ENGG*4220 Interdisciplinary Mechanical Engineering Design,
ENGG*4580 Sustainable Energy Systems Design
Winter 2015

UNIVERSITY of GUELPH

School of Engineering

(Revision 0: Dec. 28, 2014)

1 Note on Course Co-offering

The courses ENGG*4220 Interdisciplinary Mechanical Engineering Design, and ENGG*4580 Sustainable Energy Systems Design, will be cross-listed and taught in a semi-combined manner for the Winter 2015 offering.

Some lectures and tutorial sessions will be shared. The instructor and graduate teaching assistant will support both courses. Students in both courses will also work on a combined team project, and both courses will share shop and other project resources. Students should plan to be available to attend both lecture and tutorial times. The tutorial activities will be an integral part of the course. Some lectures specific to single courses will occur during tutorial sessions.

2 Instructional Support

2.1 Instructor

Instructor: William David Lubitz, Ph.D., P.Eng.
Office: THRN 2407, ext. 54387
Email: wlubitz@uoguelph.ca
Office hours: Weekly office hour (day and time TBA) or by appointment

2.2 Lab Technician (Sustainable Energy)

Technician: Mike Speagle
Office: RICH 3502, ext. 56803
Email: mspeagle@uoguelph.ca

2.3 Teaching Assistant (Both Courses)

GTA	Email	Office Hours
Kevin Tai	ktai@uoguelph.ca	TBA on Courselink

3 LEARNING RESOURCES

3.1 Course Website

Course material, news, announcements, and grades will be regularly posted to the ENGG*4580 Courselink site. You are responsible for checking the site regularly.

3.2 Required Resources

Both courses will utilize a series of textbooks, all of which are available through the University of Guelph library as e-books at no additional cost to students. ENGG*4580 students will use these texts more extensively than ENGG*4220 students. It is recommended that students download the following books in PDF format:

1. Duffie and Beckman. Solar Engineering of Thermal Processes (4th Ed.) John Wiley & Sons. 2013.
2. Wood, David. Small wind turbines: analysis, design, and application. New York, Springer. 2011.
3. Wagner and Mathur. Introduction to Hydro Energy Systems: Basics, Technology and Operation. Springer, 2011.

3.3 Recommended Resources

The following text has been utilized in ENGG*3280 Machine Design and will be a useful reference for both courses:

Norton, R. L. Machine Design: An Integrated Approach. Prentice Hall. 2011.

We will be utilizing MATLAB to simulate engineering systems. Tutorials and refresher material are available at http://www.mathworks.com/academia/student_center/tutorials/launchpad.html It is recommended that students who need a refresher in MATLAB download and refer to the User Guide: http://www.mathworks.com/help/pdf_doc/matlab/getstart.pdf

Students of both courses may find the following electronic text books relevant. All can be accessed (and downloaded in PDF format) through the University of Guelph library web site:

1. Grote, K-H, Antonsson, E. K. (editors). Springer Handbook of Mechanical Engineering. Springer. 2009. ISBN: 978-3-540-49131-6 (Print) 978-3-540-30738-9 (Online)
2. Kutz, M. (editor). Mechanical Engineers' Handbook: Materials and Mechanical Design, Volume 1, Third Edition. John Wiley & Sons Inc. 2006. Print ISBN: 9780471719854, Online ISBN: 9780471777441, DOI: 10.1002/0471777447
3. Rajamani, Rajesh. Vehicle dynamics and control. New York: Springer. 2012
4. Bautista Paz, Emilio. A brief illustrated history of machines and mechanisms. Dordrecht, New York: Springer. 2010.

3.4 Additional Resources

Lecture Information: Some lecture notes will be posted on Courselink.

Tutorial Information: Tutorial assignments and supporting materials will be posted on Courselink.

Project Information: Project requirements and supporting materials will be posted on Courselink

Miscellaneous Information: Other materials used or presented during the course will be posted on Courselink.

