Course BME 499 – Biomedical Prototyping and Fabrication
Units: 2
Term: Fall & Spring
Day – Time: Lecture: Monday – 5 pm to 5:50 pm
Laboratory: 6 pm to 7:50 pm

Location: Denney Research Building, Room 351

Instructor: Jean-Michel Maarek, Dr. Eng.
Office: Denney Research Building, Room 150
Office Hours: Tuesday: 12:30 pm to 1:30 pm
Contact Info: maarek@usc.edu, 213 740 0346. Replies to emails and calls within 48 hours

Teaching Assistant: TBD
Office:
Office Hours:
Contact Info:

Catalog Course Description
Development of physical prototypes of biomedical devices and systems. Acquisition and practice of skills for documentation and fabrication. Prototype testing and validation against requirements.

Expanded Course Description
Biomedical Engineering students, particularly sophomores and juniors, lack the knowledge and hands-on skills that enable them to design and fabricate physical prototypes of biomedical devices and systems that satisfy specific design requirements. Students will learn to develop design documentation and will acquire manufacturing skills that enable them to translate their ideas into functioning prototypes. Students who successfully complete the course will be able to design and implement physical systems for use in research laboratories and for their capstone design project.

Learning Objectives
Students will be able to:

- Develop design documentation, including requirements, dimensional drawings, and material selection for a biomedical prototype of a measurement or actuation system
- Apply techniques and select tools to manufacture a physical realization of a biomedical prototype
- Test and validate a physical prototype to verify operational performance and conformity with the design requirements

Prerequisite(s): None
Co-Requisite(s): None
Concurrent Enrollment: None
Recommended Preparation: None
Course Notes

The course plan is built around a weekly 50 min lecture followed by a 1h 50 min laboratory. The lecture presents the topic of the lesson. During the laboratory, the students practice with supervision applications of the design process or prototype manufacturing techniques related to the lesson topic. Grading is based on two exams, assignments the students prepare during the course of the semester, and a final project demonstration and design specification report the students turn in individually during the final exam period.

Enrollment is limited to 12 students per semester to better guide the students as they acquire the manufacturing skills and to accommodate the limited number of manufacturing machines available in the teaching laboratory.

Course notes and slides used in the lectures will be posted on the associated Blackboard website.

Technological Proficiency and Hardware/Software Required

None

Required Readings and Supplementary Materials


Description and Assessment of Assignments

The assignments are listed in the weekly schedule. They comprise preparing documentation (standard operating procedures) for operating laboratory equipment, completing experimental realizations in accordance with specified design requirements, and a project, which starts half-way through the semester.

The project involves developing a physical prototype for a medical monitoring system (electrocardiograph). The students will be given a printed circuit board and a circuit design. They will design a casing for the printed circuit, populate the circuit board with electronic parts, test and validate the performance of the casing and circuitry to match pre-specified design requirements, integrate the circuitry in the casing, and include connectors for the electrode leads. Two “enroute” assignments, a demonstration of the realized prototype, and one final design report will be used to assess the students’ work. Rubrics will be used to compare the students realizations to the design requirements. The final report’s rubric will rate the students’ work with respect to device performance criteria, and technical quality of the report.

The students will be informed of rating expectations and will have access to the rubrics ahead of time.

A midterm exam and a final exam will test the students knowledge of the course content through multiple choice and short answer questions.

Students enrolling in the course can expect on average four hours of work outside of class each week.
Grading Breakdown

<table>
<thead>
<tr>
<th>Assessment Tool (assignments)</th>
<th>Points</th>
<th>% of Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Midterm exam</td>
<td>100</td>
<td>15%</td>
</tr>
<tr>
<td>Assignments (5 total)</td>
<td>100 each</td>
<td>50%</td>
</tr>
<tr>
<td>Final project report</td>
<td>100</td>
<td>15%</td>
</tr>
<tr>
<td>Final exam</td>
<td>100</td>
<td>20%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>800</td>
<td>100%</td>
</tr>
</tbody>
</table>

Grading Scale

The course grade is computed based on the individual assessment grades using the indicated percentages. The letter grade is assigned on a straight scale: 90% and above leading to A, 89% - 75% leading to B, 74% to 60% leading to a C, etc. Pluses and minuses are assigned by dividing each range in corresponding halves (A, A-) or thirds (B+, B, B-, C+, C, C-, ...). Some discretion may be used in modifying this scheme depending on the overall class performance.

Students should frequently check the assignment grades posted on the Blackboard website and immediately notify the instructor by email about any error or missing grade. Any request for grade change that is made after the last day of class will not be considered.

Assignment Submission Policy

All written assignments must be submitted online through the Blackboard website. Other deliverables, including physical prototypes will be due at the beginning of class on the due date.

Grading Timeline

Assignments are graded within 10 days after the assignment is due and grades are posted in the “Grade Center” of the Blackboard website.

