ENGG*4580 Sustainable Energy Systems Design

Winter 2018
Section(s): C01

School of Engineering
Credit Weight: 0.75
Version 1.00 - January 05, 2018

---

1 Course Details

1.1 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.

Pre-Requisite(s): ENGG*3080, ENGG*3370, ENGG*3430

1.2 Course Description

The course is a capstone type of course in energy streams of mechanical engineering program. The course is designed in order to demonstrate how knowledge from junior level classes such as thermodynamics, heat transfer, fluid mechanics, engineering economics, and numerical analysis can be used to design and simulate energy systems. This is also the course to assess the thermal system design capabilities of students with regards to CEAB outcomes. The course is organized into two major sections. The first is on piping systems, blended with economics of pipe size selecetion and sizing of pumps for piping systems. The second is on heat exchangers or, more generally, devices available for the exchange of heat between two process streams.

The course requires the students to complete term projects. Each project has associated with a project description that begins with a few introductory comments and concludes with several tasks that are to be completed. Each project has an estimate of the number of engineers required to finish it in the given school term. The students are responsible for selecting project partners and , as a group, deciding on which projects they would like to work. Each group elects its own project manager or leader.

1.3 Timetable

Timetable is subject to change. Please see WebAdvisor for the latest information.

LEC Tues, Thur 01:00PM - 02:20PM MINS, Room 103

LAB Thur 08:30AM - 11:20AM THRN, Room 2313

LAB Thur 08:30AM - 11:20AM THRN, Room 3404

LAB Mon 02:30PM - 05:20PM THRN, Room 2313
LAB Mon 02:30PM - 05:20PM THRN, Room 3404

1.4 Final Exam

Exam time and location is subject to change. Please see WebAdvisor for the latest information.
EXAM Wed 02:30PM - 04:30PM (2018/04/18) Room TBA Room TBA

---

2 Instructional Support

2.1 Instructor(s)

Animesh Dutta Animesh Dutta
Email: adutta@uoguelph.ca
Telephone: +1-519-824-4120 x52441
Office: RICH 3509

2.2 Instructional Support Team

Lab Technician: Michael Speagle
Email: mspeagle@uoguelph.ca
Telephone: +1-519-824-4120 x56803
Office: RICH 3502

2.3 Teaching Assistant(s)

Teaching Assistant: Mohammad Heidari
Email: mheidari@uoguelph.ca
Telephone: 5198244120 Ext 53874
Office: Thrn 1110

---

3 Learning Resources

3.1 Required Resources(s)

Course Website (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.

SI Edition: Design of fluid thermal system by William S. Janna (Textbook)

3.2 Additional Resources(s)

Intoduction to Thermo-Fluid Systems Design Andre McDonald, Hugh L. Magande (Textbook)

W. F. Stocker: Design of Thermal Systems, McGraw Hill, 1989 (Textbook)

Duffie and Beckman. Solar Engineering of Thermal Processes (4th Ed.) John Wiley & Sons. 2013. (Textbook)

Available through the University of Guelph library as e-books at no additional cost to students.

3.3 Recommended Resources

Software

EES:

Thermal energy system analysis and design often requires the solution of simultaneous nonlinear equations. In addition, quick access to thermophysical properties of the working fluids used in the system is desirable. Modern computer software is available that can be used to solve complex systems of equations while accessing thermophysical properties. In this course, we will be using Engineering Equation Solver (EES). The EES software can be found on the course website. This software is for Mechanical Engineering Student use only. Please do not distribute the software or the EES.DFT file to anyone other than a Guelph Mechanical Engineering student.

MATLAB:

We will also 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.

COMSOL:

We also be intoducing COMSOL Multiphysics (30 licenses are available in the School) software.

3.3 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

Reading and homework assignments will be posted on the course website. Homework assignments are due at the beginning of the class period posted on the course website. Homework not submitted at the required time is considered late and will receive a grade of zero.

---

4 Learning Outcomes

4.1 Course Learning Outcomes

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

1. Understand the governing principles of energy systems.
2. Integrate prior knowledge of fluid mechanics, heat transfer, thermodynamics and engineering systems in order to compare sustainable 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 for specific goals and locations.
6. Concisely and articulately communicate the results of an energy system analysis or design process to an engineering audience.

