1 INSTRUCTIONAL SUPPORT

1.1 Instructor
Instructor: Ryan Clemmer, Ph.D., P.Eng.
Office: THRN 1337, ext. 52132
Email: rclemmer@uoguelph.ca
Office hours: By appointment

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

2 LEARNING RESOURCES

2.1 Course Website
Course material, news, announcements, and grades will be regularly posted to the ENGG*6xxx Courselink site. You are responsible for checking the site regularly.

2.2 Required Resources

2.3 Recommended Resources
2.4 Additional Resources

Lecture Information: An incomplete set of lecture notes will be posted on CourseLink prior to lecture. During lecture, additional notes and examples will be provided. It is expected that you will have a copy of the lecture notes for each class.

Lab Information: The lab manual for the laboratory exercises will be posted on CourseLink. Be sure to read the lab manual prior to attending the lab.

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

Recording of Materials: Presentations which are made in relation to course work—including lectures—cannot be recorded in any electronic media without the permission of the presenter, whether the instructor, a classmate or guest lecturer.

3 Assessment

3.1 Dates and Distribution

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Marking Scheme</th>
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</thead>
<tbody>
<tr>
<td>Lab</td>
<td>15%</td>
</tr>
<tr>
<td>Technology Presentation</td>
<td>25%</td>
</tr>
<tr>
<td>Project Proposal</td>
<td>5%</td>
</tr>
<tr>
<td>Project Presentation</td>
<td>15%</td>
</tr>
<tr>
<td>Project</td>
<td>40%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100%</strong></td>
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</tbody>
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Labs: The Fuel Cell Characterization lab will take place during class in week 5 (June 13) with the lab report due two weeks later (June 27).

Technology Presentations: Start June 16 and end July 4. Each class a different fuel cell type will be discussed.

Proposal: Due June 13.

Project Presentations: Due July 7 and July 11 in class. Each presentation is approximately 15 min.

Project Reports: Due July 14 in class.
3.2 Course Grading Policies

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 in writing, with your name, id#, and e-mail contact. See the graduate calendar for information on regulations and procedures for Academic Consideration:

http://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/sec_d0e1400.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: An overall final grade of 60% is required to pass the course.

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

Lab reports will be marked and the marks posted on Courselink. Note that up to 20% of the lab mark may be deducted for poor lab report format, poor graph or table format, or poor English (spelling, grammar, etc.). Any reports judged to be entirely unacceptable will be returned without marking for rewriting.

Late Lab Reports: There will be a late penalty of 20%/day or part thereof for any late lab reports.

4 AIMS, OBJECTIVES & GRADUATE ATTRIBUTES

4.1 Calendar Description

The fundamental principles governing fuel cell technology and the technical challenges associated with developing fuel cell systems are examined. Topics include the chemical thermodynamics and electrochemical kinetics of fuel cells, the evolution of fuel cell technology, and fuel cell system design.

Prerequisite(s): ENGG*2120, ENGG*3260 (or equivalent by permission of instructor)

4.2 Course Aims

The objective of this course is to provide an overview of the fundamental principles governing fuel cell technology and technical challenges associated with developing fuel cell systems. Understanding the fundamental chemical thermodynamics and electrochemical kinetics of fuel cells will form the basis for understanding and optimizing the operation of a fuel cell. The evolution of fuel cell technology will be examined through the study of the six major fuel cell types (AFC, PAFC, PEM, DMFC, MCFC, and SOFC). Fuel cell related processes such as hydrogen production, fuel reforming, power conditioning, and co-generation are also discussed to highlight the societal, environmental, and economic issues related to developing and implementing fuel cell technologies.
4.3 Learning Objectives
At the successful completion of this course, the student will have demonstrated the ability to:

1. Understand the chemical thermodynamics and electrochemical kinetics that govern the operation of a fuel cell system
2. Apply the fundamentals of fuel cell operation and investigate the performance of a fuel cell through a laboratory exercise and written report
3. Understand the key characteristics of the major fuel cell technologies by presenting a summary of a particular fuel cell technology
4. Present a literature review of a current fuel cell research area and discuss how a significant achievement in this area impacts the fuel cell industry through a final written report and oral presentation
5. Evaluate the social, economic, and environmental impacts of using fuel cells and the barriers associated with implementing fuel cell technology through a research project

4.4 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. 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.

