Bioengineering Design
BENG 187 and BENG 1XX
Spring 2019 thru Spring 2020
V 1.0

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Teaching Assistants: Spring 2019 – Ali Zamat, Katherine Pieri, Manon Magill
Fall 2019/Winter 2020/Spring 2020 – Katherine Pieri, to be appointed

BENG 1XXA/B are scheduled by student teams with their mentors.

Textbook(s) Recommended (Available on reserve)
- Biodesign: the Process of Innovating Medical Technologies. Eds PG Yock, S Zenios, J Makower, TJ Brinton, N. Kumar, FTJ Watkins; Principal Writer L Denend; Specialty Ed, TM Krummel; Web Ed C Kurihara

Course Sequence Description
The UCSD Bioengineering Senior Design course sequence has the philosophy of “Capstone” design courses, where students use a variety of their previously learned skills to solve a focused engineering problem. The course also serves to meet ABET Outcomes and Learning Objectives, including formal design and decision making processes, working in teams, and awareness of ethical and societal consequences.

This course sequence includes two components: BENG 187A/B/C/D, each a 1 credit hour lecture course, taken in the student’s last four quarters (spring/fall/winter/spring); and BENG 1XXA/B, each a 3 credit hour project course taken in Fall and Winter quarters. (The particular course number depends on topic and project mentor – see list at end of this syllabus.) The goal of the entire experience is for students to gain appropriate background and experience with a formal design process, mostly through BENG 187, and to have hands-on experience with engineering design for biomedical applications, mostly through BENG 1XX.

BENG 187 focuses on reporting. Simplistically, during Spring of Junior year students learn about previous projects, do brainstorming for projects, and select from a mix of faculty, student, and industry proposed projects. During Fall they learn about formal design procedures and complete the design approach for their project. In Winter they implement the design and in Spring they give their final reports.

Most projects are in faculty research labs, most often affiliated with Bioengineering, with significant Medical School participation, and several in labs affiliated with UCSD. Most teams have four students. In 2018-19 there were 130 students and 40 projects; two with industry; 4 in UCSD affiliated labs; half had Bioengineering mentors and one quarter had medical school mentors.

In more detail:
Spring Junior Year. Students are enrolled in BENG 187A. They are required to listen to and critique oral reports given by the seniors. They attend “Bioengineering Day”, which includes poster sessions given by the seniors. The juniors are required to evaluate a subset of posters. There is half-day Saturday brainstorming “hackathon” aimed to help students learn to focus on ideas for projects. There will be talks on literature review and patent search which are to be completed over the summer. Additional topics will be announced.

Students rank order choices for projects and the instructional team matches as best as possible student and faculty preferences, but also including consideration for diversity (including among the four Bioengineering majors). **Students are encouraged to be highly proactive in contacting faculty for projects.**

Fall Senior Year: In BENG 187B students learn and apply a formal design process, including needs assessment, problem formulation, design alternatives, testing, scheduling, economic, safety and ethics considerations, leading to a formal design proposal that incorporates the shorter reports done during the quarter. Teams meet with TA’s twice and the Instructor once or twice during the quarter. This process serves to guide students, to ensure uniformity across the many groups, and to evaluate work both in the project course and in the formal preparation.

In BENG 1XXA (Design Development) students work with their mentor (usually meeting once per week) to design their project. Strong emphasis is placed on starting implementation by November 15 including rigorous evaluation of the feasibility of the project at a detailed level. A laboratory notebook must be kept and will be inspected regularly and graded.
**Winter Senior Year:** BENG 187C gives background material important to bioengineering device work, including overviews of human and animal subject regulations, FDA requirements, quality management, and emerging biomedical device technologies. All students will give 2 minute “elevator pitches” or “ignite talks.”

In BENG 1XXB (Design Implementation) students implement the design they created in the Fall. Strong emphasis is being placed on completing projects by the end of Winter Quarter. Some work extends into spring quarter on an informal basis. A formal Final Report is submitted, although it may be a “near complete” draft if work is to be finished in spring.

