San José State University
Department of Mechanical Engineering
ME 267 Engineering Biomechanics, Section 02, Fall 2021

Course and Contact Information

Class Days/Time:	MW 16:30 – 17:45 PM
Classroom:	Online
Registration Code:	50111, 3 Units
Prerequisites:	Graduate standing and CE 112 or equivalent.
Instructor:	Winncy Du
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Email:	winncy.du@sjsu.edu
Office Location	E310F
Office Hours:	MW: 12:50 – 13:20; MW 17:45 – 18:15

Course Format

This class is fully online and requires use of Zoom video conferencing https://sjsu.zoom.us/ and the Canvas learning management system (LMS) https://sjsu.instructure.com/.

Online meetings require a microphone and speakers. Cameras are optional during the lectures, but required during the exams for Zoom proctoring.

Successful completion of assignments requires accessing the course website frequently, typically at least twice a week on a regular basis. Technical support for Canvas is available at "Canvas Support" under one.sjsu.edu.

Important communications regarding this class may be sent via Canvas or to student email addresses listed in MySJSU, and thus each student is expected to maintain up-to-date contact information in both systems.

Course Description: https://catalog.sjsu.edu/preview_course_nopop.php?catoid=12&coid=60804

Application of engineering mechanics to human body structure and function, involving 3-D kinematics, deformable bodies, viscoelastic behavior, and non-Newtonian fluids. Modeling of hard and soft tissues and analysis of response to loading conditions. Design considerations for biomedical and orthopedic devices.

Course Learning Outcomes

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

1. Explain the components, functions, and properties of cells, cell matrices, and cellular biomechanics.
2. Apply engineering mechanics theory and modeling to cells and cell matrices.
3. Explain blood composition, rheology, and their relationship.
4. Apply Newton's second law to derive hemodynamics of arteries and vessels.
5. Explain human circulatory system, its anatomy, and functions.

6. Apply fluid mechanics theory and modeling to the circulatory system, including unique aspects of bloodrheology and its interaction with the vasculature.
7. Qualitatively describe the heart's mechanical and electrical functions (cardiac pumping and electrical impulse).
8. Apply mechanics-of-materials theory and modeling to analyze the heart, its elastic waves, pressure-flow relationship (e.g., calculate Korteweg-Moens wave speed)
9. Quantitatively analyze capillary leakage.
10. Describe ocular anatomy, major components, and their functions.
11. Calculate intraocular pressure (IOP) and its relationship with glaucoma.
12. Qualitatively describe aqueous circulation in the anterior chamber, optic nerve head biomechanics, and ocular blood flow.
13. Apply engineering mechanics theory and modeling to muscles and bones.
14. Describe the types of muscles, skeletal muscle morphology and physiology, muscle constitutive models, and muscle/bone interactions.
15. Calculate muscle tensions, forces generated by muscles, and joint reaction force.
16. Qualitatively describe composition, structure, mechanical properties, and design of bone, especially cortical and trabecular bone.
17. Estimate (quantitatively) bone density, fracture toughness, and bone crack propagation, ligaments, tendons, and single cells.
18. Describe the structure and biomechanical properties of collagens, ligaments, tendons, and cartilage.
19. Apply engineering mechanics theory and modeling to soft connective tissues and calculate the relaxation time, strains and stresses, and elastic modulus.

Upon successful completion of the journal paper review, students will be able to:

1. Conduct a focused literature review in engineering biomechanics, and synthesize the findings for effective sharing of knowledge.
2. Use analytical models and computational tools to simulate biomechanical responses at cellular, tissue, and systems levels.
3. Write a high quality journal paper that is readily to be submitted to a reputable journal.

Required Textbook and Reading

Textbook

C. Ross Ethier and Craig A. Simmons, Introductory Biomechanics - from Cells to Organisms, New York: Cambridge University Press, 2007 (ISBN: 9780521841122). Also available in eBook format (ISBN 9780511271175).

