

Spring 2016

AME 503: Advanced Mechanical Design

Department of Aerospace & Mechanical Engineering
University of Southern California

COURSE SYLLABUS

Version: Initial Release

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Course Section:	28862R and 29053D
Course Unit:	3 Units
Prerequisite:	Senior Standing; AME 410 Recommended
Class Hours:	Tuesdays 6:40pm – 9:20pm
Class Location:	RTH-109 and DEN@Viterbi
Office Hours:	Tuesdays, 4:30pm-6:30pm
Teaching Assistant:	TBD
Office Location:	TBD
Office Hours:	TBD

Course Description and Objectives:

Mechanical engineering design is a critical skill for all mechanical engineers who will be developing products. In this course, products are not just defined as consumer goods, but rather any end results an engineer creates in the course of their work. Products may be internal or external to the company or organization. While there are both physical and non-physical products (such as digital), this course will focus on physical products.

The primary goal of this course is to aid mechanical engineers in the development of products. The approaches for developing products can be placed in two categories, those from engineering design theory and methodology and practical engineering application, or engineering judgement. Below are the specific objectives of this course.

- To instruct students on how to execute the Axiomatic Design method. This method is useful when starting with an abstract problem statement and having an organized process to drive towards a solution.
- To instruct the students on how to execute the TRIZ design method. TRIZ is particularly useful for solving conflicts in a design.
- To develop engineering judgement by providing practical advice from experienced engineers, both via the instructor, text, and class. Engineering judgement will be developed from conceptual design, to detail design, to design for manufacture. To internalize this advice, this class will consist of hands on applications.
- Mechanical engineering design, like many other engineering applications has no single “right” answer. In fact, any one person, include the instructor, only knows a small percentage of mechanical design techniques and procedures. As such, the students will be expected to actively participate and provide advice and lessons learned from their personal experiences.

Course Structure:

This course is divided into two main sections, conceptual design and detail design. The portion of the course covering conceptual design occurs during the first half of the class, prior to the midterm, and the portion on detail design occurs in the second half.

Throughout these two sections, the course can be further divided into three main themes. These are mixed throughout the course.

Engineering Design Theory and Methodology:

Engineering design theory and methodology provides a framework within which to implement the design process. This course will specifically cover the Axiomatic and TRIZ

design methods in detail. (AME 410, Design Theory and Methodology covers additional design methods, including design thinking, and Systematic Design should that be of interest).

Practical Engineering Applications:

Practical engineer applications is the knowledge which develops “engineering judgment”. This is also sometimes known as “best practices” or “Good Engineering Practice (GEP)”. While a highly trained engineering judgement requires years of practice, this course will provide a number of insights to help students develop their “engineering judgement”. Hands-on practice is implemented to assimilate this “engineering judgement”, although it is expected the material covered in the course will become of true value when working in industry.

Hands-on Practice:

This course is based on the theory that hands-on, experiential practice is essential for internalizing the course concepts. Therefore there will be a number of exercises throughout the class in the form of homework, group projects, individual projects and in class exercises.

Important Note: *The process of engineering design is not challenging in the traditional academic sense, where it can be hard to understand subjects technically. However, this class will be very challenging from an aspect of achieving quality designs, which is time consuming. Therefore, I recommend students expect that this course will take more time in preparation than other 3 hour courses. (Assume minimum of the full 9 hours/week). Compared to many other courses, this course will require greater “work ethic” than “book smarts” to be successful.*

Course Work:

The course work includes class lectures, in-class exercises, homework, quizzes, tests, presentations, and individual and group projects (note, there are both minor and major group projects). Each are defined below.

Classroom Lectures:

Weekly lectures will occur on Tuesdays. Students are required to complete reading assignments, indicated on the schedule page, before each lecture. Students are expected to make every effort to attend lectures in person or online real time, as a number of practice exercises will occur during lecture. Active participation in classroom discussion is required for all students in attendance.

In-Class Exercises:

A variety of in-class exercises will occur to assist students in understanding and assimilating the material. Students will be divided into groups for these exercises, with several groups consisting of students physically present, and other consisting of the DEN students

completing the exercises electronically. Groups for in-class exercises will be assigned at the beginning of the semester, and remain the same throughout the semester.

Homework:

This course will contain regular homework assignments. Homework exercises will be designed to accomplish work that will go into your midterm and final projects.

Quizzes:

Online quizzes will occur after each lecture, via Blackboard, and are due **before** the next class session. Quizzes may cover the material in each lecture, required readings, and class presentations. The ability to take the quiz will automatically be removed before each class session, as answers to the quizzes will be discussed in class.

