ENGG*4230 Energy Conversion

Fall 2017

Sections(s): C01

School of Engineering

Credit Weight: 0.75

Version 1.00 - September 07, 2017

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1 Course Details

1.1 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.

Pre-Requisite(s): ENGG*3080, ENGG*3260

Restriction(s): ENGG*2050

1.2 Timetable

Lectures:

Tuesday		04:00PM - 05:20PM	RICH 2529
Thursday		04:00PM - 05:20PM	RICH 2529

Laboratory:

Tuesday	Sec 01	11:30AM - 02:20PM	THRN 1012, THRN 2336, THRN 3404
Thursday	Sec 02	11:30AM - 02:20PM	THRN 1012, THRN 2336, THRN 3404
Friday	Sec 03	02:30PM - 05:20PM	THRN 1012, THRN 2336, THRN 3404

1.3 Final Exam

NO FINAL EXAM.

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2 Instructional Support

2.1 Instructor(s)

Animesh Dutta
Email: adutta@uoguelph.ca
Telephone: +1-519-824-4120 x52441
Office: RICH 3509
Office Hours: TBA on Courselink or by appointment

2.2 Instructional Support Team

Lab Technician: Michael Speagle
Email: mspeagle@uoguelph.ca
Telephone: +1-519-824-4120 x56803
Office: RICH 1507

2.3 Teaching Assistant(s)

Name	Details
Shakirudeen Salaudeen	ssalaude@uoguelph.ca
Mohammad Shallouf	mshallou@uoguelph.ca

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3 Learning Resources

3.1 Required Resources(s)

Course Website (Website)

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

3.2 Recommended Resources(s)

Renewable Energy Resources , 2nd Edition (2006) Authors: John Twidell & Tony Weir; Publisher: Taylor & Francis (Textbook)

Renewable Energy-Power for sustainable future, 3rd Edition (2012) Edited by: Godfrey Boyle; Publisher: Oxford (Textbook)

Fundamentals of Renewable Energy Process, 2nd Edition (2009) Author: Aldo Vieira da Rosa; Publisher: Elsvier (Textbook)

Sustainable Energy: Choosing Among Options, Author: Jefferson W. Tester et. al 2005, MIT Press (Textbook)

S.C. Stultz and J. B. Kitto, Steam-its Generation and Use, Babcock and Wilcox 40th Edition (Textbook)

Prabir Basu, Cen Kefa, Louis Jestin, Boilers and Burners: Design and Theory, ISBN: 0387987037 Pub: Springer; 1st edition (December 17, 1999) (Textbook)

Prabir Basu, Scott A Fraser, Circulating Fluidized Bed Boilers: Design and Operations, ISBN: 075069226X Boston : Butterworth-Heinemann, 1991 (Textbook)

Meherwan P. and Dr Boyce, Handbook for Cogeneration and Combined Cycle Power Plants, ISBN: 0791801691, Amer Society of Mechanical Engineers, January 2001 (Textbook)

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 (Textbook)

Energy Conversion Edited by Yogi Goswami 2008 (Textbook)

3.3 Additional Resources(s)

Lecture Information (Notes)

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

Lab Information (Notes)

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 (Notes)

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

Miscellaneous Information (Other)

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

3.4 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 <uoguelph.ca> e-mail account regularly: e-mail is the official route of communication between the University and its students.

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4 Learning Outcomes

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 and ASPEN Plus software to analyze techno-economically various energy conversion technologies.

4.1 Course Learning Outcomes

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

1. Have understood fully the scientific and design principles of various energy conversion, and

will become proficient in engineering calculations of the performance and preliminary design of various energy conversion systems
2. Analyze thermodynamic processes and power cycles to identify energy efficiency improvements and technological advancements.
3. Become familiar with the physics of the environmental issues, including the greenhouse effect and global climate change, and 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. Become knowledgeable with the basic principles of energy storage.
6. Create ideas and participate effectively in discussions involving energy-conscious decisions.