4.2 Engineers Canada - Graduate Attributes

Successfully completing this course will contribute to the following:

#	Outcome Set Name	Course Learning Outcome
1	Knowledge base	1, 5
1.1	Recall, describe and apply fundamental mathematical principles and concepts	1, 5
1.2	Recall, describe and apply fundamental concepts and principles in natural sciences	1, 5
1.3	Comprehend and apply fundamental engineering concepts	1, 5
1.4	Comprehend and apply program-specific engineering concepts	1, 5
2	Problem analysis	3, 4, 5
2.1	Formulate a problem statement in engineering and nonengineering terminology	3, 4, 5

#	Outcome Set Name	Course Learning Outcome
2.2	Construct a conceptual framework	3, 4, 5
2.3	Identify, organize and justify appropriate information	3, 4, 5
2.4	Execute an engineering solution	3, 4, 5
2.5	Critique and appraise results	3, 4, 5
3	Investigation	4
3.1	Propose and test working hypotheses	4
3.2	Design and apply an investigation plan	4
3.3	Analyze and interpret experimental data	4
3.4	Assess validity of conclusions within limitations of data and methodologies	4
4	Design	2, 3, 4, 5, 6
4.1	Describe the design process	2, 3, 4, 5, 6
4.2	Construct design-specific problem statements	2, 3, 4, 5, 6
4.3	Create engineering design solutions	2, 3, 4, 5, 6
4.4	Develop engineering design solutions	2, 3, 4, 5, 6
4.5	Assess engineering design solutions	2, 3, 4, 5, 6
4.6	Implement engineering design solutions	2, 3, 4, 5, 6
5	Use of engineering tools	2, 3, 4
5.1	Select appropriate engineering tools from various alternatives	2, 3, 4
5.2	Apply selected engineering tools	2, 3, 4
5.3	Recognize limitations of selected engineering tools	2, 3, 4
6	Individual and team work	3, 4, 5
6.1	Act as an individual team member to promote team success	3, 4, 5
6.2	Demonstrate leadership through team building, providing feedback and positive attitude	3, 4, 5
7	Communication skills	6
7.1	Develop and deliver clear, key concepts using methods appropriate for the intended audience	6
7.2	Critically evaluate received information	6
7.3	Demonstrate active listening and follow instructions	6

#	Outcome Set Name	Course Learning Outcome
9	Impact of engineering on society and environment	3, 4, 5
9.1	Analyze the social, environmental and legal aspects of engineering activity	3, 4, 5
9.2	Summarize the common sources of uncertainty and risk in their engineering field	3, 4, 5
9.3	Identify the impact of introducing innovative technologies to solve engineering problems	3, 4, 5
11	Economics and project management	3, 4, 5
11.1	Apply project management techniques and manage resources within identified constraints	3, 4, 5
11.2	Estimate the life cycle engineering benefits and costs associated with engineering design	3, 4, 5

---

5 Teaching and Learning Activities

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

5.1 Lecture

Topic(s): Introduction: Design Process of Energy Facilities
Reference(s): Janna; Stocker

- Design Process
- Bid Process
- Approached to Engineering Design
- Project Management
- Dimensions and Units
- Systems, Distinction Between Workable and Optimum System, Examples
- Design of an Optimum System

Topic(s): Fluid Properties and Basic Equations
Reference(s): Janna

- Fluid properties
- Measurement of viscosity
- Measurement of pressure
- Basic equations of fluid mechanics

Topic(s): Piping systems
Reference(s): Janna

- Pipe snd tubing standards
- Friction factor and losses
- Series piping systems
- Flow through pipe network
- Pipes in parallel
- Stresses in thin wall pressure vessels
- Thermal stresses
- Piping system design practices

Topic(s): Review of Thermal Processes and Applications
Reference(s): Notes provided on Courselink

- First and Second Law of Thermodynamics
- Thermodynamic Cycles
- Ideal Gas Mixtures and Psychrometry
- Energy Balance for Closed and Control Volume Systems and its Applications

