



# ENGG\*4230 Energy Conversion

01

Fall 2021

Section(s): C01

School of Engineering

Credit Weight: 0.75

Version 2.00 - September 08, 2021

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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 includes the 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 and nuclear fuels, as well as wind, solar, geothermal energy and fuel cells. Mechanisms for storing energy generated from each of these are also studied. The course also explores conversion of automobile systems, renovation of old fossil fuel fired plant technology, co-firing of opportunity fuels, waste to energy technology, emissions, and economics of energy projects.

**Pre-Requisites:** ENGG\*3260

**Co-Requisites:** ENGG\*3080

### 1.2 Timetable

**Lectures:**

Monday	10:00AM - 11:20AM	ROZH 105
Wednesday	10:00AM - 11:20AM	ROZH 105

**Laboratory:**

Tuesday	Sec 02	12:30PM - 03:20PM	THRN, Room 2313, 3402, 3404
Thursday	Sec 01	02:30PM - 05:20PM	THRN, Room 2313, 3402, 3404

### 1.3 Final Exam

NO FINAL EXAM.

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## 2 Instructional Support

### 2.1 Instructional Support Team

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

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

### 2.2 Teaching Assistants

**Teaching Assistant (GTA):** Precious Arku  
**Email:** parku@uoguelph.ca

**Teaching Assistant (GTA):** Ezra Ovadia  
**Email:** eovadia@uoguelph.ca

## 3 Learning Resources

### 3.1 Required Resources

#### 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

**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: Elsevier (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

#### 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 Courselink. 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 Process 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 including thermal power plant, 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 in thermal power plants.
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 (2018)

Successfully completing this course will contribute to the following:

#	Outcome	Learning Outcome
1	Knowledge Base	1, 5
1.3	Recall, describe and apply fundamental engineering principles and concepts	1, 5
1.4	Recall, describe and apply program-specific engineering principles and concepts	1, 5
2	Problem Analysis	1, 2
2.1	Formulate a problem statement in engineering and non-engineering terminology	1
2.2	Identify, organize and justify appropriate information, including assumptions	1, 2
2.3	Construct a conceptual framework and select an appropriate solution approach	1, 2
2.4	Execute an engineering solution	1, 2
2.5	Critique and appraise solution approach and results	1, 2
3	Investigation	3, 4
3.1	Propose a working hypothesis	3, 4

#	Outcome	Learning Outcome
3.2	Design and apply an experimental plan/investigative approach (for example, to characterize, test or troubleshoot a system)	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
4	Design	3, 4, 6
4.1	Describe design process used to develop design solution	3, 4
4.2	Construct design-specific problem statements including the definition of criteria and constraints	3, 4
4.3	Create a variety of engineering design solutions	3, 4, 6
4.4	Evaluate alternative design solutions based on problem definition	3, 4, 6
4.5	Develop and refine an engineering design solution, through techniques such as iteration, simulation and/or prototyping	3, 4, 6
5	Use of Engineering Tools	2, 3, 4
5.1	Select appropriate engineering tools from various alternatives	3, 4
5.2	Demonstrate proficiency in the application of selected engineering tools	2, 3, 4
5.3	Recognize limitations of selected engineering tools	3, 4
7	Communication Skills	1, 2
7.2	Interpret technical documentation such as device specification sheets, drawings, diagrams, flowcharts, and pseudocode	1, 2
7.3	Construct the finished elements using accepted norms in English, graphical standards, and engineering conventions, as appropriate for the message and audience	1, 2
7.4	Substantiate claims by building evidence-based arguments and integrating effective figures, tables, equations, and/or references	1, 2
7.5	Demonstrate ability to process oral and written communication by following instructions, actively listening, incorporating feedback, and formulating meaningful questions	1, 2
9	Impact of Engineering on Society and the Environment	3, 6
9.2	Evaluate the uncertainties and risks associated with engineering activities	3

#	Outcome	Learning Outcome
9.3	Anticipate the positive and negative impacts of introducing innovative technologies to solve engineering problems	6
11	Economics and Project Management	4, 6
11.3	Estimate economic impact and feasibility of an engineering project or design using techniques such as cost benefit analysis over the life of the project or design	4, 6

## 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
4-5	Biomass properties, Various conversion processes	1, 2, 4
6	Introduction to Thermal Power Plant	2
7	Fuel and Combustion Calculations	3
8-11	Design of Thermal Power Plant: pulverized, fluidized bed, integrated gasifier combined cycle systems	1, 2, 3, 4
12	Biochemical biomass conversion	1, 2, 4
<b>13</b>	<b>Test 1 October 20 Wednesday</b>	

14-17	Solar energy system design: PV and Thermal	2
18-19	Wind Energy system design	3
20	Emission control technologies	2, 3, 4
21	Geothermal Energy	1, 2, 4
22	Energy Storage	5
23	<b>Test 2 November 24 Wednesday</b>	
<b>24</b>	Project Submission/Case Study	4

## 5.2 Design Lab/Tutorial Schedule

<b>Week</b>	<b>Activity</b>	<b>Groups</b>
Week 1 - Sept 9 <sup>th</sup>	No lab	All students
Week 2 - Sept 13 <sup>th</sup>	Aspen Plus, Biomass Lab	All students
Week 3 - Sept 20 <sup>th</sup>	Aspen Plus Software, Biomass Lab	All students
Week 4 - Sept 27 <sup>th</sup>	ASPEN Plus, Biomass Lab	All students
Week 5 - Oct 4 <sup>th</sup>	Biomass Lab, Aspen Plus simulation	All students
<b>Week 6 - Oct 11<sup>th</sup></b>	<b>Thanksgiving – Holiday:</b>	<b>All students submit report to Dropbox by Oct 17</b>
Week 7 - Oct 18 <sup>th</sup>	Solar Design	All Students
Week 8 - Oct 25 <sup>th</sup>	Solar Design	All students
Week 9 -	Solar Design	All students

