Bioengineering Master's Program

University of Puerto Rico - Mayagüez

Program Description:

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

The bioengineering program focuses on computational bioengineering and biomedical engineering research. It will draw on internal areas of emphasis in order to guide students in their curriculum and maintain a flexible structure that is adaptable to technological evolutions. Two master's degrees will be offered, which correspond to Plans I, II and III, as described in Certification 09-09 of the University of Puerto Rico-Mayagüez's Academic Senate.

Master's of Science (Plan I - Thesis). This program consists of a total of 31 credit-hours: nine credit-hours in bioengineering core courses, six credit-hours in bioengineering courses, six credit-hours in courses outside of bioengineering, three credit-hours in elective courses, six credit-hours in master's thesis, and one credit-hour in graduate seminar.
Master's of Engineering (Plan II - Project). This program consists of a total of 31 credit-hours: nine credit-hours in bioengineering core courses, six credit-hours in bioengineering courses, six credit-hours in courses outside of bioengineering, three credit-hours in elective courses, six credit-hours in engineering project, and one credit-hour in graduate seminar.
Master's of Engineering (Plan III). This program consists of a total of 37 credit-hours: nine credit hours in bioengineering core courses, fifteen credit-hours in bioengineering courses, six credit-hours in courses outside of bioengineering, six credit-hours in elective courses, and one credit-hour in graduate seminar.

The degrees conferred will be Master of Science in Bioengineering to students that complete Plan I (thesis) and Master of Engineering in Bioengineering to students that complete Plan II (project) or Plan III (courses-only). The program's graduate committee will consider transfers from the doctoral program in bioengineering into the master's program, with previous recommendation from the student's thesis committee and from the program's executive director.

Admission Requirements

General requirements for admission into graduate programs at the University of Puerto Rico-Mayagüez are established in Certification 09-09 of the University of Puerto Rico-Mayagüez's Academic Senate. In addition, the Bioengineering Master's Program requires that applicants possess:

- A baccalaureate degree in engineering with a minimum grade point average (GPA) of

3.20 on a scale of **4.00**, from an accredited institution of higher learning. Depending on the applicant's academic background, admission may be granted with deficiency courses. Applicants will be encouraged, but not required, to have approved undergraduate courses in human anatomy and physiology, human cellular and molecular biology, or both.

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

Graduation Requirements

The general academic requirements for conferring the Master's of Science or Master's of Engineering degrees are established in Certification 09-09 of the University of Puerto Rico-Mayagüez's Academic Senate. Specific requirements for each degree in the graduate program in bioengineering are described below.

Total Credit-Hour Requirement

Students entering the **Master's of Science (Plan I - Thesis)** program are required to approve a minimum of thirty-one (31) credit-hours distributed in the following manner:

- 9 credit-hours in core courses
    - Principles of Biomedical Engineering (INME 6065)
    - Principles of Computational Bioengineering (BING 6004)
    - Molecular and Cellular Biology for Engineers (BING 6002)
- 6 credit-hours in bioengineering courses
- 6 credit-hours in courses outside of bioengineering
- 3 credit-hours in elective courses (either in bioengineering or outside)
- 1 credit-hour in graduate seminar (BING 8998)
    - The topics covered in the seminar will include:
        - Scientific issues
        - Social and ethical issues
        - Entrepreneurship
- 6 credit-hours in master's thesis (BING 6999)

Students entering the **Masters of Engineering (Plan II - Project)** program are required to approve a minimum of thirty-one (31) credit-hours distributed in the following manner:

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

    - The topics covered in the seminar will include:
        - Scientific issues
        - Social and ethical issues
        - Entrepreneurship
- 6 credit-hours in engineering project (BING 6998)

Students entering the **Master's of Engineering (Plan III – Courses Only)** program are required to approve a minimum of thirty-seven (37) credit-hours distributed in the following manner:

- 9 credit-hours in core courses
    - Principles of Biomedical Engineering (INME6065)
    - Principles of Computational Bioengineering (BING 6004)
    - Molecular and Cellular Biology for Engineers (BING 6002)
- 15 credit-hours in bioengineering courses
- 6 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

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

Minimum Academic Index Requirements

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

Maximum Number of Transfer Credits Allowed

Graduate courses taken at UPRM to fulfill requirements of another program may be utilized to fulfill the requirements of the bioengineering program. Courses taken at other institutions of higher learning may be utilized to fulfill master's program requirements, but are subject to residency requirements as specified in Certification 09-09 of the University of Puerto Rico-Mayagüez's Academic Senate. These norms stipulate that 60% of the courses in a student's plan of study must have been taken at UPRM. The program's graduate committee will determine which courses could be transferred. All transfer courses must be approved with a minimum grade of B. Under no conditions may thesis credits be transferred.

Residency

The "Norms that Regulate Graduate Studies at UPRM" stipulate the residency requirements as follows:
"Residency requirements at the Master's level: a minimum of two semesters of study at UPRM and having completed sixty (60) percent of the course work for the program at UPRM."

Graduate Seminar

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

Master's Thesis or Project (Plan I and Plan II only)

Master's students enrolled in **Plan I (Master of Science degree)** are required to conduct a research project in bioengineering. Students are required to submit a thesis proposal for the approval of the student's graduate committee, complete the proposed research work, prepare a thesis and orally defend the thesis.

Master's students enrolled in **Plan II (Master of Engineering degree)** are required to develop an engineering project in bioengineering. Students are required to submit a project proposal for the approval of the student's graduate committee, complete the project, prepare a written project report, and orally defend this project.

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.

ICOM 6XXX BIOINFORMATICS ALGORITHMS. 3 credit-hours. Three hours of lecture per week. Prerequisite: Graduate standing. Introduction to fundamental algorithms and algorithmic principles in Bioinformatics. General discussion on the many aspects that link Computer Science to Molecular Biology. In depth discussions on selected relevant problems in Biology, their formulations as Computer Science problems and their best known algorithmic solutions.

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 8XXX 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: BIOE6XXX (Principles of Computational Bioengineering). 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, emphazising 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 6XXX ADVANCED BIOSTATISTICS APPLICATIONS. 3 credit-hours. Three hours of lecture per week. Prerequisite: ININ-4020 Applied Industrial Statistics or BING-5XXX Fundamentals of Biostatistics. 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
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
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
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
Paul Sundaram	Mechanical Eng.	Biomaterials
Madeline Torres	Chemical Eng.	Polymers, Biomaterials, Hydrogel-Based Drug Delivery
Bienvenido Vélez	Electrical and Computer Eng.	Distributed Systems, Information Discovery and Retrieval

Contact Information

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