ENGG*4220 Interdisciplinary Mechanical Engineering Design

Winter 2019
Section(s): C01

School of Engineering
Credit Weight: 0.75
Version 1.00 - January 07, 2019

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1 Course Details

1.1 Calendar Description

This is a general design course for students registered in the B. Eng. major in mechanical engineering who wish to develop a broad based mechanical engineering foundation. Students work in groups to develop a general mechanical engineering design. Special attention is paid to the sustainability of the design, its economic feasibility and overall efficiency.

Pre-Requisite(s): ENGG*3100

1.2 Course Description

This course will provide students with practical experience in mechanical engineering system modelling and design. Students will apply theory and knowledge to the design a complex engineered system, which students will build and test.

1.3 Timetable

Lectures:

Day	Time	Location
Tuesday, Thursday	10:00 AM - 11:20 AM	THRN, Room 1435

Labs:

Section #	Day	Time	Location
0101	Friday	2:30 PM - 05:20 PM	THRN 1004

1.4 Final Exam

Date: 11:30AM - 01:30PM (2019/04/16)

Room TBA

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2 Instructional Support

2.1 Instructional Support Team

Instructor:	Hari Simha PhD, PEng
Email:	csimha@uoguelph.ca
Telephone:	+1-519-824-4120 x58262
Office:	RICH 3502
Office Hours:	MWF: 11-Noon

2.2 Teaching Assistant(s)

Teaching Assistant:	Reem Zeitoun
Email:	rzeitoun@uoguelph.ca
Office Hours:	TBD

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3 Learning Resources

3.1 Required Resource(s)

Course website (Website)

Course material, news, announcements, and grades will be regularly posted to the ENGG*4220 CourseLink website. You are responsible for checking the site regularly.

3.2 Recommended Resource(s)

Machine Design: An Integrated Approach (Textbook)

Norton, R. L. Prentice Hall.

The text has been used in ENGG*3280 Machine Design and will be a useful reference.

Materials and the Environment: Eco-informed Material Choice (Textbook)

M.F. Ashby. Materials and the Environment: Eco-informed Material Choice. Butterworth- Heinemann. Butterworth-Heinemann, 2013.

Materials and Sustainable Development (Textbook)

M.F. Ashby. Materials and Sustainable Development. Elsevier Science, 2015.

Materials Selection in Mechanical Design. (Textbook)

M.F. Ashby. Materials Selection in Mechanical Design. Elsevier Science, 2016.
This is an excellent book and is the basis for our treatment of materials selection and the famed Ashby charts. Consider buying it. A pdf copy of an older version is available online in our library's catalog.

Engineering Design (Textbook)

G. Dieter and L. Schmidt. Engineering Design: Fifth Edition. McGraw-Hill Higher Education, 2012.

Engineering Design: A Project-Based Introduction (Textbook)

C.L. Dym, P. Little, and E. Orwin. Engineering Design: A Project-Based Introduction, 4th Edition: Fourth Edition. Wiley Global Education, 2013.

Engineering Optimization (Textbook)

S.S. Rao. Engineering Optimization: Theory and Practice. Wiley, 2009.

The mechanical design process (Textbook)

David Ullman. The mechanical design process. McGraw-Hill Science/Engineering/Math, 2009.

3.3 Additional Resource(s)

Lecture Information (Notes)

Some of the lecture material will be posted on CourseLink and will constitute the main source of instructional material in this course.

Assignments (Notes)

Download the assignments according to the schedule given in the CourseLink website.

Miscellaneous Information (Notes)

Lectures are the main source of material which includes important discussions and worked examples that might not be found elsewhere. Other information related to this course will be posted on CourseLink.

Software (Software)

ANSYS and Matlab

3.4 Communication and e-mail policy

Please use lectures and tutorials as the main opportunity to ask questions about the course. Electronic communication should be limited to the course forum; however, topics of a personal and confidential nature (eg. illness, marks, and personal issues) should be emailed to the instructors e-mail: **csimha@uoguelph.ca.**

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4 Learning Outcomes

4.1 Course Learning Outcomes

By the end of this course, you should be able to:

1. Explain the engineering design process and explain the tools and concurrent nature of the process at a rudimentary level.
2. Select material for the design under single and multiple constraints and perform rudimentary eco-audits.
3. Be able to use Matlab for optimization and Ansys for design, combine the two softwares for design optimization.
4. Design a simple multi-physics system and model it in Ansys or Matlab
5. Apply skills and tools developed in the course to develop a concept, design and build a prototype.
6. Use physical principles to develop simple mathematical models