3.5 Communication & Email Policy

Please use lectures and lab help sessions as your main opportunity to ask questions about the course. Major announcements will be posted to the course website. **It is your responsibility to check the course website regularly.** As per university regulations, all students are required to check their <mail.uoguelph.ca> e-mail account regularly: e-mail is the official route of communication between the University and its students.

4 ASSESSMENT (BOTH COURSES)

4.1 Dates and Distribution

Simulation Project	Simulation Project Report	15%	Sat. Feb. 14 at 12:00 noon. Submit via Courselink Dropbox.
Design Project	Individual Design Poster Presentations and Group Design Selection	15% (+5% course bonus if design selected by group)	Week of Jan. 26 during tutorial.
	Component Problem Formulation	10%	Sat. Feb. 7 at 12:00 noon. Submit via Courselink Dropbox.
	Component Design Report	15%	Sat. Feb. 28 at 12:00 noon. Submit via Courselink Dropbox.
	Component Prototype	10%	Assembly-ready component(s) in shop/workroom staging area before Friday March 13 at 12:00 noon.
	Final Design Integration and Performance Testing	10%	Assembly and Integration: Monday March 16 to Friday March 27. Performance Testing: Monday March 30 – Wednesday April 1
	Component Performance Memo	5%	Friday April 3 at 12:00 noon.
Exams	Midterm Exam	10%	Tue. Feb. 24 during lecture period. MCKN 230.
	Final Exam	10%	Wed. April 15, 7:00 pm to 9:00 pm. Location TBD

4.2 Midterm and Final Exams

Exams will be closed book, however, each student may bring up to five sheets of 8½ inch by 11 inch paper containing notes, equations and other material chosen by the student. Both sides of sheets may contain material. Exams will cover all material in the course up to the date of the exam, including material from lectures, tutorials and projects. Exam content will be course-specific (e.g. exam content will be different for ENGG*4220 and ENGG*4580). The midterm exam will be held in MCKN 230 during the lecture period. The location of the final exam will be announced prior to the start of the final exam period.

4.3 Simulation Project

Each student will complete an individual simulation project during the first half of the semester. This project will be centered on answering one or more specific questions about a complex system using a time domain simulation coded in MATLAB. Project topics will be defined, and will be different for each course. The project deliverables are a structured report and MATLAB code. Students must follow the specified project report format, and include all required material, including flow charts and code. All code must follow consistent programming conventions and be well commented. Marks will be deducted for poorly organized or commented code. Due dates and mark allocations are given in Section 4.1. Details, requirements, report templates and other supporting materials will be posted on Courselink.

4.4 Design Project

A central theme of the course will be a large team-based design project. Design teams will consist of approximately 12 students. This multi-stage project includes both individual and team work. The project stages are summarized below. Due dates and mark allocations are given in Section 4.1. Details, requirements, report templates and other supporting materials will be posted on Courselink.

Design Project Stages

1. Individual Design Studies. Each student will independently develop their own design, including a problem definition, criteria and constraints, and evaluation of design approaches. An emphasis should be placed on determining an optimum design architecture, and defining the overall specifications of the design. Students will present their designs to their teams in a poster presentation format, and the team will select one design that will be used by the team for further detailed design. A bonus mark of 5% will be assigned to the overall course mark of the student whose design is selected to be the basis of the detailed design. The team will divide the overall design project into a series of components, and each team member will be assigned a specific component that will be their responsibility for the remainder of the project.
2. Design Plan. This plan must include detailed design specifications, criteria and constraints, and a plan for how the component(s) will be designed and prototyped in the time available.
3. Component Design. Each student will use appropriate models, simulation tools, and potentially mockup or prototype testing, to ensure their component design will function as intended. The component must also be designed in active consultation with other team members, to ensure that the component will integrate properly into the overall design. For example, at locations where components meet students must agree on loads, fasteners or fastening methods, dimensions, fits and tolerances at the locations. Students must also continually ensure that individual components will contribute to the overall performance, and meet the constraints, for the overall design.
4. Component Prototyping. Students will construct functional prototypes of their component designs.
5. Integration and Assembly. All members of the team will work to integrate their component prototypes into a functional assembled prototype.
6. Prototype Testing. The design prototype will be tested in actual use.
7. Component Performance Evaluation. Each student will submit a brief memo documenting the performance of their component, in the context of the overall performance of the design.

