EEC245 (EMS245 & ECH245) – Micro- and Nano-technology in Life Sciences

4 units

Course Format: 4 hours (Lecture, discussion session, and hands-on demonstrations when applicable)

Prerequisite: Graduate Standing

Grading: Letter

Evaluation: The final grade will be based on homework assignments (30%), a take-home mid-term exam (25%), a final project report (25%), and in-class presentations (20%). For the final project, students will be asked to identify a biomedical research problem and propose a detailed research plan to study the selected problem employing the miniaturization techniques covered in class. The project report will be formatted to serve as a foundation for pre-doctoral fellowship applications, thereby training students on essential proposal writing skills.

Expanded Course Description

Integration of microfabrication tools, nanotechnology, and life sciences have generated powerful tools to study biological questions, as well as to diagnose and treat diseases. The unifying objective of this interdisciplinary course is to attract students with different academic backgrounds and train them to be conversant across multiple disciplines, including mechanical, electrical, and biomedical engineering, as well as materials science. At the end of this course, students are expected to acquire the basic skills to approach complex biomedical problems. This objective will be executed in five synergistic components:

1. **Micro- and Nano-Manufacturing**. We will examine the key micro- and nano-fabrication techniques and discuss relevant processing and characterization instruments. There will be a special emphasis on the challenges and design considerations in process development.
2. **Surface Science and Mass Transfer.** We will review techniques to engineer advanced surfaces by modulating morphology and chemistry. In addition, we will discuss 3D morphology and its implications on molecular transport within and from functional device coatings.
3. **Devices.** We will survey important device components such as biosensors and actuators that are built using the tools discussed in Sections 1 and 2. We will examine the instrumentation required to operate such devices. Cutting-edge approaches to build multi-functional devices will be presented.
4. **Biological Interface.** Following an introduction to basic biology and biochemistry, we will study how living organisms interact with inorganic devices. We will emphasize the ways tissues respond to biomedical devices and how this response can be tuned by modulating device properties.
5. **Applications.** The fundamental knowledge acquired up to this point will be put in context by deconstructing existing and developing technologies. Examples will include bioimplantable devices for treating medical disorders. Additional examples will be discussed in accordance with the interests of the class.

Textbooks: Relevant reading material and exercises will be provided by the instructor.

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