MECH 223 Syllabus
2015W

Calendar Description

MECH 223 – Mechanical Design: design methodology, synthesis and analysis. Design projects representing both mechanical mechanism design and thermofluid systems.

Credits: 7

- Pre-requisites: MECH 220 and 221
- Co-requisites: MECH 222
- Course Dates: January 5 to 30 and April 7 to 29

Course Goals

The instructor expectation for MECH 223 is that, by the end of the course, you should be able to:

- describe the engineering design process and the related tools used in this process
- apply the design process and related tools to solve unstructured, open-ended problems with specific goals but multiple potential solutions
- demonstrate practical applications of key engineering concepts from MECH 220, MECH 221 and MECH 222
- demonstrate effective and professional communication skills through oral presentations and written documents
- work effectively in a group and develop strategies for dealing with group conflict and dysfunction

In addition, we hope that you will have a heightened appreciation for the role of an engineer as a professional in society.

Teaching Team

There are three instructors pleased to be involved with this course:

- Pete Ostafichuk, ostafichuk@mech.ubc.ca, CEME 2053A
- Markus Fengler, mfengler@mech.ubc.ca, KAISER 1190C
- Agnes d'Entremont, agnes.dentremont@mech.ubc.ca, KAIS 1132 (course coordinator)

Our office hours are by appointment, but we generally find most questions can be answered in the times before, after, or between classes.

You will also get to work with a stellar and committed group of teaching assistants, including: Kenard Agbanlog, Graham Hendra, Mahsa Khalili, Mohammad Miraskari, M'Beth Schoenfeld, Navid Shirzad, and Jeff Yeo. We ask that you direct any course questions to one of the instructors as the teaching assistants' time is dedicated to in-class activities and they do not get extra time for office hours.

Textbook

The following textbook is required for MECH 223 and is available at the UBC Bookstore for $34.65:

> **The Engineering Design Process: An Introduction for Mechanical Engineers**, Second Edition (Ostafichuk, Hodgson, Fengler, ISBN 978-0-9920587-1-5)

This edition is recommended, but previous versions of the textbook will also suffice for the course.[1]

The course is taught using Team-Based Learning (TBL) and you will need the textbook to complete reading assignments prior to class (see pages 6 and 7 for details). By the end of the course, you will have covered the entire text. The book is also used as a reference in MECH 328 and MECH 45X so be sure to hang onto it after MECH 223.

iClicker

Throughout the classes, questions will be posed using the iClicker classroom response system. Each student is required to have an iClicker for their exclusive use during classes – that is, you can borrow a clicker from a friend if you wish, as long as you are always able to bring that clicker to class and it is not concurrently being used by another MECH 223 student. Part of your course grade will be based on participation on clicker questions.

Course Topics

PART I – INTRODUCTION TO DESIGN (January)

Module 1: Design Process and Ideation

- RAP Quiz 1
- Project Management
- Generating ideas
- Evaluation and decision making

Module 2: Implementation

- RAP Quiz 2
- Minimum constraint design
- Estimating performance
- Material selection

Module 3: Mechanical Components and Mechanisms

- RAP Quiz 3 & Midterm Test 1
- Mechanisms
- Making parts
- Material selection
- Design Project 1 competition and formal presentations

[1] The original version of the book had the title "Mechanical Design: The Mechanical Design Process in MECH 223."

PART II – REFINEMENT (April)

Module 4: Specification and Design Tools

- RAP Quiz 4
- Design process
- Uncertainty analysis
- Engineering economics
- Formal design methods

Module 5: Detailed Design

- RAP Quiz 5 & Midterm Test 2
- Optimization
- Mitigating failure
- Design for manufacture, assembly, and usability

Module 6: Broad Context of Design

- RAP Quiz 6
- Societal context
- Patents and bringing ideas to market
- Design Project 2 competition and formal presentations

Course Structure

MECH 223 is a design course which will draw on the information from MECH 220, MECH 221, and MECH 222. The course is divided into two parts: January features a project that supports the MECH 221 material and April features a project that supports the MECH 222 material. The weekly schedule is similar to MECH 221 and 222, and the main activities include:

Activity	Description
Class	Design is as much art as science. As such, there is generally no single right answer, but a range of better or worse responses to a design need. Our goal is to help you develop good insight into design problems, and judgment and wisdom in assessing potential solutions. The technical content in this course will be given to you largely in the form of readings and other resources that you will be expected to go through in advance of the classes. In the classes, you will work with your team to discuss and apply the knowledge you have gained through your readings in order to develop your ability to weigh different approaches and justify the approaches you choose to take. Engineering design is also about making informed trade-offs under time and resource constraints – can you tell when it is time to say enough is enough? This also is a skill you will work on in the classes through discussing questions with your team, presenting the results of your team's discussion to the class, and engaging in broader class discussions.