Exams (Midterm and Final):

An online midterm and final will occur in place of two of the quizzes. Exams may cover the material in each lecture, required readings, material on prior quizzes, and class presentations (including student tip and project presentations).

Engineering Tip Presentation:

Starting with the third class, at the beginning of each class 3-4 students give a three minute presentation on a piece of engineering advice. The student is welcome to cover any type of engineering information, as long as it has not already be covered in class, or is not pulled from the primary textbook. This presentation should focus on explaining a new concept to students who are not familiar with it, and provide enough information so students can apply the information themselves.

Minor Group Projects:

Two minor group projects will occur in the first half of the class. The projects will focus on putting together small presentations of information. Each group project will have a unique team, comprised of DEN and on campus students.

Mid-term (Individual) Project:

This class emphasizes the importance of learning by doing. The best way to understand the methods is to practice. Each individual student will work on an individual design project, to begin the product development process. At the midterm, each student will submit a report and a presentation on their work.

Term (Team) Design Project:

This class emphasizes the importance of learning by doing. The best way to understand the methods is to practice. The term project will begin at the midterm, and continue through the end of the class. The goal is to develop a conceptual product by the end of the course. Teams

may have a minimum of 2 members, and a maximum of 8 members, and must be combined of at least one DEN and one on campus student.

Course Materials:

There are required and optional textbooks for this course. Additional handouts and reading materials may be provided on the Course Blackboard Website when needed.

Required Primary Textbook:

- *James Skakoon, "The Elements of Mechanical Design", ASME Press 2008*

NOTE: You must finish reading the assigned pages before the class of the assigned date.

Recommended Textbook:

A copy of an engineering machine/mechanical design textbook is highly recommended. You likely already have one from your prior classes, if you saved the textbook. If you do not have a general mechanical engineering design, I recommend the following. Any edition will work. This book will be useful as a reference in the class.

- *Budynas, Richard G., J K. Nisbett, and Joseph E. Shigley. "Shigley's mechanical engineering design". 10th Edition New York, NY: McGraw-Hill Education, 2015. Print.*

Optional Secondary Textbooks:

- *Suh, N.P.: "Axiomatic Design - Advances and Applications", Oxford University Press*
- *Pahl, G. & Beitz, W.: "Engineering Design - A Systematic Approach", 2nd Ed. Springer*

Grading Requirements:

Students will be graded according to the following grading scheme:

Task:	Percentage:
Participation	5
Homework	15
Quizzes	15
Midterm Exam	5
Final Exam	10

Engineering Tip	4
Minor Group Projects	6
Midterm Individual Project	20
Term Group Project	20

Details are as follows:

Participation: 5%

All students begin with a 5% participation score. Participation is measured by involvement on in-class exercises and lectures. If students are not actively involved in the class, or are distracting, the participation score may be reduced.

Homework: 15%

Total six (6) homework assignments will constitute 15% of the overall grade, with each amounting to about 3%. Each homework assignment will be centered on a design tasks. Questions are usually open-ended. Thoughtfulness, clarity, conciseness and incisiveness are required. The lowest homework grade above 50% will be dropped (if it helps you grade), and average grade will be the average of the remaining 5 homeworks.

Quizzes: 15%

A total of twelve (13) quizzes will constitute 15% of the overall grade, each worth about 1.2%. Online quizzes will occur after each lecture, via Blackboard, and are due **before** the next class session (**due by Tuesdays at 5:30 pm**). Questions will occur in random order, and once the student has proceeded to the next question, there is no going back. Quizzes are open book, open note, open friend, open Google and online. The lowest two quiz grades above 50% will be dropped (if it helps you grade), and average grade will be the average of the remaining quizzes. Questions will occur in random order, and once the student has proceeded to the next question, there is no going back. Quizzes are open book, open note, open friend, open Google and online.

Midterm Exam: 5%

Exams may cover the material in each lecture, required readings, material on prior quizzes, and class presentations (including student tip and project presentations). Questions will occur in random order, and once the student has proceeded to the next question, there is no going back. Exams are open book, open note, open friend, open Google and online.

Final Exam: 10%

Exams may cover the material in each lecture, required readings, material on prior quizzes, and class presentations (including student tip and project presentations). Questions will occur in random order, and once the student has proceeded to the next question, there is no going back. Exams are open book, open note, open friend, open Google and online.

