

**San José State University**  
**Biomedical Engineering Department**  
**BME 068, Biomedical Applications of Metals and Ceramics, Fall 2020**

**Course and Contact Information**

Instructor(s):	Matthew Leineweber
Office Location:	ENG 233G
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Email:	matthew.leineweber@sjsu.edu
Office Hours:	TR 16:30-17:30
Class Days/Time:	MW 15:00-16:15
Classroom:	<a href="https://sjsu.zoom.us/j/95553923295?pwd=TEVqTG1zcUNXTXdUcU5pOEJRZlpXQT09">https://sjsu.zoom.us/j/95553923295?pwd=TEVqTG1zcUNXTXdUcU5pOEJRZlpXQT09</a>
Prerequisites:	PHYS 50, MATH 31, CHEM 1A

**Course Description**

This course covers the fundamentals of the structure, processing, and properties of metals and ceramics used in medical technology. Emphasis is placed on using metals and ceramics for implantable and non-implantable biomedical devices. Recent trends in biomaterials are also explored.

**Course Format**

**Online Course**

The course adopts a synchronous online lecture format as a primary teaching method. Pre-recorded video lectures will be combined with live Zoom meetings to facilitate class discussions problem-solving sessions. Typical Zoom meetings will require the use of an internet-connected device (phone, tablet, or laptop) to be used with iClicker technology (iClicker remotes can also be used), for accessing online materials, or submitting in-class assignments.

**Faculty Web Page and MYSJSU Messaging**

Course materials such as syllabus, handouts, notes, assignment instructions, etc. can be found on the [Canvas Learning Management System course login website](#) at <http://sjsu.instructure.com>. You are responsible for regularly checking with the messaging system through [MySJSU](#) on [Spartan App Portal](#) <http://one.sjsu.edu> (or other communication system as indicated by the instructor) to learn of any updates.

**Canvas and Piazza**

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

In addition to Canvas, the online Piazza platform will be used for discussions on homework, exams, and all other course material. You will be responsible for enrolling yourself using the signup link provided on Canvas

## Course Goals

The fundamental objective of this course is to educate engineers on the importance of understanding the interaction between engineering metals, ceramics, and biological materials, especially the human body. Of particular importance here is the role of the structure-processing-property relationship, and how these play a key role in the design, manufacture, clinical performance, long-term reliability and quality/regulatory assurance of medical and implant devices.

## Course Learning Outcomes (CLO)

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

1. **Define** short-and long-term medical applications for metals and ceramics in biomedical engineering.
2. **Demonstrate** knowledge of how metals and ceramics are used in biomedical implants devices.
3. **Define, synthesize and apply** course principles towards materials selection; including trade-off issues and evaluations, for biomedical implants and devices.
4. **Explain** how mechanical and surface properties, including surface chemistry and topography, are affected by atomic structure and processing techniques.
5. **Identify** candidate materials and processing techniques required to meet the performance criteria for specific biomedical applications or devices.
6. **Comprehend** the design principles involved in biomedical implants and devices, especially issues of biocompatibility with living tissue, and principal mechanisms of material/implant interaction with tissues.
7. **Explain**, how the host response upon metals and ceramics impacts the design of implanted devices.
8. **Explain** the physical and chemical degradation of metal and ceramic materials in the biological environment.
9. **Define and describe** the steps in the fabrication, and the properties of: stainless steels, titanium alloys, Nitinol, and other metallic implants and their applications as biomaterials.
10. **Describe** the types of ceramics used for biomedical implants, and the reasons for using ceramics, processing requirements, and the effect of chemical composition of ceramics and bioglasses on biocompatibility.
11. **Define and describe** the steps in the fabrication and the properties of porous and bioactive ceramic implants and their applications as biomaterials

## Required Texts/Readings

### Textbook

- Chen, Q. Thouas, G. *Biomaterials: a basic introduction*. CRC Press Taylor and Francis Group. Boca Raton, FL. 2015.
- Ratner et al. *Biomaterials science: an introduction to materials in medicine*. Elsevier. Kidlington, Oxford. 2013.
- Pruitt, L. et al. *Mechanics of Biomaterials: Fundamental Principles for Implant Design*. Cambridge University Press. Cambridge. 2011.

All course texts are available in online format through the SJSU Library. Texts can be accessed using the Leganto tool in Canvas.

## **Other technology requirements / equipment / material**

iClicker Reef polling app or iClicker remote (see “In-class iClicker questions” section of this syllabus).

## **Library Liaison (Optional)**

Megwalu, Anamika

Phone: 408-808-2089

Email: [anamika.megwalu@sjsu.edu](mailto:anamika.megwalu@sjsu.edu)

## **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 assignments**

Students are expected and encouraged to work together on assignments. However, submitted homework should be individual work. Homework must be turned into the box in ENG 233 **no later than the beginning of class** on the due date. **Late submissions** will not be accepted. The lowest homework score of the semester will be dropped.

### **Quizzes**

Weekly “Pre-Lecture Quizzes” will be given online through Canvas, and will cover assigned reading and previous lecture materials. Quizzes are posted one week prior to the due-date, and should be completed before the beginning of the first class of the week. 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.

