BME Course Summary

Introduction

1. Course Information

Course Name	*Biomedical Engineering Product Design and Development II*
Institution	*Arizona State University*
Course Number	**BME 282 and #77086**
# credits	**1**
Meeting times	**Wednesdays 9:00-11:30 AM**
Is this a required course?	**No; neither "required" or "critical"**
Pre-requisites	**Biomedical Engineering major; BME 182 with C or better**
Target audience (e.g. 1st, 2nd year):	**2nd year**
Textbook	**Not required. Suggested: *Introductory Biomechanical Design Tools* by Singhose, Donnel, Frakes**
Course Website (if it exists)	**N/A**

2. Course Description

In the space below, "paste" the description of the course. This can be the actual description listed in the syllabus from the course.

Hands-on training and implementation of product design skills that combine virtual analytical model prototype development with component and sub-assembly integration to develop both virtual and physical prototypes of a medical device product at the product architecture level and verify selected product architecture specifications from design input and earlier design process verification steps.

3. Course Learning Objectives

In the space below, "paste" the course learning objectives if explicitly stated.

Students will be able to apply principles from the following subjects to biomedical product design and development: *Physiology, advanced mathematics, chemistry, biomaterials, conservation principles, physics, circuits, micro-computer applications, instrumentation, statistics, mass transport* *To determine quantitative design constraints critical to a biomedical device design.* *Students will be able to integrate the above models and subsequent design constraints to perform virtual verification of virtual prototypes.* *Students will demonstrate understanding of how this virtual prototyping fits into the design process by placing these activities in context of the design process through effective documentation and design reviews.* *Students will demonstrate effective team-working skills.*

4. Fundamental Tools and Skills

In the space below, describe the fundamental tools and skills that are addressed in the class. For example, labvview, arduino's, the design process etc.

Verification and validation of a virtual prototype *Early design process*

5. Exercises or Experiential Projects of Interest

Exercise/Project	Project Overview	Learning Activities and Assessments	Required Resources for Project Completion
EXAMPLE	Students make pulse oximeters.	**Learning Activities** • Students will use resistors and a bread board to … • In a short essay assignment, students explain… **Assessment** • Students complete a laboratory report that explains …	Function generator, resistors, oscilloscope….
1	Students perform a documentation exercise based on	**Learning Activities** • Students are given instruction in how to write a detailed protocol by reading and analyzing the instructor's description of how to bake	Origami structure, detailed description provided by professor, and notebook

Exercise/Project	Project Overview	Learning Activities and Assessments	Required Resources for Project Completion
	writing instructions for folding an origami structure.	chocolate chip cookies, then the students attempt to write a detailed protocol for how to make an origami structure. **Assessment** • The students hand their notebook to a classmate who tries to reproduce the origami structure purely from the instructions in the notebook.	
2 and 3	Students develop a simple ordinary differential equation based model of glucose homeostasis in a non-diabetic and a diabetic individual to understand the mechanisms of glucose regulation, dysregulation, and treatment options for diabetics.	**Learning Activities** • During the lab sessions, students fill in the equations and parameters until achieving a reasonable time response of glucose after eating a meal. **Assessment** • Then students vary two parameters that simulate Type I and Type II diabetes respectively	Matlab, Matlab template
4	Students develop a cartoon depiction of the components of an amperometric blood glucose measurement device and how they fit together into a system that will successfully measure blood glucose concentration.	**Learning Activities** • Creating a cartoon depiction of electrical components. **Assessment** • Discover how the components successfully measure blood glucose concentration.	Computer
5 and 6	Students develop a protocol for immobilizing glucose oxidase enzymes on an electrode.	**Learning Activities** • Students must convert a specific article methods text into detailed instructions for completing the chemistry – which in turn leads them to one of the paper's citations for which students need to navigate the university's library website. • Students also use the Michaelis-Menten equation to calculate the amount	Article for creating Nafion coating, University library website, Sigma-Aldrich

