

BENG 187B Bioengineering Design Project: Development. Hybrid Course Additions to the Syllabus Fall 2021

V1.0 17-Sep-21

Rationale for Changes:

Ultimately the rationale is health and safety of students, faculty and staff. Secondly, if someone in the class tests positive, the problems include quarantine of either or both students and instructors, with significant disruption to the delivery of course material. Maintenance of safety and course delivery strongly suggest that classes be sparser than planned in order to maintain proper social distancing.

UCSD Policy

Campus has been ambiguous as to what size class/classroom/spacing, etc. are appropriate, safe, and feasible for in person instruction. It delegates to faculty the decisions as to how to conduct classes. A presentation to the BE Department suggested substantial reductions in the attendance of in person class attendance. Hybrid is one means to do this; it also meets needs of students unable to meet in person.

Issues for BENG 187B

BENG 187B relies on:

- (a) Regular attendance by all students
- (b) In class team exercises

The problems are:

- (a) Our classroom seats 190 while there are 140 students, implying most students will be sitting next to another student
- (b) Team assignments assume talking in small groups. In a crowded auditorium, it is desirable sit closely to facilitate communication but undesirable as per health safety.

Hybrid for BENG 187B – Solution for Fall 2021

BENG 187B will be offered “hybrid”, with these characteristics

- (a) Zoom of live lectures – details to be determined; likely audio plus video of powerpoint
- (b) Recording of lectures for subsequent viewing

For team/group assignments due shortly after the end of the lecture

- (a) Requires every member of the team to make the same choice (in person or via zoom) so as to collaborate on assignments
- (b) In person – talk to your group in the lecture hall to answer assignment due immediately after class
 - (b1) alternatively – leave the lecture hall, convene outside, and answer the assignment
- (c) Live but remote – assignment to breakout rooms; assignment due immediately after class
- (d) Remote, asynchronous – make arrangements with your TA for due date/time

Final Notes

Two most important things

- (a) Health, safety of everyone
- (b) Steady progress through the course

And ... many ways to make progress

- (c) important – steady progress
- (d) not so important – how you do this

And more Final Notes

We'll adjust

- (a) Too many in lecture? – rotations? Other ideas?
- (b) Too few in lecture? – perhaps we go all remote

Schedule for BENG 187B – Fall 2021

Revised Oct 16, 2021.

Week	Date	Lecture Topic	Assignments: Individual before Lecture and Team Breakout	Polished Team Assignment Due The following Monday
0	Weds Sep 22	ASSIGNMENTS DUE BEFORE THE FIRST LECTURE (BENG 187A) Due Wednesday Sep 22 <i>Individual Literature Review; Individual Patent Search; Team Literature Review</i>		
	Fri Sep 24	Intro to the Course Problem Statement	<i>Needs, Problems, Goals</i>	<i>Needs</i>
1	Weds Sep 29	Goals	<i>Problem Statement</i>	<i>Problem Statement Goals Statement</i>
	Fri Oct 1	Interviewing	<i>Goals Statement</i>	
2	Weds Oct 6	Constraints	<i>Interviewing – preliminary lists</i>	<i>Constraints List of Interviewees</i>
	Fri Oct 8	Alternative Designs	<i>Constraints</i>	
3	Weds Oct 13	Planning, Timelines,	<i>Alternative Designs</i>	<i>Alternative Designs Contract Due Gantt Chart</i>
	Fri Oct 15	Budgeting, Parts, Resources Risks	<i>Planning, Gantt Chart</i>	
4	Weds Oct 20	Standards (Wheeler)	<i>Parts, Budget, Resources Needed</i>	<i>Risks Parts, Budget, Resources Notebook Check: Oct 25</i>
	Fri Oct 22	Intro to Human Subjects (Wheeler)	<i>Risks</i>	
5	Weds Oct 27	FDA (Wheeler)	<i>Project Exchange</i>	<i>Project Exchange Summary</i>
	Fri Oct 29	Project Exchange	<i>Project Exchange</i>	
6	Weds Nov 3	Margie Mathewson (PhD BioE, UCSD) <i>Osmium Scientific</i>	<i>Careers in Biomedical Engineering: Taking Advantages of Opportunities as They Arise</i>	<i>TA Review Week Interview Reports Nov 8 Work on project and proposal</i>
	Fri Nov 5	Taylor Williams (BS Biosystems) <i>NY Times, formerly Illumina</i> Hayley Chong (BS Bioeng) <i>Encodia and formerly Illumina</i>	<i>Panel of Recent Graduates – Advice to Seniors</i>	
7	Weds Nov 10	Anna Snell (PhD BioE, UCSD) <i>Abbot Labs</i>	Title to be determined	<i>Notebook Check Nov 15 Work on project and proposal</i>
	Fri Nov 12	No Lecture		
8	Weds Nov 17	Kristin Havranek (J.D., BSE BioE U Penn) <i>Partner at Goodwin Procter LLP</i>	<i>Basics of Intellectual Property Law</i>	<i>Work on project and proposal</i>
	Fri Nov 19	Dooley, Zac (BS BME Marquette MS BME USC) <i>SeaSpine</i>	<i>Practical Lessons for Standards in Biomedical Devices</i>	
9	Weds Nov 24	No Lecture – Thanksgiving on Thursday	<i>On Your Own: Strengths, Weaknesses; Progress to Date</i>	<i>Include Strengths, Weaknesses in Final Proposal, no separate submission</i>
	Fri Nov 26	No Lecture – Thanksgiving on Thursday	<i>Work on proposal– revisit each component</i>	
10	Wed/Fri Dec 1/3	No Lecture – meet Prof Wheeler	<i>Work on proposal – revisit each component</i>	<i>Design Review Teamwork Evaluation</i>
11	Mon Dec 6	Exam Week	<i>Proposal Due Monday 5 pm</i>	<i>Final Design Proposal Due</i>

