Bioengineering Design
BENG 187 and BENG 1XX
Spring 2017 thru Spring 2018
V 1.2 Apr 23, 2017; v2.1 Aug 20, 2017

Instructor in Charge: Bruce Wheeler, 229 PFBH, 858-534-6458, bcwheeler@ucsd.edu
Teaching Assistants: Spring 2017 – Teryn Johnson, Ismael Munoz, Anjulie Agrusa
Fall 2017/Winter 2018 – Anjulie Agrusa, Marisa Keller, Gladys Ornelas

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 additional 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. The BENG 187 series includes the reporting requirement. In simplistic form, 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.

For 2018 there are 40 projects and 140 students. Almost all are in faculty research labs, most in or affiliated with Bioengineering, with significant participation from the Medical School or other engineering departments, and several in labs affiliated with UCSD. (By comparison: In 2017 there were 33 projects and 130 students; most teams had four students. There were two student generated projects, three with industry; of the remaining, 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. The attend a full day “Bioengineering Day”, which includes poster sessions given by the seniors. The juniors are required to evaluate a subset of posters. New this year is a brainstorming “hackathon” aimed to generate from students focused ideas as to their desired projects. Also new are talks on doing literature review and patent search which are to be completed over the summer. 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).

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 includes 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. For 2017-18, strong emphasis will be placed on starting implementation by November 15. There is strong emphasis on keeping a project laboratory notebook.

Winter Senior Year: The lecture course BENG 187C gives background material important to bioengineering device work, including overviews of human and animal subject regulations, FDA requirements and reimbursement, quality management, and emerging bio- and biomedical device technologies. (Any topics
not covered in BENG 187B will be covered in BENG 187C.) This year there will be greater emphasis on reporting, especially short oral reports. 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.

Spring Senior Year: In BENG 187D student teams prepare and deliver their oral report and their posters for Bioengineering Day, with considerable TA coaching. Students create a website and a short video suitable for a lay audience. The Final Report 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 will be given at the end of 187D in the spring quarter that reflects the quality of work completed throughout the 4 quarter sequence (187A-D). At the end of 187B and 187C we will compute a grade “in progress” 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%
The BENG 187 course instructor informs the Project Supervisors of the BENG 187 “in progress” grade. Often, Supervisors find that grade to be appropriate for the Project Course (either BENG 1XXA or BENG 1XXB).

More Grading Details for BENG 187ABCD
The following are approximate guidelines for the calculation of the course grades.

Requirements for BENG 187A (For Spring 2017; subject to change)
- Assignments (40%): Individual assignments related to the engineering design process will be announced in class. These include literature and patent assignments due on the first day of classes in the fall (starting for 2017-18). Also included are a report of your meeting with your senior mentor and summaries of poster presentations by seniors on Bioengineering Day.
- Project selection (10%): 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 funding decisions. There is no grade penalty for missing up to 2 lectures.
- Brainstorming Participation and Report (20%)

Requirements for BENG 187B (subject to change). For Fall 2017
10% Individual Brainstorming Assignments
10% Notebook
15% Attendance and Participation
30% Team Assignments
15% Team work
20% Final Design Proposal

Requirements for BENG 187C (for Winter 2017; will change for 2018)
20% Draft Final Report
10% Notebook
10% Peer Evaluation
10% Design Review
10% Testing Plan
10% Poster Plan
10% Economics/Social
10% Attendance
10% Ethics

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

- Final Project Report (30%)
- Final oral presentation (grade determined by peer evaluation by BENG 187A 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%)
ABET: Senior Design Outcomes / Learning Objectives strongly overlap ABET requirements.

In Outline Form:
1. Apply the stages of the engineering design process to develop innovative and practical solutions to technical problems. Included are scheduling, consideration of alternatives and tradeoffs.
2. Work effectively in project teams by establishing common goals, equitable workloads, a framework for mutual accountability, strong communication, and a collegial environment.
3. Present various project results in effective written and graphical formats, and through informative oral presentations. Document progress at all stages.
4. Evaluate ethical issues in biomedical engineering practice, including understanding FDA regulation and human and animal subject use.

