BME 595 - Special Topics in Biomedical Engineering - Graduate Courses

Note: All BME 595 courses listed below fulfill Biomedical Engineering course distribution credit.

AY 2024-2025

Fall Semester 2024

BME 595-F01 ST: Value Creation for Graduate Research

Instructor: George Pins / Len Polizzotto

Credit: 1

This course will introduce students to the principles of innovation and its 5 disciplines. Students will learn to determine true end-users need, development of a value proposition based on these needs, how to iterate and participate in value creation forums. The goal of the course to ensure that all student research projects are creating sustained value for society.

BME 595-F02 ST: Medical Devices for Global Health

Instructor: Solomon Mensah

Credit: 3

This course will aim to combine entrepreneurship principles, business models, evident based customer discovery techniques and general product development protocols for the development of medical devices for use in low resource areas.

ME 595-F03 ST: Computational Modeling for Biofluid and Medical Devices

Instructor: Zhenglun Alan Wei

Credit: 3

This course covers computational modeling for studying biofluid mechanics in pathophysiological systems with a focus on the cardiovascular system. Students will learn about analytical and computational methods for solving problems related to biofluid mechanics and how to apply these methods to developing and testing medical devices. Students will complete a project related to course content using commercial and/or open-source software.

Recommended Background: Intermediate experience in programming (MATLAB or another programming language) and knowledge of fluids (e.g., ES 3004) or biofluids (e.g., BME 4606).

BME 595-B01 ST: Biomedical Signal Analysis

Instructor: Len Polizzotto

Credit: 2

Introduction to biomedical signal processing and analysis. Fundamental techniques to analyze and process signals that originate from biological sources: ECGs, EMGs, EEGs, blood pressure signals, etc. Course integrates physiological knowledge with the information useful for physiologic investigation and medical diagnosis and processing. Biomedical signal characterization, time domain analysis techniques (transfer functions, convolution, auto- and cross-correlation), frequency domain (Fourier analysis), continuous and discrete signals, deterministic and stochastic signal analysis methods. Analog and digital filtering.

This course follows BME4011. Students may not receive credit for both. Students taking the graduate version will have modified assignments.

Spring Semester 2025

BME 595-S01 – ST: Biofabrication

Instructor: Yonghui Ding

Credit: 3

Biofabrication involves utilizing living cells and biomaterials as building blocks, harnessing advanced manufacturing technologies to create biological systems. This course delves into the principles of biofabrication, fostering an appreciation for the intricate biological systems that govern our bodies. It offers an overview of various manufacturing processes, including 3D printing, and explores biomaterials for creating in vitro tissue models and scaffolds essential for tissue regeneration. Covering the fundamentals of micro/nano fabrication and 3D printing techniques, the course also discusses the challenges associated with transitioning from traditional 3D printing to the more intricate 3D bioprinting process. This includes considerations such as the development of bioinks and the precise control of processing conditions. The course concludes by examining cutting-edge examples of how biofabrication is presently advancing from laboratory research to practical applications in healthcare. As part of the course, students will have the opportunity to design and manufacture a tissue scaffold using 3D printing techniques, engaging in a hands-on project that reinforces their understanding of biofabrication principles.

Course Topics:
1. Introduction to Biofabrication
2. Micro/Nano fabrication (photolithography and soft lithography)
3. 3D and 4D printing techniques
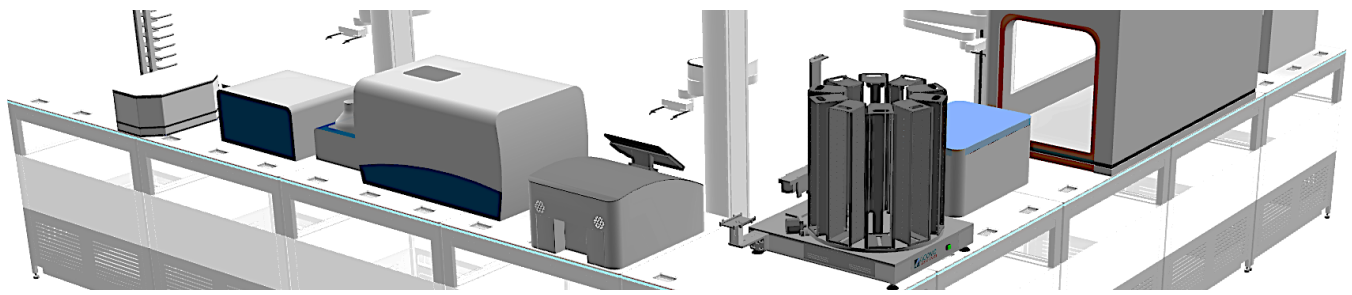4. Biomaterials and bioinks for biofabrication

