Course Title: BIOEN 482 – Bioengineering Senior Project

Instructor: Neils, C. M. and Bioengineering faculty Each student registers with an individual Bioengineering faculty member and conducts his/her senior project for that primary investigator. Writing progress and other issues are supervised by a single instructor.

Credits: ([2-6], max. 8)

UW General Catalogue Course Description: Independent senior project with final paper and poster.

Course Description:
BIOEN 482 places seniors in a research laboratory setting, under the guidance of Bioengineering faculty members to conduct individual senior projects. Students register for 8 credits, divided among 2-4 quarters with 2-6 credits per quarter. Students may either continue research begun earlier, may initiate their own projects, or may choose a project suggested by the faculty host. A host lab should be chosen by the end of the junior year, and a project plan is written as part of the BIOEN 481 Senior Design course. A senior project may be part of a larger project, but it must have definable goals and be worthy of publication in a scientific journal. During the project, seniors are members of the research group, attending group meetings and sharing lab maintenance duties in addition to planning and conducting their senior project. In larger groups, seniors are typically assigned a graduate student or post-doctoral fellow mentor. Fall quarter typically includes planning, equipment acquisition, and familiarization with lab or programming techniques. Winter quarter includes design and/or

experimentation and Spring quarter emphasizes analysis and reporting. A senior project report in the form of a thesis will be required at the conclusion of the senior project. This schedule is flexible to accommodate students' progress and graduation plans.

Prerequisites by Topic:
Bioengineering Physiology, Introduction to Molecular Bioengineering, Introduction to Biomedical Instrumentation, Bioengineering Signal Processing.

Textbooks:
None

Course Objectives: Assists in the transition from student to engineer/scientist by providing training in research and design implementation. Provides seniors experience working in a research group. Allows students to observe and practice the detailed tasks needed to plan and conduct Bioengineering projects and to maintain a research lab.

Topics Covered:
1. Writing a research paper 2. Design of experiments, tools, and devices 3. Making research presentations 4. Individual topics and techniques according to students' research projects 5. Constructive criticism of projects

Class Schedule: Students conduct research in a host laboratory on a schedule agreed between each advisor and student (8-24 hours/week). Students from all labs convene one hour per week to present their progress and to discuss research-related issues and report writing.

Computer Use:
Requires on-line access to conduct literature searches and sign up for small group meetings. Requires word processing for report preparation and presentations (Powerpoint). Other computer use varies widely between research projects, and may include numerical simulations, signal and image processing, data analysis, and programming.

Laboratory Projects: Students conduct cutting-edge research alongside graduate students in faculty laboratories. Projects may be proposed by the students or advisors, according to the interests of both. Past senior projects have included:

Schlieren imaging system to monitor ultrasound therapy;
Computer model of brain tumor growth;
pH-sensitive gels for timed release of antibodies;
Low-cost, portable tests for sexually transmitted diseases;
Implantable materials with enhanced biocompatibility.

Course Outcomes and Assessment:
BIOEN 482 provides an opportunity for students to conduct research on real medical problems in Bioengineering faculty laboratories. The progress that students make depends on their ability to perform the tasks described below, and to synthesize these tasks into a coherent effort. In addition to assessment by individual senior project advisors, 9 representative senior project reports and poster proofs (3 with high grades, 3 with low grades, and 3 with medium grades) will be assessed by a committee of faculty.

Specific outcomes in BIOEN 482 and their assessment mechanisms (*in parentheses*)

- **[b]** Design and conduct experiments as well as analyzed and interpret data *(evaluation is based on senior project report and poster; assessment according to grading rubric)*
- **[c]** Ability to design and system, component, or process to meet desired needs (evaluation is based on *senior project report and poster*; assessment according to grading rubric).
- **[e]** Identify, formulate, and solve Bioengineering problems *(evaluation is based on senior project report and poster; assessment according to grading rubric).*
- **[g]** Ability to communicate effectively *(evaluation is based on senior project report and poster; assessment according to grading rubric).*
- **[i]** A recognition of the need for, and ability to engage in, life-long learning *(evaluation is based on senior project report and poster; assessment according to grading rubric).*
- **[j]** Demonstrate a knowledge of contemporary issues *(evaluation is based on senior project report and poster; assessment according to grading rubric).*
- **[n]** The ability to make measurements on and interpret data from living systems, addressing the problems associated with the interaction between living and non-living materials and systems *(evaluation is based on senior project report and poster; assessment according to grading rubric).*

Relationship of course to Departmental Objectives:
This course allows students to apply the Bioengineering fundamentals they have learned, and to learn advanced topics and techniques, in a manner consistent with graduate and post-graduate research and training in medicine and biology. The student projects are typically part of externally funded research, and therefore address immediate or long-term issues that are of considerable importance to human health. Students

may encounter problems that require knowledge of any or all of their prior coursework, or that may require them to master concepts that they have not previously explored. Students must communicate their progress to their advisors, collaborators, and peers, who may encompass a broad range of academic and professional backgrounds.

