ENG ME 461 Mechanical Engineering Capstone Experience

Spring 2019

COURSE INFORMATION SHEET – ALL SECTIONS

Course Coverage: (Prereq: ENG ME 460. The planning and execution of a capstone project that represents a culmination of the Mechanical Engineering program. This course is a continuation of project work started in ENG ME 460, which is a prerequisite. Students work in teams on a design problem that builds upon previous coursework in Mechanical Engineering. Teams may be cross disciplinary and may include members from other engineering departments. Class time is used for weekly project meetings with faculty advisors, and for workshops on ethics, entrepreneurship, project management, and other professional topics. Oral and written communications will be emphasized. 4 cr, 2nd sem.)

Course Website: http://learn.bu.edu

Course Syllabus (Calendar): A high-level description of events and milestones is appended to this document. Because of the broad scope of projects undertaken, instructors may prescribe additional milestones or deliverables and may alter the sequence of timing of exercises. It is expected that each team will formulate a project plan, approved by the instructor, which includes events and documents to establish that the project is progressing satisfactorily. A plan will ordinarily contain target dates for demonstration of feasibility, for formal reviews with customers, for intermediate term reports, and final documentation. Thus the first major milestone in each project should be the availability of a well-thought-out plan. Each team's performance will be evaluated against its own plan.

Certain dates included in the calendar are required for orderly management of the course as a whole. These include due dates for the presentation-booklet abstracts and for the final reports and presentation materials.

Ethics and Entrepreneurship Exercises:
Each instructor will establish three or four days during the term where each section will meet as a whole for ethics, entrepreneurship, and project management exercises. It is expected that all students will attend their section's meetings, but that dates for all sections will be published so that students unable to attend their regular section's meetings will be able to make them up with a different section.

Course Staff:

Staff Member	*Primary Phone* *Other Phone*	*e-Mail*	*Office Location*
Prof. William Hauser Instructor / Course Coordinator	617-358-0663 978-681-1866	wmhauser@bu.edu	EMA 202B
Prof. Frank A. DiBella Instructor	781-937-4718 617-353-6616	fdibella@conceptsnrec.com	ENG 307
Prof. James Geiger Instructor	781-594-8269	jgeiger@bu.edu	ENG 307
Prof. Sheila Russo Instructor	617 353-2814	russos@bu.edu	EMA 219
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Mr. Kevin McDonald Graduate Student Teacher	Contact by e-mail	kevinjm@bu.edu	
Mr. David Campbell ME Laboratory Engineer	617-353-3952	dcampbel@bu.edu	EMA 202A
Mr. Joseph Estano ME Laboratory Manager	617-353-6653	jestano@bu.edu	EPIC Center
Mr. Robert Sjostrom CIM Specialist / Lab Supervisor	617-353-4246	sjostrom@bu.edu	EPIC Center

ENG = 110 Cummington Place EMA = 730 Commonwealth EMB = 15 St. Mary's Street

Class Meeting Place and Time:				
Section	**Instructor**	**Day**	**Location**	**Time**
A0	Hauser	Mon, Wed	EMA 215	1630 – 1815
A1	Hauser	Tue, Thur	EMA 205	0900 - 1045
A2	Russo	Tue, Thur	SOC B63	0900 - 1045
A3	Thornton	Mon, Wed	PHO 205	0800 - 0945
A4	Geiger	Tue, Thur	MSC B23	1830 - 2015
A5	Thornton	Mon, Wed	EMA 215	1430 - 1615
A6	Hauser	Mon, Wed	EPC 203	1630 - 1815
A7	Dibella	Mon, Wed	PHO 201	1830 - 2015

Scheduled class hours are posted in the table above, but your instructors will arrange to meet with individual teams on a modified schedule to maximize the opportunity for coaching. For example, in a four-team section scheduled to meet on Monday and Wednesday, Teams 1 and 2 might meet with the instructor for an hour each on Monday, and Teams 3 and 4 might meet with the instructor for an hour each on Wednesday. Certain class session will require all teams in a session to meet together. **So you must not schedule other activities for the "off day."** Actual meeting times will be worked out with the section instructor during the first meeting of the class. **The first class of the semester will meet at the time and place listed above.**[1]

