ENG ME 460 Senior Design I
(Fall 2019)

Instructors:

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Prof. William Hauser
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Graduate Student Teacher(s)

Nicholas Milkovich
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Class Meeting Places and Times

A1	MW	10:10 AM	11:55 AM	EMA	215	Gutierrez
A2	MW	12:20 PM	2:05 PM	EMA	215	
A3	TR	1:30 PM	3:15 PM	EMA	215	
A4	MW	10:10 AM	11:55 AM	EPC	206	Hauser
A5	MW	12:20 PM	2:05 PM	EPC	206	
A6	TR	1:30 PM	3:15 PM	EPC	206	

Course Website:
Blackboard Learn. The website contains a main folder with information applicable to all sections and separate folders for information that professors Gutierrez-Wing and Hauser may create for their individual sections.

Catalog Course Description:
The course develops skills that are crucial to the successful completion of the Senior Capstone Design project. The core technical framework is electro-mechanical systems. Through lectures, workshops, and online materials, students gain practical experience in component and system design, project planning, and engineering communications. The course guides students through execution and documentation of the conceptual design stage of their Capstone projects. (4 cr., 1st sem.)

Prerequisites:
Students enrolled in ME 460 must have completed ME 302, Mechanics II; and ME 360, Product Design. Students wishing to undertake an aerodynamics capstone project must have completed or be concurrently enrolled in ME 408, Aircraft Performance and Design.

Extended Course Description:
ME 460 is the first semester of a two semester sequence (ME460/ME461). During the first semester students complete the definition of requirements for the senior capstone design project. Most assignments, both those directly related to the teams' own projects, and those related to developing competencies more generally, will be completed collaboratively within the capstone teams.

The overall objective of the ME460/ME461 sequence is the completion of the capstone project. ME460 develops skills that are crucial to the successful completion of the project. The importance of your interaction with customers, peers, and technicians is emphasized through lectures, discussion, and class exercises that immerse you in realistic scenarios, with many of the design challenges discussed drawn from capstone projects of previous years.

The technical component of the course (math and physics based) will support your work in both the preliminary and the detail design stages. Lectures and assigned readings will expose you to principles, tools, and practices of electro-mechanical design. In-class experiential learning, through hands-on contact with the hardware, and short exercises, will reinforce these concepts.

As the term progresses, the emphasis will shift from the mastery of technical concepts to formulating the conceptual design and project plan for the teams' capstone projects (to be completed in the spring semester in ME461). The final deliverable of the Fall term will be an oral presentation and written report of the conceptual design.

Course Outcomes:

Students successfully completing ME 460 will have:

1 Gained appreciation for the breadth of knowledge, skills, and effort required to solve complex engineering problems within technical, economic, and societal constraints.

2 Applied engineering principles and methods to the design, selection and integration of electro-mechanical system components.

3 Developed an ability to design, understand, and troubleshoot systems that comprise mechanical, electrical, and control hardware.

4 Established the stages and activities of a design project and made objective estimations of the required resources.

6 Developed skills required to communicate effectively with a variety of constituencies, technical and non-technical, in a variety of scenarios associated with a design project.

7 Developed effective means for collaboration on a team whose members represent diverse skills and perspectives.

8 Established the platform for rapid progress toward the completion of the Senior Design Project in the second semester.

9 Documented the conceptual design stage of the Senior Capstone design project.

Technical Topics Covered:

1. Rotary to linear motion conversion, as exemplified in:
    a. Lead screw transmission
    b. Timing pulley/belt transmission
    c. Rack and pinion system
    d. Relationships between torque, force and velocity conversion
    e. Deviations from ideal behavior: friction, backlash

2. Actuators and control
    a. Electric motors: brushed, brushless, AC and DC
    b. DC motors
        i. Construction and operation
        ii. Position tracking using encoders
        iii. Angular velocity measurement
        iv. Motor speed closed-loop control
    c. Stepper motors
        i. Construction and operation
        ii. Control sequence
        iii. Control circuits
        iv. Position and speed control

3. Sensors and switches
    a. Limit switches, beam breakers, hall effect sensors
    b. Relays
    c. Examples of industrial applications

4. Kinematic and dynamic analysis of automated motion systems
    a. Velocity profiles
    b. Peak acceleration and actuator torque
    c. Power transmission
    d. Motor selection

Project Management Topics Covered

1. Project objectives, goals, and constraints
2. Capture and documentation of customer and technical requirements
3. Collaboration and teamwork
4. Project planning and tracking
5. Resource management
6. Communication

Senior capstone projects

Project descriptions will be posted on the course Blackboard portal. It is the students' responsibility to organize themselves in teams of no more than 5 members to select and execute their project.
Projects will not be assigned until teams have been formed. In situations where more than one team indicates interest in a project, the course instructors will determine which team is a best match for it. This may require an interview with each of the interested teams.