Additional Policies

Late assignments are not be accepted. You must attend every lecture and laboratory in their entirety because that is where you learn the course material in depth. If you must miss because of illness or a major scheduling conflict, email the instructor in advance to be excused. You are allowed up to two unexcused class absences before your course grade is affected (2 total course point/absence). Avoid using cell phones or other electronic devices in class which can prevent you and others from concentrating and learning. In case of an emergency, please take your phone outside the classroom. Only use your computers for class-related purposes.
<table>
<thead>
<tr>
<th>Week</th>
<th>Topics/Daily Activities</th>
<th>Readings/Preparation</th>
<th>Deliverables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 1</td>
<td>Introduction – Safety rules in the manufacturing laboratory – avoiding problems – Complete safety training</td>
<td>Chapters 1 and 3</td>
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<tr>
<td>Week 2</td>
<td>Documentation: standard operating procedures (SOPs), design history notes, design reviews, design requirement documents <strong>Assignment 1: Develop SOP for drill press</strong></td>
<td>Handout</td>
<td></td>
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<tr>
<td>Week 3</td>
<td>Engineering drawings – dimensions and tolerances</td>
<td>Chapter 7</td>
<td><strong>Assignment 1 due</strong></td>
</tr>
<tr>
<td>Week 4</td>
<td>Manufacturing methods – 1 (milling, cutting, molding) <strong>Assignment 2: Mill a part using dimension drawing</strong></td>
<td>Chapter 23</td>
<td></td>
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<tr>
<td>Week 5</td>
<td>Manufacturing methods – 2 (3-D printing, laser cutting and engraving)</td>
<td>Chapters 15 and 21</td>
<td></td>
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<tr>
<td>Week 6</td>
<td>Material selection for manufacturing</td>
<td>Handout</td>
<td><strong>Assignment 2 due</strong></td>
</tr>
<tr>
<td>Week 7</td>
<td>Assembly techniques (adhesives, fasteners, welding) <strong>Assignment 3: Engrave logo using laser cutter Project assigned – ECG monitor</strong></td>
<td>Chapter 19</td>
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<tr>
<td>Week 8</td>
<td>Holemaking – Midterm exam (50 min)</td>
<td>Chapter 24</td>
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<td>Week 9</td>
<td>Threading and tapping <strong>Assignment 4: Demonstrate and document on casing for ECG monitor prototype</strong></td>
<td>Chapters 25 and 27</td>
<td><strong>Assignment 3 due</strong></td>
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<tr>
<td>Week 10</td>
<td>Soldering and desoldering – 1 (through hole parts)</td>
<td>Handout</td>
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<td>Week 11</td>
<td>Soldering and desoldering – 2 (surface mount parts) <strong>Assignment 5: Demonstrate and document on soldered printed circuit board for ECG monitor prototype</strong></td>
<td>Handout</td>
<td><strong>Assignment 4 due</strong></td>
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<tr>
<td>Week 12</td>
<td>Plastic molding – mold making</td>
<td>Chapter 34</td>
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<tr>
<td>Week 13</td>
<td>Surface finishing (powder coating, plating, passivation, polishing)</td>
<td>Chapter 18</td>
<td><strong>Assignment 5 due</strong></td>
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<tr>
<td>Week 14</td>
<td>Strain relief</td>
<td>Handout</td>
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<td>Week 15</td>
<td>Failure modes and product’s end-of-life <strong>Presentation and demonstration of ECG monitor prototype</strong></td>
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<tr>
<td><strong>FINAL</strong></td>
<td>Final exam</td>
<td></td>
<td><strong>Project report due</strong></td>
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Statement on Academic Conduct and Support Systems

Academic Conduct:

Plagiarism – presenting someone else’s ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in SCampus in Part B, Section 11, “Behavior Violating University Standards” policy.usc.edu/scampus-part-b. Other forms of academic dishonesty are equally unacceptable. See additional information in SCampus and university policies on scientific misconduct, policy.usc.edu/scientific-misconduct.

Support Systems:

Counseling and Mental Health - (213) 740-9355 – 24/7 on call
studenthealth.usc.edu/counseling
Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

National Suicide Prevention Lifeline - 1 (800) 273-8255 – 24/7 on call
suicidepreventionlifeline.org
Free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week.

Relationship and Sexual Violence Prevention and Services (RSVP) - (213) 740-9355(WELL), press “0” after hours – 24/7 on call
studenthealth.usc.edu/sexual-assault
Free and confidential therapy services, workshops, and training for situations related to gender-based harm.

Office of Equity and Diversity (OED)- (213) 740-5086 | Title IX – (213) 821-8298
equity.usc.edu, titleix.usc.edu
Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants. The university prohibits discrimination or harassment based on the following protected characteristics: race, color, national origin, ancestry, religion, sex, gender, gender identity, gender expression, sexual orientation, age, physical disability, medical condition, mental disability, marital status, pregnancy, veteran status, genetic information, and any other characteristic which may be specified in applicable laws and governmental regulations. The university also prohibits sexual assault, non-consensual sexual contact, sexual misconduct, intimate partner violence, stalking, malicious dissuasion, retaliation, and violation of interim measures.

Reporting Incidents of Bias or Harassment - (213) 740-5086 or (213) 821-8298
usc-advocate.symplicity.com/care_report
Avenue to report incidents of bias, hate crimes, and microaggressions to the Office of Equity and Diversity | Title IX for appropriate investigation, supportive measures, and response.

The Office of Disability Services and Programs - (213) 740-0776
dsp.usc.edu
Support and accommodations for students with disabilities. Services include assistance in providing readers/notetakers/interpreters, special accommodations for test taking needs, assistance with architectural barriers, assistive technology, and support for individual needs.
**USC Support and Advocacy** - (213) 821-4710
uscsa.usc.edu
Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

**Diversity at USC** - (213) 740-2101
diversity.usc.edu
Information on events, programs and training, the Provost’s Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

**USC Emergency** - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call
dps.usc.edu, emergency.usc.edu
Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

**USC Department of Public Safety** - UPC: (213) 740-6000, HSC: (323) 442-120 – 24/7 on call
dps.usc.edu
Non-emergency assistance or information.