The University of British Columbia
MECHANICAL ENGINEERING 454, 457, 458, 459

CAPSTONE DESIGN PROGRAM

COURSE SYLLABUS

2019-2020

Course Coordinator: **Mike Van der Loos, Ph.D., P.Eng.**
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Course Website: http://www.canvas.ubc.ca

Introduction

MECH 45X is the capstone design project course for UBC Mechanical Engineering. The course is designed to allow you to showcase the skills and abilities you have developed in your studies here and to give you an extensive supervised experience of designing a mechanical device to fill a real need. Our hope and expectation is that this experience will prepare you well to take on professional responsibilities once you graduate. You are enrolled in MECH 454, 457, 458 or 459 depending on your specialization within MECH. If you are in MECH and also in NVD (APSC 486), then you will have certain course requirements related to the 3 additional MECH credits received. Please consult with the faculty member responsible for NVD-MECH Capstone coordination for details.

Our expectations for you in this course are high. Each project will be a full-fledged design project that you will do for a real client with real needs, and we expect you to deliver and test a working prototype by the end of the course. You will work toward this goal in teams of 4-6 people and will exhibit a professional level of commitment. Along the way, you will follow a typical engineering design process. Although the scope of each project will vary, the overall expectation is that by the end of the course you will have gained experience in the following areas:

- Team dynamics and client-designer communication,
- Reflection on the design process and on your own professional development,
- Proper assessment of your client's needs,
- Derivation of appropriate project requirements and evaluation criteria,
- Development of conceptual solutions,
- Proper analysis of your options and the selection of the most promising solution,
- Detailed design, including the necessary engineering analyses,
- Development of detailed engineering drawings of components that you will build,
- Selection of suitable manufacturing methods,
- Component and/or material procurement,
- Prototype construction,
- Prototype testing and evaluation, and
- Technical communication of results (verbal and written).

Course Organization

Overall Organization
To help you reach your goals, we will place you in design teams within a larger organizational structure. In effect, you will be a member of a project team within a "company" that specializes in related projects. Each "company" will be headed by a faculty member, who will serve as your supervisor (i.e., boss). You will choose or be assigned a client in the first days of the course.

Your team may also have access to an engineering consultant/mentor who will provide expertise in areas relevant to your particular project and be able to provide an industrial relevance and outside perspective on your project and on your work. As external resources to the teams, they are not supervisors.

The faculty supervisors are:

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The TA for the course is: Bingqi Liu. bingqi@alumni.ubc.ca

Project Team Meetings
You will be expected to have regular meetings with your supervisor. These meetings are scheduled during the MECH 45X tutorial/lab times. At these meetings, you will control the agenda – your job is to report on your progress, identify any problems or issues that you wish to discuss, assess your overall progress against your master plan, and propose activities for the coming week (subject to revision in the meeting). Prior to each meeting, you will prepare a brief memo covering the above items (use the provided agenda, slightly modified from MECH 328, as a template; bullet-point form is expected), along with an accounting for the hours each of the members of your team has worked that week. You will also bring your logbooks in for reviewing/signing on a regular basis. Meetings will include partner project teams, if applicable, and the faculty supervisor. On occasion, the industry mentor may attend, but mentor meetings are generally to be held separately. It is imperative that students prepare for the meetings in a professional manner. Project teams will be assigned a particular room location for meetings, or may elect to meet elsewhere by prior arrangement.

Project Team Meetings: Tuesdays and Thursdays 2 – 4 PM (Terms 1 and 2)

During the year (both terms), the following meeting rooms are allocated to the course:

Tu 2-4: FNH 20; MacMillan 360 C, D, E, F, G, H, J, K, L, M; IBLC: 192, 193, 194, 263, 264, 265, 266

Th 2-4: WOOD B79, G41, G44, G53, G55, G57, G59, G65, G66; FNH 20, SPPH B136, B138; IBLC: 192, 193, 194, 263, 264, 265

Other rooms may be available, including space in the Engineering Design Centre (EDC). If you and your instructor cannot find space to meet, please inform the course coordinator so that arrangements can be made.

See "Resources" below for a description of the lab space, RH 118.

Company Activities

Each project-sponsoring company is expected to meet with the student project teams on a regular basis. It is suggested that formal meetings be held at least: during the second week of the course, at the Design Reviews mid-term, and once at the end of each term. These meetings will be scheduled by the student teams. In addition, the company liaisons understand that student teams may contact them as needed via phone, email or videoconference between formal meetings.

