

# MATERIALS SCIENCE AND ENGINEERING MASTER'S PROGRAMS

## Program Description

The MSE graduate program was designed as an interdisciplinary venture that would attract highly qualified graduate students, considered as backbone of any research in academia. Although there are several UPRM departments involved in MSE research, there is no appealing accretion program available on this area. Without easy access to graduate students, it is virtually impossible for the faculty to justify the need to setup laboratories where they can conduct research. Therefore, the proposed program offers specialization in the different fields of materials science such as materials selection, nanostructured materials, magnetic materials, electronic materials, bio-materials, materials characterization, materials recycling, etc. Many of the courses offered in each of the concentrations are to be available to graduate students in other UPRM graduate programs.

The Materials Science and Engineering (MSE) program confers two degrees, depending on the plan of study selected by the participating student: a) Master of Science; and b) Master of Engineering. There are three plans of study available:

- Plan I (Master of Science): 37 credit-hour program including research thesis
- Plan II (Master of Engineering): 37 credit-hour program including a project
- Plan III (Master of Engineering): 37 credit-hour program with courses only.

## Curricular Structure

The following tables provide examples of course line-up for the expected two-year endeavor according to the Plan selected.

### Plan I

<b>First Semester</b>		10crd
INGE 6001 Fundamentals of Advanced Materials (Core)	4crd	
INGE 6002 Structure and Properties of Materials (Core)	3crd	
INGE 6008 Diffractometry and Complementary Techniques	3crd	
<b>Second Semester</b>		9crd
INGE 6004 Kinetics and Phase Transformation	3crd	
INGE 6005 Thermodynamics and Phase Equilibria	3crd	
INGE 6003 Fundamentals of Materials Chemistry	3crd	

<b>Third Semester</b>		10crd
INGE 6012 Nanostructured Materials	3crd	
INME 6016 Mechanical Metallurgy	3crd	
INCI 6064 Advanced Concrete Technology	3crd	
INGE 6017 Graduate Seminar	1crd	
<b>Fourth Semester</b>		6crd
INGE 6099 Master's Thesis	6crd	

### Plan II and Plan III

<b>Plan II</b>	<b>Plan III</b>		
<b>First Semester</b>	<b>First Semester</b>		10crd
INGE 6001 Fundamentals of Advanced Materials (Core)		4crd	
INGE 6002 Structure and Properties of Materials (Core)		3crd	
INGE 6008 Diffractometry and Complementary Techniques		3crd	
<b>Second Semester</b>	<b>Second Semester</b>		9crd
INGE 6004 Kinetics and Phase Transformation		3crd	
INGE 6005 Thermodynamics and Phase Equilibria		3crd	
INGE 6003 Fundamentals of Materials Chemistry		3crd	
<b>Third Semester</b>	<b>Third Semester</b>		10crd
INGE 6012 Nanostructured Materials		3crd	
INME 6016 Mechanical Metallurgy	INGE 6006 Diffusion Phenomena in Materials	3crd	
INCI 6064 Advanced Concrete Technology	INGE 6010 Materials Microprocessing and Engineering	3crd	
INGE 6017 Graduate Seminar		1crd	
<b>Fourth Semester</b>			6crd
INGE 6998 Master's Project	INME 6016 Mechanical Metallurgy	6crd	
INGE 5065 Materials Selection	INCI 6064 Advanced Concrete Technology		

### Overview

It is understood that with these titles, traditional and modern areas of materials science and engineering are covered (metals, ceramics, polymers, semiconductors, composites, magnetic

materials, and their mechanical as well as physical and chemical behavior). These areas are of interdisciplinary character, that is, the topics are relevant to mechanical, chemical, industrial, electrical and civil engineering, as well as physics, chemistry and computer science. The program targets materials synthesis and processing, device modeling, device fabrication and applied and computational materials and mechanics.

It is expected that the program will have considerable impact on the growth and development of Puerto Rican industry in design, fabrication, characterization of materials and product evaluation and in achieving so, it will be serving its community in vital areas, consistent with UPRM's mission. All efforts to set up the program are, therefore, a genuine investment in the future of this university and Puerto Rico.

Industrial environments are teamwork-oriented, where graduates from various conventional engineering disciplines need to interact and work with each other. Therefore, many professionals prefer an interdisciplinary graduate program such as the one proposed. As mentioned, MSE shares many aspects of its discipline with civil, mechanical, electrical, industrial and chemical engineering, and with chemistry, mathematics and computer science, and physics among other basic sciences. Their respective departments or programs sometimes do not offer the environment where students can pursue special interests of interdisciplinary nature. The strong emphasis on research in this program is the key factor in the student success rate in industry or in a research institution.

Puerto Rican industry and the government realize that a research base is required to gain competitiveness in the global market. In particular, MSE expertise is critical in the world market today, as the demand for new materials such as, semi-conductors, smart construction materials to high technology composite materials for aircrafts grows at an exponential rate. The mechanical behavior of materials makes the backbone of structural mechanics, machine design and biomechanics among others areas. Mechanical, structural, aerospace, materials, and chemical engineering, depend on the mechanics of materials to design, analyze and fabricate increasingly complex products.

Accordingly, this MSE graduate program is to benefit the industry and government of Puerto Rico by offering the following:

- Advanced technical skills and research experience in material selection, testing and design, materials engineering, device fabrication, smart materials and mechanic of materials.
- A flexible graduate program where professionals from industry can customize their graduate studies, which can be completed within an attractive time-frame for the employers.
- An interdisciplinary program where faculty and students of various science and engineering departments can participate, conduct research and learn from each other.
- Attract well-prepared MSE faculty, making UPRM even more effective in academic research and community service in a high demand, high profile and well-funded field.