**Spring Senior Year:** In BENG 187D student teams prepare and deliver their oral report and their posters for Bioengineering Day, with TA coaching. Students create a website and a short video suitable for a lay audience. The Final Report -- submitted either in Winter of Spring -- details the work done.

### Methods of Evaluation

#### Grading Overview for BENG 187A, B, C, D:

The 187 sequence uses an “in progress” or “IP” grading scheme. A single letter grade for all four components is given at the end of 187D in the spring quarter; it reflects the quality of work completed throughout BENG 187A/B/C/D. At the end of 187ABC we will compute a grade “in progress” or “shadow grade” to be used toward computation of the project course grades. However, the final grade for each of BENG 187ABCD includes evaluation of all components over the spring/fall/winter/spring sequence.

**Grading Overview for Corresponding BENG 1XXA 3-Unit Project Courses:**

Grades for the 3-unit project courses (BENG1XXA – Fall Quarter; BENG1XXB – Winter Quarter) are given in conjunction with the supervisors for the individual projects. Final Letter Grades are assigned at the end of the Fall and Winter Quarters. The work in BENG187B/C substantially contributes to the quality of work performed in these project courses and is considered a component of the BENG1XXA/B grade:

- Supervisor's evaluation of work: 67% Fall, 83% Winter
- Evaluation of work done as assigned in BENG 187B (Fall): 33%; BENG 187C (Winter): 17%

#### More Grading Details for BENG 187ABCD -- subject to change

The following are approximate guidelines for the calculation of the course grades.

**Requirements for BENG 187A (For Spring 2018; subject to change)**

- Assignments (30%): Individual assignments related to the engineering design process are announced in class, including literature and patent assignments due on the first day of classes in the fall. Also included: report of your meeting with your senior mentor; summaries of poster presentations on Bioengineering Day.
- Project selection (20%): Successful matching to a design group and project.
- Attendance and Participation (30%): Students are expected to attend lecture, complete the group’s quizzes, and submit their evaluation.
- Brainstorming Participation and Report (20%) 

**Requirements for BENG 187B (subject to change). For Fall 2018**

- 15% Individual Brainstorming Assignments
- 15% Notebook
- 10% Attendance and Participation

**Requirements for BENG 187C (for Winter 2017; will change for 2018)**

- 20% Draft Final Report
- 10% Notebook
- 10% Peer Evaluation

**Requirements for BENG 187D (for Spring 2017; will change for 2018)**

- Final Project Report (30%)
- Final oral presentation (grade by peer evaluation by BENG 187A and BENG 187D students, 20%).
- Poster and presentation at the Bioengineering Day (20%)
- Mentoring 187A students (grade given by mentee, 10%)
- Video presentation of your design (10%); Website (10%)
Three ways to think about what you should have learned at UCSD

**ABET: Senior Design Outcomes / Learning Objectives strongly overlap ABET requirements.**
1. Apply the stages of the engineering design process to develop innovative and practical solutions to technical problems. Included are scheduling, constraints, alternatives and tradeoffs. (ABET 1,2,6)
2. Work effectively in project teams by establishing common goals, equitable workloads, a framework for mutual accountability, strong communication, and a collegial environment. (ABET 5)
3. Present various project results in effective written and graphical formats, and through informative oral presentations. Document progress at all stages (ABET 3)
4. Evaluate ethical issues in biomedical engineering practice, including understanding FDA regulation and human and animal subject use. (ABET 4)
5. Be exposed to, consider, and to implement where possible societal/world problems requiring innovative thinking and entrepreneurship. (ABET 7,8)

**ABET Program Outcomes (revised 2018): Engineering graduates must have:**
1. Identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and math.
2. Apply engineering design to produce solutions that meet specific needs with standards and constraints considering public health, safety, welfare, global, cultural, social, environmental, and economic factors.
3. Communicate effectively (written and oral) with a range of audiences.
4. Recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. Function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment (inclusion of diversity) and establish goals, plan tasks, and meet objectives.
6. Develop and conduct appropriate experimentation, analyze data, and use engineering judgment to draw conclusions.
7. Acquire and apply new knowledge as needed, using appropriate learning strategies (life-long learning).
8. Identify needs for new engineering solutions for society/world and develop innovative thinking to solve bioengineering problems with creativity and entrepreneurship.

