ENGG*4580 Sustainable Energy Systems Design
Winter 2017

School of Engineering

(Revision 3: Jan. 6, 2017)

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1 Instructional Support

1.1 Instructor

Instructor: William David Lubitz, Ph.D., P.Eng.
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Office hours: By appointment

1.2 Lab Technician

Technician: Mike Speagle
Office: RICH 3502, ext. 56803
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1.3 Teaching Assistant

GTA	Email	Office Hours
Scott Simmons	ssimmons@uoguelph.ca	TBA on Courselink

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2 Learning Resources

2.1 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.

2.2 Required Resources

This course 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. Students should download the following books in PDF format:

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

2.3 Recommended Resources

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 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. Bautista Paz, Emilio. A brief illustrated history of machines and mechanisms. Dordrecht, New York: Springer. 2010.

2.4 Additional Resources

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

Tutorial Information: Supporting materials will be posted on Courselink.

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

2.5 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.

3 ASSESSMENT

3.1 Dates and Distribution

The deliverables and distribution of marks for this course, with associated due dates, is:

Deliverable or Activity	Mark	Due Date or Time and Location	Submission Type
PV Design – Problem Definition	5%	Five minute presentation to lab section Jan. 17/18. Problem definition document (two page maximum) to be submitted at start of lab section *and* PDF format file to be posted to course shared drive.	Individual
PV Design – Problem Selection	--	Each group will submit a ranked list of their preferred problem definitions (on paper) at the start of class on Friday Jan. 20. Teams will be notified which definition to use for their project by Jan. 21.	Group
Simulation Project – Definition	5%	On Wed. Jan. 25, submit paper copy of memo at start of lecture, and electronic copy as PDF file to Courselink Dropbox	Individual
PV Design – Design Defense	10%	During lab section Feb 7/8.	Group
Renewable Generation Simulation	10%	Simulation will be demonstrated, tested and critiqued during lab section Feb. 14/15.	Individual
Midterm Exam	15%	Tuesday Feb. 28 during lecture period.	Individual
PV Design – Circuit Prototype	5%	Submit circuit diagram (on paper) and demonstrate circuit prototype during lab sections Mar. 14/15.	Group
System Simulation Project Report	15%	Simulation will be demonstrated, tested and critiqued during lab section Mar. 28/29. Report due Friday, Mar. 31 at 11:59 pm in Courselink Dropbox	Individual
PV Design – Final Design	20%	Poster session and prototype demonstration during lab sections Apr. 4/5. Report due Friday, April 7 at 11:59 pm in Courselink Dropbox.	Group
Final Examination	15%	TBD during final exam period	Individual

3.2 Exams

The midterm and final exams will be closed book. Exams will cover all material in the course up to the date of the test, including material from lectures, tutorials and projects. Each student may bring a sheet of 8½ inch by 11 inch paper containing notes, equations and other material chosen by the student. Both sides

of the paper may contain material. The midterm exam will be held on Tuesday Feb. 28 in MCKN 235 during the lecture period. The final exam will be scheduled during the final exam period.

3.3 Simulation Project

Each student will complete an individual simulation project. The student will model a specific energy system, implement the model in MATLAB and simulate the performance of the system. Details, requirements and other supporting materials will be posted on Courselink.

3.4 Design Project

A central theme of the course will be a group-based design project. Design groups will consist of three or four students and will be assigned by the instructor. Students will be expected to develop and utilize simulation tools using MATLAB as part of their design process. Details, requirements and other supporting materials will be posted on Courselink.

3.5 Team Work

Team work is required for several parts of this course, particularly the design project. 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.

3.6 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%. Students must also achieve a 50% or greater mark on the individual components of the course (problem definition and exams) to pass the course. If the mark for the individual components, weighted as above, is less than 50%, than this mark will be recorded as the student's course mark, even if the course mark including group components is higher (or greater than 50%).

Late Deliverables: Late (> 4 hours) written or code submissions will be penalized if there are not acceptable compassionate or medical grounds. A one letter grade 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/review/defend during a scheduled presentation time will be assigned a grade of zero for that component.

