Design & Manufacturing
Mechanical Engineering
University of Michigan

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Design and Manufacturing I

ME250 – Winter 2014

Course description

Creating and making things is what engineers do. Students in ME250 develop engineering thinking and basic mechanical engineering skills in design and manufacturing. We study design processes, CAD and engineering drawings, free-hand sketching and ideation techniques, material selection, mechanical elements (e.g., gears, bearings, springs, motors), manufacturing processes, hands-on machine tool practice, and prototype fabrication. Lectures address these topics and skills using theory and in-class exercises, and laboratory sessions provide additional practice. Students integrate their thinking and skills in a semester-long team project involving the conceptualization, design, analysis, and fabrication of remote-controlled vehicles that can compete in the "M-Ball" game. Project work leads to a series of competitive matches, with the Final Four M-Ball games taking place during the College of Engineering Design Expo at the end of the semester.

Lectures include in-class individual and team work. Laboratory sections include instruction and practice in CAD modeling (SolidWorks), free-hand sketching, machine shop fabrication (including drilling, milling, turning, laser/waterjet cutting), and they provide ample time for ad-hoc design reviews , "Design Workshops" and individual discussions, with the instructors. Each team receives the same kit of materials and components, rules governing the size and capability of the machines, and the parameters of the game.

During the first half of the semester, students learn to apply a rigorous design process to quantitatively and qualitatively compare design options, and to justify their choices. After the midterm design review presentation, the students proceed to the detailed design of their machine, and develop and present engineering drawings before beginning fabrication. Milestones and risk assessments are emphasized to guide the teams along the intense pace of the course toward a successful and exciting fulfillment of their goals!

Active participation in the lectures and laboratory sessions is mandatory and a significant part of the final grade.

Course goals

1. Experience a design process that encompasses creative engineering thinking grounded on analysis and good sense.
2. Learn to visualize parts and assemblies in 2D and 3D, to communicate design ideas using free-hand sketching, CAD models, engineering drawings with appropriate dimensions, tolerances, and specifications, and to document work in technical reports.
3. Learn fundamental design principles, become familiar with basic materials and mechanical elements, and learn the practice and limitations of basic prototyping and manufacturing tools.
4. Learn to assess and manage project risks, milestones and schedules, and develop team collaboration and leadership skills.
5. Attain a professional demeanor, appreciate safe shop practices, and maintain high ethical standards.
6. Develop systems thinking and integrate a diversity of skills in a challenging and fun open-ended design project.

Lectures

Tu/Th, 9:00-10:30am, Stamps Auditorium (Walgreen Drama Center, North Campus). Full and on-time attendance is required.

Laboratory Sections

- M/W, 9:30-5:30 (1-hour sections begin every hour at XX:40)
- **CAD** sessions will be in room **1620A Beyster (BBB Building)**
- **DW** (Design Workshop)/project sessions in the **ME250 shop (Room 1185 GGB)**

Machine shop, 1119 GGB (for training and project work)

- M-F 8am-5pm. Extended hours will be announced during the project period.
- You will be permitted to work on your ME250 project in the ME machine shop starting **Monday, March 17th.**
- You may not work in the machine shop until you have completed training and the mill/lathe exercises (see below).

Attendance policy

- You must attend lectures and lab sessions, and arrive on time. If you must miss a lecture or lab, please inform your section GSI ahead of time.
- You must behave professionally during lecture and lab sessions; the use of mobile devices should be only for course purposes.
- **If you reserve a time slot in the machine shop and miss your reservation, this will negatively influence your team's project grade.**

Your attendance will have influence on your grade.

Assignment and grading policy

- Late assignments will not be accepted unless you have made prior arrangements.
- Questions on assignment scores must be brought to the attention of staff within one week after the assignment is returned. Write your question on a sheet of paper and staple it to the front of the assignment.
- Lecture (in-class) assignments must be completed on your own, with no discussion with your classmates, unless instructed otherwise.
- Homework assignments must be completed on your own. However,
  - You are encouraged to discuss the subject matter with your classmates but you must independently formulate your solution.
  - You may not compare your solution with your classmates.
  - You must submit the solution individually.
- Collaboration and discussion of solutions to the design milestones (MS) is encouraged, although you, or your team, must individually prepare and submit your work. It is quite obvious to the staff when your submission does not reflect your independent thought and analysis!

Violation of this policy is violation of the honor code (http://www.engin.umich.edu/students/honorcode/) and may be grounds for initiating action before the College of Engineering's Honor Council. If you have any questions about this policy, please contact the staff.

Lab safety

- Safe use of the ME 250 lab facilities and equipment is a primary concern and responsibility of ALL users. Everyone must follow the safety and equipment procedures without fail. Please carefully read the shop rules, to be distributed by the technicians.
- Everyone without exception must take four training sessions for the machine shop (cutting/drilling, milling, turning, and precision measurement). This requires online registration as described during the first lecture. **You must provide documentation of your training before the design review or you will**

automatically receive a grade of zero for the project, i.e., you will fail the class. When coming to the training sessions, enter the machine shop through room **1119 GG Brown**.

