Bioengineering Doctoral Program

University of Puerto Rico - Mayagüez

PROGRAM DESCRIPTION

The Bioengineering Doctoral Program of the University of Puerto Rico - Mayagüez (UPRM) will train students to become researchers in bioengineering by integrating the skills and competences of engineering, computational sciences, natural sciences, and medicine, while establishing an entrepreneurial culture within the students to focus on product-oriented research for future commercialization. Another program objective is to prepare graduates that are aware of the ethical and social responsibilities associated to the solution of technical problems in bioengineering.

The program will draw on internal areas of emphasis in order to guide students in their curriculum and research and to maintain a flexible structure that will allow the program to adapt itself to technological evolutions. The bioengineering program focuses on **computational bioengineering** and **biomedical engineering** research, and will consist of a total of **forty nine (49) credit-hours** for students entering the program with a **B.S. degree**, and **thirty-four (34) credit-hours** for students entering the program with an **M.S. or M.E. degree**. Of the forty-nine credit-hours, nine credit-hours will be in bioengineering core courses, six credit-hours in bioengineering courses, nine credit-hours in courses outside of bioengineering, six credit hours in elective courses, one credit-hour in graduate seminar, and eighteen credit-hours in doctoral dissertation. For students entering with an M.S. degree, 34 credit-hours will be required in the following manner: nine credit-hours in core courses, three credit-hours in bioengineering courses, three credit-hours in courses outside of bioengineering, one credit-hour in graduate seminar, and eighteen credit-hours in doctoral dissertation. Each doctoral student will be required to participate in the graduate seminar each semester and will receive one credit at the conclusion of his dissertation. Students will also be required to pass a qualifying exam, prepare a dissertation proposal and complete a dissertation research project that will demonstrate the scope of acquired knowledge and the student's creativity and scientific rigor. The dissertation must be an original contribution to the existing scientific and/or technical body of knowledge in the field of bioengineering.

ADMISSION REQUIREMENTS

General academic requirements for admission to the Ph.D. are included in Certification 09-09 issued by the UPRM Academic Senate. Additional specific program requirements are:

Students entering the program with a B.S. degree
• A baccalaureate degree in engineering with a minimum grade point average (GPA) of **3.20** on a scale of **4.00**, from an accredited institution of higher learning. Depending on the applicant's academic background, admission may be granted with deficiency courses. Applicants will be encouraged, but not required, to have approved undergraduate courses in human anatomy and physiology, human cellular and molecular biology, or both. • A baccalaureate degree in physics, chemistry, biology or related areas with a

minimum grade point average (GPA) of **3.20** on a scale of **4.00**, from an accredited institution of higher learning, and with a mathematical background at the level of differential equations. Depending on the applicant's academic background, admission may be granted with deficiency courses. Applicants will be encouraged, but not required, to have approved undergraduate courses in human anatomy and physiology, human cellular and molecular biology, or both. • International students for whom English or Spanish are not their first language are required submit a Test of English as a Second Language (TOEFL) exam score.
Student entering the program with an M.S. or M.E. degree:
• A master's degree in engineering from an accredited institution of higher learning. Depending on the applicant's academic background, admission may be granted with deficiency courses. Applicants will be encouraged, but not required, to have approved undergraduate or graduate courses in human anatomy and physiology, human cellular and molecular biology, or both. • A master's degree in physics, chemistry, biology or related areas from an accredited institution of higher learning, and with a mathematical background at the level of differential equations. Depending on the applicant's academic background, admission may be granted with deficiency courses. Applicants will be encouraged, but not required, to have approved undergraduate or graduate courses in human anatomy and physiology, human cellular and molecular biology, or both. • International students for whom English or Spanish are not their first language are required submit a Test of English as a Second Language (TOEFL) exam score.

The same norms established by the UPRM's Academic Senate as well as all previously described admission guidelines to the doctoral program are applicable to transfer students. The program's graduate committee will consider transfers from the doctoral program into the master's program, with previous recommendation from the student's thesis committee and from the program's executive director.

GRADUATION REQUIREMENTS

The general academic requirements for conferring the doctoral degree are stated in Certification 09-09 of the UPRM's Academic Senate. Specific requirements for the Doctoral Program in Bioengineering are described below.