The capstone course is intended to support your transition from student to practicing professional. While approximately 80% of scheduled class sessions will be devoted to direct support of the projects, approximately 20% of class meetings will be devoted to exercises on ethics, entrepreneurship, project management topics, 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 presentation by each team to the class as a whole. An exercise may be used as a drill in several skills, and may extend over more than one class period. For example, an ethics exercise might conceivably require analysis of basic statistics, or preparation of presentation-quality graphics, in addition to discussion of the central ethical question. Written assignments should be prepared with care and in a professional manner (printed results, logically organized, with clear titles).

Course Website: http://learn.bu.edu The website has been established for the course as a whole. It contains separate content areas for each instructor's use to post information or requirements for their sections. In case of differences between the instructor's requirements and the course-wide requirements, the instructor's requirements prevail.

Multiple Pathway Nature of the Course: ME 461 is designed to provide several pathways through which the Capstone Experience can be achieved. 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 (so long as it contains 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.

[1] Instructors will inform students registered in their sections of any deviation from this general rule.

Textbooks:

- **[**Required**]** No single textbook is required. Instructors may require certain books relevant to their sections. Books listed below are recommended as general references on design. They need not be purchased unless required by an instructor for his or her section.
- [Recommended] *Notebook-Value Marble Quad 100*, XX Supply, **ISBN** 9780471661771 The maintenance of a bound design journal is highly recommended but is not a general requirement of the course. Individual instructors may consider the maintenance and regular use of a design journal as essential to the conduct of a project. In such cases, the notebook becomes required and will be considered in evaluating team performance and individual contribution to the success of the project.
- [Recommended] David G. Ullman, *The Mechanical Design Process*, 4th ed., ISBN-13: 978-0072975741
- [Recommended] Clive L. Dym; Patrick Little; Elizabeth J. Orwin; R. Erik Spjut, *Engineering Design: A Project Based Introduction*, 3rd ed., ISBN 9780470225967
- [Recommended] Karl T. Ulrich; Steven D. Eppinger, *Product Design and Development*, 5th ed., ISBN 978-0073404776
- [Recommended] Machinery's Handbook, 29th ed., Industrial Press, 2012, ISBN 9780831129002 (Contact Joe Estano for ordering information at a reduced price. Also available in large print and electronic editions. Earlier editions remain useful. Check online availability.)
- [Recommended] Robert C. Juvinall; Kurt M. Marshek, Fundamentals of Machine Component *Design*, 4th ed., ISBN 9780471661771. A useful treatment of the mechanics of machine elements.
- [Recommended] 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."
- [Recommended] George Dieter; Linda Schmidt, *Engineering Design*, 4th ed., 2009, ISBN 9780072837032, (A useful compendium on the design process, but can be challenging as a tutorial for first-time readers.)

Expected Effort in the Course: The capstone is a 4-credit course which will require you to stretch beyond what you have learned in previous courses and will require you to seek out and learn independently material relevant to the project requirements. An excellent job will normally require at least 12 hours per week per team member.

Grading:

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

Grading: ME 461 is project-based team-based course. The starting point in determining a student's grade in this course, where the project is so important, is the performance of the team as a whole. With no other information, each member of the team should expect to receive the same grade contribution for the project element. 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. Team members who consistently fail to attend scheduled meetings, or who consistently fail to contribute to the progress of the team, may expect a D or F in the course. These grades are not simply theoretically possible but have in fact 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 document entitled Grading Guidelines which indicates what evaluators generally look for.

The website also contains a rubric entitled Project Evaluation and Feedback which some instructors have used to provide feedback on mid-term status of the project. Instructors may apply other rubrics.

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 some team member, (2) failure to complete the evaluation form. The peer evaluation form to be used in 2019 has been posted to the course website (Miscellaneous Forms Folder) and is the same one used in several other design classes.