4.5 Team Work

Team work is required for several parts of this course, particularly the design project. The design project will require each team member to design their component(s) in active consultation with other team members, and integrate their component(s) into the overall design both at the design and physical prototyping stages. If there is some observation or evidence that you have not been contributing appropriately to the team, then you will be asked to provide evidence of your individual efforts, contributions and results. Keeping a log book may be one effective means to help demonstrate your contributions. If it is determined that a student has not made a good-faith effort to contribute to the team, the entire course mark for the student will be reduced. In extreme cases, the student's course mark could be reduced to a below-passing level and the student could fail the course, even if the student has high marks on exams and the individual portions of the projects.

4.6 Course Grading Policies

Missed Assessments: If you are unable to meet an in-course requirement due to medical, psychological, or compassionate reasons, please email the course instructor. Please see below for specific details and consult 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: If you are unable to meet an in-course requirement due to religious obligations, please email the course instructor within two weeks of the start of the semester to make alternate arrangements. See the undergraduate calendar for information on regulations and procedures for Academic Accommodation of Religious Obligations:
http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-accomrelig.shtml

Passing grade: The passing grade for this course is 50%.

Late Deliverables: Late (> 4 hours) submissions will be penalized if there are not acceptable compassionate or medical grounds. A 30% penalty will be applied for deliverables submitted between 4 and 72 hours late. Deliverables received more than 72 hours late will be assigned a grade of zero. Students not ready to present in their scheduled presentation time will be assigned a grade of zero for that component.

5 AIMS, OBJECTIVES & GRADUATE ATTRIBUTES (ENGG*4220)

5.1 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.

Prerequisite: ENGG*3100

5.2 Course Aims

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

5.3 Learning Objectives

At the successful completion of this course, the student will have demonstrated the ability to:

1. Integrate prior knowledge of mechanics, materials, machine design, control systems, fluid mechanics, heat transfer, thermodynamics and engineering systems to support the design of a complex engineered system.
2. Apply engineering methods to assess the feasibility of proposed design solutions in engineering, financial and social contexts.
3. Design engineered systems to address specific needs.
4. Work as a member of a multidisciplinary design team, able to complete detailed rigorous design of system components, while communicating with the team to ensure those components are optimized within the overall system.
5. Independently identify, integrate and prioritize design criteria in the design of a solution to an identified need.
6. Concisely and articulately communicate the results of an engineering system analysis or design process to an engineering audience.

5.4 Graduate Attributes

Successfully completing this course will contribute to the following CEAB Graduate Attributes:

Graduate Attribute	Learning Objectives	Assessment
1. Knowledge Base for Engineering	1, 2, 4, 5	Exams
2. Problem Analysis	3, 5	Projects, Exams
3. Investigation	3, 4, 5	Projects
4. Design	1,2, 3, 4, 5, 6	Projects

5. Use of Engineering Tools	1, 2, 3	Projects
6. Individual and Teamwork	3, 4, 5	Projects
7. Communication	6	Projects
8. Professionalism	-	-
9. Impact of Engineering on Society and the Environment	2	Projects
10. Ethics and Equity	-	-
11. Economics & Project Management	3, 4, 5	Projects
12. Life-Long Learning	-	-

5.5 Relationships with other Courses & Labs

Previous Courses:

ENGG*3100: Engineering design process

During this course you will apply knowledge and expertise developed in all of your prior courses.

Follow-on Courses:

ENGG*41XX: Capstone engineering design.

