Senior Mechanical Engineering Design
ENGG*4xxx

ENGG*4030 Manufacturing System Design
ENGG*4220 Interdisciplinary Mechanical Engineering Design
ENGG*4310 Wind and Solar Energy Design
ENGG*4480 Advanced Mechatronic Systems Design

Winter 2013

Note: These courses will be taught as a single co-located course during the Winter 2013 semester. The following information will apply to students enrolled in any of these courses.

Instructor:

David Lubitz, P.Eng.
Associate Professor
2407 Thornbrough Hall; x54387;
wlubitz@uoguelph.ca
Office Hours: Whenever I am in my office. Scheduled office hour TBD.

Meeting Times:

Lectures	Tu/Th MacKinnon 236	11:30 - 12:50
Tutorials/Labs	TBD	

Teaching Assistant:

Fei He
hef@uoguelph.ca

Texts:

There is no required textbook for the course. A variety of materials will be utilized throughout the course.

Notes:

Copies of lecture presentation materials, plus supplemental materials, will be posted on Courselink. (Note: posting of all materials shown or discussed in class is not guaranteed.)

Prerequisites:

See University of Guelph Calendar

Course Objectives:

Following completion of this course a successful students will understand and be able to apply techniques used in the mechanical engineering design process, including:

- problem formulation
- abstracting, parameterizing and modelling design concepts
- detailed mechanical design and optimization
- material selection in mechanical design, with regard for cost, manufacturing, and fatigue
- design for reliability and safety
- testing and design refinement,
- written, graphical and oral communication of designs and the design process.

Learning Outcomes:

Learning Outcomes are becoming the norm in higher education as a means to improve accountability, to support continuous improvement in teaching and learning and to ease international mobility. The Washington Accord is the engineering agreement in this direction with 14 signatory countries including Canada.[1] As a result, the Canadian Engineering Accreditation Board (CEAB) adopted a graduate attribute approach to engineering program reviews.

Canadian Engineering Accreditation Board – Graduate Attributes

Graduate Attribute	Taught	Assessed	Graduate Attribute	Taught	Assessed
1. Knowledge Base	Y	Y	7. Communication	N	Y
2. Problem Analysis	Y	Y	8. Professionalism	N	N
3. Investigation	Y	Y	9. Environment & Society	N	Y
4. Design	Y	Y	10. Ethics and Equity	N	N
5. Engineering Tools	Y	Y	11. Project Mgmt	N	N
6. Individual & Team Work	N	Y	12. Life-long learning	N	N

The Province of Ontario has introduced UUDLEs (University Undergraduate Degree Level Expectations) for all Ontario programs. There is considerable overlap between the CEAB Graduate Attributes and the Ontario UUDLEs. However, there are important elements in Ontario's UUDLEs that are not covered by CEAB's Graduate Attributes. UUDLEs require CRITICAL THINKING, an understanding of all major engineering fields, an understanding of the methods of all non-engineering disciplines and to hold an awareness of the limits of knowledge.[2]

UUDLEs not covered in CEAB Graduate Attributes

UUDLE	Taught	Assessed
1. Critical Thinking	Y	Y
2. Other Engineering Fields	Y	Y
3. Non-Engineering Fields	Y	N
4. Awareness of Limits of Knowledge	Y	Y

[1] www.washingtonaccord.org/Washington-Accord/signatories.cfm

[2] Stiver W., 2011, CEAB's Graduate Attributes and Ontario's UUDLEs, *Proceedings of the Canadian Engineering Education Association Conference*, St. John's, NFLD, June.

Evaluation:

Item	Grade Weight	Due Dates
Design Reviews	15%	TBD
Initial Design Report	20%	Tuesday Jan. 29 at 11:30 am
Test 1	10%	Tuesday Feb. 12
Test 2	10%	Thursday March 28
Prototype Testing	20%	Week of April 1-5
Final Design Documentation (Report and Kit)	25%	Thursday April 4 at 11:30 am

Design Project:
This project will involve design of a system to address a provided problem. It will include detailed design, construction and testing of a prototype system, and production of comprehensive documentation of the final design and the design process. The class will be divided into groups. Each group will work on a provided design project that will require applying skills and knowledge from across the fields of mechanical engineering.