Tutorials	There will be four tutorial sessions each week (8-9am MWF; 11am-12 T). In these sessions, you will either have some hands-on experience with some equipment discussed in class, or have an opportunity to work on problems and prepare for class exercises. Tutorial sessions are done in your sub-teams (sometimes your full teams) with the assistance of a TA. Midterm and final exam problems will typically relate to problem session topics so you are therefore expected and encouraged to work together as a team to make sure that everyone in your team understands the material. There is a sign-in procedure for tutorials (see the next section).
Design meetings	There are two times per week arranged for project team meetings. Note that this time alone is far from sufficient to complete the project, but it will allow you a common time in your schedule to get together and coordinate your individual activities. You will be expected to provide progress reports to a TA at these meetings and have the TA sign a logbook for your project. The TA will also be there to answer design questions but note that the TA's time is shared between five groups at the meeting. In addition, a small number of these meetings will be devoted to group process/functioning issues.
Computer labs	You will have weekly computer labs to further develop your skills in using computer-based tools for engineering design. In particular, two labs will focus on the use of the CES material selection software, one lab will focus on optimization using MATLAB, and two labs will focus on the use of simulation in design. Unless otherwise specified, the **computer labs are to be completed in your assigned sub-teams (groups of 3-4)**; although you may collaborate with your full team or others, the work you submit must be prepared and presented independently.
Prototyping labs	There are specific blocks scheduled for you to do fabrication work on your project and to demonstrate prototypes of your project device. Each team will be supplied with a toolkit and a basic materials kit. There will also be some equipment in the project workspace. There will be some TA supervision and assistance during these labs, and some priority access to Department fabrication facilities and equipment. **Note that this time alone is far from sufficient to complete the project and you should expect to spend a significant amount of you own time developing and building your projects.**
Technical communications	There are MECH 226 classes and tutorials that continue through all of second term. Where possible, the tutorials and activities are integrated with design projects. If you are not registered in MECH 226, you do not attend these activities. Reports, posters, and presentations are jointly submitted for MECH 223 and MECH 226 so all students participate in these regardless of MECH 226 registration status.
Special events (Thursdays)	As with MECH 221 and MECH 222, Thursdays are generally set aside for special events. In MECH 223, you can look forward to a fun design challenge to introduce you to the design process and acquaint you with your team members; a rapid visualization workshop taught by an industrial designer to help you understand what is involved in recording and communicating design ideas; a mechanism disassembly exercise; and two design competitions. In order to give you more time on the days preceding the design project competitions and formal presentations, some lecture material has been moved from the final Wednesdays to earlier Thursdays.

Tutorial Sign-in Procedure

At the tutorials, you will "sign-in" with your team upon arrival. This is done by adding your name, student number, and time of arrival to the top of the tutorial submission your sub-team (or full team) submits. The time of arrival information will also be recorded for each individual for each tutorial in a table in the logbook.

There are no direct penalties applied to individuals or teams for late arrival, so this mainly serves as a record of when people arrive. If one member is routinely late, think about how that impacts the team – both in terms of marks and team cohesiveness – and consider discussing the situation with them. Professional behaviour, including arriving to scheduled team activities on time, is also one of the criteria in the weekly peer evaluations (see the next section). Lastly, at the end of the course, timely arrival to tutorials and meetings will be considered as one piece of evidence for whether to "bump up" students just below a grade boundary (i.e. students with grades of 49%, 54%, 67%, 79%, and 89%).

Evaluation and Grading Structure

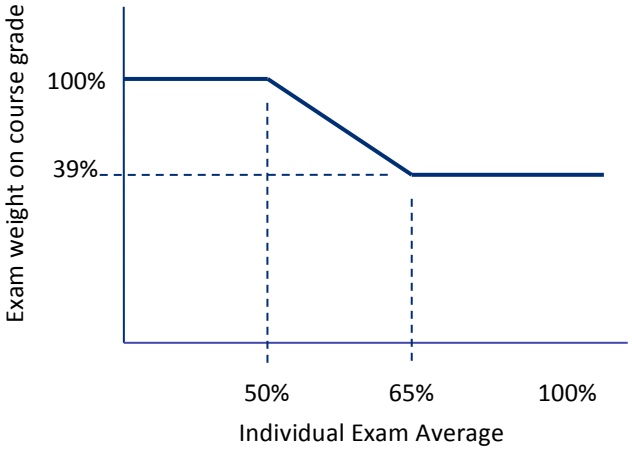
Unlike the other Mech 2 courses, MECH 223 focuses heavily on Team-Based Learning. Many of the activities will be evaluated with a single mark assigned per team but each student will still be individually responsible for the material. The nominal course grades are shown below. (Mech 2 instructors reserve the right to adjust the course grading at any time, as they feel is necessary.)

