ME 366J Mechanical Engineering Design Methodology

Mechanical Engineering Department, The University of Texas at Austin
Fall 2007, MWF 9 or 10 AM, ETC 2.136

Teaching Team

Instructor: Dr. Carolyn Conner Seepersad
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Office Hours: MWTh 1:30-2:30 PM or by appointment

Technical Teaching Assistants:
TBD. Email: TBD
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Writing Teaching Assistant:
TBD. Email: TBD

Learning Objectives:

Have you ever wondered how to approach a design problem? Have you ever wondered whether there are more effective methods for design than the ad hoc tactics you've been using? The answer is **YES**, and you will learn about them in this course.

In this course, you will have the opportunity to learn how to negotiate solutions to open engineering design problems using systematic design methods.

As you learn to approach design in a systematic way in this course, you will gain the skills and knowledge to answer the following questions:

- How do we formulate an ill-defined engineering design problem? How do we devise an appropriate plan for solving it that fosters innovation and guides the activities of designers?
- How do we generate alternative solutions in a way that promotes both creativity and purposefulness?
- What are some appropriate computational, analytical, and experimental techniques for engineering design? How can we apply them at different stages of the design process to refine and evaluate alternative solutions?
- How do we compare alternative solutions systematically and identify promising candidates?
- How can we strategically and systematically observe, analyze, compare, leverage, and experiment with existing products during the design process? How can we use this knowledge along with systematic design methods to improve an existing product?
- What are some of the prevailing approaches and guidelines—such as Design for Manufacture and Robust Design—that have been established for engineering design? In what contexts are they useful? How do we implement them?
- How can we communicate intermediate and final designs clearly and effectively in written and oral formats?
- What are the characteristics of successful design teams? What are some scheduling and planning tools, principles, and behaviors that promote the effectiveness of a team?

Textbook

Otto, K.N. and K. L. Wood, 2001, *Product Design: Techniques in Reverse Engineering and New Product Development*, Prentice Hall, Upper Saddle River, NJ.

Blackboard

The teaching team will post lecture slides, assignments, and other handouts and interesting links on the blackboard web site. Please logon at http://courses.utexas.edu. The web site is password-protected. Site activities may include exchanging email, engaging in class discussions and chats, and exchanging files. In addition, electronic class rosters will be a component of the site. Students who do not want their names included in these electronic class rosters must restrict their directory information in the Office of the Registrar, Main Building, Room 1.

Grading

	Writing	Technical Content	Total
Project Memos and Reports		35%	55%
Phase I Memo: Reverse Engineering	5%		
Phase II Memo: Adaptive Re-Design (Conceptual)	7%		
Phase III Memo: Parametric Re-Design (Embodiment)	8%		
Midterm Exam			15%
Personal Notebook			10%
Final Project Presentation			5%
Top 6 List			5%
Pop Quizzes			5%
Peer evaluations, participation, lab attendance, etc			5%
			100%

Assignments, Exams, and Related Items

Project. As a member of a team of four or five students, you will have the opportunity to reverse engineer and re-design a mechanical, thermo-mechanical, or electro-mechanical consumer product using the methodology introduced in class. The project is divided into three phases: (I) Reverse Engineering, (II) Conceptual Re-design, and (III) Parametric Re-design. The teaching team will evaluate the projects based on a series of five memos, a team project notebook, a personal design project notebook, and a final presentation. *Subsequent handouts will provide detailed guidelines for each of the project-related activities.*

Memos. You and your fellow team members will write a series of five memos detailing your project work. The teaching team will grade each memo for both technical content and writing fundamentals. Grades will be assigned for each *team*. Individual contributions will be assessed based on peer and instructor evaluations and personal design project journals.

Team Design Notebook. Your design team will be required to establish and maintain a team design notebook to document the team's collective work on the project. The journal should be kept in a loose-leaf 3-ring binder. It should include all team memos and other relevant documentation--such as references, patents, and photos--that document the status of the team's work.

Final Presentation. Your design team will present an overview of the results of its design project during the final week of classes. Content suggestions, time limits, and other important information will be provided in class before the presentations.

Midterm Exam. The midterm exam is tentatively scheduled for 7-9 PM on Wednesday, March 7. The midterm exam will include concepts from the lectures, assigned reading, and project memos. You may consult your lecture notes and textbook during the exam. There will **not** be a final exam in this course. In general, make-up exams will **not** be given. Please make arrangements with the instructor **in advance** if extraordinary circumstances prevent you from taking the exam at the scheduled time.

Personal Design Notebook. You will be required to maintain a Personal Design Notebook to document your *individual* efforts for the project. It should include accounts of design activities, thoughts, analyses, calculations, sketches, intermediate results, refinements, and other information relevant to your *individual* contribution to the design project. Record all of your project-related work in your Personal Design Notebook. Your journal should be kept in a journal notebook.

Top 6 List (and Top 3 List). At the end of the semester, you will be required to submit an essay of approximately 2000 words, in which you describe the top 6 things you have learned in this course. You will be asked to identify each of the 6 items and justify your choice with examples of how you expect to use those tools or skills in the future. Two of the items may be personal skills (e.g., improved leadership or communication skills), but the remaining items must be design tools that you have learned in this course. At midterm, you will be required to submit the first half of your list, in the form of a Top 3 List, with a total length of approximately 1000 words.

