ME350 Design and Manufacturing II
Syllabus and General Course Information
Winter 2008

Lectures Tuesday, Thursday: 2:30pm-4:00pm, CSE 1670

Course Instructors

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Recitation Sections and Graduate Student Instructors

	Section 5	Section 3	Section 4
Name:	Mike Cherry	Gaurav Parmar	Kevin Shimotsu
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Recitation Hours:	F 11:30am-1:30pm	M 11:30am-1:30pm	W 11:30am-1:30pm
Recitation Venue:	GGB 2233	GGB 2233	GGB 2233
GSI Office Hours:	TBD	TBD	TBD

Course Description

This course will cover the basics of mechanism and machine design. Specific topics will include kinematics, dynamics, mechanism synthesis, design and selection of machine components, sensors, and actuators. This is a project-based course where students will work in teams to complete two projects. The first will be the design and fabrication of a golf club tester and the second will be the modeling, assembly and testing of an inverted pendulum system.

Textbook

ME350 Winter08 Course-Pack may be purchased from DollarBill January 7 onwards. The *Course-Pack* draws material primarily from the following two textbooks

- A.G. Erdman, G.N. Sandor, and S. Kota, *Mechanism Design: Analysis and Synthesis (Volume 1)*, 2001, ISBN: 0130408727
- J.E. Shigley, C.R. Mischke, and R.G. Budynas, *Mechanical Engineering Design*, 7th Edition, 2004, ISBN 0072520361

Students DO NOT need to buy the above two textbooks. Study material for certain topics will be posted directly on Ctools.

Online References (not to be purchased)

1. Machinery Handbook (available through the library)
   http://www.knovel.com.proxy.lib.umich.edu/knovel2/Toc.jsp?BookID=309
2. ASM Materials Handbook (available through the library)
   http://products.asminternational.org/hbk/index.jsp
3. www.machinedesign.com
4. Fundamentals of Design, A.H. Slocum, 2007
   http://pergatory.mit.edu/2.007/fundamentals/

Course Pre-requisites

ME 250 Design and Manufacturing I is a pre-requisite for this course. You are expected to have (i) a basic working knowledge of elementary mechanics such as static, dynamics, and strength of materials, (ii) basic ME250 level machine shop skills (lathe, mill, drill, etc.), and (iii) working knowledge of a commercial CAD program, such as SolidWorks, IDEAS, Unigraphics, ProEngineer, or AutoCAD.

Course Learning Objectives

The goal of this course is to provide each student an understanding of (a) basic principles of mechanical design, (b) methods of synthesis and analysis of machine components and systems, and (c) relate engineering knowledge to real-world engineering problems. At the end of the course, students should be able to do the following in either a team setting or individually.

1. Identify standard mechanical and electromechanical components and systems and explain how they work.
2. Basic kinematic and kinetostatic analysis of mechanical systems.
3. Design a mechanism or machine to satisfy given motion (or other performance) requirements. Identify design tradeoffs in concept and detail design from the perspectives of functionality, manufacturability, design effort, and available resources.
4. Derive predictive models to analyze, evaluate and optimize mechanical systems. In particular, evaluate kinematic, static and dynamic performance of a mechanical system using modeling, simulation and virtual prototyping methods.
5. Test and evaluate simple machine systems and components for performance and failure.
6. Apply appropriate selection criteria to choose standard machine components such as gears, bearings, springs, motors, sensors and controllers.
7. Be able to create solid models and engineering drawings, suitable for communication to a professional machine shop.
8. Select appropriate materials and manufacturing processes based on geometry and tolerances.
9. Build, assemble and test mechanical and electromechanical systems using standard machine shop tools and mechatronics facility.
10. Understand the characteristics of common sensors and be able to read a sensor datasheet.
11. Understand the characteristics and models of various electromechanical actuators (brushed dc motor, brushless dc motor, and stepper motor) as well as hydraulic and pneumatic actuators. Be able to read and understand an actuator data sheet.
12. Be able to interface a mechanical / electromechanical system with a digital computer using LabView programming language and National Instruments DAQ and Controls hardware.

