ENG ME 360 - Electromechanical Design
Fall 2024

Instructor

Dr. Enrique S. Gutierrez Wing (esgw@bu.edu)
110 Cummington Mall, room ENG 404
Office hours : BY APPOINTMENT ONLY, Tuesdays and Thursdays 10:00 - 14:00

Dr. Pavan Bhavsar (pbhavsar@bu.edu)
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Office hours : BY APPOINTMENT ONLY, Tuesdays and Thursdays 15:00 - 17:00

Franco Julia Wise (francojw@bu.edu)
Room EMA 307
Office hours : Monday 5-6pm

Class Meeting Places and Times

Section A1, Gutierrez Wing	MW	8:00 am – 9:45 am	Room ENG 302
Section A2, Bhavsar	TR	6:30pm – 8:15 pm	Room ENG 302

Catalog Course Description:

The course focuses on the use of engineering principles, simulation and physical models in electromechanical systems 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.

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 analysis of mechanical components and multi-body systems. 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, Metrology
   Manufacture assignment

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

3. MULTI-DOF MOTION CONTROL
   Conceptual design, Linear stages, Mechanical subsystem and Electrical subsystem

4. CLOSED LOOP CONTROL
   PID control
   Multibody dynamics simulation
   Motor sizing, Motor control

Courseware

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

Assignments and Grading

Assignment/project	**Grade %**
Assignments and class exercises	35
Design projects	50
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 (see next section).

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.

Peer assessments:

At the end of each team project, you will receive a peer assessment form, in which you will describe the contributions from each team member to the collective effort. This feedback will allow the instructor to assign credit individually to each team member, based on each student's contributions.

Team members with diminished participation in team projects will be allowed to make up part of the project credit through a final evaluation which will be given on the last day of the course.

If you encounter problems regarding your team's dynamics, notify the instructor immediately, so that adjustments can be made to ensure you get the best chance to succeed in the projects.

Late work:

Your coursework must be submitted by the deadline in order to be considered for full credit. Submissions after the deadline are only allowed if written notification has been given to the course instructor before the due date and you have received written approval to submit after the deadline. Late work will incur a penalty of minimum 20% for each calendar day you delay your submission.

Absences:

Notify the course instructor before any planned absences and provide a written justification for them before your absence day. For unforeseen absences, such as due to illness, submit a written notice from your primary care physician to the course instructor.

Course Calendar – Section A1 (MW 8:00-9:45 am)

Session	Date	Module	Topic
1	9/4	IDEATION AND COMMUNICATION	Intro/Sketching/Metrology
2	9/9		Gasket measurements
3	9/11		GibbsCAM workshop
4	9/16	STEPPER MOTOR CONTROL	Arduino basics
5	9/18		Stepper motor control
6	9/23	2.5 DOF PROJECT	Linear stage design
7	9/25		MKS base control
8	9/30		Linear stage demonstrations
9	10/2		Torque, force and multibody simulation
10	10/7		Team meetings
11	10/9		Team meetings
12	10/15		Team meetings
13	10/16		Team meetings
14	10/21		Team meetings
15	10/23		Team meetings
16	10/28		Team meetings
17	10/30		Prototype troubleshooting and setup
18	11/4	PROJECT DEMOS	Prototype testing day
19	11/6	CLOSED LOOP CONTROL	PID controllers
20	11/11		DC motor PID control
21	11/13		Project intro, simulation
22	11/18		Team meetings
23	11/20		Team meetings
24	11/25		Team meetings
25	12/2		Team meetings
26	12/4	PROJECT DEMOS	Testing day
27	12/9		Final evaluation
	12/13	DESIGN PORTFOLIOS DUE	

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Course Calendar – Section A2 (TR 6:30-8:15 pm)

Session	Date	Module	Topic
1	9/5	IDEATION AND COMMUNICATION	Intro/Sketching/Metrology
2	9/10		Gasket measurements
3	9/12		GibbsCAM workshop
4	9/17	STEPPER MOTOR CONTROL	Arduino basics
5	9/19		Stepper motor control
6	9/24	2.5 DOF PROJECT	Linear stage design
7	9/26		MKS base control
8	10/1		Linear stage demonstrations
9	10/3		Torque, force and multibody simulation
10	10/8		Team meetings
11	10/10		Team meetings
12		Schedule during office hours	Team meetings
13	10/17		Team meetings
14	10/22		Team meetings
15	10/24		Team meetings
16	10/29		Team meetings
17	10/31		Prototype troubleshooting and setup
18	11/5	PROJECT DEMOS	Prototype testing day
19	11/7	CLOSED LOOP CONTROL	PID controllers
20	11/12		DC motor PID control
21	11/14		Project intro, simulation
22	11/19		Team meetings
23	11/21		Team meetings
24	11/26		Team meetings
25	12/3		Team meetings
26	12/5	PROJECT DEMOS	Testing day
27	12/5		Final evaluation
	12/10	DESIGN PORTFOLIOS DUE	