### **In-class iClicker questions**

There will be regular in-class quizzes based on multiple answer questions. Students will participate in these quizzes using the iClicker system. These quizzes will consist of “concept questions” that will help students understand core ideas, and help me to understand what material needs additional explanation. I will not use iClicker to keep track of attendance. Refer to the Grading Policy and Student Technology Resources section for additional details on iClicker. The [iClicker Reef app](https://www.iclicker.com/students) can be downloaded here: <https://www.iclicker.com/students>. Alternately iClicker remotes can be accessed through SJSU eCampus. Information on how to obtain a remote can be found on the eCampus website <http://www.sjsu.edu/ecampus/teaching-tools/reef/index.html>.

### **In-Class Activities**

Students will work in groups during the Zoom lecture periods to work on activities designed to reinforce lecture concepts. These activities will be scored based on their completion and correctness.

### **Examinations**

There will be two mid-semester examinations and one final examination. The midterm examinations will cover the entire course material covered until the time of each examination. The final examination will cover the entire course material covered during the entire semester. Examinations 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. Furthermore, the instructor reserves the right to enforce seating assignments for all exams.

## Grading Information

### Determination of Grades

Grades will be assigned based on correct completion of the assigned course material, including quizzes, homework, In-Class Activities, and examinations. The following percentage weights will be used for each category.

Homework	15%
Quizzes	10%
In-Class Activities	10%
Midterm 1	20%
Midterm 2	20%
Final Exam	20%

Final grades will be assigned using the following scoring system:

<i>Grade</i>	<i>Percentage</i>
<i>A plus</i>	<i>97 to 100%</i>
<i>A</i>	<i>93 to 95%</i>
<i>A minus</i>	<i>90 to 92%</i>
<i>B plus</i>	<i>86 to 89 %</i>
<i>B</i>	<i>83 to 85%</i>
<i>B minus</i>	<i>80 to 82%</i>
<i>C plus</i>	<i>76 to 79%</i>
<i>C</i>	<i>73 to 75%</i>
<i>C minus</i>	<i>70 to 72%</i>
<i>D plus</i>	<i>66 to 69%</i>
<i>D</i>	<i>63 to 65%</i>
<i>D minus</i>	<i>60 to 62%</i>
<i>F</i>	<i>59% or lower</i>

### Classroom Protocol

Students are expected to be logged in and ready to participate in Zoom meetings by the time the class begins. 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, and will contribute towards the In-Class Activity score. Students should remain respectful of each other at all times. Interruptive or disruptive attitudes are discouraged. Students' microphones are to be muted at all times, unless instructed to unmute by the instructor. 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.

### Webcams and Recording Lectures

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 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](mailto: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.

### **University Policies**

Per [University Policy S16-9](http://www.sjsu.edu/senate/docs/S16-9.pdf) (<http://www.sjsu.edu/senate/docs/S16-9.pdf>), relevant university policy concerning all courses, such as student responsibilities, academic integrity, accommodations, dropping and adding, consent for recording of class, etc. and available student services (e.g. learning assistance, counseling, and other resources) are listed on [Syllabus Information web page](http://www.sjsu.edu/gup/syllabusinfo) (<http://www.sjsu.edu/gup/syllabusinfo>), which is hosted by the Office of Undergraduate Education. Make sure to visit this page to review and be aware of these university policies and resources.

### **Academic Integrity**

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 68, BME Applications of Metals and Ceramics, Fall 2020

## Tentative Course Schedule *(subject to change with fair notice)*

Week	Topic
0	Course Overview & Introduction
1	Interatomic and Intermolecular Bonds Stress, strain, and deformation types
2	Stress, strain, and deformation types Bulk mechanical properties, stress-strain diagrams
3	<b><i>Labor Day - No Class</i></b> Metallic bonds & Crystal Structure
4	Microstructure, Properties, and Performance Stress Concentrations, failure modes
5	Fatigue failure - Cyclic loading, failure mechanisms, crack propagation Fatigue failure - Testing, S-N diagrams, designing for fatigue
6	Bulk Material Processing (Forging, Machining) Bulk Material Processing (Casting)
<b>MT 1</b>	<b>Midterm Review</b> <b>Midterm Exam 1</b>
7	Platinum-Iridium Systems - Phase Diagrams Surface Properties: Surface chemistry and surface topography
8	Surface Properties: Hardness, Abrasion, wear, and tribology Biocompatibility, toxicity, and corrosion
9	Biocompatibility, toxicity, and corrosion Stainless Steel: Structure, Processing, & Properties
10	Stainless Steel: Applications and Design Considerations <b>Midterm Review</b>
<b>MT 2</b>	<b>Midterm Exam 2</b> <b><i>Veterans Day - No Class - Campus Closed</i></b>
11	Titanium, Titanium Alloys, NiTi Alloys & Applications
12	Cobalt-Chrome alloys and applications <b><i>Thanksgiving Holiday - No Class - Campus Open</i></b>
13	Biomedical Ceramics – Structure and composition Bioglass, Bone Grafts, & Hydroxyapatite
14	FINAL REVIEW Final Exam: <b>Thursday, December 10 12:15-14:30</b>

*\* Dr. Leineweber is away at a conference, so there will be guest lectures. Scheduled lecture topics*