Course Road-Map and Schedule

ME350 W08 Course Road-Map

Week #	Day	Date	Lecture #	Lecture Topic	Lecturer	Reference	HW	Lab / Recitation	Lab/Recitation Topics
1	Thu	3-Jan	1	**Classes Start:** Course Overview, and Logistics; Introduction to Design of Machines, Mechanisms and Systems	SA	Lecture Notes			
	Fri	4-Jan						Rec1	Machine Shop Training (11:30-12:30), Project 1 Discussion (12:30-1:30)
2	Mon	7-Jan						Rec1	
	Tue	8-Jan	2	Machine / Mechanism Kinematics; Kinematic Diagrams; Joint Types; Degrees of Freedom;	SA	Erdman, Sandor, Kota			
	Wed	9-Jan						Rec1	
	Thu	10-Jan	3	Types of Mechanisms, Kinematic and Geometric Inversion	SA	Erdman, Sandor, Kota	HW1 Assign (Kinematics, DoF, Mechanisms)		
	Fri	11-Jan					No HW Due	Rec2	Machine Shop Training (11:30-12:30), HW1 Discussion (12:30-1:30)
3	Mon	14-Jan						Rec2	
	Tues	15-Jan	4	Introduction to ADAMS (45min); Graphical and Analytical Dyad Synthesis	MC	Erdman, Sandor, Kota			
	Wed	16-Jan						Rec2	
	Thu	17-Jan	5	Graphical and Analytical Dyad Synthesis	MC	Erdman, Sandor, Kota	HW2 Assign (ADAMS Problem)		
	Fri	18-Jan					HW1 Due; Final Teams Due	No recitation; Extended OH	ADAMS Self-Tutorial
4	Mon	21-Jan		MLK Day, No Classes				No recitation	
	Tue	22-Jan	6	Ground Pivot Specification, Path Generation	MC	Erdman, Sandor, Kota			
	Wed	23-Jan						No recitation; Extended OH	
	Thu	24-Jan	7	Dyad Synthesis: Lincages	MC	Erdman, Sandor, Kota	HW3 Assign (Mechanism Synthesis)		
	Fri	25-Jan					HW2 Due;	Rec3	LINCAGES Tutorial (1 hour); HW3 Discussion (1 hour)
5	Mon	28-Jan						Rec3	
	Tues	29-Jan	8	Instant Centers and Mechancial Advantage	MC	Erdman, Sandor, Kota			
	Wed	30-Jan						Rec3	

5	Mon	28-Jan						Rec3	LINCAGES Tutorial (1 hour); HW3 Discussion (1 hour)
	Tues	29-Jan	8	Instant Centers and Mechancial Advantage	MC	Erdman, Sandor, Kota			
	Wed	30-Jan						Rec3	
	Thu	31-Jan	9	Instant Centers and Mechancial Advantage	MC	Erdman, Sandor, Kota	HW4 Assigned (IC/MA)		
	Fri	1-Feb					HW3 Due	Rec4	Project 1: Preliminary Design Review (2 hours);
6	Mon	4-Feb						Rec4	
	Tue	5-Feb	10	Structures	DG	Lecture Notes			
	Wed	6-Feb						Rec4	
	Thu	7-Feb	11	Structural Connections and Interfaces; Fastners	DG	Shigley	HW5 assigned (Structures and Fastners)		
	Fri	8-Feb					HW4 Due	Rec5	HW4 Discusssion (1 hour, maybe not needed simply use the OH); Work with your GSI on detailed design (1 hour + OH)
7	Mon	11-Feb						Rec5	
	Tues	12-Feb	12	Power Transmission: Bearings	DG	Shigley			
	Wed	13-Feb						Rec5	
	Thu	14-Feb	13	Power Transmission: Bearings (problem solving)	DG	Shigley	No HW Assigned		
	Fri	15-Feb					HW5 Due	Rec6	Project 1: Detailed Design Review (2hours), Detailed Report is Due at the time of the DDR (this is in lieu of Exam1); Work in the machine shop after your DDR
8	Mon	18-Feb						Rec6	
	Tue	19-Feb	14	Power Transmission: Mounting, Alignment and Couplings	DG	Shigley			
	Wed	20-Feb						Rec6	
	Thu	21-Feb	15	Springs	DG	Shigley	No HW Assigned		Work in the Machine Shop
	Fri	22-Feb					DDR Report Due	No recitation	
				Winter Break (25-Feb to 29-Feb)					Work in the Machine Shop
9	Mon	3-Mar						No recitation	Work in the machine shop
	Tue	4-Mar	16	Power Transmission: Gears and Power-Screws	DG	Shigley			
	Wed	5-Mar						No recitation	
	Thu	6-Mar	17	Power Transmission: Gears and Power-Screws	DG	Shigley			
	Fri	7-Mar						Project 1 Due	Project 1 Design Competition
	Mon	10-Mar						Project 1 Due	
	Tues	11-Mar	18	No class;	SA				
	Wed	12-Mar						Project 1 Due	

