Course Title: BIOEN 401 – Bioengineering Capstone Principles

Instructor: Paul Yager

Credits: 3

UW Catalog Course Description: Teaches design principles in bioengineering and guides the development of design and research-based senior capstone projects.

Detailed Course Description:
The Department of Bioengineering offers two options for completing a senior capstone project. Students who choose the BIOEN 401-402 sequence conduct an individual design project. Students who choose the BIOEN 401-403-404-405 sequence conduct an individual research project and a team design project. The number of total credits in each sequence is equal.

BIOEN 401 prepares students for the individual capstone design project (BIOEN 402) or capstone engineering research & design sequence (BIOEN 403-404-405). Each student is encouraged to choose a host lab before starting BIOEN 401 in spring of the junior year, and must select a project topic early in BIOEN 401.

The first goal of BIOEN 401 is to teach the interrelation of design and research in bioengineering. Students will learn how to address a problem of biomedical significance using bioengineering tools. They will be coached in skills needed to thrive in a research laboratory, and to accomplish their projects efficiently. They will also learn the importance of understanding the context of their work with respect to their colleagues, their peers, their society, and their world.

The second goal of BIOEN 401 is to ensure that all students are affiliated with a research laboratory and launched on their senior capstone design project (BIOEN 402) or capstone engineering research project (BIOEN 403) by the end of the quarter. An initial review early in BIOEN 401 confirms that each BIOEN 402 project will be a culminating Bioengineering design experience; this confirmation will be made in BIOEN 404 for those students pursuing the BIOEN 403-404-405 option. Every student is required to submit a detailed plan for their design project or research project, as appropriate. The nature of the project is examined twice by the BIOEN 401 instructor or Student Affairs Committee.

BIOEN 401 may include a practice design project, in which teams of 5-6 students develop a Research and Development (R&D) plan for a marketable product.

Students will be graded on their ability to process and communicate ideas of their proposed research project, and on their practice design project if one is required.

Prerequisites:
STAT 390 or IND E 315; junior standing in the Department of Bioengineering.

Textbooks: None

Learning Objectives:
• Learning the importance of clinical significance for R&D in bioengineering.
• Learning the interrelation of design and research in bioengineering
• Learning bioengineering design to develop methods or apparatus to address a problem of high clinical significance
• Learning how to apply bioengineering tools to design a clinical device or method
- Learning the administrative issues of bioengineering R&D
- Learning how to write a research and development plan
- Learning how to present an R&D plan
- Learning the importance of bioengineering work with respect to colleagues, peers, society and the world in general.

Topics Covered:
- Bioengineering as a field: Introducing the discipline of bioengineering as a practical tool to enhance our knowledge of biology and medicine, as well as to develop technologies for medicine.
- Design: engineering design for biology and medicine, system engineering
- Research and Development: design, testing, implementation, and manufacturing principles in bioengineering R&D of a product
- Capabilities and limitations of bioengineering
- Socioeconomics: why, where, when, who

Class Schedule:
Three 1-hour lectures per week.

Computer Use:
Requires on-line access to search literature, prepare project proposals, and to communicate via email. Requires preparation of project proposals and overhead slides in digital format.

Laboratory Projects:
Students must conceive and propose cutting-edge research or design projects in faculty laboratories. Projects may be proposed by the students or advisors, according to the interests of both. The course may also include a practice design project done in teams of 4-6 students.

Course Outcomes and Assessment:
Students’ success in BIOEN 401 depends on their ability to perform the tasks described below, and to synthesize these tasks into a coherent effort. Letters and titles refer to ABET learning outcomes.

b) Design and conduct experiments, as well as to analyze and interpret data. Lectures introduce capstone project examples in which experimental design and data analysis are discussed. Students are required to design the experiments that they plan to conduct during the Capstone project, and propose methods for data analysis and interpretation. Students’ knowledge is assessed via the final capstone project plan.

c) Design a system, component, or process to meet desired needs. Lectures introduce capstone project fundamentals, capstone examples, and clinical need and engineering development, all of which are discussed in the context of the system (device or protocol) that students are required to develop during their capstone design or research project. Three lectures by the instructor (one on Capstone examples, one on bioengineering design, and one on GLP and GMP), and 2 lectures by Senior Bioengineering students are pertinent to this outcome. Assessment exercise: Design component of the capstone project proposal.

e) Identify, formulate, and solve engineering problems. Lectures introduce the concept of developing bioengineering solutions to address specific clinical needs. Lectures on Capstone fundamentals, and past or ongoing student projects are pertinent to this outcome. Additionally, students are required to attend the Undergraduate Research Symposium.
Assessment Method: Written report on undergraduate research symposium report and “Background and Significance” section the final capstone proposal:

f) Understand professional and ethical responsibility. Lectures introduce specific topics of professional and ethical responsibility, including service and society, animal studies, and human subjects. This outcome is assessed via the discussion of future directions in the draft Capstone proposal.