4.2 Engineers Canada - Graduate Attributes

Successfully completing this course will contribute to the following:

#	Outcome Set Name	Course Learning Outcome
1	Knowledge base	1, 2, 3, 5
1.1	Recall, describe and apply fundamental mathematical principles and concepts	1, 2, 3, 5
1.2	Recall, describe and apply fundamental concepts and principles in natural sciences	1, 2, 3, 5
1.3	Comprehend and apply fundamental engineering concepts	1, 2, 3, 5
1.4	Comprehend and apply program-specific engineering concepts	1, 2, 3, 5
2	Problem analysis	1, 2, 3, 4
2.1	Formulate a problem statement in engineering and nonengineering terminology	1, 2, 3, 4
2.2	Construct a conceptual framework	1, 2, 3, 4
2.3	Identify, organize and justify appropriate information	1, 2, 3, 4
2.4	Execute an engineering solution	1, 2, 3, 4
2.5	Critique and appraise results	1, 2, 3, 4
3	Investigation	3, 4
3.1	Propose and test working hypotheses	3, 4
3.2	Design and apply an investigation plan	3, 4
3.3	Analyze and interpret experimental data	3, 4
3.4	Assess validity of conclusions within limitations of data and methodologies	3, 4

#	Outcome Set Name	Course Learning Outcome
4	Design	1, 4, 6
4.1	Describe the design process	1, 4, 6
4.2	Construct design-specific problem statements	1, 4, 6
4.3	Create engineering design solutions	1, 4, 6
4.4	Develop engineering design solutions	1, 4, 6
4.5	Assess engineering design solutions	1, 4, 6
4.6	Implement engineering design solutions	1, 4, 6
5	Use of engineering tools	4
5.1	Select appropriate engineering tools from various alternatives	4
5.2	Apply selected engineering tools	4
5.3	Recognize limitations of selected engineering tools	4
6	Individual and team work	1, 2, 3, 4, 5, 6
6.1	Act as an individual team member to promote team success	1, 2, 3, 4, 5, 6
6.2	Demonstrate leadership through team building, providing feedback and positive attitude	1, 2, 3, 4, 5, 6
7	Communication skills	3, 4, 6
7.1	Develop and deliver clear, key concepts using methods appropriate for the intended audience	3, 4, 6
7.2	Critically evaluate received information	3, 4, 6
7.3	Demonstrate active listening and follow instructions	3, 4, 6
9	Impact of engineering on society and environment	3
9.1	Analyze the social, environmental and legal aspects of engineering activity	3
9.2	Summarize the common sources of uncertainty and risk in their engineering field	3
9.3	Identify the impact of introducing innovative technologies to solve engineering problems	3
11	Economics and project management	4
11.1	Apply project management techniques and manage resources within identified constraints	4
11.2	Estimate the life cycle engineering benefits and costs associated with	4

#	Outcome Set Name	Course Learning Outcome
	engineering design	
12	Life-long learning	6
12.1	Identify personal career goals and opportunities for professional development	6
12.2	Analyze a self-assessment of skills relative to SOE defined learning outcomes	6
12.3	Identify and critique limits of their field	6

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5 Teaching and Learning Activities

5.1 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 19 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 23 Thursday**	
23	Case study and review	4
24	Case study and review (Project Presentation if needed)	4

