



University of Puerto Rico
Mayagüez Campus
College of Engineering
Department of Mechanical Engineering
M.S./Ph.D. in Mechanical Engineering



Course Syllabus

1. General Information: Alpha-numeric codification: INME 6160 Course Title: Fundamentals of Micro and Nanofabrication Number of credits: 3 Contact Period: Three hours of lecture and three hours of laboratory per week
2. Course Description: English: Discussion and application of micro and nanofabrication techniques as applied to micro- electro-mechanical systems (MEMS) and nano- electro-mechanical systems (NEMS), such as photolithography, subtractive and additive techniques, surface and bulk micromachining, soft lithography and non-conventional fabrication techniques. Hands-on laboratory experience on mask design, photolithography, surface micromachining and soft lithography. Spanish: Discusión y aplicación de técnicas de micro y nanofabricación como aplica a sistemas micro-electro-mecánicos y nano-electro-mecánicos, como fotolitografía, técnicas de sustracción y adición de material, micromaquinado de superficie y en masa, litografía suave, y técnicas de fabricación no convencionales. Experiencia de laboratorio en diseño de máscaras, fotolitografía, micromaquinado de superficie y litografía suave.
3. Pre/Co-requisites and other requirements: Pre-requisite: Authorization of the Director of the Department
4. Course Objectives: <ul style="list-style-type: none">• Grasp the process of photolithography.• Describe subtractive and additive pattern transfer processes.• Describe and compare bulk and surface micromachining.• Describe and compare non-conventional fabrication technologies.• Create micro-devices based on photolithography.• Apply the theory in the laboratory.
5. Instructional Strategies: <input checked="" type="checkbox"/> conference <input type="checkbox"/> discussion <input type="checkbox"/> computation <input checked="" type="checkbox"/> laboratory <input type="checkbox"/> seminar with formal presentation <input type="checkbox"/> seminar without formal presentation <input type="checkbox"/> workshop <input type="checkbox"/> art workshop <input type="checkbox"/> practice <input type="checkbox"/> trip <input type="checkbox"/> thesis <input type="checkbox"/> special problems <input type="checkbox"/> tutoring <input type="checkbox"/> research <input type="checkbox"/> other, please specify:

6. Minimum or Required Resources Available:

Access to the Micro and Nano Devices Research Laboratory (Research and Development Center, Building H-365) and the Biosensing and Microfluidics Research Laboratory (Lucchetti 123).

7. Course time frame and thematic outline

General Topics	Contact Hours
Lithography	8
Pattern transfer with dry etching	4
Pattern transfer with additive techniques	4
Wet bulk micromachining	5
Surface micromachining	5
Soft lithography	2
X-ray lithography	2
Electron beam lithography	2
Miniaturization applications and case studies	12
Laboratory	45
Total hours: (equivalent to contact period)	90

8. Grading System

Quantifiable (S/NS) Not Quantifiable

9. Evaluation Strategies

	Quantity	Percent
<input type="checkbox"/> Exams		
<input type="checkbox"/> Final Exam		
<input type="checkbox"/> Short Quizzes		
<input type="checkbox"/> Oral Reports		
<input type="checkbox"/> Monographies		
<input type="checkbox"/> Portfolio		
<input checked="" type="checkbox"/> Projects	2	40
<input type="checkbox"/> Journals		
<input checked="" type="checkbox"/> Other, specify: Assignments	3-5	30
Lab Reports	3	30
TOTAL:		100%

10. Bibliography:**Textbook:**

- Madou, M.J., (2011) Manufacturing techniques for microfabrication and nanotechnology (Vol. 2), CRC Press, Boca Raton, FL. (**)

Other References:

- Madou, M.J., (2011) From MEMS to Bio-MEMS and Bio-NEMS: Manufacturing Techniques and Applications (Vol. 3), CRC Press, Boca Raton, FL.
- Madou, M.J., (2011) Solid-State Physics, Fluidics, and Analytical Techniques in Micro- and Nanotechnology (Vol. 1), CRC Press, Boca Raton, FL.
- Chakraborty, S., (2010) Microfluidics and microfabrication, Springer, New York, NY.
- Adams, T.M., (2010) Introductory MEMS: fabrication and applications, Springer, New York, NY.

- Folch, A., (2013) Introduction to BioMEMS. CRC Press, Boca Raton, NY.
- Zhang, D., (2013) Advanced mechatronics and MEMS devices, Springer, New York, NY.
- Kovacs, G., (1998) Micromachined Transducers Sourcebook, McGraw-Hill, New York, NY. (**)
- Rai-Choudhury, P., Ed., (1997) Handbook of Microlithography, Micromachining, and Microfabrication. Volume 1: Microlithography, SPIE Press, Bellingham, WA. (*)
- Rai-Choudhury, P., Ed., (1997) Handbook of Microlithography, Micromachining, and Microfabrication. Volume 2: Micromachining and Microfabrication, SPIE Press, Bellingham, WA. (*)

* These are classical handbooks

** These books are key classic references and remain as the top books for the subjects covered in the course and there are no up-to-date textbooks to substitute these books.

11. Law 51: The Comprehensive Educational Services Act for People with Disabilities:

States that after identifying with the instructor and the institution, the student with disabilities will receive reasonable accommodation in their courses and evaluations. For more information, contact the Department of Counseling and Psychological services at the Office of the Dean of Students (Office DE 21) or call 787-265-3864 or 787-832-4040 x 3772, 2040 and 3864.

12. Academic Integrity

The University of Puerto Rico promotes the highest standards of academic and scientific integrity. Article 6.2 of the UPR Students General Bylaws (Board of Trustees Certification 13, 2009-2010) states that academic dishonesty includes, but is not limited to: fraudulent actions; obtaining grades or academic degrees by false or fraudulent simulations; copying the whole or part of the academic work of another person; plagiarizing totally or partially the work of another person; copying all or part of another person answers to the questions of an oral or written exam by taking or getting someone else to take the exam on his/her behalf; as well as enabling and facilitating another person to perform the aforementioned behavior. Any of these behaviors will be subject to disciplinary action in accordance with the disciplinary procedure laid down in the UPR Students General Bylaws. —

13. Certification 06-43 of the Academic Senate

"The academic guidelines for offering online courses," defines: Traditional face-to-face courses are those that have less than 25% of the course's regular contact hours via the Internet. Therefore, a three-credit course will be considered "face to face" if, of the 45 hours of regular contact, 11 or less are taught via the Internet. According to certification 06-43 of the Academic Senate, a course may include up to 25% of its total contact hours via the Internet. The objective of this is so that all professors have this alternative in the case of any unscheduled eventuality.

14. Sexual Harassment: Certification 130-2014-2015 states:

Sexual harassment in the workplace and in the study environment is an illegal and discriminatory act and is against the best interests of the University of Puerto Rico. All persons who understand they have been subject to acts of sexual harassment at the University of Puerto Rico may file a complaint and request that the institution investigate, where necessary, and assume the corresponding action by the university authorities. If the complainant is a student, he or she must refer his or her complaint to the Office of the Student Ombudsperson or that of the Dean of Students.