MECHANISMS (ME 1370) **SPRING 2006**

UNITED STATES COAST GUARD ACADEMY
DEPARTMENT OF ENGINEERING

Credit Hours: 4.0 (12.0 student hrs/wk)
Format: Class / Laboratory
Prerequisite: 1211 (Dynamics), 1206 (Strength of Materials), 3211 (Multivariable Calculus), 1208 (Intro to Mechanical Engineering Design)

Course Description: Fundamentals of mechanism and machinery design are covered through the introduction of the synthesis and analysis of mechanisms and machines. Rigid-body kinematics, kinetics, and dynamics are applied to linkage analysis and design. Position, velocity, acceleration, and force analyses are covered in detail. Weekly labs are devoted to hands-on application of the engineering design process, use of synthesis/analysis software, and design-and-build workshops.

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

- Develop an understanding of the fundamentals of kinematics and kinetics.
- Develop mathematical models for linkages, machine components, and portions of larger systems.
- Write governing equations for position, velocity, acceleration, and force analysis for linkages or systems.
- Organize an analysis of systems and unstructured, poorly defined problems using a structured design approach.
- Build and analyze a functional model of a system and communicate your understanding through preparation of professional quality reports.
- Write a paper and give a speech on a technical topic of general interest.
- Use CAD and multimedia tools to communicate effectively.
- Effectively apply concepts from prerequisite courses to the design of mechanisms and machine components. Demonstrate the proper use of safety factors.

Text: Design of Machinery, 3rd Ed. by Robert L. Norton

References: Mechanics of Materials, 4th Ed. by R. C. Hibbeler
Engineering Mechanics: Statics, 9th Ed. by R. C. Hibbeler
Fundamentals of Engineering Design, 2cd ed.by Barry Hyman
Marks' Standard Handbook for Mechanical Engineers, 10th Ed. by Eugene A. Avallone and Theodore Baumeister III

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Grading:

Homework/Quizzes	25 %	Design Project/ Lab Work	25 %
Formal Exams (3)	25 %	Final Exam	15 %
		Hewitt Contest	10 %

Grades: Grades will be based on the following scale:
A: 90-100 B: 80-89.9 C: 70-79.9

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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. You have been given an incredible privilege at great expense to this nation's taxpayers and as such you are expected to put forth an honest effort. Your learning and motivation are ultimately your responsibility. Your instructor can only present the material, assess your knowledge, and do his best to assist you in understanding. 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 or behavior.

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 when unsure of concepts. 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 sleeping or any other behavior demonstrating a lack of attention is unacceptable. Failure to respect this will result in removal from class, punishment under the conduct system, and reduction in grades on which such action had an affect.

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 and shall include consideration of whether or not an assignment was started early in anticipation of unforeseen events. You are responsible for the failures of technology, 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.

Hewitt Contest**:** Mechanisms has been designated as the class for the 2/C Mechanical Engineering major participation in the Hewitt Writing and Speaking Contest. Nominees from this class will be representing the Mechanical Engineering major. The selection of contest nominees will be based on cadet and instructor evaluation of written papers and oral speeches. A cadet will be nominated for either the paper or the speech but not both. Papers will be due before Spring Break. Students are presumed to be proficient at spelling, grammar, and proper planning of drafts. All students have the opportunity to use the Writing Center and gain instructor feedback prior to final submittal and will be graded as such.

Course Notebook: Every student is encouraged to maintain a course notebook, the keeping of which is entirely at student discretion. The quality of notes taken and whether or not they are understood is each student's responsibility.

