ENG ME 360 Product Design
Spring 2019

Instructor

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Office hours by appointment

Teaching Assistant(s)

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Class Meeting Places and Times

Section A3	MW	12:20 pm – 2:05 pm	Room EMA 215
Section A4	TR	9:00 am – 10:45 am	Room EMA 215

Catalog Course Description:

The course focuses on the use of engineering principles, simulation and physical models in product design. Hands-on exercises allow students to propose solutions to practical problems and to develop their ideas through the construction and testing of physical prototypes. Topics include Arduino sensing and control, mechanical metrology, principles of efficient mechanical design, manufacturing techniques, CAE tutorials for product simulation and prototype testing. (4 cr., 1st sem.)

Prerequisites

Students enrolled in ME 360 must have completed ME 359, Computer Aided Design and Machine Components.

Extended Course Description

ME360 Product Design is a project-based course, in which the instructional objectives are achieved through hands-on assignments that emphasize the application of theoretical knowledge to the solution of practical problems.

The course is aimed at developing practical skills and judgement that will enable students to predict the behavior of systems with varying degrees of complexity, to modify such behavior through design decisions and to explain and eliminate deviations from the intended behavior through analysis and design.

The first sessions of the course are dedicated to basic communication using sketches and measurements to produce components with a desired geometry. Students develop the skills required to extract information from an existing component, represent it in sketches and drawings and communicate it to workshop personnel in order to manufacture a mating component that is constrained by the geometry of the original one.

The Arduino UNO platform is used to provide basic skills for the use of sensors and actuators and to allow the students to implement control functions in electromechanical systems. Basic electronics and programming skills are taught to allow students to achieve the practical goals of the projects, and to prepare them for subsequent design courses in which a deeper knowledge of electromechanical systems is developed.

The use of CAE tools for the design of mechanical components and systems supplements the knowledge acquired in basic engineering courses, and it facilitates the study and design of complex geometries and architectures that are difficult to analyze using analytical methods. Students are trained in the use of software for the thermal and elastic analyses of mechanical components, the design and analysis of multi-body systems and the evaluation of hydrodynamic drag forces on complex geometries. They apply the acquired skills in the design and construction of physical systems.

This course constitutes a link between the fundamental, analysis-based, engineering courses and the higher-level, synthesis-based, design courses in the Mechanical Engineering curriculum.

Course Outcomes:

Students successfully completing ME 360 will:

1 Communicate with peers, instructors and technicians using sketches, drawings, presentations, text and multimedia tools, to facilitate the accurate interpretation of ideas and the manufacture of physical components and devices.

2 Be able to design mechanical components given geometrical and motion constraints, such as dimensions, tolerances and degrees of freedom.

3 Apply knowledge of manufacturing processes to the design of mechanical components and joints.

4 Make use of CAE tools to support design decisions.

5 Design systems that require the integration of mechanical, electrical and control components.

Course topics:

1. Communication
    a. Sketching
    b. Design portfolio
    c. Public presentations

2. Component manufacturing
    a. CNC machining
    b. Thermoforming
    c. Additive manufacture (Fused deposition modelling)
3. Computer aided engineering
    a. Mechanical component shaping using FEA
    b. Multi-body system dynamics
    c. Flow simulation
4. Fundamentals of sensing, control and actuation
    a. Basic electronics
    b. Sensors
    c. Actuators
    d. Arduino IDE programming
5. Design project 1: Fundamentals of motion control
    a. Application of multi-body dynamics simulation to a 2.5 DOF motion system
    b. Joint design and manufacture
    c. Use of microprocessors for open loop motion control
    d. Testing and troubleshooting
6. Design project 2: Fundamentals of electromechanical system integration (6)
    a. Use of CFD for component shaping
    b. Electromechanical system integration
    c. Testing and troubleshooting

Courseware

Course reading material and assignments will be distributed online through Blackboard Learn.

Assignments and Grading

Assignment	**Grade %**
Metrology project: CNC gasket	10
Ergonomic design: Hot wire tool	10
Arduino interface project: PC controller	10
Mechanism synthesis: container door design	2
Motion control: 2.5 DOF system	30
Electromechanical integration project: RC boat	25
Design portfolio	13

Course grades will be computed by multiplying the total Grade % for all assignments by a factor from 0-1 that will be determined based on each student's attendance and participation in class exercises.

Resources

- Graduate Student Teachers will be available to support teams in prototyping, Arduino programming and use of CAD tools.
- Simulation tutorials will be taught in either the ECL or the Mechanical Engineering CAD lab.

Each team will be assigned a container to store components and equipment used in the course projects. Each team is responsible for the container and its contents. The containers shall not be damaged or modified in any way and shall be returned to the classroom at the end of the course.

Academic Behavior Standards

Your behavior in this course is bound by the Boston University Academic Conduct Code found at the website http://www.bu.edu/academics/academic-conduct-code. You are responsible for understanding the requirements of this code. If you are in doubt about whether any contemplated action in the course would violate the code, ask your instructor before doing it. Since this course has few objective exams, opportunities for cheating are reduced, but any work presented as your own must in fact be your own, and any work quoted or otherwise reused from others must be explicitly acknowledged. The source of images included in reports or presentations must be referenced.

Attendance and Team Contribution:

Students will receive no credit for in-class exercises in which they do not participate. There will be no opportunity to make-up for missed class exercises.
Team projects will receive a project grade. Each team member will be awarded a percentage of that grade based on her/his participation in the project. The percentage will be determined based on peer and instructor assessments.

Members are expected to inform their peers in a timely manner if unavoidable circumstances prevent their participation in scheduled team meetings. Team assignments will require all students to identify their unique contribution. Non-contribution to the team's progress will result in a failing grade for a given assignment, and sustained non-contribution, after warning, will result in a failing grade in the course.

Course Calendar

Session No.	A3: MW	A4: TR	TOPIC/ACTIVITY
1	23-Jan	22-Jan	Sketching, Ideation exercise
2	28-Jan	24-Jan	Metrology project: gasket
3	30-Jan	29-Jan	Ergonomics, clay, hand tool project: Hot wire tool
4	4-Feb	31-Jan	Work on hot wire tool
5	6-Feb	5-Feb	Arduino basics
6	11-Feb	7-Feb	Arduino advanced

7	13-Feb	12-Feb	Analysis of mechanisms: tutorial
8	19-Feb	14-Feb	Synthesis of mechanisms: tutorial
9	20-Feb	21-Feb	Linear drive, 2.5D kickoff
10	25-Feb	26-Feb	Project work: 2.5D, team meetings
11	27-Feb	28-Feb	Project work: 2.5D, team meetings
12	4-Mar	5-Mar	Project work: 2.5D, team meetings
13	6-Mar	7-Mar	Progress presentations, 2.5D
14	18-Mar	19-Mar	2.5D control (Reprap, Inkscape)
15	20-Mar	21-Mar	Project work
16	25-Mar	26-Mar	Project work
17	27-Mar	28-Mar	Project work
18	1-Apr	2-Apr	Open day exhibition
19	3-Apr	4-Apr	Project kickoff: boat
20	8-Apr	9-Apr	Flow simulation
21	10-Apr	11-Apr	Arduino advanced: power
22	17-Apr	16-Apr	Project work: boat, team meetings
23	22-Apr	18-Apr	Arduino advanced: wireless control
24	24-Apr	23-Apr	Project work: boat, team meetings
25	29-Apr	25-Apr	Project work: boat, team meetings
26	1-May	30-Apr	Boat race and course evaluations
27		2-May	Make-up work