Nov 1<sup>st</sup>

Week 10 - Introduction to RETscreen software for Hybrid All students

Nov 8<sup>th</sup> Solar wind project (Assign groups: 3/group)

Week 11 - Hybrid solar wind Design; Project submission **All students submit report to**

Nov 15<sup>th</sup> Solar Residential at dropbox in courselink **Dropbox by Oct 21**

Week 12 - Examples using RETscreen; Hybrid system All students

Nov 22<sup>rd</sup> question and answer

Week 13- Hybrid solar wind design report due dropbox **All students submit report to**

Nov 29<sup>th</sup> in courselink **Dropbox by Dec 5**

### 5.3 Other Important Dates

Thursday, September 09, 2021: First day of class

Monday, October 11, 2021: Thanksgiving holiday

Tuesday, October 12, 2021: Fall study day, no classes

Wednesday, December 1, 2021: last day of class

**Thursday, December 2, 2021:** Make up for Study Day (Tuesday Oct 12 re-scheduled)

**Friday, December 3, 2021:** Make up for Thanksgiving Day (Monday Oct 11 re-scheduled) and Last day to drop one-semester courses

## 6 Assessments

### 6.1 Marking Schemes & Distributions

Name	Scheme A (%)
Biomass combustion and emissions investigation and design, ASPEN Plus simulation	20
Solar Design: Residential	25
Hybrid solar-wind system design and techno-economical analysis	15
Test 1	20
Test 2	20



Name	Scheme A (%)
Total	100

## 6.2 Assessment Details

### **Biomass combustion and emissions design, ASPEN Plus simulation (20%)**

**Due:** Sun, Oct 17, 12:00 AM, Dropbox

**Learning Outcome:** 1, 2, 3, 4, 6

### **Test 1 (20%)**

**Due:** Wed, Oct 20, In Class

**Learning Outcome:** 1, 2, 3, 4, 6

### **Solar Design: Residential (25%)**

**Due:** Sun, Nov 21, 12:00 AM, Dropbox

**Learning Outcome:** 1, 4, 5, 6

### **Test 2 (20%)**

**Due:** Wed, Nov 24, In Class

**Learning Outcome:** 1, 2, 3, 4, 5, 6

### **Hybrid energy system design: Solar-wind system design with techno-economical analysis (15%)**

**Due:** Sun, Dec 5, 12:00 AM, Dropbox

**Learning Outcome:** 1, 3, 4, 5, 6

Both paper and electronic copies are to be submitted

## 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, students must obtain a grade of 50% or higher of

the course.

**Missed midterm tests:** If you miss the test 1 due to grounds for granting academic consideration or religious accommodation, the weight of the missed test will be added to the test 2. 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 grounds for Academic Consideration are detailed in the Undergraduate and Graduate Calendars.

Undergraduate Calendar - Academic Consideration and Appeals

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml>

Graduate Calendar - Grounds for Academic Consideration

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml>

Associate Diploma Calendar - Academic Consideration, Appeals and Petitions  
<https://www.uoguelph.ca/registrar/calendars/diploma/current/index.shtml>

### 9.3 Drop Date

Students will have until the last day of classes to drop courses without academic penalty. The deadline to drop two-semester courses will be the last day of classes in the second semester. This applies to all students (undergraduate, graduate and diploma) except for Doctor of Veterinary Medicine and Associate Diploma in Veterinary Technology (conventional and alternative delivery) students. The regulations and procedures for course registration are available in their respective Academic Calendars.

Undergraduate Calendar - Dropping Courses  
<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-drop.shtml>

Graduate Calendar - Registration Changes  
<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/genreg-reg-regchg.shtml>

Associate Diploma Calendar - Dropping Courses  
<https://www.uoguelph.ca/registrar/calendars/diploma/current/c08/c08-drop.shtml>

### 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.

For Guelph students, information can be found on the SAS website  
<https://www.uoguelph.ca/sas>

For Ridgetown students, information can be found on the Ridgetown SAS website  
<https://www.ridgetownc.com/services/accessibilityservices.cfm>

## 9.6 Academic Integrity

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 encourages academic integrity. 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.

Undergraduate Calendar - Academic Misconduct

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml>

Graduate Calendar - Academic Misconduct

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml>

## 9.7 Recording of Materials

Presentations that are made in relation to course work - including lectures - cannot be recorded or copied without the permission of the presenter, whether the instructor, a student, 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 that apply to undergraduate, graduate, and diploma programs.

Academic Calendars

<https://www.uoguelph.ca/academics/calendars>

## 9.9 Disclaimer

Please note that the ongoing COVID-19 pandemic may necessitate a revision of the format of course offerings, changes in classroom protocols, and academic schedules. Any such changes will be announced via CourseLink and/or class email.

This includes on-campus scheduling during the semester, mid-terms and final examination schedules. All University-wide decisions will be posted on the COVID-19 website

(<https://news.uoguelph.ca/2019-novel-coronavirus-information/>) and circulated by email.

## 9.10 Illness

Medical notes will not normally be required for singular instances of academic consideration, although students may be required to provide supporting documentation for multiple missed assessments or when involving a large part of a course (e.g.. final exam or major assignment).

## 9.11 Covid-19 Safety Protocols

For information on current safety protocols, follow these links:

- <https://news.uoguelph.ca/return-to-campus/how-u-of-g-is-preparing-for-your-safe-return/>
- <https://news.uoguelph.ca/return-to-campus/spaces/#ClassroomSpaces>

Please note, these guidelines may be updated as required in response to evolving University, Public Health or government directives.

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