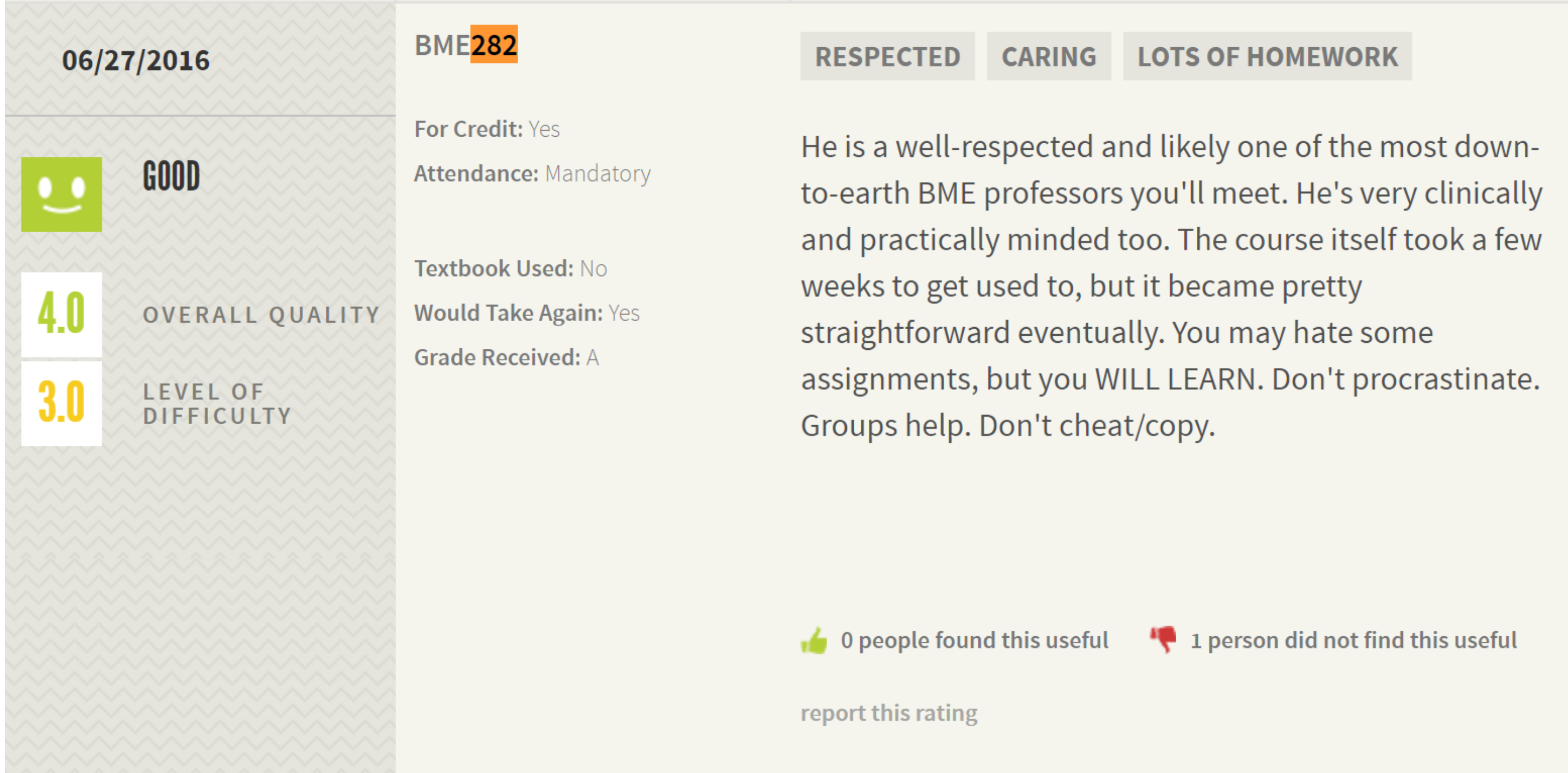
Exercise/Project	Project Overview	Learning Activities and Assessments	Required Resources for Project Completion
		of enzyme needed to achieve a 0.1μA current and determine which enzyme they would purchase from Sigma. **Assessment** • Students are directed to the Sigma-Aldrich website to find a suitable glucose oxidase enzyme and then directed to the definition of a "unit" of enzyme and the specifications sheet to find the enzymes Km value. • Students then calculate the reaction rate at a normal, high, and low value of glucose, multiply by 2 (number of electrons created per glucose consumed), and convert that to a current.	
7 and 8	Students design a simple current-to-voltage circuit, and they choose an OpAmp and Resistor to purchase from an online supplier.	**Learning Activities** • Students are expected to calculate the resistor needed to achieve voltage readouts in the range that can be detected by an Arduino. **Assessment** • Students are directed to a few suppliers of electronic components and told to choose an appropriate resistor and OpAmp for their device.	Arduino, instruction on how to choose a proper OpAmp
9 and 10	Students design a calibration test, use least-squares fitting to analyze instructor-provided data from a hypothetical calibration test, and write a simple Arduino code to use the results to convert a voltage reading to a mg/dL value on a liquid crystal display.	**Learning Activities** • Students are reminded of how to use dilutions to achieve several concentrations of glucose from a concentrated stock solution and how to make a concentrated glucose solution of known concentration. • After receiving instructions for how to calculate the sum of the square of the error and how to use the Excel plug-in Solver to minimize that sum, the students best-fit a slope and intercept to the linear portion of the data. **Assessment** • Students then calculate the necessary amounts and describe that in detail in their notebooks. • Discover that Excel treadline does not work for the best line for the data. • That slope and intercept are used to modify Arduino code found in online user forums for how to display a voltage on an LCD screen.	Matlab or Excel, Arduino, LCD screen
11 and 12	Students revisit their original calculation of the amount of enzyme	**Learning Activities** • Students are helped to modify the PDEPE template to describe those equations, and then the students run a simulation using their enzyme	Matlab, Enzyme data from Sessions 5 and 6, Matlab template

