Course Number: MAE162D/E

Course Name: Mechanical Engineering Design I/II

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COURSE CONTENT DESCRIPTION

- Description of specific societal impact topics or ethics issues that are addressed in the course:

MAE162D/E is the Senior Mechanical Engineering Capstone Design course that spans two quarters – typically, Winter and Spring – and which is required for all Mechanical Engineering undergraduate students. The course presents the basics of engineering design methodology and engineering design principles in the context of a product development cycle. Students form teams of typically 5 to 6 members and each team is asked to design, analyze, fabricate, test, and evaluate an autonomous electro-mechanical device based on a list of product design requirements and limitations, such as functions, power, size, weight, cost, etc. Starting with design concept proposals, students are instructed and guided through a formal product design cycle, which includes a conceptual design, preliminary design, final detailed design and ending in fabricating, testing, and performance evaluation of the final project. During the first Quarter (MAE162D), students are given extensive laboratory tutorials on computer aided engineering (CAD modeling and analysis) to create a "Virtual Prototype." In the second Quarter (MAE162E) and following the completion of the virtual prototype, using an NI Robotic kit (National Instrument) students are given hands-on laboratory tutorials on mechatronic system design, which they then apply to their fabricated device. Additionally, student teams are directed to stay within a given budget (less than $500) to purchase necessary components for their device and they are encouraged to scavenge parts and components from previous year's student projects to keep costs at a minimum. Early in the project teams develop and then use a Work-breakdown Schedule to delegate project design and development activities to various team members, who have to adhere and provide results within established timelines – Project Gantt Charts of design activities and progress are presented in design reports. In order for students to underline the importance of documenting their design activities, students are required to submit a series of technical reports throughout the two quarters (five reports), culminating in a detailed technical Final Design Report, which is generally well over 100 pages long. Aside from technical design activities and tasks, the Capstone Design Course is aimed to provide students the experience of contributing to best of their ability to their team's overall objectives, while remaining respectful towards all team members.

- Time dedicated to cover this content through lecture and other in-class learning activities:

The time devoted to teaching students to learn how to be an effective and respectful team member is not limited to a single lecture on engineering ethics and professionalism. Instead, we continually – throughout both Quarters – monitor and discuss team dynamics and cooperation between students by holding weekly Prof.-Team meetings. During these meetings students are encouraged to discuss openly (or in private, if necessary) their grievances or 'friction' among team members. Each Prof.-Team meeting – typically 15 teams – lasts about 20 minutes and they are held on a rotating basis during lab-hours throughout the course.

Educating Future Leaders in Mechanical And Aerospace Engineering:

Aside from fostering academic excellence, the Capstone Design Course provides a unique opportunity for students to be educated in the art of Leadership! The underlying method of teaching leadership is to have the Capstone Design Course students experience the importance of teamwork by "Transforming Groups into Effective Teams." To give an example of how we go about transforming groups into effective teams, we start give a 50-min lecture on team-building, which starts with a quote from the U.S. Olympic Water Polo Coach, Dr. Terry Schroeder, who himself received several Gold and Silver medals prior to coaching: "…I (Dr. Schroeder) ask every team player to think of himself as the leader and the captain of the team. I don't want a team and one single leader – every team member has to act as the team leader … ."

The lecture on teamwork and leadership continues by outlining common interpersonal problems that can arise in any collaborative effort, such as Project Management, Time Management, Conflict Resolution, and Communication Skills. We review conflict resolution approaches, which are predicated by asking students to (a) establish their own team policies and

expectations, (b) list effective team practices, and (c) suggest means to deal with problem team members, such as "hitchhikers and couch-potatoes on teams" who try to ride on the coattail of other members. The process of team building is a continual endeavor and spans both Quarters – we hand out team building templates in the form of instructions, team skill notes, and associated forms around the middle of the first Quarter.

Topics covered during a 50-min lecture on Ethics, Teamwork, Professionalism, and Leadership include: Ethics: Review of fundamental cannons of the Code of Ethics of the National Society of Professional Engineers (followed up by a quiz); in particular, emphasis is placed on the Engineer's Creed, which asks engineers to give the utmost of performance; participate in honest enterprises; work according to the highest standards of professional conduct; to place service before profit, personal advantage, and public welfare above all other considerations. On professionalism and leadership we give a short presentation on Dr. Ernest E. Lawrence, Nobel Laureate and his quote: "In scientific work, excellence is not about technical competence, but character."

To ensure follow-through with outlined team practices among members, we explain and implement our in-house developed confidential "peer evaluation" system, which we use to adjust the final grade of every individual team member.

OUTCOMES

- Aligned with ABET Student Outcome Criteria ABET Student Outcome Criteria #4: *The ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.*

Outcome 1: An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.

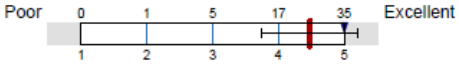
Outcome 2: Students learn to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.

Outcome 3: Students learn to form teams, assess required tasks, assign responsibilities and tasks, organize to meet deadlines, function as a successful team member, and develop leadership qualities.

APPENDIX: Student Evaluation – Current ABET course outcomes for ***MAE162D Winter-2021*** [1]:

4. ABET Course Outcomes (please note that these questions are required to be answered)

4.1) (a) Students will utilize the design process using math, science, and engineering concepts to configure thermal and/or electro-mechanical components, systems, or processes to fill a given need and to satisfy given design requirements and constraints.



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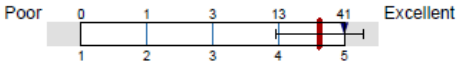
4.2) (b) Students will learn to form teams, assess required tasks, assign responsibilities and tasks, organize to meet deadlines, function as a successful team member, and develop leadership qualities.



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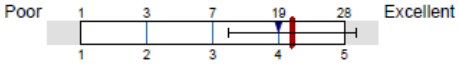
4.3) (c) Students will learn about and recognize their professional and ethical responsibilities as engineers.



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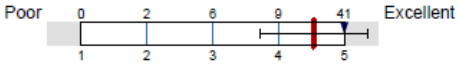
4.4) (d) Students will demonstrate clear communication, both oral and written.



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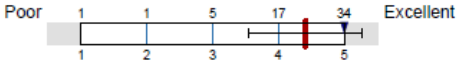
4.5) (e) Students will appreciate and recognize the need for and have the ability to acquire life-long knowledge and research through self-directed learning.



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SOURCE:

[1] R.S. SHAEFER, Evaluation of Instruction Program Report,
21W: MECH&AE 162D LEC 1: MECH DESIGN I No. of responses = 58 Enrollment = 68
Response Rate = 85.29%