Pop Quizzes. Unscheduled, pop quizzes will be given randomly at the beginning of class. Approximately 10 quizzes will be given throughout the semester. The topics will include concepts from recent lectures and assigned reading. The lowest quiz grade will be dropped automatically for each student. Absence is not grounds for a make-up quiz, except for legitimate reasons (e.g., a documented medical emergency).

Attendance, Participation, Peer Evaluations. Attendance in class and lab is mandatory and monitored with periodic roll calls. Notify the instructor **in advance** if you must be absent for a legitimate reason. The teaching team also monitors your participation in class and lab and includes this assessment in your final grade, along with the results of peer evaluations of your participation in team project activities. *The teaching team reserves the right to lower or raise grades based on peer evaluations and other assessments of project participation.*

Assigned Reading. Please read (or at least skim) the assigned reading material before coming to class. Even a brief review of the material will greatly enhance your understanding of material presented in lecture.

Deadlines and Penalties. *All assignments must be submitted on time.* Assignments are due before the beginning of class on the designated day. Unless prior approval is obtained from the teaching team, late assignments will be penalized 10% or one letter grade *per day*.

Academic Integrity

Academic dishonesty will not be tolerated in this course. Penalties are likely to include a grade of F for the activity and/or for the course. Ask your instructor or teaching assistant if you have any questions about expectations for a particular activity. You are encouraged to discuss any aspect of the course with classmates and project team members, but remember the following rules:

- Do not plagiarize the work of others by copying from the web, other students, previous students, articles, or other sources (aside from compiling work from your teammates for group project activities) without properly referencing your sources.
- Do not give or receive assistance from another student during an exam or consult any materials other than those specifically permitted by your instructor during an exam.

Prerequisites

Prerequisites are strictly enforced. According to the *Undergraduate Catalog*, the prerequisites are: Mechanical Engineering 302, 330, 336, 136L, 335, 338, and 353 with a grade of at least *C* in each; Mechanical Engineering 333H, 333T, or the equivalent with a grade of at least *C;* and admission to an appropriate major sequence in engineering. Please see the instructor if you have any questions about the requirements.

ME 366J is a prerequisite for ME 266K, Mechanical Engineering Design Project. In ME 266K, you will use much of the knowledge gained in this course, including the ability to formulate open engineering design problems and the ability to negotiate solutions to them via effective use of solution generation techniques, engineering analysis and experimentation, systematic decision-making, reverse engineering, and speaking, writing, and collaborative team-building skills.

Adding/Dropping the Course

An engineering student must have the Dean's approval to add or drop a course after the fourth class day of the semester or after the second class day of a summer term. Adds/Drops are not approved after the fourth class day, except for a good cause such as documented evidence of an extenuating non-academic circumstance (e.g., health or personal problems) that did not exist on or before the fourth class day. Applications for approval to drop a course after the fourth class day should be made in the Office of Student Affairs, ECJ 2.200.

Course/Instructor Evaluation

All students will have the opportunity to evaluate the course and instructor using the standard MEC (Management and Evaluation Center) form during the last week of classes. Intermediate surveys will also be conducted by the instructor during the semester. Constructive feedback is encouraged at any time via personal discussions or email.

ABET Requirements

ME 366J contributes to the following ABET EC2000 Program Outcomes (√):

1. (√) Knowledge of and ability to apply engineering and science fundamentals to real problems.
2. (√) Ability to formulate and solve open-ended problems.
3. (√) Ability to design mechanical components, systems, and processes.
4. (√) Ability to set up and conduct experiments, and to present the results in a professional manner.
5. (√—project dependent) Ability to use modern computer tools in mechanical engineering.
6. (√) Ability to communicate in written, oral, and graphical forms.
7. (√) Ability to work in teams and apply interpersonal skills in engineering contexts.
8. (√) Ability and desire to lay a foundation for continued learning beyond the baccalaureate degree.

9. (√) Awareness of professional issues in engineering practice, including ethical responsibility, safety, the creative enterprise, and loyalty and commitment to the profession.
10. (√) Awareness of contemporary issues in engineering practice, including economic, social, political, and environmental issues and global impact.

ME 366J also contributes to the following ASME program outcomes:

1. Knowledge of chemistry and calculus-based physics with in-depth knowledge of at least one.
2. The ability to apply advanced mathematics through multivariate calculus and differential equations.
3. Familiarity with statistics and linear algebra.
4. (√) Ability to work professionally in both the thermal and mechanical systems areas including the design and realization of such systems.

Supplemental References

Handouts to be supplied in class.

Pahl, G. and W. Beitz, 1996, *Engineering Design: A Systematic Approach*, 2nd Edition, Springer-Verlag, NY.

Pugh, S., 1991, *Total Design: Integrated Methods for Successful Product Engineering*, Addison-Wesley, Boston.

Ullman, D. G., 1997, *The Mechanical Design Process*, 2nd Edition, McGraw-Hill, NY.

