EK 210: Introduction to Engineering Design
Spring 2023

Instructor Names:

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Course Time and Location: Sections meet once weekly in EPIC

Course Credits: 2

Office Hours: Tutoring center hours in EPIC TBD.

Books and Other Course Materials

The optional textbook for this class is:
Dym, C. L. and Little, P. Engineering Design: A Project-Based Introduction 4th Edition, John Wiley and Sons, 2015.

It is available through the BU Bookstore as a paperback or in electronic format.

Courseware

Blackboard: All on-line modules may be found on BlackBoard Learn. If you are uncertain how to use Blackboard Learn, please ask one of the instructors.
Gradescope: Assignments are posted, turned in and graded on Gradescope.

Assignments and Grading

You will be graded as follows:

Weekly individual assignments (video quiz/indiv tasks) (15%)
Team problem definition assignment (10%)
EPIC project (6%)
Pair modeling assignment (12%)
Team detailed design assignments (12%)
Team prototype video, presentation and preliminary test results (10%)
Team final presentation/video (8%)
Team final report (12%)
Individual class attendance/participation, team participation/assessment results (15%)

Course Description:
A two-credit introductory course on the principles of engineering design, intended to give second- year undergraduates a basic understanding of the process of taking a product from client explanation to design concept through product deployment. Students will work in teams with time and budget constraints on societally meaningful projects. Web-based lectures will cover topics concurrent with specific phases of the projects. The course will culminate in a “Design Showcase.”

Engineering Design is “a systematic, intelligent process in which designers generate, evaluate and specify designs for devices, systems or processes whose form and function achieve clients’ objectives and users’ needs while satisfying a specific set of constraints.”

Engineering Design is:

(a) Ubiquitous: This definition applies equally to the design of mechanical devices, electronic circuitry, software or large infrastructure projects.
(b) Multi-disciplinary and team-driven: Engineers with multiple different skill sets are required to work together to achieve a common goal. Engineers must also work with manufacturing and marketing professionals and must have some basic understanding of these disciplines.
(c) Open-ended: There is not a unique answer to most design problems.
(d) Requirements-driven: Engineering designs must qualitatively and quantitatively address both stated and unstated customer needs.
(e) Constrained: Engineering designs are constrained by time and financial resources.
(f) Dependent upon communications skills: Even the best designs will not be generally adopted if engineers fail to adequately convey their ideas to key stakeholders.
(g) Relevant: Engineers engaged in both scientific research and commercial engineering routinely encounter design problems.

The fundamental assumption underlying this course is that the best way to learn these concepts is a project-based course in which students undertake *team-based design projects* with strict time limits and are then required to *communicate* these designs to others in a systematic fashion.

Over the course of the semester, teams will be required to make oral presentations (to the class and to faculty) and prepare engineering reports.

Instructional Format, Course Pedagogy and Approach to Learning

Our intention is to reserve much class time each week for you to work in teams on hands-on design projects.

There will be teams of three to four students each working on a design based on real world needs.

In order to make this format work and to maximize the time available in class to be "hands-on", we have prerecorded lecture material. This material is available on the Blackboard Learn class site.

To make this class work, **you must review the lecture materials for each week prior to class, including the first class and complete the individual assignments.** To access a week's lectures, merely click on "Week #" in the sidebar. The weekly individual assignment will be related to these lectures. The relevant sections in your text for each week are shown in the class meeting table below.

Outline of Class Meetings and Assignments:

The overall schedule of events and assignments is shown below. Please note that multiple sections of this course will be taught this semester. Different sections may be aligned with different weeks even though they are meeting in the same week.

