BU HUB FORMATTED SYLLABUS
[Customization for Spring 2022 is appended to this standard Hub Syllabus]

ME 461 Senior Design II
(Spring 2022)

Instructors:

Prof. William Hauser
(Course coordinator)
Office : Room ENG 408
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Office hours : As arranged

See full list of instructors in the appended Course Information Sheet for Spring 2022

Graduate Student Teacher(s)
[See Spring 2022 Course Info Sheet, Appended]

Class Meeting Places and Times
[See Spring 2022 Course Info Sheet, Appended]

While initial and final class meetings, presentations, and whole-class exercises will take place in the assigned classrooms, most meetings for ME461 will be arranged as weekly coaching sessions between one capstone team and one instructor. The times and places of those meetings will be arranged for mutual convenience of the instructor and the team. In all cases, students must maintain the registrar-scheduled class periods clear of encumbrances since meetings of the whole class may be held in those time slots on short notice, and students are expected to be available to attend.

Catalog Course Description
The main activity in this course is the completion of a capstone project that was begun in ME 460. Students work in teams on a design problem that builds upon previous coursework in engineering. Class time is used predominantly for weekly meetings with instructors by individual project teams. The course links topics in Communications and Research and in Information Literacy to mechanical engineering technology and project management (4 cr., 2nd semester)

Hub Learning Outcomes
Because of the intensely collaborative nature of senior projects, students are expected to complete ME460 and ME461 within the same team and within one academic year. As an outcome of successful completion of this course sequence, students will be able to craft responsible, considered, and well-structured arguments in writing, through oral communication, and the use of graphic and electronic media. The will understand the capabilities of various media and be able to apply them with discernment to the occasion at hand. Moreover, as a result of being coached through the execution of an extended engineering project, they will gain transferrable skills in research and information literacy by using standard problem-solving tools and processes of the engineering discipline.

When both ME460 and ME461 are completed, these courses together will satisfy the following BU Hub areas:

Writing-Intensive Course #2	1 unit
Oral and/or Signed Communication	1 unit
Digital/Multimedia Expression	1 unit
Research and Information Literacy	1 unit

Prerequisites

CAS WR 150, Writing, Research, & Inquiry
ENG ME 460, Senior Design 1
ENG ME408, Aircraft Performance and Design.for students undertaking an Aero-related project

Extended Course Description:

ME 461 is the second semester of a two semester sequence (ME460/ME461). These courses together fulfill the ABET certification requirement that "Students must be prepared for engineering practice through a curriculum culminating in a major design experience based on the knowledge and skills acquired in earlier course work and incorporating appropriate engineering standards and multiple realistic constraints."[1]

While approximately 80% of scheduled class time will be devoted to direct coaching of the projects, approximately 20% of class meetings will be devoted to lectures and exercises on ethics, project management, and oral and written communications. The exercises will in general require individual preparation in advance of class (written homework), discussion among team members during a class session, and a brief presentation by each team to the class as a whole.

Mechanical Engineering is a broad discipline. Within our department there are strong interests in Aeronautics and Astronautics, Manufacturing, Materials Engineering, and Design of Devices. ME 461 is designed to provide several pathways through which the Capstone Experience can match student interests and ambitions. All pathways entail a project that yields a useful solution to a non-trivial engineering problem, with realistic real-world constraints. Within that broad definition, students may undertake design of devices, design of manufacturing systems, or research (which must include a significant design element) under the guidance of a College of Engineering faculty member. Detail steps in management and documentation of the project will vary with the nature of the project. All projects will require, at minimum, a formal problem statement, a midterm presentation, a written final report, and a (usually public) final presentation.

Course Outcomes:

(These outcomes overlap and are continuous with those of ME460, Senior Design I.)
Students who successfully complete this course 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. Through coached practice, learned transferrable skills for solving problems and troubleshooting systems by decomposing them into related parts and methodically working through a hierarchy of probably causes and corrections.
3. Applied engineering principles and methods to the design, selection, and integration of components and techniques to solve non-trivial and open-ended problems of research and design.
4. Identified and documented appropriate background material: benchmarks of similar problems and solutions, citations of publicly available information, interviews with experts, and summaries of private communications.
5. Applied information analysis tools, common in engineering, to the planning of productive investigations and the selection of efficient search paths for the solution of problems. Examples include Functional Decomposition, Function and Means Charts, Decision Matrices, Ishikawa Diagrams, and the Shewert Cycle (Plan-Do-Measure-Adjust).

