MACHINE DESIGN (1440) **FALL 2006**

UNITED STATES COAST GUARD ACADEMY
DEPARTMENT OF ENGINEERING

Credit Hours: 4.0
Format: Class / Laboratory
Prerequisite: ME 1370 (Mechanisms), 1211 (Dynamics), 1206 (Strength of Materials), 3211 (Multivariable Calculus), 1208 (Intro to Mechanical Engineering Design)

Course Description: Design of machine elements, including considerations such as material strength, manufacturing processes, safety, reliability, stress concentration, fatigue, corrosion, and tribology. Mechanical power transmission devices, including shafts, gears, belts, springs, fasteners, bearings, and couplings. Introduction to mechanical component integration and design-and-build projects.

Course Objectives: Specific objectives from this course include the following abilities:

- Demonstrate understanding of the relation between the strength of a machine element and its anticipated loading (static & dynamic) and analyze to select the optimum material and dimensions to prevent undesired failure.
- Apply previous subjects (statics, strengths of materials, dynamics) to design situations and problems.
- Demonstrate a logical application of theory to the design of machine elements and demonstrate understanding of the necessary underlying assumptions and approximations.
- Demonstrate the proper use of safety factors.
- Be able to select appropriate components for specific functions because s/he has sufficient understanding of the functional capabilities of common machine elements.
- Conduct deflection analysis when important to design situations.
- Use CAD and multimedia tools to communicate effectively.
- Design a product and present the design to an audience of peers.

Text: Mechanical Engineering Design, 5th Ed. by Joseph E. Shigley and Charles R. Mischke

References: Mechanics of Materials, 4th Ed. by R. C. Hibbeler
Engineering Mechanics: Statics, 9th Ed. by R. C. Hibbeler
Design of Machinery, 3rd Ed. by Robert L. Norton
Marks' Standard Handbook for Mechanical Engineers, 10th Ed. by Eugene A. Avallone and Theodore Baumeister III

Instructors: LT Michael Plumley ext: 6521 Office: M102B
email: michael.plumley@uscga.edu
William Palm ext: 6308 Office: M127
email: william.j.palm@exmail.uscga.edu

Grading:

Homework & Quizzes	30 %	Design Project/Lab Work	25 %
Hourly Exams (3)	25 %	Final Exam	20 %

Grades: Grades will be based on the following scale:
A: 90-100 B: 80-89.9 C: 70-79.9
Their will be plus and minus categories as appropriate.

MACHINE DESIGN (1440) **FALL 2006**

Course Structure: Lectures, reading, and homework will be integrated to promote effective use of time and development of engineering analysis and problem solving skills. You will need to be proactive, think critically, and use your time effectively. Your learning and motivation are ultimately your responsibility. If the expectations for any instruction are unclear it is your responsibility to seek clarification from the instructor. Vague instructions present an opportunity for you to develop your design and project management skills. Lack of understanding of the instructions or citing of alternate standards used by past instructors or other students are not valid reasons for unacceptable submittals.

Reading: Reading assignments are listed in the course schedule. Students should read each section prior to lecture at a level that prepares them to participate in class. Students should go back to the text after class to develop a detailed understanding for homework, quizzes, and tests. Unannounced quizzes will be given throughout the semester to assess your understanding of the reading and course material.

Lecture: It is assumed students have completed the assigned reading and will ask questions. Student mastery of the material will be assumed if questions are not asked. Lecture time will generally be devoted to definitions, key concepts, and the solution of example problems. Selected students may be tasked to work through homework related problems. Students must bring the following to every class and lab: straight edge, compass, protractor, pencil, and colored pen. Proper military etiquette will be observed at all times and a lack of attention is unacceptable. Failure to respect this will result in removal from class, remediation under the conduct system, and grade reduction on applicable assignments.

Homework: The homework problems are shown on the course schedule and are subject to change. Small group collaboration with other students in which each student works on and understands the solution to each problem is encouraged. Each homework assignment is weighted equally for grading purposes except where specified. Homework shall be on the class podium prior to the beginning of class on the dates given, or as specified by the instructor. Late homework will be accepted for half credit at any time up to the start of the next scheduled exam. Homework submitted after the start of class or in the wrong format will be considered late.

Homework shall be completed on green engineering paper unless this format is not appropriate, such as for word processed documents. Begin each problem on a new page unless problems are sufficiently short enough to fit two on one page. Homework shall be neatly printed and all mistakes erased thoroughly. Place proper titles across the top of the front page to include, at a minimum, **"Name", "Date", "Course", "Problem Number", "Page Number/Total Number of Pages"**. Subsequent pages shall include "Page Number/Total Number of Pages". Include a detailed problem statement, appropriate figures, "assumptions", "audience", and calculations. Include comments and assumptions about source of equations, figures or tables used, or material properties. Answers must be clearly identified.

