



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



## **Course Syllabus**

<b>1. General Information:</b>
Alpha-numeric codification: INME 6165 Course Title: Design of Microfluidic Systems Number of credits: 3 Contact Period: Three hours of lecture per week
<b>2. Course Description:</b>
English: Discussion of advanced concepts and technologies of micro-scale flows. Analysis of microfabrication techniques, special cases of the Navier-Stokes equations, inertial microfluidics, capillary effects, droplet microfluidics, electrokinetics, acoustofluidics, optofluidics, nanofluidics, and transport phenomena in micro-scale flows. Determination of design parameters and optimization of micro-scale fluidic structures based on analytical and computational solutions of the Navier-Stokes, energy, and mass transport equations.
Spanish: Discusión de conceptos avanzados y tecnologías de flujos en la micro-escala. Análisis de técnicas de microfabricación, casos especiales de las ecuaciones de Navier-Stokes, microfluidos inerciales, efectos capilares, microfluidos de gotas, electrocinéticos, acoustofluidicos, optofluidicos, nanofluidicos y fenómenos de transporte en flujos en la micro-escala. Determinación de los parámetros de diseño y optimización de las estructuras fluidicas en la micro-escala basado en soluciones analíticas y computacionales de las ecuaciones de Navier-Stokes, energía y transporte de masa.
<b>3. Pre/Co-requisites and other requirements:</b>
Pre-requisite: Authorization of the Director of the Department
<b>4. Course Objectives:</b>
<ul style="list-style-type: none"><li>• Describe the fabrication methods of microfluidic systems.</li><li>• Grasp the important forces at play in micro-scale devices.</li><li>• Study the behavior of fluids at the micro-scale based on the Navier-Stokes equations. Design microfluidic devices based on transport phenomena equations.</li></ul>
<b>5. Instructional Strategies:</b>
<input checked="" type="checkbox"/> conference <input type="checkbox"/> discussion <input type="checkbox"/> computation <input 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:
<b>6. Minimum or Required Resources Available:</b>
None

**7. Course time frame and thematic outline**

<b>General Topics</b>	<b>Contact Hours</b>
Introduction to BioMEMS and Microfluidics	1.5
Manufacturing of Micro Systems	3
Basic Concepts and Governing Equations	3
Basic Flow Solutions	3
Resistance, Compliance, Circuit Analysis	3
Inertial Microfluidics, PIV	3
Capillary Effects	1.5
Two-phase flow, droplet microfluidics	3
Electrodynamics and Electroosmosis	3
Dielectrophoresis	1.5
Magnetophoresis	1.5
Thermal transfer, Convection – Diffusion	3
Acoustofluidics & Optofluidics	3
COMSOL Workshop	3
Microfabrication Lab Walkthrough + Soft lithography	4.5
Proposal + Project Presentations	4.5
<b>Total hours: (equivalent to contact period)</b>	<b>45</b>

**8. Grading System**

Quantifiable (S/NS)  Not Quantifiable

**9. Evaluation Strategies**

	<b>Quantity</b>	<b>Percent</b>
<input type="checkbox"/> Exams		
<input type="checkbox"/> Final Exam		
<input type="checkbox"/> Short Quizzes		
<input checked="" type="checkbox"/> Oral Reports	<b>1</b>	<b>15</b>
<input type="checkbox"/> Monographies		
<input type="checkbox"/> Portfolio		
<input checked="" type="checkbox"/> Projects	<b>1</b>	<b>15</b>
<input type="checkbox"/> Journals		
<input checked="" type="checkbox"/> Other, specify: Assignments	<b>4-6</b>	<b>60</b>
Project Proposal	<b>1</b>	<b>10</b>
<b>TOTAL:</b>		<b>100%</b>

**10. Bibliography:**

**Textbook:**

- Folch, A., (2013) Introduction to BioMEMS. CRC Press, Boca Raton, NY.
- Bruus, H., (2008) Theoretical Microfluidics, Oxford University Press, New York, NY. (\*\*)

**Other References:**

- Kirby, B., (2010) Micro- and nanoscale fluid mechanics : transport in microfluidic devices, Cambridge University Press, Cambridge, UK.
- Madou, M.J., (2011) Manufacturing techniques for microfabrication and nanotechnology (Vol. 2), CRC Press, Boca Raton, FL.

- 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.

\*\* 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.

*Revised: February, 2019*