Students entering the program with a **B.S. degree** are required to approve a minimum of **forty-nine (49) credit-hours** distributed in the following manner:

- 9 credit-hours in core courses
  - Principles of Biomedical Engineering (INME6065)
  - Principles of Computational Bioengineering (BING 6004)
  - Molecular and Cellular Biology for Engineers (BING 6002)
- 6 credit-hours in bioengineering courses
- 9 credit-hours in courses outside of bioengineering
- 6 credit-hours in elective courses (either in bioengineering or outside)
- 1 credit-hour in seminar (BING 8998)
  - The topics covered in the seminar will include:

        - Scientific issues
        - Social and ethical issues
        - Entrepreneurship
- 18 credit-hours in doctoral dissertation (BING 8999)

Students entering the program with an **M.S. or M.E. degree** are required to approve a minimum of **thirty-four (34) credit-hours** distributed in the following manner:

- 9 credit-hours in core courses
    - Principles of Biomedical Engineering (INME6065)
    - Principles of Computational Bioengineering (BING 6004)
    - Molecular and Cellular Biology for Engineers (BING 6002)
- 3 credit-hours in bioengineering courses
- 3 credit-hours in courses outside of bioengineering
- 1 credit-hour in seminar (BING 8998)
    - The topics covered in the seminar will include:
        - Scientific issues
        - Social and ethical issues
        - Entrepreneurship
- 18 credit-hours in doctoral dissertation (BING 8999)

Students will prepare a plan of study before the second month of their second semester of studies, and under the guidance of the student's graduate committee. The plan of study will be prepared taking into consideration: the student's academic and research interests, suitability of courses to prepare students for their research work, and academic offer. No more than 9 credit-hours of advanced undergraduate level courses can be used to complete doctoral degree requirements.

Minimum Academic Index Requirements

In order to complete the doctoral degree, each student must approve a minimum of 49 credit-hours with a GPA of 3.0 or higher. Students enrolled in the doctoral program may repeat a course with an earned grade of C or lower only once. Courses with a final grade of A or B cannot be repeated.

Maximum Number of Transfer Credits to be Allowed

Courses taken at UPRM in fulfillment of requirements of another graduate program may be utilized to fulfill the requirements of the proposed program. Courses taken at other institutions of higher learning may be utilized to fulfill doctoral program requirements, but are subject to residency requirements as specified in Certification 09-09 which establishes that that 60% of the courses in a student's plan of study must have been taken at UPRM. The program's graduate committee will determine which courses could be transferred. All transfer courses must be approved with a minimum grade of B. Under no conditions may thesis credits be transferred.

Residency

The "Norms that Regulate Graduate Studies at UPRM" stipulate the residency requirements as follows:

"Residency requirements at the Doctoral level: a minimum of four semesters for students entering with a Bachelors degree, and a minimum of two semesters for students entering with a Master's degree. In both cases the student will complete sixty (60) percent of the course work for the program at UPRM."

Graduate Seminar

Doctoral students will be required to register for the Graduate Seminar in Bioengineering course for the duration of their doctoral studies and will be awarded one credit-hour the semester the dissertation is turned in. Besides scientific and technical topics, the graduate seminar will also cover topics related to entrepreneurship, intellectual property, and social and ethical issues related to the field of bioengineering.

Qualifying Exam

All doctoral students will be required to take a doctoral qualifying examination in order to evaluate the candidate's competency in bioengineering core areas. The examination consists of three written parts, which will be prepared, supervised and evaluated by the program's Graduate Studies Committee in coordination with its faculty.

A student who has passed the examination will be allowed to register in BING 8999 – Doctoral Dissertation. This student is henceforth regarded as a doctoral degree candidate in the Bioengineering Program at UPRM.

A student who has failed the qualifying examination the first time may retake it a second and final time within one semester of the first attempt. According to UPRM regulations, a second failure will result in the student's dismissal from the graduate program. If the student does not hold a Master's degree in Bioengineering, the student will be given the opportunity to transfer to the Bioengineering's Master of Science or Master of Engineering programs. If none of these options is selected, the student will be suspended from the Bioengineering graduate program. After one year of suspension, the student may apply for a second and final admission to the same program or to another UPRM graduate program.

Dissertation Proposal

After successfully passing the qualifying examination, the doctoral student is required to submit a research proposal regarding his/her project of interest. Following the acceptance of the research proposal, the student is given a comprehensive examination to determine initiative, originality, breadth, and high level of professional commitment to the problem selected for investigation. This dissertation proposal exam consists of a written part (the proposal) and an oral defense of the proposal.

Dissertation

All Ph.D. candidates must undertake an independent research project that becomes a significant contribution to the advancement of knowledge in a particular area of bioengineering. All doctoral candidates must pass the oral exam in defense of his/her dissertation. Students must have passed the qualifying examination in

order to register for the doctoral dissertation course, and have passed the preliminary exam before defending his/her thesis.

