San José State University  
Department of Electrical Engineering  
EE127: Electronics for Bioengineering Applications, Spring 2017

Course and Contact Information

Instructor: Farhad Taghibakhsh
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Office Hours: 1 hour, immediately following class on Tue or Thu or by appointment
Class Days/Time: Tuesdays & Thursdays 3:00 – 4:15PM
Classroom: ENG 303 – Lab: ENG 290
Prerequisites: EE98 (required), Electronics lab experience recommended

Course Format

Classroom lecture, hands-on lab, and your participation are main components of this course. The lab part is very important and therefore, mandatory. You are expected to have prior experience operating basic electronics lab equipment such as oscilloscopes, function generators, DC power supplies, multi-meters, etc. It is your responsibility to learn these skills on your own if you have not already. There are numerous YouTube tutorials on these subjects.

As a senior-level technical elective, this course requires you to think and learn on your own. You should not expect your instructor to solve all problems for you. Instead, I will help you identify the problem, break it down and find a solution. We’ll repeat this many times in the class room and the lab, practice it on assignments and you are expected to learn the process and apply it to new problems on your own; that would be your exams, and later on your other works. On assignments and exams, I will frequently expect you to apply your knowledge, make inferences, and draw conclusions to arrive at the correct answer pretty much the same way we practice in the class room. This is a more realistic representation of engineering in practice, and some students may find that there is a considerable learning curve. I encourage students who find themselves in this category to see me earlier rather than later.

Make-Up Lectures
You’ll be notified in advance in case I am not available for a lecture. If the ISA or another qualified person is not available to present, lectures will be rescheduled. Any make-up lectures will be held on Saturdays from 11:00AM-12:15PM, subject to room availability.
Canvas and Communication
Course materials such as syllabus, handouts, notes, assignment instructions, etc. can be found on the Canvas learning management system course website. You are responsible for regularly checking Canvas, your e-mail, MySJSU, or other communication systems as indicated by the instructor to learn of any updates.

Course Description
1) Study of the fundamental concepts of electrical circuits relevant to the use and design of biomedical instruments and devices currently used for patient care using several examples.
2) Introduction to some advance technologies.

Course Goals
This course is meant for engineering students who have some basic exposure to electric circuits and want to deepen their knowledge in the electronics and signal processing areas relevant to the use and design of biomedical instruments and devices. The course will provide an overview of necessary physiology and building blocks for biomedical electronics. It will allow students to build and test these devices in the lab and will provide the basis for signal analysis and processing. The course will also cover examples of biomedical instrumentation and devices currently used in patient care. Students can also use this knowledge in other medical device classes offered by the Biomedical Engineering program and become better prepared to move into the medical-device industry with a thorough understanding of biomedical devices currently used for patient care.

Course Learning Outcomes (CLO)
Upon successful completion of this course, students will be able to:

1. CLO 1 Understand basics of circuits and physiological sources for many biomedical signals
2. CLO 2 Solve fundamental problems involving operational amplifiers
3. CLO 3 Build circuits for operational amplifiers
4. CLO 4 Explain the operational characteristics of bio-potential amplifiers
5. CLO 5 Build basic bio-potential amplifiers and record data for future analysis
6. CLO 6 Record data for data-acquisition equipment for biomedical signals
7. CLO 7 Solve fundamental signal processing problems
8. CLO 8 Explain several biomedical devices and some advanced technologies
9. CLO 9 Build some basic sensors and analyze the data

Required Texts/Readings

Textbook

Other Readings
3) Microelectronic Circuits, Adel S. Sedra, Oxford University Press.
Course Requirements and Assignments

SJSU classes are designed such that in order to be successful, it is expected that students will spend a minimum of 3 hours for each unit of credit (normally three hours per unit per week), including preparing for class, participating in course activities, completing assignments, and so on. More details about student workload can be found from University Syllabus Policy S16-9 at http://www.sjsu.edu/senate/docs/S16-9.pdf.

Problem Sets (CLO’s 1, 2, 4, 6, 7, 8)
Several problem sets will be assigned throughout the semester. The average frequency of these assignments will be fewer than or equal to one problem set per week.

Labs, Lab Reports, Post-Lab Questions (CLO’s 1-9)
This course will consist of approximately 4 labs. Students will work in groups to build lab experiments and collect data. Each lab requires a lab report and a post-lab homework assignment. Lab Reports will be group assignments unless otherwise stated. Post-Lab Questions will be individual assignments. Students will be required to work on the Post-Lab Questions on their own, and the Academic Integrity Policy will be strictly enforced. Lab Report and Post-Lab Questions submissions must be typed, not handwritten.

