San José State University
College of Engineering
Biomedical Engineering Department
BME 210, Mathematical Methods in Biomedical Engineering, Spring 2020

Course and Contact Information

Instructor:	Matthew Leineweber
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Office Hours:	TBD
Class Days/Time:	W 18:00-20:45
Classroom:	ENG 341
Prerequisites:	CompE 30, Math 133A, Graduate standing (or instructor consent)

Course Format

The course consists of one 165 minute session every week, and will focus on both mathematical theory and application of mathematical tools to solve problems related to biomedical engineering. The session will be split between traditional lecture and on hands-on implementation of the techniques discussed using MATLAB and Simulink.

Technology Intensive, Hybrid, and Online Courses

This course will make use of MATLAB and Simulink to assist in solving the problems discussed in lecture. These tools will be needed to help with homework, online quizzes, and the course project. We will also be using iClicker software to facilitate course discussion and provide regular feedback on student understanding of core concepts.

Canvas Page and Messaging

Course materials such as syllabus, handouts, notes, assignment instructions, etc. can be found on the Canvas learning management system course website. All communications relevant to the course will be sent out using the Canvas messaging system (Canvas email and announcement board). You are responsible for regularly checking with the messaging system through Canvas to learn of any updates by logging into https://sjsu.instructure.com/.

Course Piazza Site

A link to the course Piazza site is provided on Canvas, or the site can be accessed directly at the URL piazza.com/sjsu/spring2020/sp20bme210sec01mathematicsinbme/home. Piazza is the fastest way for you to ask technical questions to the professor while allowing them to share their response to all students at once. You may post questions anonymous to other students (professor will see who you are). Students may also answer your questions, endorse responses made by other students, and mark duplicate questions.

To ensure fair treatment of all students and to provide students with the most rapid and consistent instructional information, **the professor will not answer technical and policy questions by email.** Technical and policy questions include those regarding homework content, exam content, assignment deadlines, etc. Students should instead post to the class discussion board on Piazza.

Email Policy

Please send **emails regarding personal issues** (academic integrity issues, personal grades, medical issues, etc.) to the professor. To receive the most rapid response to your email message, please start the subject line with the characters "**BME210**". Out of fairness to all students, email communications related to technical questions or course policy will *not* be returned (please post these types of questions to the course Piazza site).

Course Description

Mathematical and computational methods applied to biomedical engineering. Topics include: i) statistical analysis of biomedical datasets, ii) design of experiments to meet FDA requirements, iii) solution techniques for partial differential equations, and iv) modeling of stochasticity in biological systems including error analysis. Prerequisite: CompE 30, Math 133A, Graduate standing (or by instructor consent)

Course Overview (Optional)

The ability to communicate biomedical concepts through mathematics is integral to the success of any biomedical engineer, regardless of whether he or she is working in research, design, quality control, or any other area. This course focuses on how engineers can apply mathematical approaches to describe biomedical engineering phenomena using both analytical and numerical methods.

Course content will begin with a review of some of the fundamental methods relating to differential equations, as well as a recap of the fundamentals of programming in MATLAB, including basic plotting and data representation. New analytical and numerical techniques for solving first-order and higher ordinary differential equations will then be discussed. Methods for constructing and solving partial differential equations will focus on applications to biomedical engineering. Linear algebra concepts will be reviewed, and then used to in applications pertaining to statistical analysis (e.g. linear regression), and numerical solutions to differential equations.

Course Learning Outcomes (CLO) (Required)

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

1. **Formulate** a mathematical expression(s) to describe a biomedical system or phenomenon.
2. **Simplify** a problem using assumptions or given parameters to arrive at an analytical solution, and interpret the solution with respect to the assumptions, simplifications, and dependence on the parameters.
3. **Use** numerical methods to arrive at an approximate solution to an engineering problem, and interpret the findings and any discrepancies with experimental data and/or analytical solutions to the problem.
4. **Communicate** the definition, methods, and solution to biomedical engineering problems through mathematical expressions, oral presentations, written reports, and questions-and-answer sessions.

Required Texts/Readings

Textbooks

Kreyszig et al., "Advanced Engineering Mathematics", 10th Ed. Wiley & Sons Publishing, 2011.
Schiesser, W. "Partial Differential Equation Analysis in Biomedical Engineering", Cambridge University Press, 2013.