Topic(s): Heat transfer fundamentals
Reference(s): Janna

- Conduction and convection problems with case studies
- Optimum thickness of insulation

Topic(s): Winter break

Topic(s): Heat exchangers design
Reference(s): Janna; Andre McDonald,

- Double pipe heat exchangers design
- Shell and tube heat exchangers design
- Plate and frame and cross flow heat exchangers design

Topic(s): Modeling of Energy Equipments
Reference(s): Notes provided on Courselink

- Equation Fitting for Characterization of Energy Equipments: Application of Equation Fitting Techniques for Characterization of Energy Processes and Equipments
- Processes and Thermodynamic Properties
- Equipments: Heat Exchanger, Pumps, Turbo-machinery, etc

Topic(s): Simulation and Optimization of Energy Systems
Reference(s): Notes provided on Courselink

- Information Flow Diagrams
- Simulation Techniques: Applications of Successive Substitution Method and Newton-Raphson Method to Energy Systems
- Optimisation: Application of Lagrange Multipliers and Search Methods to Energy Facilities

Topic(s): Pinch Technology
Reference(s): Notes provided on Courselink

- Basic Concepts of Pinch Technology
- Stream Networks and Significance of Pinch
- Determination of Heating and Cooling Load by Tabular Method
- Design of Recovery Systems
- Installation of Heat Pumps and Heat Engines and Process Retrofit.

Topic(s): Sustainable Design: Philosophy of sustainable design Eco audits, critical materials
Reference(s): Notes provided on Courselink
Case studies in wind turbines and electric cars

Topic(s): Life Cycle Analysis of Energy Systems
Reference(s): Notes provided on Courselink

5.2 Lab

Topic(s): EES
Design problem

Topic(s): EES
Design Problem

Topic(s): EES
Design Problem

Topic(s): COMSOL
Design Problem

Topic(s): COMSOL
Design problem

Topic(s): COMSOL
Design Problem

Topic(s): Winter break

Topic(s): MATLAB
Design Problem

Topic(s): MATLAB
Design Problem

Topic(s): MATLAB, EES, COMSOL
Design Problem

Topic(s): EES, MATLAB, Comsol,
Design Problem

Topic(s): Project Presentation
Design Project Presentation

---

6 Assessments

6.1 Assessment Details

Design Problem (30.00%)
Due at start of tutorial. Presented during tutorial. Submit zipped file package on Courselink, and bring presentation materials to tutorial.

three software EES, MATLAB and Comsol will be used to solve the problems.

Show and Tell (5.00%)
In class

Test 1 (20.00%)
Date: Week 7In Class
Feb 27

Final design and presentations (Group) (25.00%)
Date: Week 13In tutorial
Design documentation due at start of tutorial. Presentations during tutorial.

1/2 individual grading

1/2 group grade

Final Exam (20.00%)
Date: Webadvisor

6.2 Test

The test will be closed book, however, each student may bring a sheet of 8.5 inch by 11 inch paper containing notes, equations and other material chosen by the student. Both sides of the paper may contain material. No calculators will be permitted. The test will cover all material in the course up to the date of the test, including material from lectures, tutorials and projects. The test will be held during the lecture period.

6.3 Design Project

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

6.4 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.

7 Course Statements

7.1 Passing grade

The passing grade for this course is 50%.

7.2 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.

7.3 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 a full letter grade after marking is completed as a late penalty.

7.4 Grading Philosophy

The grading philosophy used in this course is based on the concept that design has a significant creative component, that there are many possible solutions, and that much of design does not result in right or wrong understanding or results. Marking in this course will be based on the premise that your work is assumed to be a “B” until there is evidence that the work is exemplary or aspects that are disappointing. Exemplary and disappointing components are integrated to produce a final assessment. Letter grades are used to reflect that the process is not ±2% accurate and that design could never be assessed with fine resolution.

The following letter grade translation will be used to convert letter grades to numeric form:

A+	Really Exemplary	100
A	Exemplary	90
A-		82
B+		78
B	Expected	75
B-		72
C+		68
C	Satisfactory	65
C-		62
D+		58
D	Disappointing, serious flaws	55
D-		52
F	Inadequate	35
X	No submission or	0

	wholly inadequate	

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.

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.