A Title X Family Planning Program offering comprehensive sexual and reproductive health is available to all members of the university community. This program offers evaluation and medical consultation, health and sexual health education, guidance in reference to abstinence, natural family planning, referrals, PAP smears tests and others tests for sexually transmitted diseases such as Clamidia and HIV, as well as education and availability of anticonceptive methods. A gynecologist specialist physician is part of this program.

A Stress Management Center offers services to all the university community by previous appointment. This center specialized in teaching techniques such as music therapy, visualization and direct relaxation. The psychologist coordinates this service. The Center is a practice center for psychology students from the Social Science Department.

A Traffic Safety Project sponsored by the Puerto Rico Traffic Safety Commission offers educational and promotional activities establishing traffic safety as part of a healthy way of life among all members of the community.

The department sponsored three students' organizations that advocate healthy lifestyles among theirs peers.

Counseling and Guidance

Counseling and guidance are offered to the students so that they achieve a better understanding of themselves and make an adequate adjustment to the college 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 provides personal counseling, career and life planning, testing, and psychological and social work services. Counselors assist students with personal, educational, and career development issues and concerns. They also teach a freshman orientation course called "UNIV 0002-0006 - University Success Skills" during the first semester. Psychologists provide individual therapy, crisis intervention, and offer workshops and lectures about personal, emotional, and social growth topics. The social worker provides individual, couples, and family intervention about social issues such as relationships with parents, communication, violence, marriage, pregnancy, and financial needs. Workshops according to student needs are offered throughout the year. Topics such as stress management, assertiveness, personal and social growth, study skills, time management, and decision-making are covered.

A Career Resource Library is available for students. It contains information on undergraduate and graduate studies, on job-hunting techniques, and labor market trends. Occupational information and distribution of test applications for admission to graduate and professional schools are also handled at the library. College catalogs and bulletins from other institutions both in print and microfiche are also available.

A Tutoring Program offers remedial help services in basic academic areas as Mathematics, Spanish, English, Chemistry, and Physics. Tutors are selected among honor or advanced students.

The Counseling Program for Student Athletes is focused in helping athletes overcome difficulties resulting from the amount of time and energy devoted to sports.

A Freshman Orientation Week is offered one 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 also gives freshman the opportunity to meet faculty, staff and other

students. Members of the Peer Counseling Program work intensively during this week and throughout the year in coordination with the Department of Counseling.

A Freshman Orientation Course is offered during the first semester. It consists of one hour per week discussions on diverse topics such as academic regulations, study skills, time and stress management, sex education, and others. It has been designed to enhance academic and social integration to college.

Counseling and Guidance Faculty

Professional Counselors

ARELIS ARCELAY LÓPEZ, *Professor (Counselor IV)*, M.A.E., 1980, Interamerican University of Puerto Rico at San Germán Campus.

LISANDRA COLÓN RIVERA, *Assistant Professor (Counselor II)*, M.A.M.C.R. 1994, University of Puerto Rico at Río Piedras.

OLGA COLLADO DE CRUZ, *Associate Professor (Counselor III)*, M.A.E. 1974, Interamerican University of Puerto Rico at San Germán Campus.

TERESITA CRUZ DIAZ, *Assistant Professor (Counselor II)*, M.A., 1974, University of Puerto Rico at Río Piedras.

IVONNE DOMINGUEZ BIDOT, *Associate Professor (Counselor III),* M.A.E. 1983, Interamerican University of Puerto Rico at San Germán Campus.

AGNES D. IRIZARRY IRIZARRY, *Associate Professor (Counselor III)*, M.A.E., 1978, Interamerican University of Puerto Rico at San Germán Campus.

NEYSA LÓPEZ GARCÍA, *Professor (Counselor IV),* M.P.H.E. 1970, University of Puerto Rico, Medical Sciences Campus, M.A.E., 1983, Interamerican University of Puerto Rico at San Germán Campus.

VILMA D. LOPEZ MUÑOZ, *Associate Professor (Counselor III)* M.A.E. 1982, Interamerican University of Puerto Rico at San Germán Campus.

EDWIN MORALES TORO, *Professor (Counselor IV)*, M.A.E. 1977, Interamerican University of Puerto Rico at San Germán Campus.

ROSA L. MONTALVO VÉLEZ**,** *Associate Professor (Counselor III),* M.A.E. 1985, Interamerican University at San Germán Campus.

GLORIA MUÑIZ CRUZ**,** *Associate Professor (Counselor III),* M.S. 1979, University of Bridgeport.

DALILA RODRÍGUEZ DÍAZ**,** *Professor (Counselor II),* M.A.E., 1981, Interamerican University of Puerto Rico at San Germán Campus.

MADELINE J. RODRIGUEZ VARGAS, *Instructor (Counselor I)*, M.A.E. 2000, Interamerican University of Puerto Rico at San Germán Campus.

IVONNE I. ROSADO TORRES**,** *Professor (Counselor IV),* M.A.E. 1979, Catholic University of Puerto Rico.

PURA B. VICENTY PAGAN, *Assistant Professor (Counselor II)*, M.A.M.C.R., 1987, University of Puerto Rico at Río Piedras.

Social Worker

ARISBEL CRESPO DURAN, *Associate Professor (Social Worker III)*, M.S.W., 1978, University of Puerto Rico at Río Piedras.

Psychologists

ZAIDA M. CALDERON FONTANES, *Assistant Professor (Psychologist II),* M.S. 1988, Louisiana State University at Natchitoches.

NIDIA S. LOPEZ RODRIGUEZ, *Associate Professor (Psychologist III)*, M.A. 1974, Interamerican University of Puerto Rico at Ramey Campus, M.A., 1982, University of Puerto Rico at Río Piedras, Ph.D. 1994, Carlos Albizu University (Centro Caribeño de Estudios Postgraduados).

NORMA I. MORALES CRUZ, *Associate Professor (Psychologist III)*, Ph.D. 1993, University of Missouri.

ANDRÉS VELÁZQUEZ**,** *Professor (Psychologist IV)*, Ph.D. 1992, Syracuse University.

MIRIAM VÉLEZ MORALES**,** *Assistant Professor (Psychologist II),* M.A. 1994, Interamerican University of Puerto Rico at San Germán Campus.

Off-Campus Housing

The Department of Off-Campus Housing assists students, faculty and staff with locating off-campus housing and offers support throughout the off-campus living experience, providing counseling, information and referral in housing-related matters. Also maintains an interactive apartment, house, rooming houses search database, which is updated every two weeks and contains hundreds of available rental units. Searches can be done by several customized

criteria such as owner's name, location, housing alternatives and rental range.

Other services include consumer information about leases, utilities, safety, transportation, temporary housing, finances and many other topics relevant to living off-campus. The Off-Campus Housing Department plays a role in educating the off-campus student community regarding their rights and responsibilities both as tenants and as a member of the community. It also advises homeowners interested in establishing lodging about the codes required by governmental agencies. Maintains a bulletin board with advertisements about selling and buying goods and services in the community. The Housing Mediation Services is a voluntary confidential resource that seeks to assist in the resolution of problems that may arise between students and landlords or among roommates in the areas of housing. The service offers the concerned parties a forum to represent and discuss their problems before a neutral third party. It facilitates the resolution process by providing information to the parties and by suggesting approaches to the handling of problems. Please note that we do not offer legal advice, we referral to local legal advice programs off-campus. Other services are the Child Care Program for Students sponsored by Río Piedras Campus-UPR. The purpose of this program is to provide federal subsidies for off-campus childcare while their student parents attend university classes.

The Off-Campus Housing Department complies with the Ethical Principles and Standards for College and University Student Housing Professional of the ACUHO organization.

Placement

The Placement Department's main objective is to provide students with the best resources available that will help them obtain permanent, summer, and temporary employment. The services provided include the arrangement of on campus interviews with prospective employers, the coordination of employer presentations, and job referrals. The department offers seminars and workshops that help develop job hunting techniques, resume preparation, and interviewing skills.

Annually, the department organizes a Job Fair, where companies and government agencies from Puerto Rico and the United States participate. They have job opportunities for students seeking permanent, summer, and coop positions. Each year the number of student participation increases. The Job Fair is open to students from the various disciplines offered.

A library and video library containing information on the companies that recruit is available for student use.

The department has skilled personnel offering individual help reviewing resumes, cover letters, employment applications, etc.

Every year the department prepares an employment report, with each graduating class, that exposes the number of students that find jobs or continue their graduate studies in Puerto Rico and the United States and how many continue to seek employment.

Graduate students are advised to seek summer or temporary experience in their field of studies.

Student Exchange Programs and International Student Services

The Mayagüez Campus is an active member of the National Student Exchange Consortium and the International Student Exchange Program. Exchange is an excellent way to explore different academic, social, and cultural settings. National Student Exchange offers students the opportunity to do course work at another college or university in the United States and its territories.

The International Student Exchange Program offers students the opportunity to take course work in 23 different countries. The Programs encourage students to experience and learn from the exposure to different regional, cultural, and ethnic perspectives and to broaden their educational background. A qualified, full-time undergraduate student may participate for up to one academic year. To be eligible to participate in the Program, a student must have at least a 2.5 grade point average.

This Office also provides orientation services to students from other countries. These students become acquainted with registration procedures, educational facilities, student services, and other

sources of assistance. Information is offered in areas of immigration, financial assistance, foreign embassies on the island, programs sponsored by international agencies, housing, and other matter of special concern. The Office works closely with the academic community, the administration, and the local community to familiarize the student with life on campus and the culture of Puerto Rico.

International students sponsor special events throughout the year to promote cultural exchange and familiarize the University community with their country.

Athletic Activities

Students are encouraged to participate in organized sports and other recreational physical activities sponsored by the Department of Athletic Activities.

The University is a member of the Inter-University Athletic League and fully participates in a variety of intercollegiate sports. The University is also a corresponding member of the National Collegiate Athletic Association (NCAA) and is in the process of becoming an active member. The Inter-University Program offers fourteen men's and eleven women's sports for students who demonstrate superior athletic activities. Men's sports include baseball, basketball, cross-country, judo, soccer, softball, swimming, table tennis, tennis, track and field, decathlon, volleyball, weight lifting, and wrestling. Women's sports include aerobics, basketball, cross-country, judo, softball, swimming, table tennis, tennis, track and field, heptathlon, and volleyball.

The Intramural Program provides activities and competitions that take place mostly on campus grounds. Students, faculty and staff participate in a wide variety of activities for both men and women. Among the sports included are basketball, judo, micro-football, soccer, softball, swimming, table tennis, tennis, volleyball, water polo, weight lifting, and wrestling. Student teams of the Intramural Program can participate in the Extramural Program and compete with other universities and non-university groups.

The Department of Athletic Activities allows the use of campus athletic facilities and equipment in support of non-organized recreation. Students and university-sponsored teams can borrow equipment and utilize facilities in their free time.

The athletic facilities include a Gymnasium, a Coliseum, a 50-meter swimming pool, basketball, volleyball and tennis courts, a synthetic running track, weight-lifting gymnasium, a training and conditioning exercise room, an athletic field, softball park, and judo and wrestling areas.

Band and Orchestra

Students with musical talents can be members of different music groups such as the Concert Band, Marching Band, Choir, String Ensemble, and other pop-rock and Latin music groups. Students interested in participating in any of the groups are required to pass an audition.

Groups are required to rehearse twice a week to develop interpretive skills and maintain an ample musical and artistic program. The ensembles present a variety of concerts and performances on campus and throughout the outside community as representatives of the University.

Quality of Life Office

The Quality of Life Office offers a wide variety of services in order to promote a safe campus community, which is conducive to the attainment of the educational objectives of this institution. This Office encourages a safe and secure environment that contributes to the wellness of the campus community.

Proactive prevention programs are offered to deal with problems like campus crime, violence, sexual assault, and the use and abuse of alcohol and other drugs which affect quality of life on our university. This Office fosters the fulfillment of the institutional policies.

Social and Cultural Activities

The University offers diverse social and cultural activities that can be enjoyed by everyone. These events are free of charge and include concerts, shows, dances, plays, films, presentations, tournaments, and exhibitions by recognized artists and performing groups. Special events such as the Pep Rally promote school spirit and student involvement.

Most activities are celebrated on campus facilities such as the Ramón Figueroa Chapel Amphitheater, the Coliseum, the Gymnasium, and the Athletic Field. University sponsored activities are also offered in the city of Mayagüez, in municipal government facilities such as the Yagüez Theater, the Cultural Center, and the municipal Coliseum.

Student Government

The General Student Council is the student government on campus. The Council is composed of representatives from the different colleges, elected by the student body, and provides students the opportunity to express their opinions and views to the University administration. Additional information may be obtained at the General Student Council Office located on the first floor of the Student Center.

Student Organizations and Clubs

The University has over one hundred recognized student organizations and clubs, which serve the various needs and interests of students. These organizations range from campus branches of national organizations to local clubs and special interest groups. They provide the opportunity for involvement in student activities, community service, and leadership and personal development. For further information students should contact the Department of Social and Cultural Activities.

Student Center

The Student Center constitutes the University community center, and is open to students, faculty, staff, alumni, and visitors. It is a focal point for cultural, social, and recreational activities, and provides study areas for students. A number of Departments under the Office of the Dean of Students are located in the Center. These are the offices of Counseling and Guidance, Off-Campus Housing, Placement, Social and Cultural Activities, and the Student Exchange Program and International Student Services.

Other areas within the Center are the Alumni Office, the General Student Council Office, the Graphic Arts Workshop, and an Art Exhibitions Room. There is a Game Room for playing table tennis, pool, chess, and other recreational games. The Student Center also houses the Campus Cafeteria, Campus Bookstore, Post-Office, and a Hair Styling Salon. A Student Aid Center located on the ground floor provides low cost specialized services, such as photocopying, photographic film development, fax services, etc.

ADMINISTRATIVE SERVICES

Alumni Office

The Alumni Office is engaged in activities designed to strengthen the relations between the Institution and its graduates. The Office supports and works in close coordination with the Alumni Association encouraging membership, raising funds through donations, organizing the annual homecoming event and developing other important activities.

Campus Bookstore

The bookstore supplies the university community with textbooks, general reading books, office and school supplies, souvenirs, gifts, and personal effects. It is located on the first floor of the Student Center.

Campus Cafeteria

The cafeteria, located in the Student Center, is equipped with furniture especially designed for the student's comfort. It is conveniently divided into two dining rooms and a snack bar. Breakfast, lunch, and snacks are served Monday through Friday from 6:00 a.m. to 10:00 p.m.

Computing Facilities

The Campus Computer Center is located on the first floor of the Luis Monzón Building. It operates 24 hours a day, year-round, with 18 hours daily under operator assistance. The Center serves the academic community in both instruction and research, as well as the Campus Administration.

The principal academic computing facility consists of a Digital VAX 6510 computer with 64MB of main memory and 12GB of disk

storage. An ALPHA 2100 5/250 is the system exclusive for library automation, any user on campus and from other institutions can access the on-line catalog by using a terminal or a personal computer attached to the network. An ALPHA 8250 substitutes a VAX 6610 computer for the Administrative Information Systems and student services. This ALPHA system has 1 GB in memory and 32 GB of disk storage.

Each system operates on a time-sharing basis and is capable of handling more than 200 concurrent users. There are more than 600 terminals accessing the systems plus more than 1,500 personal computers around campus.

The Computer Center operates computing rooms in the Monzón and Business Administration buildings. Services offered include use of data processing equipment (i.e. terminals and microcomputers), document printing, software and consulting. These rooms are available to all students and academic personnel. Most of the departments operate additional computing facilities. These facilities vary from personal computers to minicomputers and workstations.

The VAX computers and most of the workstations on campus are connected to the institutional network, RUMNET (Recinto Universitario de Mayagüez - Network). Also many departments have their own local area networks connected to RUMNET.

RUMNET is part of the wide are network of the University of Puerto Rico (UPRENET) which connects the university campuses, regional colleges and other university agencies like the Agricultural Experimental Station. It allows remote access, file transfers, and mail exchange between units. UPRENET is connected to the Internet and Bitnet networks, allowing campus users to reach computers almost anywhere in the world.

Computing services for the academic community are offered through the User Support Office of the Computer Center at the Monzón Building. Consulting, training, preparation of user guides and manuals plus the operation of the public computing facilities and computer equipment maintenance and repair are offered. A monthly newsletter *Compunews* is published.

There is no cost to the student body or to the academic personnel for the use of computation facilities on campus except for those courses that require them. The university covers the operational expenses of the facilities. The use of the facilities are measured by attendance and number of users registered in the systems. Present plans include the measure of resources usage, CPU time and designation of quotas to the users.

Several academic departments operate their own computer laboratories. Some facilities have specialized hardware or software so their use is restricted to students enrolled in certain courses or doing research. Most departmental laboratories are open to the general Campus population.

Press and Publications

The Campus Press Office is the link between the University Community and local and international media. Through press releases and articles regularly published in major daily, weekly newspapers and other publications, the public is informed of the Campus major events. The Press Office also covers radio and TV media.

University Service Enterprises

The University Service Enterprises is a department under the Office of the Dean of Administration, primarily dedicated to the administration of the Campus Hotel.

FEES

TUITION

For U.S.A. citizens residents of Puerto Rico:

$75 per credit for students enrolled in graduate programs plus applicable regular or special fees,
$50 for students enrolled in thesis only

For U.S.A. citizens non-residents of Puerto Rico:

Same tuition as resident students, plus an additional sum equivalent to what a Puerto Rican student would have to pay in the public university of their state of origin.

They also pay the applicable regular or special fees.

For foreign students:

$3,500 per year for students enrolled in graduate programs, plus applicable regular or special fees.

Visiting students:

$50 per graduate course plus $10 maintenance fee each academic session.

REGULAR FEES

Application for admission	$15
Graduation fee	$20
Application for transfer to a different Program	$17
Application for readmission	$27
Late registration fee	$10
Transcript of credits (per copy)	$ 1
Duplicate of admission letter, class ticket or schedule card (per copy)	$ 1
Identification card	$ 5

SPECIAL FEES

Laboratories fees (per laboratory course)	$25
Maintenance fee (per registration period)	$ 35
Annual Basic Medical Insurance	----*
Annual Basic Medical Insurance including pharmacy	----*

* May change from year to year in accordance with changes in contracts with insurance companies.

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 be beyond thirty days before the end of the course. In those exceptional cases, the student must apply for deferred payment of fees prior to the registration day with ample time so that the merits of the application can be evaluated. On the registration day, the students to whom deferred payment of fees is granted must pay at least 50% of the total fees. The balance must be paid at least thirty (30) days before the last day of classes of the semester. Students who fail to pay accordingly must pay a late payment charge of three ($10.00) dollars.

Students who fail to settle their accounts with the University thirty days before the last day of classes every semester, or the 1st. day of July during the 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 per cent refund of tuition 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 PROGRAMS OFFERED

The Mayagüez Campus of the University of Puerto Rico offers graduate programs leading to the following degrees:

Master of Arts
in Hispanic Studies and English Education.

Master of Business Administration
in Human Resources, and Industrial Management. The Master of Business Administration in Finance and in Marketing will be offered in the near future.

Master of Engineering
in Chemical, Civil, Computer, Electrical, Management Systems, and Mechanical Engineering.

Master of Science
in Agricultural Economics, Agricultural Education, Agronomy, Animal Industry, Crop Protection, Extension Education, Food Science and Technology, Horticulture, and Soils.

in Biology, Chemistry, Geology, Marine Sciences with programs: Biological Oceanography, Physical Oceanography, Geological Oceanography and Chemical Oceanography, Mathematics, Pure Mathematics, Statistics, Scientific Computing, and Physics.

in Chemical, Civil, Computer, Electrical, Industrial, and Mechanical Engineering.

Doctor of Philosophy
in Marine Sciences, Chemical Engineering, Civil Engineering, Computing and Information Sciences and Engineering.

It should also be mentioned that Doctoral degrees in Applied Chemistry, Biology, Biotechnology, and Mechanical Engineering will be offered in the near future. On the other hand, a Master of Science degree in Nursing is available through a consortium with the School of Medical Sciences of the University of Puerto Rico. Information on this program should be requested at the respective department.

Efforts are being directed towards offering and receiving graduate courses using distance-learning technology.

PHILOSOPHY AND OBJECTIVES

Over the years, graduate programs have been offered in many fields in response to the needs of the community. New programs, particularly doctoral programs, are being developed to harmonize current and future societal needs and the strengthening of the intellectual and technological capabilities of the professionals formed in the Mayagüez Campus.

The fundamental objective of the graduate programs at the Mayagüez Campus is to develop

in the graduate student a mastering knowledge of his/her field of study and of the resources and techniques that will enable him/her to carry out independent and professional work or research in the arts, sciences, and technology.

In a broader sense, additional objectives of the programs are:

1. to extend the boundaries of knowledge through research that contributes to the development of the student, the University, and the social and technological community;
2. to preserve, acquire and transmit knowledge to successive generations, insofar as graduate schools are the institutions primarily responsible for the education of future college and university teachers;
3. and to serve as a focus for research and teaching in the Caribbean area, with the recognition of Puerto Rico's unique position as a crossroad of the Americas. In this context, all graduate programs stress the importance of attaining a high level of scholarship.

ORGANIZATION OF GRADUATE STUDIES

Graduate studies at the Mayagüez Campus are organized around four basic units: the Office of Graduate Studies, the Graduate Council, the Departmental Graduate Committee, and the Student's Graduate Committee. The functions and responsibilities of these components are described below.

Office of Graduate Studies

The Office of Graduate Studies is an academic and administrative unit within the Office of the Dean of Academic Affairs. It is the responsibility of the Office to see that all pertinent academic and administrative regulations at the graduate level are followed, to coordinate all graduate activities, and to insure that proper guidance is provided to all the academic units that offer graduate programs as well as other related units.

The Director of Graduate Studies, who is also an Associate Dean of Academic Affairs, chairs the Office. An Associate Director collaborates in duties assigned by the Director of Graduate Studies.

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

The Graduate Council

The Graduate Council is an organization in which all the academic units that offer graduate programs are represented. The Council consists of the Director and Associate Director of Graduate Studies, the Dean (or representative) of each college that offers graduate programs; a representative of each Departmental Graduate Committee; and a representative of the graduate students in each college.

The Council acts as an advisory board to the Office of Graduate Studies. The basic roles of this council are:

- act as a forum for the discussion of all matters pertaining to graduate studies;
- studies proposals for new programs or the revision of existing ones;
- makes recommendations on the administration and regulations involving graduate studies;
- evaluates and decides on any complementary regulations that a department submits for its own program so that they are consistent with campus regulations;
- and evaluates and decides on student pleas regarding administrative and academic decisions on which it has jurisdiction.

The Departmental Graduate Committee

The Departmental Graduate Committee consists of at least three members, including the department chairperson, who usually presides over it. In multidisciplinary programs, it will include representation from each department involved.

The functions and responsibilities of the committee include:

- the formulation of complementary regulations, the evaluation of applications for admission, readmission, and transfer;
- the accreditation and convalidation of courses taken in other institutions or prior to admission to the Mayagüez Campus;

- the preparation of qualifying and comprehensive examinations with the assistance of qualified faculty, and the promotion and periodic evaluation of the graduate programs.

The Student's Graduate Committee

The committee shall consist of at least three members in the Master's program and of at least four members in the Doctoral program. The chairperson of the department will appoint the student's committee taking into consideration the interests of the latter and those of the faculty. The committee will be presided by the student's thesis advisor.

The committee is responsible for:

- the preparation or changes of the student's plan of study;
- the revision and approval of the student's dissertation, thesis, or project proposal;
- directing the studies and research until the completion of the degree;
- the revision and approval of the dissertation, thesis, or project report and its oral defense (if it is included in the student's program).

The student's advisor must hold an academic degree equal to or higher than the degree that the student is working for. The advisor shall:

- inform the student about the regulations and procedures related to graduate studies;
- oversee that the student's committee, in consultation with the student, prepares the latter's plan of study;
- revise and approve the dissertation, thesis, or project proposal, and recommend any necessary changes;
- meet regularly with the student to evaluate his/her academic progress and the development of the research or project;
- provide adequate resources to carry out the research;
- verify that other members of the graduate committee offer the corresponding collaboration, and
- give the final grade on thesis and project work.

The Representative of Graduate Studies

The representative of graduate studies is a professor or professional that represents the Director of Graduate Studies in the oral examination of the dissertation, thesis, or project report. This person must belong to a department or program different from the student's. The representative shall oversee that the examination of the dissertation, thesis, or project report takes pace according to the regulations, participate in the administration, evaluation and decisions concerning the exam, and recommend corrections and changes to the final document, if necessary.

ADMISSIONS

Those interested in admission to graduate studies at the Mayagüez Campus must file the application form with the Office of Graduate Studies. Providing three letters of recommendation, three official transcripts of the student's academic record at every institution of higher education attended; and the application fee will complete the application. All application forms and credentials should be sent to: Director, Office of Graduate Studies, P.O. Box 9020, University of Puerto Rico, Mayagüez, Puerto Rico 00681-9020. Applications should be completed before ***February 15*** for admission in the first semester, and before ***September 15*** for the second semester. All credentials submitted by applicants become property of the University and cannot be returned.

Admission to graduate studies requires the favorable recommendation of the corresponding Departmental Graduate Committee. Applicants may be asked to submit additional evidence if it is deemed necessary. The department will forward its recommendation to the Dean of the College for his approval and to the Director of the Office of Graduate Studies for final action.

Academic Requirements for Admission

General requirements for admission to graduate studies are:

1. Holding a bachelor's degree from the University of Puerto Rico or an equivalent from an accredited institution.
2. Having a working knowledge of the Spanish and English languages as determined by the program to which the solicitant is applying.

3. Satisfying one of the following academic index requirements:
   (a) graduation grade point average of 2.50 or better; or
   (b) grade point average of 3.00 or better in the major field; or
   (c) have approved a minimum of 60 credit hours during the last five semesters of the bachelor's program with a grade point average of 3.00 or better.
4. Satisfying all department requirements, which may include, but are not limited to, holding a bachelor's degree in the area of specialization in which the applicant intends to pursue graduate studies, having a grade point average higher than that required in (3) above, and having approved courses in specific subjects. The section covering the specific department in this bulletin should be consulted.

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 first obtain admission as a non-degree student and approve, with an average of at least 3.00, a minimum of nine credits in advanced undergraduate and/or graduate courses during the first three semesters following the mentioned admission. Up to nine credits approved under this provision may be credited towards a degree if the applicant is admitted as a graduate student.

All applicants should realize that meeting the above requirements does not constitute a guarantee for admission. Rather, candidates are selected on a competitive basis from among those that satisfy the requirements and taking into consideration the availability of funds in the program.

READMISSIONS

Students in good standing who have voluntarily interrupted their studies in the Mayagüez Campus of the University of Puerto Rico and desire to resume them must apply for readmission. Applications must be filled with the Registrar's Office before the deadline established in the official academic calendar. The student will pay a non-refundable fee of twenty-seven dollars ($27.00). The Registrar will process each application through the Departmental Graduate Committee, the Dean of the College, the Director of Graduate Studies, and will notify the applicant of the action taken. Readmissions may be granted just once.

STUDENT CLASSIFICATION

Graduate students can be classified according to their admission status (full standing, conditional standing, and visiting); according to their academic load (full time or part time); and according to their academic status (good standing or on probation). These categories are now defined.

A student in **Full Standing** is one who, at the time of admission, satisfies all requirements and is admitted without reservations of any kind.

A student in **Conditional Standing** is one who, at the time of admission, satisfies all requirements, except for some deficiencies in undergraduate courses. In that case, full-standing status can be granted when the student approves said deficiencies, provided he or she does it within the first two years of study. Deficiencies cannot amount to more than four courses. Each one should be passed with a grade of C or better, maintaining a grade point average of 3.00 or better in all the deficiencies.

A **Visiting** student is one who does not seek a graduate degree, but desires to take advanced undergraduate or graduate courses for his/her own academic or professional benefit. Up to 12 credits of the advanced undergraduate or graduate courses approved under this classification may be used to satisfy degree requirements if the student is admitted as a full- or conditional-standing student.

A **Regular** or **Full-Time** student is one who takes at least nine advanced undergraduate or graduate credits per semester; 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.

A student **on Probation** is one whose grade point average in advanced undergraduate o r graduate courses drops at any time below 3.00 or

receives a non-satisfactory (NS) grade in 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 eliminates the probation status. Failure to overcome the causes for probation after a prescribed period of time will lead to academic dismissal from the University.

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

GRADING SYSTEM

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, and NS, not satisfactory. Incompletes must be removed within 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) taking A=4, B=3, C=2, D=0, F=0. Courses with an incomplete report are not included. Credit for thesis research or project is not given until the thesis or report is finally approved. A graduate grade index of 3.00 is considered satisfactory.

GRADUATE COURSES NUMBERING SYSTEM

Advanced undergraduate courses are codified in the 5000's**.** All graduate courses are codified with a number between 6000 and 8999. Courses codified between 8000 and 8999 are mostly intended for the doctoral level.

ALPHABETICAL DISCIPLINE CODES

ADMI BUSINESS ADMINISTRATION
AGRO AGRONOMY
ASTR ASTRONOMY
BIOL BIOLOGY
BOTA BOTANY
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 ECONOMY
EDAG AGRICULTURAL EDUCATION
EING ENGLISH EDUCATION
ESHI HISPANIC STUDIES
ESMA MATHEMATICAL STATISTICS
ESTA STATISTICS
EXAG AGRICULTURAL EXTENSION
FINA FINANCE
FISI PHYSICS
GEIN INDUSTRIAL MANAGEMENT
GEOL GEOLOGY
GERE MANAGEMENT
GERH HUMAN RESOURCES MANAGEMENT
HORT HORTICULTURE
INCI CIVIL ENGINEERING
INEL ELECTRICAL ENGINEERING
INGL ENGLISH
ININ INDUSTRIAL ENGINEERING
INME MECHANICAL ENGINEERING
INPE ANIMAL INDUSTRY
INQU CHEMICAL ENGINEERING
MATE MATHEMATICS
MECU QUANTITATIVE METHODS
MERC MARKETING
PLSC PLANT SCIENCE
PROC CROP PROTECTION
QUIM CHEMISTRY
SICI COMPUTERIZED INFORMATION SYSTEMS
ZOOL ZOOLOGY

PLAN OF GRADUATE STUDY

There is no general specific curriculum on any program, although in many cases a number of core courses are required. The student's Plan of Graduate Study will be prepared by his/her committee taking into consideration the needs of the individual. This plan must be approved by the president of the Departmental Graduate Committee and submitted to the Office of Graduate Studies during the student's second semester of graduate work.

PROPOSAL

Graduate students pursuing a degree in which a dissertation, thesis, or project is required must

submit a proposal describing the goals, objectives, previous work, justification, general and plan of action. This document must be completed before the student is registered for dissertation, thesis, or project credit for a second time.

GENERAL ACADEMIC REGULATIONS

Academic Load

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

Residence Requirements

Studying two academic semesters and approving 60 percent of the credits at the Mayagüez Campus satisfies residence requirements for the Master's degree. Studying four academic semesters and approving 60 percent of the credits at the Mayagüez Campus satisfies residence requirements for the doctoral degree.

Transfer

A student in good standing can apply for transfer to another department within the Mayagüez Campus (during the period prescribed in the official academic calendar). The student will pay a non-refundable fee of seventeen ($17.00) dollars. The department for which the student is applying will send its recommendation to the Dean of the College for his/her approval and to the Director of Graduate Studies for final action. Only students with an academic index of at least 3.00 will be considered.

Repetition of Courses

A graduate student can repeat once up to three advanced undergraduate or graduate courses in which he/she has a grade of C or lower. Each department or program will establish its own repetition policy for other undergraduate courses.

Withdrawal from Courses

A graduate student should avoid withdrawing from courses. Nevertheless, he/she can do so during the period prescribed in the official academic calendar, with the approval of his/her advisor and the authorization of the Dean of the College and of the Director of Graduate Studies. Unauthorized withdrawals will result in a grade of "F" in all such courses.

Withdrawal from the University

A student may withdraw completely from the Mayagüez Campus at any time until the last day of classes. The student must obtain written permission from the Dean of the College and the Director of Graduate Studies. The Registrar will post a "W" in every course in the Plan of Graduate Study for that semester. Any student who has withdrawn from Graduate Studies must apply for readmission (during the period prescribed in the official academic calendar) if he/she intends to continue graduate work. The student may apply for readmission only once.

Academic Dismissal

A graduate student shall be dismissed from the University if he/she:

1. does not approve deficiency courses as indicated in a conditional admission during the first two years of study;
2. maintains a grade point average below 3.00 for three consecutive semesters;
3. receives a grade of "NS" in dissertation, thesis, or project for a third consecutive time;
4. is placed on probation in three nonconsecutive occasions;
5. fails for the second time any of the degree examinations;
6. fails to satisfy all the requirements for a Master's degree within six academic years after being admitted;
7. fails to satisfy all the requirements for a doctoral degree within ten academic years when admitted with a bachelor's degree, or within eight academic years when admitted with a Master's degree.

REQUIREMENTS FOR THE MASTER'S DEGREE

There are three options in programs leading to the Master's degrees at Mayagüez. The applicant

should seek information on the program of interest to determine which options are available in that program.

In all cases the student shall approve all the courses in his/her Plan of Graduate Study with an academic index of at least 3.00. Graduate courses approved by the student as a senior in the Mayagüez Campus can be accepted as long as they were not used to satisfy the Bachelor's degree requirements.

These students must inform the Registrar in writing their intention to use a course as part of their Plan of Graduate Study. The last day to notify the Registrar is the last day to submit the application for graduation from the bachelor's degree. The student must also comply with the residence requirements.