Other Readings

Dunn S.M., Constantinides A., and Moghe P.V. "Numerical Methods in Biomedical Engineering", First Edition, Elsevier Academic Press (2006).

Textbook is available for free to SJSU students through the SJSU Library website (https://sjsu-primo.hosted.exlibrisgroup.com/primo-explore/fulldisplay?docid=01CALS_ALMA51439174850002901&context=L&vid=01CALS_SJO&search_scope=EVERYTHING&tab=everything&lang=en_US

Chapra S.C., "Numerical Methods for Engineers", Seventh Edition, McGraw-Hill (2015).

Beezer R.A., "A first course in linear algebra", Version 3.30, Congruent Press (2014).
Strang G.A. http://math.mit.edu/~gs/linearalgebra/
Strang G.A. http://math.mit.edu/~gs/dela/

Other technology requirements

MATLAB R2019b is recommended. Students may access MATLAB remotely through SJSU using the "Desktop as a Service" capabilities on SJSU One. Students may also use MATLAB Online (https://www.mathworks.com/products/matlab-online.html). MATLAB Grader will also be used for some online assignments (https://grader.mathworks.com/). Students will need to create a free Mathworks account to access these features.

Library Liaison

Anamika Megwalu
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Course Requirements and Assignments

"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 three hours per unit per week) for instruction, preparation/studying, or course related activities, including but not limited to internships, labs, and clinical practica. Other course structures will have equivalent workload expectations as described in the syllabus."

Homework

Homework assignments will include questions and problems related to the materials covered in the lectures, as well as assignments that require the use of MATLAB/Simulink. Students are expected and encouraged to work together on assignments. However, submitted homework should be individual work. Homework must be turned in before the beginning of class (6:00PM) on the due date. Late assignments will not be accepted. **The lowest homework score at the end of the semester will be dropped.**

Quizzes

Quizzes will periodically be given online through Canvas, and will cover assigned reading, homework, and lecture materials. Quizzes should be completed before the beginning of class on ***Wednesdays (6:00 PM)***, and will focus primarily on the application and extension of course concepts. Missed quizzes cannot be re-taken or made-up and will be scored as zero, unless prior approval has been given. Prior approval will only be given under exceptional circumstances, or if the instructor is informed at the beginning of the semester. **The lowest quiz score of the semester will be dropped.**

Midterm examination

There will be one mid-semester examinations. The examination will cover the entire course material covered prior to the Spring Recess. The exam may include multiple-choice questions, open-ended questions, and problems. The exam will be assigned as a "take-home" format, with the specific format details provided prior to the test. The dates of the mid-semester examination is indicated in the Course Schedule.

Project, Paper, and Presentation

A semester-long project will be assigned in the first two weeks of class. The project will be completed in teams of 3-4 students, assigned by the professor, and will consist of three parts: (1) A written report, (2) an oral presentation, and (3) a computational solution. Grades will be determined through a combination of instructor and peer scoring, including a portion of the grade based on participation in peer review of other groups. The project is described in full detail in the Project Description document provided by the instructor on Canvas.

Final Examination or Evaluation

The final examination will be held on the date and time stipulated by SJSU's Final Examination Schedule for the particular semester**.** The final examination will cover the entire course material covered during the semester. The final examination may include multiple-choice questions, open-ended questions, and problems. During the exam, students can have only a non-programmable scientific calculator. Internet-connected devices, books and notes are not allowed.

Grading Information

Determination of Grades

Grades will be determined based on all the assignments and examinations, weighted as reported in the table below:

Homework	15%
Quizzes	15%
Midterm	20%
Project	20%
Final Exam	30%

Absence during examinations, without prior approval, will result in a zero. Prior approval will be given only under exceptional circumstances. Please contact the instructor as soon as possible if you have such a situation.

Grade	*Percentage*
A plus	*97 to 100%*
A	*93 to 96%*
A minus	*90 to 92%*
B plus	*87 to 89 %*
B	*83 to 86%*
B minus	*80 to 82%*
C plus	*77 to 79%*
C	*73 to 76%*
C minus	*70 to 72%*
D plus	*67 to 69%*
D	*63 to 66%*
D minus	*60 to 62%*

NOTE that “All students have the right, within a reasonable time, to know their academic scores, to review their grade-dependent work, and to be provided with explanations for the determination of their course grades.” See University Policy F13-1 at http://www.sjsu.edu/senate/docs/F13-1.pdf for more details.