4.2 Engineers Canada - Graduate Attributes (2018)

Successfully completing this course will contribute to the following:

#	Outcome	Learning Outcome(s)
1	Knowledge Base	2, 5, 6
1.1	Recall, describe and apply fundamental mathematical principles and concepts	2, 5, 6
1.2	Recall, describe and apply fundamental principles and concepts in natural science	5, 6
1.3	Recall, describe and apply fundamental engineering principles and concepts	2, 5, 6
1.4	Recall, describe and apply program-specific engineering principles and concepts	2, 5, 6
2	Problem Analysis	2, 5, 6
2.1	Formulate a problem statement in engineering and non-engineering terminology	5, 6
2.2	Identify, organize and justify appropriate information, including assumptions	5, 6
2.3	Construct a conceptual framework and select an appropriate solution approach	2, 5, 6
2.4	Execute an engineering solution	2, 5, 6

#	Outcome	Learning Outcome(s)
2.5	Critique and appraise solution approach and results	5, 6
3	Investigation	5
3.1	Propose a working hypothesis	5
3.2	Design and apply an experimental plan/investigative approach (for example, to characterize, test or troubleshoot a system)	5
3.3	Analyze and interpret experimental data	5
3.4	Assess validity of conclusions within limitations of data and methodologies	5
4	Design	1, 2, 4, 5
4.1	Describe design process used to develop design solution	1, 4, 5
4.2	Construct design-specific problem statements including the definition of criteria and constraints	1, 4, 5
4.3	Create a variety of engineering design solutions	4, 5
4.4	Evaluate alternative design solutions based on problem definition	2, 4, 5
4.5	Develop and refine an engineering design solution, through techniques such as iteration, simulation and/or prototyping	4, 5
5	Use of Engineering Tools	2, 3, 4, 5
5.1	Select appropriate engineering tools from various alternatives	2, 3, 4, 5
5.2	Demonstrate proficiency in the application of selected engineering tools	2, 3, 4, 5
5.3	Recognize limitations of selected engineering tools	2, 3, 4, 5
6	Individual & Teamwork	4, 5
6.1	Describe principles of team dynamics and leadership	4, 5
6.2	Understand all members' roles and responsibilities within a team	4, 5
6.3	Execute and adapt individual role to promote team success through, for example, timeliness, respect, positive attitude	4, 5
6.4	Apply strategies to mitigate and/or resolve conflicts	4, 5
6.5	Demonstrate leadership through, for example, influencing team vision and process, promoting a positive team culture, and inspiring team members	4, 5

#	Outcome	Learning Outcome(s)
	to excel	
7	Communication Skills	5
7.1	Identify key message(s) and intended audience in verbal or written communication as both sender and receiver	5
7.2	Interpret technical documentation such as device specification sheets, drawings, diagrams, flowcharts, and pseudocode	5
7.3	Construct the finished elements using accepted norms in English, graphical standards, and engineering conventions, as appropriate for the message and audience	5
7.4	Substantiate claims by building evidence-based arguments and integrating effective figures, tables, equations, and/or references	5
7.5	Demonstrate ability to process oral and written communication by following instructions, actively listening, incorporating feedback, and formulating meaningful questions	5
9	Impact of Engineering on Society and the Environment	2
9.1	Analyze the safety, social, environmental, and legal aspects of engineering activity	2

4.3 Relationships with other Courses & Labs

Previous Courses:
ENG*3100: Engineering design process

Follow-on Courses:
ENGG*41XX: Capstone engineering design

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5 Teaching and Learning Activities

5.1 Lecture

Week 1
Topic(s): What is mechanical design?
Description of process
Design for manufacture and assembly

Week 2
Topic(s): Modeling
Dimensional analysis
Analytical and numerical models
Finite element /Finite difference

Week 3
Topic(s): Optimization
Introduction to design optimization
Linking models and optimization
Matlab for optimization - case studies

Week 4
Topic(s): Materials selection
Material properties for interdisciplinary design Ashby charts, case studies pressure vessels, brake materials, and armor

Week 5
Topic(s): Materials selection
Cost modeling, Multiple constraints
Case studies

Week 6
Topic(s): Sustainable design
Philosophy of sustainable design
Eco audits, critical materials,
Case studies in wind turbines and electric cars

Week 7
Topic(s): Winter break

Week 8
Topic(s): Mid term 1
Mid term 1 and intro to Ansys

Week 9
Topic(s): Thermo-mechanical design
Thermo-mechanical problems Bi-morph cantilever, Brakes,
clutches, high p heat x-changers