Publication in Peer-Reviewed Journals

All students should have at least one (1) scientific article related to the dissertation submitted in a peer-reviewed journal before the thesis defense.

COURSE DESCRIPTIONS

The following courses will comprise the academic offerings of the doctoral program in Bioengineering:

INEL 5208 PRINCIPLES OF BIOMEDICAL INSTRUMENTATION. 4 credit-hours. Three hours of lecture and two hours of laboratory practice per week. Prerequisite: INEL 4201 or consent of the department head. Theoretical and practical aspects of the methods used to measure physiological events with emphasis in the cardiovascular, pulmonary and nervous systems.

INEL 6097 BIOMEDICAL ACOUSTICS. 3 credit-hours. Three hours of lecture per week. Prerequisite: Graduate standing or consent of the instructor. Application of acoustics principles toward the design of diagnostic and therapeutic medical devices. Use of computer tools to simulate the acoustic response of systems composed of biological tissues.

INQU 8027 CHEMICAL ENGINEERING PRINCIPLES APPLIED TO DRUG THERAPY. 3 credit-hours. Three hours of lecture and two hours of laboratory practice per week. Prerequisite: This is an elective course intended for graduate students in chemical engineering or related fields. The course focuses on the application of chemical engineering principles applied to drug therapy including knowledge of pharmacokinetic and pharmacodynamic concepts, design of therapeutic regimens, and emphasis on the application of transport phenomena for the design and modeling of drug delivery devices. Upon completion of this course students are expected to understand the basic principles, models and theories of drug delivery, analyze physiological characteristics of biological systems and evaluate their implication in biological transport, design and calculate dosage regimes, create transport models for biological molecules, estimate diffusion coefficients, and design drug delivery systems from experimental data.

INQU 8007 TRANSPORT PHENOMENA IN BIOLOGICAL SYSTEMS. 3 credit-hours. Three hours of lecture per week. Prerequisite: INQU6016 or consent of the instructor. This is an elective course intended for graduate students in chemical engineering or related fields. The course discusses the integration of the fundamentals of transport phenomena to biological systems. It focuses on the application of momentum and mass transport from the cellular to the organ level, including artificial organs. Upon the completion of the course the students are expected to understand the fundamental principles of biological transport processes by formulating the mathematical expressions of these principles and

their solution; analyze physiological characteristics of biological systems, and evaluate their implication in biological transport.

INME 6065 PRINCIPLES OF BIOMEDICAL ENGINEERING. 3 credit-hours. Three hours of lecture per week. Prerequisite: Authorization of the Director. Application of engineering principles and quantitative methods in biology to analyze and describe complex biological systems. Survey of human anatomy and physiology, modern molecular biology, professional ethics, and regulatory issues.

INME 6115 BIOMATERIALS. 3 credit-hours. Three hours of lecture per week. Prerequisite: Authorization of the Director. Study of advanced materials as applied to biomedical systems. Integration of materials science and engineering concepts with biology for the successful design of interfaces between living cells and organic and inorganic materials.

INME 6135 TISSUE ENGINEERING. 3 credit-hours. Three hours of lecture per week. Prerequisite: Permission of department head. Study of tissue engineering applied to biomedical systems with emphasis on quantitative cell and tissue biology, cell and tissue characterization, engineering methods and design, and clinical applications.

BING 6004 PRINCIPLES OF COMPUTATIONAL BIOENGINEERING. 3 credit-hours. Three hours of lecture per week. Prerequisite: Graduate standing or permission of department head. Study of computational issues and methods employed in molecular biology. Biological data sources available on the internet will be introduced and analyzed.

BING 8202 STRUCTURAL BIOINFORMATICS. 3 credit-hours. Three hours of lecture per week. Prerequisite: BING 6004. Analysis and prediction of the conformation of biological macromolecules. Study of the relation between macromolecular structure and function, with emphasis on proteins.

BING 6002 MOLECULAR AND CELLULAR BIOLOGY FOR ENGINEERS. 3 credit-hours. Three hours of lecture per week. Prerequisite: Graduate standing or consent of the instructor. Study of the biology of cells, emphasizing examples relevant to bioengineering. Topics such as protein structure and function, cellular membranes and organelles, cell growth and oncogenic transformation, cellular transport, receptors and cell signaling, the cytoskeleton, the extracellular matrix, and cell movement will be included.