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Tentative Lecture Schedule-Revised 01MAY06

#	Day	Date	Lecture	Reading ("Due")	Assigned	Due
1	M	1/9	Course Intro/Expectations; Design Process	1.00; 16.00-16.03	**[1]** Essays; Syllabus Review	
2	W	1/11	Definitions, Links, Joints, DOF, Grubler, Grashof	2.01-2.08;	**[2]** 2-7(a-e), 2-8 (a-e), Course Gantt	1
3	F	1/13	Isomers, Inversion, Transformation	2.08-2.18	**[3]** 2-9, 2-15-part1, 2-43	2
	M	**1/16**	**MLK Day Holiday Leave**			
4	W	1/18	Graphical 2&3 Position Synthesis, Quick Return Mechanisms	3.01-3.03	**[4]** 3-1, 3-3	3
5	F	1/20	Coupler Curves, 4&5bar, Cognates	3.04-3.07	**[5]** 3-5, 3-34	4
6	M	1/23	Straight Lines, Dwells	3.08-3.09	**[6]** 3-72	5
7	W	1/25	Position Analysis	4.01-4.05	**[7]** 4-57 (FOURBAR)	6
8	F	1/27	Position Analysis 4bar Slider	4.6-4.7	**[8]** 4-6 (a), 4-7a	7
9	M	1/30	Position Analysis Any Point	4.9-4.11	**[9]** 4-13(a), 4-14 (a), 4-15 (a)	
10	W	2/1	Analytical Linkage Synthesis	5.01-5.03	**[10]** 5-9	8, 9
11	F	2/3	Analytical Linkage Synthesis	5.04-5.05	**[11]** *(dropped)*	
12	M	2/6	Analytical Linkage Synthesis	5.07-5.08	**[12]** 5-31	10
13	W	2/8	Analytical Linkage Synthesis	5.09-5.13		
14	**F**	**2/10**	**EXAM 1 (Chpt 1-5)**			
15	M	2/13	Velocity Analysis – Graphical	6.01-6.02	**[13]** 6-4a* **[14 part 1]** 6-87 a	12
16	W	2/15	Velocity Analysis – IC	6.03-6.04	**[14 part 2]** 6-86, 6-87 b	
17	F	2/17	Velocity Analysis – Centrodes and Slip	6.05-6.06	**[15]** 6-5a	13, 14
	M	**2/20**	**Pres Day Holiday Leave**			
18	W "M	2/22	Velocity Analysis – Analytical	6.07 *6.08-6.09*	**[16]** 6-87 c	15
19	F	2/24	Acceleration Analysis	7.01	**[17]** 7.3a (related to 4-6, and 6-4)	16
20	M	2/27	Acceleration Analysis – Analytical	7.03	**[18]** 7.4a*, 7-12	17, Ex 1 retake
21	W	3/1	TBD – (More on Vector Loops)			18
22	**F**	**3/3**	Dynamics/Kinetics Fundamentals	1.10, 10.00-10.06	**[19]** 10-5*	{Hewitt Final}
	M	**3/6**	**SPRING BREAK LEAVE**			
	W	**3/8**	**SPRING BREAK LEAVE**			
	F	**3/10**	**SPRING BREAK LEAVE**			
23	M	3/13	Dynamics/Kinetics Fundamentals Lumped parameter models, etc.	10.07-10.13	**[20]** 10-24	
24	W	3/15	**EXAM 2 (Chpt 1-7)**			
25	F	3/17	Dynamic Force Analysis	11.01-11.02		
26	M	3/20	Dynamic Force Analysis- Single Link	11.03	**[21]** 11-24* (use "matrix method")	19, 20
27	W	3/22	Dynamic Force Analysis- 4bar	11.04-11.05	**[22]** 11-24* (as written)	21
28	F	3/24	Dynamic Force Analysis- 5bar	11.06		22
29	M	3/27	Dynamic Force Analysis- Torque and Flywheels	11.08, 11.10-11.11		
30	W	3/29	Dynamic Force Analysis - Balance	12.01-12.05		