Other Readings

This class will also depend heavily on published research articles. Each student must be familiar with engineering literature search tools and library access to full-text articles. Tutorials are available at http://library.sjsu.edu/ and help is available from library staff.

Course Requirements and Assignments

According to the Office of Graduate and Undergraduate Programs https://www.sjsu.edu/curriculum/courses/syllabus-info.php, "*Success in this course is based on the expectation that students will spend, for each unit of credit, a minimumof 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 including but not limited to internships, labs, clinical practice. Other course structures will have equivalent workload expectations as described in the syllabus*."

In addition to textbook reading and class participation, course requirements and assignments are as follows:

- Participation Tasks: There will be several participation tasks to promote active engagement throughout the semester. Possible examples include discussion posts, online quizzes or surveys, and peer review. Completed tasks will be tallied for credit according to deadlines and there are no make-up options. Tasks may be in-class or online, so it is important to attend class and to check Canvas regularly.

  Team assignments may be used for some portions of the above tasks.

- Homework: Homework problems will be assigned corresponding to lecture topics and assigned reading. Some of the homework may be software-based. Students are encouraged to discuss general strategies collaboratively, but each student is expected to prepare and submit his or her own individual work. Raw copying, especially of figures or software code, is cheating and will be reported accordingly. Your lowest HW grade will be dropped when calculating your final grade.

- Journal Review Paper: A journal review paper will be written and submitted in teams of 2 or 3 students based on published scholarly literature. Thisassignment is intended to develop skills in lifelong learning, information literacy, critical thinking, and communication applied to biomechanics. More specific requirements are defined in documentation to be distributed separately.

  Instead of journal review papers, students can also choose:

  Simulation: This is an opportunity to exercise, verify, or showcase an open-ended problem solving (or research) using engineering analysis or simulation/modern tools, and teamwork (2 or 3 students). More specific requirements are defined in documentation to be distributed separately.

- Midterm & Final Exams: All students are expected to complete one midterm and one final exams inclass as scheduled. Special accommodations for disabilities must be coordinated through the Accessible Education Center http://www.sjsu.edu/aec/.

Grading Information

The course grade is calculated from a weighted sum of all graded components as follows:

10% for Participation Tasks
20% for Homework
20% for Journal Review Paper
20% for Midterm Exam
30% for Final Exam

Percentage points for grades assignments and exams correspond to letter grade as follows:

93.0-100	A	90.0-92.9	A-		
87.0-89.9	B+	83.0-86.9	B	80.0-82.9	B-
77.0-79.9	C+	73.0-76.9	C	70.0-72.9	C-
67.0-69.9	D+	63.0-66.9	D	60.0-62.9	D-
0-59.9	F				

Late Policy: Unless otherwise specified for a particular assignment, work that is submitted late will be accepted with reduced credit accordingly:

Homework

- One day late: -10%
- Two days late: -25%
- Three days late: -50%
- Four days late: -100%

Midterm & Final Exam

- 1 ~ 5 minutes late: -10%
- 6 ~ 10 minutes late: -25%
- 11~15 minutes late: -50%
- Over 15 minutes late: -100%

Exceptions: Any grading appeals or petitions must be communicated promptly in writing (or email). Exceptions will normally be evaluated at the very end of the semester in context with overall semester track record and all other exceptions class-wide. Special consideration for truly unavoidable and extenuating circumstances will depend on timeliness and strength of supporting documentation (e.g., doctor's note, police report, military orders).

Classroom Protocol

Although University Policy F15-12 at http://www.sjsu.edu/senate/docs/F15-12.pdf states that "Attendance shall not be used as a criterion for grading", the policy also states, "Students are expected to attend all meetings for the courses in which they are enrolled as they are responsible for material discussed therein" and furthermore, "Participation may be used as a criterion for grading when the parameters and their evaluation are clearly defined in the course syllabus and the percentage of the overall grade is stated."