Special Needs

The University of Texas at Austin provides upon request appropriate academic adjustments for qualified students with disabilities. For more information, contact the Office of the Dean of Students at 471-6259, 471-4641 TDD or the College of Engineering Director of Students with Disabilities at 471-4321.

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Mechanical Engineering Department, The University of Texas at Austin
Fall 2007, Course Schedule

DATE	TOPICS	READING	ASSIGNMENTS DUE
8/29	**Introduction and Overview** Course Overview. *In-class Activity.*		Team Selection Data to TA's by Thu, 8/30 @ 5 PM (by Email)
8/31	*In-class Activity Continued.* Why Study Design? Introduction to Design Processes, Design Methodology, and Reverse Engineering	Ch. 1, pp. 1-27,48 Optional: pp. 28-47	Assignment 0
9/3	Labor Day – NO CLASS		
9/5	**Phase 1: Understanding the Opportunity & Clarifying the Task** Scoping the Design Task: Technical Questioning, Mission Statement, Teaming, Scheduling	Same + Ch. 3 pp. 83-97, 110 Optional: pp. 98-109	Product Choice**;** Gantt Charts; Personal and Team Design Notebooks (due in lab on Tu/W)
9/7	**NO Class** – Team working day		
9/10	Understanding the Customer: Customer Needs Analysis and Activity Diagrams	Ch. 4, pp. 111-145 (other examples through book)	
9/12	Establishing Engineering Specifications: HOQ and Requirements List	Ch. 7: 259-262, 289-297 Optional: pp. 262-289	
9/14	Functional Analysis: Black Box Modeling and Function Trees	Ch.5 p.147-154, 162-188, 192-194 (other examples through book)	
9/17	Functional Analysis Cont'd: Function Structures	Same	
9/19	Guest Speaker		**Team Notebook w/ Memo #1** **Personal Notebooks**
9/21	Intro to Reverse Engineering: Prediction of Components, Properties, & Functions. Fishbone Diagrams. Product Teardown Procedure.	Ch. 1: pp. 21-27 Ch. 6: pp. 197-204, 234-237, 256	
9/24	Reverse Eng'g Cont'd: BOM, Exploded Views, Subtract and Operate, Force Flow	Ch. 6: pp. 204-211, 242-243 Ch. 6: pp. 212-220, 245 Ch. 6: pp. 236	
9/26	Reverse Eng'g Cont'd: Actual Function Structures, Function Sharing and Modularity	Ch. 10: pp. 459-460 6: pp. 236-238	
9/28	**Phase 2: Conceptual Design** Introduction to Conceptual Design. *In-class Activity.*		
10/1	Concept Generation	Ch. 10: pp. 411-454	
10/3	**No Class –** Team Working Day		
10/5	Concept Generation Cont'd	Same	**Team Notebook w/ Memo #2** **Personal Notebooks** Phase I Peer Evaluations
10/8	Concept Generation Cont'd. In-Class Activity	Same Optional: pp. 443-454	
10/10	Forming Concept Variants: Morphological Matrix and Preliminary Evaluation	Ch. 10: pp. 454-475	
10/12	Evaluating and Selecting Concepts	Ch. 11: pp. 477-500	

10/15	Selecting Concepts.	Same	
10/17	Selecting Concepts Cont'd. *In-class Activity.*		
10/19	Exam Review		**Top 3 List**
10/22	**No Class** – Prepare for exam		**MIDTERM EXAM (Evening)**
10/24	**No Class** – Team Working Day		
10/26	**Phase 3: Embodiment and Detail Design** Introduction to Embodiment Design. *In-class Activity.*	Ch. 12, all	**Team Notebook w/ Memo #3** **Personal Notebooks**
10/29	*Discuss Exam Solutions*		
10/31	Product Architecture and Flexibility	Ch. 8	
11/2	Modeling and Simulation	Ch. 13: pp. 603-613, 622-632, 661-662 Optional: 632-644, 648-660	
11/5	Modeling and Simulation, Cont'd. Examples.		
11/7	Optimization	Ch. 16: pp. 781-783, 789-801, 818-821, 822-831	
11/9	Experimentation and DOE	Ch. 18: pp. 891-909, 909-929, 950-958	**Team Notebook w/ Memo #4** **Personal Notebooks** Phase II Peer Evaluations
11/12	Experimentation and DOE, Cont'd.	Same	
11/14	*In-class Activity.* Intro to Robust Design.	Ch. 19	
11/16	FMEA	Ch. 12: 564-571, 592-595	
11/19	Prototyping (similitude, material & process choice)	Ch. 17	
11/21	Design for Manufacturing & Assembly	Ch. 14	
11/23	**No Class –** Thanksgiving Holiday		
11/26	Design for Manufacturing & Assembly, Cont'd.	Same	
11/28	**No Class** – Team Working Day		In-lab preliminary Memo #5 check
11/30	Course Review *Course Critiques		**Team Notebook w/ Memo #5** Phase III Peer Evaluations
12/3	Final Project Presentations		**Personal Notebook** **Top 6 List**
12/5	Final Project Presentations		
12/7	Final Project Presentations		

-- No Final Exam --