San José State University, Biomedical Engineering Department
BME 254, Microscale Biomedical Systems: Physics and Applications, Spring 2019

Course and Contact Information

Instructor: Prof. Melinda Simon

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Office Hours: T 5:00-6:00pm
Th 12:00-1:00pm

Class Days/Time: T 6:00-8:45 pm

Classroom: Engineering Building, E 333

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 3-hour session per week. The session will be broken up into two parts: lecture and activity. A 15-minute break will be provided during each class meeting. The activity portion will consist of problem solving using COMSOL and/or MATLAB, discussion of a journal article or review paper, or both. 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 here in eBook, paperback and hardback formats:
http://www.cambridge.org/us/academic/subjects/engineering/thermal-fluids-engineering/micro-and-nanoscale-fluid-mechanics-transport-microfluidic-devices?format=AR#gwDDXfL5Zvt6RQM7.97

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 in the College of Engineering computer lab in room E390 that is open to all engineering students for use from 7:00am-11:00pm Monday-Friday. 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
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Course Requirements and Assignments

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.

Journal article review
Several journal articles will be assigned for reading throughout the semester. For a select portion of these articles, 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.

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 in-class based on materials presented in class and in assignments.

Final Examination
A comprehensive final exam will be given at the end of 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 graded homework assignments, a journal article presentation, a term project, as well as a midterm and comprehensive final exam.

Homework	10%
Journal article reviews	15%
Project & presentation	20%
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+	> 97%
A	> 93% – 97%
A-	> 90% – 93%
B+	> 87% – 90%
B	> 83% – 87%
B-	> 80% – 83%
C+	> 77% – 80%
C	> 74% – 77%
C-	> 70% – 73%
D	> 60% – 70%
F	< 60%

Late Work Policies

Homework is due in class, ***at the beginning of class***, on the due date. Homework: 10%/day off of the maximum possible score (accepted up to 3 days late).
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/"

BME 254/Microscale Biomedical Systems Spring 2019 Course Schedule

Course Schedule *(subject to change with fair notice on Canvas)*

Week	Date	Lecture Topics
2	29 Jan	Introduction to Microfluidics, fabrication and connection strategies
3	5 Feb	Fluid Mechanics review—Navier-Stokes, Couette and Poiseuille's Law
4	12 Feb	Electrical circuit analogy for microfluidics, Dimensionless numbers and mixing
5	19 Feb	Inertial Microfluidics
6	26 Feb	Wetting, surface tension, capillary pressure
7	5 Mar	Droplet Microfluidics
8	12 Mar	**MIDTERM** exam, followed by: Electrophoresis and Electrowetting
9	19 Mar	Dielectrophoresis
10	26 Mar	Acoustofluidics
11	2 Apr	SPRING RECESS- No class.
12	9 Apr	Optofluidics
13	16 Apr	Case study – Microfluidics for PCR and sequencing prep
14	23 Apr	Case study – Microfluidic rare cell sorting
15	30 Apr	Case study – Organ on a chip – Microfluidics vs. Animal models
16	7 May	Project presentations in class
	21 May	**FINAL EXAM (17:15-19:30pm), E333**