ENGG**4230 Energy Conversion
Fall 2015

UNIVERSITY of GUELPH

School of Engineering

(Revision 0: September 10, 2015)

---

1 INSTRUCTIONAL SUPPORT

1.1 Instructor

Instructor: Animesh Dutta, Ph.D., P.Eng.
Office: RICH 3509, ext. 52441
Email: adutta@uoguelph.ca
Office hours: TBA on Courselink or by appointment

1.2 Lab Technician

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

1.3 Teaching Associate

GTA	Email	Office Hours
Jhantu Kumar Saha	jsaha@uoguelph.ca	TBA on Courselink

---

2 LEARNING RESOURCES

2.1 Course Website

Course material, news, announcements, and grades will be regularly posted to the ENGG*4230 Courselink site. You are responsible for checking the site regularly.

2.2 Required Resources

None

2.3 Recommended Resources

It is not necessary to purchase a textbook in order to follow the course as notes will be provided. However, useful background reading includes:

1. Renewable Energy Resources , 2nd Edition (2006) Authors: John Twidell & Tony Weir; Publisher: Taylor & Francis
2. Renewable Energy-Power for sustainable future, 3rd Edition (2012) Edited by: Godfrey Boyle; Publisher: Oxford
3. Fundamentals of Renewable Energy Process, 2nd Edition (2009) Author: Aldo Vieira da Rosa; Publisher: Elsvier
4. 4.Sustainable Energy: Choosing Among Options, Author: Jefferson W. Tester et. al 2005, MIT Press
5. S.C. Stultz and J. B. Kitto, Steam-its Generation and Use, Babcock and Wilcox 40th Edition
6. Prabir Basu, Cen Kefa, Louis Jestin, Boilers and Burners: Design and Theory, ISBN: 0387987037 Pub: Springer; 1st edition (December 17, 1999)
7. Prabir Basu, Scott A Fraser, Circulating Fluidized Bed Boilers: Design and Operations, ISBN: 075069226X Boston : Butterworth-Heinemann, 1991
8. Meherwan P. and Dr Boyce, Handbook for Cogeneration and Combined Cycle Power Plants, ISBN: 0791801691, Amer Society of Mechanical Engineers, January 2001
9. Rolf Kehlhofer, Rolf Bachmann, Henrik Nielsen and Judy Warner, Combined-Cycle Gas and Steam Turbine Power Plants, ISBN: 0878147365, Pennwell Pub; 2nd edition, August, 1999
10. Energy Conversion Edited by Yogi Goswami 2008

2.4 Additional Resources

Lecture Information: All the lecture notes are posted on the web page (week #1-#12).

Lab Information: The handouts for all the lab sessions are within the lab section. All types of resources regarding tutorials, links to web pages can be found in this section.

Assignments/Projects: Download the assignments/projects according to the schedule given in this handout. All the solutions will be posted as indicated.

Miscellaneous Information: Other information related to Digital Design are also posted on the web page.

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

Projects and Labs: 60 %

Submission 1 (15%): Solar Design: Residential, Friday Oct 16
Submission 2 (15%): Biomass combustion and emissions design, Friday Nov 13
Submission 3 (25%): Hybrid solar-wind techno-economical analysis: Tuesday, Dec 1st, in class
Note: Both paper and electronic copies are to be submitted

Participation in tutorial and geothermal lab: 5%

Test 1: 20%

Thursday Oct 22 in class

Test 2: 20%

Tuesday Nov 24 in class

3.2 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: In order to pass the course, you must pass both the laboratory and exam course portions. Students must obtain a grade of 50% or higher on the exam portion of the course in order for the laboratory write-up portion of the course to count towards the final grade.

Missed midterm tests: If you miss a test due to grounds for granting academic consideration or religious accommodation, the weight of the missed test will be added to the final test. There will be no makeup midterm tests.

Lab Work: You must attend and complete all laboratories. If you miss a laboratory due to grounds for granting academic consideration or religious accommodation, arrangements must be made with the teaching assistant to complete a makeup lab.

Late Lab Reports: Late submissions of lab reports will not be accepted.

4 AIMS, OBJECTIVES & GRADUATE ATTRIBUTES

4.1 Calendar Description

The course introduces the technical criteria for the design of efficient energy conversion processes and systems. It covers review of boilers and cycles, fuel and combustion calculations, and fundamentals of both traditional and emerging energy conversion processes and systems for production of thermal, mechanical, and electrical energy. Topics include fossil, biomass, nuclear fuels, wind, solar, geothermal and fuel cells. Mechanisms for storing energy generated from each of these systems are also studied. The course also discusses conversion of automobile, renovation of old fossil fuel fired plant, co-firing of opportunity fuel, waste to energy technology, emission, and economics of energy projects.

Prerequisite(s): ENGG*3080, ENGG*3260
*Restriction(s):*ENGG*2050.

4.2 Course Aims

This course is an introductory course in digital logic design, which is a basic course in most electrical and computer engineering programs. The main goals of the course are (1) to teach students the fundamental concepts in classical manual digital design and (2) to illustrate clearly the way in which digital circuits are designed today, using CAD tools.

This course is an advanced course in energy stream, which will enhance your knowledge and concepts in energy, energy conversion and energy storage. Current and emerging technologies for conversion of thermal, mechanical, chemical, nuclear, solar and electrical energy will be studied along with the introduction of RETscreen software to analyze techno-economically various energy conversion technologies.

