Doctoral Program in Mechanical Engineering

University of Puerto Rico, Mayagüez Campus

Academic Program Description

Mechanical Engineering is one of the oldest branches of engineering, with a wide array of applications ranging from the fundamental aspects of mass, momentum, and energy transfer, to the design, analysis, and manufacturing of static and dynamic engineering components, energy systems, biomedical devices as well as the mechanical aspects of materials. Due to the complex nature of today's problems, mechanical engineers must be versatile in many areas, from theoretical concepts to applications in engineering. Our Bachelor of Science (BS) program has more than 100 years of history and consistently produces top-notch professionals as demonstrated by our world-class alumni. For those looking to increase their level of knowledge in Mechanical Engineering, the Department has been offering a Master of Science (MS) and a Master of Engineering (MEng) option for more than 40 years. Many of our colleges in neighbor academic institutions located in Puerto Rico and South America are graduates from our MS/MEng program. However, the degree option that enables the student to push the boundaries of science and engineering knowledge to the known limit and beyond has been a key ingredient absent from our academic recipe, until now. Starting January 2016, the Department of Mechanical Engineering (INME) is proud to announce the offering of a Doctoral Degree (PhD) in Mechanical Engineering; the first of it's kind in the island.

The philosophy of the Doctoral Program in Mechanical Engineering is to prepare students in creative thinking and at the same time provide a robust fundamental background on transformative research in the field of engineering. The curriculum is designed for candidates that hold a BS degree in mechanical engineering or related fields. The first two years are parallel to the Master's Program in terms of core courses, specialty area courses, and electives. During the third and fourth year of study, the student's Dissertation Committee and the student's affinity to certain topics in mechanical engineering will define the rest of the curriculum. The program has been designed with flexibility in mind with plenty of credit hours in electives, which allows the enrichment of the student's curriculum with cutting-edge research topics not included in the specialty area courses. The PhD in Mechanical Engineering is focused in four areas of study or specialty areas: (1) Thermal/Fluid Science, (2) Machine Science, (3) Materials and Manufacturing, and (4) Bio/Micro-Scale Engineering. The PhD degree consists of **sixty one (61) credit hours for students entering the program with a BS degree and thirty seven (37) credit hours for students entering the program with an MS or MEng degree**. A summary of the curricular sequence for each case is included below.

Students **entering the program with a bachelor's degree** in Mechanical Engineering need to approve a minimum of **sixty one (61) credit hours**, which are distributed in the following fashion:

- 1 credit hour in Doctoral Seminar
- 42 credit hours in Coursework (i.e. advanced math, specialty area courses, elective courses)
- 18 credit hours in Doctoral Dissertation

Students **entering the program with a Master of Science or Master of Engineering degree** in Mechanical Engineering need to approve a minimum of **thirty seven (37) credit hours**, which are distributed in the following fashion:

- 1 credit hour in Doctoral Seminar

- 18 credit hours in Coursework (i.e. advanced math, elective courses)
- 18 credit hours in Doctoral Dissertation

A maximum of 9 credit hours in 5000 level courses (advanced undergraduate) can be transferred to the study plan of a doctoral student from a previously earned degree at the University of Puerto Rico in Mayagüez (UPRM). In addition to the courses, students must approve a Qualifying Examination (based on the undergraduate curriculum at INME) and a Preliminary Examination (based on the PhD curriculum). Finally, students must submit a Doctoral Proposal, approve a Dissertation Defense, and submit the final dissertation. The dissertation constitutes an original contribution to the existing body of scientific knowledge in the field of mechanical engineering or related areas. The credit distribution for students entering the program with a BS degree is based on students with a background in Mechanical Engineering. Remedial courses (deficiencies) will be required for students with background in related fields (e.g. Chemical Engineering, Civil Engineering, Electrical Engineering, Physics). The assignment of the deficiencies will be based on the chosen Specialty Area and the courses approved by the applicant as shown in the student's permanent academic record (transcript). The credit distribution for students entering the program with an MS/MEng degree is based on a master's degree obtained from the Department of Mechanical Engineering at the University of Puerto Rico in Mayagüez. The transfer of credits for students with an MS/MEng degree from other accredited academic institutions will be evaluated on a case-by-case basis.