Engineering Tip: 4%

Each student will present a tip they have found to be useful in engineering design. Tips may not overlap with those in the primary textbook, and may not have been presented before in lecture. Visual aids must be used (either Viewgraphs, prototypes, or product), the pitch must last less than 2 minutes, and a maximum of 1 viewgraph chart is allowed (note, no creating multiple viewgraphs on one page by fading images in and out). Each student's presentation will be evaluated for enthusiasm, quality of visual aids, and foundation on engineering design principles.

Minor Group Projects: 6% (3% each)

Two minor group project will occur during the class, focused on presenting a specific assigned concept. More details will be provided at a later time.

Mid-term (Individual) Project: 20%

This class emphasizes the importance of learning by doing. The best way to understand the methods is to practice. Each individual student will work on an individual design project, to begin the product development process. At the midterm, each student will submit a report and a presentation on their work.

Term (Team) Design Project: 20%

This class emphasizes the importance of learning by doing. The best way to understand the methods is to practice. The term project will begin at the midterm, and continue through the end of the class. The goal is to develop a conceptual product by the end of the course. Teams may have a minimum of 2 members, and a maximum of 8 members, and must be combined of at least one DEN and one on campus student.

As the size of the project teams may vary, different amounts of work are expected for the various team sizes. The table below illustrates expected outcomes:

Team Size:	Expected Output:
2	2
3	2.75

4	3.5
5	4
6	4.5
7	5.25
8	6

Specific grading rubric for each project will be released at a later time.

Note that 20% of your semester grade is based on the results of your design project, which is a team effort. All project work done by the team is first given a team grade. This team grade is then weighted for each student, based on confidential peer-evaluations by all team members at the end of the semester according to the following scheme.

Each student will be asked to fill out a questionnaire, which rate every team member (including him/herself) for the percentage participation to the team project, from 0 (no participation) to 10 (100% participation). The evaluations are averaged in order to find each student's participation. The project grade of each student of a team will be weighted based on his or her percentage of participation.

On the final project, extra credit is available. Up to 3% (on the project total score) is available for prototyping your project, or a component of your project. Prototype is due at the final presentation.

Up to 2% (on the project total score) is available for conducting focus group. You must document who attended the focus group, how you selected your participants, how long the focus group lasted, and what the results of the focus group were. You must also submit your questioning route plan.

Up to 2% (on the project total score) is available for conducting customer surveys for project. You must state how surveys informed your decisions, and provide a copy of the survey, along with the statistical results.

Academic Integrity:

"The Viterbi School of Engineering adheres to the University's policies and procedures governing academic integrity as described in SCampus. Students are expected to be aware of and to observe the academic integrity standards described in SCampus, and to expect those standards to be enforced in this course."

Students with Disabilities:

Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to the instructor as early in the semester as possible.

Course Schedule

#	Date	Lecture	Project	Readings	Quiz Due	Assignment Due
1	1/10	Introduction and Customer Needs				
2	1/17	Customer Needs and Functional Requirements		Text: Sec. 1	Quiz 1	Homework 1
3	1/24	Axiomatic Design Theory		Text: 2 Handout	Quiz 2	Homework 2
4	1/31	Axiomatic Design: An Example	Minor Group Project A		Quiz 3	
5	2/7	Brainstorming and Ideation		Text: 7, 9, 10	Quiz 4	Homework 3
6	2/14	Conceptual Design Part 1: Selecting Components & Constraints		Text: 3, 8, 15	Quiz 5	Homework 4
7	2/21	Conceptual Design Part 2: Sketching, Loadpaths, and Structures	Minor Group Project B	Text: 4,5,6, 12, 13, 17	Quiz 6	
8	2/28	Conceptual Design Part 3: Prototyping Midterm Project Reviews Part 1	Midterm Project Review	Text: 11, 14	Quiz 7	Homework 5
9	3/7	Midterm Project Reviews Part 2	Midterm Project Report/Review		Quiz 8	
10	3/14	Spring Break, No Classes				
11	3/21	TRIZ Design			Mid-term	
12	3/28	TRIZ Design: An Example			Quiz 9	
13	4/4	Detail Design 1: Component Selection		Text: 16, 18, 20, 21	Quiz 10	Homework 6
14	4/11	Detail Design 2: Design for Manufacture and Tolerances		Text: 19, 22, 23, C	Quiz 11	
15	4/18	Detail Design 3 Patents			Quiz 12	
16	4/25	Conclusion Project Reviews Part 1	Term Project Report/Review		Quiz 13	
	5/9 (7-9)	Final Exam Period: Project Reviews Part 2	Term Project Review		Final	

Key to Colors:

Green = Engineering Design Theory and Methodology Classes
Purple = Engineering Application/Engineering Judgement Classes
Red = Presentations/Student Projects