- Every aspect of the final design must be defensible: the group should have rational answers supported by robust engineering to questions about any aspect of the design. Attention to details and optimization will be essential. Do not take short cuts, or assume that just making "something that works," will be sufficient in this course.
- Optimization of the design will be essential to achieve a passing mark. The designers will be expected to give detailed explanations of the design of each component, including (as appropriate) material choice, fabrication technique, cost, weight, reliability and sustainability. Optimization of processes (e.g. control techniques) and energy usage (e.g. power consumption of motors, transmissions, control systems, etc.) is required. Groups will be expected to demonstrate their design is optimized for safety, reliability, manufacturing, sustainability and user interaction. A final report will be completed that documents the design process, with an emphasis on the optimization of the design.
- The final design should be an "easy to build kit." This kit should consist of all the required parts and materials needed, plus instructions to fabricate and commission the design.
- The instructions for the kit should include comprehensive drawings (parts, assemblies, circuit diagrams, processes and visualizations) that follow engineering conventions.
- Ease of manufacturing is essential. The project design should be optimized for small scale production using a minimum of tools and facilities. If special tools or tooling are needed to fabricate the design, the kit instructions must include how these are built.
- The construction and testing of a prototype is an essential part of the project. Marks will be assigned for the prototype and its performance.
- The design should seek to improve on the current state-of-the-art. The designers are particularly encouraged to consider "value added" design features. The team is also encouraged to be creative and consider "less obvious" possibilities that would add value and set their design apart.
- The final design will not include duct tape, hot glue, wires-twisted-together, scrap wood or wood screws – unless these components are truly part of an optimum solution.

Team Work Expectations:
The Design Project will be completed in teams. There will not be a formal peer evaluation. However, if the instructor becomes aware or suspicious that one or more members have not been substantive contributors to the work then an oral evaluation interview will be arranged. The result of the interview could lead to a grade multiplier of less than 1.0 or the lack of contribution may lead to filing of a case for academic misconduct assessment by the Dean's office. Keeping a logbook may be a prudent step.

Design Reviews:
Regular design reviews will be held with the instructor and each project team. Team members will be expected to provide updates on recent work, explain and defend current design work and choices, and identify action items for the upcoming week. Responses to questions/concerns/action items from the prior design review will be required. Several times during the semester, design reviews will be held with the entire class, so that student teams can learn from, and critique, each other.

Initial Design Report:
The initial design report will be a comprehensive document including:

- Background information, including
  - Specific problem statement for the design
  - Current state-of-the-art
  - Specific, detailed constraints and criteria including identified safety, reliability and financial concerns.
- Presentation of a range of possible design approaches, with preliminary analysis of each approach.
- The overall concept and design framework of the design that will be developed further, including reasoning for its selection.
- Initial predicted performance of the design.
- A detailed plan, including scheduling, to ensure completion of the design work, prototype construction and testing before the end of the semester.
- Identification of each team member's primary and secondary responsibilities for the remainder of the semester.

The initial design report documents the first phases of the design process, including problem definition, background, generation of design alternatives and selection of the preferred alternative for detailed design. After this milestone, the overall design framework is fixed, and the team will proceed with detailed design of the selected alternative.

Tests:
Two tests will be held during the lecture time periods. Tests will be closed notes and books. Data and equation sheets will be made available to you with the test (posted for your information approximately 1 week prior to the test). You will be permitted to bring in your own single aid sheet (8½" x 11").

Prototype Testing:
Each team will have a prototype of their design constructed and ready for testing before Monday, April 1. Prototypes will be tested outdoors over the course of the week. The team will be expected to define a testing program to determine if the prototype meets design objectives, and identify areas for future development. The rooftop lab above Thornbrough 3402 will be made available for secure outdoor testing. Prototype testing results are to be incorporated into the final design report.

Assignments:
Assignments will be provided. The value in completing the assignment yourself will be for your learning. You are responsible for the material that is reflected by these assignments. Assistance in completion of the assignments will be given during the tutorial periods.

Policies:

- Design reviews are part of the evaluation process of the course. All group members will be expected to attend all design reviews. Individuals not attending will receive a mark of zero unless acceptable grounds for compassionate consideration are provided to the instructor.
- **Late penalties**: Reports or deliverables (e.g. prototypes for testing) submitted late, but within 96 hours will receive a 10% non-compounding penalty per day (i.e., the report will be marked, and then the final mark will be multiplied by $1-0.1\times(1+\text{number of days late})$); after 96 hours reports will not be accepted and a grade of zero (0) will be assigned. These penalties will not apply in cases of accepted compassionate or medical grounds – if these grounds exist see the instructor as soon as possible.
- A failing grade will be assessed when a solution is fundamentally flawed.
- **Literacy and Numeracy Expectations:** It is required that students will demonstrate reasonable competency in both numeracy and literacy. Failing grades **will** be assigned on entire questions or projects (or substantial portions thereof) for writing or calculations that are below the 4^{th} year level.
- **Academic Integrity:** Team projects must include a cover page that includes the signature of each student, acknowledging that they have made a substantial contribution to the work, and that the work is solely that of the students. Students who have not signed the cover page will NOT receive the grade assessed for the report. The University's academic misconduct policies will be applied, as described in the Calendar, when it becomes known that a student(s) has committed academic misconduct including claiming credit for work that they have not substantively contributed to.
- Notify the instructor immediately if you identify a conflict between course requirements and religious requirements, such as holy days of obligation.
- The instructor reserves the right to make changes to the course if needed, in accordance with University of Guelph academic regulations. Any course changes from those listed in this course outline will be announced in class and posted on the course Courselink page.