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6 AIMS, OBJECTIVES & GRADUATE ATTRIBUTES (ENGG*4580)

6.1 Calendar Description

The analysis and design of sustainable energy systems are presented in this course. Techniques considered include generation of alternative designs to satisfy a problem definition; evaluation of alternative designs; application of modeling simulations and cost analyses.

Prerequisites: ENGG*3370, ENGG*3430, ENGG*4230
Restriction: ENGG*4310

6.2 Course Aims

This course will introduce students to the design of sustainable energy systems, through a combination of theoretical, practical and design-based investigation. A particular emphasis will be placed on the understanding and engineering of entire energy systems.

6.3 Learning Objectives

At the successful completion of this course, the student will have demonstrated the ability to:

1. Understand the governing principles of solar, wind and hydro energy systems.
2. Integrate prior knowledge of fluid mechanics, heat transfer, thermodynamics and engineering systems in order to compare renewable energy systems.

3. Apply knowledge of specific renewable energy technologies to assess the feasibility of proposed energy systems in engineering, financial and social contexts.
4. Critically evaluate proposed energy technologies and systems for practicality and potential performance.
5. Design energy systems based on solar, wind and hydro technologies for specific goals and locations.
6. Concisely and articulately communicate the results of an energy system analysis or design process to an engineering audience.

6.4 Graduate Attributes

Successfully completing this course will contribute to the following CEAB Graduate Attributes:

Graduate Attribute	Learning Objectives	Assessment
1. Knowledge Base for Engineering	1, 5	Exams
2. Problem Analysis	3, 4, 5	Exams, Projects
3. Investigation	4	Projects
4. Design	2, 3, 4, 5, 6	Projects
5. Use of Engineering Tools	2, 3, 4	Projects
6. Individual and Teamwork	3, 4, 5	Projects
7. Communication	6	Projects
8. Professionalism	-	-
9. Impact of Engineering on Society and the Environment	3, 4, 5	Projects
10. Ethics and Equity	-	-
11. Economics & Project Management	3, 4, 5	Projects
12. Life-Long Learning	-	-

6.5 Relationships with other Courses & Labs

Previous Courses:

ENGG*3080: Energy conversion technologies

ENGG*3370: Applied fluids and thermodynamics systems

ENGG*3430: Heat and mass transfer, including radiative heat transfer

ENGG*4230: Energy conversion processes

Follow-on Courses:

ENGG*41XX: Capstone engineering design.

7 AIMS, OBJECTIVES & GRADUATE ATTRIBUTES CONT'D (BOTH COURSES)

7.1 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/D2L but these are not intended to be stand-alone course notes. 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 project.

7.2 Students' Learning Responsibilities

Students are expected to take advantage of the learning opportunities provided during lectures and tutorials. 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 TEACHING AND LEARNING ACTIVITIES

8.1 Timetable

Lectures:

Tuesday		8:30 – 9:50	MCKN 230
Thursday		8:30 – 9:50	MCKN 230
Tutorials:			
Tuesday	ENGG*4220: 01	11:30 – 14:20	THRN 1004/1025/3404
Monday	ENGG*4220: 02	14:30 – 17:20	THRN 1004/1025/3404
Tuesday	ENGG*4580	11:30 – 14:20	THRN 1004/1025/3404

Note: Lectures will sometimes be held during tutorial periods. Tutorial activities will sometimes take place during lecture periods. Do not plan to miss tutorial periods.

8.2 Course Topics and Schedule

The following schedule may be modified during the semester depending on course needs.