**Senior Design Objectives**
- Identify design objectives, functions and specifications
- Compare alternative designs
- Design with an awareness of basic regulatory requirements
- Document the design process and evolution
- Make effective technical presentations in oral and written formats
- Learn to use feedback effectively for design revision
- Work effectively as a team, including effective communication among team members,
- Integration of results
- Scheduling
- Working within Constraints
- Understanding of Standards; recognition of their role in your project materials and use of your product

**The BENG 1XX Courses**
- All BENG 1XXA courses are “Design Development in …”
- All BENG 1XXB courses are “Design Implementation in …”
- BENG 119A/B … Biomechanics
- BENG 126A/B … Bioinformatics
- BENG 127A/B … Molecular Systems
- BENG 128A/B … Genetic Circuits
- BENG 129A/B … Cell Systems Bioengineering
- BENG 139A/B … Molecular Bioengineering
- BENG 147A/B … Neural Engineering
- BENG 148A/B … Cardiac Bioengineering
- BENG 149A/B … Vascular Bioengineering
- BENG 169A/B … Tissue Engineering
- BENG 179A/B … Bioinstrumentation
Assignment Policies:

Instructor Flexibility and Limits

The instructors’ goal is to maximize learning by students. We realize that the lives of seniors can be complicated and are willing to be flexible when we can. However, with ~140 students and weekly deadlines, there is only a little “wiggle room”. Hence, talk to us first.

Because there are so many components to the final grade, it is quite insensitive to small issues, such as missing a lecture. We are likely to turn down requests that are of very low impact on the final grade but require significant effort to accommodate special cases.

However, repeated or egregious problems may lead us to apply the rules below. We are especially sensitive to Academic Integrity issues.

Rules When We Must Apply Them

We can work with almost anyone with reasonable problems and constraints. We cannot work with large numbers of students pushing the rules. TALK TO US!

ALL parts of the homework must be turned in and may be graded. Late homework will not be accepted unless pre-arranged (and only for extenuating circumstances, e.g. medical or family emergency; an exam in another class is not an acceptable excuse).

Academic Integrity

We use Plagiarism Checkers!

The Department of Bioengineering adheres to the UCSD Policy on Integrity of Scholarship. The University expects all will honor this principle and in so doing protect the validity of the University’s intellectual work. For students, this means that all academic work will be done without unauthorized aid of any kind.

This course emphasizes group work – but you must acknowledge your teammate’s contributions.

How to Do Well:

It is imperative that you do not fall behind. Regular attendance is required and strongly rewarded in leading to more efficient Team Meetings. Do NOT fall behind in your design project !!!

Miscellaneous: Students with learning disabilities or requiring special teaching conditions or have religious conflicts, please see us ASAP. Also, please work with your team to keep on schedule.

FINAL NOTE ON ASSIGNMENTS AND GRADING

This course has more assignments than any other in your UG career – possibly as many as all your other courses combined:

- Attendance – 35 weeks worth of documentation
- Individual assignments – 20 weeks of assignments
- Team assignments – 2*10 +10 = 30 assignments
- Notebook submissions: 6 times
- Oral reports, formal reports, webpages, ....

TA’s will do the grading; they will be more rigorous early to establish our expectations as to quality; later they will be “spot checking” submissions. We cannot check everything, however.

Our goals include … you will always …

(a) …show up prepared at group/committee meetings (individual assignments due in lecture)
(b) …use your group meeting time efficiently (team assignments due at end of lecture)
(c) …not wait to work on your project (summer assignment, incremental work each week in Fall)
(d) … maximize your use of your team’s meeting time
(e) …enter your lab notebook entries continually (not all in December and March)