Exercise/Project	Project Overview	Learning Activities and Assessments	Required Resources for Project Completion
	to use to determine if mass transport limitations will cause too much change in their reading with time.	concentration. **Assessment** • Students analyze what happens if they use a much greater amount of enzyme and much less enzyme. • Students are asked to determine the amount of enzyme that optimizes between signal-to-noise (more enzyme is better) and the percent change in glucose concentration in 60 seconds (less enzyme is better).	
13 and 14	Students use SolidWorks to design and spec a case for their alpha prototype, and they develop a simple business plan analysis and perform a simple statistical analysis to determine how often (based on their sales estimates) that their test strips will yield a catastrophic error.	**Learning Activities** • Design using SolidWorks and design an alpha prototype. **Assessment** • Develop a business plan and conduct a statistical analysis for error of product.	SolidWorks
15	Students go back through all of the previous assignments to modify their design so that it is consistent throughout.	**Learning Activities** • Discover if they need to modify their design and complete that modification. **Assessment** • Have a "working" prototype with appropriate tools.	All previous session outcomes and accompanying required resources

6. Additional thoughts

If you have any other thoughts about this course, but have not been able to reflect it elsewhere in the document, please feel free to do so here.

Instructor is Jerry Coursen. His "Rate my Professors" is as follows:



There was also a study conducted on this course with key information listed below:

- In this study we seek to determine whether students are able to see the connection of courses in the BME curriculum to the design process and their utility in the design process
- This sophomore-level design experience in the BME curriculum may increase student perception of the relevance of and usefulness of other classes in the BME curriculum to biomedical design. It also may increase the students' motivation to learn the material taught in those classes. Students who complete this sophomore-level design experience were better able to apply the steps of the design process to a biomedical design, and their virtual prototypes were more complete and described in greater depth than students who had not completed this sophomore-level design experience.
- They also had trouble with "unenthusiasm" of students