PLAN I. With Thesis Requirement

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

1. Approve all courses in his/her Plan of Graduate Study as follows:
   (a) A minimum of thirty credits in advanced undergraduate and graduate courses.
   (b) A minimum of twenty-one credits at the graduate level, including up to six credits in thesis research.
   (c) A minimum of six credits in courses related to, but outside the area of specialization.
2. Carry out a research program, as specified in his/her Plan of Graduate Study and prepare a thesis.
3. Approve an oral exam on the thesis subject. In the event that the student fails the exam, he/she will have the opportunity to take a second exam in the same semester or in the next one. The result of the second exam is final.

PLAN II. With Project Requirement

In addition to the common requirements stated above, the student shall complete those specified in the PLAN I description, except that the work completed will lead to a project report instead of a thesis. An oral exam on the project will also be required. In the event that the student fails the exam, he/she will have the Opportunity to take a second exam in the same semester or in the next one. The result of a second exam is final.

PLAN III. Without Thesis or Project Requirement

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

1. Approve all courses in his/her Plan of Graduate Study as follows:
   (a) A minimum of thirty-six credits in advanced undergraduate and graduate courses.
   (b) A minimum of twenty-seven credits at the graduate level.
   (c) A minimum of twenty-one credits in the major field of study.
   (c) A minimum of six credits in courses related to, but outside the area of specialization. Courses within the major department can be used to satisfy this requirement only when there are two or more distinct and well-defined areas.

2. Pass a written examination on the material covered in the major field courses. If the student fails, he/she may take a second exam in the same semester, or in the next one. The result of the second exam is final.

REQUIREMENTS FOR THE DOCTOR OF PHILOSOPHY DEGREE

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

In order to qualify for the degree, the student shall:

1. Approve a qualifying examination.
2. Approve all the courses in his/her Plan of Graduate Study with an academic index of at least 3.00.
3. Comply with the residence requirements.
4. Pass a comprehensive examination on the course matter covered in the program. The exam may be written, or both written and oral. If the student fails, he/she may take a second exam later that semester, or in the semester that follows. The result of the second exam is final.
5. Carry out an independent research project that will represent a significant contribution to the advancement of knowledge, and write a thesis. The dissertation should be a

scholarly presentation suitable for publication.
6. Pass a final oral exam on the research and thesis. If the student fails, he/she may take a second exam later that semester, or in the one that follows. The result of the second exam is final.
7. Approve all courses in his/her Plan of Graduate Study as follows:
   (a) A minimum of fifty-two credits in advanced undergraduate and graduate courses.
   (b) A minimum of thirty-four credits in graduate-level courses, including up to eighteen credits in dissertation research.
   (c) A minimum of nine credits outside the field of specialty but in related areas.
8. Credits approved before admission to the doctoral program may be accredited upon recommendation of the departmental graduate committee, as long as the student meets residence requirements. Master's thesis, or project research credit cannot be accredited.

FINAL EXAMINATION

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

The examining committee will consist of the student's committee and a representative of the Director of Graduate Studies. It will be presided by the student's advisor. All corrections to the thesis or report should be completed within the time period specified by the committee. That period shall not go beyond the last day of classes of the semester immediately following that in which the exam is taken.

OTHER GRADUATION REQUIREMENTS

In addition to the requirements specified in the section on general academic regulations, the student must:
1. Have satisfied all financial obligations to the University of Puerto Rico, Mayagüez Campus.
2. Have filed an application for the degree at the Registrar's Office before the deadline established in the official academic calendar.
3. Have been recommended for the degree by the Faculty.
4. Attend Commencement Exercises, unless excused by the Registrar.

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

The Proposal

To an extent, the proposal is an agreement between the student and his graduate committee regarding the scope of the research. The goals and procedures described in the proposal can change during the course of the research, but excessive modification should be avoided. A radical change of thesis topic requires a new proposal. The proposal should be about fifteen pages in length.

Format of the Proposal

1. *Cover:* The title is a brief, clear description of the research. The required signatures should follow a prescribed format.
2. *Justification:* Describes the importance of the topic and its possible original contribution.
3. *Previous work:* Summarizes the contents of publications directly related to the topic and the present status of knowledge in the field.
4. *Objectives:* An organized, detailed explanation of the objectives of the research.
5. *Procedure:* A description of the methods that will be used to achieve the goals of the research.
6. *Bibliography:* A list of references cited according to the style accepted in the field of specialty.

The Dissertation, Thesis, or Project Report

The dissertation, the thesis, or the project report (hereinafter referred to as document), has two objectives: to demonstrate that the student can work and do research independently, and to show that he commands the skills needed to communicate effectively with the academic and

scientific community. Through their signature, the members of the Graduate Committee certify that they have carefully read and revised the document.

The document may be written in English or in Spanish. Two unbound copies are deposited in the Office of Graduate Studies thirty days before the final examination date. This period is needed to revise the document, designate the representative of graduate studies, and provide this person with sufficient time needed to read the document and make arrangements for the oral examination.

The copyright of the thesis belongs to the author. The Office of Graduate Studies makes the necessary arrangements to publish the thesis with ProQuest Information and Learning Company (formerly known as Bell and Howell/UMI).

Presentation of the Manuscript

The document is printed on 20 lb. paper, using standard fonts no smaller than 10 characters per inch. (As a minimum, Times New Roman 12, Arial 10, or similar fonts are recommended.) The text is double-spaced, with single spacing allowed for footnotes and the captions of tables and figures. Paragraph beginnings should be indented five spaces.

Margins

The following margins apply throughout the manuscript: 2.5 cm (1 inch) on the bottom and right side, 3.5 cm (1.25 inches) on the top, and 4.0 cm (1.5 inches) on the left side. Tables, illustrations, and page numbers should fit within these margins.

Pagination

Preliminary pages are numbered with lowercase roman numerals centered near the bottom margin. On the first page of the main divisions of the document (chapters, bibliography, appendices, etc.), the number is Arabic, placed at the bottom, centered and within the margins. The remaining pages carry Arabic numerals on the upper right hand corner, within the margin. The cover page and pages containing only illustration legends are not numbered. The cover page is followed by page ii.

Tables and Figures

Tables and figures are numbered and carry a legend or descriptive title. The title of the table is placed above the table and the title of the figure is placed below the figure. If the figure legend does not fit within the page margins, it should be centered on a separate unnumbered page placed facing the figure; the left and right margins of this page are inverted. Titles used in the text must be the same as those used in the list of tables and in the list of figures. All the tables and figures should be cited in the text.

Since the manuscript will be microfilmed by ProQuest Information and Learning Company, please keep in mind that: lines on a graph should be identified by labels or symbols rather than colors, shaded areas will have better contrast if cross-hatching is used instead of color, photographs should be professional-quality black and white.

Division and Organization of the Dissertation, Thesis, or Project Report.

Preliminary Pages

1. *Cover:* The title is a brief, clear description of the research. The required signatures should follow a prescribed format.
2. *Abstract*: Explains in less than 150 words (350 for doctoral dissertations) the purpose of the research, the main methods used, the results obtained, and the most important conclusions.
3. *Resumen:* Spanish version of the abstract. Both summaries must have the same content.
4. *Copyright page (optional*)
5. *Dedication (optional)*
6. *Acknowledgments*
7. *Table of contents*: Includes from the list of tables to the list of appendices. All parts, chapters, and sections should appear in this table, with their corresponding page numbers and headings as they appear in the text.
8. *List of tables:* Use the same titles that appear in the text.
9. *List of figures:* Use the same legends that appear in the text.
10. *List of symbols and abbreviations (optional*)

Text

The first chapter or section is the Introduction. This describes the work and relates it to the current knowledge of the field. The objectives of the study should be clearly stated in this section or in a separate one titled Objectives. The second chapter is usually a review of the literature.

The following chapters present a detailed description and discussion of the problem studied. The materials and methods sections should provide enough information so that a trained individual can repeat the observations.

The results may be presented in text, tables or figures. Explanation of the tables and figures to the point of presenting again the data should be avoided. All measurements and quantities should be expressed using the international system of units (SI system). In the discussion section, the results are explained and compared with the knowledge available in the literature.

The conclusions and recommendations for future research are the topics of the last two sections. Appendices are placed after the bibliography.

Bibliography

This section includes articles published in journals, papers in press (accepted for publication), books, theses, and articles published on the Internet. It should not include manuscripts in preparation, manuscripts submitted to a journal but not yet accepted, papers presented in technical meetings, or personal communications. If all the articles cited in the text appear in the bibliography (and vice versa), the section should be titled Literature Cited.

Articles may be cited in the text by author and year of publication or by numbers assigned to the references. In the first system, the bibliography is ordered alphabetically; first articles with one author, chronologically, then articles by that author and a second author, arranged by the last name of the second author and chronologically, and finally papers with three or more authors, arranged by the last name of the first author and chronologically (not by the last names of the other authors).

In the second system, the bibliography may be ordered alphabetically or by order of appearance in the text. In both systems, articles with three or more authors are cited in the text by the last name of the first author followed by et al., but all the authors are listed in the bibliography.

Journal names should be spelled out or abbreviated consistently. It is not necessary to underline titles or journal names. Literature entries should provide all the information needed to locate the reference.

The following examples may be used when preparing the bibliography.

article- Greenspan E. H. and J. Stern. 1993. Analysis of the chemical composition of Spanish lime (*Melicoccus bijugatus*). J. Chem. Anal. 45(3): 334-359.

article in a book- Greenspan, E. H. and J. Stern. 1993. Analysis of the chemical composition of Spanish lime (*Melicoccus bijugatus*). In: E. Cassidy (ed.). Chemical composition of tropical fruits, pp. 334-359. Smith & Sons Publishing Company, Ontario, Canada.

book- Greenspan, E. H. and J. Stern. 1993. The chemical composition of Spanish lime (*Melicoccus bijugatus*). Smith & Sons Publishing Company, Ontario, Canada, 335 pp.

thesis- Greenspan, E. H. 1993. The chemical composition of Spanish lime (*Melicoccus bijugatus*). M.S. Thesis, University of Puerto Rico, Mayagüez, P.R., 335 pp.

newspaper article- Greenspan, E. H. 1993. The chemical composition of Spanish lime. The San Juan Star, San Juan, Puerto Rico, Feb. 20. p.5-6.

Internet publication- Greenspan, E. H. and J. Stern. 1993. Analysis of the chemical composition of Spanish lime (*Melicoccus bijugatus*). http://www.uier.edu/articles/greenspan/paper1.html. Active June 1998.

COLLEGE OF AGRICULTURAL SCIENCES

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

A management team, including the Dean of the College of Agricultural Sciences, the Associate Dean of the Faculty of Agriculture, the Associate Dean and Deputy Director of the Agricultural Experiment Station, and the Associate Dean and Deputy Director of the Agricultural Extension Service, imparts direction to the plans and programs of the College of Agricultural Sciences. The Coordinator of International Programs in Agriculture adds a new dimension to the College of Agricultural Sciences. The Office administers a number of training and research programs in tropical agriculture, mainly through the use of external funds provided to the University by international agencies particularly by the Agency of International Development (AID). The Mayagüez Campus is one of the 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). For this and other reasons, 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 field of agriculture. At the Graduate level, the Faculty of Agriculture offers study programs leading to the Masters of Science degree in Animal Industry, Agricultural Economics, Agricultural Education, Agricultural Extension, Agronomy, Soils, Crop Protection, Food Science and Technology, and Horticulture. Programs leading to a Master in Agricultural Education degree and a Master in Agricultural Extension are also offered (no admissions granted temporarily).

Besides the library, laboratories and farm facilities for research at the Mayagüez Research Center, facilities are also available at the Río Piedras Research Center and at the six substations located at different geographic regions of Puerto Rico. The USDA Tropical Agriculture Research Station (TARS), adjacent to the Mayagüez Campus, offers technical assistance and makes available to the graduate students their Library and other physical facilities for research.

AGRICULTURAL ECONOMICS

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

In addition to the admission requirements of the Office of Graduate Studies, a Bachelor of Science degree in Agricultural Sciences or its equivalent is required. There are no specific program requirements above those of Graduate Studies Office. All students are required to write a thesis.

It is possible for the students to focus their thesis research on the research projects of the Department. Research facilities of the Agricultural Experiment Station are available to the students, and also Department microcomputers for research.

The program includes subjects in the following areas: Agricultural Production Economics, Farm Management, Marketing, and Natural Resources Economics.

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

AGRICULTURAL ECONOMICS (ECAG)

Graduate Courses

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 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 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 6660. AGRICULTURAL PRICES (II) (Even numbered years). 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 6990. SUPERVISED PROFESSIONAL OCCUPATIONAL EXPERIENCE FOR COOP STUDENTS. From three to six credit hours. Only three credits will be considered within the minimum of the required 30 credits for the graduate program.

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 6995. SPECIAL PROBLEMS IN AGRICULTURAL ECONOMICS (I, II, S)-(I, II, S). Three credit hours. One to three research periods per week each semester.

This course provides for study in any phase of Agricultural Economics in which the student is especially interested. Individual problem methods.

ECAG 6997. SELECTED TOPICS (On demand). One to three credit hours. Prerequisite: Consent 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: Consent 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 ECONOMICS FACULTY

A list of professors that 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.

MYRNA COMAS PAGAN, *Assistant Specialist of Extension*, M.S. (1990), University of Puerto Rico. Research and Teaching Interests: Farm Management and Agricultural Marketing.

RESTITUTO DEYNES SOTO, *Extension Specialist* , M.S. (1975), University of Puerto Rico. Research and Teaching Interests: Agricultural Economics.

JORGE FERNANDEZ CORNEJO, *Adjunct Professor* (Agricultural Economics), 1990, Ph.D., University of Delaware.

GLADYS GONZALEZ, *Professor*, Ph.D. (1984), University of Missouri. Research and Teaching Interests: Natural Resources Economics, Land Use, Production Economics.

JORGE GONZALEZ, *Professor*, Ph.D. (1986), University of Missouri, J.D. (1995), Pontifical Catholic University of Puerto Rico. Research and Teaching Interests: Agricultural Marketing and Agribusiness.

JUAN ORTIZ LOPEZ, *Associate Investigator*, M.S. (1986), University of Puerto Rico. Research and Teaching Interests: Agricultural Economics.

ROOPEHAND RAMGOLAM, *Professor*, Ph.D. (1974), Louisiana State University, Ad Honorem.

AGRICULTURAL EDUCATION

The Department of Agricultural Education offers programs leading to the 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.

The minimum course work required for the Master of Science degree is 30 credits, including three research credits. Candidates for the Master of Science degree are required to prepare and present a thesis.

The 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, Supervision, etc.

AGRICULTURAL EDUCATION (EDAG)

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 (EXAG)

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.

AGRICULTURAL EDUCATION FACULTY

A list of professors that 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.

MILDRED FELICIANO, *Extension Specialist*, Ph.D. (1994), The Pennsylvania State University. Research and Teaching Interests: Health Education

JOSE M. HUERTA, *Extension Specialist*, Ph.D. (1993), The Ohio State University. Research and Teaching Interests: Research, Evaluation, and Rural Development.

DAVID PADILLA VELEZ, *Associate Professor*, Ph.D. (1993), The Ohio State University. Research and Teaching Interests: Agricultural Education, Teacher Education.

LUIS F. SILVA GUERRERO, *Professor,* Ph.D. (1988), Cornell University. Research and Teaching Interests: Curriculum Development, Higher Education, Developments in International

Agricultural Projects, Communications, Microcomputers in Education.

JOSE A. VILLAMIL FREYTES, *Professor*, Ph.D. (1978), University of Connecticut. Research and Teaching Interests: Curriculum Development, Higher Education Administration, Administration and Supervision, Vocational and Teaching Education.

CARLOS A. VIVONI REMUS, *Extension Specialist*, Ph.D. (1991), University of Massachusetts. Research and Teaching Interests: Communication.

AGRONOMY AND SOILS

The Department of Agronomy and Soils offers programs leading to the Master of Science degree with emphasis in Agronomy and Soils. In addition to the admission requirements of the Office of Graduate Studies, a Bachelor of Science degree in Agricultural Sciences or its equivalent is required.

Although there are no specific course requirements, most students are expected to take two courses each in seminar and biometrics. All students are required to undertake a research project, prepare a thesis, and approve an oral exam based on the thesis subject. There are no additional academic requirements above those stated by Graduate Studies.

The Department has special laboratory facilities for the study of nitrogen fixation, soil and plant tissue analysis, and crop physiology. The facilities of the Agricultural Experiment Station are available to students for their thesis research. The Department is actively involved in International Programs and has received grants for research in Crop Modeling, Nutrient Management, Plant Breeding and others.

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

AGRONOMY (AGRO)

Advanced Undergraduate Courses

AGRO 5005. AGRICULTURAL BIOMETRICS (I, S). Three credit hours. Two hours of lecture and one three-hour laboratory per week.

Introduction to the fundamental concepts of the application of biometrical methods to agricultural problems; graphical presentation of data; concepts of randomness and probability; frequency distribution and sampling; Chi-square and t-test; measures of dispersion and relationships; and analysis of variance.

AGRO 5006. GENESIS, MORPHOLOGY AND CLASSIFICATION OF SOILS (I). Three credit hours. Two hours of lecture and one three-hour laboratory per week. Prerequisite: AGRO 3005.

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 one three-hour laboratory per week. Prerequisite: AGRO 5006.

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 non-agricultural uses. Representative soil profiles are studied during field trips.

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 consent 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 5016. ADVANCED SOIL FERTILITY (II) (Even numbered years). Three credit hours. Three hours of lecture per week. Prerequisite: AGRO 4037.

A detailed discussion of the soil properties affecting crop growth; tilt, soil structure, soil water, soil reaction, ionic exchange, absorption, soil organic matter and soil microorganisms; review of recent literature on the subject; laboratory methods of recent literature on the subject; laboratory methods of assessing soil fertility.

AGRO 5501. AGRICULTURAL BIOTECHNOLOGY (II) (Even numbered years). Three credit hours. Three hours of lecture per week. Prerequisites: QUIM 3062, (BIOL 3015 or BIOL 3300), and either BIOL 3770 or PROC 4016.

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

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 6600. ADVANCED AGRICULTURAL BIOMETRICS (II). Three credit hours. Two hours of lecture and one three-hour laboratory per week. Prerequisite: AGRO 5005.

Advanced study of analysis of variance, covariance, regression and correlation; methods of constructing and analyzing designs for experimental investigations as applied to problems in agriculture.

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.

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 6651-6652. SEMINAR (I, II)-(I, II). One credit hour per semester. One research period per week each semester.

Discussion of assigned or selected readings of investigation related to problems in Agronomy, presentation of original work related to research in Agronomy.

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: Consent 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: Consent 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.

PLANT SCIENCE (CFIT)

CFIT 6605. RADIOISOTOPES TECHNIQUES IN AGRICULTURE. Three credit hours. Two lectures and one three-hour laboratory per week.

This course is geared for advanced undergraduate and graduate students. It entails fundamental techniques in the use of radioisotopes in agricultural problems.

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.

AGRONOMY AND SOILS FACULTY

A list of professors that 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.

ALBERTO BEALE COSIO, *Associate Researcher*, Ph.D. (1979), University of Florida, Gainesville. Teaching & Research Interests: Agronomy.

JAMES SCOTT BEAVER, *Researcher*, Ph.D. (1980), University of Illinois at Urbana. Teaching & Research Interests: Plant Breeding.

LINDA W. BEAVER, *Professor*, Ph.D. (1981), University of Illinois at Urbana. Teaching & Research Interests: Plant Breeding.

FRIEDRICH H. BEINROTH, *Professor*, Ph.D. (1965), University of Stuttgart, West Germany. Teaching & Research Interests: Soil

Classification, Soil Formation, Soil Interpretation.

WINSTON DE LA TORRE, *Associate Professor*, Ph.D. (1988), North Carolina State University. Teaching & Research Interests: Plant Physiology and Plant Biochemistry.

RAÚL E. MACCHIAVELLI, *Professor*, Ph.D. (1992), Pennsylvania State University. Teaching & Research Interests: Statistics, Biometry.

GUSTAVO MARTINEZ, *Associate Researcher*, Ph.D. (1995), Ohio State University. Teaching & Research Interest: Soil Chemistry.

MIGUEL MUÑOZ, *Associate Researcher*, Ph.D. (1988), Ohio State University. Teaching & Research Interests: Soil Chemistry and Soil Mineralogy.

JULIA O'HALLORANS, *Assistant Researcher*, Ph.D. (2001), New Mexico State University. Teaching and Research Interest: Soil Fertility.

JUAN G. PEREZ BOLIVAR, *Assistant Professor*, Ph.D. (2000), University of Florida. Teaching & Research Interests: Soil Classification, Wetlands.

ELVIN ROMAN PAOLI, *Assistant Researcher*, Ph.D. (1997), Kansas State University, Teaching & Research Interest: Agronomy.

EDUARDO C. SCHRÖDER, *Professor,* Ph.D. (1980), North Carolina State University. Teaching & Research Interests: Soil Microbiology, Agronomy.

DAVID SOTOMAYOR RAMIREZ, *Associate Professor*, Ph.D. (1995), Kansas State University. Teaching & Research Interests: Soil Fertility, Nutrient Management.

RAMON I. TORRES LOPEZ, *Associate Professor*, Ph.D. (1993), Texas A&M University. Teaching & Research Interests: Plant Genetic and Physiology.

JOSE VILLARRUBIA CRUZ, *Professor,* Ph.D. (1980), North Carolina State University. Teaching & Research Interests: Foresting and Soil Science.

ANIMAL INDUSTRY

The Department of Animal Industry offers a program of studies leading towards the degree of Master of Science in Animal Industry. 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 must conduct a research project and write a thesis on a subject of the student interest.

The graduate program in Animal Industry is designed to develop research skills in subjects related to food producing animals, including swine, poultry, rabbits, beef and small ruminants. Available courses deal with production and management of the most important animal species as well as nutrition, breeding, reproduction, behavior and animal processing and manufacturing.

The students that are accepted to the program are expected to take basic courses in statistics, biochemistry and physiology and complete their coursework with elective courses offered by the Department.

Research facilities consist of modern laboratories located on-campus and the animal facilities located at Research Centers and Agricultural Experiment Stations of the College of Agricultural Sciences. Some new or remodeled facilities for slaughtering poultry, swine and cattle are located at the Lajas Substation.

As part of their training, graduate students are expected to acquire some teaching experience either by giving selected lectures in an undergraduate course or by serving as the instructor in charge or as an aide in the laboratory sections of certain courses.

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

ANIMAL INDUSTRY (INPE)

Advanced Undergraduate Courses

INPE 5346. DAIRY BY-PRODUCTS (On demand). Three credit hours. Two hours of lecture and one three-hour laboratory per week. Prerequisite: INPE 4008.

The manufacture of ice cream, cheese, and butter.

INPE 5347. VETERINARY PARASITOLOGY (II). Three credit hours. Two hours of lecture and one three-hour laboratory per week. Prerequisites: INPE 3005 and (BIOL 4015 or BIOL 3022 or BIOL 3052).

Morphology, life cycle, and control of farm animals' parasites.

INPE 5355. ADVANCED BEEKEEPING (On demand). Three credit hours. Two lecture and one three-hour laboratory per week. Prerequisite: INPE 4016.

Commercial Management of Apiaries. The course includes the production of queen bees, and the various methods used to obtain honey and to extract the wax.

INPE 5357. SCIENCE AND TECHNOLOGY OF FRESH MEATS (On demand). Three credit hours. Two hours of lecture and one four-hour laboratory per week. Prerequisite: INPE 4005 or Consent of the Director of the Department.

Principles and practices in the handling, processing and preservation of beef, pork, and poultry meats.

Graduate Courses

INPE 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.

INPE 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.

INPE 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.

INPE 6607-6608. GRADUATE SEMINAR (I, II)-(On demand). One credit hour per semester. One meeting per week per semester.

Lectures, discussions, and reports on selected topics in Animal Industry.

INPE 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.

INPE 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.

INPE 6613. MILK SECRETION (On demand). Three credit hours. Three hours of lecture per week.

Physiology of milk secretion.

INPE 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.

INPE 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.

INPE 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.

INPE 6625. ANIMAL ENERGY METABOLISM (II). Three credit hours. Three hours of lecture per week. Prerequisite: Consent of the Director of the Department.

Cell structure and its relationship with energy metabolism; concept and types of energy; laws of thermodynamics and their relationship with animal metabolism; energy utilization for different processes; energy requirements of animals; environmental effects on energy metabolism; control systems of energy metabolism; techniques utilized to study energy metabolism.

INPE 6626. ANIMAL PROTEIN METABOLISM (I). Three credit hours. Three hours of lecture per week. Prerequisite: Consent 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.

INPE 6637. NEUROENDOCRINE AND CIRCULATORY PHYSIOLOGY. 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.

INPE 6638. RENAL, RESPIRATORY AND DIGESTIVE PHYSIOLOGY. 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.

INPE 6990. SUPERVISED PROFESIONAL OCCUPATIONAL EXPERIENCE FOR CO-OP STUDENTS. From three to six credit hours. Prerequisites: Consent of the Director of the Department and to be a Coop Plan student. Only three credits will be considered within the minimum of the required 30 credits for the graduate program.

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.

INPE 6995-6996. SPECIAL PROBLEMS (I, II, S)-(I, II, S). One to five credit hours per semester. One to five research periods per week each semester.

Advanced studies in animal industry problems and procedures. Problems will be assigned according to experience, interests, and need of the individual student.

INPE 6997. SELECTED TOPICS (I,II). One to three credit hours. Prerequisite: Consent of the Director of the Department.

Selected topics in biotechnology, physiology, nutrition, reproduction, animal health and management of domestic species.

INPE 6998. SELECTED TOPICS (On demand). One to three credit hours. Prerequisite: Consent of the Director of the Department.

Selected topics in biotechnology, physiology, nutrition, reproduction, animal health and management of domestic species.

INPE 6999. RESEARCH AND THESIS (I,II,S). One to six credit hours. One to six research periods per week.

Organized research in Animal Industry at the Master's thesis level, including thesis presentation and discussion as a part of the requirements for a Master of Science degree with a major in Animal Industry.

ANIMAL INDUSTRY FACULTY

A list of professors that 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.

AMERICO CASAS GUERNICA, *Assistant Researcher*, M.S. (1984), University of Puerto Rico. Teaching and Research Interest: Beef Cattle Production.

DANILO S. CIANZIO MUJICA, *Professor*, Ph.D. (1980), Iowa State University. Teaching and Research Interest: Beef Cattle Production and Meat Technology.

ANGEL A. CUSTODIO GONZALEZ, *Associate Professor*, Ph.D. (1983), Texas A&M University. Teaching and Research Interest: Animal Breeding and Genetics.

JOHN A. FERNANDEZ VANCLEVE, Professor, Ph.D. (1986), University of Kentucky. Teaching and Research Interest: Reproductive Physiology.

JORGE GONZALEZ ORTIZ, *Associate Extension Specialist*, M.S. (1986), University of Puerto Rico. Teaching and Research Interest: Swine Production.

JOSE R. LATORRE ACEVEDO, *Professor*, Ph.D. (1986), University of Arkansas. Teaching and Research Interest: Poultry Production and Avian Physiology.

JAIME MOYA GUZMAN, *Assistant Researcher*, Ph.D. (1986), Texas A & M University. Teaching and Research Interest: Dairy cattle nutrition and management.

CARLOS NAZARIO PAGAN, *Assistant Extension Specialist*, M.S. (1988), North Carolina State University. Teaching and Research Interest: Poultry husbandry.

WILMA PAGAN PADILLA, *Assistant Researcher*, Ph.D. (1989), Ohio State University. Teaching and Research Interest: Milk chloride levels.

JOSE PANTOJA LOPEZ, *Associate Extension Specialist*, Ph.D. (1994), Ohio State University. Teaching and Research Interest: Dairy Science; DHIA Records.

DANIEL G. PESANTE ARMSTRONG, *Professor,* Ph.D. (1985), Louisiana State University. Teaching and Research Interest: Apiculture.

PAUL F. RANDEL FOLLING, *Researcher*, Ph.D. (1963), Louisiana State University. Teaching and Research Interest: Ruminant Nutrition.

ARIEL RAMIREZ RAMIREZ, *Associate Extension Specialist*, M.S. (1983), Louisiana State University. Teaching and Research Interest: Mastitis.

ERNESTO O. RIQUELME VILLAGRAN, *Professor,* Ph.D. (1975), Washington State University. Teaching and Research Interests: Energy and Protein Metabolism; Forage Utilization.

EDGARDO R. RIVERA COLON, *Associate Professor*, D.V.M. (1984), Tuskegee University. Teaching and Research Interests: Animal Physiology; Swine Production.

BENJAMIN RIVERA HERNANDEZ, *Assistant Professor*, D.V.M. (1975), Michigan State University. Teaching and Research Interests: Reproduction; Horse Production.

AIXA RIVERA SERRANO, *Assistant Specialist*, M.S. (1985), University of Puerto Rico. Teaching and Research Interest: Beef Cattle Production.

ABNER RODRIGUEZ CARIAS, *Associate Professor*, Ph.D. (1996), Michigan State University. Teaching and Research Interest: Ruminant Nutrition; Microbiology.

HECTOR RODRIGUEZ PASTRANA, *Associate Specialist*, M.S. (1987), University of Puerto Rico. Teaching and Research Interests: Beef cattle, small ruminant and rabbit production.

TEODORO RUIZ LOPEZ, *Assistant Researcher*, Ph.D. (1993), University of Florida. Teaching and Research Interests: Dairy Nutrition; Forage Utilization.

CARMEN SANTANA NIEVES, *Associate Professor*, Ph.D. (1993), University of Illinois. Teaching and Research Interests: Swine Production; Environmental Physiology; Animal Behavior.

VICTOR SIBERIO TORRES, *Professor*, Ph.D. (1996), Michigan State University. Teaching and Research Interests: Swine Production; Non-ruminant Nutrition.

SAUL WISCOVITCH TERUEL, *Assistant Extension Specialist*, M.S. (1985), University of Puerto Rico. Teaching and Research Interest: Aquaculture.

CROP PROTECTION

The Department of Crop Protection offers a program leading to the degree of Master of Science. The major disciplines include entomology, nematology, phytopathology, and weed science.

Applicants must meet the Graduate Studies Office requirements and have a Bachelor of Science degree in Agricultural Sciences or its equivalent. Candidates are expected to have approved undergraduate courses in the major departmental disciplines, soils sciences and crop production.

The program in Crop Protection is designed to develop research skills in subjects related to this field. Courses from other departments such as statistics, experimental design, and biology, can be considered for this program.

Laboratories to conduct crop protection research are available to students at Mayagüez and at the Río Piedras Research Center of the Agricultural Experiment Station. Field facilities are available at the College Farm in Mayagüez and at the six substations.

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

CROP PROTECTION (PROC)

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 consent 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: CFIT 4008 or PROC 4008.

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 6009-6010. SEMINAR (I, II)-(I, II). One credit hour per semester. One hour of discussion per week.

Discussion of topics on crop protection including results of research work.

PROC 6603. METHODS OF RESEARCH IN PATHOLOGY (II) (Odd numbered years). Four credit hours. Two hours of lecture and two laboratories of three hours per week.

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 6608. ADVANCED TROPICAL PHYTOPATHOLOGY (I) (Even numbered years). Four credit hours. Four hours of lecture per week. Prerequisite: PROC 6604 or CFIT 6604.

Study and analysis 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 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, pineapple, 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: consent 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: Consent 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: Consent 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.

CROP PROTECTION FACULTY

A list of professors that 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.

EDWIN ABREU, *Associate Researcher*, M.S. (1977), University of Puerto Rico, Mayagüez Campus. Teaching and Research Interests: General Entomology, Population Dynamics, Integrated Pest Management, Insect Biology, Biology, Biological Control, and Plant Mites.

ARISTIDES ARMSTRONG, *Associate Researcher*, M.S. (1981), University of Puerto Rico, Mayagüez Campus. Teaching and Research Interests: General Entomology, and Control of Insect Pests on Economic Crops.

JULIO BIRD, *Emeritus Professor*, Ph.D. (1957), University of Minnesota. Teaching and Research Interest: Plant Virology.

JOSE A. CHAVARRIA, *Associate Researcher*, Ph.D. (1997), University of Auburn, Alabama. Teaching and Research Interest: Plant Pathology.

JOSE A. DUMAS, *Assistant Researcher*, Ph.D. (1999), University of Puerto Rico-Río Piedras. Research Interest: Pesticide Residues Analysis. Teaching Interest: Analytical Chemistry.

RODRIGO ECHAVEZ, *Researcher*, M.S. (1977), University of Puerto Rico, Mayagüez Campus. Teaching and Research Interests: Nematology, Phytopathology, and Diseases of Beans and Sugarcane.

ROSA FRANQUI, *Associate Researcher*, Ph.D., (1995), University of Wisconsin, Madison. Teaching and Research Interest: General Entomology and Biological Control.

ANGEL L. GONZALEZ, *Associate Professor*, Ph.D. (1998), University of Illinois, Urbana. Teaching and Research Interests: General Entomology, Biological Control.

RAFAEL INGLES, *Researcher,* M.S. (1990), University of Puerto Rico, Mayagüez Campus. Research and Teaching Interests: General Entomology, Pesticide Registration.

MARIA DE L. LUGO, *Associate Researcher*, Ph.D. (1993), University of Arkansas. Teaching and Research Interest: Weed Science.

ALBERTO PANTOJA, *Researcher*, Ph.D. (1985), Louisiana State University. Teaching and Research Interests: General Entomology and Plant Resistance to Arthropods.