Week 10
Topic(s): Electro-mechanical design
Electro-mechanical problems
Energy harvesting, electrostatic torsion

Week 11
Topic(s): Fluid-structure interaction
Intro to fluid-structure interaction
Cantilevers, self-excitations, flow in pipes

Week 12
Topic(s): Piezoelectric problems
Fluid, mechanical, and electrical interaction
Intro to ultrasonics

Week 13
Topic(s): Project presentations

5.2 Lab

Week 1
Topic(s): Group Formations
Intro to Matlab and Ansys

Week 2
Topic(s): Proposal and Assignment 1

Week 3
Topic(s): Project activity and Intro to Matlab/optimization

Week 4
Topic(s): Assignment 2 and Intro to Ansys

Week 5
Topic(s): Project activity and Intro to Ansys multi-physics

Week 6
Topic(s): Assignment 3 and Project Activity

Week 7
Topic(s): Project activity

Week 8
Topic(s): Assignment 4 and project activity

Week 9

Topic(s): Ansys multi-physics - design of a disc rotor brake

Week 10
Topic(s): Project activity
Week 10 through week 12 - project activity

5.3 Disclaimer

The instructor reserves the right to change any or all of the above in the event of appropriate circumstances, subject to the University of Guelph Academic Regulations.

5.4 Important Dates

Monday, January 7, 2019: First day of classes

Feb 18-22, 2019: Reading Week (no classes)
Friday, March 8, 2019: 40th class day, last day to drop classes
Friday, April 5, 2019: Last class day
Final exam. - tbd

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6 Assessments

6.1 Assessment Details

Assignments (0%)
Learning Outcome(s): 1,2,3,6
(4unmarked assignments)

Test #1 (20%)
Date: Tue, Feb 26
Learning Outcome(s): 1,6

Test #2 (20%)
Date: Thu, Mar 21
Learning Outcome(s): 2,6

Final Exam (30%)
Date: Fri, Apr 20, 2:30 PM - , 4:30 PM, Room TBA on WebAdvisor
Learning Outcome(s): 1,2,6

Project (30%)
Date: For dates see below
Learning Outcome(s): 3,4,5

Description	Weight	Submission	Location/Time
Group Formation & Project Selection (Week #1)	-	-	Lab time
Project Proposal (Week #2)	5%	Group	Lab time
Project Progress (Week #6)	15%	Group	Lab time
Mock-up/Prototype Test Results (Week #12)	40%	Group	Lab time
Project Presentation (Week #13)	20%	Group	Lecture time
Final report (1 April, 2019)	20%	Group	Courselink

6.2 Tests and Final Exams

In-class tests and final exam will be open-book. You are allowed to bring anything you want to the exam. You may even use the internet. Some items in the questions are deliberately omitted and you are expected to find the missing information. Final exam will cover all material in the course up to the date of the exam, including material from lectures, tutorials and project.

6.3 Design Project

A project will be carried out in groups of 3-4 members. The chosen topic:

- Should involve a minimum of two fields of physics (thermo-mechanical, electro-mechanical , and so on.)
- Should involve a modeling component. Modeling using Maple, Matlab or ANSYS, or any other program is required.
- Should be feasible to fabricate in the semester. Plan ahead and apply for lab fund. The project deliverables are as follows:

1. Project proposal: No more than two pages with problem definition, constraints, design criteria and analysis approach.
2. Progress report: Detailed design with design calculations, constraints, criteria, drawings and specifications.
3. Prototype: Final prototype with test results and validated against model.
4. Final report: Including test results and validations with model. Discussion of discrepancies
   between model and results.

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7 Course Statements

7.1 Course Grading Policies

Academic Consideration: In the event a course requirement is not met owing to medical, psy- chological, or compassionate reasons communicate with the course instructor. For exams missed on account of medical reasons, an instructor's note is required. See the undergraduate calendar for information on regulations and procedures for Academic Consideration**:** http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml

Accommodation of Religious Obligations: In the event a course requirement is not met owing to religious obligations, please e-mail the instructor within two weeks of the commencement of the semester. See the undergraduate calendar for information on regulations and procedures for Academic Consideration of Religious Obligations: http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-accomrelig.shtml

Passing Grade: Exams account for 70% of the marks for this course, and the project accounts for 30% of the marks. In order to pass this course, at least, 50% of marks must be obtained in each of these portions. That is, a minimum of 35% of the marks for the exam

portion and a minimum of 15% marks in the project must be scored for passing. Failure to meet any of the two criteria will result in a failure grade (your total mark or 49%, whichever is less).