No team should 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 about lack of contribution by one or more person. Students should make problems within their teams known to the instructor early enough to permit meaningful intervention and correction.

Grading (Customer Satisfaction): Periodic and end-of-terms reviews by customers become explicitly inputs to the evaluation and grading of the project.

Notebooks and Electronic Project Records: ***Each team is required to establish an instructor-visible Google Drive folder. Files for final presentations and other course-wide documents will be drawn from these folders***. Individual sections will establish content requirements and file organization structures.

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. You are responsible for helping to create a supportive environment for all students' success. You are not to willfully interfere with any other team's project, nor to remove or alter any other team's project materials or built artifacts. 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 and referenced. Violations of these standards will be referred to the College of Engineering Academic Conduct Committee. If you are in doubt about whether any contemplated action would violate the code, ask your instructor before doing it.

Financial support for model or prototype: Please also note that, unless specific alternate agreements are documented in writing, the model or prototype developed for your project is the property of your customer (or the ME Department if you have no other identified customer). It is to be left with your customer (or the Department) on completion of the project. By accepting a project proposed by your customer, you enter into an implicit contract. The customer will have been waiting for your work product and might well have sought it elsewhere if you had not agreed to supply it. Thus, there is a cost to your customer even if he/she has not paid money. In addition to being of use to your customer, prototypes are important to the department to show to future students as well as to our accreditors and other visitors.

In past years the department has provided an allocation of approximately $100 per student. The 2019 budget has not been finalized as of Release 1 of this document, though we anticipate funding similar to last year. ***Each team will be required to track its expenses through an online spreadsheet (Google Sheets) which must be visible to the section instructor and to the expense approvers.***

During your conceptual design, talk with your instructor, or with Joe Estano, David Campbell, or Bob Sjostrom about your fabrication needs and any materials or tools you may require. Material is often available for reuse from previous projects. Recognize also that the EPIC personnel have seen hundreds of student projects and may be able to suggest ways to achieve whatever function you need with materials that are available or easily procured. Take advantage of their experience and insight – and do so early.

Teams who require transportation to customer sites may incur expenses that exceed the nominal per-team allocation. In such cases, each team should estimate its expenses and discuss them early with the section instructor so that overall expenses are contained with the budget for the course. Additional funds may be available, upon presentation of a strong case, when the funds would make a large difference in the outcome of the project. ***Extra money will not be spent when weaknesses in the project suggest that additional money will make no difference in the outcome***.

The team shopper: New for spring 2019, each team will be asked to identify a person to act as its *shopper*. The shopper will have access to an expedited order procedure for materials purchased from McMaster-Carr and will be able to generate shopping carts directly on a BU-specialized Amazon website. Items required for the project, and ordered through the website, will be charged to the department, thus eliminating the need for reimbursement. The cost of the

items will, however, count against each team's budget, and orders will require approval (done electronically) by one of the course's designated approvers. This mechanism must be used only for project-required materials – no personal items. Shoppers will be trained in the use of the Amazon Business website and in the restrictions that apply to its use. Abuse of the purchasing privilege will lead to revocation of the privilege and may trigger legal action if fraudulent activity occurs. Further instructions will be posted to Blackboard Learn.

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, we would ordinarily reveal that a project was judged best for its year, or that it represented a high level of achievement.

Final Presentations will be recorded (video and audio) and may be streamed live to coworkers, relatives, and friends of the presenters, to alumni and friends of the Department, and to others with an interest in the topics being presented. Final Presentations are open to the public. In cases where projects are undertaken under non-disclosure agreements, it is our policy to provide a full report and presentation to the customer, usually followed by a separate public presentation in which certain details may be redacted. The amount to be omitted is a matter of negotiation with the customer.

The format of final presentations is currently under review, with two main objectives: to reduce the number of days required from two to one, and at the same time to create more opportunity for interaction between teams and members of the audience who are interested in a particular project.