Exams (CLO’s 1-9)
There will be 3 exams during the semester: 2 in-term exams and 1 final exam. All exams are cumulative. The in-term exam dates are tentatively scheduled for Tuesday, Mar. 7, 2017 and Tuesday, Apr. 18, 2017 in class. The final exam is on Thursday May 18. The exams cover both lecture and lab material. The instructor reserves the right to make parts of the exams take-home. Attendance at all scheduled exams and on-time submission of any take-home exam portions is mandatory. Failure to take or submit an exam at the scheduled time will result in a zero grade. Make-up exams will not be offered except under extraordinary circumstances and may differ from the original exam administered. Make-up exams may also be of different difficulty compared to the original exam. Inform the instructor as soon as you believe you may need a make-up exam. If possible, submit your request before the actual exam. Eligibility for a make-up exam will be determined on a case-by-case basis by the instructor.

Students who require exam accommodations through the Accessible Education Center (AEC) must hand the appropriate AEC form for the instructor to sign as soon as possible, but no fewer than 14 days prior to the scheduled exam. Note that because of AEC policy, students requiring exam accommodations for the final exam will need to hand the appropriate AEC form to the instructor as soon as possible, but no fewer than 14 days prior to the AEC deadline for final exam accommodations (AEC’s deadline is usually about a month before finals).

Semester Project (CLO’s 1-9)
A project consisting of research and/or design will be due near the end of the semester. This project is designed to cover multiple Course Learning Outcomes and will require significant time investment.

Participation
A portion of your grade will be determined by your participation in class, your participation in the Discussions threads on Canvas, your preparedness for labs, your contribution to your lab and project groups, and peer evaluations from members of your groups.

NOTE that University policy 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.”
**Grading Policy**

**Breakdown**
Problem Sets (15%), Lab Reports and Post-Lab Questions (20%), In-Term Exam 1 (10%), In-Term Exam 2 (10%), Final Exam (25%), Semester Project (15%), Participation (5%).

**Assignment Submissions**
Unless otherwise noted, all assignments and work must follow these requirements and be submitted electronically to Canvas:

- Submit as a single, scanned or typed PDF file (1 file with all work).
  - Except for Lab Reports and Post-Lab Questions, typed submissions are preferred.
  - For Lab Reports and Post-Lab Questions, typed submissions are mandatory.
- Pages in the submission must be properly oriented.
- If the assignment contains multiple problems, your solutions to the problems should be submitted and presented in numerical order.
- Unless otherwise noted, the file name for all electronic submissions should contain:
  - The assignment name
  - Your last name(s) and first initial(s)
  - Your group number (if applicable)
- Scanned submissions:
  - Should be scanned with a scanner—not a photo taken with a smartphone.
  - Should be in black & white (not gray scale)
  - If written in pencil must be close to black in appearance (most modern scanners have a “threshold” or “darkness” setting that will allow you to make sure the pencil is dark enough to be read easily).
- All work must be legible. Illegible work will be left ungraded and no credit will be given. What qualifies as “illegible” is up to the grader’s discretion.
- Box or circle all final answers. Large figures/diagrams or paragraph responses are exempt from this requirement.
- Violations of the above policy may result in a penalty or a zero grade at the grader’s discretion.

It is your responsibility to account for technical difficulties that may occur during electronic submission of assignments. Do not wait until right before the deadline to upload your assignment! If you encounter Internet connectivity issues, a scanner jam, etc., you will miss the deadline and your work will not be accepted. Canvas’ server clock is very accurate and is synchronized with the official NIST government clock. In most cases, I have set Canvas to reject late uploads (even if late by 1 second). In the unlikely scenario that Canvas is down or not working properly and you are unable to submit your assignment even though it is before the deadline, you must e-mail me your submission before the deadline (the timestamp on the message must be before the deadline) for your work to be accepted and considered on time.

See Late Policy.

**Extra Credit**
Extra credit assignments will not be available. However, points may be available on certain assignments in the form of bonus questions, etc.

**Late Policy**
Late work will not be accepted except under extraordinary circumstances and will be determined by the instructor on a case-by-case basis. In general, late work will receive a zero grade. If you think/know you’ll have
to turn in an assignment after the due date, it’s always better to speak with the instructor at least several days before it’s due. If you notify the instructor after the due date and could have notified the instructor earlier, the instructor is much less likely to consider your case. See Assignment Submissions.

**Letter Grade Determination**

Final course letter grades will be determined by the total weighted score of all problem sets, lab reports and post-lab questions, exams, the semester project, and participation according to the **Breakdown** of the grade mentioned above in Grading Policy. Conversion to letter grade is done based on the below tale:

- 94% and above  A
- 93% - 90%  A-
- 89% - 87%  B+
- 86% - 84%  B
- 83% - 80%  B-
- 79% - 77%  C+
- 76% - 74%  C
- 73% - 70%  C-
- 69% - 67%  D+
- 66% - 64%  D
- 63% - 60%  D-
- below 60%  F

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 following University Policies:

[University Policy S06-4](http://www.sjsu.edu/senate/docs/S06-4.pdf)

[University policy F15-12](http://www.sjsu.edu/senate/docs/F15-12.pdf)

[University Syllabus Policy S16-9](http://www.sjsu.edu/senate/docs/S16-9.pdf)

**Classroom Protocol**

Respect your instructor, ISA/TA, and classmates. Attend all lectures and labs. Do your best to show up on time, and give your instructor and group mates as much advanced notice of any absences as possible. Please silence your phones and electronics during lecture and lab.