[1] Accreditation Policy and Procedure Manual, Effective for Reviews During the 2018-2019 Accreditation Cycle, ABET Engineering Accreditation Committion, http://www.abet.org/wp-content/uploads/2018/02/A001-18-19-Accreditation-Policy-and-Procedure-Manual-2-28-18.pdf , as accessed 7/12/2018.

6. Experienced the value of self-education and life-long learning by extending their knowledge and skills beyond the material taught in courses.
7. Established the stages and activities of a design project, identified research objectives and unambiguous development milestones, made informed estimations of the required resources, and executed the research and development project against a plan..
8. Demonstrated skills required to communicate effectively with a variety of constituencies, technical and non-technical, in a variety of scenarios associated with a design project.
9. Made reasoned arguments for alternate actions in historically-real cases where engineering ethics was in play.
10. Produced a comprehensive written report and delivered a polished, multi-media, public presentation.

Technical Skills Exercised
The technical competencies employed vary with the requirements of the project but have recently included design of machines, design or improvement of manufacturing processes, design of medical devices, design of research apparatus, and integration of mechanical technology into highly interdisciplinary projects.

Project Management Skills Exercised:
Research and Information Literacy Topics Covered:
(Project Management and the Practices of Research and Information Literacy overlap.)

1. Setting of specific goals and recognition of constraints.
2. Discovery of customer requirements and their translation into technical requirements.
3. Program execution per an established research methodology such as the the Shewhart Cycle, the House of Quality, or Quality Functional Deployment
4. Division of labor, allocation of tasks, and exercise of mechanisms for accountability within the team.
5. Creation of documents necessary for the orderly management of the project: customer communications, status reports, technical reviews, written, oral, and mult-media reports.
6. Financial justification and management of expenses against a budget.
7. Status reporting to customers
8. Defining important separable units of R&D effort; and creating useful, recognizable, and unambiguous metrics of completion.

Other Outcomes
ME460 and ME461 together satisfy the ABET accreditation requirement that "Students must be prepared for engineering practice through a curriculum culminating in a major design experience based on the knowledge and skills acquired in earlier course work and incorporating appropriate engineering standards and multiple realistic constraints." The course supports achievement of the ABET Criteria 3 Student Outcomes, adopted by vote of the College of Engineering Faculty, and quoted below.[2]

> Graduates of the Boston University College of Engineering Undergraduate degree programs (Biomedical Engineering, Computer Engineering, Electrical Engineering, Mechanical Engineering) will have the ability to:
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> 1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics

[2] Undergraduate Outcomes, http://www.bu.edu/eng/about/undergraduate-outcomes/, as accessed 10/23/2019.

2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. An ability to communicate effectively with a range of audiences
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Instructional Format, Course Pedagogy, and Approach to Learning
The instructional format of ME461 is project experience, with instructor coaching and customer feedback.

Books and Other Course Materials

The following texts are recommended, but not required:

Clive L. Dim, Patrick Little, Engineering Design: A Project-Based Introduction, 3rd Edition, ISBN 9780470225967. Summary and examples of project management structures and tools for design projects.

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

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."

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

Courseware
Course reading material will be distributed online through the course Blackboard site.

Grading

Element	Approximate Weight
Project	70%
Teamwork (peer assessed)	20%
Ethics and Project Management	10%

ME 461 is project-based team-based course. The starting point in determining a student's grade in this course, where the project is paramount, is the performance of the team as a whole. With no other information, each member of the team will usually receive the same grade for the project. Nonetheless, an individual may receive a lower or higher grade than the team as a whole, depending on such inputs as written peer evaluations, observations by the course instructors, comments from customers, and comments from shop personnel. In recent times, individual performance has been marked up or down relative to the team as a whole by as much as a full grade, e.g., B+ lowered to C+. Though capstone grades typically fall in the A to B- range, failing grades are not just theoretically possible but have actually been awarded in recent years.