Week	**Topic**	**On-Line Learning Content**	**In-Class Activity**	**Optional Reading**	**Assignments**
1	Overview of the Course Design process. Practice with problem statement & functional analysis	a) Class organization and requirements b) Defining engineering design c) How to write a design problem statement d) Functional requirements e) Safety	a) Overview of the course b) Assignment of teams c) High level description of semester projects d) Random selection of projects e) Practice writing prob statement f) Practice: obj/metrics etc g) Intro to FA	Chapters 1-6	**Before class**: Indiv. Gradescope assignment. (Fan problem statement, glass box for screwdriver) **In class:** Participate in discussions
2	Skill building 1: Power supplies and MOSFETs	a) Problem identification b) Customer needs c) Power, Voltage, Current, Mosfets Extras 1. Arduino basics 2. LEDs, resistors	Fan activities (power)	Chapters 5-6,	**Before class**: Indiv Gradescope assignment (Prob statement, FA related, Arduino running) **In class**: Fan activities. Output turned in.
3	Conceptual design EPIC intro	a) Determining the design space b) Evaluating Designs c) Sketching Extras: 1) OnShape	a) EPIC project intro b) Finalize Conceptual design c) Design reviews	Chapters 6-9, 16 Appendix II	**Before class**: Indiv. Gracescope assignment (morph chart, On-shape) Problem def. due **In class**: EPIC proj intro, design review, set conceptual design
4	Skill building 2: Understanding light.	a) EPIC safety b) Modeling: basic concepts c) Models vs Prototypes	a) Modeling comments b) Light activities	Chapter 12	**Before class**: Indiv. Gradescope assignment

Week	Topic	On-Line Learning Content	In-Class Activity	Optional Reading	Assignments
	Preliminary design/modeling	d) Types of models e) Examples of models f) Intro to Light			(EPIC safety quiz, EPIC project submission), **In class**: Light concepts, select modeling tasks
5	Detailed design Skill building 3: EPIC project	a) Reminders about Modeling & EPIC assignments	a) EPIC project		**Before class**: **In class**: EPIC project. Circuit drawing, Code flow chart, Physical sketches, Light calcs, BOM
6	Prototype start	a) Power budget b) Powering LEDs	a) Detailed design assignment description b) Design review c) Start build		**Before class**: Indiv. Gradescope Assignment Modeling assignment **In class**: Design review – finalize detailed design. Obtain parts, start code, circuit, physical build
7	Prototype build	a) Teaming b) Project management	a) Work on build b) Create Gantt	Chapters 15	**Before class**: Indiv. Gradescope Assignment (Gantt) Work on project Detailed design assignment **In class**: Work on project
8	Prototype test	a) Effective presentations b) Ethics in Design c) Inclusive Design (User based design)	a) Start product testing	Chapter 11, 17	**Before class**: Indiv Gradescope Assignment Work on project **In class**: Product testing
9	Demo's presentations	a) CDO info, portfolios	b) Prototype Demonstrations c) Start presentations/review of presentations		**Before class:** (working on model) Team assessment due Prototype video Presentation **In class**: Presentations

Week	Topic	On-Line Learning Content	In-Class Activity	Optional Reading	Assignments
10	Presentations Design iteration	a) Technical report writing	a) Presentations/review of presentations b) Define iteration	Chapter 11	**Before class**: Indiv Gradescope Assignment (define iteration) **In class**: presentations/review
11/12	Manufacturing and Design for Sustainability	a) Design for MN b) Design for sustainability	a) Discuss final deliverables b) Implement iteration	Chapter 14	**Before class:** Indiv Gradescope Assignment **In class**: Implement new feature
12/13	Finalize products		a) Review of effective written communication		**Before class:**
13/14	Project Presentations		a) Team presentations b) Course Evaluation		**Before class**: Final presentation. Final Video Final report Team assessment due **In class**: Present design
	Design Showcase by product		Elevator pitch/product demo		

Other Notes

If you are a student with a disability or believe you might have a disability that requires accommodations, please contact the Office for Disability Services (ODS) at (617) 353-3658 to coordinate any reasonable accommodation requests. ODS is located at 19 Deerfield Street on the second floor.

Attendance in class is mandatory. Since this is a team-based class, failure to attend is not only a disservice to yourself but to your teammates. In the event of illness or other family emergency, please notify both the instructors and your team. Failure to do so will be regarded as an unexcused absence and will be taken into account as we determine your "Participation and Attendance" grade. Note that religious events are not considered unexcused absences. See the Policy on Religious Observance for more details.