4.5 Students’ Learning Responsibilities
Students are expected to take advantage of the learning opportunities provided during lectures and the lab session. 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.

4.6 Relationships with other Courses & Labs
Prerequisite Courses:

ENG*2120: Topics include the fundamental properties and processing of polymers, ceramics, metals and composite materials and the mechanisms to alter mechanical properties such as strength and ductility.

ENG*3260: Topics include energy transfer and energy balance in closed and flow through systems, entropy analysis, and efficiencies.
5 Teaching and Learning Activities

5.1 Timetable

Lectures:
- Monday: 9:30 AM – 11:20 AM, THRN 1002
- Thursday: 9:30 AM – 11:20 AM, THRN 1002

Laboratory:
- In THRN 3404 in Week 5

5.2 Lecture Schedule

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<tr>
<th>Week</th>
<th>Lecture Topics</th>
<th>Learning Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction: Fuel Cell Systems</td>
<td>1, 3, 5</td>
</tr>
<tr>
<td>2, 3</td>
<td>Chemical Thermodynamics</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Electrochemical Kinetics</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Fuel Cell Lab, Alkaline Fuel Cells</td>
<td>2, 3</td>
</tr>
<tr>
<td>6</td>
<td>Phosphoric Acid Fuel Cells</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>Polymer Electrolyte Membrane Fuel Cells</td>
<td>3</td>
</tr>
<tr>
<td>8</td>
<td>Molten Carbonate Fuel Cells</td>
<td>3</td>
</tr>
<tr>
<td>9</td>
<td>Solid Oxide Fuel Cells</td>
<td>3</td>
</tr>
<tr>
<td>10</td>
<td>Hydrogen Production and Storage</td>
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<td>11</td>
<td>Future Outlook</td>
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<tr>
<td>12</td>
<td>Project Presentations</td>
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5.3 Other Important Dates

Drop Date: The last date to drop one-semester courses, without academic penalty, is Friday, July 8th. Two-semester courses must be dropped by the last day of the add period in the second semester. Refer to the Graduate Calendar for the schedule of dates:
http://www.uoguelph.ca/registrar/calendars/graduate/current/sched/sched-dates-f10.shtml

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.
6.1 Sustainable Energy Lab Safety

This section outlines some of the safety related procedures and information for use in the Sustainable Energy Lab in THRN 3404. Safety in the laboratory is critical. **You will not be allowed to do the lab unless you attend the safety session prior to the lab.** If you have any concerns or comments related to safety in this laboratory you can reach Mike Speagle, at ext. 56803, in THRN 3502.

1. Be prepared. You should download and print a copy of the ENGG*6xxx Lab Manual from CourseLink. Be sure to carefully read the specific manual section before you go to perform each of the laboratory exercises.

2. You must do as instructed by the laboratory demonstrator. If you are not sure about something ask the demonstrator. Inform the demonstrator if you become aware of a potential hazard.

3. Food and beverages cannot be stored or consumed in this laboratory

4. Safety glasses are mandatory for all experiments. You will not be allowed to perform an experiment without them.

5. Proper footwear is mandatory for all the experiments. This means no open toed shoes or sandals.

6. The fire extinguisher, first aid kit, and phone are located at the front of the lab (THRN 3404). Dial ext. 52000 in case of emergencies.

7. All accidents should be reported to the demonstrator.

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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 or a short-term disability should contact the Centre for Students with Disabilities as soon as possible.

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