University Policies

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/ .

Library Resources

The engineering librarian as listed at http://library.sjsu.edu/staff-directory/sjsu-library-subject-liaisons can provide faculty and students with research instruction and resources, as needed, in person and online through the library website http://library.sjsu.edu/. Research guides http://libguides.sjsu.edu/ are accessible for departments and subject areas, including a guide specific to mechanical engineering at http://libguides.sjsu.edu/me.

ME 267 Engineering Biomechanics Course Schedule

This schedule is subject to change with fair notice via announcement in class or notification via Canvas.

Week Dates	Topics and Textbook Reading Sections	HW Assignments Journal paper due
Week 1 8/23, 8/25	Introduction to course Ch.2 Cellular Biomechanics: 2.1-2.4: Cell & cell energy system	HW1: 2.2; 2.3
Week 2 8/30, 9/1	2.5-2.7: Cell-matrix; cell mechanical properties, measurement, modelling, and response to mechanical events.	HW2: 2.4; 2.5
Week 3 9/8	2.8-2.9: Cells' mechanical stimulation & mechanobiological effects	HW3: 2.13; 2.14
Week 4 9/13, 9/15	Ch. 3 Hemodynamics. Journal paper review guide. 3.1-3.3: blood rheology, large artery hemodynamics, blood flow in small vessels	HW4: 3.4; 3.5 Review paper proposal
Week 5 9/20, 9/22	Ch. 4 Circulatory System 4.1-4.3 Anatomy of the vasculature, hear; arterial pulse propagation	HW5: 4.1; 4.2
Week 6 9/27, 9/29	4.4 Capillaries (filtration, pressure, leakage) 4.5-4.6 Veins and scaling of hemodynamic variables	HW6: 4.3; 4.6 Review paper proposal due on 9/27
Week 7 10/4, 10/6	Ch. 5 Interstitium (optional). Darcy's law & clearance of edema Review for Midterm Exam	----------
Week 8 10/11, 10/13	**Midterm Exam** on Monday, Oct 11 (online proctor) Ch. 6 Ocular Biomechanics. 6.1 Ocular anatomy	HW7: 6.1; 6.4
Week 9 10/18, 10/20	6.2 Biomechanics of glaucoma 6.3 Ocular blood flow	HW8: 6.2; 6.3
Week 10 10/25, 10/27	Ch. 8 Muscles & movement. 8.1 Muscle types; skeletal muscle morphology & physiology 8.2 Muscle constitutive modeling	HW9: 8.3; 8.4
Week 11 11/1, 11/3	8.3 Whole muscle mechanics 8.4 Muscle/bone interactions	HW10: 8.5; 8.9 Journal paper pre-evaluation
Week 12 11/8, 11/10	Ch. 9 Skeletal Biomechanics. 9.1 & 9.2 Bones, their composition & structures 9.3 Mechanical properties of cortical and trabecular bone	HW11: 9.1; 9.2
Week 13 11/15, 11/17	9.4 Bone fracture & failure mechanics 9.5 Functional adaptation & mechanobiology	HW12: 9.3; 9.4
Week 14 11/22	9.6-9.7 Design of bone; soft connective tissues	HW13: 9.5; 9.6
Week 15 11/29, 12/1	9.8-9.10 Collagen, ligament, tendon cartilage and their properties. Journal paper presentations	Journal paper presentations (12/1)
Week 16 12/6	Course review and Final Exam preparation	Review Paper due
Week 17 12/10	Final Exam: 14:45 – 17 (Zoom Proctor)	

All students are expected to be available during the university-designated final exam period for this class, as listed at https://www.sjsu.edu/classes/final-exam-schedule/fall-2021.php. The time will be used for project presentations.

The 2021-2022 academic calendar is posted at https://www.sjsu.edu/provost/docs/Academic_Calendar-AY2021-22.pdf.