FALL 2019

AME 410: ENGINEERING DESIGN THEORY AND METHODOLOGY

Department of Aerospace & Mechanical Engineering

University of Southern California

COURSE SYLLABUS

Instructor: Prof. Yan Jin

Professor of Aerospace and Mechanical Engineering

Office: Room 400D, Olin Hall of Engineering

Email: yjin@usc.edu

SkypeID: Prof.Yan.Jin

http://impact1.usc.edu/yjin

Course Section:	28762R
Course Unit:	3 Units
Prerequisite:	Junior Standing
Class Hours:	Wednesdays 6:30pm – 9:10pm
Class Location:	GFS-101
Office Hours:	Wednesdays 11am-12pm
Teaching Assistant:	Hao Ji (haoji@usc.edu) Office hours: Tuesdays, 2pm - 4pm, VHE 202

Course Description and Objectives:

Design is the most central activity that defines the engineering profession (Simon 1969)*. To compete in today's relentless market, an engineer must be able to identify market needs, generate creative product ideas that meet the needs, and develop innovative products that realize the ideas. During this process, systematic thinking and creativity play key roles for success. In this course, engineering design is treated in a holistic process of product development, starting from market analysis and product definition to conceptual design and product design. Developing systematic thinking and fostering creativity are the two general goals of this class. The specific objectives for this course are for students:

- To have a general and systematic understanding of how engineering design process is carried out in practice and how it is described and prescribed in different design models and methods. This general understanding of the basic concepts of design and different types of design processes is important for students to have a general idea of what is the state of knowledge of design practice and research.

- To understand specific issues of engineering design and the systematic methods to deal with these issues. Engineering design is not carried out in a completely free space. It must meet customer needs, conform to the principles of physics, deal with various information uncertainties, and meet the limits of time and budget. Students will learn how these issues will manifest themselves in the design process and what methods can be applied to address them.

- To learn and master systematic approaches to solving various design problems. To solve large and complex design problems, one needs to know how to approach the problem and how to proceed when there are options. This course will teach a systematic approach to design that is built on both practical design experiences and fundamental physical and decision-making principles.

- To understand the value of design in a broader context. Engineering design can also be viewed as part of a product development process that includes both design and manufacturing. Furthermore, it is part of a business process that competes with other business entities. To develop a competitive product for the market requires a good sense of value of design. Students will learn such topics as design for manufacturing, utility theory for design decision-making and other quality and efficiency related topics.

- To practice learned methods through real design projects. Students will be given small design problems as homework and relatively large design problems as term projects. The design problems will be carefully selected to allow students practice learned design theory and methods.

* Simon, H.A. (1969). *The Sciences of the Artificial*, MIT Press, Cambridge, Massachusetts.

Course Structure:

The scope of this course covers four components, namely, market analysis, product definition, conceptual design, product design and evaluation. To make the learning process more effective and efficient, the course structure is designed to include the following modules.

Part 1: Introduction to Design – Get to Know Design

The goal of this module is to introduce basic concepts of design, product and process in the context of engineering design.

- What is design? What is not design? What does it take to do design?
- What is a product? What are possible and meaningful features of a product?
- What are general processes of problem solving, decision making, and inventing? And how do they relate to design?
- What is design process? What are different phases and different kind of processes?

Part 2: Product Planning – Identify and Define Competitive Products

Product planning is a part of the design process that deals with generating competitive product definitions based on company goals and market analysis.

- What are company's goals, skills and capabilities?
- What is market? What is market situation? What product do you plan to make?
- What are market needs? What do people need, want, and desire?
- Who are your competitors? How well are they doing in satisfying market needs?
- What are your targets and plans in competing with others?

Part 3: Conceptual Design – Generate Creative & Marketable Product Concepts

Conceptual design is at the heart of engineering design process that determines what your product should be.

- What are main functions and auxiliary functions of the product to be designed?
- How do these functions relate to each other?
- What are possible ways or means to achieve the functions identified? What are desirable ones and best ones?

- How can one become more creative and what are practicable creative design methods?
- How should one compose a product concept based on the possible partial solutions?
- How should one evaluate and select from possible product concepts?

Part 4: Product/Embodiment Design – Develop Effective & Efficient Physical Realizations

Product design, also called embodiment design, is the process to create concrete physical realizations for the design concepts generated at the conceptual design stage.

- What are the rules, principles, and guidelines that should be followed in realizing design solutions?
- How should one deal with various constraints?
- What are the structural, material, manufacturing, and assembling factors that need to be considered during product design?
- How can one predict the performance of the product and estimate the cost breakdowns?