Thus, students in BIOEN 482 progress toward our departmental objectives by:

- Integrating engineering concepts with mathematics, physics, chemistry, computing, and biology to solve biomedical problems. (assessment via the senior project report)
- Deriving design principles from nature to create biomedical devices and materials. (assessment via the senior project report)
- Communicating problems and their solutions effectively with physicians, biologists and other engineers. (assessment via the senior project report, poster and oral poster presentation)
- Taking ethical and social issues into consideration (assessment via the senior report)
- Continuing to develop technical knowledge and awareness to maintain leadership in human health issues (assessment via the senior project report)

Bioengineering Senior Project Rubric

Group Members: _____ Year: _____ Project:

BioE graduates will be able to conduct a design/research project which meets specified requirements by…

ABET Ref#	Objective	4 Exemplary	3 Proficient	2 Apprentice	1 Novice	Score
b	**Design and conduct experiments as well as analyze and interpret data**: Utilize BioE skills to test experimental hypothesis or concept apparatus from design plans (developed in BioE481); correctly analyze results; compile results in lab notebook, detailed notes, and oral and/or written reports	Analysis is complete, correct and conclusions consistent with results. Appropriate analytical methods are selected and correctly implemented. Quality laboratory conduct is followed including: results compiled in a professional manner in lab notebook, and oral/written reports.	Analysis is sufficiently complete and correct, but contains 1 or 2 minor errors. Analytical methods for analysis are appropriate and correctly implemented. Basic laboratory conduct is followed including lab notebook, detailed notes, and/or written or oral reports.	Analysis is satisfactory, but contains 1 or more conceptual and/or procedural errors. Analytical tools sufficiently implemented with minor errors. Basic laboratory conduct is followed including lab notebook or detailed notes and reports.	Analysis contains major conceptual and/or procedural errors. Analytical tools applied are inappropriate and/or not implemented correctly. Basic laboratory conduct is only partially followed (little to no details in lab notebook and/or infrequent reports).	
c	**Ability to design a system, component, or process to meet desired needs** Apply design plans (developed in BioE48); modify and improve based on experimental results.	Design adaptations based on acquired results are considered to better adapt the design to the desired needs. More than one option considered and tested and the best adaptation is utilized.	Design adaptations based on acquired results are considered to better adapt the design to the desired needs. At least one option is considered and tested.	A design adaptation based on acquired results is considered to better adapt the design to the desired needs. Only one option is considered but not tested.	Original design followed without thought to modification.	
e	**Identify, formulate, and solve BioE problems**: Make conclusions regarding validity of hypotheses or feasibility of design based on experimental and test data; consider alternatives; justify choice	2 or more alternative solutions are considered; all evaluated correctly based on clearly defined experimental or test data; conclusion is clearly justified.	2 or more alternatives solutions are considered; each is evaluated to some extent based on the experimental or test data; conclusions is justified.	An alternative is considered along with original hypotheses; evaluation criteria (data) contains some minor errors; results imprecisely defined and do not address the problem well; conclusion not well justified.	Only the original hypotheses or designed is considered; no alternatives suggested; no evaluation criteria are presented to justify the conclusion	
g	**Effectively communicate:** Prepare written report in form of thesis. Prepare a poster suitable for display at a national meeting.	Written report is virtually error-free, logically presents project, is well organized and easy to read, and contains high quality data/graphics. Printed poster is well organized; problem clearly defined; data clearly presented with quality data/graphics; conclusions made based on presented data	Report is logically presented, well organized, easy to read, contains high data/quality graphics, and contains few minor grammatical and/or rhetorical errors. Printed poster is adequately organized; problem clearly defined; data presented with only minor graphic or grammatical errors; conclusions made based on presented data.	Report is generally well written but contains some grammatical, rhetorical and/or organizational errors; project is not well explained and not fully discussed. Printed poster not clearly organized; problem not well defined; data has grammatical or graphics errors; conclusions made based on presented data.	Does not present project clearly, is poorly organized and/or contains major grammatical and/or rhetorical errors. Printed poster poorly organized; problem not well defined; data has major grammatical and/or graphics errors. Data does not justify the conclusions.	
i	**A recognition of the need for, and ability to engage in , life-long learning**: Literature review and references to be included in written thesis	Current literature on the topic is discussed in relation to the project and key points relevant to the project are identified. Proper referencing shows that the literature was thoroughly searched.	Thorough referencing throughout paper where required. The current literature is discussed in relation to the project	Adequate referencing throughout paper where required. The current literature is discussed in relation to the project.	Only a few papers are referenced and mentioned briefly in the paper. References not included in sections that require one.	

Bioengineering Senior Project Rubric

Group Members: _____ Year: _____ Project:

j	**Demonstrate a knowledge of contemporary issues** surrounding the research such as environmental; social; legal; ethical; geopolitical (included in written thesis)	Identifies a number of important E, S, L, E, G considerations; evaluates strengths & weaknesses of each category, including present and future ramifications.	Identifies a number of important E, S, L, E, G considerations; includes limited discussion of the strengths & weaknesses of each category, including present ramifications.	Identifies only a few of the obvious E, S, L, E, G considerations with shallow discussion of the ramifications.	Lists E, S, L, E, G considerations with no discussion of the ramifications.	
n	**The ability to make measurements on and interpret data from living systems, addressing the problems associated with the interaction between living and non-living materials and systems**	Student clearly knows what parameters need to be measured and is proficient at more than one type of measurement to address the problem. Student is familiar with the advantages and disadvantages of all the methods.	Student is aware of what parameters need to be measured and is proficient at least one type of measurement. Student is familiar with the advantages and disadvantages of this method of measurement	Student is aware of how to make at least one type of measurement interpret the data. Student does not clearly understand the advantages and disadvantages of this measurement at addressing the interaction between living and non-living materials and systems.	Student unclear on how to make measurement and how to interpret the data. No thought is given problems involved with interaction between living and non-living systems	