Class Activities (Terms 1&2: Thursdays, 4:00-5:00 PM, CHBE 101)

The capstone design program is an opportunity to further explore the design process that you were formally taught in your second and third year design courses (MECH 2 and MECH 328). Formal instruction on the design process will therefore ***not*** be given to the class during the lecture portion of MECH 45X. Instead, the weekly lectures will feature the following (see calendar), rotating in an approximately monthly cycle:

- **Invited lectures** by professional engineers on how the design process works in a company or organization, usually focusing on a specific project or topic. These lectures will provide you with a better understanding of what your professional expectations should be for the coming years.
- **In-class milestone-preparation Participatory Workshops**, just prior to each major deliverable, to focus on the application of a key design concept to each team's project. Specific instructions will be handed out to guide each team in the preparation of a one-page document to be shared with the class. Up to 5 teams will be called at random to present their document to the class. The instructors will lead a 5-10-minute discussion/critique, with the goal of providing insight to all the teams on design rationale.
- **Reflection sessions.** We will break out into groups of teams. Our goals are (1) to have students share their experiences relating to various aspects of the design process in these focused sessions and learn from each other, and (2) to have teams present ONE research paper during the course of the year specifically on an aspect of design methodology, not the project topic per se.
- Other events may be scheduled in the lecture slot. See CANVAS for announcements.

IMPORTANT: The invited lectures, workshops and reflection sessions will count as part of the participation portion of your course mark.

Communication

General:

Communication between project teams, supervisors, clients, and mentors will be done primarily through phone, email, CANVAS and on-line file repositories such as SmartSheet, DropBox or Google Docs. *You are responsible for setting up a site for your MECH 45X files.*

Term-1 start-up and project selection:

The CANVAS website contains a list of all the proposed projects submitted by various clients. Starting Imagine day and BEFORE the Thursday, Sept. 5, 2019 project introductions, review the projects and discuss them with instructors and classmates, with the goal of using the Thursday afternoon time to ask informed questions to aid in project selection. Fill in the **"Project Selection Quiz"** on CANVAS and select your top five choices from 1 (highest) to 5. IMPORTANT: YOU MUST BE ENTHUSIASTIC AND WILLING TO WORK WHOLEHEARTEDLY ON ANY PROJECT THAT YOU MARK ON THE RANKING SHEET. While we endeavour to give students their top-rated project, and indeed have a good track record of doing so, you should feel no less willing to work on your #5 than on your #1 ranked project.

The deadline is Monday, Sept. 9 at 7:00 AM. The CANVAS quiz will automatically be closed at that time. If you have any special requests relating to team formation, there is a comment question. For all other matters, such as project choice, please email the course coordinator, Mike Van der Loos, by the same time. Emails received after the deadline will not be considered. On that Monday, the instructors will match students up with as close to their top project choices as possible. By noon on the following day, Tuesday, the team formation and project selection will be finalized and posted on CANVAS. Note that we will strive to be as egalitarian as possible and give each student a project ranked highly. When you select your top projects, you should be able to enthusiastically embrace working on any of them for the remainder of the year.

Students who do not submit their project rankings by the deadline will be placed on a project of the instructors' choice (and compatible with their specialization).

Note on Options/Specializations: You should ONLY rank projects that have *some* aspect consistent with your option/specialization. We will check for validity of responses. This is essential for program accreditation and proper completion of your transcript. A project may have students from multiple options/specializations, depending on the project topic.

In forming teams, we will strive to maximize team diversity to the extent that we can, given project rankings, to increase the opportunity for divergent thinking styles on each team to lead to highly creative designs. We will not fulfil special requests to be teamed up with a particular other student because you happen to be friends. We will gladly accept special requests on the basis of demonstrable diversity (e.g., Myers-Briggs assessments).

Project Selection Deadline: Before 7:00 AM, Monday, September 9, 2019

The first team meeting with the faculty supervisor will be held on Tuesday, Sept. 10, in one of the meeting rooms reserved for the course. A schedule will be provided.

Deliverables and Evaluation

You will be evaluated in multiple ways in four main categories (the 4 Ps): Proposal, Process, Product and Presentation.

Proposal: You must produce a proposal that is acceptable to yourselves, to your client, and to your supervisor, all of whom must sign off on it before you may officially proceed. You should involve your mentor in this phase as well. Expect multiple iterations on this deliverable.

Process: To do well in this course, you must be determined to work steadily. This is necessary not only because you have regular progress review meetings and because there are numerous milestones to meet and items to submit for evaluation, but because physical resources such as technician and shop time are limited. Therefore, to explicitly encourage steady, focused work, part of your mark will be based on your cumulative progress. You are expected to put in 100 hr per term per team member, which implies that you need to be working on the project for roughly 8 hr per week.

Product: You will be judged not only on the prototype itself, but also on the drawings and models that you make of it. We will solicit feedback from your client, which will be included in the overall evaluation.

Presentation: You will present not only your final design, but generate numerous short reports and other documents along the way, for example, a discussion of the state of the art and relevant patent/scientific literature material, a technical analysis, a discussion of manufacturing options, a presentation of conceptual models, economic &/or ergonomic &/or ethical &/or social impact analyses, etc. There will also be marked design presentations, at least one per term.

End of Course *Design and Innovation Day*: To celebrate your hard work and to show off your capabilities, we will have a formal trade show at the end of the course before the exam period. Second and third year students will be invited, as will your clients and technical consultants, along with potential employers. Friends and family will be welcome, and the public will be invited as well.