g) Communicate effectively. One lecture by the instructor is on technical communication.

h) Understand the impact of engineering solutions in a global and societal context. Content and assessment is similar to that presented above for outcome f.

i) Recognize the need for, and engage in, life-long learning. Lectures introduce the concept of bioengineering research and development based on the current state of the art, and the need to be engaged with current practice in order to be an effective bioengineer. This outcome is assessed via the undergraduate research symposium report.

j) Know contemporary issues. Content and assessment is similar to that presented above for outcome i. This outcome is assessed via the “background and significance” discussion in an early draft of the capstone project proposals.

Relationship of course to Departmental Objectives:

This course teaches design principles to junior-level students in Bioengineering. This objective is accomplished through formal lectures, an R&D plan for design and testing of a bioengineering product, and a research plan for their capstone design projects. The course is a stepping stone for students to learn about engineering research, design and implementation. Thus, students in BIOEN 401 progress toward our departmental objectives by:

• Learning design principles for bioengineering products (methods or apparatus)
• Learning the importance of working in teams
• Learning the importance of social and ethical consideration in bioengineering design
• Learning communications skills

References:


BIOEN 401 Lecture topics

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BIOEN 401 Assignments: preparing for BIOEN 402 research and design project

Capstone Project Proposal Outline (1-page): 10%
This homework requires the students to interact with the Bioengineering faculty to identify a Capstone Project for their senior year, and to write a 1 page outline of the Capstone project. The outline should including the clinical need of the project, the design component, and discussion on ethical, social, legal and translational issues.

Laboratory Description (3-page): 15%
This homework requires student to write a 3-page document on the lab they will work in, providing the people and major projects in the group, the major equipment they will use in their Capstone projects, and the relationship between the students' and others' projects.

Report on Mary Gates Undergraduate Research Symposium or CoE Open House (1-page): 5%
This homework requires the students to visit the College of Engineering Open House and report on one of the exhibits, or to attend the Mary Gates symposium and report on one of the posters or presentations. The report should address the design and research elements demonstrated in the exhibit.

Preliminary Capstone Proposal (3-page): 15%
This homework motivates further discussion between the student and faculty advisor, as additional details of the project developed.

Design Component of the Capstone Proposal (2-page): 10%
This homework requires students to discuss the design component of their Capstone proposals. The proposal should discuss the background, significance and current engineering solutions of the clinical need that the students are going to address.

Final Capstone project proposal (10-page): 35%
This homework is the final full proposal of the Capstone design project of the students. Each proposal must have an experimental plan, data analysis plan, and description of the project’s design component. The background and significance of the project should be discussed, and in this discussion the hope is that the students will recognize the need for life-long learning. The students are required to discuss the social context of their proposals. A portion of the grading is based on the overall presentation of the report.

Class presentation of capstone proposal (5 minutes): 10%
BIOEN 401 Assignments: preparing for BIOEN 403 research project

Capstone Project Proposal Outline (1-page): 10%
This homework requires the students to interact with the Bioengineering faculty to identify a Capstone Project for their senior year, and to write a 1 page overview of the Capstone project. The overview should including the clinical need of the project, the design of experiments, and discussion on ethical, social, legal and translational issues.

Laboratory Description (3-page): 15%
This homework requires students to write a 3-page document on the lab they will work in, providing the people and major projects in the group, the major equipment they will use in their Capstone projects, and the relationship between the students' and others' projects.

Report on Mary Gates Undergraduate Research Symposium or CoE Open House (1-page): 5%
This homework requires students to visit the College of Engineering Open House and report on one of the exhibits, or to attend the Mary Gates symposium and report on one of the posters or presentations. The report should address the design and research elements demonstrated in the exhibit.

Preliminary Capstone Proposal (3-page): 15%
This homework motivates further discussion between the student and faculty advisor, as additional details of the project developed.

Design of experiments in the Capstone Proposal (2-page): 10%
This homework requires students to discuss the experimental design component of their Capstone proposals. The proposal should discuss why the particular experimental strategy and methods were chosen, confounding factors that must be addressed, and current background, significance and current engineering solutions of the clinical need that the students are going to address.

Final Capstone project proposal (10-page): 35%
This homework is the full proposal of each student’s Capstone research project. Each proposal must have an experimental plan, data analysis plan, and description of the project’s design component. The background and significance of the project should be discussed, and in this discussion the hope is that the students will recognize the need for life-long learning. The students are required to discuss the social context of their proposals. A portion of the grading is based on the overall presentation of the report.

Class presentation of capstone proposal (5 minutes): 10%