The following important dates should be observed for the selection and assignment of capstone projects:

Dates	
Sep 03-Sep 06	Read project descriptions posted online and identify projects of interest. Complete (individually) the teammate and project area survey at https://forms.gle/d7Rcw1J2r5dgRGJd6
Sep 03-Sep 13	Form teams with peers interested in similar project areas, e.g. aero, machine design,manufacture, etc.
Sep 13-Sep 27	Each team indicates its top four project choices through an online form (link will be posted shortly)

Sep 15	Deadline for consideration of student-proposed projects. Send project title, description and expected deliverables to Prof. Hauser (wmhauser@bu.edu) and set up an appointment with him to talk about your proposal. NOTE: Student projects are NOT automatically approved upon submission.
Oct 04	Capstone projects assigned to teams

Books and Other Printed References

Some in-class exercises will require the availability of a laptop computer or tablet. At least one member of each team should have access to such a device.

The following texts are useful references, but are not required:

Jack A. Collins, Henry R. Busby, George H. Staab, Mechanical Design of Machine Elements, John Wiley and Sons, ISBN-13: 978-0470413036, any edition

Robert C. Juvinall, Kurt M. Marshek, Fundamentals of Machine Component Design, John Wiley and Sons,
ISBN-13: 978-1118012895, any edition

Andre Sharon, Machine Design and Control – A Systems Level Approach, Custom Printing , John Wiley and Sons, any edition

Machinery's Handbook, 29th ed., Industrial Press, 2012, ISBN 9780831129002, Any recent edition is useful. Check for online availability.

Edward R. Tufte, The Visual Display of Quantitative Information, 2nd ed., ISBN 978-0961392147. The classic treatise on "how to communicate information through the simultaneous presentation of words, numbers, and pictures."

Manufacturing Methods Available in EPIC

[https://docs.google.com/document/d/1KdZnh55L0mH46BKxQdRehMyq_loJCq1m259YgNMujvI/edit]

This set of files, compiled by Professor Thornton, contains a basic introduction to the manufacturing methods that are available in EPIC for use in projects or for personal use.

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

Assignments and Grading

Homework (individual, unless otherwise indicated)	25%
Senior capstone midterm report (written and oral)	20 %
Senior capstone conceptual design report (written and oral)	40%
Attendance,teamwork and class participation	15 %

Resources

- Abstracts of final reports, as well as video recordings of final presentations for the past several years, are available at the department website. They are indexed at the course website.
- Graduate Student Teachers will be available to support teams in mechanics, Matlab and Arduino programming environments, and use of CAD tools.
- We anticipate being able to assign each team its own project-storage locker space.

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:
The primary metric of responsible attendance will be the student's degree of contribution to the team. 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. Students will receive no credit for in-class exercises for which they are not present. 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
(Dates subject to adjustment**)**

Sep 03 – Sep 04	First Day of Classes Team building exercise
Sep 05 – Sep 09	Diagnostic exam. Senior capstone organization: teams and projects.
Sep 10 – Sep 11	Motion conversion
Sep 12 – Sep 25	Actuators and control
Sep 26 – Oct 09	Analysis of motion systems. Sensors and switches.
Oct 15	Capstone Project Kick-off
Oct 16– Nov 05	Capstone team meetings and coaching sessions
Nov 06– Nov 12	Capstone project midterm presentations: problem definition, benchmarking, concept selection, preliminary analysis
Nov 13 – Nov 26	Capstone team meetings and coaching sessions
Nov 27 – Dec 01	Thanksgiving Recess
Dec 02	Conceptual design presentation files due; Presentations Start
Dec 05	Conceptual design written reports due; Last day of Presentations
Dec 09-10	Course Debriefing and Evaluations
Dec 11	Makeup day