

Bioengineering Senior Design: Overview for Mentors

Bruce Wheeler, 16-Mar-22 – Post COVID (hopefully !)

Six Simple Things

1. Meet weekly with your team (~1-2 hours)
2. Guide but don't dictate
3. Arrange for resources
4. Students: ~10-12 hours per week
5. Two Quarters – Fall/Winter (ends Mid-March)
6. Review Your Students' Team Contract

Well, Another Simple Thing: You and your students will be productive and have fun

Post COVID19 Assumptions

- UG students in small teams/projects will be allowed in research labs.
- If we must, we have experience in converting in-person to computational projects..
- 3D printing, etc.: Engineering's Maker Lab (see below) should be available throughout. BioE bought a pair of modest resolution 3D printers; they are available by appointment this coming year.

Two Course Sequences

BENG 187ABCD (Spring/Fall/Winter/Spring): overview -- 1 credit each, 2 meetings per week.

BENG 1XXA/B (Fall/Winter): 3 hour project courses **where the real work is done**
(don't worry about the course numbers XX)

BENG 1XXA: design the project BENG 1XXB: build the design.

BENG 187A: learn about projects and select one

BENG 187B: formal project proposal methodology for work in BENG 1XXA

BENG 187C: background in relevant topics – FDA, Human Subjects, Ethics, ...

BENG 187D: presentations (oral, poster, web site, video)

Concept of a Capstone Design Course

Students use knowledge from previous coursework to design and implement an engineering project. Required by our accrediting agency 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

Many projects extend into Spring Quarter. If the project needs more work, please consider: (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): **BENG** Biotechnology (chemical, molecular, tissue): **BTECH**)

Bioinformatics (comput'l, genomics) (**BINF**) Biosystems (modeling, computational, electrical): (**BSYS**)

Student skill sets vary by major.

Project Range is exceptionally broad: <http://beweb.ucsd.edu/courses/senior-design/projects/> **Examples:**

Tissue Engineered Lymph Node Scaffold ...

In-Ear EEG for Psychoacoustic ...

Laryngospasm Device

Machine Learning ... to Detect ... Miscarriage

Test Fixtures for Spinal Implant

Home Health ...

BENG1XXA/B titles: “Design Development/Implementation in ...” Biomechanics, Bioinformatics, Molecular Systems, Genetic Circuits, Cell Systems Bioeng, Molecular Bioeng, Neural Eng, Cardiac BioEng, Vascular BioEng, Tissue Eng, Bioinstrumentation. *(don’t worry; we take care of the students and course titles)*

What is Organized for Activities in the Project Courses ... might be ...

1. 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 of 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 students work in a variety of conditions – please discuss.

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; local industry (multiple before COVID)

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.

We especially support industry and clinical mentors. We pledge enhanced interaction.

How Much Guidance Should You Provide?

Pedagogically, the purpose 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 for you to “launch them” and they take over before the Fall Quarter is over

Resources and Budget

JSOE has design/fabrication facilities for students, notably the Envision Maker Studio. <http://jacobsschool.ucsd.edu/envision/facility.shtml>. Bioengineering major **BENG** but not **BTECH BINFO BSYS** students, will have taken multiple MechE courses and have access to greater machining opportunities.

- Bioengineering has 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. This is “win-win” as student teams make progress on projects otherwise not pursued.
- The BioE Dept budgets \$500 per team to defray expenses, subject to approval.
- JSOE students have excellent access to computational resources.

Our Supervision

Course instructors meet with each team: consulting and design reviews multiple times each quarter. We critique oral and poster reports. We monitor weekly assignments.

BENG 187A (Spring) Project Selection (completed by mid June). Lecture topics include:

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|---------------------------------|--------------------------|---------------------------|
| 1. Intro to Projects | 2. Learning from Seniors | 3. Brainstorming Exercise |
| 4. Literature and Patent Search | 5. Ethics | 6. BioE Technology |

BENG 187B (Fall) – Preparing the Proposal (informs projects, takes some time away from lab)

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

BENG 187C (Winter) – Background (takes little time from project)

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|---------------|----------------------------------|---------------------------|
| 1. Ethics | 6. Quality Control | 11. Writing and Proposals |
| 2. IRB | 7. Standards (and Organizations) | 12. 'Final Report |
| 3. Animal Use | 8. Emerging Technologies | 13. BME around the world |
| 4. Testing | 9. Poster Presentations | 14. Career Advice |
| 5. FDA | 10. Oral Presentations | 15. Elevator/Ignite Talks |

Guest Speakers: Emphasize Industry/Pragmatic Advice – 8 speakers – **Would you Like to Speak?**

We have an extraordinarily successful series of speakers: “Bioengineering Around the World”

Critical need: “what are jobs like?”

BENG 187D (Spring) Presentations

Team Oral Presentation (20 mins) Poster at Bioengineering Day
Web site, Video Meet juniors Graduate

Grading

I solicit grades from Mentors for both Fall and Winter. I combine these with the BENG 187BC grades to generate the project grades. Rationale: work in BENG 187BC is part of the project.

Notes:

Teamwork is essential to Senior Design. So is attendance, team meetings, etc. -- we insist and enforce.

We inspect notebooks regularly. (You may do the inspection to maintain confidentiality.)

Fall Weekly Schedule – two lecture meetings per week.

Lecture on topic for 25 mins. Meeting time for 25 mins.

Individuals bring assignment to lecture; teams combine ideas; submit at end of lecture

Rewritten assignment due the next Monday – it is part of the formal proposal.

Winter Weekly Schedule – two lecture meetings per week.

BioE Topics Lectures: 30 mins, team questions for 30 mins

Guest Lecturers: 30 min, 5 min team discussion, 15 min Q&A, individual Q assignment

Guest Speakers are Critical to Expanding Our Students Perspectives!

Miscellany

Teams meet in lecture each week -- great opportunity to discuss / schedule meetings

We will sign NDAs.

A complete set of assignments/syllabi for BENG 187A/B/C/D is available by request.

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Zoom works. <https://jacobsschool.ucsd.edu/faculty/profile?id=398>