LYDIA I. RIVERA VARGAS, *Associate Professor*, Ph.D. (1994), Ohio State University. Teaching and Research Interests: Plant Pathology, Biochemistry of Host-pathogen Interaction.

RITA L. RODRIGUEZ, *Researcher*, Ph.D. (1991), Cornell University. Teaching and Research Interests: Plant Virology, and Characterization of Geminoviruses.

ROCIO DEL P. RODRIGUEZ, *Researcher*, Ph.D. (1988), Pennsylvania State University. Research and Teaching Interests: Plant Pathology, Host-parasite Relations, Chemical Control, and Etiology of Diseases of Vegetables, Edible Legumes, Fruits and Coffee.

JESSE ROMAN, *Emeritus Professor*, Ph.D. (1968), North Carolina State University. Research and Teaching Interests: Nematology, Taxonomy, Chemical Control, Biological Control of Nematodes and Insects, and Nematode Diseases of Plantains and Starchy Crops.

CARLOS ROSARIO, *Professor*, Ph.D. (1988), Pennsylvania State University. Research and Teaching Interests: Urban Entomology, Integrated Pest Management and Medical Entomology.

NELSON SEMIDEY, *Researcher*, Ph.D. (1992), University of Arkansas, Fayetteville. Teaching and Research Interests: Weed Science.

FELICITA VARELA, *Assistant Researcher*, M.S. (1983), University of Puerto Rico. Research and Teaching Interests: Plant Pathology, Integrated Disease Management, Host-Parasite Relationship.

ROBERTO VARGAS, *Associate Professor*, Ph.D. (1995), Auburn University. Teaching and Research Interests: General Nematology, Plant Pathology, Biological Control, Rhizosphere

Microecology, Organic Nematicides and Sustainable Agriculture.

NYDIA E. VICENTE, *Associate Researcher*, M.S. (1983), University of Puerto Rico, Mayagüez Campus. Teaching and Research Interests: Nematology, Nematode Diseases of Vegetables and Integrated Nematode Management.

MILDRED ZAPATA, *Researcher*, Ph.D. (1989), University of Nebraska. Teaching and Research Interests: Plant Pathology, Phytobacteriology, Plant-microbe Interactions, Determinants of Pathogenicity of Phytopathogenic Bacteria, Diseases of Legumes, Vegetables and Ornamentals, Biological Control.

FOOD SCIENCE AND TECHNOLOGY

Please refer to the Interdisciplinary Programs section for information.

HORTICULTURE

The Department of Horticulture offers a program leading to the degree of Master of Science in Horticulture.

In addition to the admission requirements of the Office of Graduate Studies, a Bachelor of Science degree in Agricultural Sciences or its equivalent is required. Students who are deficient in horticulture may be required to complete satisfactorily certain horticultural courses (not to be used towards degree). A maximum of four (4) courses could be taken in the first year of study if needed. A minimum of thirty (30) credits is required for the completion of the Master degree including a thesis.

The program includes courses in plant propagation, production, management, and physiology in such commodities as vegetables, starchy crops, fruits, coffee and ornamentals.

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

HORTICULTURE (HORT)

Advanced Undergraduate Courses

HORT 5005. ADVANCED FLORICULTURE (II). Three credit hours. Two hours of lecture and one three-hour laboratory per week. Prerequisite: HORT 4025.

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 (On demand). Two credit hours. One hour of lecture and one three-hour laboratory per week. Prerequisite: HORT 4008.

This course aims to review the different phases of experimental work in vegetable growing with assigned field problems. Field trips required.

Graduate Courses

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 eggplants, 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 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. Prerequisite: BIOL 5018.

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 6705. GRADUATE SEMINAR. One credit hour. One hour of lecture per week. Prerequisite: Consent of the Director of the Department.

Discussion of topics in Horticulture including results of research work.

HORT 6990. SUPERVISED PROFESSIONAL OCCUPATIONAL EXPERINCE 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: consent 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: Consent 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'S THESIS (I, II). Six credit hours. One to three research periods per week each semester.

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.

HORTICULTURE FACULTY

A list of professors that 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.

BRYAN BRUNNER FULTON, *Associate Researcher*, Ph.D. (1992), Michigan State University. Research and Teaching Interests: Breeding and Germplasm Improvement (Fruits and Ornamentals).

FEIKO H. FERWERDA, *Assistant Researcher*, Ph.D. (2001), University of Florida. Research and Teaching Interests: Plant Tissue Culture and Molecular Markers.

CARLOS A. FIERRO BERWART, *Professor*, Ph.D. (1972), Rutgers University. Research and Teaching Interests: Plant Tissue Culture, Plant Growth Regulators, Morphogenesis, Plant Propagation.

JOHN M. GILL, *Associate Professor*, Ph.D. (1994), Rutgers University. Research and Teaching Interests: Plant Tissue Culture and Plant Genetic Transformation.

LIZZETTE GONZALEZ GILL, *Associate Professor*, Ph.D. (1996), Rutgers University. Research and Teaching Interests: Ornamental Horticulture.

SALLY GONZALEZ MIRANDA, *Associate Extension Specialist*, MLA (1987), Ball State University. Research and Teaching Interests: Landscape Design, Arboriculture and Urban Forestry, Urban Horticulture.

MARIA DEL C. LIBRAN SALAS, *Associate Professor*, Ph.D. (1996), University of Illinois. Research and Teaching Interests: Ornamental Horticulture.

MIGUEL MONROIG INGLES, *Extension Specialist*, M.S. (1983), University of Puerto Rico, Mayagüez Campus. Research and Teaching Interests: Coffee Production and Management.

EDNA NEGRON DE BRAVO, *Professor,* Ph.D. (1987), The Pennsylvania State University. Research and Teaching Interests: Food Science.

SALVADOR SALAS QUINTANA, *Professor*, Ph.D. (1988), Rutgers University. Research and Teaching Interests: Plant Physiology and Biochemistry (Coffee, Vegetables and Starchy Crops).

JOSE ZAMORA ECHEVARRIA, *Assistant Extension Specialist*, M.S. (1991), University of Puerto Rico, Mayagüez Campus. Research and Teaching Interests: Tropical Fruit Crop Production and Management.

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 the 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 the University of Puerto Rico at Mayagüez 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 started 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 doctorate degree in this field.

Depending on his/her department, the student may have various options for fulfilling the 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.

BIOLOGY

The Department of Biology offers a program leading to the degree of Master of Science. Although there are no formal options, students are able to specialize in bacteriology, bioremediation, botany, cellular and molecular biology, comparative physiology, conservation biology, developmental biology, ecology, entomology, evolution, genetics, herpetology, immunology, invertebrate zoology, microbiology, mycology, ornithology, parasitology, physiology, structural biology, systematics virology, or zoology.

In addition to the admission requirements of the Graduate Studies Office, a Bachelor of Science degree in Biology or its equivalent is required. Generally, only applicants with an overall grade point average of at least 3.00 in biology courses will be considered for admission.

The requirements for the major in the Department of Biology are met with the approval of at least twenty-one credit hours of graduate courses including the thesis. BIOL 6689 (Biological Research Methods) and BIOL 6690 (Graduate Seminar) are required of all students. All other program requirements are those of Graduate Studies. All students are required to write a thesis, and to present a departmental seminar related to their thesis research prior to their graduation.

Departmental facilities include laboratories dedicated to research in botany, cellular and molecular biology, comparative physiology, entomology, virology, microbiology, mycology, and other areas of biology; a herbarium and greenhouse; zoological collections, a laboratory of animal behavior, and a darkroom. In addition, the Biology Department operates a Microscopy Center, housed in the Physics Building. A new Biology Building is under construction and it is expected to be completed by 2003.

COURSES OFFERED BIOLOGY (BIOL)

(I)= courses normally offered during the First Semester
(II)= courses normally offered during the Second Semester
(S)= courses normally offered during the Summer Session

Advanced Undergraduate Courses

BIOL 5005. ELEMENTARY PLANT ANATOMY (II) (Even numbered years). Three credit hours. Two hours of lecture and one three-hour laboratory per week. Prerequisite: BIOL 3435 or BIOL 3417.

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 (II) (Even numbered years). Three credit hours. Two hours of lecture and one three-hour laboratory per week. Prerequisite: BIOL 3435 or BIOL 3417.

The general principles of plant morphology, including evolutionary tendencies, phylogenetic lines and the life cycles of the principal groups of plants.

BIOL 5009. PTERIDOLOGY (On demand). Three credit hours. Two hours of lecture and one three-hour laboratory per week. Prerequisite: BIOL 3417 or BIOL 3435.

Lectures and laboratories on the morphology, taxonomy and ecological distribution of the local ferns and their allies. Assigned readings and field trips.

BIOL 5016. PLANT EVOLUTION (I) (Odd numbered years). Two credit hours. Two hours of lecture per week. Prerequisite: BIOL 3435 or BIOL 3417.

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 5017. TROPICAL BRYOLOGY (On demand). Three credit hours. Two hours of lecture and one three-hour laboratory per week. Prerequisite: BIOL 3417 or consent of the Director of the Department.

The biology of mosses, liverworts, and hornworts, emphasizing the structure, identification, reproduction, and ecology of the native species of Puerto Rico. Field trips required.

BIOL 5018. PLANT PHYSIOLOGY (II). Four credit hours. Three hours of lecture and one laboratory of three hours per week. Prerequisites: (QUIM 3032 or QUIM 3062) and (BIOL 3417 or BIOL 3435) or QUIM 3072 or QUIM 3463.

Plant physiology: diffusion, transpiration, absorption and transport, mineral nutrition, metabolism, growth and development, hormones, effects of environmental factors.

BIOL 5045. SCANNING ELECTRON MICROSCOPY (SEM). Three credit hours. Two hours of lecture and one three-hour laboratory per week. Prerequisite: Consent 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 5397. EUKAKYOTIC MOLECULAR GENETICS. Four credit hours. Two hours of lecture and two four-hour laboratory per week. Prerequisites: BIOL 3300 AND QUIM 5071.

Genome complexity; gene structure, regulation of transcription; mRNA processing; transposons; signal transduction; the genetics of development, the cell cycle, and cancer; research techniques in molecular genetics.

BIOL 5416. HERPETOLOGY (I). 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 (On demand). 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 (I) (Even numbered years). 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 (I). Three credit hours. Two hours of lecture and one three-hour laboratory per week. Prerequisite: BIOL 3770.

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 and BIOL 3770.

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 5765. MYCOLOGY (II) (Even numbered years). Three credit hours. Two hours of lecture and one three-hour laboratory per week. Prerequisite: BIOL 3770.

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 (I). 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 (II) (Even numbered years). Three credit hours. One hour of lecture and two three-hour laboratory periods per week. Prerequisite: BIOL 3125.

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 (On demand). One to three credit hours. Thirty to sixty hours of workshop/practice per credit. Prerequisite: Consent 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 6015. INSECT MORPHOLOGY (I) (Odd numbered years). 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 6155. PLANT ECOLOGY (II) (Odd numbered years). Four credit hours. Two hours of lecture and two three-hour laboratories per week.

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 (II) (Odd numbered years). 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 6356. CYTOGENETICS (II) (Even numbered years). Three credit hours. Two hours of lecture and one three-hour laboratory per week.

A study of different aspects of the cell that affect inheritance.

BIOL 6369. POPULATION GENETICS (II) (Even numbered years). 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 (II) (Even numbered years). Three credit hours. Two

hours of lecture and one three-hour laboratory per week. Prerequisite: BIOL 5416 or consent 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 (I) (Even numbered years). 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 (II) (Odd numbered years). 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 (I) (Odd numbered years). Three credit hours. Two hours of lecture and one three-hour laboratory per week.

Discussion of selected topics in genetics.

BIOL 6631. CELLULAR BIOCHEMISTRY AND PHYSIOLOGY (I). 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 (I) (Odd numbered years). Three credit hours. Two hours of lecture and one three-hour laboratory per week. Prerequisite: BIOL 5765.

A study of the fungi pathogenic to man.

BIOL 6637. TAXONOMY AND MORPHOLOGY OF FUNGI (I) (Even numbered years). 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 (I) (Odd numbered years). 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 6650. BACTERIAL DIVERSITY. Three credit hours. Two hours of lecture and two hour-and-a-half laboratories per week.

The diversity of prokaryotic organisms in relation to ecophysiological and evolutionary perspectives, emphasizing their isolation, identification, and application.

BIOL 6688. SCIENTIFIC PHOTOGRAPHY FOR BIOLOGISTS (I). Two credit hours. Two three-hour laboratories per week. Prerequisite: Consent 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 (I). Two credit hours. Two hours of lecture per week.

Methods and theory of investigation in the biological field, including study of the biological literature and 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 (I). 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 MICRO-BIOLOGY (I) (Even numbered years). 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 6990. RESEARCH (I, II). One to six credit hour periods per week.

Research for a thesis.

BIOL 6991-6992. SPECIAL STUDIES IN BIOLOGY (I, II)-(I, II). 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 (On demand). One to three credit hours. One to three hours of lecture per week. Prerequisite: Consent of the Director of the Department.

Selected topics in biology, botany, microbiology, and zoology.

BIOL 6994. SPECIAL TOPICS IN BIOLOGY II (On demand). One to three credit hours. One to three hours of lecture per week.

Selected topics in biology, botany, microbiology, and zoology.

BIOL 6997. SPECIAL TOPICS IN BIOLOGY: LABORATORY (On demand). One to three credit hours. One to three two- to four-hour laboratories per week.

Selected topics in biology, botany, microbiology, and zoology.

Botany (BOTA)

BOTA 6006. PHYSIOLOGY OF BACTERIA (II). Three credit hours. Two hours of lecture and one three-hour laboratory per week.

The physiology of bacteria and the biochemistry of microbic processes.

BOTA 6007. PHYTOGEOGRAPHY (II) (Even numbered years). Three credit hours. Three hours of lecture per week. Prerequisite: BIOL 5416.

A study of the geographical distribution of plants, with special emphasis on the ecological and historical factors affecting their distribution.

Zoology (ZOOL)

Advanced Undergraduate Course

ZOOL 5005. INVERTEBRATES OF PUERTO RICO (I) (Odd numbered years). 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: BIOL 4426.

Lectures, conferences, reading and laboratory work dealing with practical problems of classification, morphology and host relations of animal parasites.

ZOOL 6025. SYSTEMATIC ZOOLOGY (II) (Even numbered years). Three credit hours. Three hours of lecture per week.

The naming and classification of animals, rules and basis of nomenclature, quantitative methods of analysis, and methods for presentation of systematic findings.

ZOOL 6039. ANIMAL ECOLOGY (On demand). Three credit hours. Two hours of lecture and one three-hour laboratory per week.

A study of the principles of ecology as applied to animals.

ZOOL 6056. ZOOGEOGRAPHY (I) (Even numbered years). Three credit hours. Three hours of lecture per week.

A study of the geographical distribution of animals, with special emphasis on factors affecting this distribution. Assigned readings and reports.

ZOOL 6058. INSECT TAXONOMY (II) (Odd numbered years). 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.

BIOLOGY FACULTY

A list of professors that 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.

JAIME A. ACOSTA, *Assistant Professor*, Virginia Polytechnic Institute and State University, Ph.D. (1995). Research Interests: Entomology, Biocontrol of Hymenoptera, Ecology of Fire Ants. Teaching Interests: Biology, Ecology, Zoology, Entomology.

MONICA ALFARO, *Instructor*, Ph.D. in Progress, University of Puerto Rico. Research Interests: Marine Biology, Ecology of Zooplankton. Teaching Interests: Biological Sciences, Zoology.

ROBERT BARD, *Professor*, Ph.D. (1977), Miami University. Research Interests: Molecular, Cellular and Developmental Biology. Teaching Interests: Biology and Embryology.

ANGEL BERRIOS ORTIZ, *Professor*, Ph.D. (1975), University of Illinois, Urbana. Research Interests: Biology of Invertebrates, Entomology. Teaching Interests: Zoology, History of Biology, Insect Morphology, Medical Entomology.

CARLOS BETANCOURT, *Professor*, Ph.D. (1981), Iowa State University. Research Interests: Food Mycology, Environmental Mycology, Taxonomy and Ecology of Aquatic Fungi. Teaching Interest: Mycology.

FERNANDO BIRD PICO, *Associate Professor*, Ph.D. (1994), University of Kansas. Research Interests: Herpetology, Ecology and Population Genetics, Conservation Biology. Teaching Interests: Herpetology, Systematic Zoology, Population Genetics, Comparative Vertebrate Anatomy.

SONIA BORGES, *Professor*, D.Sc. (1988), Universidad Complutense de Madrid. Research Interests: Systematics and Ecology of Terrestrial Oligochaetes (Annelida), Organic Waste Management. Teaching Interests: Zoology.

GARY J. BRECKON, *Professor*, Ph.D. (1975), University of California at Davis. Research Interests: Taxonomy and Ecology of Antillian Plants, especially rare and endangered species. Teaching Interests: Botany and Ecology.

LUCY BUNKLEY WILLIAMS, *Associate Professor*, Ph.D. (1984), Auburn University. Research Interests: Fish Parasitology and Pathology. Teaching Interests: Parasitology, Marine Sciences, Zoology, Ichthyology.

ROSA BUXEDA, *Associate Professor*, Ph.D. (1993), Rutgers University, New Brunswick. Research Interests: Science Education, Microbial. Teaching Interests: Microbial Physiology, Microbiology, Microbial Biochemistry.

CARLOS J. CASTILLO, *Professor*, Ph.D. (1973), University of Pennsylvania. Research Interests: Proteoglycans. Teaching Interests: Cellular Biology, Immunology.

MILDRED CHAPARRO, *Professor*, Ph.D. (1985), Texas A&M University. Research Interests: Food Microbiology. Teaching Interests: Microbiology, Food Microbiology.

JESUS D. CHINEA, *Assistant Professor*, Cornell University, Ph.D. (1992), Research Interests: Ecology, Forest Dynamics, Exotic Species, Restoration Ecology, Applications of Remote Sensing and GIS to Ecology. Teaching Interests: Ecology, Botany.

CARLOS A. DELANNOY, *Professor*, Ph.D. (1984), University of Colorado. Research Interests: Endangered Species. Teaching Interests: Ornithology, Ecology, and Conservation Biology.

NANETTE DIFFOOT CARLO, *Associate Professor*, Ph.D. (1992), Virginia Polytechnic Institute and State University. Research Interest: Molecular Studies of Viral Replication. Teaching Interests: Virology, Molecular Biology.

DUANE A. KOLTERMAN, *Professor*, Ph.D. (1982), University of Wisconsin. Research Interests: Conservation Biology, Plant Biosystematics. Teaching Interests: Botany.

ALLEN R. LEWIS, *Professor*, Ph.D. (1979), University of Rochester. Research Interests: Behavioral Ecology, Population Biology. Teaching Interests: Ecology, Animal Behavior.

SANDRA L. MALDONADO RAMIREZ, *Assistant Professor*, Ph.D. (2001), Cornell University, Ithaca, New York. Research Interests: Mycology, Aerobiology, Plant Pathology. Teaching Interests: Mycology.

JOSE A. MARI MUTT, *Professor*, Ph.D. (1978), University of Illinois, Urbana. Research Interests: Taxonomy of Apterygota. Teaching Interests: Zoology, Entomology, Invertebrates.

JUAN C. MARTINEZ CRUZADO, *Professor*, Ph.D. (1988), Harvard University. Research Interests: Molecular Population Genetics and Evolution. Teaching Interests: Genetics, Molecular Genetics.

ARTURO MASSOL, *Associate Professor*, Ph.D. (1994), Michigan State University. Research Interests: Biodegradation, Microbial Diversity, Environmental Microbiology. Teaching Interests: Microbial Ecology, General Microbiology, Industrial Microbiology.

RAFAEL MONTALVO, *Instructor*, Ph.D. (2002), University of Nebraska. Research Interest: Extremophiles, Taxonomy, Physiology and Benetics of Archaca. Teaching Interest: Micology.

VIVIAN NAVAS, *Professor*, Ph.D. (1990), University of Illinois, Urbana. Research Interests: Cell and Structural Biology. Teaching Interest: Biology, Histology, Election Microscopy.

CARLOS RIOS VELAZQUEZ, *Associate Professor*, Ph.D. (2000), University of Wisconsin-Madison. Research Interest: Bacterial Genetics and Physiology, Genetics and Proteomics. Teaching Interest: Microbial Physiology and Genetics, Industrial Microbiology, General Biology.

CARLOS A. PEREZ MUÑOZ, *Associate Professor*, Ph.D. (1991), University of California, Davis. Research Interests: Botany, Structural Biology, Plant Morphogenesis. Teaching Interests: Biology, Botany, Plant Morphology, Plant Anatomy, Microtechniques, Scientific Photography for Biologists .

JUAN A. RIVERO, *Distinguished Professor*, Ph.D. (1953), Harvard University. Research Interests: Herpetology, Evolution and Ecology of Reptiles and Amphibians. Teaching Interests: Herpetology, Evolution, and Sex Biology.

ALEJANDRO RUIZ ACEVEDO, *Professor*, Ph.D. (1981), University of Oklahoma. Research Interests: Microbiology, Immunology, Medical Mycology. Teaching Interests: Medical Mycology, Immunology, Clinical Microbiology, Industrial Microbiology.

CARLOS SANTOS FLORES, *Associate Professor*, Ph.D. (2001), University of Wisconsin-Madison. Research Interests: Freshwater Ecology, Taxonomy of Algae and Microinvertebrates, Aquatic Fungi Taxonomy and Ecology. Teaching Interests: Limnology, Freshwater Biology, Plankton Ecology.

INES SASTRE DE JESUS, *Associate Professor*, Ph.D. (1987), City University of New York. Research Interests: Systematics of Bryophytes, using rbcl, Bryophyte Ecology and Conservation. Teaching Interests: General Biology and Botany.

RICHARD D. SQUIRE, *Professor*, Ph.D. (1969), North Carolina State University. Research Interests: Genetics and toxicology of the brine shrimp, Artemia. Teaching Interests: Genetics, Citogenetics.

JOHN M. USCIAN, *Associate Professor*, Ph.D. (1994), University of Nebraska. Research Interests: Marine Fish, Biochemistry/Physiology. Teaching Interests: Physiology, Anatomy.

MARIA VARGAS, *Associate Professor*, Ph.D. (1997), Arizona State University. Research Interests: Mycology, Entomopathogenic fungi,

Microscopy. Teaching Interests: Mycology, Microbiology, Microscopy.

CHEMISTRY

The Department of Chemistry offers a program leading to the degree of Master of Science. In addition to the admission requirements of the Graduate Studies Office, a Bachelor of Science in Chemistry or its equivalent, as determined by the departmental graduate committee, is required. Although there are no formal options, students are able to specialize in analytical, physical, inorganic, organic, or biochemistry.

The requirements for the master's degree in the Department of Chemistry are met with the approval of at least eighteen credit hours of graduate courses in Chemistry, exclusive of the thesis. Three of the following core courses are required: QUIM 6011, Advanced Inorganic Chemistry I; QUIM 6401, Advanced Organic Chemistry I; QUIM 6605, Advanced Physical Chemistry; QUIM 6215, Advanced Analytical Chemistry. In addition, students are required to take QUIM 6005 and QUIM 6006, (Graduate Seminar I and II), and write a thesis.

The department is housed in a four-story building (185,000 square feet) with modern facilities for teaching and research featuring 36 research and 22 teaching laboratories as well as 10 classrooms, a computer center and a cold room. Research facilities include a large variety of sophisticated instrumentation, such as a state of the art femtochemistry (laser) system, two NMR spectrometers (300 and 500 MHz), a visualization center with workstations and instrumentation for chromatography, spectroscopy and electrochemistry.

Approximately thirty faculty members with Ph.D. degrees have on-going research projects in the areas of polymers, organic synthesis, environmental chemistry, molecular spectroscopy, material characterization, computational chemistry, electrochemistry, and biochemistry, among others.

COURSES OFFERED CHEMISTRY (QUIM)

(I)= courses normally offered during the First Semester
(II)= courses normally offered during the Second Semester
(S)= courses normally offered during the Summer Session

Advanced Undergraduate Courses

QUIM 5065. CHEMISTRY OF SYNTHETIC DRUGS (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: QUIM 3072 or QUIM 3032 or QUIM 3450.

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.

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.

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.

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. One four-hour laboratory per week. Prerequisite: QUIM 5073. Corequisite: QUIM 5072.

Characterization of carbohydrates, molecular modeling, and spectroscopic analysis of biomolecules.

QUIM 5085. FOOD CHEMISTRY (On demand). Four credit hours. Three hours of lecture and one four-hour laboratory per week.

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 and MATE 3031 or MATE 3183 or MATE 3144.

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.

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.

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 3072 or QUIM 3450.

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 3072 or QUIM 3032 or QUIM 3450.

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.

Elucidation of the structure of organic compounds by spectroscopic methods, including infrared, ultraviolet, nuclear magnetic resonance, and mass spectrometry techniques.

QUIM 5165. POLYMER CHEMISTRY (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: QUIM 3072 or QUIM 3032 or QUIM 3450.

Structure, properties, synthesis, reactions, and physical behavior of polymers. Experimental methods used in their analysis.

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. 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 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 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 6026. SPECIAL TOPICS IN INORGANIC CHEMISTRY (On demand). Three credit hours. Three hours of lecture per week. Corequisite: QUIM 6011 or consent 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 6035. NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: Consent 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 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 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 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 6916. ADVANCED INSTRUMENTAL ANALYSIS (I,II). Four credit hours. Two hours of lecture and two four-hour laboratories per week.

Theory and practice of modern chemical analysis using spectroscopic, electroanalytical, and separation techniques.

QUIM 6994. SPECIAL TOPICS: LABORATORY. From one to three credit hours. From one to three laboratories of two to four hours per week.

Selected laboratory topics in inorganic chemistry, organic chemistry, analytical chemistry, physical chemistry, and biochemistry.

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 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.

GRADUATE FACULTY INVOLVED IN RESEARCH AND THEIR RESEARCH INTERESTS

MARIA A. APONTE HUERTAS, *Professor,* Ph.D. (1982), University of Florida. Development of bacterial polymers as biodegradable materials; biodegradable polymers for controlled released technology.

MAYRA E. CADIZ, *Professor*, Ph.D. (1985), University of Puerto Rico. Synthesis of derivatives of cisplatin; synthesis and interaction of platinum drugs with DNA; Synthesis of metal complexes as potential antitumor compounds.

ARNALDO CARRASQUILLO, *Associate Professor,* Ph.D., (1995), Texas A&M. 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, *Associate Professor*, Ph.D. (1991), University of Texas at Austin. 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.

JOSE E. CORTES, *Professor*, Ph.D. (1989), University of North Texas. Synthesis and characterization of fulerene-transition metal complexes. Electronic and geometric structure of fulerene-transition metal complexes and the relationship of their structure with the complexes chemical reactivities. Integration of high scholl biology, chemistry, mathematics, and physics using calculator-based laboratory technology.

ASTRID J. CRUZ, *Associate Professor*, Ph.D. (1993), University of Massachusetts. 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.

MARITZA DE JESUS, *Associate Professor*, M.S. (1984), University of Puerto Rico-Mayagüez Campus. Optimization of GC-MS

and GC-FID tropical analysis of thermally labile essential oils in plants. Development of methodologies for the analysis of samples of environmental origin.

EMILIO DIAZ, *Professor*, Ph.D. (1986), University of Wisconsin, Madison. Isolation and characterization of oxidative enzymes from fungi; study of the role of oxidative enzymes on fungal pathogenicity. Isolation and inhibition studies of histidine decarboxylase from microorganisms which contaminate fish and dairy products. Study of the effects of antioxidants on the development of rancidity in frozen tilapia.

SAMUEL P. HERNANDEZ, *Professor*, Ph.D. (1986), Johns Hopkins University. 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.

AIDALU DE LOS A. JOUBERT CASTRO, *Assistant Professor,* Ph.D., (1998), Washington State University, Pullman. 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, *Associate Professor*, Ph.D. (1993), University of Cincinnati. Mid-infrared FT-IR spectroscopy of transient species and reaction intermediates, mainly radicals using matrix-isolation. Photochemical reactions and reactions dealing with semiconductor materials.

JUAN LOPEZ GARRIGA, *Professor*, Ph.D. (1986), Michigan State University. Study of the structure and function relationships in heme proteins using site directed mutagenesis, FT-IR, resonance Raman vibrational analysis, and NMR spectroscopy. Kinetic study of the reaction between hemoglobin and ligands (for example, O_2, CO, NO, and H_2S) using time-resolved infrared and resonance Raman techniques. Ultrafast geminate chemical dynamics analysis using time-resolved picosecond and femtosecond spectroscopy. Development and implementation of a coherent link between pre-college education and the university.

GUSTAVO E. LOPEZ, *Professor*, Ph.D. (1992), University of Massachusetts. Classical and Path integral Quantum Monte Carlo simulations of the thermodynamic properties of condensed matter systems; *ab-initio* calculations of weakly bound systems.

ENRIQUE MELENDEZ, *Associate Professor*, Ph.D. (1992), University of Utah. Synthesis, kinetics, and metal-DNA interactions of titanocenes. Bonding and reactivity of transition metal diene complexes.

NAIRMEN MINA, *Associate Professor*, Ph.D. (1996), Baylor University. FT-IR, Near IR, VIS and photoacustic spectroscopy of organic compounds at cryogenic temperatures. Chemical kinetics and spectroscopy of CFC's.

LUIS A. MORELL, *Associate Professor*, Ph.D. (1993), University of California, Riverside. Organic synthesis and development of hetero Diels-Alder reaction. Conformational analysis of sugar derivatives.

ELSIE I. PARES MATOS, *Assistant Professor*, Ph.D. (2000), Purdue University, Indiana. Regulation of gene expression by DNA-protein and protein-protein interactions.

BELINDA PASTRANA, *Associate Professor*, Ph.D. (1995), Rutgers University, New Jersey. Use of recombinant DNA technology to express proteins for the biophysical study of protein-peptide and protein-ligand interactions. Molecuar modeling studies of biological molecules.

FRANCIS PATRON, *Assistant Professor,* Ph.D., (1997), Purdue University. Chemistry education research on the teaching and learning of chemistry with particular interest in phyical chemistry.

DORIS RAMIREZ-SOTO, *Professor*, Ph.D. (1989), Rutgers University. Isolation and characterization of gibberellins in tropical crops.

ROBERT RIOS, *Associate Professor,* Ph.D. (1995), Rutgers University, New Jersey. 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, *Associate Professor*, Ph.D. (1991), University of Puerto Rico. Analysis and structural studies of macromolecules, natural products, organic and inorganic molecules, utilizing X-ray crystallography as the main analytical tool.

LUIS A. RIVERA, *Associate Researcher*, Ph.D. (1990), University of Puerto Rico. Synthesis, spectroscopic studies and theoretical correlations of heterocyclic and substituted polycyclic aromatic compounds with potential activity. Analytical method development for trace detection of energetic compounds. Thermal stability studies of substituted polycarbonates, polyesters and other polymeric substances with potential applications as insulation materials in aircraft.

CYNTHIA ROBLEDO LUIGGI, *Professor*, Ph.D. (1981), University of Florida. Synthesis of oligopeptides containing one or more aromatic amino acids; study of small molecule-nucleic acid interactions; synthesis of oligopeptides with unusual amino acids, symthesis of oligopeptides analogs.

LOLITA RODRIGUEZ, *Associate Professor*, M.S. (1985), University of Puerto Rico-Mayagüez Campus. In vitro evaluation of decoctions from plants of reputed ethnopharmaceutical activity to treat kidney stones disease. The project includes measurements of free and complex Ca^{+2} in solution, dissolution of calcium oxalate or calcium phosphate by plant decoctions, and inhibition of crystal or stone growth by plant extracts.

MANUEL RODRIGUEZ FLORES, *Professor*, Ph.D. (1968), University of Florida. Applications of gas chromatography /mass spectrometry and FT-IR spectroscopy to the development of methods for the analysis of samples of environmental origin (e.g., air, water, soil); also, for the characterization of the constituents of the flavor and aroma of tropical fruits.

FELIX ROMAN, *Professor*, Ph.D. (1989), University of Nebraska. Development of analytical method for the determination of trace levels of metals and pesticides in biological and environmental matrices.

RODOLFO ROMAÑACH, *Associate Professor*, Ph.D., (1986), University of Georgia. 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.

FERNANDO A. SOUTO, *Professor*, Ph.D. (1978), University of Alberta. Association of organic dyes in solution, equilibrium polymerization, electronic absorption and emission spectra, excitation energy transfer, photochemistry of alkaloids. N-oxides, amperometric glucose biosensor, solid-state impedance immunological biosensors. In addition, there is on-going work with *Lippia dulcis* Trey: Formation and growth in tissue culture; initiation, growth, and viability of calli and cell suspension cultures; production and biosynthesis of terpenes and terpenoids by *in vitro* cell cultures.

CARMEN A. VEGA, *Professor*, Ph.D. (1975), University of Florida. 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.

MARISOL VERA, *Professor*, Ph.D. (1986), Purdue University. Characterization of oligonucleotide structures and small molecule-nucleic acid complexes by NMR; analytical applications of multinuclear NMR Evaluation of pesticides in soils amended with compost.

RENE S. VIETA, *Professor*, Ph.D. (1984), Texas A&M University. Synthesis and mass spectrometric studies of saturated nitrogen heterocycles. Mechanisms of oxazoline formation. Synthesis of diamines that are precursors of cyclic ureas.

ENGLISH

The Department of English offers a program leading to the degree of Master of Arts in English Education (MAEE).