Important Dates

January 24 (Fri)	Deadline to finish machine shop training
January 27 (Mon)	Project Teams are formed
February 13 (Thu)	Exam 1 (Individual, during class time)
February 24 and 26 (Mon/Wed)	Project Design Review
March 17 (Mon)	Building machine in ME shop starts
March 27 (Thu)	Exam 2 (Individual, during class time)
April 16 (Wed)	Performance test of machines, and Shipping Day (Machines inspected and locked until Expo)
April 17 (Thu)	M-Ball Contest at Design Expo
April 22 (Tue)	Final report due

Note: *The ME250 schedule and list of assignments (Google spreadsheet) is the official reference for due dates. Any changes to due dates will be reflected there, and no new syllabus will be distributed.*

Course materials

- Notes and readings via http://ctools.umich.edu, MECHENG 250 001 W14
- Coursepack: The ME250 Coursepack, available from Dollar Bill Copying on Church Street for $34.25, is required. A coursepack from a previous semester is acceptable.

Schedule and list of assignments (including due dates)	http://bit.ly/19F5BBC
Kit contents	http://bit.ly/WdIByr
Rules of the M-BALL game	http://bit.ly/1dnbZhZ
Control system documentation	http://bit.ly/WJO54F
Suggested suppliers for extra components	http://bit.ly/92baHI
Office hours	http://bit.ly/1eCP0hK

Peer Evaluations

Confidential peer evaluations will be completed after the design expo, and can contribute from 0% to 10% to your individual course grade. If you contribute ≈equally, you will get 50 points; thus, in this nominal case the peer evaluation will not affect your grade. Your peer evaluation score will be assigned based on your % contribution to the project, which will be calculated as the average of the scores reported individually by your team members (including yourself). If there is a significant disparity in effort on your team, please make the staff aware of the issue as early as possible. For a 4-person team, the points will be assigned as follows:

% contribution	points
<15%	0
15-16.5	10
16.5-18	20
18-20	30
20-23	40
23-27	**50**
27-30	60

30-32	70
32-33.5	80
33.5-35	90
>35	100

Teams of 3 students will be evaluated by the staff on a case-by-case basis, recognizing that the load is greater than a 4-person team. *We cannot predict the grade distribution; however, based on past semesters it is likely that a 5% difference in your total course grade will make a difference of one or two letter grade steps.*

If you do not submit your evaluation, you will receive zero points for your peer evaluation score for that segment of the course.

Grading

Homework assignments 10 %

- See "Assignment and grading policy" above

Exam 1 15 %

Exam 2 15 %

Design Project 60 %

- Milestones 1-4, design process 10 %
- Milestone 5, design review 15 %
- Milestones 6-9, engineering + manufacturing 10 %
- Machine (milestone 10) 10 %
- Final report 10 %
- Peer evaluations 5 %

Lab attendance will also have an impact on your grade. Missing a lab section (without prior approval from the instructors) will negatively affect your grade.

Note: We cannot predict the grade distribution; however, based on past semesters it is likely that a 5% difference in your total course grade will make a difference of one or two letter grade steps.

Instructional staff

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ME250 Schedule and Assignments, Winter 2014

