San José State University, Biomedical Engineering Department
BME 254, Microscale Biomedical Systems: Physics and Applications, Fall 2020

Course and Contact Information

Instructor:	Prof. Melinda Simon
Office Location:	Engineering Building, E233 M
Telephone:	(408) 924-3956
Email:	melinda.simon@sjsu.edu
Office Hours:	TBA, held online via Zoom
Class Days/Time:	Th 6:00-8:45 pm
Classroom:	Class meetings will be held via Zoom.
Prerequisites:	BME 117, Math 123 or Math 133A, and graduate standing; or instructor consent

Course Format

Technology Intensive, Hybrid, and Online Courses

This course meets for one, online 3-hour session per week. The session will be broken up into various activities consisting of some lecture, problem solving using COMSOL and/or MATLAB, and discussions of a journal article or review paper. MATLAB (or Octave) and COMSOL will be required to complete homework assignments.

Faculty Web Page and MYSJSU Messaging

Course materials such as syllabus, handouts, notes, assignment instructions, etc. can be found on Canvas Leaning Management System course login website at http://sjsu.instructure.com. You are responsible for regularly checking with the messaging system to learn of any updates.

Course Description

Introduction to microscale physics and phenomena used in biomedical systems; analytical techniques and diagnostic applications. Course will discuss: microscale fluid mechanics (Navier-Stokes), electrical phenomena (Maxwell), and particle/molecule/device interactions. Case studies focus on applications of microscale physics to biomedical engineering analyses.

Course Learning Outcomes (CLO)

Upon successful completion of this course, students will be able to:

1. **Describe** commercial systems that use microfluidic technology.
2. **Explain** different manufacturing methods used for microfluidic devices, and **discuss** the merits of each.

3. **Understand** and **apply** basic governing equation systems for physics relevant at the microscale.
4. **Apply** engineering analysis to microscale systems.
5. **Understand** the role of microscale systems in the biomedical engineering field.
6. **Describe** recent advances in microscale biomedical devices.
7. **Apply** modern engineering tools to the analysis of complex systems.
8. **Prepare** and deliver a professional presentation, using presentation software, to an audience of peers

Required Texts/Readings

Required reading material will consist of the following material: which will be posted to the Canvas page:

1) Peer-reviewed journal articles and review papers, posted to the Canvas page for the course
2) Readings from:
   Rubenstein D.A., Yin W., and Frame M.D. Biofluid Mechanics: An Introduction to Fluid Mechanics, Macrocirculation, and Microcirculation, Academic Press (2015) ***1st edition available free of charge to SJSU students*** via the MLK library.

Other useful texts (not required)

1) Brian J. Kirby. Micro- and Nanoscale Fluid Mechanics. ISBN: 978-1-107-61720-9
   Available free of charge to SJSU students through the MLK library

2) Henrik Bruus. Theoretical Microfluidics (ISBN-13: 978-0199235094) (2007), available from Amazon.com

3) Hywel Morgan and Nicholas G. Green. AC Electrokinetics: Colloids and Nanoparticles (Microtechnologies and Microsystems) ISBN-13: 978-0863802553, available from Amazon.com

Other technology requirements / equipment / material

We will use MATLAB and COMSOL during in-class problem sessions, and these software programs will be required to complete homework assignments. Both software programs are available through the College of Engineering virtual desktop. Detailed instructions for access will be posted on Canvas.
If you would like your own copy, MATLAB provides a student version for $49 (https://www.mathworks.com/store/link/products/student/new?s_tid=ac_buy_sv_cta) or you can download open-source Octave for free at: https://www.gnu.org/software/octave/.

Library Liaison

Megwalu, Anamika
Phone: 408-808-2089
Email: anamika.megwalu@sjsu.edu

Course Requirements and Assignments

Assignment Submissions

All assignments are to be submitted electronically through the course website on Canvas. ***Absolutely NO assignments will be accepted via email to the instructor.***

Homework

There will be several homework sets, designed to reinforce concepts discussed in class and prepare you for the midterm and final exam problems. MATLAB and/or COMSOL may be required to complete the problems. Homework sets will be announced in class, posted on Canvas, and due one week from the date of assignment. You are encouraged to ask one another clarifying questions and give suggestions on homework problems, however, please do your own work. A portion of the assigned homework problems may be discussed in class. Please post questions about homework to the Canvas discussion board so that all students might benefit from responses.

Several journal articles will be assigned for reading throughout the semester. For some homework assignments, students will prepare a critical review of the work featured in the article. Specific instructions for items to include in the review will be posted on Canvas.

Journal article presentation

Students will work in groups of 3 to dissect a journal article, present it to the class, and lead a class discussion around the findings of the paper (or a demo of device design using COMSOL or MATLAB). Detailed instructions and a grading rubric will be posted on Canvas.

Project

Over the course the class, you will work in a group to develop and analyze a microfluidic device/ system to address a particular set of needs or conditions based on a problem statement given by the instructor. You will submit one project report for the team and deliver a group presentation during one of the last two class sessions of the semester. Details about project topics and requirements will be discussed in class and published on Canvas.

Midterms

A midterm will be given based on materials presented in class and in assignments. The midterm examination will be given online and administered through the Canvas Learning Management system. Further details about the exam format and logistics will be communicated later in the semester.

Final Examination

A ***comprehensive*** final exam will be given at the end of the semester. The final examination will be given online and administered through the Canvas Learning Management system. Further details about the exam format and logistics will be communicated later in the semester.