31	Th "F"	3/30	Engine Dynamics-Kinematics, Gas forces, Binomial Expansion	13.01-13.03	**[23]** 13.1, 13.3, 13.5	
	F	**3/31**	**ETHICS FORUM**			
32	M	4/3	Engine Dynamics – Equivalent Masses-Inertia & Shaking Forces	13.04-13.05	**[24]** 13-7, 13-9	
33	W	4/5	Engine Dynamics- Inertia and Shaking- Torques and Couples	13.06-13.07	**[25]** 13-11	
34	F	4/7	Engine Dynamics- Flywheels & Pin Forces	13.08-13.09	**[26]** 13-19	23, 24, 25
35	M	4/10	Engine Balance- Single Cylinder	13.10-13.11		26
36	W	4/12	Cams and SVAJ Functions	8.01-8.03	**[27]** 8-7	
37	F	4/14	Polynomials and Harmonics	8.04-8.06	**[28]** 8-12	
38	M	4/17	Cam Sizing	8.06-8.07		27
39	W	4/19	Engine - Multi-Cylinder	14.01-14.03	**[30]** 14-2	28
40	**F**	**4/21**	**Exam 3 (Chpt 1-7, 10-11, 13)**			
41	M	4/24	Engine Balance- Multi-Cylinder	14.04-14.06 14.09	**[31]** 14-9	30
42	W	4/26	Exam 3 Mitigation Quiz			31
	F	**4/28**	**STUDY CONF DAY**			
	TBD	**TBD**	**FINAL EXAM**			

- Not all assignments are listed, students are responsible for recording due dates and changes given in class.
- Schedule subject to change.
- It is highly recommended that you do not save all assignments until the night before the due date.
- * Denotes problems which may be completed using project related mechanism or part instead of textbook question's figure
- Highlighted assignments denote those which were changed to "optional" homework assignments.

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Tentative Lab Schedule-Revised 01MAY06

#	Tues	Thurs	Lab	Due
1	1/10	1/12	Hewitt Intro, Research Skills, Sustainable Energy Lecture	**[1]** Essays for HW 1
2	1/17	1/19	Project 1 Introduction, Design Process Review & Report Specifications;	**[H1]** Hewitt Brainstorm/Background Bibliography
3	1/24	1/26	Project 1 Continues…	**[H2]** Hewitt Thesis Draft **[P]** Project Progress Report
4	1/31	2/2	Project 1 Continues… Stengths Review-Static Failure Theories	**[H3]** Hewitt Bibliography/Final Thesis/ Outline (5%) **[P]** Project Progress Report
5	2/7	2/9	Project Ph 2 Introduction Stengths Exercises-Static Failure Theories	**[H4]** Hewitt Draft 1 **[P]** Project Progress Report
6	2/14	2/16	Project Ph 2 Continues… Recitation Exercises	**[P]** Project Progress Report **[P1] Project Phase 1 Due**
7	2/21	2/23	Project Ph 2 Continues… Project Progress Meetings	**[H6]** Hewitt Draft 2 **[P]** Project Progress Report
8	2/28	3/2	Project Ph 2 Continues… Project Ph 3 Introduction	**[P]** Project Progress Report **[H5]** Hewitt Peer Review Remarks
	3/7	**3/9**	**SPRING BREAK LEAVE!!!**	**[H7] Hewitt Due in class 3/3**
9	3/14	3/16	Project Ph 3 Continues Project Individual Progress Meetings	**[P]** Project Progress Report Recommend Phase 2 completion here
10	3/21	3/23	TSD/HEAT TRANSFER LAB	**[P]** Project Progress Report **[L2] Project Ph 2 Due**
	3/28	*****	**Hewitt Speeches** **THURS LAB cancelled**	**[H9]** Hewitt Speech Rehearsal Sheets **[P]** Project Progress Report* *Thursday labs turn in project prior to normal start of lab period.
11	4/4	4/6	Project Ph 4 Introduction Lab/Demo Single Cylinder Engines	**[P]** Project Progress Report **[L3] Project Ph 3 Due**
12	4/11	4/13	Project Ph 4 Continues… Project Group Progress Meetings	**[P]** Project Progress Report
13	4/18	4/20	Project Ph 4 Continues… Project Group Progress Meetings	**[P]** Project Progress Report incl Project Phase 4 Draft & Solidworks Model
14	4/25	4/27	Project Ph 4 Presentations	**[P]** Project Progress Report- incl presentation rehearsal sheets **[L4.1] Project Ph 4 Due** **[L4.2] Project Ph 4 Presentation**