1. Early to Mid October
 - a. Required – end your TA a short summary of progress to date and problems to date. This has to be easily scanned by your TA to focus on the most important issues – good and bad – and to summarize your progress.
 - b. Schedule zoom as instructed
2. First Week of December
 - a. Formal design review with Prof Wheeler
 - b. See assignments for documentation that must be submitted before the meeting
 - c. Schedule Zoom meeting as instructed
 - d. Purposes:
 - i. Pushing you to keep your project moving before the end of quarter
 - ii. Identify problems
 - iii. Feedback on quality of design
 - iv.

Sessions with Guest Lecturers:

Lecturer talks for 25 minutes

Individual Assignment: 2 questions for the speaker – must submit before end of class on CANVAS

We'll try to keep zoom open after formal end of class

Project Exchange

- Teams will be paired and then explain project to each other. Come prepared to discuss your project to your classmates.
- Team assignment: give a summary of the other team's project, including names of team members, mentor (and affiliation), title, and one paragraph summary of the other team's project. One report is due after the last of the Project Exchange sessions (currently schedule for 3 sessions).

Bioengineering Design
BENG 187 and BENG 1XX
Spring 2021 thru Spring 202
V 1.0 Mar 14, 2021

Instructor in Charge: Bruce Wheeler, 229 PFBH, 858-534-6458, bcwheeler@ucsd.edu

Teaching Assistants

Spring 2020: Katherine Pieri, Neha Chhugani, Vasiliki Courelli, Caressa Robinson
Fall 2020, Winter 2021, Spring 2021: to be determined

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

Textbook(s) Suggested (Available on library 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

COVID! -- Lectures are remote; projects are a combination of remote and in person, depending on resources of the mentor. We (the instructors) are here for you! Please reach out.

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 (Accreditation Board for Engineering and Technology) 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 learn much background into the Biomedical Engineering Profession (FDA, ..., reporting, ... standards, ... testing). They implement their design in BENG 1XXB. In BENG 187D 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.

For 2020-2021 there are 165 students: 50 Bioengineering, 25 Bioinformatics, 17 Biosystems, and 73 Biotechnology. There are 44 projects: 23 with Bioengineering faculty, 8 with medical school faculty; 4 with companies, 5 with other JSOE departments, 1 from Scripps Institute of Oceanography, 3 from the J Craig Venter Institute. Several of these have joint sponsorship across departmental lines.

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 are two brainstorming “hackathon” sessions during lecture time 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.

Project Generation and Assignment

The major activity of the spring is the generation of projects and the assignment of students.