Success in this course is based on the expectation that students will spend, for each unit of credit, a minimum of 45 hours over the length of the course (normally 3 hours per unit per week with 1

of the hours used for lecture) for instruction or preparation/studying or course related activities. Other course structures will have equivalent workload expectations as described in the syllabus.

Grading Information

Learning will be assessed through homework assignments, a journal article presentation, a term project, as well as a midterm and comprehensive final exam.

Homework	10%
Journal article presentation	10%
Project & presentation	25%
Midterm	20%
Final Exam	35%

Per SJSU's policy F15-12, attendance shall not be used as a criterion for grading. However, demonstrations using MATLAB and COMSOL in class sessions will provide helpful suggestions (and a head start) on homework problems.

Determination of Grades

Letter Grade	Percent
A plus	> 97%
A	> 93% – 97%
A minus	> 90% – 93%
B plus	> 87% – 90%
B	> 83% – 87%
B minus	> 80% – 83%
C plus	> 77% – 80%
C	> 74% – 77%
C minus	> 70% – 73%
D	> 60% – 70%
F	< 60%

Late Work Policies

Homework is due ***at the time specified on Canvas***, on the due date. Late assignments will be accepted, with a penalty of 1.5% off the maximum score per hour that the submission is past the deadline.
Project (late submission admitted under exceptional circumstances and pending instructor approval):

- One day late: -10%
- Two days late: -25%
- Three days late: -50%
- No submission will be accepted later than three days after the deadline.

Classroom Protocol

I expect and require that students be respectful of their peers. This translates to:

- Computer use during class is restricted to course-related activities
- Cell phones must be set to silent for the duration of the class meeting
- Students will respect a diversity of opinions, ethnicities, cultures, and religious backgrounds
- Students will treat online discussions with their peers as if they were in-class, face-to-face interactions

University Policies (Required)

Per University Policy S16-9, university-wide policy information relevant to all courses, such as academic integrity, accommodations, etc. will be available on Office of Graduate and Undergraduate Programs' Syllabus Information web page at http://www.sjsu.edu/gup/syllabusinfo/"

Recording Zoom Classes

This course or portions of this course (i.e., lectures, discussions, student presentations) will be recorded for instructional or educational purposes. The recordings will only be shared with students enrolled in the class through Canvas. The recordings will be deleted at the end of the semester. If, however, you would prefer to remain anonymous during these recordings, then please speak with the instructor about possible accommodations (e.g., temporarily turning off identifying information from the Zoom session, including student name and picture, prior to recording). Students are not allowed to record without instructor permission Students are prohibited from recording class activities (including class lectures, office hours, advising sessions, etc.), distributing class recordings, or posting class recordings. Materials created by the instructor for the course (syllabi, lectures and lecture notes, presentations, etc.) are copyrighted by the instructor. This university policy (S12-7) is in place to protect the privacy of students in the course, as well as to maintain academic integrity through reducing the instances of cheating. Students who record, distribute, or post these materials will be referred to the Student Conduct and Ethical Development office. Unauthorized recording may violate university and state law. It is the responsibility of students that require special accommodations or assistive technology due to a disability to notify the instructor.

Technical difficulties

Internet connection issues: Canvas autosaves responses a few times per minute as long as there is an internet connection. If your internet connection is lost, Canvas will warn you but allow you to continue working on your exam. A brief loss of internet connection is unlikely to cause you to lose your work. However, a longer loss of connectivity or weak/unstable connection may jeopardize your exam.

Other technical difficulties: Immediately email the instructor a current copy of the state of your exam and explain the problem you are facing. Your instructor may not be able to respond immediately or provide technical support. However, the copy of your exam and email will provide a record of the situation.

Contact the SJSU technical support for Canvas:

Technical Support for Canvas
Email: ecampus@sjsu.edu
Phone: (408) 924-2337
https://www.sjsu.edu/ecampus/support/

If possible, complete your exam in the remaining allotted time, offline if necessary. Email your exam to your instructor within the allotted time or soon after.

Academic Dishonesty

Students who are suspected of cheating during an exam will be referred to the Student Conduct and Ethical Development office and depending on the severity of the conduct, will receive a zero on the assignment or a grade of F in the course. Grade Forgiveness does not apply to courses for which the original grade was the result of a finding of academic dishonesty.

BME 254/Microscale Biomedical Systems Fall 2020 Course Schedule

(subject to change with fair notice on Canvas)

Week	Date	Lecture Topics
1	20 Aug	Introduction to Microfluidics, fabrication and connection strategies
2	27 Aug	Commercialization of Microfluidics; Kinematics review
3	3 Sept	Fluid Mechanics review—Navier-Stokes, Couette and Poiseuille's Law
4	10 Sept	Electrical circuit analogy for microfluidics, Dimensionless numbers and mixing
5	17 Sept	Inertial Microfluidics
6	24 Sept	Wetting, surface tension, capillary pressure
7	1 Oct	**MIDTERM** exam, Droplet Microfluidics
8	8 Oct	Electrophoresis and Electrowetting
9	15 Oct	Dielectrophoresis
10	22 Oct	Acoustofluidics and Optofluidics
11	29 Oct	Application area – Microfluidic rare cell sorting
12	5 Nov	Application area – Organ on a chip
13	12 Nov	Application area – PCR on a chip
14	19 Nov	Application area – Single cell analysis, Sequencing prep
15	26 Nov	NO CLASS - Thanksgiving
	10 Dec	**FINAL EXAM (17:15-19:30pm), online**