All homework and reports should be handed in on Gradescope, unless otherwise specified by one of the instructors. Late work will be deducted one letter grade, unless previously approved by an instructor.

Boston University's academic conduct code may be found at *https://www.bu.edu/academics/policies/academic-conduct-code/.* A particular concern is plagiarism while writing engineering reports. Any copying of articles, websites, or other material from the web without citation will be considered plagiarism and will be referred to the judicial system at Boston University.

BU Hub Learning Outcomes:

Teamwork and Collaboration: The BU Hub defines two learning outcomes for teamwork and collaboration:

1. As a result of explicit training in teamwork and sustained experiences of collaborating with others, students will be able to identify the characteristics of a well-functioning team.

The goal of this course is to prepare you for your future career in engineering and often, engineers do not get to pick whom they work with. Therefore, faculty instructors determine team composition; students do not self-select. Optimal team size is four and will most likely include students hoping to pursue different engineering disciplines.

To prepare you for working in a team environment, you will be given both on-line modules and readings on important topics. These modules and readings include:

(a) A module on the basics of project management and the various tools available to project managers to plan and coordinate resources.
(b) A module on team development and dynamics, reviewing the general evolution of teams from formation to high-performance.
(c) Modules on both oral and written team communications.
(d) Readings on design team dynamics.
(e) Readings on managing design projects.

Collaboration tools that are specifically taught or covered during these various modules, readings and lectures include team charters / contracts, work breakdown structures, team calendars and GANTT and PERT charts.

Your team will interact with the instructors in a one-on-one fashion on a weekly basis. During these sessions, the faculty will enquire about team performance and mentor the team in solving any issues that may have emerged.

2. Students will demonstrate an ability to use the tools and strategies of working successfully with a diverse group, ***such as*** *assigning roles and responsibilities, giving and receiving feedback, and engaging in meaningful group reflection that inspires collective ownership of results.*

During the semester, you will be expected to honestly evaluate the performance of each of your teammates utilizing a standardized assessment form.

While each student will self-identify and identify their team members during the evaluation process, the collective feedback for each team will be consolidated by the instructor, enabling him/her to provide a summary of team performance while protecting the anonymity of individual team members. Our collective experience is that this methodology allows us to gather more accurate data. After receiving the data, we are able to interact directly with teams to help teams address and solve both typical (e.g. poor team meeting norms or unreliable members) and atypical (e.g. cultural barriers) team issues.

Further, during the semester, you will be explicitly asked to evaluate roles and responsibilities, scheduling and the overall quality of your team's output.

Other Outcomes:

The course has other goals in addition:

I. Understand both that design is an "open-ended and ill-structured process" with no unique solution and the range of design problems (e.g., Boeing 787, software)
II. Gain some understanding of the complexity of seemingly simple products, basic supply chain and product architecture concepts.
III. Become familiar with basic project management tools pervasive in engineering for planning, organizing, leading and controlling projects: team roles, Gantt charts, etc.
IV. Learn techniques for determining both market and customer needs; write project statements.
V. Understand the process of converting customer need into engineering specifications.
VI. Become exposed to both quantitative and qualitative techniques for generating multiple designs and then choosing the "best".
VII. Have a clear understanding of the distinction between models and prototypes; learn various techniques for building prototypes.
VIII. Have a rudimentary knowledge of mathematical modeling in design.
IX. Begin to practice effective engineering communication, including CAD programs and their uses.
X. Be exposed to principles of industrial design, including ergonomic, aesthetic and user-interface issues. Distinguish between good and bad industrial design.
XI. Learn to work in teams.

These outcomes match to the ABET outcomes a-k as follows:

Student:	1	2	3	4	5	6	7
Course:	i-x	i-x	ix	i, ii, x	ii, iii, ix, xi	vi, viii	i

Emphasis:	5	5	4	4	5	2	2