Course Work:

The course work includes class lectures, quizzes, homework, mid-term exam, mini-projects and term project.

Classroom Lectures:

Weekly lectures will be offered on Wednesdays. Students are required to complete reading assignments, indicated in the schedule page, before each lecture. Usually the weekly 3-hour classroom lecture is divided into two parts. During the first 75 minutes, the instructor will present and discuss the contents outlined in the schedule page. In the second 75 minutes, students will ***work in groups*** to *discuss the topics* lectured and discussed by the instructor and *practice design methods* by solving small design problems (in the first several weeks) or their project design problems (as the course progresses). Active participation in classroom discussion is strongly required for all students.

Quizzes:

Online quizzes will occur after each lecture, via Blackboard, and are due before the next class session. Quizzes may cover the materials in each lecture, required readings, and class presentations.

Homework:

For the first half of the course, there will be weekly homework assignments. Each homework assignment has 2-3 short questions and/or one small design problem intended to help students (1) assimilate the reading material and organize their thoughts about it, and (2) digest key concepts learned from the lectures. Thoughtfulness, clarity, conciseness and incisiveness are required.

Mid-term Exam:

After the "Part 3: Conceptual Design" module is completed, there will be a mid-term exam. The exam will be open-book and open-note. Questions of the exam will be similar to, but more comprehensive than, the homework questions and design problems. Students will be asked to answer questions and solve small design problems.

Mini-Design Projects:

Two mini design projects will be given. Each will be completed over the course of 1 to 2 weeks and give the student an opportunity to design and build a small machine. One design project will occur during the first week, and the second will occur in the second to last week. The students shall implement the design methods learned in class on the second mini-design project.

Term Design Project:

This course is Project-Based. The term project will be carried out throughout the course by student teams of 5-6 members. Each team will propose a design project, or bid for one, and develop a specific design solution for their design project problem. By doing the project, students will digest and apply the theory and methods learned from the class, enhance their creativity, and develop the experience of solving close-to-real engineering design problems. Students should form project teams after the very first lecture. Project Teams will give multiple *Project Briefings* to the whole class, and will submit two *Project Progress Reports* and a *Final Project Report*.

Course Materials:

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

Required Textbook:

- *David Ullman," The Mechanical Design Process", 5th Edition*

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

Optional Textbook:

- *Pahl, G. & Beitz, W.: "Engineering Design - A Systematic Approach", 2nd Ed. Springer*
- *Suh, N.P.: "Axiomatic Design - Advances and Applications", Oxford University Press*
- *Terninko, J. "Step-by-Step QFD – Customer-Driven Product Design", 2nd Ed., St. Lucie Press, A CRC Press Company.*

Grading Requirements:

Students will be graded according to the following grading scheme:

Attendance: 5%

This class involves classroom group discussion every week. Therefore, attendance is very important. Missing a class means losing 1% of the total grade unless an approval is given by the instructor prior to the class. The attendance will be taken every week. Students need to check in on Blackboard within 10 minutes after the class starts. The check-in code varies every week and will be announced in the classroom before each class starts.

Quizzes: 10%

A total of twelve (12) quizzes will constitute 10% of the overall grade. The online assignment will appear after each class on Blackboard and will be due on the next class day by 6:00pm.

Homework: 20%

Total five (5) homework assignments will constitute 20% of the overall grade, with each amounting to 4%. Each homework assignment has 2-3 short questions and/or one small design problem. Questions are usually open-ended. Thoughtfulness, clarity, conciseness and incisiveness are required.

Midterm exam: 25%

Midterm exam is open-book and open-note, limited to the materials that have been discussed in classroom lectures, quizzes, homework assignments, and design team projects. Questions will be similar to, but more comprehensive than, the homework questions and design problems. There will be query questions and small design problems involved.

Mini-Design Project: 10%

Two (2) mini design projects will be given constitute 10% of the total grade, with the first being 4% and the second 6%. Grade will be determined by how well the project performs compared to metrics which will be given in the project assignment sheet.

Term project: 30%

Note that 30% of your semester grade is based on the results of your design project, which is a team effort. All project work done by a 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.

Academic Integrity

USC seeks to maintain an optimal learning environment. General principles of academic honesty include the concept of respect for the intellectual property of others, the expectation that individual work will be submitted unless otherwise allowed by an instructor, and the obligations both to protect one's own academic work from misuse by others as well as to avoid using another's work as one's own. All students are expected to understand and abide by these principles. SCampus, the Student Guidebook, (www.usc.edu/scampus or http://scampus.usc.edu) contains the University Student Conduct Code (see University Governance, Section 11.00), while the recommended sanctions are located in Appendix A. Academic integrity will be strongly enforced.

