Fairfield University
School of Engineering

Syllabus for: Advanced Machine Design, ME312

Instructor: Prof. William Dornfeld

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Instructor Assistance: One Half Hour before or after every class, or by appointment

Lecture Hours: 6:30 to 9:30 PM Wednesdays

Class Requirements:

1) Completion of ME311 (Machine Design) is a prerequisite for this course.
2) Assigned homework will be discussed at the following class session – students will present their solutions at the beginning of the session.
3) Oral and written reports will be required for the research and design projects.

Course Description:

The advanced study of mechanical designs emphasizes the process of developing creative solutions through conceptual analysis and synthesis. The first part of the course covers a series of topics related to the design of rotating mechanical systems, but also to welded joints, fracture mechanics, and composites. Part 2 includes a research project where each student investigates and reports on a topic in advanced design. Part 3 is a design project where students in teams compete to develop a design for a product, applying structured design practices to real hardware. Responsible design (safety factors and ethics) will be addressed.

Course Objectives	Expected Outcomes
1. Students will develop their design skills.	a. Demonstrate an understanding of the design process. b. Synthesize many potential solutions to a given design need.
2. Students will learn how to investigate advanced design concepts.	a. Students will research and report on advanced techniques in design.
3. Students will learn the characteristics governing the application of typical machine elements.	a. Use appropriate engineering data to select and size machine elements.
4. Students will develop their oral and written communication skills.	a. Generate professional quality design project report. b. Deliver oral research and design presentations. c. Explain homework solutions to class.
5. Students will learn to apply computer techniques to design analysis and to use the Web to obtain design information.	a. Use computing tools to solve homework problems and in design project.
6. Students will learn to function in team situations.	a. Demonstrate teamwork in design projects.
7. Students will learn professional and ethical responsibility.	a. Ability to understand and apply safety margins. b. Ability to identify and manage design dilemmas.

Schedule:

Session		Topics	Reading (Before Class!)
1	16 Jan 08	Introduction – Fundamentals of the Design Process; Rolling Contact Bearings; Hertzian Contact	1.1 – 1.4, 13.1 – 13.3, 13.6, [Skim 13.4, 13.5, & 13.7.1 - .3], 13.7.4 – 13.7.6, 13.9 [except Weibull details], 8.3
2	23 Jan 08	Lubrication & Journal Bearings	8.1 – 8.2, 8.4 – 8.6; 12.4 – 12.4.4 Select Research Topics
3	30 Jan 08	Flexible Mechanical Elements	19.1 – 19.4, (Skim 19.5), 19.6
4	6 Feb 08	Shafts, Axles, Spindles, Keys & Flywheels	Chap. 11
5	13 Feb 08	Brakes & Clutches	Chap. 18
6	20 Feb 08	Gears; Exam 1 Distributed	Chap. 14
7	27 Feb 08	Gears, Design Project Launch	Team Selection
	5 Mar 08	Spring Break – No Class	
8	12 Mar 08	Research Project Presentations	Written Research Reports Due
9	19 Mar 08	Rivets & Welded Joints	16.5 – 16.6
10	26 Mar 08	Welded Joints	
11	2 Apr 08	Fracture Mechanics	6.3 – 6.5, 7.11
12	9 Apr 08	Project Concept Reviews; Exam 2 Distributed	
13	16 Apr 08	In-Class Exam; Project Work	
14	23 Apr 08	Project Work	
15	30 Apr 08	Project Presentation	Written Project Reports Due

Textbook: *Fundamentals of Machine Elements*, Hamrock, Jacobson, & Schmid, McGraw-Hill, 2nd Ed – 2004, ISBN 0072465328, **BE SURE YOU GET THE SECOND EDITION**.
< http://highered.mcgraw-hill.com/sites/0072465328/student_view0/index.html>
Errors in the book are listed on the course web site.

Attendance Policy: Students are expected to attend all classes. In case of absence, students are responsible to acquire notes from classmates. Homework assignments are on the course web site.

Homework Policy: Homework is collected on the day it is due (the next class).

Academic Dishonesty Policy: See http://www.fairfield.edu/x8236.html. Consequences of cheating on exams or projects range from receiving a zero for a specific exam or project, to failing the course, to being expelled from the University.

Special Accommodations: Any students who have arranged for special accommodations through the Office of Student Support Services should present a letter from that Office confirming their need.

The course will be graded as follows:

Midterm Exams (2)	40%
Research Reports (Oral & Written)	20%
Design Project Reports (Oral & Written)	30%
Homework/Participation/Professionalism	10%

Rolling Contact Bearings Web Reference: *SKF Electronic Handbook*, The handbook is available in a .zip file (4.8 MB) on the ME312 Course Website: <http://www.faculty.fairfield.edu/wdornfeld/312Resources.html>.

Reference Materials (Not Required, but inexpensive, good books):

Design of Weldments, Omer W. Blodgett, Lincoln Electric, Cleveland, 1993
Structures, or Why Things Don't Fall Down, J. E. Gordon, DaCapo Press, N.Y., 2003
The New Science of Strong Materials, J. E. Gordon, Princeton U. Press, N.J., 1988

Research projects involve selecting and researching an advanced design topic, writing a 4-8 page summary of the topic, and delivering a 10 to 15-minute talk on the topic including at least one example. Sample topics for research projects:

▪ Design for Manufacturing	▪ Systems Engineering
▪ Design for Assembly	▪ Concurrent Design
▪ Design for X	▪ Rapid Prototyping
▪ Reverse Engineering	▪ "S" Curves / Redesign
▪ TRIZ / Invention Machine	▪ Robust Design
▪ Axiomatic Design	▪ TQD – Total Quality Development
▪ Project Management Techniques	▪ QFD – Quality Function Deployment
▪ Value Engineering	▪ Reliability
▪ Statistical Process Control	▪ Probabalistic Design
▪ Cumulative Fatigue (Miner/Manson)	▪ Optimal Design
▪ Shock Design	▪ Optimization with MS Excel
▪ Benchmarking	▪ Theory of Constraints (Elihu Goldrat)
▪ Patenting	▪ Weibull Analysis

- **Design** projects involve a team competition to design a product using a structured design process. Potential topics for the competition include:

▪ A jack to lift the front or rear of a car	▪ A robotic tire gripper
▪ A portable crane	▪ A garage door opener
▪ A can crusher	▪ A lift device (with ball or Acme screws)
▪ A casting transfer device	▪ A brake for a drive shaft
▪ A drum dumper	▪ An amusement ride
▪ A gravel conveyor	▪ A waste compactor/baler
▪ A construction lift	▪ An exercise machine
▪ A paper shredder	▪ A patient lift
▪ A mobile boat lift	▪ A portable piano mover
▪ A stump grinder/remover	

Given a set of Customer requirements, all teams will develop a design for the same device, including manufacturing procedures and estimated costs. Deliverables include: 1) a brainstorming summary and 2) a concept review summary/downselect.

- **An alternative Design Activity** involves doing a detailed synthesis of a mechanical device such as a speed reduction gearbox given the required power capacity, reduction ratio, and volume available. A design notebook is generated to track the evolution of the design and record engineering calculations.