Application Requirements

The Department of Mechanical Engineering follows the graduate program admission requirements described in the Certification 09-09 from the Academic Senate at the UPRM, "Normas que Rigen los Estudios Graduado en el Recinto Universitario de Mayagüez".

Special Admission Requirement:

- A master's or bachelor's degree in engineering or physics with a minimum grade point average (GPA) of 3.0 on a 4.0 scale from an accredited institution of higher education. The Departmental Graduate Committee (DGC) will evaluate each applicant on a case-by-case basis. The CGD can grant a conditional admission for applicants that do not hold a BS in mechanical engineering. In this case, the students need to approve the deficiency courses within the first year of study. The assignment of the deficiency courses will be based on the applicant's academic background and the selected specialty area.
- Submit the Graduate Record Examination (GRE) score, although there is no minimum score required. This requirement applies only to students that apply to the program with a BS degree.
- Obtain a minimum score of 80 (out of 120) in the TOEFL iBT (Test of English as a Foreign Language, administered via the internet). Applicants with scores between 70 and 79 can be considered in meritorious cases, based on an interview performed by the DGC. If admitted, the Committee might require for the student to approve a graduate level English course at the UPRM. *This requirement applies to applicants whose first language is other than Spanish or English*. Applicants with US citizenship are not automatically exempt from this requirement.
- Submit the applicant's class rank. The class rank is an official document prepared by the academic institution that grants the applicant's BS degree, which indicates the ranking position occupied by the student in his/her graduating class. This document is required only for international applicants whose highest degree is a Bachelor of Science.

The norms and procedures established by the Office of Graduate Studies (OEG, following it's acronym in Spanish), as well as the particular requisites of the program are applicable to students transferring form the doctoral to the master's program. The DGC will consider said transfers upon recommendation from the student's Dissertation Advisor and the Chairman of the Department.

Graduation Requirements

The general academic requirements to confer a Doctoral degree are specified in the Certification 09-09 from the Academic Senate at the UPRM. Specific requirements for the Doctoral Program in Mechanical Engineering are described below.

1. Coursework Requisite

Students entering the program with a bachelor's degree in Mechanical Engineering need to approve a minimum of sixty one (61) credit hours, which are distributed in the following fashion:

- 1 credit hour in Doctoral Seminar (INME 8017)
- 6 credit hours in Advanced Math Courses
- 12 credit hours in Specialty Area Courses
- 15 credit hours in Mechanical Engineering Elective Courses
- 9 credit hours in Free Electives
- 18 credit hours in Doctoral Dissertation (INME 8099)

Students entering the program with a Master of Science or Master of Engineering degree in Mechanical Engineering need to approve a minimum of thirty seven (37) credit hours, which are distributed in the following fashion:

- 1 credit hour in Doctoral Seminar (INME 8017)
- 3 credit hours in Advanced Math Courses
- 0 credit hours in Specialty Area Courses
- 6 credit hours in Mechanical Engineering Elective Courses
- 9 credit hours in Free Electives
- 18 credit hours in Doctoral Dissertation (INME 8099)

Students will prepare a Study Plan during their first semester of study under the supervision of the DGC Coordinator and the Director of the Dissertation Committee (research advisor). The preparation of the Plan of Study will take into account factors such as the academic and research interests of the student, course relevance with respect to the selected research topic and academic offering. A maximum of 9 credit hours in 5000 level courses can be used as part of the doctoral degree requirements. 5000 level courses must be from INME.

2. Minimum Academic Index

Students must approve courses in the curriculum with a GPA of 3.0 or higher. Students enrolled in the Doctoral Program may repeat a course with a grade of C or less only once.

3. Maximum Number of Transfer Credits

Students entering with a Bachelor's Degree in engineering from the UPRM can transfer up to 9 credit hours to the Doctoral Program from 5000 or 6000 level courses approved with a grade of A or B. Students entering with a Masters in Mechanical Engineering from the UPRM can transfer up to 24 credit hours from the MS/MEng Study Plan to the Doctoral program. Graduate courses taken from other programs within the UPRM or other duly accredited institutions of higher education can be used to meet the requirements of the program if they are approved by the DGC and do not create a conflict with the Residency Requirement (Certification 09-09, see details below).