In addition to fulfilling the admission requirements set forth by the Office of Graduate Studies, prospective candidates must verify that they have successfully completed study in the following areas: introductory linguistics (3 credits); phonetics (3 credits); the structure of grammar of the English language (3 credits); and a broad acquaintance with both English literature (6 credits) and American Literature (3 credits). If a prospective candidate is deficient in one or more of these areas, a conditional admission may be granted in accordance with the established regulations of the Office of Graduate Studies. Applicants are expected to speak and write English fluently and accurately. The Department of English requires an interview and a diagnostic essay of all prospective candidates.

Although there are no formal divisions within the MAEE program, students may choose to emphasize the study and teaching of language or of literature. Four courses are required of all students. The student must check this requisite with the Department.

In addition to the common program requirements for obtaining a Master's degree, MAEE candidates may choose either "Plan I. With Thesis" or "Plan III. Without Thesis or Project Requirement (requires a comprehensive examination)."

COURSES OFFERED

ENGLISH (INGL)

Advanced Undergraduate Courses

(I)= courses normally offered during the First Semester
(II)= courses normally offered during the Second Semester

INGL 5007. ORAL COMMUNICATION (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: Consent 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: Consent 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: Consent 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: Consent 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 5025. CURRENT APPROACHES IN LINGUISTIC THEORY (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: Consent of the Director of the Department.

Recent developments in linguistic theory and their application to related issues.

Graduate Courses

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 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 6030. THEORY AND PRACTICE OF COMPOSITION (On demand). 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 (On demand). 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 6055. STUDIES IN LITERATURE I (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 (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 6985. SPECIAL TOPICS I (I). Three credit hours. Three hours of seminar per week.

Selected topics in linguistics, literature, or pedagogy.

INGL 6986. SPECIAL TOPICS II (II). Three credit hours. Three hours of seminar per week.

Selected topics in linguistics, literature, or pedagogy.

INGL 6995. RESEARCH (I, II). 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.

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.

ENGLISH 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.

EDITH ALGREN DE GUTIERREZ, *Professor*, Ph.D. (1984), Rensselaer Polytechnic Institute. Research and Teaching Interests: Rhetoric, English Composition, Communication.

ANDREW S. ALLEN, *Associate Professor*, Ph.D. (1980), University of California at Berkeley. Teaching Interests: Linguistics, Phonetics, Syntax. Research Interests: Historical Linguistics, Morphology, Sociolinguistics, Grammaticalization.

OSWALDO AYMAT, *Professor*, Ph.D. (1988), University of Texas at Austin. Teaching Interests: EFL Methodology, Second Language Acquisition. Research Interests: EFL Methodology, Culture and Foreign Language Acquisition.

JOAN BAKER GONZALEZ, *Professor*, M.S. (1965), University of Wisconsin. Teaching Interests: TESOL Methods and Techniques, Curriculum Development and Evaluation,

Phonetics. Research Interests: Materials Development, Listening Comprehension, Acquisition of Grammar.

NANDITA BATRA, *Professor*, Ph.D. (1986), University of Rochester. Research and Teaching Interests: 19th Century British Literature, 20th Century British and American Literature, Commonwealth Literature, Women's Studies, Computers and Composition, ESL Composition.

EILEEN K. BLAU, *Professor*, Ph.D. (1980), University of Florida. Teaching Interests: Reading in a Second Language, ESL Methodology, Applied Linguistics. Research Interests: Reading and Listening Comprehension.

ELIZABETH P. DAYTON, *Associate Professor*, Ph.D. (1996), University of Pennsylvania. Research and Teaching Interests: Socio-linguistics, Bilingualism, Psycholinguistics.

KATHLEEN FERRACANE, *Professor*, Ph.D. (1987), State University of New York. Teaching Interests: Caribbean Literature, Shakespeare, American Literature, Gender-related Studies. Research Interests: Caribbean Literature.

NICKOLAS A. HAYDOCK, *Associate Professor*, Ph.D. (1994), University of Iowa. Teaching Interests: Ancient and Medieval Narrative, Chaucer, Shakespeare, Lyric Theory, The Novel, Old English and Middle English Language, History of the English Language: Research Interests: Chaucer and the 15th Century, Medieval Translations, Translating Medieval Texts, Pathos, Poetics.

ANTHONY HUNT, *Professor*, Ph.D. (1971), University of New Mexico. Teaching Interests: American Literature, Twentieth Century Literature, Poetry as a Genre, Drama as a Genre, The Teaching of Literature, Research Methods. Research Interests: Twentieth Century Literature, Poetry as a Genre, Methods for Teaching Literature.

JOSE M. IRIZARRY, *Assistant Professor*, M.A.E.E. (1989), University of Puerto Rico. Teaching and Research Interests: Modern and Contemporary American Literature, Literary Theory, African-American Literature, Minority Women Writers, Composition, Computers in the Classroom.

MARY MARTIN BETANCOURT, *Professor*, Ph.D. (1986), Fordham University. Research and Teaching Interests: Composition Theory and Practice, Foundations of English Education in Puerto Rico, Educational Assessment and Evaluation.

MARTA M. MORENO MONTALVO, *Professor*, Ph.D. (1987), Georgetown University. Teaching and Research Interests: Applied Linguistics, ESL Methodology, Linguistics, Language Acquisition, Affective Factors in the Language Classroom, Contrastive Grammar, Teacher Training.

DARNYD W ORTIZ SEDA, *Professor*, Ph.D. (1990), Florida State University. Research and Teaching Interests: Short Story, Drama, Theater, Composition.

OLGA I. PADILLA FALTO, Assistant Professor, Ph.D. (1996), Georgetown University. Research and Teaching Interests: Second Language Acquisition, Individual Differences, Testing.

ELLEN PRATT, *Assistant Professor*, M.A. (1982), Interamerican University of Puerto Rico. Teaching Interests: Phonetics, Psycholinguistics, Teaching Writing, Second Language Acquisition, Reading, Composition. Research Interests: Second Language Writing, Second Language Acquisition, Teaching Writing with Computers, Teacher Research, Qualitative Research.

ISMAEL RIVERA RODRIGUEZ, *Associate Professor*, Ph.D. (1995), Pennsylvania State University. Teaching Interests: Literature. Research Interests: English Renaissance Drama.

LINDA RODRIGUEZ, *Associate Professor*, Ph.D. (1994), University of Michigan. Teaching Interests: Caribbean Literature, Women's and Gender Studies. Research Interests: Historical Novel, Women's and Gender Studies, Caribbean Literature, Latino Literature.

ROBERT T. SHERWIN, *Professor*, Ph.D. (1975), The Pennsylvania State University. Research and Teaching Interests: American Literature, Irish Literature, Composition, Technical Writing.

BARBARA STRODT, *Associate Professor*, Ph.D. (1979), University of California at Los

Angeles. Teaching Interests: TESL Methods and Techniques, Second Language Listening and Speaking, Reading. Research Interests: Listening Comprehension, Inference, Acquisition of Grammar.

GEOLOGY

The Department of Geology offers graduate study leading to the degree of Master of Science. Applicants for admission should hold a Bachelor of Science degree in Geology or its equivalent from an accredited institution, 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), and have taken the Graduate Record Examination (the general GRE is required and the geology GRE is recommended), in addition to the requirements of the Graduate Studies Office. Students not meeting these requirements may be admitted on a provisional basis until deficiencies are removed.

The requirements for the major in the Department of Geology are met with the approval of at least twenty credit hours of graduate courses in Geology, exclusive of thesis. The following specific courses are required: Geology and Tectonics of the Caribbean and Graduate Seminar I and II. All students are required to write a thesis.

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; 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 a wide variety of geochemical and geophysical measurements. Geochemical instrumentation includes:

- CAMECA Camebax SX50 electron microprobe
- SIEMENS D5000 X-ray diffractometer
- SIEMENS SRS303 X-ray fluorescence spectrometer

and various ancillary equipment, all purchased through a grant from the National Science Foundation Minority Research Center of Excellence program. Supporting wet chemistry facilities have been recently renovated. Equipment is available to prepare petrographic thin sections.

The Department also hosts the UPRM Gas Analysis Stable Isotope Laboratory (GASI Lab), recently constructed through a grant from the National Science Foundation Major Research Instrumentation program and the University of Puerto Rico Central Administration. The GASI Lab is centered on a Micromass Isoprime mass spectrometer interfaced to dedicated peripherals for automated isotopic analysis of a wide range of materials in either dual inlet or continuous flow mode. The Isoprime includes the ability to conduct deuterium analyses in continuous flow mode and is capable of 100 water measurements/day.

The Department also has a portable gravimeter, portable magnetometer, portable seismometer, and geodetic and hand-held GPS equipment. Computing facilities consist of an extensive networked array of PC and Macintosh microcomputers, a Sun Microsystems Ultra5, an HP Design Jet 755 larger format printer and several laser printers. An existing remote sensing /GIS laboratory is slated for expansion in February 2002 with the addition of 10 new PC microcomputers, a PC server, and updated software.

Seismic Network

The Puerto Rican Seismic Network (Red Sísmica de Puerto Rico) is administered by the Department of Geology. The staff oversee a

network of short period and broadband seismometers installed in Puerto Rico and nearby islands. The main objective of the SNPR is to process and analyze local, regional, and teleseismic earthquakes. The data generated are distributed among the scientific and academic community, civil defense organizations, and the general public.

COURSES OFFERED
GEOLOGY (GEOL)

(I)= courses normally offered during the First Semester
(II)= courses normally offered during the Second Semester
(S)= courses normally offered during the Summer Session

Advanced Undergraduate Courses

GEOL 5005. MARINE GEOLOGY (Even numbered years) (On demand). Three credit hours. Two hours of lecture and one two-hour laboratory per week. Prerequisite: Consent 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 (Odd numbered years) (On demand). Three credit hours. Two hours of lecture and one two-hour laboratory per week. Prerequisite: GEOL 4046.

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 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: Consent 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 (Odd numbered years) (On demand). Three credit hours. Two hours of lecture and one three-hour laboratory per week. Prerequisite: GEOL 3056.

Optical crystallography, detailed microscopic study of rock forming minerals.

GEOL 5020. GEOPHYSICS (Odd numbered years) (On demand). Three credit hours. Three hours of lecture per week.

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 consent 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 Consent 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. SEISMOLOGY (Even numbered years) (On demand). Three credit hours. Three hours of lecture per week.

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 5605. GEOLOGICAL HAZARDS (Even numbered years) (On demand). Three credit hours. Two hours of lecture and one three-hour laboratory per week.

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 5994. SPECIAL TOPICS IN PALEONTOLOGY WITH LABORATORY. One to three credit hours. Zero to two hours of lecture per week. One to three laboratory periods of two to four hours per week. Prerequisite: Consent of the Director of the Department.

Special topics in paleontology. 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 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 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. CARTOGRAPHY AND GEODESY IN GEOSCIENCES. Three credit hours. Two hours of lecture and one three-hour laboratory per week.

Quantitative methods of cartography and geodesy in map-making; surveying, and surface deformation study for the geosciences with an emphasis on differential GPS and the generation of hypsometric and geophysical data from airborne and satellite platforms. Examples of environmental, geological, and natural hazard mitigation applications from the Caribbean.

GEOL 6125. PROBLEMS IN ENGINEERING GEOLOGY (On demand). Three credit hours. Two hours of lecture and one three-hour 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 (On demand). 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 6165. CLASTIC SEDIMENTOLOGY (Odd numbered years) (On demand). Three credit hours. Two hours of lecture and one three-hour laboratory per week.

Origin of clastic sedimentary rocks and the characteristics of the environments in which they are formed. Field trips are required.

GEOL 6175. PALEOECOLOGY (Even numbered years) (On demand). Three credit hours. Three hours of lecture per week.

Use of geological evidence and the ecology of living organisms to understand the nature and development of past environments.

GEOL 6185. ORE DEPOSITS (Odd numbered years) (On demand). 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 (Even numbered years) (On demand). Three credit hours. Two hours of lecture and one three-hour 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 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 6999. RESEARCH AND THESIS (I, II). Three to six credit hours.

Research in geology and presentation of a thesis.

GEOLOGY FACULTY

A list of professors that 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, *Assistant Professor*, Ph.D., (1996), University of South Florida. Research Interests: Environmental remote sensing, GIS.

JAMES JOYCE, *Professor*, Ph.D. (1985), Northwestern University. Research Interests: Caribbean geology; neo-tectonics; Quaternary geology; metamorphic petrology. Teaching Interests: Caribbean geology; metamorphic petrology; structure and tectonics; Quaternary geology.

THOMAS MILLER, *Assistant Professor,* Ph.D., (1982), McMaster University. Research Interests: Karst geomorphology; hydrogeology. Teaching interests: Geomorphology; environmental geochemistry.

WILSON RAMIREZ, *Assistant Professor*, Ph.D. (2000), Tulane University. Carbonate petrology, low temperature geochemistry, ground water, geology of reef systems.

ROBERT RIPPERDAN, *Assistant Professor*, Ph.D. (1990), California Institute of Technology. Research Interests: Stable Isotope Geochemistry; geobiology and paleoclimatology. Teaching Interests: Environmental geochemistry; stable isotope geochemistry and paleoclimatology.

HERNAN SANTOS, *Assistant Professor*, Ph.D. (1999), University of Colorado. Research Interests: Carbonate sequence stratigraphy; biostratigraphy; paleontology. Teaching Interests: Sedimentology; stratigraphy; paleontology.

JOHANNES H. SCHELLEKENS, *Professor*, Ph.D. (1993), Syracuse University. Research Interests: Island arc development; mineral deposits; volcanic geochemistry; ancient and modern hydrothermal processes. Teaching Interests: Ore petrology and ore geology; global tectonics and metallogenesis.

AD HONOREM PROFESSORS

JOHN ROOBOL, *Professor,* Ph.D., (1970), University of London. Research Interests: Volcanology.

KEITH ROWLEY, *Assistant Investigator,* Ph.D., (1978), University of the West Indies. Research Interests: Volcanology.

HISPANIC STUDIES

The Department of Hispanic Studies offers a program leading to the degree of Master of Arts. In addition to the admission requirements of the Graduate Studies Office, a Bachelor of Arts degree in Hispanic Studies or its equivalent is required.

Academic program requirements above those of Graduate Studies include approving a minimum of thirty credits. All students are required to write a thesis. In addition, candidates for the degree must approve comprehensive examinations in the areas of Spanish literature, Hispano American literature, Puerto Rican literature, and linguistics.

COURSES OFFERED HISPANIC STUDIES (ESHI)

(I)= courses normally offered during the First Semester
(II)= courses normally offered during the Second Semester
(S)= courses normally offered during the Summer Session

* Graduate Courses

(* Graduate courses do not require prerequisites.)

ESHI 6005. STYLISTICS (On demand). Three credit hours. Three hours of lecture per week.

An analysis of the phenomenon of "style" in Hispanic literature and the schools of thought dedicated to the study of stylistics.
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 6015. GONGORISM (On demand). Three credit hours. Three hours of lecture per week.

A study of Gongorism as a conception of the literary language in different periods of Spanish and Spanish American Literature.

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 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 (Odd numbered years). 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 (I, II). 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 (Even numbered years). 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 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 Bestos, Fuentes, Carpentier, Paz, Di Benedetto, García Márquez, Yáñez, Vargas Llosa, Donoso.

ESHI 6096. DIALECTOLOGY AND SOCIOLINGUISTICS IN THE CARIBBEAN SPANISH. 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 6405-6406. THE SPANISH LANGUAGE IN AMERICA (I)-(II). Three credit hours per semester. Three hours of lecture per week each semester.

A comparative study and analysis of the characteristics that define the unity and the variety of our vernacular language in Puerto Rico, the rest of the Spanish American countries, and Spain.

ESHI 6407. SPECIAL TOPICS IN HISPANIC LANGUAGE AND LITERATURES (On demand). Three credit hours. Three hours of lecture per week.

Selected topics in Hispanic language and literatures.
ESHI 6561-6562 (On demand). THE NOVEL IN SPANISH AMERICA. Three credit hours per semester. Three hours of lecture per week each semester.

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. METHODS OF LITERARY CRITICISM I (I). Three credit hours. Three hours of lecture per week.

Literary criticism in the twentieth century; analysis of critical works in the field of Hispanic letters; problems and methods related to the historical and philosophical approaches.

ESHI 6606. METHODS OF LITERARY CRITICISM II (II). Three credit hours. Three hours of lecture per week.

Literary criticism in the twentieth century; analysis of critical works in the field of Hispanic letters; problems and methods related to the linguistic, sociological, and psychological approaches.

HISPANIC STUDIES FACULTY

A list of professors that 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.

MARLENE ACARON RAMIREZ, *Professor*, M.A. (1974), University of Puerto Rico, Mayagüez Campus. Research and Teaching Interests: Puerto Rican and Spanish American Literature, Studies of the Female Gender in Literature.

ELSA R. ARROYO VAZQUEZ, *Professor*, Ph.D. (1989), Rutgers University. Research and Teaching Interests: Spanish American Literature with emphasis on Puerto Rico and the Caribbean, Literary Theory, Studies of the Female Gender in Literature. Essay Writer.

AMARILIS CARRERO PEÑA, *Assistant Professor*, Ph. D. (2000), The Pennsylvania State University. Research and Teaching Interest: Latin American Literature, Brazilian Literature, Spanish Literature (Golden Age). Studies in short story, poetry and novel.

RAFAEL COLON OLIVIERI, *Professor*, Ph.D. (1990), New York University. Research and Teaching Interests: Puerto Rican Literature, Modernism. Poet.

ROBERTO FERNANDEZ VALLEDOR, *Professor*, Ph.D. (1986), University of Puerto Rico. Research and Teaching Interests: Spanish American and Antillean Literature, Essay, Novel. Essay and Short Story Writer.

MANUEL FIGUEROA MELENDEZ, Associate Professor Ph.D. (1997), University of Puerto Rico. Research and Teaching Interests: Spanish Literature, Theatre. Novelty Poetry, Love in Literature. Poet, Essay and Short Story Writer.

FRANCISCO GARCIA MORENO BARCO, Associate *Professor*, Ph.D. (1992), Michigan State University. Research and Teaching Interests: Spanish, Narrative and Writing.

JACQUELINE GIRON ALVARADO, *Associate Professor*, Ph.D. (1993), The Pennsylvania State University. Research and Teaching Interests: Spanish American Poetry and Theater (20th Century). Puerto Rican Literature, Feminist Literature Criticism, Short Story Writer, Poet, Literature Critic.

MIRIAM GONZALEZ HERNANDEZ, *Associate Professor*, Ph.D. (1994), Florida State University. Research and Teaching Interests: Puerto Rican and Spanish American Literature, Short Story and Writing, Puerto Rican Women Writers.

MAGDA GRANIELA RODRIGUEZ, *Professor*, Ph.D. (1987), University of Illinois, Urbana. Research and Teaching Interests: Spanish American and Mexican Literature, Critical Theory of Literature, Novel, Writing.

DORIS MARTINEZ VIZCARRONDO, *Assistant Professor*, Ph.D. (1998), Universidad Autónoma de Madrid, Research and Teaching Interests: Linguistics.

ALFREDO MORALES NIEVES, *Associate Professor*, Ph.D. (1987), University of California at Irvine. Research and Teaching Interests: Spanish American and Hispanic Caribbean Literature. XIX Century, Essay, Philosophy and Studies of Nationhood, Race, Gender in Literature, Writing. Poet and short story writer.

CATALINA OLIVER PREFASI, *Associate Professor*, Ph.D., (1982), New York University, New York, Research and Teaching Interests: Spanish Literature (19th Century, 17th Century – Cervantes Novel Theater, Golden Age Drama).

AMPARO ORTIZ ACOSTA, *Associate Professor*, Ph.D. (1989), University of Puerto Rico. Research and Teaching Interests: Hispanic Linguistics, Syntax, Writing.

JULIA C. ORTIZ LUGO, *Associate Professor*, Ph.D. (1989), Tulane University. Research and Teaching Interests: Spanish American and Puerto Rican Literature, Modernism, Oral Literature and Writing. Essay Writer.

DAVID L. QUIÑONES ROMAN, *Associate Professor*, Ph.D. (1988), University of Massachusetts at Amherst. Research and Teaching Interests: Spanish Literature (17th Century-Golden Age Fiction-Cervantes), Spanish Literature (Medieval Period), Spanish American Literature (from Colonial Period to Modernism). Poet.

JOSEFINA RIVERA DE ALVAREZ, *Emeritus Professor*, Ph.D. (1954), Universidad Central de Madrid. Research and Teaching Interest: Puerto Rican Literature.

VICTOR J. RIVERA DIAZ, *Assistant Professor*, Ph.D. (1997), University of Illinois-Urbana. Research and Teaching Interests: Knowledge Presentation and Advertising, Memory Processes and Media, Communication and Mass Communication Theory, Business Communication, Journalism Writing.

AURA N. ROMAN LOPEZ, *Professor*, Ph.D. (1981), Tulane University. Research and Teaching Interests: Spanish American Literature, Folklore. Poet.

JORGE MA. RUSCALLEDA BERCEDONIZ, *Professor*, Ph.D. (1988), Universidad Autónoma de México. Research and Teaching Interests: Poetry, Novel, Essay, Spanish American and Puerto Rican Literature. Poet and Novelist.

EVELYN SANABRIA LUGO, *Associate Professor*, M.A. (1972), University of Puerto Rico. Research and Teaching Interest: Spanish Literature.

PATRICIA TRIGO TIO, *Associate Professor*, M.A. (1985), University of Puerto Rico, Mayagüez Campus. Research and Teaching Interests: Puerto Rican Literatures and Spanish Grammar.

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 the degrees of Master and Doctor of Philosophy in Marine Sciences.

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 of both its scope and its capabilities the Institute grew to become, in August 1968, the Department of Marine Sciences. It has continued to broaden and strengthen its academic and research activities and currently has active programs of investigation and instruction in the fields of physical, chemical and geological oceanography, marine biology, and aquaculture. The faculty has grown progressively to its present level of 22 staff members offering about 70 courses encompassing a wide range of topics in marine science—the largest such program in the Caribbean Basin.

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, and through basic and applied research. Emphasis on excellence in academic and research programs has placed the DMS and UPR 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 the academic programs of the DMS are to provide students with a firm grounding in marine sciences, an advanced knowledge of techniques for data collection and analysis, and instruction at the forefront of their fields of specialization. Students specialize in a particular discipline but are required to gain a knowledge of other disciplines comprising the broad field of marine sciences. This is achieved by means of compulsory core courses in biological, chemical, geological and physical oceanography and a seminar course in current topics.

The University of Puerto Rico Sea Grant College and the Puerto Rico Resource Center for Science and Engineering contribute substantially to the strength of the Marine Sciences Program. There is a considerable interaction with other science departments in Mayagüez and with the Medical Sciences and Río Piedras campuses. During the last five years the department has received more than $6.5 million in grants.

Each year a number of research assistantships are awarded from departmental funds and from research grants. Departmental assistantships are awarded on merit and are not available to new masters students in their first semester. Assistantships from research funds are awarded at the discretion of the principal investigator.

FACILITIES

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. Situated here are the departmental administrative offices, a number of laboratories and faculty offices, and the offices of the UPR Sea Grant College Program. Also 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 such specialized collections in the Caribbean. The collection is supported by additional holdings in the Mayagüez Campus General Library, many of which are specific to marine sciences, and by the small, but specialized Sea Grant Library.

The DMS Puerto Rico and US Virgin Islands Climatology Center brings the latest climate data and weather information and any climate data record for the Caribbean. The Climate Office has access to a network of over 120 stations located throughout Puerto Rico and over 20 stations around the US Virgin Islands. It is also a repository for a wealth of information on climate obtained from many other organizations, including the National Climate Center, Asheville, and the Climate Analysis Center, Washington, DC. The Center receives journals on climate topics and has a large collection of climate data on CD-ROM.

The Department of Geology maintains and operates a scanning electron microscope (SEM) that is available to the DMS personnel. Additionally, DMS researchers have access to the SEM maintained and operated by the Faculty of Natural Sciences of UPR Río Piedras.

Isla Magueyes (Magueyes Island)

The major departmental facilities are located at the field station on Isla Magueyes. A complex of 7 buildings, with a combined area approaching 30,000 sq. ft., houses faculty and student offices, research laboratories and classrooms and laboratories for teaching. Included are reference museums for both fish, invertebrates and algae. The museum holdings, with 13,000 specimens of fishes, 5,000 invertebrate specimens, and 35,000 algae specimens, represent only important regional collections, but are the largest within the Antilles. Over 6,000 sq. ft. of wet lab space is available. Filtered seawater is provided by a flow-through system supplying up to 85 gal/min., and blown air is piped to the laboratories. The various laboratories possess most types of instrumentation and equipment essential for modern, sophisticated research. Of particular note are the marine physiology laboratory, which contains freeze drying and solvent extraction facilities including high-speed, refrigerated centrifuges for the isolation of natural products, and the marine chemistry laboratory which contains salinometers, spectrophotometers, pH meters, a filter fluorometer, gas chromatograph, rotary evaporator, and a flow injection nutrient analyzer.

Other pertinent resources for research include a well-equipped algae culture facility, fresh- and salt-water fish culture tanks, and a hatchery facility for aquaculture. Four microcomputers are maintained for general use; additional microcomputers are located in individual laboratories.

The Department maintains a complete diving facility including a dive locker, maintenance shop, and a compressor room equipped with an electric compressor rated at 5,000 psi. Tanks, regulators and other diving equipment are maintained and available for staff and students. A gas-powered, portable compressor may be used for extended field trips.

The marine research fleet can perform offshore and inshore research. This is accomplished by three large offshore vessels and seventeen smaller boats for inshore studies. Four of the small boats are high speed for trips to outlying reefs.

The R/V *Isla Magueyes* is a 71 ft. trawler type vessel with a range of 7200 miles. Navigation and communication facilities consist of Sat Nav, SSB radio, VHF radio, 24-mile radar and a 400-fathom depth sounder. The stern deck has a six-ton Pitman crane and a dual spool winch capable of loads up to 5000 lbs. for trawling and 200 m of cable for oceanographic work. There is ample room on the stern to stage and conduct most experiments. The 200 sq. ft. laboratory is equipped with air conditioning, salt or fresh water, 110/120 AC power from 20-kW or 50-kW generators, and an 8 cu. ft. freezer. There are air-conditioned accommodations for twelve scientists.

The R/V *Pezmar* is a 51-ft Thompson trawler. Navigation and communications equipment are VHF radio, 16-mile radar, and a depth sounder. 110 AC power is supplied from a 3.75-kW generator. A hydraulic capstan and a winch with 100 m of cable are aboard for fisheries or oceanographic research. The Pezmar can accommodate 5 scientists and has a range of 1400 miles.

The R/V *Gaviota* is a 35-ft Downeast power vessel. It is equipped with VHF radio and depth sounder. The Gaviota provides an excellent dive platform and is suitable for coastal studies.

Maintenance facilities are housed in four main buildings, which include workshops, a marine mechanic's shop, and a small boat and outboard motor repair shop. A power plant with two diesel generators provides electricity during power failures.

A 1,500 sq. ft. dormitory is located at the field station and is available to the many visiting researchers who come to Magueyes each year. Complete with kitchen and bath facilities, the dormitory can accommodate up to 20 persons.

Lajas

Aquaculture facilities are based mainly at the DMS Aquaculture Station in Lajas, approximately 6 miles from Magueyes Island. The station features 10 acres of earthen ponds including 40 experiment/production ponds ranging in size from .02 hectare (ha) to .4 ha, a .2 ha irrigation pond, and a .8 ha reservoir pond. Smaller facilities consist of a series of fiberglass and concrete tanks, and plastic pools. A wet lab building serves as a hatchery, a holding area for live animals, and as a site for controlled laboratory experiments. Also maintained at the

station are a water chemistry laboratory, and offices for faculty and staff.

The Puerto Rican Commercial Aquaculture Research and Development Center

(CIDACPR) of UPRM Department of Marine Sciences (DMS) was formed in 1994 to assist the Commonwealth of Puerto Rico with development of aquaculture in the Island. CIDACPR is funded by the Industrial Incentives Program (formerly the Science and Technology Board) of the Secretariat for Economic Development and Commerce of PR, and the University of Puerto Rico. CIDACPR has specialists in economics and marketing, analysis of aquaculture enterprises, research facilities, and extension services, the latter in collaboration with the Agricultural Extension Service and the Sea Grant College Program.

CIDACPR has research and production facilities in Lajas and Sabana Grande in Southwest Puerto Rico and consists of 19 employees, including some DMS professors. It offers key services to the Puerto Rican community, performs scientific research to support the local aquaculture industry, and provides fish fingerlings and postlarval prawns for these activities. Formulated fish feed is sold to the farmers through CIDACPR, eliminating the necessity of small-scale aquaculture operations to purchase large quantities of feed. The CIDACPR program provides products and assistance requesting help. CIDACPR also supports training for masters and doctoral students within the Department of Marine Sciences. Research at the CIDACPR station focuses on commercial aspects of aquaculture development in Puerto Rico and experimentation with new species and new culture techniques.

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

MARINE SCIENCES (CIMA)

Advanced Undergraduate Course

CIMA 5005. INTRODUCTION TO OCEANOGRAPHY (I, II) (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: Consent 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.

Graduate Courses

CIMA 6619. SCUBA METHODS IN MARINE SCIENCE. Two credit hours. One hour of lecture and one water session per week. Prerequisites: Swimming ability, plus documentation of good health, including a chest X-ray, and Consent of the Instructor.

Diving skills stressed to expand the marine scientist's in-the-sea working capabilities; lectures in diving physics, physiology, equipment and related medical aspects; introduction to recompression chamber operational techniques; ocean diving procedures, with attention given to differences in topography and predictable interplay between divers and marine animals.

CIMA 6625-6626. GRADUATE SEMINAR. One credit hour per semester. One session per week each semester.

Discussion of recent developments in the marine sciences and related disciplines. Students will present topics connected with their specialties.

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 5006. SEAFOOD PROCESSING (II) (On demand). Four credit hours. Three hours of lecture and one three-hour laboratory per week.

Techniques for processing seafood products and their effects on quality and consumer acceptance.

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 5016. PHYCOLOGY (I, II). Three credit hours. Two hours of lecture and one three-hour laboratory per week.

Fundamental study of algae in general, with reference to the main groups: Chlorophyta, Xantophyta, Cianophyta, Phaeophyta, Rhodophyta. Study of biology, life histories, morphogenesis, ecology, evolution, taxonomy, and commercial or industrial uses of algae, and their importance in the bio-economics of the sea and other bodies of water. Intensive use will be made of audiovisual techniques, the herbarium, the laboratory, and field trips.

CMOB 5017. MARINE ECOLOGY AND RESOURCE MANAGEMENT. Five credit hours. Three hours of lecture and two three-hour laboratories per week. Prerequisite: Consent 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 5018. MARINE ECOLOGY. Six credit hours. Ten hours of lecture and eighteen hours of laboratory per week during six weeks in the summer.

A study of marine communities and their environment, with special consideration of ecosystems in the sea.

CMOB 5035. ENDANGERED MARINE VERTEBRATES. Two credit hours. Two three-hour periods of practice per week.

Biology, diseases, autopsy, and care of protected and endangered marine vertebrates. Field trips are required.

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 6017. LENGTH-FREQUENCY METHODS IN FISHERIES BIOLOGY (II) (On demand). Three credits hours. Three hours of lecture per week. Pre-requisite: consent of the Director of the Department.

Techniques for sampling, analyzing, and interpreting length-frequency distributions to determine the dynamics and vital parameters of populations. Application of computer-based methods will be emphasized.

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 6026. SEAFOOD TECHNOLOGY. Three credit hours. Three hours of lecture per week. Prerequisite: CIMA 5006 or CMOB 5006.

Industrial and regulatory procedures to ensure the quality of fish, shellfish, and related products. Field trips are required.

CMOB 6056. WATER QUALITY MANAGEMENT IN AQUACULTURE. Three credit hours. Three hours of lecture per week.

Manipulation of water quality to improve production of aquatic organisms. Field trips are required.

CMOB 6075. FRESHWATER INVERTEBRATES. Three credit hours. One hour of lecture and two two-hour laboratories per week.

Identification of freshwater invertebrates, their role in the environment, and their importance in aquaculture and pollution studies.

CMOB 6077. ZOOPLANKTON ECOLOGY (On demand). Three credit hours. Two hours of lecture and one three-hour laboratory per week. Prerequisite: Consent 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 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.

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 6636. WATER QUALITY IN FISH PONDS (II). Four credit hours. Three hours of lecture and one three-hour laboratory per week.

Physical, chemical, and biological characteristics of water that affect the growth and health of organisms cultivated in freshwater.

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: Consent of the Director of the Department.

Theory, practice, and applications of molecular marine biology.

CMOB 6686. FISH NUTRITION (I) (On demand). Four credit hours. Three hours of lecture and one three-hour laboratory per week.

The nutritional requirements and the digestive physiology of marine and freshwater fish.

CMOB 6687. DESIGN AND MANAGEMENT OF AQUACULTURE HATCHERIES (I, II) (On demand). Four credit hours. Three hours of lecture and one four-hour laboratory per week.

Theory and practice in the cultivation of tropical aquatic species emphasizing a systems approach to the design and management of hatcheries.

CMOB 6689. CULTURED AQUATIC ORGANISMS HEALTH. Three credit hours. One hour of lecture and two three-hours laboratories per week.

The nature, prevention, diagnosis, and treatment of parasites and diseases of cultured aquatic organisms. Field trips are required.

