

Bioengineering Senior Design: Overview for Mentors

Bruce Wheeler, 10-Oct-18 v1.0

Five Simple Things

1. Meet weekly with your team
2. Guide but don't dictate
3. Expect ~10 hours per week
4. Two Quarters – Fall and Winter (ends March 23)
5. Review Student Team Contract (new this year)

Two Course Sequences

BENG 187ABCD (Spring/Fall/Winter/Spring): overview 1 credit lecture courses

BENG 1XXA/B (Fall/Winter): 3 hour project courses where the work is done

Formally:

BENG 1XXA is to design the project; BENG 1XXB is to implement the design.

BENG 187A is to learn about projects and to select one

BENG 187B is to learn formal project proposal methodology – and conceptualize and document the design being done in BENG 1XXA

BENG 187C is to gain background in relevant topics – FDA, Human Subjects, Ethics, ...

BENG 187D is for presentation (oral, poster, web site, video)

Concept of a Capstone Design Course

Students use previous coursework knowledge to design and implement an engineering project. This is required by ABET (Accreditation Board for Engineering and Technology). Virtually all engineering curricula in the USA require Senior Design (also known as “Capstone Design”).

Course Timing:

Spring Junior Year: project assigned

Summer: literature review and patent search

Fall: Design Proposal and Start Implementation

Winter: **Finish Implementation** / Final Report

Spring: Presentations

Historically, too many projects have extended well into Spring Quarter. If the project needs more work, I recommend: (a) drawing a line at end Winter Quarter for the formal project; and (b) enroll the students in BENG 199 (Independent Study) for Spring. Work with your team to define the endpoint.

Bioengineering's Four Majors all take Senior Design and are interspersed on many teams

Bioengineering (more mechanics oriented)

Biotechnology (chemical, molecular, tissue)

Bioinformatics (computational, genomics)

Biosystems (modeling, computational, electrical)

Student skill sets vary by major.

Range of Projects – exceptionally broad:

2018-19 examples: Cartilage Bioreactor; Bioinformatic Platform for Analyzing Hair Regeneration; Computational / 3D Printing of Model for Atrial Occlusion Procedure; Home Health Monitor

Previous Projects <http://beweb.ucsd.edu/courses/senior-design/projects/>

Titles of the BENG1XXA/B courses: “Design Development/Implementation in ...” Biomechanics (119), Bioinformatics (126), Molecular Systems (127), Genetic Circuits (128), Cell Systems Bioeng (129),

Molecular Bioeng (139), Neural Eng (147), Cardiac BioEng (148), Vascular BioEng (149), Tissue Eng (169), Bioinstrumentation (179)

Range of Activities in the Project Courses

1. Arranged regular lab hours, often necessitated by need for direct supervision
2. Irregular lab hours as students gain skills needed to work alone, in teams or with grad students
3. Implemented in students' apartments – often computational work
4. Use JSOE (Jacobs School of Engineering) resources on ad hoc basis
5. Bioengineering Department Lab on ad hoc basis
6. Company facilities
7. Entirely student driven projects

Every year we have versions of each of these – please use your judgment as to how to organize.

Who Are the Mentors

Participation has been by faculty and researchers in JSOE (BioE, ECE, CSE, MAE, Nano), Biological Sciences, Chemistry, Medicine (Pediatrics, Medicine, Orthopedic Surgery, Surgery), Bioinformatics, J. Craig Venter Institute, Sanford Burnham Prebys, and several companies (currently Zenobia) and individuals (currently Mr. Sam Attenberg).

Often the faculty mentor is assisted by a Senior Grad Student or Postdoc who can provide the weekly meetings with the team and more personalized assistance.

How Much Guidance Should You Provide?

Pedagogically, the purpose of the experience is for students to learn to do it themselves. However, the Mentor is needed for much more than suggesting the project and providing resources:

- As rapidly as possible, get the students engaged and eager to recognize and solve problems
- Check that they are making progress on solutions regularly
- Check that their solutions make sense
- Help with bottlenecks
- If you have proposed a specific project, please bring them “up to speed” as quickly as possible
- Best is when you “launch them” and they take over before the Fall Quarter is over

The instructors meet with every team

- Summer –TA's; this has already happened
- October – TA's
- November – Prof Wheeler
- November/December – TA's in conjunction with Oral Reports
- January – TA's
- February – Prof Wheeler
- March – TA's with Ignite/Elevator Talks
- April – TA's to prepare for Poster Presentations

Resources and Budget

- JSOE has design/fabrication facilities for students, notably the Envision Maker Studio. <http://jacobsschool.ucsd.edu/envision/facility.shtml>. Bioengineering major students often have access to greater machining opportunities as they take several MAE courses.
- Bioengineering has very limited space for senior design activities in Fall, but more in Winter quarter.
- Historically the department has relied on faculty to support student projects in modest ways. Most often this has been “win-win” as the student teams made progress on projects that otherwise the faculty would not be able to pursue.

- This year the Bioengineering Department has allocated a budget of roughly \$500 per team that can defray these expenses; students must justify and have the proposed purchases be approved, of course.

BENG 187A (Spring)

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| 1. Literature and Patent Search | 2. Intellectual Property |
| 3. Brainstorming Exercise | 4. Project Selection |

BENG 187B (Fall) – preparing the proposal – takes some time away from lab work

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| 1. Literature/Patent Review (over summer) | 6. Constraints |
| 2. Needs Statement | 7. Resources; Budget; Parts; Costs |
| 3. Problem Statement; Team Contract; Interview List | 8. Schedule / Bottlenecks |
| 4. Goals Statement | 9. Strengths / Weaknesses |
| 5. Alternative Designs | 10. Final Design Proposal |
- Also: team oral report on proposal (5 min)

The compilation of these assignments covers almost all of the formal proposal due in December.

BENG 187C (Winter) – background – takes one hour per week – “contributes” time to lab work

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| 1. Ethics | 7. Standards (and Organizations) |
| 2. IRB | 8. Emerging Technologies |
| 3. Animal Use | 9. Poster Presentations |
| 4. Testing | 10. Oral Presentations |
| 5. FDA | 11. Writing and Proposals |
| 6. Quality Control | 12. Final Report |

Also: Individual 2 min Elevator/Ignite Talks

BENG 187D (Spring) Presentations

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| Team Oral Presentation (20 mins) | Poster at Bioengineering Day | Web site, Video |
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Grading

I solicit grades from Mentors for both Fall and Winter. I combine these with the BENG 187ABCD grades to generate the project grades on the logic that the work in the overview courses (especially BENG 187B) contributes to the performance of the project.

Notes:

Team work is an essential part of Senior Design.

We inspect notebooks every other week.

Fall Weekly Schedule

- Individual Assignment – brainstorm an element of the formal design – due Weds in lecture
- Lecture on topic for 25 mins; teams work for 25 mins; preliminary team report due immediately
- Attendance taken
- Team Assignment due Monday – it comprises one section of formal report due in December

Spring Weekly Schedule

- Lecture for 30 mins
- Individual assignment is questions for lecturer, due at 30 min mark
- Team assignment referencing the lecture due 30 min after lecture end
- Attendance Taken

Note: teams meet in lecture every week. They have lots of opportunity to discuss and reschedule.

A complete set of assignments for BENG 187B is available as a compressed file by request. Also includes syllabi for BENG 187ABCD.