Project generation proceeds along several paths: 1. Prof. Wheeler recruits projects from faculty and industry; often these are continuations of previous projects. 2. Students recruit faculty to sponsor a project; very often this occurs for students who have worked in their laboratories.

Assignment occurs in one of three ways: 1. Students who have worked with a faculty member to identify a project are assigned to that project and may recruit other students to the team. 2. Students may approach faculty who have proposed a project and, if there is sufficient mutual interest, a team is created. 3. Students express a preference for listed projects and Prof. Wheeler assigns students doing his best to balance student interests and skills needed to carry out the project.

Usually one or two student initiated projects are pursued; projects from EWH or similar organizations are encouraged. Occasionally teams recruit a team member from another JSOE major – sometimes the student can get credit for the activity. While there are no formal senior project sharing courses, we will work with students and other departments to see if there is a match to be made.

Students are encouraged to be highly proactive in contacting faculty for projects. This is especially true this spring due to the greater difficulties in communication.

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 – once over the summer, once in early fall, and, selectively, in the last weeks of the quarter. They meet with Prof. Wheeler in mid quarter to review progress.

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. Given problems with COVID – we greatly encourage more frequent meetings.

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 -- this is online in 2020-21.

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 or Spring -- details the work done.

We add: Online 2020 BE Day was overwhelmingly successful. 2021 plans are for online BE Day.

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. Please see details on the syllabi for BENG 187B and (when published) BENG 187C.

- BENG 1XXA: ½ Mentor; 1/3 BENG 187B; 1/6 proposal content evaluation by BENG 187B instructor
- BENG 1XXB ½ Mentor; 1/6 BENG 187B; 1/3 content evaluation by BENG 187C instructors

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 2020; subject to change)

- 10%, 10%, 10%: lit review (individual and team), patent search
- 10%, 10%: participation/report in senior oral and poster reporting
- 20%: Brainstorming Participation and Report and Class Assignments
- 10%, 10%, 10%: meet/report with senior team mentors, and (over summer) project and TA mentors

Requirements for BENG 187B (subject to change). For Fall 2020

- 10% Individual Assignments
- 10%/10% Team Assignments (quick and long)
- 20% Final Design Proposal
- 20% Notebook
- 10% Attendance
- 10% Team Work/Peer Eval.
- 10% Design Review

Requirements for BENG 187C (for Winter 2019; will change for 2020)

- 25% Draft or Final Report
- 5% Individual Assignments
- 5% Team Assignments
- 20% Notebook
- 10% Team Work +Peer Eval.
- 10% Design Review
- 10% Ignite/Elevator Talk
- 10% Poster Draft
- 5% Attendance

Requirements for BENG 187D (for Spring 2019; will change for 2020)

- 15%: Project Report
- 20%: Final oral presentation
- 20%: Poster
- 20% Presentation (BE Day)
- 10%: Mentoring juniors
- 10%: Web Page
- 5% Video

Four ways to think about what you should have learned at UCSD and are learning in Senior Design.

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.

ABET/BMES Biomedical Engineering Educational Criteria: all apply to senior design

... Breadth and depth across the discipline ... experience in:

- a. Applying principles of engineering, biology, human physiology, chemistry, calculus-based physics, mathematics (through differential equations) and statistics;
- b. Solving bio/biomedical engineering problems, including those associated with the interaction between living and non-living systems;
- c. Analyzing, modeling, designing, and realizing bio/biomedical engineering devices, systems, components, or processes; and
- d. Making measurements on and interpreting data from living systems.

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 ...”
- BENG 119A/B ... Biomechanics
- BENG 126A/B ... Bioinformatics
- BENG 127A/B ... Molecular Systems
- BENG 128A/B ... Genetic Circuits
- BENG 129A/B ... Cell Systems Bioengineering
- All BENG 1XXB courses are “Design Implementation in ...”
- 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 ~160 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. In general we do not accept late homework regardless of the validity of the excuse. There are so many assignments that this will even out over the four courses (BENG 187ABCD).

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:

Attendance – 35 weeks worth of documentation	Individual assignments – 20 weeks of assignments
Team assignments – $2 \times 10 + 10 = 30$ 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**

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