CMOB 8636. MARINE PARASITOLOGY (I) (On demand). Four credit hours. Two hours of lecture and two three-hour laboratories per week.

Parasitology of marine organisms with emphasis on local fauna; collecting methods, preparation for the study and identification of parasites.

CMOB 8645. MARINE PHYSIOLOGY (I) (On demand). Three credit hours. Three hours of lecture per week.

The physiological processes at the cellular and organismal levels directly concerned with the adaptation of the organism to the physical and chemical environment of the ocean; the more specialized physiological processes encountered in the study of the growth and behavior of marine organisms.

CMOB 8646. MARINE PHYSIOLOGY LABORATORY (II) (On demand). One or two credit hours. One or two three-hour laboratories per week. Corequisite: CMOB 8645.

Laboratory research projects on a specific physiological process of marine organisms in response to marine environment. Project by arrangement.

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 8656. SELECTED TOPICS IN PHYSIOLOGICAL ECOLOGY (II) (On demand). Three credit hours. Three hours of lecture per week.

The physiological bases for ecological relationships as displayed in representative examples. Individual laboratory projects will be required of all students.

CMOB 8657. AQUACULTURE (I, II) (On demand). Four credit hours. Three hours of lecture and one three-hour 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, mollusks, and crustaceans.

CMOB 8658. ADVANCED MARINE PARASITOLOGY. Three credit hours. One hour of lecture and two three-hour laboratories per week. Prerequisite: CMOB 8636.

Study of advanced topics on the parasites of marine animals. A research project will be required.

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: Consent of the Director of the Department.

Population dynamics of exploited species, management and conservation principles for commercial fisheries.

CMOB 8668. BIOLOGY OF MARINE FISH LARVAE. Four credit hours. Three hours of lecture and one three-hour laboratory per week.

The systematics, development, biophysics, distribution, behavior, and larval recruitment of marine fishes, with an emphasis on tropical taxa.

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 8678. MARINE POPULATION BIOLOGY (I, II) (On demand). Three credit hours. Three hours of lecture per week.

Principles of population biology and their application to the organization of marine communities.

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 8685. THE RHODOPHYTA OF PUERTO RICO. Three credit hours. Two hours of lecture and one three-hour laboratory per week. Prerequisite: CMOB 8679.

A study of the life cycles, reproduction, taxonomy and ecology of the macroscopic red algae of Puerto Rico.

CMOB 8686. ICHTHYOLOGY I (II) (On demand). Three credit hours. Two hours of lecture and one three-hour laboratory per week.

A 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.

A study of the systematics, evolution and distribution of fishes, with emphasis on marine forms.

CMOB 8689. PIGMENT PHYSIOLOGY (II) (On demand). Three credit hours. Three hours of lecture per week.

Physiological function of marine pigments.

CMOB 8690. CULTURE TECHNIQUES EMPLOYED IN ALGAE RESEARCH. Three credit hours. One hour of lecture and two two-hour laboratories per week. Prerequisite: CMOB 8679 or CMOB 8685.

Algae culture and its research methodology to determine the life history of red algae.

CMOB 8695. THE PHAEOPHYTA (I, II) (On demand). Three credit hours. Two hours of lecture and one three-hour laboratory per week. Prerequisite: CMOB 5016 or CMOB 8679.

Life cycles, biology, morphology, ecology, taxonomy and evolution of the brown algae. Field trips required.

CMOB 8696. THE CHLOROPHYTA (I, II) (On demand). Three credit hours. Two hours of lecture and one three-hour laboratory per week. Prerequisite: CMOB 5016 or CMOB 8679.

Life cycles, biology, morphology, ecology, taxonomy, and evolution of the benthic marine green algae. Field trips required.

CMOB 8699. PHYCOLOGY SEMINAR (II) (On demand). One credit hour. One hour of lecture per week.

Discussion of recent works in marine phycology and topics related to student research problems.

CMOB 8705. SPECIAL PROBLEMS IN EXPERIMENTAL MARINE PHYCOLOGY (I, II) (On demand). One to three credit hours. One to three sessions per week. Prerequisite: Consent of the Director of the Department.

Project specifically related to experimental research on marine algae. The presentation of an independent research project is required.

CMOB 8707. CURRENT TOPICS IN PHYCOLOGICAL RESEARCH (II) (On demand). Two

credit hours. One hour of lecture and one hour of seminar per week. Prerequisite: CMOB 5016 or CMOB 8679.

Advanced topics in phycology; classical and current papers in phycological research; seminars on assigned topics.

CMOB 8708. CORAL REEF BIOLOGY. Four credit hours. Three hours of lecture and one three-hour laboratory per week.

Evolution, characteristics, and distribution of coral reefs. Field trips 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 8745. AQUACULTURE IN THE THIRD WORLD (I, II) (On demand). Two credit hours. Two hours of lecture per week.

Aquaculture systems and strategies in Third World countries.

CMOB 8992. A,B,C. SPECIAL PROBLEMS IN MARINE PHYSIOLOGY (I, II) (On demand). One to three credit hours. One to three sessions per week.

Courses dealing with specific techniques in the laboratory related to problems in areas of osmoregulation, ionic equilibrium, and pigment physiology.

CMOB 8993. A,B,C. SPECIAL TOPICS IN AQUACULTURE (I, II) (On demand). 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.

CMOB 8995. A,B,C. SPECIAL PROBLEMS IN FISHERIES BIOLOGY (I, II). One to three credit hours. One to three sessions per week.

Individual student research on the biology of commercial fish and invertebrates, and on commercial fisheries.

CMOB 8996. A,B,C. SPECIAL PROBLEMS IN MARINE ALGAE (I, II) (On demand). One to three credit hours. One to three sessions per week.

Individual student research on selected problems dealing with the marine algae of Puerto Rico.

CMOB 8997. A,B,C. SPECIAL PROBLEMS IN ICHTHYOLOGY (I, II) (On demand). One to three credit hours. One to three sessions per week.

Individual student research on marine fishes.

MARINE SCIENCES CHEMICAL OCEANOGRAPHY (CMOQ)

Graduate Courses

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 8616. OCEANOGRAPHIC TECHNIQUES (I). Three credit hours. One hour of lecture and one six-hour laboratory period per week; also a three days duration training cruise. Pre-requisite: consent of the Director of the Department.

Training in the use of standard shipboard and laboratory techniques in physical, chemical, geological and biological oceanography. Planning and execution of a trip on a cruise. Data collection, processing and analysis.

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)

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 bita-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.

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 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: Consent 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 6665. MATHEMATICAL MODELING OF MARINE SYSTEMS. Three credit hours. Three hours of lecture per week. Prerequisite: Consent 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 6667. MECHANICS OF COASTAL SEDIMENT TRANSPORT. Three credit hours. Three hours of lecture per week.

Development of mathematical models to represent coastal sediment transport.

CMOF 8607. ESTUARINE CIRCULATION (I) (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: CMOF 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, near shore 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.

MARINE SCIENCES FACULTY

A list of professors that 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.

DALLAS E. ALSTON, *Professor*, Ph.D. (1978), Auburn University. Research Interest: Culture of Invertebrate Organisms. Teaching Interest: Invertebrate Aquaculture.

NILDA E. APONTE, *Associate Professor*, Ph.D. (1990), University of Puerto Rico, Mayagüez Campus. Teaching Interests: Taxonomy, Morphology and Life History of Marine Algae. Research Interest: Marine Botany.

RICHARD S. APPELDOORN, *Professor*, Ph.D. (1980), University of Rhode Island. Research and Teaching Interests: Fisheries Biology.

ROY ARMSTRONG, *Associate Professor*, Ph.D. (1990), University of Puerto Rico. Research Interests: Remote Sensing and Water Optics.

DAVID L. BALLANTINE, *Professor*, Ph.D. (1977), University of Puerto Rico, Mayagüez Campus. Research Interests: Taxonomy and Ecology of Marine Algae. Teaching Interest: Marine Botany.

JORGE E. CAPELLA HERNANDEZ, *Associate Professor*, Ph.D. (1989), Texas A&M University. Research and Teaching Interest: Physical Oceanography.

JORGE E. CORREDOR, *Professor*, Ph.D. (1978), University of Miami. Research Interests: Chemical Oceanography, Pollution. Teaching Interests: Marine Chemistry.

RICARDO CORTES MALDONADO, *Professor*, M.S. (1976), University of Puerto Rico, Mayagüez Campus. Research and Teaching Interest: Aquaculture.

JORGE R. GARCIA SAIS, *Associate Researcher*, Ph.D. (1992), University of Rhode Island. Teaching Interest: Zooplankton Ecology. Research Interest: Zooplankton.

DANNIE A. HENSLEY, *Professor*, Ph.D. (1978), University of South Florida. Research Interests: Systematics and Ecology of Fishes. Teaching Interests: Ichthyology.

JOHN M. KUBARYK, *Professor*, Ph.D. (1980), Auburn University. Research and Teaching Interests: Seafood Technology, Aquaculture.

JOSE M. LOPEZ DIAZ, *Professor*, Ph.D. (1976), University of Texas. Research and

Teaching Interests: Water Pollution Control, Marine Ecology.

AURELIO MERCADO IRIZARRY, *Professor*, M.S. (1973), University of Miami. Research Interests: Geophysical Fluid Dynamics. Teaching Interests: Physical Oceanography.

JACK MORELOCK, *Professor*, Ph.D. (1967), Texas A&M University. Research Interests: Sediments, Beach and Littoral Studies, Reef Sediments and Marine Terraces, Geophysical Surveys. Teaching Interest: Geological Oceanography.

JULIO MORELL, *Associate Researcher*, M.S. (1983), University of Puerto Rico. Research Interests: Biochemistry and Environmental Chemistry.

GOVIND NADATHUR, *Associate Professor*, Ph.D. (1982), Gujarat University of India. Research and Teaching Interests: Microbiology, Genetics and Biotechnology of Marine Organisms.

ERNESTO OTERO-MORALES, *Assistant Researcher,* Ph.D. (1998) University of Georgia. Research Interests: Microbial Biogeochemistry. Teaching Interests: Microbial Ecology, Biogeochemistry.

THOMAS R. TOSTESON, *Professor*, Ph.D. (1959), University of Pennsylvania. Research Interests: Marine Physiology and Pharmacology. Teaching Interests: Physiology.

ERNESTO WEIL, *Associate Professor*, Ph.D. (1992), University of Texas at Austin. Research Interests: Coral Systematics, Ecology, and Evolution, Coral Reef Ecology.

ERNEST H. WILLIAMS, *Professor*, Ph.D. (1974), Auburn University. Research Interests: Systematics and Culture of Parasites of Fishes. Teaching Interest: Fisheries.

AMOS WINTER, *Professor*, Ph.D. (1981), The Hebrew University of Jerusalem. Research and Teaching Interests: Paleoceanography, Marine Geology.

PAUL YOSHIOKA, *Professor*, Ph.D. (1973), University of California, San Diego. Research and Teaching Interests: Marine Ecology.

BAQAR R. ZAIDI, *Researcher*, Ph.D. (1983), University of Puerto Rico, Mayagüez Campus. Research Interest: Marine Physiology. Teaching Interest: Microbial Ecology.

MATHEMATICS

The Department of Mathematics offers two programs leading to the degree of Master of Science, and participates in an Interdisciplinary Program leading to a Ph.D. Degree 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 can specialize in Applied Mathematics, Statistics or Pure Mathematics.

Applicants for admission should have an undergraduate degree in mathematics or its equivalent in addition to the requirements of the Office of Graduate Studies. Candidates are expected to have approved undergraduate courses in linear algebra, algebraic structures, and advanced calculus.

In addition to the requirements of the Graduate Studies Office, the Master of Science degree includes approving eight credits in core courses and fifteen credits in the area of specialization.

MASTER OF SCIENCE IN SCIENTIFIC COMPUTING

Applicants for admission should have an undergraduate degree in Science or Engineering with a minimum grade point average of 2.5/4.0. Candidates are expected to have approved courses in multivariable calculus, differential

equations, and data structures, as well as having experience programming in C or Fortran.
In addition to the requirements of the Office of Graduate Studies, the Master of Science degree includes approving twelve credits in core courses, six credits in an outside area, nine credits in the area of specialization, three thesis credits and two internship credits.

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

MATHEMATICS (MATE)

Advanced Undergraduate Courses

MATE 5016. GAME THEORY (On demand). Three credit hours. Three hours of lecture per week.

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 its equivalent.

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.

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 MATE 3185.

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 MATE 3185.

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.

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 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, nonlinear, geometric programming, dynamic programming, the path method.

MATE 6201-6202. ABSTRACT ALGEBRA (II)-(I). Three credit hours per semester. Three hours of lecture per week each semester. Prerequisite: Consent 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 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 6627-6628. TOPICS IN ANALYSIS (I)-(II on demand). Three credit hours per semester. Three hours of lecture per week. Prerequisite: Consent 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 6631-6632. TOPICS IN MATHEMATICAL LOGIC (I)- (On demand). Three credit hours per semester. Three hours of lecture per week each semester. Prerequisite: Consent 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 hours of lecture per week.

A more advanced study of some topics covered in Mathematics of Modern Science. Sturm-Liouville systems, calculus 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. Prerequisite: MATE 4009.

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: Consent 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 (On demand). Three credit hours. Independent study.

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 hour. One to three hours of lecture per week. Prerequisite: Consent 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 adviser.

COMPUTER SCIENCE (COMP)

Advanced Undergraduate Courses

COMP 5045. AUTOMATA AND FORMAL LANGUAGES (I). Three credit hours. Three hours of lecture per week. Prerequisite: Consent 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 consent 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.

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 6785. ANALYSIS OF ALGORITHMS (II). Three credit hours. Three hours of lecture per week. Prerequisite: consent 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: Consent 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.[';

MATHEMATICAL STATISTICS (ESMA)

Advanced Undergraduate Course

ESMA 5015. STOCHASTIC SIMULATION (I) (Even numbered years). Three credit hours. Three hours of lecture per week. Prerequisite: ESMA 4001 or MATE 4001.

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 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.

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: Consent 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: Consent 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 consent 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.

MATHEMATICS FACULTY

A list of professors that 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.

EDGAR ACUÑA FERNANDEZ, *Professor*, Ph.D. (1989), University of Rochester. Teaching and Research Interests: Linear Models, Data Analysis, and Computational Statistics.

JULIO E. BARETY, *Professor*, Ph.D. (1972), University of New Mexico. Research Interests: Fourier Series, Abstract Harmonic Analysis. Teaching Interests: Analysis, Pure and Applied Mathematics.

ALVARO BOLAÑO DE LA HOZ, *Associate Professor*, Ph.D. (1988), University of Montana. Research Interests: Optimal Control Theory, Mathematical Modeling. Teaching Interest: Applied Mathematics.

DOROTHY BOLLMAN, *Professor*, Ph.D. (1964), University of Illinois, Urbana. Research Interests: Parallel Algorithms, High Performance Computing. Teaching Interest: Computer Science.

LUIS F. CACERES DUQUE, *Assistant Professor*, Ph.D. (1998), University of Iowa, Iowa City, Iowa. Research and Teaching Interests: Logic, Algebra, Teaching undergraduate abstract algebra using games, applications and technology.

GABRIELE CASTELLINI, *Professor*, Ph.D. (1986), Kansas State University. Research and Teaching Interests: Category Theory, Categorical Topology and Commutative Algebra.

DENNIS G. COLLINS, *Professor*, Ph.D. (1975), Illinois Institute of Technology. Research Interests: Applied Mathematics, Applied Logic, Mathematical Physics of Quantum Theory, Differential Equations. Teaching Interests: Mathematical Modeling; Numerical Analysis.

WIESLAW DZIOBIAK, *Professor*, Ph.D. (1982), Wroclaw University, Poland. Research and Teaching Interests: Algebraic Logic.

ENRIQUE GALLO, *Assistant Professor,* M.S. (1976), University of California, Berkeley. Research and Teaching Interests: Linear Programming, Dynamic Programming, Stochastic Processes.

ERIC GAMESS, *Assistant Professor*, Ph.D., (2000), Universidad Central de Venezuela. Research and Teaching Interests: Computer Network, Operatory Systems, Languages, Parallel Computer.

HAEDEH GOORANSARAB, *Assistant Professor*, Ph.D. (1997), Purdue University, West Lafayette, Indiana. Research and Teaching Interests: Complex Dynamics, Networks.

DARRELL W. HAJEK, *Professor*, Ph.D. (1971), University of Florida. Research and Teaching Interests: General Topology: Topological Extensions, Compactifications; Evaluation of Teaching Effectiveness; Numerical Analysis.

MIGUEL L. LAPLAZA, *Professor*, Ph.D. (1965), Universidad de Madrid. Research and Teaching Interests: Algebra, Category Theory.

RAFAEL MARTINEZ PLANNEL, *Professor*, Ph.D. (1983), Michigan State University. Research and Teaching Interests: Geometric Topology.

DANIEL L. McGEE, *Associate Professor*, Ph.D. (1995), University of Arizona. Research and Teaching Interests: Mathematical Modeling, Applied Biostatistics.

DEBORAH ANN MOORE, *Associate Professor*, Ph.D. (1995), University of Oklahoma. Research and Teaching Interests: Elementary and Undergraduate Mathematics Education.

BALCHANDRA C. OLTIKAR, *Professor*, Ph.D. (1977), Carleton University, Canada. Research and Teaching Interests: Expert Systems, Profinite Groups, Algebra.

ARTURO PORTNOY, *Associate Professor*, Ph.D. (1997), Rensselaer Polytechnic Institute, Troy, NY. Research and Teaching Interests: Analysis, Differential Equations, Applied Mathematics.

JULIO C. QUINTANA DIAZ, *Professor*, Ph.D. (1996), University of Wales, United Kingdom. Research and Teaching Interests: Applied Statistics, Sampling, Regression.

WILFREDO QUIÑONES, *Professor*, Ph.D. (1986), University of Massachusetts. Research and Teaching Interests: Applied Mathematics and Analysis.

BETTY RAMIREZ, *Professor*, Doctor in Computer Science (1990), Universidad Politécnica de Madrid, Spain. Research and Teaching Interests: Artificial Intelligence.

WOLFGANG ROLKE, *Professor*, Ph.D. (1992), University of Southern California. Research and Teaching Interests: Mathematical Statistics, Probability Theory.

KRZYSZTOF ROZGA, *Professor*, Ph.D. (1976), University of Warsaw, Poland. Research and Teaching Interests: Mathematical Physics, Differential Geometry.

TOKUJI SAITO, *Professor*, Ph.D. (1985), Texas A&M University. Research and Teaching Interests: Applied Statistics.

HECTOR SALAS, *Professor*, Ph.D. (1983), University of Iowa. Research and Teaching Interests: Operator Theory.

FREDDIE SANTIAGO HERNANDEZ, *Associate Professor*, Ph.D. (1988), State University of New York at Stony Brook. Research and Teaching Interests: Differential Geometry.

ROBERT W. SMITH, *Professor*, Ph.D. (1979), University of Florida. Research and Teaching Interests: Statistics, CAI, Computers, Stochastic Processes and Analysis.

LEV G. STEINBERG, *Professor*, Ph.D. (1988), Institute for Mathematics and Mechanics of Academy of Science, Alma-Ata, USSR. Research Interests: Inverse Problems, Mathematical Modeling, Nonlinear Mechanics. Teaching Interests: Differential Equations and Numerical Analysis.

PABLO TARAZAGA, *Professor*, Ph.D. (1977), Universidad Nacional de San Luis, Argentina. Research and Teaching Interests: Optimization and Linear Algebra.

PEDRO VASQUEZ URBANO, *Associate Professor*, D.Sc. (1997), George Washington University, Washington D.C. Research and Teaching Interests: Linear and Non-linear Programming, Scheduling, Neural Networks.

JULIO VIDAURRAZAGA, *Professor*, Ph.D. (1982), State University of New York at Stony Brook. Research and Teaching Interests: Riemannian Geometry, Positive Curvature, Analysis, Linear Algebra, Geometry.

UROYOAN WALKER, *Assistant Professor*, Ph.D. (2001), Louisiana State University. Research and Teaching Interests: Linear Algebraic Group, Galois Cohomology, Algebraic Number Theory, Quadratic Forms.

KEITH WAYLAND, *Professor*, Ph.D. (1979), Louisiana State University. Research and Teaching Interests: Number Theory, Combinatorics, Graph Theory, Cryptography.

PHYSICS

The Department of Physics offers a graduate study program leading to the degree of Master of Science. Applicants for admission should have an undergraduate degree in Physics or its equivalent in addition to the requirements of the Graduate Studies Office. Students not meeting these requirements may be admitted on a provisional basis until leveling courses are completed.

The requirements for the major in the Department of Physics are met with the approval of at least eighteen credit hours of graduate courses in Physics, exclusive of thesis. The following specific courses are required: Introduction to Theoretical Physics, Quantum Mechanics, Electromagnetic Theory, Mathematics of Modern Science and Graduate Seminar. All students are required to write a thesis.

There are current research projects in the Department in the fields of condensed matter/materials science, laser spectroscopy, high energy Physics, astrophysics, astronomical optics, statistical Physics, hydrodynamics, and atmospheric Physics. Department facilities include well-developed laboratories for experimental research in laser spectroscopy and condensed matter/materials science, a completely automated observatory and a planetarium.

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 with advanced spectroscopic equipment including double spectrometers and photon counting systems. Thin film and crystal growth facilities include systems for Pulsed Laser Deposition, Ion-beam Sputtering, Metal-organic Chemical Vapor Deposition, and Sol-gel techniques, high-temperature furnaces and other preparation equipment. Materials characterization facilities include a high-resolution x-ray diffractometer specially equipped for thin film studies, Atomic Force/Scanning Tunneling Microscope, multiple wavelength ellipsometer, and an Electron Spin Resonance spectrometer. Additional facilities available to researchers through the UPR Materials Characterization Center include Scanning Electron Microscopy, Auger Electron Spectroscopy with depth profiling, Secondary Ion Mass Spectroscopy, and X-ray Photo-emission Spectroscopy.

Experimental research in high energy Physics is conducted in close collaboration with Fermilab, in Illinois, and data analysis and transmission facilities to aid this effort are located in the Department. Research in radioastronomy is performed with the Arecibo radiotelescope. A research project in adaptive optics for astronomy is currently being started. Distributed computational resources sustaining research are available through several laboratories, at a computers room for use by Department students and faculty, and though communications connections to campus and external facilities. The Department also has a precision machine shop and electronics shop supporting research activities. Additional facilities include an automated 16-inch reflector telescope, and a planetarium with capacity for 60 occupants.

COURSES OFFERED IN PHYSICS (FISI)

(I)= courses normally offered during the First Semester
(II)= courses normally offered during the Second Semester
(S)= courses normally offered during the Summer Session

Advanced Undergraduate Courses

FISI 5037-5025. 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, photo-conductivity and luminescence.

FISI 5047. LASER PHYSICS. Three credit hours. Three hours of lecture per week. Prerequisites: FISI 4105 and FISI 4068.

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.

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 6090-6190. INTRODUCTION TO THEORETICAL PHYSICS (I)-(II). Three credit hours per semester. Three hours of lecture per week each semester.
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. A,B,C. SPECIAL TOPICS IN PHYSICS (I, II). One to three credit hours. One to three meetings per week. Prerequisite: Consent 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 consent 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.

PHYSICS FACULTY

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

JOSE D. ALEMAR, *Professor*, Ph.D. (1977) Texas A&M University. Research Interests: Non-Destructive Evaluation with Ultrasonics, Underwater Acoustics.

DORIAL CASTELLANOS, *Associate Professor*, Ph.D. (1991) University of South Carolina at Columbia. Research Interests: Solid State Physics, Electron Spin Resonance, Foundations of Quantum Mechanics.

MARK J.L. CHANG, *Assistant Professor*, Ph.D. (1998) University of Durham, United Kingdom. Research Interests: Optics.

CARLOS CONDAT, *Professor*, Ph.D. (1987) University of Massachusetts at Amherst. Research Interest: Condensed Matter Theory.

FELIX E. FERNANDEZ, *Professor*, Ph.D. (1987) University of Arizona. Research Interests: Thin Film Physics, Ferroelectric and Wide Bandgap Semiconductor Materials, Materials Characterization.

JEFFREY F. FRIEDMAN, *Associate Professor*, Ph.D. (1992) University of Oklahoma. Research Interests: Pulsars, High Temperature Ion-molecule Reactions.

WEIYI JIA, *Professor*, Ph.D. (1982) Institute of Physics, Chinese Academy of Sciences. Research Interests: Laser Spectroscopy, Luminescent and Laser Materials.

HECTOR JIMENEZ-GONZALEZ, *Associate Professor*, Ph.D. (1992) Massachusetts Institute of Technology. Research Interests: Experimental Solid State Physics, Magneto-optics.

WINSTON KHAN, *Professor*, Ph.D. (1964) University of Birmingham, United Kingdom. Research Interests: Hydrodynamics, Turbulence Phenomena.

ALEXANDER LEYDERMAN, *Professor*, Ph.D. (1971) Solid State Institute of the Academy of Science, Chernogolovka, USSR. Research Interests: Solid State Physics, Spectroscopy, Nonlinear Optics.

HUIMIN LIU, *Professor*, Ph.D. (1986) Academia Sinica, China. Research Interests: Laser Spectroscopy, Nonlinear Optics.

ANGEL M. LOPEZ, *Professor*, Ph.D. (1977) University of Massachusetts. Research Interests: Experimental High Energy Physics.

JOSE R. LOPEZ, *Professor*, Ph.D. (1983) Michigan State University. Research Interests: Physics Education, Biophysics.

HECTOR MENDEZ-MELLA, *Assistant Professor*, Ph.D. (1990) Centro de Investigación y Estudios Avanzados, Physics Department, Mexico City, Mexico. Research Interests: Experimental Elementary Particle Physics.

RUBEN A. MENDEZ PLACIDO, *Professor*, Ph.D. (1988) University of Florida at Gainesville. Research Interests:
Quantum Electrodynamics, Atomic Physics.

LESZEK NOWAKOWSKI, *Professor*, Ph.D. (1983) N. Coppernicus University, Torun, Poland. Research Interests: Radioastronomy. Pulsars.

MOISES ORENGO AVILES, *Associate Professor*, Ph.D. (1996) Brown University. Research Interests: Physics Education, Nuclear Magnetic Resonance.

CARLOS U. PABON, Assistant Professor, Ph.D. (1994) City College of New York. Research Interests: Atmospheric Physics.

JOSE PALATHINGAL, *Professor*, Ph.D. (1965) University of Pennsylvania. Research Interests: Nuclear Physics.

LUIS M. QUIÑONES-RODRIGUEZ, *Professor*, Ph.D. (1973) Purdue University. Research Interests: Astronomy, Nuclear Physics.

RAFAEL RAMOS, *Associate Professo*r, Ph.D. (1994) Boston University. Research Interests: Computational Materials Science. Statistical Mechanics.

MAHARAJ S. TOMAR, *Associate Professor*, Ph.D. (1973) University of Roorkee, India. Research Interests: Semiconductor Devices and Optoelectronics, Ferroelectric and Ionic Conduction Devices.

ESOV VELAZQUEZ, *Assistant Professor*, Ph.D. (1999) University of Puerto Rico. Research Interests: Theoretical Statistical Mechanics.

COLLEGE OF BUSINESS ADMINISTRATION

The College of Business Administration of the University of Puerto Rico at Mayagüez was established by the Council of Higher Education in 1970.

The College aims at the development of leaders in the field of business. With this objective in mind, it directs its efforts toward the following goals:

1. To familiarize the student with the study of man, through the arts and sciences.
2. To develop the desire among students for the search of truth.
3. To strengthen the democratic form of government by emphasizing the need for businessmen to participate in governmental affairs.
4. To develop in the students the ability to solve business problems, by making available to them the knowledge that concerns the operation of business enterprises.

The College also aims at the development of research as it applies to business management. It hopes to provide business enterprises as well as government with new techniques in the field. Moreover, this College is ready to cooperate with the Government of Puerto Rico and private industry in the development of research projects that pursue the aforesaid goals.

The College of Business Administration develops academic programs, which are relevant to the necessities of Puerto Rico. It is continuously taking steps to maintain good relations with business firms and governmental agencies in order to ascertain their needs for human resources, so that new as well as existing programs may be turned to those needs.

BUSINESS ADMINISTRATION

The College of Business Administration offers a program leading to either a general MBA or a degree of Master of Business Administration in Human Resources or in Industrial Management or in Finance or in Marketing.

Applicants for admission should have approved an undergraduate course in each of the following areas: calculus, microeconomics, accounting and statistics, besides having a Bachelor's degree and meeting the general requirements of the Graduate Studies Office.

Candidates must submit scores of GMAT (350) or PAEG (475) exams as additional requirement for admission.

Academic program requirements besides those of Graduate Studies include approving the following core courses: Managerial Accounting, Managerial Economics, Managerial Statistics, Financial Management, Organizational Behavior, Business Policy, Managerial Quantitative Methods, Decision Analysis, and Marketing Management. A total of forty-eight credits are required. A maximum of twelve credits may be approved by examination from among the following: Managerial Statistics, Macroeconomic Analysis, Managerial Accounting, Financial Management, Marketing Management, Organizational Behavior, and Managerial Quantitative Methods. Twenty-one credits must be approved in elective courses.

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

ACCOUNTING (CONT)

CONT 5006. TAX LIABILITIES FOR BUSINESSES IN PUERTO RICO. (I)(S) 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 6005. MANAGERIAL ACCOUNTING (I). 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 6005. SPECIAL TOPICS (I, II). Three to six credit hours. Three to six hours of lecture per week.

Selected topics in Business Administration.

ADMI 6006. COOP PLAN PRACTICE (I)(II). One to three credit hours.

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 (II). 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. Three credit hours.

Comprehensive study of a specific business problem with the purpose of integrating the knowledge acquired in the graduate program.

ADMI 6996. THESIS (I)(II). Zero to six credit hours.

Research in Business Administration. Presentation and approval of a thesis is required.

COMPUTERIZED INFORMATION SYSTEMS (SICI)

SICI 6065. MANAGEMENT INFORMATION SYSTEMS (I). Three credit hours. Two and a half hours of lecture and two and a half hours of laboratory per week.

Basic concepts in data processing and the evaluation and usage of the computer as a valuable tool in decision-making. Utilization of commercially available software packages in word processing, spreadsheets and data-base management that will enable the student to use the computer as a managerial resource will be emphasized.

ECONOMICS (ECON)

ECON 6026. CONTEMPORARY ECONOMIC ISSUES. Three credit hours. Three hours of lecture per week.

Study of contemporary problems in the economies of Puerto Rico and the United States. Macroeconomics issues include: dependency of foreign investment, promotion of internal savings and use of federal funds. Microeconomics issues include: the administration of business in competitive markets such as agriculture, commerce and banking.

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.

ECON 6225. MACROECONOMIC ANALYSIS (I). Three credit hours. Three hours of lecture per week.

Applied aggregate economic theory, including analysis of the determinants of income, output, employment and prices. Employment and price levels effect on consumer and investment demand and upon the process of decision making. Business cycles, inflation and interest rates.

ECON 6226. MICROECONOMIC ANALYSIS (On demand). Three credit hours. Three hours of lecture per week.

Examination of demand and supply, market structures; partial equilibrium in competitive, imperfectly competitive and monopolistic markets; elasticity. Mathematical analysis of different microeconomic theories.

ECON 6227. PROJECT EVALUATION (On demand). Three credit hours. Three hours of lecture per week. Prerequisites: FINA 6015, CONT 6005 and MECU 6035.

Cost benefit analysis; discount rates; estimation and value of shadow prices; external effects; investment criteria, uncertainty.

FINANCE (FINA)

FINA 6015. FINANCIAL MANAGEMENT (II). 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 (On demand). Three credit hours. Three hours of lecture per week. Prerequisites: FINA 6015 and ECON 6026.

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 (On demand). 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 (On demand). 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 (On demand). 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.

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. Prerequisite: GERE 6025.

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. Prerequisite: GERE 6025.

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.

GERH 6095. SEMINAR ON HUMAN RESOURCES MANAGEMENT. Three credit hours. Three hours of seminar per week. Prerequisite: GERH 6040 or GERE 6040.

Current topics in human resources administration: human resources planning, impact of technological change, new concepts in training and development, career planning, utilization of data processing systems for the human resources processes, affirmative action plans and their impact on human resources administration, design and administration of fringe benefits, legal safety requirements, among others.

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 6006. FACILITIES LAYOUT AND WORK DESIGN. Three credit hours. Three hours of lecture per week.

Theory and practice of work measurement systems. Time studies using direct observations and predetermined time systems. Production line construction and balancing. Concepts, strategies and models used in work systems design. Principles and practices related to location, planning, facility layout plan and design. Application of operations research techniques to the design of facilities.

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.

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: GEIN 6035 or MECU 6035.

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: GEIN 6035 or MECU 6035.

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. Prerequisite: GEIN 6035 or MECU 6035.

Nature, objectives, planning, organization and techniques for project management; team building; project-record keeping and reporting.

MANAGEMENT (GERE)

GERE 6025. ORGANIZATIONAL BEHAVIOR (I). 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 (On demand). 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 (On demand). 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 (On demand). 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 (On demand). 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 6096. BUSINESS POLICY (II). Three credit hours. Three hours of lecture per week. Prerequisites: CONT 6005, ESTA 6005, GERE 6025, FINA 6015, (GEIN 6035 OR MECU 6035), MERC 6055, ADMI 6008 AND ECON 6027.

Analysis and interpretation of the formulation and implementation of policies that integrate the different functional areas of a business. The study of managerial complex cases will be emphasized.