NOTE that University policy F69-24 at http://www.sjsu.edu/senate/docs/F69-24.pdf states that “Students should attend all meetings of their classes, not only because they are responsible for material discussed therein, but because active participation is frequently essential to insure maximum benefit for all members of the class. Attendance per se shall not be used as a criterion for grading.”

Classroom Protocol

Academic Integrity

All work completed by each student is expected to be his/her own, original work, including (but not limited to) all homework, quizzes, exams, and projects. Cheating and/or dishonesty of any form will not be tolerated. **ANY academic misconduct will be met with an automatic failing grade in the course, followed by a formal review by the SJSU Academic Affairs office.**

The SJSU Academic Integrity Policy (http://info.sjsu.edu/static/catalog/integrity.html) will be strictly enforced. Please take the time to familiarize yourself with the policy and its definitions of cheating and plagiarism, consequences and sanctions, and academic review procedures following any incidents.

Attendance and arrival times

Students are expected to be set up for lecture by the time the class begins and remain in the classroom for the duration of the lecture. Attendance in class is not mandatory and shall not be used per se as a criterion for grading. However, class attendance and participation are highly recommended.

Behavior

Students should remain respectful of each other at all times. Students will respect a diversity of opinions, ethnicities, cultures, and religious backgrounds. Interruptive or disruptive attitudes are discouraged. While in the classroom, the use of electronic devices (laptops, tablets, smartphones) MUST be limited to activities closely related to the learning objectives (following along with slides, REEF polls, MATLAB activities, etc.). While in the classroom, electronic devices should not be used for personal communication, included messaging and use of social media. All cell phones must be silenced prior to entering the classroom.

Safety

Students should familiarize themselves with all emergency exits and evacuation plans. In particular, if the class meeting ends in the evening, students should be aware of their surroundings when exiting the building, and are encouraged to carry a cell phone for emergency communications.

University Policies

Per University Policy S16-9 *(http://www.sjsu.edu/senate/docs/S16-9.pdf)*, relevant information to all courses, such as academic integrity, accommodations, dropping and adding, consent for recording of class, etc. is available on Office of Graduate and Undergraduate Programs’ Syllabus Information web page at http://www.sjsu.edu/gup/syllabusinfo/”. Make sure to visit this page, review and be familiar with these university policies and resources.

BME 210 / Mathematical Methods in BME, Spring 2020, Course Schedule

Course Schedule

	Session	Date	Lecture topics, examinations, lab activities	Reading*
Week 0	**Lec0**	**January 22**	**NO CLASS**	
Week 1	Lec1	January 29	Introduction; First and Second order ODEs	K1.1-1.7, 2.1-2.2, 2.4-2.8, 2.10
Week 2	Lec2	February 5	Higher-order ODEs and Systems of ODEs	K3.3-3.3, 21.2-21.3
Week 3	Lec3	February 12	Laplace Transforms	K6.1-6.9
Week 4	Lec4	February 19	Fourier Analysis	K11.1-11.4
Week 5	Lec5	February 26	Fourier Analysis and applications	K11.7-11.10, Handout
Week 6	Lec6	March 4	Intro to Partial Differential Eqns	K12.1-12.2
Week 7	Lec7	March 11	Partial differential equations; **Midterm Assigned**	K12.3-12.6
Week 8	Lec8	March 18	Partial differential equations (PDEs) 2	K12.7-12.12
Week 9	Lec9	March 25	Numerical Methods for Hyperbolic PDEs	S1.2
Week 10	**Lec10**	**April 1**	**SPRING RECESS – NO CLASSES**	
Week 11	Lec11	April 8	Numerical Methods for Parabolic PDEs	S1.3
Week 12	Lec12	April 15	TBD	
Week 13	Lec13	April 22	TBD	
Week 14	Lec14	April 29	Presentations Cohort 1;	
Week 15	Lec15	May 6	Presentations Cohort 2; Review	
FINAL EXAM WEEK	**FINAL**	**May 13**	**17:15-19:30**	

*K = Kreyszig: *Advanced Engineering Mathematics*
S = Schiesser: *Partial Differential Equation Analysis in Biomedical Engineering*