4. Residency Requirement

The Certification 09-09 states the residency requirement for doctoral level students as follows: "Have completed in the UPRM a minimum of four semesters for students entering with a BS and without an MS/MEng or a minimum of two semesters for students entering with an MS/MEng. In both cases, the student must approve at least sixty percent of the program credits in the UPRM. "

5. Doctoral Seminar

The primary purpose of the Doctoral Seminar is to share technical and scientific knowledge among peers and expose students to a broad variety of research topics in Mechanical Engineering. In addition, students will receive lectures and workshops in technical writing, presentation skills, intellectual property, ethics, and laboratory safety among other issues. The Seminar course is offered during the Mechanical Engineering Universal Hour (MWF 4:30pm-5:20pm) once a week. Doctoral students will enroll with zero (0) credits each semester until the last semester (semester of Dissertation Defense), in which case, students will receive one (1) credit for the Seminar. Students will present the progress of their research projects every other semester or as deemed appropriate by Seminar Coordinator.

6. Qualifying Examination

The Qualifying Examination is a written examination based on core knowledge of the undergraduate program in Mechanical Engineering at the UPRM. The student must successfully pass the examination before the start of the second year of studies in the Doctoral Program. Students can repeat the examination in the case of failure in the first attempt. The student cannot become a doctoral candidate if he/she fails the examination for the second time. The logistics of the examination and the passing score are set by the DGC.

7. Preliminary Examination

The preliminary examination will consist of an oral and a written part to be administered during the fifth semester of study. Its content will be based on knowledge and skills gained by the courses included in the students' Plan of Study.

- Written Part: The purpose of the written examination is to assess students' knowledge on the material covered in the selected Specialty Area Courses. Faculty members in the students' Specialty Area will prepare the written exam.
- Oral Part: The purpose of oral examination is to assess the student's ability to conduct doctoral level research. This assessment requires the student to demonstrate a thorough understanding of his/her research project. The Preliminary Examination Committee will be responsible for the administration of the oral examination. The Committee will consist of faculty members in the student's specialty and research area. The chair or co-chair of the student's Dissertation Committee cannot be part of the Preliminary Examination Committee.

8. Final Examination (Dissertation Defense)

Each candidate is required to approve the Final Examination, which is largely a defense of the dissertation, but is not limited to that. The examination will be conducted by the Evaluation Committee and will include a presentation of the research work performed by the candidate, followed by a session of questions open to the public. This is followed by a closed session where the Committee evaluates the candidate with scientific rigor. The student's Dissertation Committee and a representative from the Office of Graduate Studies compose the Evaluation Committee.

9. Dissertation Proposal

Doctoral students must submit a Dissertation Proposal during their third semester of study. The Dissertation Proposal is used to define topic and breadth of the student's research. The proposal should include a scientific literature review, relevance of the proposed work, hypotheses (if applicable), objectives, methodology, preliminary results, and references.

10. Dissertation

All doctoral candidates must develop an independent research project that represents a significant contribution to body of knowledge in the student's field of research in Mechanical Engineering. The student must complete a minimum of eighteen (18) credit hours in Doctoral Research to meet graduation requirements. After passing the Dissertation Defense, students have until a deadline set by the OEG for final delivery of the dissertation, which must incorporate all of the corrections identified by the Evaluation Committee. The deadline will be during the final exams period corresponding to that semester.

11. Peer Reviewed Publications

All doctoral students must have a minimum of one (1) scientific article accepted in a journal refereed by peers and one (1) peer reviewed conference proceeding or two (2) peer reviewed journal articles accepted for publication before submitting the form to request the Dissertation Defense. The publications herein must be related to the research work performed by the doctoral candidate towards the PhD degree. The selected referred journal must be indexed at the time of publication by the InCites™ Journal Citation Reports® (Thomson Reuters).