Mark Components			
Item	**Number**	**Weight**	**Team* or Individual**
Readiness Assurance Process (RAP) Quizzes	6 6	5% 5%	I T
Computer labs	5	5%	T
Tutorials, Exercises, and Clicker questions	-	5%	T, T, I
Projects			
Oral presentations and posters (10%) Project 1 report and Project 2 design review (13%) Management charts and logbooks (2%) Competition scores and prototypes (10%)	2+2 1+1 2+2 2	35%	T
Midterm Exams**	2 2	12% 3%	I T
Final exams**	2 1	27% 3%	I T

* Note 1: The team component of your grade will be subject to a peer assessment which is designed to recognize individual contributions to the team's achievements. Using the *iPeer* online peer evaluation tool, each student will evaluate their teammates' contributions and performance, they will evaluation their own performance, and they themselves will likewise be evaluated. Self-evaluations are for self-reflection and information for the course instructors only and will not influence course grades. The peer evaluation scores within a team (with self-evaluations removed) will average 100% – some individuals will have higher and some lower. The team contribution to each individual's course grade will be determined by multiplying the team grade by the individual's peer evaluation score. In total, there will be seven peer evaluation

events, evenly-spaced in the course. Each peer evaluation event will be open for one week. Late evaluations will be accepted up to one week late, but submitting a late evaluation will reduce your evaluation score by 2% per day late. Following the close of each peer evaluation event, you will receive anonymous and randomly-ordered scores and comments from your teammates. There will be a "dry run" peer assessment early in the first project so that you will be able to identify any issues early and make changes to how your team is functioning.

** Note 2: Midterm exams and Final Exam #1 are each written twice: first as individuals and then immediately followed a second time in your assigned sub-teams. Final Exam #2 is only written individually. You must pass the individually-written exam components on average (receive a composite exam grade of 50% weighted as above on the non-team exams) in order to pass the course. As the project and team marks tend to be quite high, you must achieve a composite individual exam grade of at least 65% in order to receive full credit for the other mark components shown above. For an exam average less than 65%, the weight of the individual exams towards your final grade linearly increases, reaching a maximum of 100% for an exam average of 50% (see the figure to the right). This prevents a student from getting a high mark in the course with an unsatisfactory understanding of the course material.



Team-Based Learning

MECH 223 uses a Team-Based Learning (TBL) approach for the projects and classes. In the TBL method, basic familiarity with course material is gained through readings prior to class and class time is used to focus on application and high-level learning. In contrast, conventional approaches to teaching see class time spent to deliver the basic material and you would be left on your own to figure out the high-level learning out of class.

The six sections of the course (as listed in the Course Topics above) will each follow the format:

1. Out-of-class reading
2. In-class Readiness Assurance Process (see below)
3. Tutorial group work
4. In-class group work
5. In-class discussion
6. Application to project (where applicable)

The two halves of the course will each culminate in a team design project.

In MECH 223, we generally view learning in design as progressing through three different stages: first knowledge, then application, and finally judgment. As shown in the table below, the TBL approach involves the instructor at the higher-level stages rather than leaving you to figure those out on your own.

Level of Learning	Examples of the types of things you do with this level of learning	Traditional Teaching Approach	TBL Approach
Knowledge: learn basic course material (low-level)	Describe methods, list elements, identify parts, compare features	The class is used for the instructor to convey knowledge while students take notes or listen; readings are often assigned but rarely completed by students	On their own, students can obtain most of the basic knowledge needed by completing readings; the first class of a module is used to test understanding and provide feedback
Application: learn to use the course material (mid-level)	Solve problems, construct models, analyze components, explain observations	Some examples are done in class by instructors and in tutorials by TAs; students spend out-of-class time practicing application on their own	Class time and tutorial time is largely used to work through exercises. Projects and team assignments extend these opportunities out of class but results are discussed in class.
Judgment: learn to think critically and extend the course material (high-level)	Invent new approaches, formulate conclusions, judge feasibility, justify arguments	There is very little or no formal high-level instruction; students grapple with this on their own, outside of class; there is no feedback provided by instructors	A significant portion of class time is used to discuss judgment and other high-level learning. The instructor facilitates discussions and is actively involved in providing feedback.