Missed Tests: If you miss a test due to grounds for granting academic consideration or religious accommodation, the weight of any missed test will be added to the final exam weight. There will be no makeup quizzes, tests, or midterm.
Questions Concerning Grades: If you have questions about the grade of your quiz or test received, please ask your TA within one week of the document being returned. However, all requests for re-marking must be made to the instructor and accompanied by a re-marking request letter. Any item that is re-marked will be re-marked entirely. Therefore it is strongly suggested that you thoroughly review your entire document before making a re-marking request. Pencil-written works will not be re-marked. Re-marking requests will not be honoured more than one week after the document has been returned.

Project Work: All presentations for the project must be attended by the entire group, and the progress and final report must be uploaded as per the stated deadlines. If you miss a project report due to grounds for granting academic consideration or religious accommodation, arrangements must be made with the teaching assistant to submit the missed report. Late submissions of reports will not be accepted.

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8 School of Engineering Statements

8.1 Instructor's Role and Responsibility to Students

The instructor’s role is to develop and deliver course material in ways that facilitate learning for a variety of students. Selected lecture notes will be made available to students on Courselink but these are not intended to be stand-alone course notes. Some written lecture notes will be presented only in class. During lectures, the instructor will expand and explain the content of notes and provide example problems that supplement posted notes. Scheduled classes will be the principal venue to provide information and feedback for tests and labs.

8.2 Students' Learning Responsibilities

Students are expected to take advantage of the learning opportunities provided during lectures and lab sessions. Students, especially those having difficulty with the course content, should also make use of other resources recommended by the instructor. Students who do (or may) fall behind due to illness, work, or extra-curricular activities are advised to keep the instructor informed. This will allow the instructor to recommend extra resources in a timely manner and/or provide consideration if appropriate.

8.3 Lab Safety

Safety is critically important to the School and is the responsibility of all members of the School: faculty, staff and students. As a student in a lab course you are responsible for taking all reasonable safety precautions and following the lab safety rules specific to the lab you are working in. In addition, you are responsible for reporting all safety issues to the laboratory

supervisor, GTA or faculty responsible.

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9 University Statements

9.1 Email Communication

As per university regulations, all students are required to check their e-mail account regularly: e-mail is the official route of communication between the University and its students.

9.2 When You Cannot Meet a Course Requirement

When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons please advise the course instructor (or designated person, such as a teaching assistant) in writing, with your name, id#, and e-mail contact. The grounds for Academic Consideration are detailed in the Undergraduate and Graduate Calendars.

Undergraduate Calendar - Academic Consideration and Appeals
https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml

Graduate Calendar - Grounds for Academic Consideration
https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml

9.3 Drop Date

Courses that are one semester long must be dropped by the end of the fortieth class day; two-semester courses must be dropped by the last day of the add period in the second semester. The regulations and procedures for course registration are available in the Undergraduate and Graduate Calendars.

Undergraduate Calendar - Dropping Courses
https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-drop.shtml

Graduate Calendar - Registration Changes
https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/genreg-reg-regchg.shtml

9.4 Copies of Out-of-class Assignments

Keep paper and/or other reliable back-up copies of all out-of-class assignments: you may be asked to resubmit work at any time.

9.5 Accessibility

The University promotes the full participation of students who experience disabilities in their academic programs. To that end, the provision of academic accommodation is a shared responsibility between the University and the student.

When accommodations are needed, the student is required to first register with Student

Accessibility Services (SAS). Documentation to substantiate the existence of a disability is required; however, interim accommodations may be possible while that process is underway.

Accommodations are available for both permanent and temporary disabilities. It should be noted that common illnesses such as a cold or the flu do not constitute a disability.

Use of the SAS Exam Centre requires students to book their exams at least 7 days in advance and not later than the 40th Class Day.

More information can be found on the SAS website
https://www.uoguelph.ca/sas

9.6 Academic Integrity

The University of Guelph is committed to upholding the highest standards of academic integrity, and it is the responsibility of all members of the University community-faculty, staff, and students-to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff, and students have the responsibility of supporting an environment that encourages academic integrity. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor.

Undergraduate Calendar - Academic Misconduct
https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml

Graduate Calendar - Academic Misconduct
https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml

9.7 Recording of Materials

Presentations that are made in relation to course work - including lectures - cannot be recorded or copied without the permission of the presenter, whether the instructor, a student, or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

9.8 Resources

The Academic Calendars are the source of information about the University of Guelph’s procedures, policies, and regulations that apply to undergraduate, graduate, and diploma programs.

Academic Calendars
https://www.uoguelph.ca/academics/calendars