12. Language Requisite

UPRM teaching is bilingual in nature, consisting of English and Spanish. However, English will be the language of choice for Doctoral Seminar presentations, dissertation related manuscripts, scientific publications, etc.

Advanced Math Course Selection List

Course Code	*Course Title*	*Pre-Requisites*
MATE 6025	Numerical Linear Algebra	N/A
MATE 6026	Numerical Optimization	N/A
MATE 6045	Optimization Theory	N/A
MATE 6672	Numerical Mathematical Analysis	N/A
MATE 6674	Numerical Methods for Differential Equations	N/A
MATE 6675	Mathematics of Modern Science I	N/A
MATE 6676	Mathematics of Modern Science II	N/A
ESMA 6305	Statistical Methods	N/A
ESMA 6660	Biostatistical Analysis	Director's authorization
ESMA 6661	Theory of Statistics I	N/A
ESMA 6662	Theory of Statistics II	ESMA 6661
ESMA 6665	Statistical Computing	ESMA 6205 or Director's authorization
ININ 6025	Linear and Discrete Optimization	ININ 4021
ININ 6005	Experimental Statistics	ININ 4010
ININ 6010	Multiple Regression Analysis	ININ 4010
INQU 6001	Mathematical Methods in Chemical Engineering	N/A

Specialty Area Course Selection List

	Thermal Science	*Machine Science*	*Materials and Manufacturing*	*Bio and Micro-Scale Engineering*
Specialty Area Courses	INME 6001: Advanced Thermodynamics	INME 6048: Continuum Mechanics	INME 6045: Automatic Assembly System	INME 6065: Principles of Biomedical Engineering
	INME 6010: Fluid Mechanics & Convective HT	INME 6019: Fracture Mechanics	INME 6107: Smart Materials and Devices	INME 6115: Biomaterials
	INME 6024: Numerical Analysis Transport Phenomena	INME 6039: Vibrations	INME 6810: Mechanical Fund Electronic Packaging	INME 6810: Mechanical Fundamentals Electronic Packaging
	INME 6055: Heat Conduction and Radiation	INME 6037: Finite Element Analysis	INME 6115: Biomaterials	INME 6160: Principles Micro and Nano Fabrication
		INME 6030: Mechanics of Composite Materials	INME 6160: Principles Micro and Nano Fabrication	INME 6165: BioMEMS
		INME 6748: Solid Mechanics	INME 6046: Design for Product Manufacturability	INME 6170: Design of Microfluidic Systems
		INME 6046: Design for Product Manufacturability	INME 6030: Mechanics of Composite Materials	INME 6135: Tissue Engineering
		INME 6021: Engineering Systems Design		

For a full list of Mechanical Engineering course available to our graduate students, visit us in our website.
http://engineering.uprm.edu/inme/academic/grad/current-graduate-students/courses/list-inme-grad-courses/

Doctoral Program Credit Distribution

Students entering the program with a BS Degree in Mechanical Engineering*

Requirement	Credit	Description
Seminar	1	INME 8017: Doctoral Seminar
Advanced Math	6	See Full List of Advanced Math Courses Above
Specialty Area Courses	12	The focus of the coursework in the Graduate Curriculum is in four (4) Specialty Areas listed as follows: • **Thermal/Fluid Science** • **Machine Science** • **Materials and Manufacturing** • **Bio/Micro-Scale Engineering** Each Specialty Area has a list of courses to choose from (see link below). The student has to approve 3 courses in the selected Specialty Area and 1 course listed as an option under any of the Specialty Areas. See Full List of Specialty Area Courses Above
ME Electives	15	Electives are chosen in consultation with the student's Research Advisor. The following restrictions apply: (1) a maximum of 9 credits of 5000 level courses, (2) INME 5015/5995/5996/6995 courses must be approved by the Graduate Committee.
Free Electives	9	
Dissertation	18	Doctoral Research
Total	61	

* The credit distribution shown is based on a student with a background in Mechanical Engineering. Remedial courses (deficiencies) will be required for students with background in related fields (e.g. Chemical Engineering, Civil Engineering, Electrical Engineering, Physics). The assignment of the deficiencies will be based on the chosen Specialty Area and the courses approved by the applicant as shown in the student's permanent academic record (transcript).