4.3 Learning Objectives

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

1. Have understood fully the scientific and design principles of various energy conversion.
2. Analyze thermodynamic processes and power cycles to identify energy efficiency improvements and technological advancements.
3. Critique equilibrium model of combustion for the estimation of performance and emissions.
4. Evaluate and critique competing energy conversion technologies on an economic and efficiency basis.
5. Be knowledgeable with the basic principles of energy storage.
6. Create ideas and participate effectively in discussions involving energy-conscious decisions.

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

4.5 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.

4.6 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.

4.7 Relationships with other Courses & Labs

Previous Courses:

ENGG*1100 & ENGG*2100: Core design process skills are essential for the energy design project. Team and project management skills are equally important.

ENGG*2230: Design of wind turbine dominantly builds on fluid mechanic principles

ENGG*3260: Energy conversion dominantly builds on thermodynamic principles

ENGG*3080: Energy resources and technology sets the context for the energy conversion challenges that ENGG*4230 addresses

Before (Regular) and After (Coop) Courses:

ENGG*3100: Continuing to advance your design skills is essential for energy conversion

ENGG*3430 & ENGG*3370: Application of thermo fluid principles, and heat and mass transfer limitations can play a significant role in the effectiveness of many energy conversion system design

ENGG*3410: Automated control systems play an integral role in the operation and success of energy conversion facility.

Follow-on Courses:

ENGG*4580 and ENGG*41X: Many final design teams and projects will draw on 4230 skills. Directly benefitting teams addressing energy conversion challenges in their design work. Indirectly benefitting teams that require thermodynamics, fluid mechanics, programming and/or CFD skills.

5 TEACHING AND LEARNING ACTIVITIES

5.1 Timetable

Lectures:			
Tuesday		2:30 – 3:50	MCKN 224
Thursday		2:30 – 3:50	MCKN 224
Tutorials:			
Tuesday	Sec 01	8:30 - 11:30	THRN 2336
Thursday	Sec 02	8:30 - 11:30	THRN 2336
Laboratory:			
Tuesday	Sec 01	8:30 - 11:30	THRN 3404
Thursday	Sec 02	8:30 - 11:30	THRN 3404

5.2 Lecture Schedule

Lectures	**Lecture Topics**	**Learning Objectives**
1	Introduction to energy conversion and sustainability	1, 6
2	Fundamentals of Energy Conversion: Energy forms, conversion systems and energy intensity	1, 2
3	Emission intensity, climate change and energy conversion planning	1, 6
4-6	Solar energy system design: PV and Thermal	1, 2, 4
6-7	Wind Energy system design	1, 2, 4
8	Biomass properties	1, 2, 4
9-11	Thermo-chemical biomass conversion	1, 2, 4
12	Biochemical biomass conversion	1, 2, 4
13	**Test 1 October 22 Thursday**	
14	Review of boilers and cycles	2
15	Fuel and Combustion Calculations	3
16-18	Design of Solids Fuel Conversion Technologies: pulverized, fluidized bed, integrated gasifier combined cycle systems	1, 2, 3, 4
19	Emission control technologies	2, 3, 4
20	Geothermal Energy	1, 2, 4
21	Energy Storage	5
22	**Test 2 November 24 Tuesday**	
23	Presentation	4
24	Presentation	4

5.3 Design Lab/Tutorial Schedule

Week	Activity	Groups
Week 1 - Sept 8th	No lab	All students
Week 2 - Sept 14th	Lab Safety and Solar project: Residential	All students
Week 3 - Sept 21st	RETscreen software introduction	All students
Week 4 - Sept 28th	[Exp 1: Bomb Calorimeter + Biomass Combustion Design Project (Pellet Stove)]+ RETScreen (PV)	Group 1 + (2, 3, 4)
Week 5 - Oct 5th	[Exp 1: Bomb Calorimeter + Biomass Combustion Design Project (Pellet Stove)] + RETScreen (Wind)	Group 2 + (1, 3, 4)
Week 6 - Oct 12th	**Thanksgiving – Holiday: work on your solar project due Friday Oct 16th printout + dropbox in courselink**	
Week 7 - Oct 19th	[Exp 1: Bomb Calorimeter + Biomass Combustion Design Project (Pellet Stove)] + RETScreen (Biomass)	Group 3 + (1, 2, 4)
Week 8 - Oct 26th	[Exp 1: Bomb Calorimeter + Biomass Combustion Design Project (Pellet Stove)] + RETScreen - questions)	Group 4 + (1, 2, 3)
Week 9 - Nov 2nd	Hybrid Solar wind	All students
Week 10 - Nov 9th	Hybrid solar wind **Design project submission Biomass combustion and emissions, Friday Nov 13 printout + dropbox in courselink**	**All students**
Week 11 - Nov 16th	Geothermal + hybrid question and answer	All students
Week 12 - Nov 23th	Geothermal + hybrid question and answer	All students
Week 13-Nov 30th	**Hybrid solar wind design report due December 1st /presentation in class Dec 1st and 3rd**	**All students**

5.4 Other Important Dates

Thursday, September 10, 2015: First day of class

Monday, October 12, 2015: Thanksgiving holiday

Tuesday, October 13, 2015: Fall study day, no classes

Friday, November 6, 2015: 40th class day, last day to drop classes

Friday, December 4, 2015: last day of class

6 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.

If the laboratory rules are not followed, consequences will include removing student's access to the lab. If this results in lab work not being completed, the student will receive a grade of 0.

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