MARKETING (MERC)

MERC 6055. MARKETING MANAGEMENT (II). 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 (On demand). 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 (On demand). 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 6059. INTERNATIONAL MARKETING (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: MERC 6055.

Study of the specific marketing management issues, which arise when entering overseas markets conducting international operations, as compared to domestic operations. Problems on the identification and the evaluation of markets opportunities abroad, developing marketing strategies adapted to specific national or world zone need, and the constraints and the coordination of strategies in world markets will be emphasized.

MERC 6065. MARKETING RESEARCH (On demand). 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.

MERC 6066. PRODUCT STRATEGIES. Three credit hours. Three hours of lecture per week.

Essential components of product management. Topics such as: practical methods of analysis, strategy formulation, and implementation, innovation process and new products ventures; screening, developing and testing new products; financial analysis of alternate strategies for new products are included.

PHILOSOPHY (PHIL)

PHIL 6178. ADVANCED BUSINESS ETHICS (II). Three credit hours. Three hours of lecture per week.

Advanced study of ethical approaches and their applications in business, emphasizing the different aspects of the concept of responsibility.

QUANTITATIVE METHODS (MECU)

MECU 6037. ADVANCED TOPICS IN MATHEMATICAL PROGRAMMING (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: MECU 6035.

Lineal models for optimization, dual problem, parametric sensitivity analysis, integer programming, zero-one programming, network models, dynamic programming. Application of these models to current business problems.

STATISTICS (ESTA)

ESTA 6005. MANAGERIAL STATISTICS (I). 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 (On demand). 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.

BUSINESS ADMINISTRATION FACULTY

A list of professors that 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.

HECTOR BRAVO VICK, *Assistant Professor*, MA (1973), University of Illinois at Urbana-Champaign. Teaching Interest: Human Resources Management.

MARTA COLON DE TORO, *Professor*, MBA, (1980), University of Miami. Teaching Interest: Human Resources Management.

JOSE A. CRUZ CRUZ, *Associate Professor*, Ph.D. (1997), University of Pittsburgh, Research and Teaching Interests: Information Systems and Expert Systems.

WILLIAM J. FREY, *Professor*, Ph.D. (1986), Southern Illinois University at Carbondale. Teaching Interests: Business Ethics.

EULALIO ORTIZ RODRIGUEZ, *Professor*, CPA, MS ACC (1976), University of Syracuse. Research and Teaching Interests: Accounting.

EVA Z. QUIÑONES HERNANDEZ, *Associate Professor*, CPA, MSA (1988), University of Texas at Austin. Teaching Interests: Accounting.

BODAPATI V. RADHAKUMARI GANDHI, *Professor*, Ph.D. (1983), Texas A & M University. Research and Teaching Interests: Industrial Engineering.

SALVADOR RAMIREZ SEDA, *Instructor*, JD (1989), University of Puerto Rico, Río Piedras. Teaching Interests: Business Law.

LOIDA RIVERA BETANCOURT, *Professor*, Ph.D. (1990), University of Birmingham. Teaching Interests: Economics, Finance.

JOSE M. ROMAGUERA CASABLANCA, *Professor*, Ph.D. (2001), University of Durham. Research and Teaching Interests: Marketing, Entrepreneurship.

YOLANDA RUIZ VARGAS, *Assistant Professor*, Ph.D. (2000), University of Texas-Pan American. Teaching Interests: Finance, Entrepreneurship.

MIGUEL SEGUI FIGUEROA, *Professor,* JD (1994), Pontifical Catholic University of Puerto Rico; L.L.M. (1991), University of Puerto Rico.

Research and Teaching Interests: Quality Control, Quantitative Methods, Operations Management, Production Planning and Control.

JAIME E. SEPULVEDA RIVERA, *Assistant Professor*, CPA, LLM (1990), Georgetown University. Teaching Interests: Accounting.

PEDRO VALLE CARLO, *Professor,* Ph.D., (1984) New York University, Research and Teaching Interests: Human Resources Management, Labor Relations.

JORGE I. VELEZ AROCHO, *Professor*, Ph.D. (1978), University of Florida, Research and Teaching Interests: Management, Entrepreneurship.

COLLEGE OF ENGINEERING

The College of Engineering offers graduate programs in Departments of Chemical, Civil, Electrical and Computer, Industrial, and Mechanical Engineering. It also includes the Water Resources Institute, the Transportation Institute, and the Technical Information Center.

The Water Resources, the Center for Engineering Infrastructure, the Construction Research, and the Transportation Institutes offer an opportunity for undergraduate and graduate students and professors to join their efforts in the common goals of research and development in these areas in their fields as they apply to Puerto Rico, and to offer technical and scientific training for the best utilization of our own resources.

Those interested in participating in these programs should request further information directly from the Institutes. The College of Engineering offers Master of Science degrees in Chemical, Mechanical, Computer, Industrial and Civil ; and Masters of Engineering degrees in Chemical, Mechanical, Computer, Industrial and Civil Engineering.

The Departments of Chemical, Computer and Civil Engineering offers a Doctor of Philosophy degree (Ph.D.) program.

CHEMICAL ENGINEERING

The Department of Chemical Engineering offers programs leading to the degrees of Master of Science, Master of Engineering, and Doctor of Philosophy (Ph.D.).

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 of the Graduate Studies Office include taking the following four courses: Advanced Thermodynamics, Transport Phenomena, Reactor Design, and Mathematical Methods in Chemical Engineering. Academic graduation requirements for Ph.D. program above those of the Graduate Studies Office include taking the following courses: Advanced Thermodynamics, Transport Phenomena, Reactor Design, Mathematical Methods in Chemical Engineering, Numerical Methods in Chemical Engineering, and Catalysis. Students in the Master of Science program are required to carry out a research project and write a thesis (Plan I). Students in the Master of Engineering program are required to work on a design or development project and write the corresponding report (Plan II). Students in the Doctor of Philosophy program are required to pass a written qualifying exam and prepare a doctoral dissertation. The doctoral dissertation must be an original contribution to the state of the art in the field of study.

Most research activity in the department centers on industrial pollution control, process simulation and optimization, process control, catalysis, energy conversion, biomedical engineering, biochemical engineering, transport phenomena and advanced materials, and mass transfer.

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

CHEMICAL ENGINEERING (INQU)

Advanced Undergraduate Courses

INQU 5005. PROCESS HEAT TRANSFER (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: INQU 4001.

Design of heat exchangers for chemical processes, condensers and condensation of multicomponent mixtures, evaporation by natural and forced circulation, extended surface heat exchangers, design of process furnaces.

INQU 5006. MATHEMATICAL TOPICS IN CHEMICAL ENGINEERING (On demand).

Three credit hours. Three hours of lecture per week. Prerequisites: (MATE 4009 or MATE 3048) and INQU 4005.

Statistical analysis of experimental data, curve fitting, and sampling theory; nomography; problem solving with digital computers. Emphasis is given to chemical engineering applications.

INQU 5008. COMPUTER SIMULATION OF PROCESSES AND UNITS (I). Three credit hours. Three hours of lecture per week. Prerequisites: INGE 3016, INQU 4002, and consent of the Director of the Department.

Analysis, design, and simulation of chemical processes and units using computer programs developed by students under guidance of a faculty member.

INQU 5009. CHEMICAL ENGINEERING APPLICATIONS TO BIOMEDICAL SYSTEMS (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: Consent of the Director of the Department.

Modeling and analysis of vital functions in the human body by methods similar to those used to study the behavior of processing units in chemical plants, such as tracer techniques, microscopic and cell-scale mass and energy transfer, fluid mechanics of the circulatory system, and reactor kinetics applied to body systems.

INQU 5015. FUNDAMENTALS OF AIR POLLUTION (I). Three credit hours. Three hours of lecture per week. Prerequisite: INCI 4008 or 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 Corequisite: INCI 4008.

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 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 5021. CHEMICAL ENGINEERING PROCESS DESIGN I (I, II). Three credit hours. Three hours of lecture per week. Prerequisite: ECON 3021. Corequisites: INQU 4002 and INQU 4017.

Principles of economic evaluation, cost estimation, mathematical techniques and process simulation as applied to chemical engineering design.

INQU 5022. CHEMICAL ENGINEERING PROCESS DESIGN II (I, II). Three credit hours. Three hours of lecture per week. Prerequisites: INQU 4017 and INQU 4002, and INQU 5021.

Application of the principles of economic evaluation, cost estimation, mathematical techniques, and simulation to the chemical engineering design of processes and/or equipment.

INQU 5025. ANALYSIS AND CONTROL OF PROCESSES (I, II). Three credit hours. Three hours of lecture per week. Prerequisites: INQU 4002, INQU 4017 and INQU 4008.

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.

Discussion of the elements of microclimate in urban, rural, and valley environments. Dispersion of air pollutants in these environments.

INQU 5027. EQUILIBRIUM STAGE PROCESSES (On demand). Three credit hours. Three hours of lecture per week. Prerequisites: INQU 4002 and INGE 3016.

The equilibrium stage concept is applied to the analysis and design of stage-wise separation processes, with application to distillation, gas absorption, and extraction. Multicomponent systems, computer methods, and practical aspects of design are studied.

INQU 5028. ADVANCES IN CHEMICAL ENGINEERING (On demand). Two credit hours. Two hours of lecture per week. Prerequisite: INQU 4002. Corequisite: INQU 4027.

Discussion of chemical engineering topics in which recent advances are particularly striking.

INQU 5030. CHEMICAL ENGINEERING LABORATORY II (I, II). Two credit hours. Two three-hour laboratory periods per week. Prerequisites: INQU 4002 and INQU 4017. 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. BIOCHEMICAL ENGINEERING (On demand). Three credit hours. Three hours of lecture per week. Prerequisites: INQU 4017 or (QUIM 4042 and QUIM 5072).

Concepts of microbiology and biochemistry. Kinetics of enzyme-catalyzed reaction networks and immobilized enzyme systems; transport phenomena in microbial systems; biological reactor design and analysis; analysis of multiple interacting microbial populations.

INQU 5036. PARTICULATE SYSTEMS (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: INQU 4002.

Creation, characterization, separation and agglomeration of particles. Sizing fractionation of powders, surface area and pore size determinations. Pulverization, crystallization, agglomeration, tableting and granulation.

INQU 5037. MEMBRANE SEPARATION PROCESSES. Three credit hours. Two hours of lecture and one hour of discussion per week. Prerequisite: INQU 4002.

Study of the principles of membrane separation processes such as: reverse osmosis, nanofiltration, ultrafiltration, microfiltration, dialysis, electrodialysis, gas permeation, and pervaporation. The study will cover mass transfer and the design and operational aspects for both liquid and gas separation systems. The separation, purification, and recovery processes will be applied to the chemical, biochemical, and food industries.

INQU 5045. TRANSPORT PHENOMENA (On demand). Three credit hours. Three hours of lecture per week. Prerequisites: (INQU 4008 and INQU 4010) or INCI 4008.

Momentum, energy, and mass transport. Emphasis is given in the understanding of basic physical principles and their mathematical description.

INQU 5995. SPECIAL PROBLEMS (I, II, S). One to three credit hours. One to three laboratory, library or independent work periods per week. Prerequisite: Consent 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: Consent 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: Consent 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 6006. SIMULATION OF CHEMICAL PROCESSES (On demand). Three credit hours. Three hours of lecture per week.

A study of modern numerical procedures suitable for digital computer simulations; principles of formulation of mathematical models, fundamental laws. Advanced analysis of momentum, energy, and mass transport in continuous media.

INQU 6007. OPTIMIZATION OF CHEMICAL PROCESSES (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: INQU 6006.

Application of optimization techniques to chemical engineering problems. Emphasis on minimum and maximum theory, geometric programming, linear programming, dynamic programming, and search techniques.

INQU 6008. ADVANCED PROCESS DESIGN TECHNIQUES (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: Consent of the Director of the Department.

Study of techniques for the solution of complex systems of non-linear process equations as encountered in process design. Computer calculations appropriate for process design. Typical flow-sheet-type design programs. Study of optimization techniques.

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 6017. ANALYSIS OF SEPARATION PROCESSES (On demand). Three credit hours. Three hours of lecture per week.

Application of phase equilibria to chemical engineering separation processes. Emphasis is given to multicomponent systems, particularly in distillation and absorption processes. Ideal and non-ideal mixtures, including azeotropic and extractive distillation. Design of separation equipments by analytical and numerical methods.

INQU 6018. ADVANCED HEAT TRANSFER (On demand). Three credit hours. Three hours of lecture per week.

Advanced studies in heat transfer applied to chemical processes and equipment design.

INQU 6019. ADVANCED THERMODY-NAMICS (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 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/feed forward control, ratio control,

multivariable 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 BIO-CHEMICAL 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 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 8005. FINITE ELEMENTS IN TRANSPORT PHENOMENA. Three credit hours. Three hours of lecture per week.

Application of finite elements to the solution of differential equations governing distinct and practical problems in transport phenomena.

INQU 8006. ATMOSPHERIC TRANSPORT PHENOMENA. Three credit hours. Three hours of lecture per week. Prerequisite: INQU 6016.

Turbulent momentum, heat and mass transport in the atmosphere. Modeling of atmospheric pollutants dispersion.

INQU 8015. MODELS FOR FLOW SYSTEMS IN CHEMICAL REACTORS. Three credit hours. Two hours of lecture and one one-hour laboratory per week. Prerequisites: INQU 6005 and INQU 6007.

A study of the flow systems in various chemical reactors involving multiphase transport processes associated with chemical reactions. Includes the study of: multiphase chemical reactors, types of flow systems, mathematical models applicable to chemical reactors, analytical and numerical optimization methods.

INQU 8016. SPECIAL TOPICS IN HETEROGENEOUS CATALYSIS. Three credit hours. Three hours of lecture per week. Prerequisites: INQU 6025.

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 8099. DOCTORAL SEMINAR. One credit hour.

Oral presentations and discussions in areas of interest.

INQU 8995. SPECIAL PROBLEMS. One to six credit hours.

Research and special problems in Chemical Engineering.

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.

CHEMICAL ENGINEERING FACULTY

A list of professors that 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.

GUILLERMO AGUAYO TALAVERA, *Professor*, Ph.D. (1972), University of Cincinnati. Research Interest: Computer Process Simulation and Design. Teaching Interests: Process Simulation, Distillation, Computers, Separation Processes.

JAIME BENITEZ RODRIGUEZ, *Professor*, Ph.D. (1976), Rensselaer Polytechnic Institute. Research Interests: Air Pollution, Composting Waste Treatment. Teaching Interests: Air Pollution Control, Unit Operations, Thermodynamics, Dispersion of Air Pollutants.

MOSES N. BOGERE, *Associate 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.

JULIO G. BRIANO PERALTA, *Professor*, Ph.D. (1983), University of Pennsylvania. Research Interests: Thermodynamics, Absorption and Surface Phenomena, Correlation of Petroleum-Like Fluids. Teaching Interests: Thermodynamics, Momentum, Heat, and Mass Transfer.

REINALDO CABAN GIOVANETTI, *Professor,* Ph.D. (1976), University of Wisconsin-Madison. Research Interests: Electrochemistry, Hydrometallurgy, Transport Processes. Teaching Interests: Applied Mathematics, Transport Phenomena, Thermodynamics.

NELSON CARDONA MARTINEZ, *Professor,* Ph.D. (1989), University of Wisconsin-Madison. Research Interests: Heterogeneous Catalysis and Chemical Reaction Kinetics, Surface Thermodynamics and Surface Science. Teaching Interests: Kinetics and Catalysis, Thermodynamics.

GUILLERMO COLON BURGOS, *Professor,* Ph.D. (1986), University of Massachusetts. Research Interests: Fermentation, Membrane Technology, Supercritical Extraction, Mass and Energy Transfer in Porous Media. Teaching Interests: Mass and Energy Transfer, Industrial Pollution Control, Food Engineering, Material and Energy Balances.

JOSE A. COLUCCI RIOS*, Professor*, Ph.D. (1985), University of Wisconsin-Madison. Research Interests: Catalysis and Electrochemistry with Emphasis on Environmental. Teaching Interests: Chemical Reaction Engineering, Catalysis, Applied Mathematics, Electrochemistry and Plant Design.

L. ANTONIO ESTÉVEZ DE VIDTS, *Professor*, Ph.D. (1983), University of California-Davis. Research Interests: Supercritical Fluids Fundamentals and Applications; Bubble Columns Hydrodynamics and Applications; Distillation Tray Efficiency. Teaching Interests: Thermodynamics, Momentum, Heat and Mass Transfer, Separation Processes, Reactor Design, and Applied Mathematics.

SATYA N. MANDAVILLI, *Professor*, Ph.D. (1959), Indian Institute of Technology. Research Interests: Reaction Engineering, Mass Transfer, Phase Equilibria, Solid-Solid Reactions, Bioprocessing, Bioreactor Design and Performance, Complex Biocatalytic Reactions. Teaching Interests: Chemical Engineering Kinetics, Chemical Engineering Thermodynamics, Mass Transfer, Reactor Design, Mathematical Modeling, Transport Phenomena.

NARINDER K. MEHTA, *Researcher*, Ph.D. (1979), California Coast University. Research Interests: Environmental monitoring, Photo-catalytic Oxidation, Biodegradation, Corrosion

Inhibition (EIS), ATR-IR of Surface Films, Instrumental Analysis.

LUENY MORELL DE RAMIREZ, *Professor,* M.S.Ch.E. (1977), Stanford University. Research Interests: Sludge Composting, Bio-remediation, Waste Recycling, Engineering Education, Curriculum Development Outcome Assessment. Teaching Interests: Mass and Energy Balances, Thermodynamics, Heat Transfer, Polymer Technology.

FEDERICO PADRON GARAY, *Assistant Professor,* B.S.Ch.E., P.E., (1965), University of Puerto Rico. Research Interests: Desalting Seawater, Recovering Compounds from Vegetable Sources, Solar Energy from Plant Operations and Optimization, Pharmaceutical Operations. Teaching Interests: Chemical Plant Design, Project and General Management, and Pharmaceutical Operations.

CARLOS A. RAMIREZ QUIÑONES, *Professor*, Sc.D.Ch.E. (1979), Massachusetts Institute of Technology. Research Interests: Artificial Pancreas, Polymers as Physical Supports for Drug Delivery, Biomedical Engineering. Teaching Interests: Transport Phenomena, Kinetics, Applied Mathematics, Fundamentals of Bioengineering.

ABRAHAM RODRIGUEZ RAMIREZ, *Professor*, Ph.D. (1973), New York University. Research Interests: Air Pollution Control, Chromatography. Teaching Interests: Unit Operations, Fluid Mechanics, Material and Energy Balances.

LORENZO SALICETI PIAZZA, *Associate 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, *Associate 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, Transport Phenomena.

DAVID SULEIMAN ROSADO, *Associate 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, *Assistant Professor*, Ph.D. (2001), Purdue University. Research Interests: Biochemical Engineering, Biomedical Engineering, Materials, and Polymers. Teaching Interests: Polymers, Thermodynamics.

CARLOS VELAZQUEZ FIGUEROA, *Assistant 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.

GILBERTO VILLAFAÑE RUIZ, *Professor*, Ph.D. (1974), Tulane University. Research Interests: Biomedical Engineering, Kinetics. Teaching Interests: Kinetics and Catalysis, Reactor Design, Biomedical Engineering.

CIVIL ENGINEERING AND SURVEYING

The Department of Civil Engineering and Surveying offers programs leading to the degrees of Master of Science, Master of Engineering, and Doctor of Philosophy. There are no formal options, but students are able to specialize in structural, environmental/water resources, geotechnical or transportation engineering.

In addition to the admission requirements of the Graduate Studies Office, a Bachelor of Science degree in Civil Engineering or its equivalent is required. Students in the Master of Science (Plan I) program are required to obtain 24 course credits, to carry out a research project and write a thesis. Students in the Master of Engineering (Plan II) program must obtain 27 course credits, work on a design or development project and write an engineering report. Students in the Master of Engineering (Plan III) program must obtain 36 credits in courses and pass a comprehensive exam. Students in the Doctor of

Philosophy program are required to obtain 57 course credits to pass a qualifying exam that has a written and oral component, and prepare a doctoral dissertation. The doctoral dissertation must be an original contribution to the state of the art in the field of study.

The Department has over 26,000 square feet of laboratory space for teaching and research activities. There are laboratory facilities for engineering materials, structures and structural models, soil mechanics, highway engineering, environmental engineering, traffic engineering, and surveying and topography. A wind tunnel facility is available for modeling and simulation of wind effect on constructions. A strong floor facility for testing full-scale structures is also available. Each laboratory has a director and a trained laboratory technician.

The Department has in its premises a computer laboratory equipped with microcomputers and their accessories, and terminals connected to the Campus mainframe computer. Computer facilities are available to faculty and students around the clock, seven days a week. A new 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. In addition, there are two computer laboratories: 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; and the CAIDEL (Computer Aided Instruction Delivery Laboratory) facility is equipped with microcomputers and visual aids equipment to aid in the teaching of courses.

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

CIVIL ENGINEERING (INCI)

Advanced Undergraduate Courses

INCI 5005. CONSTRUCTION COST ESTIMATES (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: INCI 4055.

Conceptual and preliminary cost estimates: Cost index, square feet method, unit of service method, parametrics estimates, and other methods. Source of data for preparing cost estimates. Detailed cost estimates: unit price estimates, lump sum estimates, instruction to bidders, process for preparing detailed estimate, materials, labor, equipment, project indirect cost, recapitulation, company indirect cost, profit and contingency. Construction cost estimates of building and engineering projects. Use of the computer for cost estimating.

INCI 5006. APPLIED HYDRAULICS (I). Three credit hours. Three hours of lecture per week. Prerequisite: INCI 4138.

Dimensional analysis and modeling; hydraulic machinery and structures; steady conduit and open channel flow; pipe network system.

INCI 5007. SOLID WASTE MANAGEMENT (II). Three credit hours. Three hours of lecture per week. Prerequisite: INCI 4008.

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 (I). Three credit hours. Three hours of lecture per week. Prerequisite: INCI 4138.

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

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 5012. APPLIED SANITARY ENGINEERING CHEMISTRY (II). Four credit hours. Three hours of lecture and one three-hour laboratory per week. Prerequisite: INCI 4008.

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 (I). Three credit hours. Two lectures and one three-hour laboratory per week. Prerequisite: INCI 4008.

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. 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 Consent of the Director of the Department.

Use of matrix methods in the analysis of structures; flexibility and stiffness methods.

INCI 5026. BRIDGE DESIGN (II). Three credit hours. Three hours of lecture per week. Prerequisites: INCI 4012 and INCI 4022.

Bridge analysis and design; bridge types, characteristics; design problems.

INCI 5027. MODEL ANALYSIS OF STRUCTURES (On demand). Three credit hours. Two hours of lecture and one three-hour laboratory per week. Prerequisite: INCI 4022.

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 (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: Consent of the Director of the Department.

The scope of planning; legal bases for planning; transportation planning process; public spaces and recreation; land use; zoning; land subdivision. Economic and social aspects of planning. Planning at the local, regional and national levels.

INCI 5047. INTRODUCTION TO ROCK MECHANICS (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: INCI 4139 or INCI 4031.

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.

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.

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 (II). Three credit hours. Three hours of lecture per week. Prerequisite: INCI 4022.

Application of methods for analysis of statically indeterminate structures. Moment distribution. Slope deflection and energy theorems.

INCI 5075. PLANNING AND SCHEDULING OF CONSTRUCTION PROJECTS (I, II). Three credit hours. Three hours of lecture per week. Prerequisite: INCI 4055.

Introduction to planning and scheduling of construction projects. Presentation of basic concepts of planning and scheduling: division of the project into tasks or activities and estimation of the duration of each task; bar charts, development of networks of the two classical types; critical path method and precedence. Presentation of random networks using PERT and simulation languages for construction projects. Presentation of resource leveling and project control concepts. Utilization of computer programs to accomplish the analysis of the methods previously described.

INCI 5146. INTRODUCTION TO TRAFFIC ENGINEERING (I). Three credit hours. Three hours of lecture per week. Prerequisite: INCI 4137.

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: Consent 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 (On demand). One to six credit hours. The contact will vary according to the topic to be presented. Prerequisite: Consent 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: Consent 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: Consent 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: Consent 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 wastewater. Waste analysis, biodegradation, and wastewater characterization.

INCI 6015. SANITARY ENGINEERING MICROBIOLOGY (On demand). 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 (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: Consent 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 (I). Three credit hours. Three hours of lecture per week.

Analysis of structural elements to determine stresses, forces, strains, displacements and stability in continuous and discrete systems.

INCI 6018. FINITE ELEMENT ANALYSIS OF STRUCTURES (II). Three credit hours. Three hours of lecture per week. Prerequisite: INCI 5018, or Consent of Department Director.

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 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 (On demand). 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 (On demand). 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 6037. APPLIED SOIL MECHANICS (On demand). Three credit hours. Three hours of lecture per week.

Application of soil mechanics to earth pressure and retaining walls; foundations of buildings; stability of earth slopes; braced cuts; settlement and contact pressure; seepage.

INCI 6038. FOUNDATION ENGINEERING (I). Three credit hours. Three hours of lecture per week.

Case histories of projects in foundation engineering; design and construction procedures for foundations, embankments and other civil engineering earthworks.

INCI 6045. PAVEMENT DESIGN (I). Three credit hours. Three hours of lecture 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. HIGHWAY ECONOMICS (II). Three credit hours. Three hours of lecture per week. Prerequisite: Consent of the Director of the Department.

Studies and methods of analysis employed in planning the proper function and character of highway facilities, and the broad administrative policies such as highway needs, finance, and economics that affect highway planning and programming.

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 (I). Three credit hours. Three hours of lecture per week.

Introduction to sediment transport. Hydrodynamics of fluid-particle systems. Initiation of particle motion. Relation of bed forms to flow regime. Design of stable channels and live bed stable channels. Bedload and suspended sediment transport. Local Scour in channels. Measurements of sediment transport.

INCI 6063. COMPUTER HYDROLOGIC MODELING (II). Three credit hours. Three hours of lecture per week. Prerequisite: INCI 5008.

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 (On demand). 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 6069. SOIL DYNAMICS (On demand). 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 6076. PHYSICO-CHEMICAL TREATMENT OF WATER (I). Three credit hours. Three hours of lecture per week.

Theory and applications 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 6098. REHABILITATION OF REINFORCED CONCRETE STRUCTURES (On demand). 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 6115. PROGRAMMING METHODS IN CIVIL ENGINEERING (On demand). 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 6335. GRADUATE SEMINAR (On demand). 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 6995. SPECIAL PROBLEMS (I, II). One to six credit hours.

Research and special problems in Civil Engineering.

INCI 8999. DOCTORAL RESEARCH AND THESIS (I, II). Nine to fifteen credit hours.

Research and presentation of a thesis, which constitutes a significant contribution to the field of specialization of the student.

CIVIL ENGINEERING FACULTY

A list of professors that 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, *Assistant Professor, Ph.D*. (1999), Georgia Institute of Technology. Research Interests: Experimental Material Characterization, Construction and Rehabilitation of Structures of Composite Materials. Teaching Interest: Finite Element Analysis, Mechanics of Composite Materials, Construction Materials.

JUAN B. BERNAL VERA, *Professor,* Ph.D. (1984), The University of Texas at Austin. Research Interests: Foundations. Teaching Interests: Soil Mechanics, Numerical Methods.

ARSENIO CACERES FERNANDEZ, *Assistant Professor*, Ph.D. (1998), West Virginia University. Research Interest: Materials for Civil Engineering, Composite Materials Applications and Civil Engineering Infrastructure, Damage Mechanics, Construction Materials made from Recycled Products, Concrete Technology. Teaching Interest: Civil Engineering Materials, Composite Materials, Reinforced Concrete Design.

BENJAMIN COLUCCI RIOS*, Professor*, Ph.D. (1984), Purdue University. Research Interests: Pavement Evaluation, Bituminous Materials. Teaching Interests: Highway Engineering, Transportation.

ELBA DIAZ DE OSBORNE, *Associate Researcher*, M.S. (1968), University of Puerto Rico.

LUIS A. GODOY, *Professor*, Ph.D. (1979), University College, The University of London. Research Interests: Stability of Structures, Thin Walled Structures, Applied Mechanics, Numerical Methods. Teaching Interests: Structural Analysis, Theory of Stability, Plates and Shells, Theory of Elasticity, Mechanics of Materials.

ANTONIO GONZALEZ QUEVEDO, *Professor,* Ph.D. (1991), Purdue University. Research Interest: Construction Engineering Management. Teaching Interests: Project Planning and Control, Construction Management.

SERGIO L. GONZALEZ QUEVEDO, *Associate Professor*, Ph.D. (1985), Massachusetts Institute of Technology. Research Interests: Transportation Demand Models, Analysis of Public Transportation Systems. Teaching Interests: Transportation and Highway Engineering.

JOSE O. GUEVARA, *Associate Professor*, Ph.D. (1990), University of Florida.

NELSON IRIZARRY GUTIERREZ, *Assistant Professor,* Ph.D., (1997), Texas A&M University, Highway Geometric Design, Urban Highway Planning, Geographical and Land Information Systems, Intelligent Information Systems.

RICARDO LOPEZ RODRIGUEZ, *Professor*, Ph.D. (1988), University of Illinois, Urbana-Champaign. Research Interests: Behavior of Reinforced Concrete Structures, Earthquake Engineering and Wind Engineering. Teaching Interests: Reinforced Concrete, Structural Analysis, Wind Engineering, Dynamic Analysis.

FELIPE LUYANDA VILLAFAÑE, *Professor*, D.E. (1981), Rensselaer Polytechnic Institute. Research Interests: Highway Safety, Analysis of Public Transportation Systems, Statistical Models. Teaching Interests: Transportation and Highway Engineering.

JOSE F. LLUCH GARCIA, *Professor*, Ph.D. (1981), Georgia Institute of Technology. Research Interests: Project Planning and Scheduling, Analysis of Construction Operations, Microcomputers in Construction Engineering. Teaching Interests: Construction Management.

FRANCISCO MALDONADO FORTUNET, Instructor, M.S. (1994), Georgia Institute of Technology.

JOSE A. MARTINEZ CRUZADO, *Associate Professor*, Ph.D. (1993), University of California at Berkeley. Research Interests: Earthquake Resistance Engineering, Concrete Behavior, Compaction of Concrete. Teaching Interests: Reinforced Concrete, Structural Steel Design, Earthquake Resistance Structures.

INGRID Y. PADILLA, *Assistant Professor*, Ph.D. (1998), University of Arizona. Research and Teaching 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.

ISMAEL PAGAN TRINIDAD, *Professor*, M.S.C.E. (1977), University of Puerto Rico at Mayagüez. Research Interests: Urban Drainage, Tropical Hydrology, Flash Floods, Natural Disasters, Water Infrastructure. Teaching Interests: General Hydrology and Hydraulics, Applied Hydraulics, Groundwater Hydrology and Hydraulics, Water Resources Systems, Stochastic Hydrology, Flood Control, Disaster Mitigation.

RICARDO RAMOS CABEZA, *Assistant Professor*, Ph.D. (1999), Rensselaer Polytechnic Institute. Research Interest: Soil Dynamics, Solid Structures Interaction, Earthquake Engineering. Teaching Interest: Foundation Engineering, Steel Structures Design.

JORGE RIVERA SANTOS, *Professor*, Ph.D. (1988), University of Colorado-Boulder. Research Interest: Water Resources Engineering. Teaching Interests: Water Resources Systems, Hydrologic Simulation, Computer Graphics.

ROQUE A. ROMAN SEDA, *Professor*, Ph.D. (1981), Vanderbilt University, Nashville. Research Interests: Principles, Mechanisms and Simulations of Water and Wastewater Treatment Processes, Mathematical Modeling and Operational Optimization of Water and Wastewater Treatment Processes. Teaching Interests: Water and Wastewater Treatment Technology, Applied Hydraulics, Computer Applications in Environmental Engineering.

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, Design of Steel Structures.

IVONNE SANTIAGO LOPEZ, *Associate Professor*, Ph.D. (1995), New Mexico State University. Research Interests: Physico-Chemical Treatment of Water and Wastewater, Toxicity Studies, Air Pollution. Teaching Interests: Water and Wastewater Treatment Technology, Environmental Engineering, Physico-Chemical Processes.

RAFAEL SEGARRA GARCIA, *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.

LUIS E. SUAREZ COLCHE, *Professor*, Ph.D. (1986), Virginia Polytechnic Institute and State University. Research Interests: Dynamic Behavior of Vibrations, Active and Passive Control. Teaching Interests: Structural Dynamics, Structural Analysis, Structural Mechanics.

DIDIER M. VALDES DIAZ, *Assistant Professor*, Ph.D. (1999), 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 Interest: Transportation and Highway Engineering.

DANIEL A. WENDICHANSKY, *Associate Professor,* Ph.D. (1996), State University of New York at Buffalo. Research Interests: Bridge Design, Earthquake Analysis and Design Pre-stressed Structures, Energy Dissipation System, Experimental Analysis.

RAUL E. ZAPATA LOPEZ, *Professor*, Ph.D. (1987), University of Florida at Gainesville. Research Interests: Climatological Data, Water Resources Engineering, Wind Engineering, Groundwater, Hydraulics, Sediment Transport, Fluid Mechanics. Teaching Interests: Sediment Transport, Water Resources, Aqueduct and Sewerage Design, Hydraulics, Groundwater, Wind Engineering.