Students entering the program with an MS/MEng Degree**

Requirement	Credit	Description
Seminar	1	INME 8017: Doctoral Seminar
Advanced Math	3	See Full List of Advanced Math Courses Above
Specialty Area Courses	0	The focus of the coursework in the Graduate Curriculum is in four (4) Specialty Areas listed as follows: • **Thermal/Fluid Science** • **Machine Science** • **Materials and Manufacturing** • **Bio/Micro-Scale Engineering** Specialty Area Courses are Transferred from an MS/MEng Degree in Mechanical Engineering at the University of Puerto Rico in Mayagüez (UPRM). For students entering the program with an MS/MEng from other disciplines or academic institutions, see the information listed below this table.** See Full List of Specialty Area Courses Above
ME Electives	6	Electives are chosen in consultation with the student's Research Advisor. The following restrictions apply: (1) a maximum of 9 credits of 5000 level courses, (2) INME 5015/5995/5996/6995 courses must be approved by the Graduate Committee.
Free Electives	9	
Dissertation	18	Doctoral Dissertation
Total	37	

**The credit distribution shown is based on an MS/MEng degree obtained from the Department of Mechanical Engineering at the UPRM. The transfer of credits for students with an MS/MEng degree from other disciplines or accredited academic institutions will be evaluated on a case-by-case basis.

Faculty Distribution per Research Area

Research Area	Mechanical Engineering Faculty
Aerospace and Unmanned Vehicles	• Dr. J. Guillermo Araya • Dr. Vijay Goyal • Dr. Pedro Resto • Dr. David Serrano • Dra. Sheilla Torres
Automation/Mechatronics	• Dr. Fred Just • Dr. Pedro Resto
Bioengineering	• Dra. Silvina Cancelos • Dr. Rubén E. Díaz-Rivera • Dr. Yi Jia • Dr. Pedro Resto • Dr. Paul Sundaram
CAE and Design	• Dr. David Dooner • Dr. Vijay Goyal • Dr. José Lugo • Dr. David Serrano
Fluid Mechanics	• Dr. J. Guillermo Araya • Dra. Silvina Cancelos • Dr. Rubén E. Díaz-Rivera • Dr. Gustavo Gutierrez • Dr. Vikram Pandya • Dr .Orlando Ruiz • Dra. Sheilla Torres
Heat Transfer/Energy Systems	• Dr. J. Guillermo Araya • Dr. Sandra Coutín • Dr. Gustavo Gutierrez • Dr. Francisco Rodriguez • Dr. Orlando Ruiz • Dr. David Serrano • Dra. Sheilla Torres • Dr. Ricky Valentín
Manufacturing	• Dr. Jayanta Banerjee • Dr. Rubén E. Díaz-Rivera • Dr. Pedro Quintero • Dr. Pedro Resto

	• Dr. Lourdes Rosario • Dr. Ricky Valentín
Mechanics of Materials	• Dr. Pablo Caceres • Dr. Vijay Goyal • Dr. Fred Just • Dr. Nestor Perez • Dr. Pedro Quintero • Dr. Paul Sundaram
Micro and Nano Engineering	• Dra. Sylvina Cancelos • Dr. Rubén E. Díaz-Rivera • Dr. Yi Jia • Dr. Pedro Quintero • Dr. Pedro Resto

For a full list of Mechanical Engineering faculty members and their contact information, please visit http://engineering.uprm.edu/inme/people/faculty/

Contact Information

Rubén E. Díaz-Rivera, PhD
Graduate Program Coordinator
Department of Mechanical Engineering
787-832-4040 X2529
rubene.diaz@upr.edu
http://engineering.uprm.edu/inme/academic/grad/

Mrs. Yolanda Pérez
Academic Orientation Officer
787-832-4040 X 2362/2560
yolanda.perez4@upr.edu

Ms. Denisse Negrón
Academic Affairs Administrative Secretary
787-832-4040 X5884
denisse.negron2@upr.edu