All these goals can be achieved with the proposed graduate program, placing PR students on equal footing with the rest of the professionals in the country. The master's degree will also prepare and encourage students to pursue doctoral degrees.

### *Number of graduate assistantships*

For the first year of the program one should expect at least 10 students enrolled (all Plans). As the program starts with an introductory line-up of courses (three new ones per semester), five graduate students are expected to enroll in the first semester while five more would move from other related programs. These latter groups is formed by students who are already working on MSE research who perceive the academic formation offered by the program more aligned with their career goals. Of the first cohort of 10, it is believed that 6 to 8 could be enrolled in Plan I. These are the ones that would require sponsorship, i.e. graduate assistantship upon the first and ensuing years of the program. To support their research endeavor leading to a thesis, they will have to be supported either with external funding or institutional moneys.

### *Plan for graduate assistantships*

It is estimated that of the aforementioned 8 yearly assistantships (to initiate the program), four would be supported by existing and upcoming federal grants. Therefore, there is the need for four more assistantships provided by the institution. Naturally, if more federal and local grants are obtained, the program will expand; yet, the need of institutional support may not diminished. In effect, more often in the last years, federal grants (as those awarded by NSF, for instance) require that stipends and assistantships budgeted in the funded proposals be restricted to US citizens, US nationals and –not always- permanent residents. In Puerto Rico and the mainland, a strong component of graduate programs is the participation of foreign nationals. At UPRM, those international students are frequently from Latin American nations. The impossibility of defraying their participation with federal monies is obliging that, in order to support research, those foreign nationals be awarded institutional assistantships. For this reason, it is not foreseen that such institutional investment should lessen in the upcoming years of the program.

### **Courses**

The following list of courses will be offered for the master's program

#### Core Graduate Level Courses

**INGE 6001 Fundamentals of Advanced Materials**

**INGE 6002 Structure and Properties of Materials**

**INGE 6004 Kinetics and Phase Transformation**

**INGE 6005 Thermodynamics and Phase Equilibria**

**INGE 6008 Diffractometry and Complementary Techniques**

**INGE 6011 Computational Materials Science**

**INGE 6007 Polymer Science & Engineering**

**INGE 6003 Fundamentals of Materials Chemistry**

**INGE 6012 Nanostructured Materials.**

**INGE 6010 Materials Microprocessing and Engineering**

**INGE 6006 Diffusion Phenomena in Materials**

**INGE 6009 Solidification Processes**

**INGE 6995 Selected Topics**

Other Advanced Undergraduate Elective Courses (existing courses)

**INGE 5066 Recycling of Materials**

**INGE 5065 Materials Selection**

**QUIM 5125 Chemical Thermodynamics**

**QUIM 5165 Polymer Chemistry**

**INME 5008 Corrosion**

**INME 5018 Materials Failure Analysis**

**INME 5025 Metals Fatigue**

Other Graduate Level Elective Courses (existing courses)

**INEL 6055 (FISI 5011) Introductory Solid State Devices**

**INEL 6075 Solid State Device Fabrication and Technology**

**INME 6015 Dislocation Theory**

**INME 6016 Mechanical Metallurgy**

**INME 6030 Mechanics of Composite Materials**

**INME 6009 Advanced Manufacturing Processes**

**INME 6019 Fracture Mechanics**

**INME 6037 Finite Element Analysis I**

**INCI 6023 Analysis of Structures of Composite Materials**

**INCI 6064 Advanced Concrete Technology**

**INCI 6057 Theory of Elasticity**

**INCI 6018 Finite Element Analysis II**

## Faculty

The following is a list of the members of the MSE Committee along with their academic preparation

Prof. Bárbara Calcagno	B.S., Chemical Engineering, Universidad Simón Bolívar, Venezuela, 1977 M.S., Chemical and Biochemical Engineering, University of Pennsylvania, 1981 Ph.D., Materials Science, University of Wisconsin-Madison, 2010
Prof. Yang Li	B.S., Physics, University of Science and Technology, Beijing, China, 1984 M.S., Materials Physics, University of Science and Technology, Beijing, China, 1989 Ph.D., Materials Physics, University of Science and Technology, Beijing, China, 1993
Prof. Carlos Marín	B.S., Physics of Materials, Universidad Autónoma de Madrid, Spain, 1992 M.S., Physics of Materials, Universidad Autónoma de Madrid, Spain, 1994 Ph.D., Physics of Materials, Universidad Autónoma de Madrid, Spain, 1997 Ph.D., Mechanical Engineering, Rensselaer Polytechnic Institute, 2002
Prof. Agnes Padovani	B.S., Chemical Engineering, University of Puerto Rico - Mayagüez, 1997 Ph.D., Chemical Engineering, Georgia Institute of Technology, 2002
Prof. Oscar Perales	B.S., University of Engineering, Lima, Perú, Metallurgical Engineering, 1986 Dr. Eng., Tohoku University, Sendai, Japan, Materials Processing, 1998
Prof. Jeannette Santos	B.S., University of Puerto Rico - Mayagüez, Chemical Engineering, 1980 M.S., University of Wisconsin - Madison, Chemical Engineering, 1982 Louisiana State University - Baton Rouge, Chemical Engineering, Ph.D. 1995
Prof. Oscar Marcelo Suárez (coordinator)	B.S., Universidad Nacional de Córdoba, Argentina, Aeronautical & Mechanical Engineering, 1984 M.S., University of Wisconsin-Madison, Metallurgical Engineering, 1993 Ph.D., University of Wisconsin-Madison, Metallurgical Engineering, 2000
Prof. Oswald Uwakweh	B.S., University of Ibadan, Nigeria, Mechanical Engineering, 1981 M.S., University of Nancy, France, Materials Science and Engineering, 1985 Ph.D., University of Nancy, France, Materials Science and Engineering, 1990

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