10	Mon	10-Mar						Project 1 Due	Project 1 Design Competition
	Tues	11-Mar	18	No class;	SA				
	Wed	12-Mar						Project 1 Due	
	Thu	13-Mar	19	Intro to Mechatronic System Design	SA	Lecture Notes	HW6 Assigned (Bearing+Gears)		
	Fri	14-Mar						Rec7	HW6 Discussion (1 hour Gears); Project 2 Introduction (1 hour); LabView Tutorials (self)
11	Mon	17-Mar						Rec7	
	Tue	18-Mar	20	Sensors	SA	Lecture Notes	Project 1 Report Due		
	Wed	19-Mar						Rec7	
	Thu	20-Mar	21	Sensors and Signal Conditioning Electronics	SA	Lecture Notes	HW7 (LV)		
	Fri	21-Mar					HW6 Due	Rec8	Project2: Learn to interface Optical Encoder in LV (1 hour) + ADAMS modeling of IP system (1 hours)
12	Mon	24-Mar						Rec8	
	Tues	25-Mar	22	Actuators	SA	Lecture Notes			
	Wed	26-Mar						Rec8	
	Thu	27-Mar	23	Actuators and Drivers	SA	Lecture Notes	No HW Assigned		
	Fri	28-Mar					HW7 Due	Rec9	Project 2: Control a DC motor from LV (1hour) + ADAMS modeling of IP system (1hour)
13	Mon	31-Mar						Rec9	
	Tue	1-Apr	24	Turbomachinery	DG	Lecture Notes			
	Wed	2-Apr						Rec9	
	Thu	3-Apr	25	Hydraulics	DG	Lecture Notes	No HW Assigned		
	Fri	4-Apr					No HW Due;	Rec10	Get the IP system to work; Project 2 Presentation
14	Mon	7-Apr						Rec10	
	Tues	8-Apr	26	Course Review / Cam Design and Sizing	DG	Shigley			
	Wed	9-Apr						Rec10	
	Thu	10-Apr	27	Course Review			No HW Assigned		
	Fri	11-Apr		Take-home component of Exam Assigned			No HW Due; Project 2 Report Due	No recitation	
15	Mon	14-Apr						No recitation	
	Tue	15-Apr	28	**Last Day of Classes**: In-class component of Exam					

Grading Format and Policy

The grade break-down for the course is as follows:

1. Project 1: 30%
2. Project 2: 15%
3. Homework: 25% (best six out of seven)
4. In-class Quiz: 10% (unscheduled)
5. Final Exam: 20% (entire syllabus)

Note: Of the total 45% grade for the two projects, 5% is reserved for lab protocol and class participation

Grading Rules

1. Of the seven assignments assigned, the lowest score assignment will be dropped for each student. Best six assignment grades will be counted.
2. Students are expected to work independently on all homework assignments and exams per honor code. Collaboration on homework is permitted, but each student must do his/her own work.
3. All assignments are due on Friday mornings 10AM, unless otherwise specified. Late assignments will not be accepted. Please talk to Prof. Awtar in case of an emergency.
4. Projects are team-oriented. Peer-evaluations will be considered in determining project grades for individual team members, and will be administered three times during the course of the semester.
5. Students are encouraged to discuss their grades with the instructor as frequently as needed. The student is always given the benefit of the doubt in all grade discussions and every effort will be made to find ways to help a student improve his/her grade throughout the semester.

Design Projects

Design Project 1: Golf-club Swinging Mechanism

In this project your team is tasked with constructing a mechanism to test golf clubs using the synthesis techniques covered in the course. You will then analyze and evaluate your design using commercial multi- body dynamics software while using your CAD package of choice to perform detailed design development. Your team will then fabricate a prototype of your design which will be used in a class competition for maximum distance and repeatability.

Design Project 2: Inverted Pendulum Balancing System

In this project, your team will be provided with a kit of mechanical, electrical and electromechanical components. Your tasks will include mechanical assembly, electrical assembly and wiring, and interfacing the system with a computer equipped with National Instruments PCI Data Acquisition Cards. You will create a thorough dynamic model the system in ADAMS and compare the model/simulation with the actual experimental performance.