BING 6016 ERGONOMICS FOR BIOMEDICAL SCIENTISTS AND ENGINEERS. 3 credit-hours. Three hours of lecture per week. Prerequisite: Permission of department head. Study of anatomical and physiological concepts that describe and predict human motor capabilities, with particular emphasis on the evaluation and design of manual activities in diverse occupations. Use of quantitative and simulation models to explain muscle strength performance, cumulative and acute musculoskeletal injuries, physical fatigue, and human motion control.

BING 6017 ADVANCED BIOSTATISTICS APPLICATIONS. 3 credit-hours. Three hours of lecture per week. Application of statistical methods to solve biomedical and bioengineering problems. Use of generalized linear models, including logistic, Poisson, and binomial regressions. Design of experiments under biological process constraints and appropriate data analysis. Use of artificial neural network techniques to model nonlinear relationships among qualitative and quantitative variables of a biomedical system.

BING 6998 ENGINEERING PROJECT. 0-6 credit-hours. Variable contact period. Prerequisite: Permission of program's director. Comprehensive study of a specific bioengineering problem selected to integrate the knowledge acquired in the graduate program of study.

BING 6999 MASTER'S THESIS. 0-6 credit-hours. Variable contact period. Prerequisite: Permission of program's director. Research in the field of Bioengineering and presentation of a thesis.

BING 8995 ADVANCED TOPICS IN BIOENGINEERING. 1-6 credit-hours. Variable contact period. Prerequisite: Permission of program's director. Study of advanced topics in bioengineering.

BING 8997 INDEPENDENT STUDIES. 1-3 credit-hours. Variable contact period. Prerequisite: Permission of program's director. Independent studies in bioengineering.

BING 8998 GRADUATE SEMINAR. 0-1 credit-hours. One hour of seminar per week. Prerequisite: Permission of program's director. Oral presentations and discussions in areas of interests in bioengineering.

BING 8999 DOCTORAL DISSERTATION. 0-9 credit-hours. Variable contact period. Prerequisite: Permission of program's director. Development, preparation and defense of a dissertation based on an original research work in bioengineering

FACULTY

The UPRM Bioengineering Graduate Program has a very active interdisciplinary group of faculty members. Faculty members come from various academic departments within the Colleges of Engineering and Arts and Sciences.

Name	Department	Research Areas
Jorge Almodóvar	Chemical Eng.	Biomaterials
Noel Artiles	Industrial Eng.	Statistics, Experimental Design
Mauricio Cabrera	Industrial Eng.	Bioinformatics, probability and statistics
Silvina Cancelos	Mechanical Eng.	Biomedical acoustics, bubble dynamics
Miguel Castro	Chemistry	Nanoscaled sensors
Ubaldo Córdova	Chemical Eng.	Transport Phenomena, Applied Mathematics
Rubén Díaz	Mechanical Eng.	Transport Phenomena in Biological Systems,

		Micro/Nano Fabrication Technologies
Maribella Domenech	Chemical Eng.	Tumor cell signaling, microfluidic systems for 3D cell culture
David González	Industrial Eng.	Experimental Design
Samuel Hernández	Chemistry	Spectroscopy
Eduardo Juan	Electrical and Computer Eng.	Biomedical Acoustics, Bioinstrumentation
Magda Latorre	Chemical Eng.	Nanoparticle-cell interactions
Juan López Garriga	Chemistry	Structure and function relationships in hemeproteins
Vidya Manian	Electrical Eng.	Brain computer interfaces, brain imaging, image processing, biosensory data fusion
Lourdes Medina	Industrial Eng.	Medical device development and manufacturing
Juan C. Martínez Cruzado	Biology	Molecular biology
Enrique Meléndez	Chemistry	Metal-based drugs and biosensors
Taras Oleksyk	Biology	Bioinformatics, genetics
Patricia Ortiz	Chemical Eng.	Biotechnology, microbiology
Oscar Perales	General Eng.	Nanotechnology, material sciences
Nazario Ramírez	Industrial Eng.	Experimental Design, Prediction of Drug Stability
Pedro Resto	Mechanical Eng.	Microfluidic devices
Karen Ríos	Mathematics	Mathematical Biology
Manuel Rodríguez	Electrical and Computer Eng.	Database Management Systems
Jaime Seguel	Electrical and Computer Eng.	Parallel and Distributed Computing, Bioinformatics
David Serrano	Mechanical Eng.	Rehabilitative Medical Devices
Heidy Sierra	Computer Information Sciences and Engineering	Biophotonics
Paul Sundaram	Mechanical Eng.	Biomaterials
Madeline Torres	Chemical Eng.	Polymers, Biomaterials, Hydrogel-Based Drug Delivery
Bienvenido Vélez	Computer Information Sciences and Engineering	Bioinformatics

CONTACT INFORMATION

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