Minimum Quality of Written Deliverables: All written deliverables must be written clearly in grammatically correct English. Deliverables that do not meet a minimum writing quality will be returned unmarked, and the student or group will be required to rewrite and resubmit the deliverable by a specified date. If the student or group does not resubmit the deliverable, or the resubmission is also poorly written, the student or group will receive a mark of zero for the deliverable. The final mark for a rewritten deliverable will be reduced by 25% after marking is completed as a late penalty.

4 AIMS, OBJECTIVES & GRADUATE ATTRIBUTES

4.1 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

4.2 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.

4.3 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 across a range of parameters, including practicality, potential performance, safety and sustainability.
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.

4.4 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	-	-

4.5 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

4.6 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.

4.7 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.

5 TEACHING AND LEARNING ACTIVITIES

5.1 Timetable

Lectures:

Tuesday, Thursday	8:30 am – 9:50 am	MCKN 235
Tutorial:		
Tuesday (01)	11:30 am – 2:20 pm	THRN **1004**/3404 ← *Note new lab room*
Wednesday (02)	8:30 am – 11:20 am	THRN **1313**/3404 ← *Note new lab room*

5.2 Course Topics and Schedule

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

Week	Topics	Text or Reference Material*
Jan. 10/12	Introduction, energy resources, met. data, TMYs	Pode & Diouf, Duffie & Beckman Ch. 19, notes
Jan. 17/19	Review of solar resource (sun position, rad. models)	Duffie & Beckman Ch. 2
Jan. 24/26	Solar thermal panels and systems	Duffie & Beckman Ch. 6, 8, 10
Jan. 31/Feb 2	Solar PV systems and components	Pode & Diouf
Feb. 7/9	Energy storage	Pode & Diouf, notes
Feb. 14/16	Review of wind energy system concepts, Betz limit.	Wood Ch. 1, 2, notes
Feb. 21/23	*Reading Week*	
Feb. 28/Mar. 2	Tuesday Feb. 28: Midterm during lecture period Thursday Mar. 2: Lift and drag, airfoils.	Wood, Ch. 4, notes
Mar. 7/9	Wind turbine blade design: BEM method.	Wood, Ch. 3, 5, notes
Mar. 14/16	Hydropower and hydraulic energy conversion	Wagnur and Mathur, notes
Mar. 21/23	Design of hydropower plants	Wagnur and Mathur, notes
Mar. 28/30	Energy distribution system modeling	Notes provided on Courselink
Apr. 4/6	Tuesday: Review. Thursday: No lecture (conflict w/ 41X)	

* Text books can be downloaded at no additional cost via the University of Guelph library website.

5.3 Other Important Dates

Drop Date: The last date to drop one-semester courses, without academic penalty, is Friday, March 10, 2017. Refer to the Graduate Calendar for the schedule of dates:

http://www.uoguelph.ca/registrar/calendars/index.cfm?index

5.4 Lab Schedule

The following table shows the planned lab schedule at the time of publication. It may be modified during the semester depending on course needs.

Labs will be held in Thorn. 3404 or Thorn. 2313. The location of each lab will be announced in lecture before the lab.

Week and Lab Date	Lab Topic
1 – Jan 10/11	MATLAB Review – Scripts and Functions (2313)
2 – Jan 17/18	Design Project - Problem Definition (3404) MATLAB Review – File I/O (2313)
3 – Jan 24/25	MATLAB Sun Position and Liu and Jordan model (2313)
4 – Jan 31/Feb 1	MATLAB Simplified Solar Thermal Storage (2313)
5 – Feb 7/8	Design Project – Design Defense (3404)
6 – Feb 14/15	Generation Simulation Evaluation (2313)
7 – Feb 21/22	*Reading Week*
8 – Feb 28/Mar 1	MATLAB Wind Resources (2313)
9 – Mar 7/8	Midterm returned MATLAB Airfoil performance model (2313)
10 – Mar 14/15	Design Project – Circuit Prototype (3404) MATLAB Introduction to BEM (2313)
11 – Mar 21/22	MATLAB BEM Design (2313)
12 – Mar 28/29	Simulation Project Evaluations (2313) Hydropower Problems (3404)
13 – Apr 4/5	Design Project – Presentations (3404) Hydropower Problems (3404)

6 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.

7 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.

7.1 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

8 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/

9 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.

10 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