5. Applications of biofabrication in tissue models (organoids, organ-on-chip)
6. Applications of biofabrication in regenerative scaffolds

BME 595-S02 ST: Advanced Lab Automation & Screening

Instructor: Ross Lagoy

Credit: 3

In this special topic course, students will explore the cutting-edge and interdisciplinary field of automated laboratory systems, gaining essential fundamental skills for careers in industries such as biotechnology, drug discovery, and research. Through hands-on experiences and advanced discussions, students will delve into topics ranging from automated high-throughput assay development to cloud laboratory solutions. By the end of the course, students will be prepared to excel at the intersection of scientific, technical, and business management roles within diverse sectors, including biotechnology and pharmaceutical companies, start-ups, and academic or non-profit research institutions.

ST BME 595: ADVANCED LABORATORY AUTOMATION & SCREENING (ALAS)
Spring Semester 2025

Objective: In this special topic course, students will explore the cutting-edge and interdisciplinary field of automated laboratory systems, gaining essential fundamental skills for careers in industries such as biotechnology, drug discovery, and research. Through hands-on experiences and advanced discussions, students will delve into topics ranging from automated high-throughput assay development to cloud laboratory solutions. By the end of the course, students will be prepared to excel at the intersection of scientific, technical, and business management roles within diverse sectors, including biotechnology and pharmaceutical companies, start-ups, and academic or non-profit research institutions.

Instructor: [in] Prof. Ross Lagoy, ross.lagoy@wpi.edu

Recommended Background: Biological and chemical experimental design, engineering, basic programming skills, data analysis.

Textbook: No textbook is required. Materials will be distributed through Canvas and GitHub.

**Recommended References**: NIH Assay Guidance Manual, Python Docs, SLAS, SiLA, hybrid tutorials.

Grading: Grades will be based on the final project, presentations, assignments, and participation.

Final Project: Students will translate a manual assay into an automated workflow. Students can choose their own project topics. Detailed guidelines will be provided. Projects should be approved by the semester break, and will conclude with formal presentations and an industry standard report.

```
# commands
left_pipette.pick_up_tip()
left_pipette.aspirate(100, plate["A1"])
left_pipette.dispense(100, plate["B2"])
left_pipette.drop_tip()
```


Proposed Schedule:

Week 1: Course overview, intro to lab automation
Week 2: Assays and instrumentation
Week 3: Programming and software in the lab
Week 4: LIMS, data integration (w/industry guest)
Week 5: Workflow mapping and project design
Week 6: Business case discussion (w/industry guest)
Week 7: High-throughput assay design
--break--
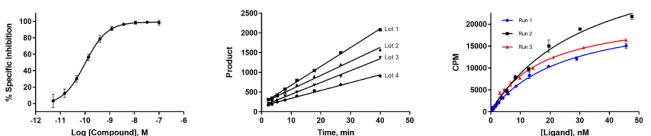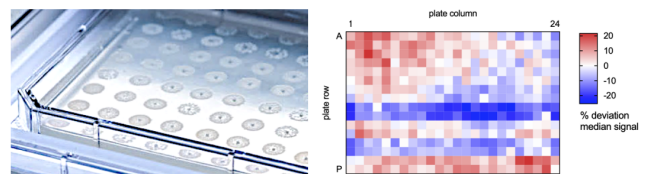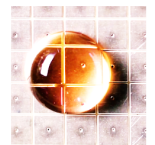
Week 8: Screening (w/industry guest)
Week 9: Human-robot interaction
Week 10: Robotic modules, work cell integration
Week 11: Virtual and cloud lab networks
Week 12: Digital twins (w/industry guest)
Week 13: AI and the lab of the future
Week 14: Project Presentations