ME 360 Electromechanical Design

ENG ME 360 - Electromechanical Design
Fall 2022

Instructor
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Office hours by appointment

Teaching Assistant(s)
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Office hours : MR 9 :00-11 :00 a.m.

Class Meeting Places and Times

Section A1	MW	6:30 pm – 8:15 pm	Room ENG 302
Section A2	TR	6:30 pm – 8:15 pm	Room ENG 302

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, principles of electromechanical design, CAE tutorials for system simulation and prototype testing. (4 cr., 1st sem.)

Prerequisites

Students enrolled in ME 360 must have completed ME 357, 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 problem definition and basic communication using sketches.

The design of components and systems with varying degree of complexity is taught using a combination of demonstrations, tutorials and design exercises. Systems include structures, mechanisms, machines and electromechanical systems, in which concepts of different types of design tools and concepts are applied: static, kinematic, dynamic and electrical simulation, construction and troubleshooting.

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 workshops 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
   Sketching, Problem definition
   Ideation and graphic communication assignment

2. BASIC MOTOR CONTROL
   Arduino platform: programming, analog and digital signals
   Sensing, Control and power signals, Data acquisition and processing

3. CLOSED LOOP CONTROL
   PID control
   Motor sizing, Motor control

4. MECHANISMS
   Analysis, Synthesis, Prototyping

5. DESIGN PROJECTS
   Conceptual design, Linear stages, Mechanical subsystem and Electrical subsystem

Courseware

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

Assignments and Grading

Assignment/project	Grade %
Gasket project	10
Design project 1	35
Design project 2	25
Mechanism design	15
Design portfolio	15

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.

Resources

Teaching assistants will be available to support teams in prototyping, Arduino programming and use of CAD tools.

Each team will be assigned a container to store components and equipment used in the course projects. The teams are responsible for the containers and their 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 – Section ENG ME360 A1, MW 6:30-8:15 pm.

Session No.	Date	MODULE	Topic
1	9/7	IDEATION AND COMMUNICATION	Sketching
2	9/12		Metrology
3	9/14	POWER AND CONTROL	Arduino basics
4	9/19		Servo, DC
5	9/21		Stepper motor control
6	9/26		MKS Base
7	9/28	2.5 DOF PROJECT	Kickoff, machine components
8	10/3		Linear stage design
9	10/5		Linear stage demonstrations
10	10/11		Team meetings
11	10/12		Team meetings
12	10/17		Team meetings
13	10/19		Team meetings
14	10/24		Team meetings
15	10/26		Team meetings
16	10/31		Prototype troubleshooting and setup
17	11/2		Prototype testing day
18	11/4	CLOSED LOOP CONTROL	PID controllers
19	11/7		DC motor PID control
20	11/9		Team meetings
21	11/14		Team meetings
22	11/16		Team meetings
23	11/21		Prototype testing day
24	11/28	MECHANISMS	DOFs, joints, basic mechanism simulation
25	11/30		Multi-body simulation
26	12/5		Synthesis of mechanisms
27	12/7	FINAL PROJECT DEMOS	Closed loop control project demos
	12/12	DESIGN PORTFOLIOS DUE	

Course Calendar – Section ENG ME360 A2, TR 6:30-8:15 p.m.

Session No.	Date	MODULE	Topic
1	9/6	IDEATION AND COMMUNICATION	Sketching
2	9/8		Metrology
3	9/13	POWER AND CONTROL	Arduino basics
4	9/15		Servo, DC
5	9/20		Stepper motor control
6	9/22		MKS Base
7	9/27	2.5 DOF PROJECT	Kickoff, machine components
8	9/29		Linear stage design
9	10/4		Linear stage demonstrations
10	10/6		Team meetings
11	10/13		Team meetings
12	10/18		Team meetings
13	10/20		Team meetings
14	10/25		Team meetings
15	10/27		Team meetings
16	11/1		Prototype troubleshooting and setup
17	11/3		Prototype testing day
18	11/8	CLOSED LOOP CONTROL	PID controllers
19	11/10		DC motor PID control
20	11/15		Team meetings
21	11/17		Team meetings
22	11/22		Prototype testing day
23	11/29	MECHANISMS	DOFs, joints, basic mechanism simulation
24	12/1		Multi-body simulation
25	12/6		Synthesis of mechanisms
26	12/8	FINAL PROJECT DEMOS	Closed loop control project demos
	12/12	DESIGN PORTFOLIOS DUE	