ELECTRICAL AND COMPUTER ENGINEERING

1. Applied Database and Software Engineering Laboratory (ADASEL)

ADASEL is an instructional laboratory dedicated to teaching and training on database systems and software engineering. Both areas have in common the study of specification, design and implementation methods, which makes a common laboratory a choice for both areas. ADASEL is used as a laboratory for the courses ICOM4017 (Database Systems), ICOM4009 (Software Engineering) and ICOM6005 (Database System Design). With the adequate permits, the lab can be used for other courses and special assignments. The laboratory has 30 Dell (500Mhz/1GHz) workstations, a Dell PowerEdge 500 Server (2 processor) and a Sun Enterprise 450 Server. In addition, it has specialized software for software development, such as Rational Development Studio (for analysis, modeling and testing of software), Microsoft Development Studio (for implementation), Microsoft Office 2000 Developer Edition and Microsoft Project (for software project management).

2. LARSIP

LARSIP is the Laboratory of Applied Remote Sensing and Image processing of the Electrical and Computer Engineering Department located in the University of Puerto Rico at Mayaguez. Collaborations with other fields of knowledge such as Mathematics, Geology, Marine Sciences, and Agriculture create an interdisciplinary environment. It was established with funding from the National Science Foundation (NSF). Additional funding for LARSIP and its research projects has been provided by the National Aeronautics and Space Administration (NASA), National Science Foundation (NSF), U.S. Army Topographic Engineering Center, DEPSCoR, Biometrics Imagineering, American Telephone and Telegraph (AT&T) Corporation, RAYTHEON Corporation and the University of Puerto Rico (UPR). Four components define the laboratory: research, development, outreach and consultation.

Research:

The research performed at LARSIP is related with preprocessing, modeling and analysis of data in order to retrieve information. The research areas are: Image Processing, Remote Sensing, Geographic Information System, and Global Positioning System. The modeling is based on fields such as Signal Processing, Pattern Recognition, Parameter Estimation. Current applications are in development of topographic maps, climate modeling, atmospheric temperature estimation, hyperspectral data analysis, fingerprint modeling and detection.

Development:

An important objective of LARSIP is to create knowledge that are useful in the decision making process. This implies that a large amount of effort is involve in developing useful products. An important set of products is algorithms implemented in software packages. Some algorithms are being embedded in hardware systems. Examples of it are: Hyperspectral Data Analysis Toolbox, Pattern Recognition & Image Analysis Toolbox, and Fingerprint Verification System.

Outreach:

LARSIP is committed to transfer the developed technology. This component has an educational aspect. The laboratory trains high school, undergraduate and graduate students in areas such as Remote Sensing, Geographic Information System, Global Positioning System, Image Processing, Pattern Recognition, and Optoelectronic Systems. We also provide continue education through a series of seminars for people in the public and private sectors who wants to be updated in this kind of technology. LARSIP is committed to transfer the technologies to other countries in the Caribbean and South America through seminars, workshops and presentations. Examples of this kind of involvement is a current relation with the Universidad Autónoma de Santo Domingo in Dominican Republic.

Consultation:

The objectives of this component are: the study of land use and land cover of the Earth's surface and the study of the basic dimensions of environmental resources available. This will enable a process that will integrate the findings into a sound planning and decision-making process for the benefit of the community. LARSIP works directly with companies and governments in areas such as project planning and management, environmental characterization, pollution monitoring, land-cover and land-use determination and assessment, hydrology, soil surveys, bathymetry, interpretation and mapping, and digital Photogrametry. All of these applications use some form of topographic information such as maps, images, aerial photography to describe the surface and subsurface information.

3. CenSSIS

The Engineering Research Center (ERC) for Subsurface Sensing and Imaging Systems (CenSSIS) seeks to revolutionize the ability to detect and image objects that are underground, underwater, or embedded within living tissue or manmade structures. The Center combines expertise in wave physics, sensor engineering, inverse scattering, computational modeling, image processing, and data management to create new sensing systems prototypes. The CenSSIS partnership includes four Academic Core Partners - Northeastern University (lead partner), Boston University, Rensselaer Polytechnic Institute, and the University of Puerto Rico at Mayagüez - and four Strategic Affiliates -Massachusetts General Hospital, Brigham and Women's Hospital, Lawrence Livermore National Laboratory, and the Woods Hole Oceanographic Institution. Over 25 industrial partners will provide their insight into the research challenges and help speed technology transfer.

CenSSIS will attack currently intractable problems in sensing and imaging involving the detection, location, and identification of objects that are obscured beneath various absorptive, diffusive, or dispersive media. Mapping plumes underground, detecting a tumor under the skin, or identifying developmental defects in the interior of an embryo are diverse applications that share a common problem of distinguishing an object from its surrounding medium. These diverse applications, however, have similar research barriers and similar solutions whether the probing wave is electromagnetic or acoustic, whether the medium is soil or tissue, or whether the target is a land mine or a tumor. To address the barriers, the Center will focus on three interdisciplinary research thrusts: Subsurface Sensing and Modeling; Physics-based Signal Processing & Image Understanding; and Image / Data Information Management. Biological, medical, soil, and sea test beds will be used to enable a wide range of next-generation sensing and imaging systems.

A prime CenSSIS goal is to produce graduate engineers and scientists who are familiar with a systems approach to technology development, and thus are better prepared to be successful in industry and academic careers. To meet this goal, CenSSIS will create a new team-based learning environment for students, with four major

program elements. These are: 1) Research internship experiences in industry; 2) New discovery-based, educational laboratories, putting modern imaging technology in the hands of undergraduates early in their education to solve real, open-ended problems; 3) Undergraduate and graduate interdisciplinary, team-taught courses; and 4) Design competitions and summer pre-engineering programs which will impact middle and high school students.

This award provides $2.6 million for the first year of NSF support to the ERC through a five-year cooperative agreement, which is renewable in year three and in year six.

4. CPES Summary

Established in August 1998, the Center for Power Electronics Systems (CPES) is one of the nation's relatively few National Science Foundation engineering research centers. Its vision is to provide the nation with the capabilities to become a world leader in power electronics through a multi-disciplinary, multi-university, and multi-industrial partner program extending over a ten-year period. The program will be based on an integrated systems approach to standardize power electronics components and packaging techniques in the form of highly Integrated Power Electronics Modules (IPEMs). The IPEM approach makes possible increased levels of integration in the components that comprise a power electronic system - devices, circuits, controls, sensors, and actuators. These components are integrated into standardized manufacturable subassemblies and modules that, in turns, are customized for specific applications.

The Center has four primary goals:

1. Enable 10-fold improvements in the quality, reliability, cost-effectiveness and design cycle-time of IPEMs in a comprehensive *Research Program*
2. Demonstrate developed system integration concepts and technology transfer in two *Demonstrative Programs*: Distributed Power Systems, Motor Drives
3. Train future technical leaders by developing innovative power electronics system-oriented curricula to foster inter-disciplinary learning in a comprehensive *Education Program*
4. Deploy the knowledge gained by C-PES initiatives through an active *Outreach Program* and an *Industrial Affiliate Program*.

CPES is a consortium of 5 Universities and over 80 industries led by Virginia Polytechnic Institute in partnership with University of Wisconsin-Madison, Rensselaer Polytechnic Institute, North Carolina A&T, and the University of Puerto Rico-Mayagüez. Virginia Tech and the University of Wisconsin host the two largest university/industry collegiate programs in the field of power electronics in the nation. The current research programs at the five universities affiliated with C-PES are directed toward specific research areas relevant to the Center's goals. At Virginia Tech (VT), research is focused on high-frequency power conversion devices and circuit technologies, power electronic packaging, and systems integration. Research at the University of Wisconsin-Madison (UW-M) is focused on industrial and utility-grade power conversion, electric machines and motor drives, and industrial controls. At Rensselaer Polytechnic Institute (RPI), research is focused on novel discrete power semiconductor materials, process techniques, power devices, and smart power ICs. At North Carolina A&T State University (NCA&T), research is focused on nonlinear control, neural networks, and fuzzy logic-based intelligent control. At the University of Puerto Rico-Mayagüez (UPRM), research is focused on power converters, motor drives, cost modeling and system integration. Thus, CPES, with its extensive resources and established industrial collaboration programs, will be able to significantly leverage NSF support to accomplish its goals.

5. Graduate Bulletin of Information 2002-2003

Electrical and Computer Engineering

Graduate Bulletin of Information 2002-2003

Many of the products and services in modern society are based upon the work of electrical and computer engineers. The reduction in the cost of digital electronic devices has led to an explosive growth in the use of computers and computation. At the same time, our increased understanding of computation science has made possible the de-

velopment of new software systems of increased power sophistication, and flexibility.

Electrical communication systems involving, wire, optical fiber, or wireless technology abound in radio, television, telephone, and computer-communication networks. Modern electronics has made possible instrumentation systems for use in all branches of the physical and biological sciences, as well as in most areas of engineering and manufacturing. Digital signal processing have made possible information extraction and processing capabilities in areas of environmental sciences, communication and computer systems. Electrical machines and power electronic circuits control a multitude of systems that affect our lives in many different ways. Electric power that is essential to the functionality of modern society is controlled and distributed by a complex transmission and distribution network.

From participation in multi-million-dollar national engineering research centers to smaller, single-investigator efforts, the Department's faculty has created a strong, collaborative research environment where ideas and information can flow freely across the various specialties. It is an environment in which students can develop a solid background in their chosen specialty, while also becoming familiar with other vital issues in the field. The research environment lends extra vitality to graduate and undergraduate courses. Faculty experts teach courses in their area of specialty and develop courses in state-of-the-art applications. All faculty members teach at the undergraduate and graduate levels.

The Department of Electrical and Computer Engineering offers Bachelors and Master degrees in Electrical and Computer Engineering and a Ph.D. Program in Computing Sciences and Engineering (jointly with the Mathematics Department). The Department's research and graduate programs involves 14 laboratories, groups and centers, more than 30 graduate-level courses, 45 faculty members, and 80 graduate students.

More information about the program and research facilities can be found at the ECE Web page at http://www.ece.uprm.edu

Master Degree in Electrical Engineering

Students pursuing the degree of Master of Science or Master of Engineering in Electrical Engineering may specialize in the areas of electronics, power systems, power electronics, control systems, applied electromagnetism, communications, and digital signal processing.

A Bachelor of Science degree in Electrical Engineering or its equivalent is required for admission. Applications from science and other engineering disciplines are also welcome and admitted students usually are given a conditional admission status that requires them to take undergraduate courses to cover deficiencies in their background. Applicants must have a minimum general and major GPA of 2.80/4.00 (those with a GPA between 2.50 and 2.79 may be considered at the discretion of the ECE Graduate Admissions Committee). Applicants must have a basic knowledge of both Spanish and English.

Master Degree in Computer Engineering

Students pursuing the degrees of Master of Science and Master of Engineering in Computer Engineering may specialize in the areas of software engineering, digital systems and VLSI design, and digital signal processing.

A Bachelor of Science degree in Computer Engineering or its equivalent is required for unconditional admission. Applications from science and other engineering disciplines are also welcome and admitted students usually are given a conditional admission status that requires them to take undergraduate courses to cover deficiencies in their background. Applicants must have a minimum general and major GPA of 2.80/4.00 (those with a GPA between 2.50 and 2.79 may be considered at the discretion of the Graduate Admission Committee). Applicants must have a basic knowledge of both Spanish and English.

Computing and Information Sciences and Engineering Ph.D. Program

The Department of Electrical and Computer Engineering participates in an Interdisciplinary Program leading to a Ph.D. Degree in Computing and Information Sciences and Engineering. Refer to the Interdisciplinary Programs section for information.

Major Research Areas:

Power and Power Electronics

Signal Processing

Applied Electromagnetics

Electronics

Controls

Computer Engineering and Sciences

Supporting Infrastructure for Research

The Electrical and Computer Engineering Department is a very dynamic academic unit within the University of Puerto Rico, Mayagüez Campus (RUM) and one of the top ones in obtaining external funds and resources within the University of Puerto Rico System. Currently, the Department is carrying out research projects with external funds for more than $14 Million, generating significant benefits to several sectors of the Institution

The Department has three major research centers: the Tropical Center for Earth and Space Studies (TCESS), Laboratory of Remote Sensing and Image Processing (LARSIP) and the Center for Computing Research and Development (CECORD). Our Department is member of the Center for Power Electronic Systems (CPES), and the Center for Subsurface Sensing and Imaging Systems (CENSSIS), both are NSF Engineering Research Centers. Also, the Department is a member of the outreach program of the NSF-ERC Packaging Research Center at Georgia Institute of Technology. A brief description of each Center and Laboratories is presented in the following paragraphs.

Tropical Center for Earth and Space Studies (TCESS)

The Tropical Center for Earth and Space Studies (TCESS) at the University of Puerto Rico at Mayagüez comprises a multidisciplinary effort in several components: Space Information Laboratory (SIL), Bio-Optical Oceanography, Materials and Electronics for Space Applications (MESA), Information Processing and Extraction Group (IPEG), an Education and Outreach Effort GLOBE/TEST, and Carbon Sequestration in Tropical Watersheds. TCESS was first funded by NASA's University Research Centers Program in July 1, 1995, and renewed for another five years in October 1, 2000, with a yearly reporting and reviewing requirement for renewal.

The Bio-Optical Oceanography component studies the existence of multiple physical and climatological processes whose impact on the fertilization of the Caribbean Sea and Tropical Western Atlantic (TWA) is not well known. For example, meso-scale fertilization of the eastern Caribbean Sea occurs in the fall as modulated by the maximum discharge of the Orinoco River. In the summer months, Aeolian dust form the Sahara region could be an important, and yet unquantified source of nutrients. Coastal upwelling from the Colombian and Venezuelan coasts also provides nutrients to surface waters. On a unit area basis, the TWA could play a larger role in the global oceanic carbon budget than previously estimated.

Higher spectral and spatial resolution imagery, and the availability of multimode sensing modalities enhance and open the opportunities to use remotely sensed data in many traditional and novel applications. The effective use of remotely sensed data requires the development of information processing and extraction algorithms that can integrate physical-models with statistical signal processing methods and deal with high data resolution and dimensionality in an efficient manner. Physics-based signal processing provides an essential common ground for the research to be carried out at the Information Processing and Extraction Algorithms (IPEA) in modeling and algorithm development for hyperspectral image processing, microwave remote sensing, multi-modal sensor fusion, image compression, high-dimensional texture analysis, and inverse problems.

The MESA component is engaged in a research program on thin-film materials with high potential for sensor and other optoelectronic applications of interest to NASA and industry at large. Broad areas of expected impact are microwave communications, UV-astronomy, and sensor devices in general. Particular topics of research will include (1) electroceramic thin films doped with rare earths or transition metals for frequency-agile microwave applications and electroceramic "smart" optical limiters; (2) wide bandgap semiconductors for materials development oriented to UV sensor applications; (3)

nanocrystaline silicon for UV-enhanced detectors and porous silicon for high-sensitivity gas and liquid sensors. The proposed research will exploit the substantial infrastructure and expertise we have developed for theses activities. Close collaboration will be established with research groups in several NASA Centers.

The Space Information Laboratory has installed ground stations with the capability to acquire AVHRR, SeaWiFS, RADARSAT, LANDSAT 7 and the MODIS instrument aboard the Terra satellite. Funding has been requested to capture ERS data as well. The SIL proposes to develop and commercialize the enhanced imagery, tools, applications packages, and services required by users within TCESS and throughout the Caribbean Basin. In addition, SIL interacts and provides data for the studies conducted by the other components, and serves as a test bed for the algorithms and products obtained by IPEG.

The Global Learning and Observations to Benefit the Environment (GLOBE), during the past three years has trained by means of workshops, Saturday academies, and follow-up activities, ninety teachers from seventy-six Hispanic schools. These teachers in turn have trained more than two thousand pre-college students who reported more than seventeen thousand eight hundred observations from tropical environments to the GLOBE data center. These activities create the spark that many students need to develop an interest in science and engineering. The overall goal of the GLOBE Teachers Enhancement in Science and Technology (TEST) project is to transform a significant number of teachers into technology proficient pre-college educators by the year 2005. The intensive yearly weeklong workshop and the six Saturday academies will provide teachers the opportunity to link the GLOBE and GIS activities through hands-on experiences. We expect to that during a five year period three hundred Hispanic teachers and more than six thousand Hispanic students will be trained under the TEST activities.

Center for Computing Research and Development

The Center for Computing Research and Development was established in 1995 to support the research activities of the NSF grant entitled: Development of a Computer Engineering Research Environment at UPR-Mayaguez. The major goals of this grant are to develop the research environment needed to start a Ph.D. program in computer engineering and computer science, and to increase minority participation in graduate school and research. The Center was conceived as an organization supported with research grants. Currently, it's being supported with grants from the National Science Foundation, The Economic Development Administration of Puerto Rico and funds from the University of Puerto Rico.

Mission

The mission of CECORD is to promote and support research and development in all areas of computing and computer applications, in accordance with the mission and objectives of the UPR- Mayagüez Campus and the University of Puerto Rico.

Objectives

The main objectives of the Center are to:
foster high quality undergraduate and graduate computing research, promote research collaborations, serve as a vehicle for dissemination of all aspects of computing research, promote interdisciplinary applied research involving computing, promote and sponsor faculty development activities, serve as a model in the use of computing technology, promote the enhancement and development of new academic programs in computing, as appropriate, promote the development of computer applications that will benefit our society.

Software Research Lab (SoReL)

The Software Research Lab (SoReL) is a graduate and undergraduate research laboratory funded by the National Science Foundation under the Next-Generation Software Program. A grant of $449,000 for three years (1999-2002) was Awarded to Drs. Javier A. Arroyo-Figueroa (PI), Nestor Rodriguez and Jose A. Borges (Co-PIs), for the "Event-Rule Framework (ERF) Project", to develop a novel approach to specify and implement distributed systems using a framework based on events and rules. The purpose of the lab is to provide hardware and software facilities for the development of centralized and distributed software components.

The Department recognizes the importance of having students involved in research as early as possible. The Industrial Affiliates Program was

founded thirteen years ago as a means to provide undergraduate students with the opportunity to engage in research sponsored by our industry affiliates, under the supervision of a faculty member. Many undergraduate students also participate in research through our Undergraduate Research courses (INEL 4998 and ICOM 4998) and obtain practical experience through the Practice in Engineering course (INEL 4048)

Several computing and research laboratories are available to be used in the undergraduate courses and research projects. The Electrical and Computer Engineering Department operates CEENET, a network consisting of Windows, Linux and Solaris servers running on multiprocessor computers. In addition, several clusters of workstations provide user's access to the computational resources. Thru CEENET local users have access to other resources within the Campus and the Internet.

Among the laboratory facilities used exclusively for undergraduate level work are:

- Applied Database and Software Engineering Laboratory (ADASEL)
- Electrical Measures and Electronics Laboratory
- Electromechanical Conversional Laboratory
- Communications and Signal Processing (DSP) Laboratory
- Instructional Computer-Aided Design Laboratory (INCADEL)
- Integrated Circuits Design Laboratory (ICDL)
- Linux Laboratory
- Microprocessor Systems Development Laboratory
- Network and Operating Systems Laboratory
- Process Instrumentation and Control Laboratory
- Robotics Laboratory
- Tools and Toys Laboratory (DSP)

Among the research laboratory facilities available for both undergraduate senior and graduate level work are:

- Atmospheric Phenomena Laboratory
- Center for Power Electronic Systems (CPES)
- Computing Research Laboratory
- Electric Energy Processing Systems Laboratory
- Human Computer Interaction Laboratory
- Ionospheric Radar Laboratory
- Laboratory for Applied Remote Sensing and Image Processing (LARSIP)
- Microwave and Antenna's Laboratory
- Optoelectronic Systems Research Laboratory
- PASCOR Laboratory
- Power Electronics Laboratory
- Radiation Laboratory
- Software Research Laboratory (SoReL)
- Space Information Laboratory Process Control Laboratory

Electric Energy Processing Systems Laboratory (EEPSL)

The Electric Energy Processing Systems Laboratory (EEPSL) has experimental and computational facilities dedicated to research (close to 1,400 sq.ft.). EEPSL is directed and used by ECE personnel, but it also supports multidisciplinary projects with Industrial and Mechanical Engineering.The laboratory was established under NSF grant ECS 9702860 (PECASE Award), it is part of the NSF Engineering Research Center for Power Electronics Systems (CPES) under grant ECS 9731677, is being expanded by MRI grant ECS 0116314 and will also be supported by ECS 0134021 (CAREER Award). There are three areas that comprise EEPSL: energy systems component testing and prototyping; energy systems component modeling and simulation; power
quality and energy conversion.

Component testing and prototyping research is supported by a computer-based testbench for implementation of control and identification algorithms for drive systems. The system is based on the rapid prototyping system for control algorithms using Dspace 1103 board. The test bed is designed for fractional horsepower motors and include in addition to the Dspace system, instrumentation for voltages a currents, power electronics, and a Magtrol Dynamometer. The laboratory also has a computer-based test bed for the validation of electrothermal models for power electronic modules. This test bed consist of a LabWindows/CVI from National instruments DAC system in conjunction with several Keithley digital multimeters connected using the GPIB protocol. Instrumentation collects voltage

and current as well as thermocouple measurements.

Modeling and simulation research is supported by a computational facility based on a SUN Enterprise 250 server, five SUN Ultra workstations and 121.8GHz Pentium PCs. The computer is connected to the rest of the world via the UPRM Internet 2 network. Software available includes: Matlab: Mathematical package including Simulink (block diagram simulations); Saber, Pspice: Circuit design, modeling, analysis Magsoft's FLUX 2D & 3D: electromagnetic and therma FDM and FEM modeling and analysis, C/C+++, FORTRAN compilers, EMTP: transient and power system analysis, EPRI Stability Analysis Program, Visio, AutoCAD

The power quality and energy conversion area of EEPSL will include a surge generator for transient studies and tests, a photovoltaic research facility and instrumentation for power quality monitoring and analysis.

Major equipment at EEPSL include:
Magtrol HD-705-6 Dynamometer (max. torque 50 lb-in., 1.4 kW max - 5 min)
Brushless DC 1 hp motor (APIGettys)
Several fractional horsepower three-phase induction and brushless motors
LabWindows CVI development kit.
Circuit boards for controller implementation: Analog Devices ADSP 2102,
ADMC200-EVAL;
DSPACE DS1102 DSP Controller Board (TI's C31) rapid prototyping control
development system
3 Siemens M75 photovoltaic modules
HP function generators
Power supplies from fraction volts to 500 Vdc
Boards for controller implementation: Analog Devices ADSP 2102,
ADMC200-EVAL; DSPACE DS1102 DSP Controller Board. (TI's C31).

There is also general measurement equipment available at EEPSL:
Digital scope - HP 54602B, 150 MHz
High voltage and high current probes
HP table multimeters
Tektronic THS 720P portable scope
QUADTech 2200 Transformer Test System
Fluke 43 Power Quality Analyzer

Industrial Affiliates Program

The Industrial Affiliates Program (IAP) is an organization that is geared toward enriching and enhancing the educational experience of interested undergraduate students. IAP offers a creative technical educational experience to complement the University's strong Electrical and Computer Engineering curriculum. The program was founded in 1989 and is fully sponsored by several global corporations working in tandem with the Faculty at the University of Puerto Rico. Their joint collaboration has resulted in the ability for many of our students to gain increased exposure to the field of engineering through direct involvement in educational outreach opportunities, technical projects, and research efforts.

The applied educational experience and exposure to new technology coupled with their formal academic studies has had two very positive effects on the participating students. First, the students are highly attractive to prospective employers, and second, it has provided the impetus for others to continue pursuing a higher degree. As for the participating companies, they benefit from various levels of involvement, including recruitment and collaborative research projects.

Departmental Highlights and Faculty Distinctions

Among its faculty members Dr. Miguel Velez is a recipient of the Presidential Early Career Award for Scientists and Engineers (PECASE), which is the highest honor, bestowed by the US government to faculty in the beginning of their careers. There are four recipients of the prestigious CAREER awards from the National Science Foundation (NSF), Dr. Jose L. Cruz, Dr. Rafael Rodríguez Solís, Dr. Miguel Vélez and Dr. Efraín O'Neill. Dr. Sandra Cruz Pol recently obtained a NASA Faculty Award for Research (FAR).
The University of Puerto Rico in Mayagüez (UPRM) was granted a Major Research Instrumentation award by the Electrical and Communication Systems Division of NSF for the amount of $150,000 to begin in January 2002. This grant will improve existing computational and experimental facilities at UPRM's Electric Energy Processing Systems Laboratory (EEPSL) affiliated to the Center for Power Electronics Systems (CPES). Improving this research facility is vital in order to carry out research projects and meaningful industry collaborations in energy

systems, especially in power electronics and power quality. The requested instruments will also be used to develop design projects and laboratory experiments that will improve research and training activities at both graduate and undergraduate levels. These tools will bring research to the classroom through research projects, seminars, special topic courses, and demonstrations. UPRM faculty involved in this project are Efraín O'Neill-Carrillo, Miguel Vélez-Reyes, Javier Quintana and Lionel Orama.

Dr. Sandra Cruz Pol was given the Outstanding Achievement in Mentoring Award by the GEM organization on their 25th anniversary celebration. This award was given on May, 2001 in San Diego, California.

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

ELECTRICAL ENGINEERING (INEL)

Advanced Undergraduate Courses

INEL 5205. INSTRUMENTATION (I). Three credit hours. Three hours of lecture per week. Prerequisite: INEL 4206 and INEL 4202.

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 (II). Three credit hours. Three hours of lecture per week. Prerequisite: INEL 4207.

Design methods in combinational and sequential systems. Use of programmable logic devices in digital systems design. Analysis and design of system controllers.

INEL 5305. ANTENNA THEORY AND DESIGN (II). Three credit hours. Three hours of lecture per week. Prerequisite: INEL 4152 and INEL 4301.

Radiation mechanism. Types of antennas; impedance; radiation patterns; arrays. Antenna measurements.

INEL 5306. MICROWAVE ENGINEERING (I). Three credit hours. Three hours of lecture per week. Prerequisite: INEL 4152.
Rectangular and circular wave guides; passive components; tubes, and solid-state devices used in microwave systems.

INEL 5307. OPTICAL COMMUNICATIONS (I). Three credit hours. Three hours of lecture per week. Prerequisites: INEL 4301 and INEL 4152.

Optical communication principles; transmitter and receiver design; fiber optic channels.

INEL 5309. DIGITAL SIGNAL PROCESSING (I). Three credit hours. Three hours of lecture per week. Prerequisite: INEL 4301.

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 4011 or ININ 4010) and INEL 4301.

Information theory; coding theory; signal design; noise and probability of error.

INEL 5325. COMMUNICATION SYSTEM DESIGN: CIRCUITS AND ANTENNAS (I). Three credit hours. One hour of lecture and two two-hour laboratories per week. Prerequisite: INEL 5305 or INEL 5306.

Design of communication circuits and antennas. Several design projects including: specification, evaluation and selection of alternatives and implementation. Written reports and computer use required.

INEL 5326. COMMUNICATION SYSTEM DESIGN: SIGNAL PROCESSING (II). Three credit hours. One hour of lecture and two two-hour laboratories per week. Prerequisite: INEL 5309.

Block diagram design and simulation of communication systems. Design projects

including: specification, evaluation and selection of alternatives, and implementation. Computer and laboratory work and written reports required.

INEL 5407. COMPUTER AIDED POWER SYSTEM DESIGN (II). Three credit hours. Three hours of lecture per week. Prerequisite: INEL 4415.

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, INEL 4416 and INEL 4505.

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 5505. LINEAR SYSTEM ANALYSIS (II). Three credit hours. Three hours of lecture per week. Prerequisite: INEL 4505.

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 4206 and INEL 4505.
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. Prerequisite: INEL 4505.

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. Prerequisites: INEL 4206 or ININ 4057.

Analysis and design of automated pneumatic systems using programmable controllers. Programming of industrial robots.

INEL 5995. SPECIAL PROBLEMS (On demand). One to six credit hours.

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 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 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 (On demand). 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 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 (On demand). 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 6075. INTEGRATED CIRCUITS FABRICATION (On demand). 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 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 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.

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 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 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.

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.

COURSES OFFERED

COMPUTER ENGINEERING (ICOM)

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.

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 5015. ARTIFICIAL INTELLIGENCE. Three credit hours. Three hours of lecture per week. Prerequisite: ICOM 4036.

An introduction to the field of artificial intelligence: LISP language, search techniques, games, vision, representation of knowledge, inference and process of providing theorems, natural language understanding.

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 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 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.

ELECTRICAL AND COMPUTER ENGINEERING FACULTY

A list of professors that 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.

JAIME ARBONA FAZZI, *Professor,* Ph.D. (1972), University of Arkansas. Research and Teaching Interests: Digital and Analog Electronics, Microprocessors.

JAVIER ARROYO FIGUEROA, *Associate Professor*, Ph.D. (1997), University of Florida. Research and Teaching Interests: Object-Oriented Databases, Distributed Systems, Programming Languages.

GERSON BEAUCHAMP BAEZ, *Professor,* Ph.D. (1990), Georgia Institute of Technology. Research and Teaching Interests: Systems and Control Theory, Fuzzy Logic Based Systems, Instrumentation, and Process Control.

JOSE A. BORGES, *Professor*, Ph.D. (1989), University of Illinois. Research and Teaching Interests: Visual Programming Languages, Software Engineering, User Interfaces, Object Oriented Languages.

JUAN R. CARO MORENO, *Professor*, M.S.N.E., (1971), University of Puerto Rico.

JOSE R. CEDENO MALDONADO, *Assistant Professor*, Ph.D. (2000), Ohio State University.

JOSE COLOM USTARIZ, *Associate Professor*, Ph.D. (1998), Pennsylvania State University.

ISIDORO COUVERTIER, *Associate Professor*, Ph.D., (1996), Louisiana State University. Research Interests: Computer Networks, Programming Languages, Operating Systems, Application Development.

JORGE A. CRUZ EMERIC, *Professor*, U.P.R., Ph.D. (1976), University of Florida. Research and Teaching Interests: Digital Signal Processing, Adaptive Filters and Compensators.

SANDRA CRUZ POL, *Associate Professor*, Ph.D. (1998), Pennsylvania State University.

JOSE L. CRUZ RIVERA, *Professor*, Ph.D. (1996), Georgia Institute of Technology. Research and Teaching Interests: Digital Systems, Optoelectronic Computing, Device Modeling.

RAFAEL FERNANDEZ SEIN, *Professor*, M.E.E. (1968), Cornell University. Research and Teaching Interests: Computer Applications, Microprocessor Interfacing.

SHAWN D. HUNT, *Professor*, Ph.D. (1992), Michigan State University. Research and Teaching Interests: Non-linear Dynamic Systems, Neural Networks, Digital Signal Processing.

HENRICK M. IERKIC VIDMAR, *Professor*, Ph.D. (1980), Cornell University. Research and Teaching Interests: Radar Systems, Antennas, Digital Signal Processing, Dynamics of the Atmosphere, Microwaves.

SAMUEL R. IRIZARRY MILAN, *Professor*, Ph.D. (1974), University of Michigan. Research and Teaching Interests: Electromagnetic Theory.

AGUSTIN A. IRIZARRY RIVERA, *Associate Professor*, Ph.D. (1996), Iowa State University. Research and Teaching Interests: Power Systems.

MANUEL JIMENEZ CEDENO, *Assistant Professor*, Ph.D. (1999), Michigan State University.

LUIS O. JIMENEZ RODRIGUEZ, *Professor*, Ph.D. (1996), Purdue University. Research and Teaching Interests: Machine Learning, Image Processing, Artificial Intelligence.

EDUARDO J. JUAN GARCIA, *Assistant Profesor*, Ph.D. (2001), Purdue University.

BALDOMERO LLORENS ORTIZ, *Professor*, PD, EE (1976), Massachusetts Institute of Technology. Research and Teaching Interests: Modern Control Systems, Automation.

HECTOR MONROY AYALA, *Professor*, M.S.E.E. (1971), Ohio State University. Research and Teaching Interests: Ionospheric Studies, Communication Systems, Microwaves and Antennas.

JOSE NAVARRO FIGUEROA, Instructor, M.S.E.E., University of Puerto Rico, Mayaguez.

THOMAS L. NOACK, *Professor,* Ph.D. (1963), Iowa State University. Research and Teaching Interests: Data and Computer Communications, Computer Networking, Control Systems.

EFRAIN O'NEILL CARRILLO, *Assistant Profssor*, Ph.D. (1999), Arizona State University.

JORGE ORTIZ ALVAREZ, *Professor,* Ph.D. (1984), University of Houston. Research and Teaching Interests: Digital Systems, Control Systems Computer Software.

ROGELIO PALOMERA GARCIA, *Professor,* Docteur des Sciences (1979), Swiss Federal Polytechnical Institute. Research and Teaching Interests: Filters, Linear and Non-linear Electronic Circuits.

HAMED PARSIANI, *Professor*, Ph.D. (1979), Texas A&M University. Research and Teaching Interests: Video Compression, Digital and Optical Fiber Communications, Digital Signal Processing, Microprocessors.

ROBERTO PEREZ COLON, *Professor*, M.E.E. (1979), University of Puerto Rico- Mayaguez.

JOSE E. RAMOS FIGUEROA, *Instructor*, M.S.E.E. (2001), University of Puerto Rico-Mayaguez.

PEDRO I. RIVERA, *Professor*, Ph.D. (1990), University of Florida.

JOSE A. RIVERA CARTAGENA, *Associate Professor*, Ph.D. (1992), The City University of New York. Research and Teaching Interests: Analog and Digital Electronics, Speech and Image Coding.

WILSON RIVERA GALLEGO, *Assistant Professor*, Ph.D. (2000), Mississippi State University.