Senior Capstone is a project-based course, so grading is inherently more subjective than in courses assessed by tests with answers that are manifestly right or wrong. While there is no uniform score sheet that applies to all projects, certain common elements are normally considered in evaluating the quality of project deliverables. The course website contains a course-staff-prepapred document entitled Grading Guidelines which indicates what evaluators generally look for.

The website also contains a rubric entitled Project Evaluation and Feedback which course instructors have used to provide feedback on mid-term status of the project.

Grading (Peer Evaluation): At least twice in the semester you will be requested to complete a written evaluation of your group's performance as a team. Fortunately, most teams figure out an operating style that allows each member to be productive and therefore to receive full credit in the peer evaluation exercise. Two situations can cause significant loss of credit: (1) survey results that point to poor teamwork by a team member, (2) failure to complete the evaluation form. The peer evaluation form to be used in 2021 has been posted to the course website (Miscellaneous Forms Folder).
Your team should not tolerate substandard contribution from any of its members. Too often teams give everyone high marks during early peer evaluations only to complain bitterly at the end of the course about lack of contribution by some one person. Students should make problems within their teams known to the instructor early enough to permit meaningful intervention.

Project Notebooks and Electronic Project Records: Most sections will require teams to maintain electronic project records which are readily accessible during meetings with instructors and which are available on short notice for inspection. ***Each team is required to establish a Google Drive folder. Files for final presentations and project archives will be drawn from these folders***. Individual sections may establish specific content requirements and file organization structures. Maintenance of a bound notedbook is required in some sections.

Reports and Presentations: Capstone Project Reports and recordings of Capstone Project Final Presentations will be retained by the department and may be used in the instruction of future classes.

When so used, grades awarded to the reports will not be revealed. However, the fact that a project was judged best for its year, or that it represented a high level of achievement, would ordinarily be revealed.

Resources

- Abstracts of final reports, as well as video recordings of final presentations for the past several years, are available at the department website, and are indexed at the course website.
- We anticipate, but cannot assure, that Graduate Student Teachers will be available to support teams in technical areas where previous teams have required assistance, specifically the coding and application of Arduino processors, the use of MatLab, and coding in C.
- We anticipate being able to assign each team its own project-storage locker space.
- The department will allocate funds for capstone-project related expenses. In previous years the course has been budgeted at approximately $100 per enrollled student. The allocation to teams will be based on identified needs. Procedures for requesting purchases and seeking reimbursement are posted to the course website. Students undertaking projects for outside customers routinely have access to facilities, tools, and materials that would otherwise be unavailable within university resources.

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, cheating is unlikely, 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.

Calendar Overview:

Week	Activities, Events, and Milestones
1	Project restart, f/b on ME 460 End-of-Term Reports and Presentations
2	Team Design Review and Weekly Presentation, Focus on identifying needed resources and picking appropriate R&D strategies Focus on Planning and the refinement of modules and milestones
3	Team Design Review and Weekly Presentation, Focus on Customer Feedback
4	Team Design Review and Weekly Presentation, Focus on defining tests for achievement of the original objectives

5	Engineering Ethics Case Study I ***(Individual preparation required in advance. ~2 pages of outlined argument)***
6	Team Design Review and Weekly Presentation, Review for completeness of documents nominally available at this stage: project description, bibliography, benchmarking, project plan, feasibility report
7	**Midterm Presentations and Reports**: Status, Plans, Customer Satisfaction Review and feedback from instructors and peers.
8	Team Design Review and Weekly Presentation Focus on how to report and substantiate achievements claimed
9	Engineering Ethics Case Study II ***(Individual preparation required in advance. ~2 pages of outlined argument)***
10	Team Design Review and Weekly Presentation, Focus on final report and presentation drafts, with attention to presence and appropriateness of documentation
11	Team Design Review and Weekly Presentation, Focus on final report and presentation drafts, with attention to document clarity and style
12	Team Design Review and Weekly Presentation Demonstration of research results through functioning product
13	Final presentation rehearsal, Final results documentation and presentation to customers
14	Wrapup, all documentation and presentation material due, Course, Instructor, Peer Evaluations
	Capstone Presentations