Mark Sharing: As in MECH 328, teamwork often involves the risk of some members not pulling their weight or not allowing certain team members to make their own contribution, or, conversely, performing above expectations. We will therefore use the iPeer on-line peer review process twice in each term as a way of assessing and addressing these issues.

Report and presentation dates will be posted on the course CANVAS website. For each of the deliverables, we will post a document in the "Dossier" folder. The timing is flexible and will finalized by you and your supervisor. *The dates in italics are NOT flexible.*

Project Selection	***7AM, Monday, September 9, 2019***
Proposal Document	**In October, 2019**
Concept Presentations	***Team meeting times, Oct. 22 & 24, 2019***
CFP Presentations	***Team meeting times, Nov. 19 & 21, 2019***
Technical Analysis	**January, 2020**
Alpha Design Review Presentations	***2-5PM, March 10 & 12, 2020***
Test Protocol Reviews	***Team meeting times, March 17 & 19, 2020***
Design and Innovation Day	***April 7, 2020***
Final Report and Logbook	***4PM, Monday, April 20, 2020***

Marking Rubric

Your mark will be a combination of your team mark and an individual component, combined with an iPeer-derived adjustment.

Team Mark:	
- Design documentation as per the Dossier List:	900 points
- Quality of the Prototype:	400 points
Conc. Alt. presentation 10%	
CFP presentation 10%	
Alpha design review 20%	
Final design review 60%	
- Team participation	
(participatory workshops, presentation reviews, reflections):	100 points
Total Team Mark:	**1400 points**

Individual Mark:	
- Participation	
(lectures, completing the iPeer evaluations)	100 points
- Logbook	80 points
- Design Paper literature review	20 points
Total Individual Mark:	**200 points**

The instructor team reserves the discretion to override this nominal marking ratio between individual and team components in situations of significant disparity in contribution or performance between student team members. iPeer and other sources will be used to inform any changes.

Total mark: Team + Individual: 1600 points

Max mark: 100% of 1600 points

Resources

Textbook

We recommend that each team have access to a copy of ***Product Design and Development***, by **Karl Ulrich** and **Steven Eppinger 2016,** to guide you through the overall design process.

The MECH 2 instructors have written a reference book for MECH 2 students. If you don't have a copy already, this book will be available for purchase to 4th-year students. Please contact Prof. Pete Ostafichuk.

Consultation with Faculty

As mentioned earlier, you will have weekly meetings with your instructor. You should also use your connections with other faculty in the department and elsewhere as resources.

Technician Resources
Machine Shop Instructor: Markus Fengler, mfengler@mech.ubc.ca, KAIS 1190C, 827-5655

Instrumentation Shop Supervisor: Glenn Jolly, gjolly@mech.ubc.ca, KAIS 1220, 822-4530

Each team will have access to assistance from these technicians to assist with completion of the project, with the cost coming out of the team budget. We encourage you to plan ahead for how you will use this time – remember that the shop gets busy toward the end of the terms.

Drawings must be submitted for any work done by workshop technicians. All drawings must be submitted to Markus Fengler for scheduling and allocation. Unsuitable drawings will be returned for correction and revision. Work will not start until suitable drawings have been submitted. Each drawing must be approved and signed by the project supervisor.

Student Shop Time
Students are encouraged to do project work in the shop on their own, as equipment and safety permit. Access to both the student shop and the main machine tools (milling machine and lathes) are likewise scheduled.

NOTE: Any student using the machine shop must first obtain insurance ($7; bought through the Mechanical Engineering Department) and have completed a shop orientation session.

Workshop Space

The course has access to a lab space in Rusty Hut, RH118. This can be opened by your UBC ID card for most of the duration of the two terms: from Oct. 2 through May 31. There are twenty $1m^3$ lockers. You will be given the combination to your locker's padlock. If you have large items, use bike lock technology to secure them in the lab near your locker (tag such items with the provided ID forms).

There is a storage room, RH104 (~opposite RH118), which has supplies left over from previous years. You'll find plywood, plastic tubing, some fasteners, motors, etc. Use at will. The door's combination will be provided to you.

Toolbox

A toolbox is available for sign-out from the Machine Shop. This should nominally be kept in the team locker in RH 118, and must be signed back in at the end of the academic year. Please note the policy for broken/lost items.

Funds

Each project team will be allocated up to $750 from the MECH Department. These funds are available for materials, components, logbooks, posters, etc., and may be released from the internal account in three ways: (1) as reimbursements upon presentation of receipts, (2) as charges for materials available through our shop, or (3) by ordering parts or supplies through UBC's ECE Stores. Further details on the procedure will be provided later in the course. You should have additional funds at your disposal from your sponsor. All expenditures must be approved by the team's faculty supervisor.

APSC 496-D Option

If you are interested in pursuing (or are enrolled in) the option to combine the New Venture Design Course and MECH Capstone, please consult the faculty coordinator for details.