Machine Shop Training and Protocol

For Project 1, all students will use the GG Brown Machine Shop (run by Bob Coury) to build and assemble their hardware. Machine shop training is mandatory for every student before he/she is allowed to use any of the two facilities.

Machine shop training is scheduled in the first two week of classes and will be discussed in your Recitation sections. If you miss this training, there will be no makeup sessions, and you will be unable to work on Project 1. Also, note that it is assumed that you have had the ME250 training before you enrolled in this class. If you did not take ME250 at the University of Michigan and therefore need ME250 training, please contact your GSI immediately. Also, note that there is no substitute for the ME350 training in the GGBrown machine-shop. Any training in other machine shops within or outside the university is not acceptable as a substitute.

Machine shop rules and protocols have to be followed at all times while accessing and working in the machine shops. Detailed instructions have been posted on Ctools and every student is required to read and understand these rules. Failure to follow machine shop rules will result in temporary or permanent loss of shop privileges. Lab and machine-shop protocol carry 5% of the overall course grade.

'X50 Mechatronics Lab (GGB 1089)' Access and Protocol

For Project 2, all students and teams will make use of the X50 Mechatronics Lab (GGB1089). Students will have access to this lab during their regular recitation hours. Extra hours request may be made to the GSIs. Every effort will be made to accommodate the needs and schedules of students. Students should always work in this lab under the supervision of the GSI or instructor. Detailed lab rules and instructions (including safety instructions) have been posted on Ctools and every student is required to read and understand these rules. Failure to follow lab rules will result in temporary or permanent loss of lab privileges. Lab and machine-shop protocol carry 5% of the overall course grade.

Team-Work

Success in this course depends heavily on teamwork. Students will be assigned to groups of four that will work together the entire semester. It is expected that the students within a team will work together on homework, projects and in-class activities. It is not unusual for team's to experience some conflict during the semester. What is important is that the teams deal with this in a positive and constructive manner. Teams having problems working together should make every effort to resolve them by themselves. The course instructors and GSIs will be available to help and facilitate smooth team operation, but the end responsibility lies with the team.

Solid-Modeling and Engineering Drawings

This course will make extensive use of solid-modeling for design generation, presentation, and communication. After preliminary brain-storming using hand-sketches, and analyses using Lincages and ADAMS, all teams are expected to create detailed solid models of their designs.

These solid models will also be used to generate engineering drawings that are necessary before starting any fabrication in the machine shops. The final report will also require solid models and engineering drawings. Students are free to use any solid modeling software of their choice.

Modeling and Simulation Tools

This course will utilize Matlab (or other Math software), ADAMS and Linkages to model, simulate and design mechanical and electromechanical systems. Tutorials and training material will be provided. All computers in the CAEN labs have the latest versions of these software.

Experimental Tools

All sensor and actuator interfacing in this course will be carried out using National Instrument's hardware (PCI DAQ cards) and software (LabView). All computers in the X50 Mechatronics Lab are equipped with PCI -6230 DAQ cards that provide a variety of analog and digital inputs/outputs. All computers in the X50 Mechatronics Lab as well as CAEN clusters have the latest versions of National Instruments software. Detailed step-by-step tutorials will be provided for all aspects of LabView that are needed in this course.

Course Web-site

An 'ME350 W08 ctools' site has been set up for this course, and all students currently enrolled and on waiting list have been given access. If you drop this course and would like to be removed from this site, please send an email to the instructor or GSI. All course material (lectures, lab exercises, handouts, manuals, datasheets, tutorials, etc.) will be posted on this site. Students are expected to visit this site frequently to stay up to date with the course material and any pertinent announcements.

Class Attendance and Participation:

Attendance in ALL lectures, recitations and labs are mandatory and class participation is strongly encouraged. The course schedule does not permit any make-up sessions for missed a missed lecture/recitation/lab. In case of an emergency, please notify the instructor(s) or GSI in advance. Student feedback is vital to the effectiveness of this class. Comments, suggestions and feedback from individual students or student groups are welcome throughout the semester.

Academic integrity is a key component of the educational process. All students should familiarize themselves with the College of Engineering Honor Code (http://www.engin.umich.edu/students/honorcode/code/index.html). The Honor Code process in the College provides for a fair and uniform application of sanctions against students who violate our community standards, as well as providing an opportunity for transgressors to learn from their unacceptable behavior. Please contact the instructor(s) for any clarification.