Your presentation of homework should focus on communicating effectively what you have done, why you have done it, and how you have done it. You should employ sketches, diagrams, equations, calculations, and written explanations of your process and results. Homework requiring the use of computers must include appropriate computer printouts and/or graphs which are clearly explained and labeled. Neatness counts.

Exams and Quizzes: Formal exam dates are specified on the course schedule. There may be quizzes

throughout the semester with grading determined based on the number of quizzes and their difficulty. Quiz grading shall be determined by the class instructor. The final exam is mandatory and will be given at that time and place scheduled by the registrar.

Design Projects/Lab: Design projects will be assigned in the laboratory portion of this course. The projects involve the use of the design process. Students will perform analyses, submit a report, and present their findings as directed. Students should start projects early. Waiting until last minute will not allow for clarification of instructions, proper planning and execution, or the seeking of assistance. Project grades will be deducted 20 points if late and an additional 20 points every 24 hours after. Consideration for extensions will only be given in extreme cases such as family emergencies. You are responsible for the failures of technology, so plan ahead, save early, and save often. Excessive messiness or spelling and grammatical errors shall be deemed unacceptable and returned for late submittal.

Collaboration, Assistance, and Documentation**:** Students are expected to seek assistance and to work together to learn the material. Students who do not seek assistance are presumed to have mastered the material. Projects are expected to be unique and therefore collaboration shall be discussed for them separately. Simply copying homework or other assignments from other sources is forbidden. Assignments completed with assistance or guidance from someone or something other than the student completing it must be documented with a brief statement specifying the type and source of help received.

Course Notebook: As part of the requirements for ABET, you must maintain a complete course notebook. The notebook must contain all notes taken in class, handouts and all graded materials (problem and design assignments and exams). The notebook should be arranged chronologically and should be tabbed. Submission of a complete course notebook at the time of the final examination is a requirement for passing. Your notebooks will be returned to you.

MACHINE DESIGN (1440) **FALL 2006**

Achieving Educational Outcomes

This course, which is required of all students majoring in ME, is intended to help you achieve some of the desired outcomes of an undergraduate engineering program. The accrediting agency for engineering programs, ABET, has specified the following as required outcomes for all undergraduate engineering majors. Areas shown in italics only indicate that some knowledge development should occur as a result of completing this course. Those areas in bold and italics indicate outcomes that are intended to have significant knowledge development by your experience in this course. At the completion of the course, you will be asked to self-evaluate how well you have achieved these outcomes through your efforts:

Engineering programs must demonstrate that their graduates have:

1. ***An ability to apply knowledge of mathematics, science and engineering***
2. ***An ability to design and conduct experiments as well as to analyze data***
3. ***An ability to design a system, component or process to meet desired needs***
4. *An ability to function on multi-disciplinary teams*
5. ***An ability to identify, formulate and solve engineering problems***
6. *An understanding of professional and ethical responsibility*
7. *An ability to communicate effectively*
8. The broad education necessary to understand the impact of engineering solutions in a global and societal context
9. *A recognition of the need for and an ability to engage in life-long learning*
10. *A knowledge of contemporary issues*
11. ***An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.***
12. An ability to develop as leaders in the Coast Guard.

Additional ABET requirements for graduates of Mechanical Engineering programs include:

