FALL 2023 RUTGERS

TOPICS IN ECE 14:332:436:06 (Biomedical Technologies: Design & Development)
16:332:598:01 (Biomedical Technologies: Design & Development)

1. COURSE DESCRIPTION:

This is an interdisciplinary course that introduces students to the field of biomedical technologies. Students learn fundamental concepts in the areas of bioelectrical engineering, point-of-care sensors, fabrication, micro/ nano technologies, microfluidics, data processing, and global healthcare applications. The course will provide a detailed background on the engineering principles used for biosensor development. Sensor fabrication and characterization of the point-of-care biosensors will be taught. The course also will also introduce students to the on-chip sample processing, surface functionalization techniques, label-free detection of biomolecules, instrumentation, and data processing. Course will highlight the development of personalized predictive systems for health care using machine learning techniques. Course also includes case studies of point-of-care sensors. The course is cross listed for senior undergraduates and starting graduate students.

2. LOGISTICS:

Instructor: Dr. Umer Hassan
Credits: 3
Classes: Tuesdays/ Fridays @ 12:10PM – 1:30PM @ SEC-216

Contact info:
Email: umer.hassan@rutgers.edu Office: EE-215
Ph: (848) 445-2164
Webpage: www.hassan.rutgers.edu

Office hours: TBA

3. COURSE MATERIALS:

Course Website: https://rutgers.instructure.com/courses/243675

1. All lecture videos or slides will be posted on Canvas for your access.
2. No textbook is required.
3. Supplementary notes/ papers will be provided by the instructor.
4. A personal computer/ laptop is required to view the lectures and complete any assignments.

4. PRE REQUISITIES:

No specific pre-requisites are needed for school of engineering (SoE) senior undergraduate and graduate students. Course is designed toward engineering students, senior undergraduate or beginning graduate students.

Note: *Outside SOE, any interested students please contact instructor at (umer.hassan@rutgers.edu) to inquire about the course and specific pre-requisites topics needed and obtain registration permission*.

5. COURSE LEARNING OBJECTIVES:

Educational/ Content-based objectives:

1. Students will be exposed to the interdisciplinary areas.
2. Students will learn fundamental biosensing principles in point-of-care sensors.
3. Students will learn design, development, and characterization of biosensors.
4. Students will learn assay integration for a point-of-care sensor.
5. Students will learn biochemical, bioelectrical, structural, optical, and acoustic sensing methodologies.
6. Students will learn bottom-up approach of a biosensor design for diagnostic applications.
7. Students will learn the instrumentation, data processing, and machine learning integration with sensors.
8. Students will learn the commercialization and regulatory approaches for the biosensors.
9. Finally, course aims to instill “need-driven” based critical thinking in students to solve biomedical challenges using engineering principles.

Skill-based objectives:

1. Students will be prepared for a commercial job in the areas of biosensors, BioMEMS, and global health.
2. Students will be prepared for graduate school research.
3. Students will learn group participation and project development.
4. Students will learn how to write a technical report in this field.
5. To further develop the students’ ability for effective communication, presentation, and group participation.

6. TOPICS COVERED (TENTATIVE):

#	Topics
1	1. Course overview 2. Introduction to unmet needs in the global healthcare 3. Role of biomedical technologies
2	1. Introduction to point-of-care biomedical technologies 2. Richard Feynman lecture & intro to micro-nano technologies
3	1. Role of biomarkers in sensing 2. Quick review of biology (cells, proteins, DNA/RNA) 3. Disease progression (e.g., HIV/AIDS and Cancer)
4	1. Stepwise process for a modular design of a point-of-care (POC) biomedical sensor 2. Case study
5	1. Microfabrication techniques (SU-8 lithography) 2. Rapid prototyping and additive manufacturing
6	1. Biological samples collection 2. Relevant biomarkers for biomedical technologies 3. Biosafety practices
7	1. Introduction to microfluidics 2. Unique architecture design for on-chip sample processing 3. Simulations in COMSOL
8	1. Electrical biosensing principles 2. Electrochemical, conductance, and impedance sensors
9	1. Optical biosensing principles (fluorescence detection & Raman spectroscopy) 2. Fluorescence Microscope and Flow Cytometer
10	1. Specific leukocytes capture and counting 2. Surface functionalization and proteins quantification 3. DNA identification and PCR assays
11	1. Instrumentation design and signal processing 2. Biostatistics to evaluate performance of biosensors

12	1. Multiplexing biomedical technologies 2. Nanoparticles for sensing
13	1. Clinical data integration with biosensors 2. Machine learning for predictive healthcare prognostics
14	1. Commercialization of biomedical technologies 2. FDA regulatory approaches for medical devices

7. STUDENT ASSESSMENT AND COURSE GRADING (Tentative):

- 5miniexams(5x5%=25%)
- 7 homework assignments (7 x 5% = 35%)
- 1 class project (report + presentation) (30%)
- 1 mini-presentation (10%)

8. COURSE POLICIES

8.1. Policy on late work submission

• Late work is eligible for 50% of original points (applicable only to first late submission submitted within 1-week after the deadline and only assignments)

8.2. Extension of assignment deadlines

Deadline extension to submit any assignment can be granted due to the following reasons:

- Documented illness
- Varsity athletic commitments
- Observance of religious holidays
  Note: *Extension request (an email to instructor) will be sent prior to the deadline except for medical emergencies*.

8.3. Disability accommodation:

In case of any disabilities with requirement of any special accommodation request in the class, instructor encourages the student to Rutgers Office of Disability Services (ODS; ods.rutgers.edu) for a Letter of Accommodation (LOA). On receipt of the LOA, instructor will implement the ODS accommodation recommendation for the student.

8.4. Academic integrity policy:

It is recommended that students will review **Academic Integrity Policy.** Any violations to this policy will be reported to Office of Student Conduct (New Brunswick).
Note: *If you put in hard work, you have what it takes to succeed in this course. Don't engage in academic misconduct and jeopardize the hard work you've put into this course*.

Policy: http://nbacademicintegrity.rutgers.edu