5.2 Design Lab/Tutorial Schedule

Week	Activity	Groups
Week 1 - Sept 7th	No lab	All students
Week 2 - Sept 11th	Lab Safety	All students
Week 3 - Sept 18th	Solar project: Residential (Assign Groups: 3/group)	All students
Week 4 - Sept 25th	ASPEN Plus software introduction and assign groups for Biomass Combustion investigation Lab (3/Group)	All students
Week 5 - Oct 2nd	[Exp 1: Bomb Calorimeter + Biomass Combustion Design Project (Pellet Stove)]+ Aspen Plus simulation	Tuesday (11:30 -2:20 pm) Groups 1 and 2 at Lab + Groups (3-6) at Simulation Thursday (11:30 -2:20 pm) Groups 1 and 2 at Lab + Groups (3-6) at Simulation Friday (2:30 to 5:20

		pm) Groups 1 and 2 at Lab + Groups (3-5) at Simulation
Week 6 - Oct 9th	**Thanksgiving – Holiday: work on your solar project**	A**ll students**
		Tuesday (11:30 -2:20 pm) Groups 3 and 4 at Lab + Groups (1, 2, 5, 6) at Simulation
Week 7 - Oct 16th	[Exp 1: Bomb Calorimeter + Biomass Combustion Design Project (Pellet Stove)] + Aspen Plus Simulation	Thursday (11:30 -2:20 pm) Groups 3 and 4 at Lab + Groups (1, 2, 5, 6) at Simulation
		Friday (2:30 to 5:20 pm) Groups 3 and 4 at Lab + Groups (1, 2, 5) at Simulation
Week 8 - Oct 23th	ASPEN Plus simulation questions and answers **Solar Design project Submission Friday) october 24 (Printout +dropbox in courselink)**	**All students**
		Tuesday (11:30 -2:20 pm) Groups 5 and 6 at Lab + Groups (1 - 4) at Simulation
Week 9 - Oct 30th	[Exp 1: Bomb Calorimeter + Biomass Combustion Design Project (Pellet Stove)] + Aspen Plus Simulation	Thursday (11:30 -2:20 pm) Groups 5 and 6 at Lab + Groups (1 - 4) at Simulation
		Friday (2:30 to 5:20 pm) Groups 5 at Lab + Groups (1 - 4) at Simulation
Week 10 - Nov 6th	Introduction to RETscreen software for Hybrid Solar wind project (Assign groups: 3/group)	All students
Week 11 - Nov 13 th	Hybrid solar wind **Design project submission Biomass combustion and emissions, Friday Nov 10 printout + dropbox in courselink**	**All students**
Week 12 - Nov 20 st	Examples using RETscreen; Hybrid system question and answer	All students
Week 13- Nov 27th	**Hybrid solar wind design report due November 30th printout + dropbox in courselink /presentation in the computer lab for each section(15 mins/Group)**	**All students**

5.3 Other Important Dates

Thursday, September 07, 2017: First day of class

Monday, October 9, 2017: Thanksgiving holiday

Tuesday, October 10, 2017: Fall study day, no classes

Friday, November 3, 2017: 40th class day, last day to drop classes

Friday, December 1, 2017: last day of class

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6 Assessments

6.1 Marking Schemes & Distributions

Name	Scheme A (%)
Solar Design: Residential	15.00
Biomass combustion and emissions investigation and design, ASPEN Plus simulation	25.00
Hybrid solar-wind system design and techno-economical analysis	20.00
Test 1	20.00
Test 2	20.00
Total	100.00

6.2 Assessment Details

Solar Design: Residential

Due: Tuesday, October 24

Biomass combustion and emissions design, ASPEN Plus simulation

Due: Friday, November 10

Hybrid solar-wind techno-economical analysis

Due: Thursday, November 30, In Class

Both paper and electronic copies are to be submitted

Test 1

Due: Thursday, October 19, In Class

Test 2

Due: Thursday, November 23, In Class

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7 Course Statements

7.1 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.

7.2 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.

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.

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 regulations and procedures for Academic Consideration are detailed in the Undergraduate Calendar.

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 Dropping Courses are available in the Undergraduate Calendar.

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: www.uoguelph.ca/sas

9.6 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 or faculty advisor.

The Academic Misconduct Policy is detailed in the Undergraduate Calendar.

9.7 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, a classmate 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 which apply to undergraduate, graduate and diploma programs.