Readiness Assurance Process

The Readiness Assurance Process (RAP) is a technique in Team-Based Learning.[2] It is used to ensure that students are familiar with background information on a topic so that class time can be used more effectively. In particular, students are responsible for learning simple concepts through assigned readings before coming to class so that more time is available for high-level learning guided by instructors. (That is, instead of using the class time to *convey* basic knowledge, the RAP process allows us to spend that time *discussing and practicing how to use* that knowledge.) The steps in the RAP in class are:

1. Individual RAP quiz: an individual multiple-choice test based on a general understanding of material from assigned readings
2. Team RAP quiz: the same multiple-choice test that was conducted individually, but this time taken as a team
3. Instructor feedback: immediate feedback by instructors to ensure all students understand the material before proceeding with more advanced topics

[2] Michaelsen, Larry K., Arletta Bauman Knight & L. Dee Fink. "Team-Based Learning." Stylus Publishing, Sterling, 2004.

Team Structure

The course is organized in a two-level structure – the division and the team. Each student is assigned to a team to work with throughout MECH 223.[3] Teams are comprised of either six or seven students and five teams together constitute a division (thereby making four divisions in the class). Teams play an important role both in class and in the design projects; the divisions is most important in the projects. Some activities are best suited to groups of 3 or 4 so each team is also divided into an assigned sub-team. To maximize team diversity, each MECH 223 team is formed from students drawn from different lab sections in MECH 221. Using MECH 220 and 221 grades and an entrance survey to MECH 223, each team is formed to have roughly equal average GPA and ability in team skills, hands-on skills, and communication skills. In addition, the TypeFocus personality type indicator is used to ensure a distribution of Myers-Briggs personality types on each team.[4]

Professional Standards

All students in this course and in engineering at UBC are expected to conduct themselves in accordance with the high standards demanded of the profession of engineering. This includes, but is not limited to, acting in accordance with University policies on academic conduct. The UBC Calendar articulates what academic is and the responsibility of each student to inform themselves of the standards:

> *Students are responsible for informing themselves of the guidelines of acceptable and non-acceptable conduct for graded assignments established by their instructors for specific courses and of the examples of academic misconduct set out below. Academic misconduct that is subject to disciplinary measures includes, but is not limited to, engaging in, attempting to engage in, or assisting others to engage, in any of the actions described below.*
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> *Cheating, which may include, but is not limited to: falsification of any material subject to academic evaluation, including research data; use of or participation in unauthorized collaborative work; use or possession in an examination of any materials (including devices) other than those permitted by the examiner; use, possession, or facilitation of unauthorized means to complete an examination (e.g., receiving unauthorized assistance from another person, or providing that assistance); and dishonest practices that breach rules governing examinations or submissions for academic evaluation…*
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> *Plagiarism, which is intellectual theft, occurs where an individual submits or presents the oral or written work of another person as his or her own... Failure to provide proper attribution is plagiarism because it*

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[3] As noted by Michaelsen et al., it is essential that teams be formed by the instructors in order to minimize barriers to group cohesiveness. In addition, assigned teams ensure that student resources are distributed as evenly and as effectively as possible. Additional research in team effectiveness has revealed that by a ratio of almost 2 to 1, students found their worst team experience came from working in groups they themselves formed while the best experiences were in instructor-formed teams (Weiman, "Why Groups Fail: Student Answers," *The Teaching Professor*, Vol. 5, No. 9, November 1991). In perhaps the most comprehensive study of team performance in engineering, it has been shown that diverse, instructor-formed teams not only outperform student self-selected teams, but they also have a more positive course and team experiences (Brickell, J.L., Porter, D.B., Reynolds, M.F., and Cosgrove, R.D., 1994, Assigning Students to Groups for Engineering Design Projects: A Comparison of Five Methods, Journal of Engineering Education, July 1994).

[4] Except for rare exceptions, seven of the Myers-Briggs preferences (Introversion, Extraversion, Sensing, iNtuition, Thinking, Judging, and Perceiving) are represented on all teams by at least two students. There are often not enough students in Mechanical Engineering with a Myers-Briggs preference for "Feeling" to ensure equal distribution of that preference across teams.

represents someone else's work as one's own. Plagiarism should not occur in submitted drafts or final works. A student who seeks assistance from a tutor or other scholastic aids must ensure that the work submitted is the student's own. Students are responsible for ensuring that any work submitted does not constitute plagiarism. Students who are in any doubt as to what constitutes plagiarism should consult their instructor before handing in any assignments...

You are expected to familiarize yourself with the full set of standards on academic conduct from the Calendar, particularly if you are new to UBC or Canada. I recognize that there may be temptations to "borrow" another student's work in order to complete an assigned task on time, but I urgently implore you to resist this temptation. You will not learn by copying, and the benefit to your final grade will generally be minuscule. At the same time, in engaging in any form of academic misconduct you risk severe consequences that could follow you long after you leave UBC, if you are allowed to continue your studies. Also note that there is also little difference between copying another person's work and providing your work to another person to copy; both are dishonest and with be dealt with in the same manner and with the same severity.

If you have any doubt about what is acceptable practice, please see one of the course instructors for guidance.