Professional Registration: Though it is not formally a part of the course, we encourage students to register for and take the Fundamentals of Engineering Exam. In 2018 the department reimbursed the base cost of registration[1] to students who directed that their scores be submitted to BU. Since notification of results may occur after you graduate, and reimbursement may follow by several weeks, you must provide the department an address which will be valid after graduation. The exam is administered via computer at designated test centers and may be taken year-round. BU seniors have typically taken it in March, April, or May, and the pass rate in recent years has been 100%. The student chapter of ASME has sometimes organized review sessions led by ME professors. ***The registration process requires several steps and may take weeks to complete.*** Do not delay getting started. For a current description of the exam and of the registration process, see the FE Exam Guide.

Final Exam: No final exam is scheduled for this course.

Incomplete: Incompletes will be permitted only for the most extreme extenuating circumstances. They must be arranged for before the end of classes.

Issue	Date	Content
0.1	01/18/2019	Draft for review by instructors
0.2	01/20/2019	Revised draft. Multiple wording changes
1.0	01/21/2019	Release 1

[1] The base cost of registration is defined as the examination cost for registration in Massachusetts. The cost in other states may be higher.

Class Session	Activities, Events, and Milestones	T/R Sections	M/W Sections
1	**Initial Class Meeting**	Tue, 01/22	Wed, 01/23
2	Individual Team Design Reviews	Thu, 01/24	Mon, 01/28
3	Individual Team Design Reviews	Tue, 01/29	Wed, 01/30
4	Individual Team Design Reviews	Thu, 01/31	Mon, 02/04
5	Individual Team Design Reviews	Tue, 02/05	Wed, 02/06
6	Individual Team Design Reviews	Thu, 02/07	Mon, 02/11
7	Individual Team Design Reviews	Tue, 02/12	Wed, 02/13
8	**Feasibility Demonstrations Due**	Thu, 02/14	Tue, 02/19
	Presidents' Day Holiday	Mon, 02/18	Mon, 02/18
9	Individual Team Design Reviews	Thu, 02/21	Wed, 02/20
10	Individual Team Design Reviews	Tue, 02/26	Mon, 02/25
11	Individual Team Design Reviews	Thu, 02/28	Wed, 02/27
12	Individual Team Design Reviews	Tue, 03/05	Mon, 03/04
13	**Model Demonstration & Report to the customer** **Team and Peer Evaluations**	Thu, 03/07	Wed, 03/06
Spring Recess		Tue, 03/12	Mon, 03/11
		Thu, 03/14	Wed, 03/13
14	Individual Team Design Reviews	Tue, 03/19	Mon, 03/18
15	Individual Team Design Reviews	Thu, 03/21	Wed, 03/20
16	Individual Team Design Reviews	Tue, 03/26	Mon, 03/25
17	**Midterm Report**	Thu, 03/28	Wed, 03/27
18	Individual Team Design Reviews	Tue, 04/02	Mon, 04/01
19	Individual Team Design Reviews	Thu, 04/04	Wed, 04/03
20	Individual Team Design Reviews	Tue, 04/09	Mon, 04/08
21	Individual Team Design Reviews	Thu, 04/11	Wed, 04/10
	Patriots Day Holiday Observed	Mon, 04/15	Mon, 04/15
22	Individual Team Design Reviews	Tue, 04/16	Wed, 04/17
23	Testing and Product Functionality Demonstrations; Senior Conference Booklet Abstracts Due	Thu, 04/18	Mon, 04/22
24	Testing and Product Functionality Demonstrations	Tue, 04/23	Wed, 04/24
25	**Last day for machining parts in EPIC, 4/25, 4:00 PM**	Thu, 04/25	Mon, 04/29
26	**Team and Peer Evaluations; Presentation Graphics Available**	Tue, 04/30	Wed, 05/01
27	**Final Report Due**	Thu, 05/02	
	Capstone Presentations	Fri, 3-May	
	Final Exams Begin (No Final Exam in ME461)	Tue, 05/07	
	Final Exams End (No Final Exam in ME461)	Sat, 05/11	
	Engineering Commencement	Sat, 05/18	
	University Commencement	Sun, 05/19	