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

MACHINE DESIGN (1440) **FALL 2006**

Tentative Schedule updated 18SEP 06

			LECTURE TITLE	READING DUE	HOMEWORK DUE
1	Th “M	8/24	Course Intro;	Chapter 1	
2	M	8/28	Limits, Fits, Tolerances, Dimensions, Drawings & Standards	4-8 to 4-9	[1] Handout
3	W	8/30	Review: Material Properties	5-4, 5-20	[2] 4-29, 4-30
4	F	9/1	Review: Stress/Deflection in Beams	Hibbeler	
		9/4	LABOR DAY		
5	W	9/6	Review: Directionality of Stress, Spring Stress	Hibbeler	[3] Strengths Quiz 1
6	F	9/8	Review: Steady Loading Failure Theory	6-1 to 6-10	[4] Strengths Quiz 2
7	M	9/11	Variable Loading & Fatigue	7-1 to 7-4, 7-12	[5] Handout
8	W	9/13	Endurance Limit and Fatigue Strength	7-5 to 7-9	[6] Handout
9	F	9/15	Variable Loading (Fatigue) Failure Theory	7-13 to 7-14, 7-16, 7-17	[7] Handout
10	M	9/18	Combined Loading Fatigue Failure Theory	7-15	[8] Handout
11	W	9/20	Fatigue Failure (Continued)		
12	F	9/22	Shaft Sizing Using Failure Theories	18-1 to 18-5, 18-7 to 18-8	[9] Handout
13	M	9/25	Springs - Helical Extension and Compression Stress, Stability, Vibration	10-1 to 10-6, 10-10	[10] Handout
14	W	9/27	Springs - Helical Strength & Failure	10-7, 8 & 10-11	
15	F	9/29	Spring - Helical Torsion	10-12	[11] Handout
16	M	10/2	Spring Fatigue & Torsion Continued		[12] Handout
17	W	10/4	**EXAM 1**		
18	F	10/6	Belts	17-1 to 17-4	[13] Handout
		10/9	COLUMBUS DAY		
19	W	10/11	Chains & Wire Rope	17-5 to 17-6	[14] 17-7
20	F	10/13	Gears -General & Trains	13-1 to 13-8	[15] 17-17
21	M	10/16	Gears - General & Trains	13-12 to 13-13	
22	W	10/18	Gears - Force Analysis	13-14	[16] Handout
23	F	10/20	FACULTY IN SERVICE DAY		
24	M	10/23	Gears - Bending Stresses	14-1, 14-3 to 14-14	[17] 13-17
25	W	10/25	Gears - Wear Stresses	2-21, 14-2, 14-3 to 14-14	
26	F	10/27	Gears - Continued		[18] 14-30
27	M	10/30	Clutches & Brakes - Short Shoe	16-1	
28	W	11/1	**EXAM 2**		
29	F	11/3	Clutches & Brakes - Drum	16-2 to 16-3	[19] Handout
30	M	11/6	Clutches & Brakes - Band, Friction, Disk	16-4 to 16-6	
31	W	11/8	Clutches & Brakes - Materials	16-8 to 16-11	[20] 16-4
	F	11/10	Threads & Power Screws	8-1 & 8-2	
32	M “F”	11/13	VETERAN’S DAY		
33	W	11/15	Threaded Fasteners & Tension Connections	8-3 to 8-5, 8-7, 8-8	
34	F	11/17	Bolt Strength & Failure	8-6, 8-9 to 8-11	[21] 8-8
35	M	11/20	Bolt Strength & Failure		
	W	11/22	THANKSGIVING		

	F	11/24	THANKSGIVING		
36	M	11/27	Bolt Groups, Rivets, Set Screws, Keys	8-13 to 8-17	[22] Handout
37	W	11/29	Bearings - Rolling Contact	11-1,2,3,6,9,10	
38	F	12/1	Bearings - Journal	12-1 to 12-7	[23] 11-11
39	M	12/4	Bearings- Journal (Continued)		
40	W	12/6	**EXAM 3**		
41	F	12/8	Welding - General	9-1, 9-6, 9-7	
42	M	12/11	Welding - Stress/Strength in Welds and Joints	9-2 to 9-5	
43	W	12/13	Welding – Practical Examples		[24] 9-4, 9-7

- Answers provided at the end of the chapter, but they may not always be correct.
- Pop quizzes are counted towards homework grade and will be up to 5% of total grade
- Any homework assignment may be altered to use a component of your project as the element being analyzed. Jot down your proposed component and a general description of the similar analysis you plan to perform. You must submit this and obtain instructor approval at least 3 business days prior to the due date.

Tentative Lab Schedule

#	Tues	Thur	Lab	Due
1	**8/25 "T"**	**9/7**	**Gears**	
2	8/29	8/31	Project Phase 1: Problem Definition, Research, Conceptualization, Initial Design Choice Design Process Review & Report Specs	
3	9/12	9/14	Phase 1 Continued…	Project Progress Report **Gear Lab Due**
4	9/19	9/21	Phase 1 Continued…	Project Progress Report
5	9/26	9/28	Project Phase 2: Chosen Design - Calcs & Experimentation	Project Progress Report **Project Phase 1 Due**
6	10/3	10/5	Phase 2 Continued…	Project Progress Report
7	10/10	10/12	**TBD**	Project Progress Report
8	10/17	10/19	Phase 2 Continued…	Project Progress Report **TBD Report Due**
9	10/24	10/26	Phase 2 Continued…	Project Progress Report
10	10/31	11/2	Phase 2 Continued…	Project Progress Report [] Initial parts order **Project Phase 2 Due**
11	11/7	11/9	Project Ph 3: Design Build and Test	Project Progress Report
12	11/14	11/16	Project Ph 3 Continues…	Project Progress Report
13	11/28	11/21	Competition 1 Project Phase 4: Design Improvement	Project Progress Report **Project Ph 3 Due**
14	12/5	11/30	Project Ph 4 Continues…	Project Progress Report
15	12/12	12/7	Project Presentations	Project Progress Report- incl presentation rehearsal **Project Ph 4 Presentation** **Project Ph 4 Due**