**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](http://www.sjsu.edu/gup/syllabusinfo/) at http://www.sjsu.edu/gup/syllabusinfo/”

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**EE127: Electronics for Bioengineering Applications, Spring 2017**

Schedule is subject to change by instructor at any time with verbal or written notice. The California Faculty Association is in the midst of a contract dispute with management. It is possible that the faculty union will call a
strike or other work stoppage this term. While the faculty hopes this will not be necessary, students will be informed as soon as possible of any disruption to the class meeting schedule.

**Course Schedule**

<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Topics, Readings, Assignments, Deadlines</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1/26</td>
<td>No Lab. Course Overview, Intro to Medical Instrumentation (Ch. 1)</td>
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<tr>
<td>2</td>
<td>1/31</td>
<td>Intro to Medical Instrumentation, Op-Amps (Ch. 1, 3)</td>
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<tr>
<td>2</td>
<td>2/2</td>
<td>No Lab. Op-Amps (Ch. 3)</td>
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<tr>
<td>3</td>
<td>2/7</td>
<td>Op-Amps, In-amps (Ch. 3)</td>
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<tr>
<td>3</td>
<td>2/9</td>
<td>Lab 1: Op-Amps</td>
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<tr>
<td>4</td>
<td>2/14</td>
<td>Active Filters, Frequency Response, Transfer Functions (Ch. 3, 6.5, 1.10)</td>
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<tr>
<td>4</td>
<td>2/16</td>
<td>Lab 1: Op-Amps</td>
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<tr>
<td>5</td>
<td>2/21</td>
<td>Physiology and Origin of Bio-potentials (Ch. 4)</td>
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<tr>
<td>5</td>
<td>2/23</td>
<td>No Lab. Physiology and Origin of Bio-potentials (Ch. 4)</td>
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<tr>
<td>6</td>
<td>2/28</td>
<td>Volume Conduction, EMG (Ch. 4), Review</td>
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<td>6</td>
<td>3/2</td>
<td>Lab 2: EMG</td>
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<tr>
<td>7</td>
<td>3/7</td>
<td>IN-TERM EXAM 1 [All topics up to and including Physiology and Origin of Bio-potentials]</td>
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<tr>
<td>7</td>
<td>3/9</td>
<td>Lab 2: EMG</td>
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<tr>
<td>8</td>
<td>3/14</td>
<td>EEG, ECG (Ch. 4)</td>
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<td>8</td>
<td>3/16</td>
<td>No Lab. Blood-Glucose Sensors (Ch. 10.7), Bio-potential Amplifiers (Ch. 6)</td>
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<tr>
<td>9</td>
<td>3/21</td>
<td>Bio-signal Processing (Quantization, Sampling) (Notes)</td>
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<tr>
<td>9</td>
<td>3/23</td>
<td>Lab 4: Glucometer</td>
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<tr>
<td>10</td>
<td>3/28</td>
<td>Spring Recess. No Class.</td>
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<tr>
<td>10</td>
<td>3/30</td>
<td>Spring Recess. No Class.</td>
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<tr>
<td>11</td>
<td>4/4</td>
<td>Bio-signal Processing (Aliasing, LTI/LSI Systems) (Notes)</td>
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<td>11</td>
<td>4/6</td>
<td>Lab 4: Glucometer</td>
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<tr>
<td>12</td>
<td>4/11</td>
<td>PPG, Diodes, Transistors, Review</td>
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<td>4/13</td>
<td>Lab 5: PPG</td>
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<td>4/18</td>
<td>IN-TERM EXAM 2 [All topics up to and including Bio-signal Processing]</td>
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<td>4/20</td>
<td>Lab 5: PPG</td>
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<td>14</td>
<td>4/25</td>
<td>Bio-potential Electrodes: Electrode-Electrolyte Interface (Notes, Ch. 5)</td>
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<td>4/27</td>
<td>No Lab. Bio-potential Electrodes: Half-Cell Potential, Polarization (Ch. 5)</td>
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<td>15</td>
<td>5/2</td>
<td>Bio-potential Electrodes: Circuit Model, Electrode-Skin Interface (Ch. 5)</td>
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<tr>
<td>Week</td>
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<td>16</td>
<td>5/9</td>
<td>Electrical Safety (Ch. 14)</td>
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<tr>
<td>16</td>
<td>5/11</td>
<td>No Lab. Special Topics, Review</td>
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<td>Final Exam</td>
<td>5/18</td>
<td>Thursday, May 18, 2:45PM-5:00PM Location ENG 303</td>
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