week	Date		Lectures #	Instructor	Topic	Labs #	Topic	Assignments - individual	Assignments - team	Machine Shop (outside of class hours)
1	9-Jan	Th	1	MU	**Course introduction, logistics, safety, project description**					
2	13-Jan	M				1	DW (Design Workshop) 1: Strategies; begin to submit team preferences	Strategies (draft for discussion)		Machine Shop Training: (Lathe, Mill, Cutting/Drilling, and Measurement)
	14-Jan	Tu	2	MU	The design process, concept sketching, free-body diagrams					Machine Shop Training: (Lathe, Mill, Cutting/Drilling, and Measurement)
	15-Jan	W				2	CAD 1	MS1: Strategies (final, w/peer-review)		Machine Shop Training: (Lathe, Mill, Cutting/Drilling, and Measurement)
	16-Jan	Th	3	MU	Orthographic drawings and pictorial drawings					Machine Shop Training: (Lathe, Mill, Cutting/Drilling, and Measurement)
3	20-Jan	M				-	*no lab -- MLK Day*			Machine Shop Training: (Lathe, Mill, Cutting/Drilling, and Measurement)
	21-Jan	Tu	4	MU	Materials and intro to mechanical elements, via the kit					Machine Shop Training: (Lathe, Mill, Cutting/Drilling, and Measurement)
	22-Jan	W				3	CAD 2; last day to submit team preferences	HW1: Orthographic views and pictorial views		Machine Shop Training: (Lathe, Mill, Cutting/Drilling, and Measurement)
	23-Jan	Th	5	MU	Analysis: Statics; Gears, pulleys, belts, chains					Machine Shop Training: (Lathe, Mill, Cutting/Drilling, and Measurement)
4	27-Jan	M				4	DW 2: Strategy Selection, and team confirmation			Lathe or Mill Exercises
	28-Jan	Tu	--	MU	---Snow Day---					Lathe or Mill Exercises
	29-Jan	W				5	CAD 3	MS2: Strategy Selection		Lathe or Mill Exercises
	30-Jan	Th	6	MU	Bearings and wheels					Lathe or Mill Exercises
5	3-Feb	M				6	DW 3: Analysis (for DR)	HW2: CAD, Analysis (Statics)		Lathe or Mill Exercises
	4-Feb	Tu	7	MU	Electric Motors and control system					Lathe or Mill Exercises
	5-Feb	W				7	CAD 4			Lathe or Mill Exercises
	6-Feb	Th	8	MU	Springs and power screws				MS3: Team strategy; concept identification	Lathe or Mill Exercises
6	10-Feb	M				8	DW 4: Distribute kits, continue analysis; mockups			Lathe or Mill Exercises
	11-Feb	Tu	9, 10	MU	Sectional Views; Exam review			HW3: Machine Elements; Analysis: Dynamics		Lathe or Mill Exercises
	12-Feb	W				9	Waterjet and laser cutting			Machine shop closed; laser cutter training only.
	13-Feb	Th	-	MU/GSI	**Exam #1 (lectures 2-8): individual**					Lathe or Mill Exercises
7	17-Feb	M				10	DW5: Grading of MS4. Design review prep, mockups		MS4: Concept selection and module identification	Lathe or Mill Exercises
	18-Feb	Tu	11	KS	Dimensioning, tolerances					Lathe or Mill Exercises
	19-Feb	W				11	CAD 5: Drawings			Lathe or Mill Exercises
	20-Feb	Th	12	KS	Statistical tolerances					Lathe or Mill Exercises
8	24-Feb	M				12	**Midterm design review**		MS5: DR (Design Review)	Lathe or Mill Exercises
	25-Feb	Tu	13	KS	Machining processes					Lathe or Mill Exercises
	26-Feb	W				-	**Midterm design review (continued)**		MS5: DR continued	Lathe or Mill Exercises
	27-Feb	Th	14	KS	Fasteners and couplings					Lathe or Mill Exercises
	28-Feb	Fr						HW4: Lec 11, 12		
-	3-Mar	M				-	*No classes -- spring break*			Lathe or Mill Exercises
	4-Mar	Tu	-		*No classes - spring break*					Lathe or Mill Exercises
	5-Mar	W				-	*No classes -- spring break*			Lathe or Mill Exercises
	6-Mar	Th	-		*No classes - spring break*					Lathe or Mill Exercises
	7-Mar	Fri								
9	10-Mar	M				13	Bike Lab			Lathe or Mill Exercises
	11-Mar	Tu	15	KS	Polymer shaping processes; Machine shop protocols					Lathe or Mill Exercises
	12-Mar	W				14	Motor lab part I		MS6: Most Critical Module (MCM) engineering complete: solid model, part drawings, bill of materials	Lathe or Mill Exercises
	13-Mar	Th	16	KS	Casting					Must submit lathe and mill exercise parts no later than today.
	14-Mar	Fri						HW5: Lec 13, 14, 15		
10	17-Mar	M				15	Motor lab part II		HW6: Bike lab	
	18-Mar	Tu	17	KS	Bulk deformation processes					
	19-Mar	W				16	Project Work		MS7: 3 manufactured parts	
	20-Mar	Th	18	KS	Sheet metal forming					
	22-Mar	Fr								
11	24-Mar	M				17	Project Work		HW7: Motor lab	
	25-Mar	Tu	19	KS	Rapid prototyping (by Toby Donajkowski) & Exam Review			HW8: Lec 16, 17, 18		
	26-Mar	W				18	Project Work			
	27-Mar	Th	-	KS/GSI	**Exam 2 (lectures 11-18): individual**					
	28-Mar	Fri								
12	31-Mar	M				19	Project Work			
	1-Apr	Tu	-	-	No lecture					
	2-Apr	W				20	Project Work		MS8: MCM progress; ALL engineering complete	
	3-Apr	Th	-	-	Guest Lecture from Shell, and Marshmallow Challenge activity					
	4-Apr	Fri								
13	7-Apr	M				21	Project Work			
	8-Apr	Tu	-	-	No lecture					
	9-Apr	W				22	Project Work		MS9: Machine almost done	
	10-Apr	Th	-	-	No lecture					
	11-Apr	Fri								
14	14-Apr	M				23	Project Work			
	15-Apr	Tu	-	-	No lecture					

ME250 Schedule and Assignments, Winter 2014

week	Date		Lectures #	Instructor	Topic	Labs #	Topic	Assignments - individual	Assignments - team	Machine Shop (outside of class hours)
	16-Apr	W				24	Test of machine performance		MS10: Final machine (Score is based on prototype design and manufacturing, not contest performance); also team video is due	
	17-Apr	Th	-	-	Project Competition @ CoE Design Expo!					
	18-Apr	Fri							3D Printing (Rapid Prototyping) part and answers to questions	
15	21-Apr	M				-	No lab	Peer Evaluation		
	22-Apr	Tu	-						Project Final report	