With reference to ABET student outcomes:
1. Apply the stages of the engineering design process to develop innovative and practical solutions to technical problems (ABET a, c, e, f, j, k).
2. Work effectively in project teams by establishing common goals, equitable workloads, a framework for mutual accountability, strong communication, and a collegial environment. (ABET d, g, i).
3. Present various project results in effective written and graphical formats, and through informative oral presentations (ABET g, h, i).
4. Evaluate ethical issues in engineering practice in terms of NSPE’s Code of Ethics (ABET f) and apply techniques in failure analysis and hazards analysis to engineering systems (ABET a, e, h).

ABET Program Outcomes Engineering programs must demonstrate that their graduates have:
   a) an ability to apply knowledge of mathematics, science, and engineering
   b) an ability to design and conduct experiments, as well as to analyze and interpret data
   c) an ability to design a system, component, or process to meet desired needs
   d) an ability to function on multidisciplinary teams
   e) an ability to identify, formulate, and solve engineering problems
   f) an understanding of professional and ethical responsibility
   g) an ability to communicate effectively
   h) the broad education to understand the impact of engineering solutions in a global and societal context
   i) a recognition of the need for, and an ability to engage in life long learning
   j) a knowledge of contemporary issues
   k) an ability to use modern engineering tools

Senior Design Objectives
- Identify design objectives, functions and specifications
- Compare alternative designs
- Design with an awareness of basic FDA 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
- Effective communication among team members,
- Assignment of tasks
- Integration of results
- Scheduling

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.

We note that there are many components to the final grade; hence, that grade 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
ALL parts of the homework must be turned in and will 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).

Any requests for a re-grade must be made in writing to the TAs and will result in a re-grade of the entire assignment, not just a specific section, first by the TAs themselves and, if this dispute remains, by the course instructor. Such re-grading could result in a higher or lower overall grade.

Academic Integrity
The Department of Bioengineering adheres to the UCSD Policy on Integrity of Scholarship. The University expects that both faculty and students 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 by the individual (or team) to whom it is assigned, without unauthorized aid of any kind.

You can find the University’s policies at: https://academicintegrity.ucsd.edu/.

All suspicion of academic misconduct will be reported to the Academic Integrity Office. Academic misconduct is not just blatant cheating (e.g., copying off another student during an exam), but what you might have thought of as “minor cheating” in high school, for example: copying other students’ papers or homework; copying or using old papers/reports; working with others on individual assignments; forgetting to cite material you took from an outside resource; turning in work completed in total or part by another. Students are REQUIRED to USE GOOD ETHICAL JUDGMENT – including asking your instructors for advice.

Those students found to have committed academic misconduct will face administrative sanctions imposed by their college Dean of Student Affairs and academic sanctions imposed by Instructor in Charge. The standard administrative sanctions (outside the control of the instructor) include: the creation of a disciplinary record (which will be checked by graduate and professional schools); disciplinary probation; and attendance at an Academic Integrity Seminar (at a cost to the student). Students can also face suspension and dismissal from the University. Academic sanctions imposed by the instructor can range from an F on the assignment to an F in the class. Students who assist in or are complicit with cheating could also be in violation of the Policy, including being aware of but not reporting cheating by others.

In other words, cheating of any kind whatsoever will not be tolerated in any form in this course and will be punishable to the maximum extent possible as per university rules and policies.

This course emphasizes group work – but it requires acknowledgement of the contributions of the different individuals.

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; you will find it difficult to catch up once you fall behind.

Miscellaneous: Students with learning disabilities or requiring special teaching conditions, please see us ASAP. If you are an observant member of a religion that has a holiday that conflicts with a lecture sometime during the semester, please work with your team so that you and the team are always on schedule.