Week	Tuesday – ENGG*4580 Variable Locations	Tuesday – ENGG*4220 MCKN 230	Thursday (Both Courses) MCKN 230
1 Jan 5	Intro to Course, Overview	Intro to Course, Overview	Modular System Modelling and Coding
2 Jan 12	Solar Photovoltaic Systems	Vehicle Power Model	System: Electric Vehicle (battery+motor+controller)
3 Jan 19	Solar Resource (Incidence Angle)	Vehicle Structures and Loads	Electric Vehicle Model
4 Jan 26	Solar Resource (Incoming Rad, Data)	Aerodynamic Drag	Energy Storage – Batteries
5 Feb 2	Solar Thermal Systems	Rolling resistance	Wiring
6 Feb 9	Passive Solar Systems	Vibrations, Vehicle Suspension	High Current DC Systems
7	Reading Week		
8 Feb 23	Test 1	Test 1	Energy Storage – Non-battery
9 Mar 2	Test Return and Review	Test Return and Review	Airfoils
10 Mar 9	Wind Engineering	Wind Engineering	Wind Turbines – Betz Limit
11 Mar 16	Wind Turbines – Balance of Plant	Wind Turbines – Balance of Plant	Hydro – Systems, Energy
12 Mar 23	Hydro – Turbines	Hydro - Turbines	Energy Return on Investment
13 Mar 30	Design Testing	Design Testing	Test Results Review, Course Conclusion

8.3 Other Important Dates

Drop Date: The last date to drop one-semester courses, without academic penalty, is Friday, March 6, 2015. Refer to the Graduate Calendar for the schedule of dates:
http://www.uoguelph.ca/registrar/calendars/graduate/current/sched/sched-dates-f10.shtml

8.4 Lab Schedule

The following schedule may be modified during the semester depending on course needs.

Week	ENGG*4580	ENGG*4220
1 Jan 5	MATLAB Review	MATLAB Review
2 Jan 12	Solar Photovoltaic System Model	Vehicle Power Model
3 Jan 19	Solar Resource Model	Vehicle Drivetrain Model
4 Jan 26	Design Presentation and Selection	Design Presentation and Selection
5 Feb 2	Design Review	Design Review
6 Feb 9	Design Review	Design Review
7	Reading Week	
8 Feb 23	Design Review, Component Design	Design Review, Component Design
9 Mar 2	Design Review, Component Fabrication and Testing	Design Review, Component Fabrication and Testing
10 Mar 9	Design Review, Component Fabrication and Testing	Design Review, Component Fabrication and Testing
11 Mar 16	Design Review, Component Fabrication and Testing	Design Review, Component Fabrication and Testing
12 Mar 23	Design Review, Design Assembly	Design Review, Design Assembly
13 Mar 30	Design Testing	Design Testing

9 LAB AND SHOP 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 or shop you are working in. In addition, you are responsible for reporting all safety issues to the laboratory or shop supervisor, GTA or faculty responsible.

If the laboratory or shop rules are not followed, consequences will include removing student's access to the lab or shop. If this results in lab or shop work not being completed, the student will receive a grades of zero, and may be unable to achieve a passing mark in the course.

10 ACADEMIC MISCONDUCT

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 discourages misconduct. 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.

10.1 Resources

The Academic Misconduct Policy is detailed in the Undergraduate Calendar:
http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml

A tutorial on Academic Misconduct produced by the Learning Commons can be found at:
http://www.academicintegrity.uoguelph.ca/

Please also review the section on Academic Misconduct in your Engineering Program Guide.

The School of Engineering has adopted a Code of Ethics that can be found at:
http://www.uoguelph.ca/engineering/undergrad-counselling-ethics

11 ACCESSIBILITY

The University of Guelph is committed to creating a barrier-free environment. Providing services for students is a shared responsibility among students, faculty and administrators. This relationship is based on respect of individual rights, the dignity of the individual and the University community's shared commitment to an open and supportive learning environment. Students requiring service or accommodation, whether due to an identified, ongoing disability for a short-term disability should contact the Centre for Students with Disabilities as soon as possible

For more information, contact CSD at 519-824-4120 ext. 56208 or email csd@uoguelph.ca or see the website: http://www.uoguelph.ca/csd/

12 RECORDING OF MATERIALS

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

13 RESOURCES

The Academic Calendars are the source of information about the University of Guelph's procedures, policies and regulations which apply to undergraduate, graduate and diploma programs: http://www.uoguelph.ca/registrar/calendars/index.cfm?index