Academic Conduct

Plagiarism – presenting someone else's ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in SCampus in Section 11, Behavior Violating University Standards https://scampus.usc.edu/1100-behavior-violating-university-standards-and-appropriatesanctions/. Other forms of academic dishonesty are equally unacceptable. See additional information in SCampus and university policies on scientific misconduct, http://policy.usc.edu/scientific-misconduct/.

Discrimination, sexual assault, and harassment are not tolerated by the university. You are encouraged to report any incidents to the Office of Equity and Diversity http://equity.usc.edu/ or to the Department of Public Safety http://capsnet.usc.edu/department/department-publicsafety/online-forms/contact-us. This is important for the safety of the whole USC community. Another member of the university community – such as a friend, classmate, advisor, or faculty member – can help initiate the report or can initiate the report on behalf of another person. *The Relationship*

and Sexual Violence Prevention & Services https://studenthealth.usc.edu/rsvp/ provides 24/7 confidential support, and the sexual assault resource center webpage https://sarc.usc.edu/reporting-options/ describes reporting options and other resources.

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. DSP is located in STU 301 and is open 8:30 a.m.–5:00 p.m., Monday through Friday. Website and contact information for DSP: http://sait.usc.edu/academicsupport/centerprograms/dsp/home_index.html, (213) 740-0776 (Phone), (213) 740-6948 (TDD only), (213) 740-8216 (FAX), ability@usc.edu.

Emergency Preparedness/Course Continuity in a Crisis

In case of a declared emergency if travel to campus is not feasible, *USC Emergency Information* http://emergency.usc.edu/ will provide safety and other updates, including ways in which instruction will be continued by means of blackboard, teleconferencing, and other technology..

AME-410 Course Schedule:

W#	Date	Lecture	Class Exercise	Project	Readings	Quiz Due	Assignment Due
1	8/28	Course Introduction & Intro to Engineering Design	DE#1: PBP	Mini-Proj#1 assigned Project Topics Intro	Textbook: pp.1-19		
2	9/4	Engineering Design: Concepts and Processes	DE#2: FBF	Mini-Proj#1: Test	Textbook: pp.21-45	Qz1	MP#1: Test PW#1: Proj Bid
3	9/11	Overview of Engineering Design Process	DE#3: PTF	Projects assigned	Textbook: pp.81-138	Qz2	HW#1
4	9/18	Product Planning and Specification	DE#4: HFC PW#2: QFD		Textbook: pp:141-172	Qz3	HW#2
5	9/25	Functional Design	DE#5: STI PW#3: FD	Progress Report 1 assigned	Textbook: pp.175-195	Qz4	HW#3 (PW#2)
6	10/2	Generate Design Concepts	**Briefing1**: Task Planning & Specification		Textbook: pp.195-226	Qz5	PW#3: Req. List & Functional Design
7	10/9	Evaluate Design Concepts	PW#4: CGE		Textbook: pp.229-257	Qz6	HW#4
8	10/16	Axiomatic Design & Conceptual Design Recap	**Briefing2**: Concept Generation		Handout#1 Textbook	Qz7	HW#5 **Progress Report-1**
9	10/23	**Mid-term Exam**					
10	10/30	Product Generation: Prep & Example	PW#5: EDP	Progress Report 2 assigned	Textbook: pp.259-294	Qz8	PW#2-4
11	11/6	Embodiment Design Guidelines	PW#6: RPM	Final Report assigned Mini-Proj#2 assigned	Textbook: pp.259-294 Handout#2	Qz9	PW#5: Embodiment Design Prep
12	11/13	Product Evaluation	PW#7: PE		Textbook: pp.297-335	Qz10	PW#5&6: Embodiment Design
13	11/20	Design for X and Lifecycle Engineering (FMEA's)	**Briefing3**: Product Generation		Textbook: pp.337-397 Handout#3	Qz11	PW#5-7: **Progress Report-2**
14	11/27	Thanksgiving University Holiday. No class					
15	12/4	Engineering Design: Recap	Mini-Project 2 Test		Textbook Handout#4	Qz12	MP#2: Test & Design Log
16	12/6	**Final project presentation**			**Final Project Report (PDF file)**		

HW=Homework; DE=Design Exercise; PW=Project Work; MP=Mini-project, Qz=Quiz