DOMINGO A. RODRIGUEZ, *Professor*, Ph.D. (1988), City University of New York. Research and Teaching Interests: Digital Signal Processing, Telecommunications, Design of Algorithms for Scientific Computation, Computer Algebra.

PROVIDENCIA RODRIGUEZ, *Instructor*, M.B.E. (1994), Case Western Reserve University.

MANUEL RODRIGUEZ MARTINEZ, *Assistant Professor*, Ph.D. (1996), University of Maryland.

NESTOR J. RODRIGUEZ RIVERA, *Professor*, Ph.D. (1988), University of Wisconsin-Madison. Research and Teaching Interests: Computer

Architecture, Human-Computer Interfaces, VLSI Design.

RAFAEL RODRIGUEZ SOLIS, *Assistant Professor*, Ph.D. (1997), The Pennsylvania State University. Research and Teaching Interests: Microwave Circuits, Antennas, Numerical Methods in Electromagnetics.

JOSE ROSADO ROMAN, *Assistant Professor*, Ph.D. (1999), Cornell University.

JULIO A. SANTIAGO PEREZ, *Professor*, M.S.E.E. (1970), Rensselaer Polytechnic Institute. Research and Teaching Interests: Electric Power Engineering, Computer Applications to Power Systems, Atmospheric Sciences, Induced Voltages in Transmission Lines.

NAYDA G. SANTIAGO SANTIAGO, *Instructor*, M.E. (1990), Cornell University.

JAIME SEGUEL CAMPODONICO, *Professor*, Ph.D. (1987), City University of New York. Research and Teaching Interests: Functional Analysis and Computational Mathematics.

MANUEL TOLEDO, *Assistant Professor*, Ph.D. (1995), Boston University.

RAUL TORRES MUNIZ, *Assistant Professor*, Ph.D. (1998), University of Virginia.

RAMON VASQUEZ ESPINOSA, *Professor*, Ph.D. (1984), Louisiana State University. Research and Teaching Interests: Image Processing, Artificial Vision, Artificial Intelligence, Pattern Recognition, Remote Sensing, Electronic Device Modeling, Computer Architecture and System Programming, Microprocessors, Automation and Manufacturing.

FERNANDO VEGA, *Associate Professor*, Ph.D. (1989), Syracuse University.

BIENVENIDO VELEZ, Ph.D., Computer Science (1999), Massachusetts Institute of Technology.

MIGUEL VELEZ REYES, *Professor*, Ph.D. (1992), Massachusetts Institute of Technology. Research and Teaching Interests: Modern control and estimation theory; model-based signal processing; application of model-based signal processing to on-line process monitoring, estimation, and control of physical systems; intelligent control systems; energy management systems; dynamics estimation and control of electromechanical systems.

KRISHNASWAMI VENKATESAN, *Professor,* Ph.D. (1974), University of Roorkee (India). Research and Teaching Interests: Power Electronic Circuits, Electric Drives, Stability and Control of Power Systems, Electric Machines, Switching Power Supplies.

INDUSTRIAL ENGINEERING

The Department of Industrial Engineering offers three graduate programs at the Master's degree level: a Master of Engineering in Management Systems Engineering, a Master of Science in Industrial Engineering with thesis, and a Master of Science in Industrial Engineering without thesis. Students in all three programs may choose a specialization in management systems engineering, quality control systems, or manufacturing systems.

The graduates from these programs are prepared to be competent at an advanced level in their area of specialization. Graduates from the Management Systems Engineering specialization will be able to design and predict the behavior of integrated systems of people, equipment, materials, and information. Graduates from the Quality Systems specialization will be able to develop systems that can assure quality levels and predict failures and cost of quality of products and services. Graduates from the Manufacturing Systems specialization will be able to design and implement automated manufacturing systems that can comply with requirements of safety, productivity and return on investment.

The Master of Engineering in Management Systems Engineering degree requires 30 credits, which includes a 3-credit master's project. The Master of Science in Industrial Engineering degree with thesis requires 30 credits, including a 6-credit thesis based on original research. The Master of Science in Industrial Engineering degree without thesis requires 36 credits and the approval of a comprehensive exam. Students with a background in an area other than indus-

trial engineering may be required to complete remedial courses at the bachelor's level.
All students must take three core courses, one in experimental statistics, other in advanced production control, and another in systems simulation. There are two required courses that depend on the area of specialization: Discrete Linear Optimization and Advanced Engineering Economy for the Management Systems specialization, Multiple Regression Analysis and Quality Control Systems for the Quality Systems specialization, and Material Handling Systems and Automatic Assembly Systems for the Manufacturing Systems specialization. Additionally, there are a number of elective courses that depend on the degree sought and the area of specialization.

In addition to the admission requirements of the Graduate School Office a Bachelor of Science degree in Engineering is required. Students with an engineering degree other than in Industrial Engineering are required to take some additional undergraduate courses. Applicants graduated from non-English speaking foreign universities must present evidence of having taken the TOEFL examination and their graduating class ranking to be considered for admission.

The Department of Industrial Engineering has well-equipped laboratory and computer facilities. These facilities include a robotics laboratory, a quality control laboratory, human factors and ergonomics laboratory, and a manufacturing laboratory. The Department also has a number of computer facilities for teaching and research purposes.

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

INDUSTRIAL ENGINEERING (ININ)

Advanced Undergraduate Courses

ININ 5505. TOTAL QUALITY MANAGEMENT (I, II). Three credit hours. Three hours of lecture per week. Prerequisite: ININ 4078 or consent 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 5559. ENGINEERING STATISTICS. Three credit hours. Three hours of lecture. Prerequisite: MATE 3032 and INGE 3016.

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.

Introduction to reliability theory; system analysis; constant 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 (Every third semester). Three credit hours. Three hours of lecture and/or discussion per week. Corequisite: ININ 4021.

Conceptual and practical aspects involved in the scheduling of resources. Examples and applications drawn from areas such as manpower, computer, and transportation.

Graduate Courses

ININ 6005. EXPERIMENTAL STATISTICS (I). Three credit hours. Three hours of lecture and/or discussion per week.

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 (Every fourth semester). Three credit hours. Three hours of lecture and discussion per week.

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 (Every third semester). Three credit hours. Three hours of lecture per week. Prerequisite: Consent 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 (Every third semester). Three credit hours. Three hours of lecture and discussion per week.

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 (II). Three credit hours. Three hours of lecture and discussion per week.

Advanced topics in forecasting, inventory and applied stochastic processes as they relate to production control systems. Integration of these topics in the production planning process using mathematical optimization techniques and case studies.

ININ 6020. QUEUEING THEORY AND APPLICATIONS (Every fourth semester). Three credit hours. Three hours of lecture per week.

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 (Every third semester). Three credit hours. Three hours of lecture and discussion per week.

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 (I). Three credit hours. Three hours of lecture and discussion per week.

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 (Every third semester). Three credit hours. Three hours of lecture per week. Prerequisite: Consent 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. AN INTRODUCTION TO TIME SERIES ANALYSIS (Every fourth semester).

Three credit hours. Three hours of lecture per week. Prerequisite: ININ 5559.

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 stochastic estimation by means of the Kalman filter.

ININ 6045. MATERIAL HANDLING SYSTEMS (Every third semester). Three credit hours. Three hours of lecture per week.

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 (Every third semester). Three credit hours. Three hours of lecture per week. Prerequisite: ININ 6005.

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 polychotomous 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 6078. QUALITY CONTROL SYSTEMS (Every third semester). Three credit hours. Three hours of lecture per week.

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 (I, II, S). One to three credit hours.

Study of previous work and literature on a selected topic of the industrial engineering field.
ININ 6998. ENGINEERING PROJECT (I, II, S). 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 (I, II, S). One to six credit hours.

Research in the Industrial Engineering field leading to the presentation and approval of a thesis.

INDUSTRIAL ENGINEERING FACULTY

A list of professors that 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.

JACK T. ALLISON, *Professor*, Ph.D. (1983), Texas A&M University. Teaching and Research Interests: Operations Research, Facility Design, Pavement Management.

NOEL ARTILES LEON, *Professor*, Ph.D. (1989), Iowa State University. Teaching and Research Interests: Applied Statistics, Queuing Theory, Quality Control, Operations Research.

SONIA M. BARTOLOMEI SUAREZ, *Assistant Professor*, Ph.D. (1996), Pennsylvania State University. Teaching and Research Interests: Production Control, Facility Layout Planning, Material Handling Systems, Work Measurement, and Simulation.

VIVIANA I. CESANI, *Assistant Professor,* Ph.D., (1998), University of Wisconsin, Madison. Teaching and Research Interests: Production Systems, Cellular Manufacturing, Engineering Economics, and Risk Analysis.

JOSE R. DELIZ ALVAREZ, *Professor,* Ph.D. (1971), New York University. Teaching and Research Interests: Reliability, Statistical Quality Control, Production Planning and Control, Total Quality Management, Engineering Statistics, Design of Experiments.

DAVID R. GONZALEZ**,** *Associate Professor,* Ph.D., (1996), Pennsylvania State University. Teaching and Research Interests: Statistical Quality Control, Applied Statistics and Simulation.

MERBIL GONZALEZ MARTINEZ, *Professor*, Ph.D. (1984), Rensselaer Polytechnic Institute. Teaching and Research Interests: Production Control, Economic Analysis.

WILLIAM HERNANDEZ RIVERA, *Associate Professor*, Ph.D. (1996), Texas A&M University. Teaching and Research Interests: Information Systems, Real Time Process Control, Optimization, and Genetic Algorithms.

MARIA DE LOS A. IRIZARRY SERRANO, *Associate Professor*, Ph.D., (1996), North Carolina State University. Teaching and Research Interests: Production and Ergonomics.

OMELL PAGAN PARES, *Associate Professor*, Doctor of Engineering (1995), Universidad Politécnica de Madrid. Teaching and Research Interests: Production Systems and Total Quality Management.

NAZARIO D. RAMIREZ BELTRAN, *Professor*, Ph.D. (1988), Texas A&M University. Teaching and Research Interests: Operations Research, Applied Statistics, Time Series Analysis, Optimization and Neural Networks.

PEDRO RESTO BATALLA, *Professor*, Ph.D. (1982), Texas A&M University. Teaching and Research Interests: Manufacturing, Automation, and Simulation.

AGUSTIN RULLAN TORO, *Associate Professor*, Ph.D. (1990), Lehigh University. Teaching and Research Interests: Automation, Robotics, Facility Layout Planning, Modern Material Handling Systems and Cost Modeling.

GÜRSEL A. SÜER, *Professor*, Ph.D. (1989), Wichita State University. Teaching and Research Interests: Production Systems, Cellular Manufacturing, Expert Systems, and Genetic Algorithms, Scheduling.

ZULMA TORO RAMOS*, Professor*, Ph.D. (1988), Georgia Institute of Technology. Teaching and Research Interests: Production and Manufacturing Systems, Material Handling Systems, Ergonomics.

MECHANICAL ENGINEERING

Contact Information

Mechanical Engineering Department
GraduateStudies
PO Box 9045
Mayaguez, Puerto Rico 00681 USA

Phone: 1-787-832-4040 ext.3659
Fax: 1-787-265-3817

E-mail: gradschool@me.uprm.edu
Internet: http://www.me.uprm.edu

Highlights

Mechanical engineering graduate students can earn either a Master of Science or a Master of Engineering degree. Research facilities include labs for materials testing rapid solidification, manufacturing and rapid prototyping, instrumentation, vibration and acoustics, solar energy testing, atomization and heat and mass transfer.

Program Facts	
Program Founded	1967
Program Start Dates	
Expected Length Master's	1.5-2.5 years
Expected Length PhD	n/a
# of Faculty	21
% Highest Degree in Field	100%
# Endowed Chairs/Profs	not available
Annual Research Funding	2.0 M

Student Profile

	Masters	PhD
Students Applied/yr	50	
Students Accepted/yr	20	
Students Enrolled/yr	50	
Total Program Enrollment	50	
# of International Students	25	

Admissions at a Glance

Application Fee	US$15; $23 (late)
GRE Score	not required

Domestic Student Application Deadlines:
February 15 (summer and fall admission),
September 15 (January admission)

International Student Application Deadlines:
February 15 (summer and fall admission),
September 15 (January admission)

Minimum English Requirements:
N/A

Expenses at a Glance

In-State Student Tuition:

Master´s	US$75/graduate credit
PhD	n/a

Out-of-State Student Tuition:

Master´s	varies by state
PhD	n/a

International Student Tuition:

Master´s	US$1750/semester
PhD	n/a

The Department of Mechanical Engineering (DME) at the University of Puerto Rico-Mayagüez (UPRM) offers graduate study in Mechanical Engineering leading to a Master of Science (MS) or Master of Engineering (ME) degree.

The program structure is flexible enough to allow participants to specialize in one or more subject areas. Students can choose a concentration in thermal sciences, manufacturing, materials and machine sciences, or a program that combines courses from two concentration areas.

Students in the MS program are required to take a minimum of 25 credit hours in coursework, work on a research project, and write a technical report.

Students in the ME program are required to take a minimum of 28 credit hours in coursework, work on a design or development project, and write an engineering report.

Admissions

Applicants to graduate study in Mechanical Engineering must have a Bachelor of Science degree in Mechanical Engineering or its equivalent.

Prospective students should have a general GPA of 2.75 (on a scale of 4.0) and a GPA of 3.0 or better in the field of specialty. A working knowledge of English and Spanish is required.

International applicants must provide evidence of available financial resources to cover educational and living expenses for at least the first year of study.

Applications for graduate study should be submitted by February 15 for admission in summer or in August and by September 15 for admission in January.

Expenses and Financial Support

Tuition fees at UPRM vary. Residents of Puerto Rico pay US $75 per graduate credit and other

us citizens pay US$75 per graduate credit plus the differential amount that a resident of Puerto Rico would pay in the public university in their state of residence. For example, a Texan studying in Puerto Rico pays the same differential rate of tuition as Puerto Rican studying in Texas. International students pay US$1750 per semester.

Research and teaching assistantships are funded by the university and include tuition waivers and stipends, which vary according to the recipient's teaching load. The allowance for a full-time assistantship is between US$700 and US$ 912 per month.

Buildings and Facilities

The DME maintains well-equipped research facilities which include laboratories for materials testing, rapid solidification, manufacturing and rapid prototyping, instrumentation, vibration and acoustics, solar energy testing, and atomization.

The department has several computer facilities for research purposes. Microcomputers and workstations are connected to campus mainframes and are accessible to faculty and students on a continuous basis.

The Heat and Mass Transfer Research Laboratory (HMTRL), a research facility dedicated to basic and applied theoretical and experimental research in heat and mass transfer phenomena, is also maintained by the DME. Facilities associated with this laboratory include Pentium PCS, Silicon Graphics CAD workstations, a solar collector testing facility, spray cooling and forming experimental facilities, and instrumentation to measure flows, humidity, pressures and temperatures.

The Material Science Laboratories include a Material Graphic laboratory, a mechanical testing facility and a rapid solidification facility, which uses a 35 K induction. Basic equipment for material graphic preparation, heat treatment furnaces and a sophisticated optical imaging system are available.

The Vehicle Design and Research Laboratory is involved with alternate vehicle research for modern transportation needs. The laboratory is equipped with machine shop, a chassis dynamometer, and emission measurement equipment and computer data acquisition facilities. Current research topics include solar powered vehicle, alternate hybrid vehicles, and rail transportation system.

The Mechanical Systems Response Research Laboratory (MSRRL) supports research efforts in various areas that focus on mechanical/material component systems in military and civil applications. Areas ranging from structural vibration control, material characterization, infrastructure health monitoring and diagnostics, to even MEEMS sensor development and applications is currently being perform. MSRRL is supported through research efforts from 5 faculty members from different departments. MSRRL performs research sponsored from various government agencies such as DoD, NSF, NSF-EPSCoR, NASA, and private industry. projects include topics such as:

- Characterization of Sandwich Composite Materials used in Civil and Military Stealth Applications
- Vibration Control using shape memory alloys
- Vibration Shaker Design
- Damage Detection and Health monitoring using Neural Networks
- Flow induced vibrations
- Acoustic Emission in Damage Detection and Material Characterization
- Novel Dynamic Material Characterization techniques

The MSRRL laboratory is equipped for research in mechanical/material component systems. The laboratory has a laser vibrometer, several dynamic signal analyzers, acoustic emission equipment, transducers, conditioning amplifiers, power supplies, oscilloscopes, and a vacuum system for composite manufacture.

International Students

The International Students Office (ISO) acquaints international students with registration procedures, educational facilities, economic assistance, programs sponsored by international agencies, housing and other matters of concern.

The ISO also sponsors visits to various places of interest on the Island to familiarize students with Puerto Rican customs and culture. International students sponsor special events throughout the year to promote cultural exchange and

familiarize the UPRM community with their countries of origin.

Research Areas

The Department of Mechanical Engineering has a diverse faculty performing research in various areas. These include but are not limited to 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.

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

MECHANICAL ENGINEERING (INME)

Advanced Undergraduate Courses

INME 5005. LUBRICATION (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: Consent 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 Consent 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 (I). Three credit hours. Three hours of lecture per week. Prerequisite: INME 4007.

Electrochemical principles and corrosion mechanisms; protection and prevention of corrosion in metals; the effects of temperature, environment, and metallurgical factors.

INME 5015. SELECTED TOPICS IN MECHANICAL ENGINEERING. One to six credit hours. One to six hours of lecture per week. Prerequisite: Consent 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 (II) (Even numbered years). Three credit hours. Three hours of lecture per week. Prerequisites: INME 4012 and INME 4007.

Materials science concepts used to identify, correct and prevent failures 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.

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 5995. SPECIAL PROBLEMS. One to six credit hours. One to six hours of lecture per week. Prerequisite: Consent of the Director of the Department.

Researches and special problems in Mechanical Engineering and related fields.

Graduate Courses

INME 6001. ADVANCED THERMODYNAMICS I (I) (On demand). Three credit hours. Three hours of lecture per week.

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 consent 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: Consent 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 consent 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: Consent 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: Consent 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: Consent 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 6011. ANALYSIS OF MACHINE MEMBERS I (On demand). Three credit hours. Three hours of lecture per week. Prerequisite: INME 4026 or consent of Department Director.

An extension of stress and deflection analysis, with emphasis on those topics pertinent to the design of machine members; the application of basic and advanced theory to design analysis in situations in which weight, temperature, fatigue, dynamic loads, and other modes of loading and failure are relevant.

INME 6012. ANALYSIS OF MACHINE MEMBERS II (On demand). Three credit hours.

Three hours of lecture per week. Prerequisite: INME 6011 or consent of Department Director.

A continuation of INME 6011.

INME 6015. DISLOCATION THEORY (Every third semester). Three credit hours. Three hours of lecture per week. Prerequisite: INME 4007 or consent 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 consent of Department Director.

Dislocation theory applied to the deformation of metals; including the mechanisms of glide; fatigue; creep, and fracture.

INME 6017-6018. SEMINAR. One credit hour per semester. One meeting per week each semester.

Discussion and reports on selected topics in Mechanical Engineering.

INME 6019. FRACTURE MECHANICS (Every third semester). Three credit hours. Three hours of lecture per week. Prerequisite: Consent 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 consent 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: Consent 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: Consent 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: Consent 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.

Fundamental concepts of finite element analysis. Method of weighted residuals, Galerkin's method, and variational equations. Linear elliptic boundary value problems with applications in static structural analysis and steady state heat conduction. Eigenvalue, parabolic, and hyperbolic problems with applications to transient heat conduction and structural vibrations. Comparison of finite element results with exact solutions. Organization and implementation of typical computer programs.

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 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 6995. ADVANCED SELECTED TOPICS IN MECHANICAL ENGINEERING (On demand). One to three credit hours. One to three lecture, discussion or laboratory periods per week.

Selected advanced topics in Mechanical Engineering not covered by existing courses.

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.

MECHANICAL ENGINEERING FACULTY

A list of professors that 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.

JAYANTA BANERJEE, *Professor*, Ph.D. (1969), M.Ed. (1987), University of Waterloo, Canada. Research and Teaching Interests: Manufacturing, Technology Transfer and Culture.

SANDRA COUTIN RODICIO, *Assistant Professor*, Ph.D. (1996), Kansas State University. Research and Teaching Interests: Numerical Heat Transfer and Fluid Flow in Manufacturing Processes and HVAC Systems.

DAVID B. DOONER, *Associate Professor*, Ph.D. (1991), The 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.

NIHAD DUKHAN, *Visiting Professor*, Ph.D. (1996), University of Toledo, Illinois. Research and Teaching Interests: Heat transfer system and design.

JORGE E. GONZALEZ CRUZ, *Associate Professor*, Ph.D. (1994), Georgia Institute of Technology. Research and Teaching Interests: Heat Transfer and Fluid Mechanics, Spray Cooling, Solar Energy.

VIJAY GOYAL, *Assistant Professor*, Ph.D. (2002), Virginia Polytechnic Institute and State University. Research and Teaching Interests: Non-linear Continuum Mechanics, Vibration and Stability Analysis, and Finite Element Method.

GUSTAVO GUTIERREZ, *Assistant Professor*, Ph.D. (2002), University of Wisconsin, Milwaukee. Research and Teaching Interests: Heat and Mass Transfer, Fluid Flow, Computational Fluid Mechanics.

YI JIA, *Associate Professor*, Ph.D., Harbin Institute of Technology. Research and Teaching Interests: Tribology, Research and Development of Surface Micro Structures in Power Transmission Components.

FREDERICK A. JUST AGOSTO, *Assistant Professor*, Ph.D. (1997), Virginia Polytechnic Institute. Research and Teaching Interests: Damage, Detection, Vibration Control/Smart Structures, Alternative Vehicle Design.

SCOTT KIEFER, *Assistant Professor*, Ph.D. (2000), North Carolina State University, Research and Teaching Interests: Mechatronics of Autonomous Vehicles, Electrostatic Modeling of Blinds using Matlab, Microprocessors Applications to Mechanical Systems in both Thermal and Machine Domain.

NESTOR L. PEREZ, *Associate 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, *Professor*, Ph.D. (1978), University of Texas-Austin. Research and Teaching Interests: Heat transfer, HVAC Systems, Design of Thermal and Energy System Sciences.

LOURDES M. ROSARIO, *Professor*, Ph.D. (1988), University of Rhode Island. Research and Teaching Interests: Computer-aided Engineering, Design of Automatic Assembly Systems and Vibratory Bowl Feeder.

ALI SABZEVARI, *Professor,* Ph.D. (1966), Case Western Reserve University of Technology. Research and Teaching Interests: Wind Engineering, Wind Flow in and around Buildings, Natural Ventilation, Wind Induced Vibrations, Design of Wind Energy Conversion System.

DAVID SERRANO, Professor, Sc.D. (1987), Massachusetts Institute of Technology. Research and Teaching Interests: Artificial Intelligence, CAE, Concentraint Based Systems.

ANTONI DKRZYPINSKI, *Visiting* Professor, Ph.D. (1970), Krakow University Polonia. Research and Teaching Interests: Manufacturing Processes and Systems.

PAUL A. SUNDARAM, *Professor*, Ph.D. (1988), Ohio State University. Research and

Teaching Interests: Mechanical Properties of Materials, Materials Science, Metal-metric Composites, Material-environment Interaction, Fracture Materials.

MIGUEL A. TORRES FEBUS, *Associate Professor*, Ph.D.. (1993), Massachusetts Institute of Technology. Research and Teaching Interests: Dynamics and Control of Mechanical and Electromechanical Systems. Design and Development of Mechatronics Systems both in the Machine and Thermal Domain, Information-driven Machines.

NELLORE S. VENKATARAMAN, *Professor*, Ph.D. (1970), Purdue University. Research and Teaching Interests: Analytical Modeling in Fluid and Thermal Sciences, Rarefied Gas Dynamics.

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 that intersect more than one academic discipline, providing thus 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 Mayagüez Campus of the University of Puerto Rico offers a program of study leading to the degree of Philosophy Doctor in Computing and Information Sciences and Engineering (CISE). Subject areas cover a wide range of advanced studies and research problems of interdisciplinary nature in computing and information sciences and engineering. Due to its interdisciplinary character, the program is composed by areas of specialty that can be renewed according to the evolution of the discipline, availability of specialists, and societal demand. At present, the program counts with a specialty in Computer Science and Engineering, which focuses on the design, analysis, and development of software and digital information systems; and a specialty of Scientific Computing, which focuses on the use of high-performance computing for the mathematical solution of problems in science and engineering.

The program is designed to prepare leaders of information technology innovation for highly qualified careers in academia, government or industry. A student planning to enter the Ph.D. in CISE should have a B.S. degree in Engineering or Science, and the equivalent to the undergraduate courses of Data Structures, Programming Languages, and Calculus III and Linear Algebra. An undergraduate course in Digital Circuits is also required for applicants interested in Digital System Implementations. Students deficient in one or more of these courses are expected to remove these deficiencies during the first year of study. Applicants should also submit their GRE score, and an essay explaining their personal vision of the discipline, and professional expectations.

The program contemplates a minimum of 57 academic credits distributed as follows: 9 credits in core courses, 12 credits in elective courses inside the student's specialty, 9 credits in elective courses outside the student's specialty, 6 of them in a specialty of the program, 6 credits in advanced courses, 3 credits in seminars, and 18 credits in doctoral dissertation. The core courses are: Analysis of Algorithms, Foundations of Computing, and Computer Architectures. The elective courses for the specialty of Computer Science and Engineering can be selected from the elective courses of the Master in Science in Computer Engineering, while the electives for the specialty of Scientific Computing, from the Master in Science in Scientific Computing. Qualifying and candidacy examinations are also required. The qualifying examination is based on the core courses, and it is offered the first week of classes, each August. The candidacy examination, on the other hand, is based on the student's thesis proposal and is offered by the student's committee. Overall, the curriculum emphasizes research and creativity over passive learning. Thesis results are expected to be published in a recognized journal before the Ph.D. degree is conferred.

More information is available in the Website Http://phe.ece.uprm.edu . Course descriptions may be found in http://ece.uprm.edu/cecord/phd .

DOCTORAL PROGRAM IN COMPUTING AND INFORMATION SCIENCES AND ENGINEERING (CIIC)

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 8015. ADVANCED TOPICS. Three credit hours. Three hours of lecture per week.

Study of advanced topics in sciences 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.

FOOD SCIENCE AND TECHNOLOGY PROGRAM

The Mayagüez Campus of the University of Puerto Rico offers a program of study leading to the degree of Master of Science in Food Science and Technology. Subject areas cover a wide range of basic and applied approaches in a multidisciplinary setting. Due to its multidisciplinary nature, the program is composed of four areas of specialization: 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. 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. Students deficient in the various areas of food science will be expected to remove these deficiencies during the first year. Students should have the following courses or their equivalent: Microbiology (BIOL 3770), Introductory Calculus II (MATE 3022), Biochemistry (QUIM 5071), and Introductory Physics and Laboratory (FISI 3091 and FISI 3093). Upon entering the program, each student may be assigned a faculty adviser, which will serve as the thesis adviser.

Programs Goals and Objectives

To gather and coordinate already existing activities in the food science and technology area in three colleges:

College of Agricultural Sciences
College of Arts and Sciences
College of Engineering

Goals

- To promote the cooperation and a productive coordinated effort among the departments involved in the program, required for a successful multidisciplinary graduate program.
- To contribute to the development of the scientific and the technological knowledge needed for the growth and improvement of the food industry.
- To develop the professional resources that Puerto Rico needs to assure a diverse, safe, and nutritious food supply for our society.
- To promote the research and development of processed opening of new markets for such commodities.
- To provide a contact and forum for the efficient exchange of information and

utilization of expertise between university, government agencies, and the food sector.

Program of Study

Summary of Credits in Program

Core Courses

Course		Credits
QUIM 5085	Food Chemistry	4
BIOL 6705	Advanced Food Microbiology	3
CITA 6601	Food Processing I	3
CITA 6603	Food Processing Laboratory	1
CITA 6615	Food Technology	3
CITA 6655	Seminar	1
CITA 6999	Research	6
		21

Professional Recommended Electives

AGRO 5005	Agricultural Biometrics	3
AGRO 6000	Advance Biometric	3
INPE 5357	Science and Technology of Fresh Meats	3
QUIM 6335	Food Analysis	4
INPE 5346	Milk Products	3
CMOB 6016	Advanced Seafood Technology	2
CMOB 5006	Seafood Processing	4
CITA 6997, 6998	Special Topics	1-3
CITA 6995, 6996	Special Problems	1-3
CITA 6990	Professional Experience Occupational	3-6
CITA 6016	Sensory Properties of Food	3
BIOL 5008	Sanitary Bacteriology	3

Occupational Information

The program is designed to prepare individuals for technical and scientific careers in the food allied industries, government agencies, academia and international agencies. The program also promotes entrepreneurship.

Publications

Journal of Food Protection
Food Technology
Journal of Food Science and Technology International
Food Packaging
Journal of Food Science
The World of Ingredients
Food Processing
Prepared Foods
Meat & Poultry
Food Quality
Meat Processing
Dairy Foods
Meat Marketing & Technology

Professional Associations

Association of Food and Drug Officials (AFDO)
Institute of Food Technologies (IFT)
"Asociación de Ciencia y Tecnología de Alimentos" (ACTA)
Council for Agricultural Science and Technology (CAST)
Food Protection (AOAC)

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

FOOD SCIENCE AND TECHNOLOGY (CITA)

Graduate Courses

CITA 6601. FOOD PROCESSING I (I, II). 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, II). One credit hour. One four-hour laboratory per week. Corequisites: 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 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. From three to six credit hours. Only three credits will be considered within the minimum of the required 30 credits for the graduate program.

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 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: Consent 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: Consent 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.

FOOD SCIENCE AND TECHNOLOGY FACULTY

A list of professors that 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.

CARMIN BUESO, *Ad Honorem Professor*, Ph.D. (1978), Rutgers University. Research Interest: Fruits and Vegetable post-harvest. Teaching Interest: Food Chemistry; Biochemistry.

MILDRED CHAPARRO, *Professor*, Ph.D. (1985), Texas A&M University. Research Interests: Food Microbiology. Teaching Interests: Microbiology, Food Microbiology.

DANILO CIANZIO, *Professor*, Ph.D. (1980), Iowa State University. Research and Teaching Interests: Beef Cattle Production.

GUILLERMO COLON BURGOS, Professor, Ph.D. (1986), University of Massachusetts. Research Interests: Fermentation, Membrane Technology, Supercritical Extraction, Mass and Energy Transfer in Porous Media. Teaching Interests: Mass and Energy Transfer, Industrial Pollution Control, Food Engineering, Material and Energy Balances.

JOSE CORTES, *Associate Professor*, Ph.D. (1987), University of North Texas. Research and Teaching Interests: Kinetics and Mechanisms of Organometallic Reactions; Analytical Methods in Food Chemistry.

EMILIO DIAZ, *Professor*, Ph.D. (1986), University of Wisconsin-Madison. Research Interest: Isolation and characterization of oxidative enzymes from fungi; study of role of oxidative enzyme on fungal pathogenicity. Teaching Interest: Organic Chemistry, Biochemistry, and Enzyme Reaction Mechanisms.

FRED FERNANDEZ, *Researcher,* M.S. (1979), Virginia Polytechnic Institute and State University. Research Interest: Food Microbiology.

VILMA GONZALEZ, *Associate Specialist*, M.S. (1981), University of Puerto Rico. Research Interests: Food Safety, Weight Management, Food Habit, Nutrition and Prevention of Chronic Disease. Teaching Interests: Human Nutrition, Food Safety.

CAROL L. HARPER, *Associate Professor*, Ph.D. (1991), Colorado State University. Research and Teaching Interests: Food Engineering and Packaging.

JAVIER HUERTAS, *Assistant Researcher*, M.S. (1996), University of Puerto Rico, Mayagüez Campus. Research Interests: Fermentation, Computer Process Control.

JOHN M. KUBARYK, *Professor*, Ph.D. (1980), Auburn University. Research and Teaching Interests: Seafood Technology, Aquaculture.

JOSE R. LATORRE, *Professor*, Ph.D. (1986), University of Arkansas. Research and Teaching Interests: Poultry Physiology and Reproduction.

ANN MACPHERSON, *Foods and Nutrition Specialist*, Ph.D., (1993), University of Puerto Rico. Research Interest: Human Nutrition.

EDNA NEGRON DE BRAVO, Professor, Ph.D. (1987), The Pennsylvania State University. Research and Teaching Interests: Food Science.

FERNANDO PEREZ MUÑOZ, *Ad Honorem Professor*, Ph.D. (1996), Iowa State University. Research Interests: Food Processing, Process Improvement Engineering. Teaching Interests: Food Processing, Post-harvest Handling, Physical Properties of Food, Food Sensory.

WINNA T. RIVERA SOTO, *Assistant Specialist*, (2000), Cornell University. Research Interest: Behavioral factors that influence food habits; fruit and vegetable consumption; nutrition and chronic diseases relationship. Teaching Interest: The impact of agriculture on people's nutritional status; nutritional benefits of fruits and vegetables, introductory nutrition; public health nutrition.

MANUEL RODRIGUEZ FLORES, *Professor,* Ph.D. (1968), University of Florida. Research Interest: Tropical Fruit Flavors Analysis, GCMS. Teaching Interest: Physical Chemistry.

MARIA DEL C. RODRIGUEZ, *Assistant Specialist*, (1997), Cornell University. Research Interest: Dietary assessment and behavior change; Program evaluation in nutrition education programs. Teaching Interests: Human Nutrition, Dietary assessment; community nutrition, diet and health.

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