Description
A design is prepared for a full-scale chemical/biochemical process. It starts with a critical review of alternate processes and development of detailed flow plan by a team of students. Process synthesis with consideration of safety, environmental impact and energy efficiency is followed by equipment design and costing. Problem formulation, alternative design solutions and professional decision making are emphasized. Regulations, standards and codes related to design tasks are reviewed, bringing the students closer to real world engineering. Modeling and simulation of the process using available software packages are essential part of the course. The final report includes sections on process safety and hazard analysis, environmental impact analysis and detailed process economics analysis.

General Learning Objectives
Based on case study format, this course introduces students to synthesis and analysis chemical, biochemical and pollution abatement processes and equipment selection and sizing through creative problem solving and teamwork while applying basic principles in chemical engineering and economics learned in other courses in the curriculum. The general objectives are for the student to become able to:
• apply engineering and professional judgement to propose solutions to open-ended design problems.
• formulate problems and apply decision making to evaluate design alternatives.
• identify safety, environmental, social, legal and economic issues, and their impact on design decisions.
• develop strong technical communication skills in order to present and defend technical information and design decisions in both written and oral format and recognize the need for continual (life-long) learning to keep abreast of new developments and information that could affect decisions related to design, modifications and improvements in chemical processes.

These objectives are accomplished within the framework of a workshop, simulating to the extent possible, and the real-world industrial environment. During the workshops, groups of up to six students are given guidance and coaching (interactive learning) to assist in moving forward the design project. Each group of project engineers is assigned to a specific section head (Teaching Assistant).
Specific Learning Objectives
The course is organized to develop following professional and job-related skills of students while they apply acquired knowledge of engineering concepts and principles to an independent study of industrial design project.

Teamwork and Time Management
Students should be able to:
• work in a team as they become more familiar with dynamics of teamwork and learn to make use of strengths of team members.
• divide a project into tasks and sub-tasks with deadlines and milestones to allow scheduling and resource allocation and utilization.

Information Collection, Analysis and Synthesis
Students should be able to:
• collect required information from different sources including literature, industry, equipment suppliers, internet, specialists etc.
• analyse sometimes conflicting information and learn to deal with it.

Critical Thinking - applied to design process
Students should be able to:
• recognize existence of alternative solutions for the same problem.
• compare alternatives based on selected criteria.
• ensure check calculations and consultations before making a recommendation.

Engineering Judgment
Students should be able to:
• apply approximations in design calculations based on sound reasoning and documentation.
• apply practical considerations to reduce downtime, improve safety and operability of a system being designed.

Engineering Safety & Environmental Protection
Students should be able to:
• incorporate engineering safety in their final design and modify the design accordingly
• perform HAZOP study for the designed units
• perform Layers of protection analysis (LOPA) for their design
• do risk assessment for the process
• perform environmental protection analysis addressing safety issues
• perform safety and risk analysis

Communication
Students should be able to:
• present their work both orally and in written format as per acceptable standards.
• participate in two formal group presentations to communicate progress.
• submit two large formal reports and three shorter progress reports.
## Mapping Learning outcome with Graduate attributes

<table>
<thead>
<tr>
<th>Course Learning Outcome</th>
<th>Mapped Graduate Attribute</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Teamwork</strong></td>
<td><strong>ITW2 level</strong>: Demonstrate ability to contribute to team goals - evaluate and utilize strengths of team members for an effective team.</td>
</tr>
<tr>
<td></td>
<td><strong>ITW3 level</strong>: Demonstrate ability to evaluate peer and self performance based on team effectiveness – ability to apply conflict management techniques to resolve team issues – both short and longer term</td>
</tr>
<tr>
<td><strong>Time Management</strong></td>
<td><strong>Ethics and Equity (EE3 level)</strong>: Apply principles of professional accountability: Principles of professional accountability are applied to individual team members and to the teamwork with clear expectations and accountability.</td>
</tr>
<tr>
<td>Information Collection, Analysis and Synthesis</td>
<td><strong>Investigation (IN1 level)</strong>: Demonstrate ability to define and plan an investigation successfully: Exhibit ability to collect and analyse information from different sources based on a defined plan.</td>
</tr>
<tr>
<td></td>
<td><strong>Design (DE1 level)</strong>: Demonstrate ability to frame complex, open-ended design problem in engineering terms: Information related to the design problem is collected, summarized, assessed and presented in context of the design problem.</td>
</tr>
<tr>
<td></td>
<td><strong>Life-long learning (LL2 level)</strong>: Demonstrate ability to learn independently: Ability to collect, summarize, analyze, evaluate and synthesize information from wide variety of source</td>
</tr>
<tr>
<td>Critical Thinking - applied to design process</td>
<td><strong>Design (DE2 level)</strong>: Demonstrate ability to generate diverse set of candidate potential design solutions: The diverse set of potential design solutions meet the functional requirements and accepted standard.</td>
</tr>
<tr>
<td></td>
<td><strong>Investigation (IN3 level)</strong>: Demonstrate ability to critically analyze and interpret the data to reach the valid conclusions: The data from different sources may present a conflicting picture which is resolved by critically analysis using appropriate set of criteria.</td>
</tr>
<tr>
<td>Engineering Judgment</td>
<td><strong>Design (DE3 level)</strong>: Demonstrate ability to select candidate engineering design solutions for further development: Can identify suitable design solutions for further development.</td>
</tr>
<tr>
<td></td>
<td><strong>Use of engineering tools (ET2 level)</strong>: Demonstrate ability to apply appropriate engineering tools and resources: Appropriate engineering tools and resources are selected and applied at different stages of the development of the design – these may include process simulators, online resources, consultants etc.</td>
</tr>
</tbody>
</table>
### Engineering Safety & Environmental Protection

- **Impact of engineering on society and environment (IESE3 level):** Demonstrate understanding of the concept of environmental stewardship: Environmental protection principles are incorporated into the design project at different stages of development to minimize environmental impact.

- **Economics and project management (EPM3 level):** Demonstrate ability to incorporate risk management into engineering.

### Communication

- **Communication skills (CS2 level: Ability to prepare and deliver a professional oral presentation):** Demonstrate ability to prepare and deliver a professional oral presentation, using appropriate combination of language, style and non-verbal communication.

- **Communication skills (CS3 level: Ability to write effective technical reports, demonstrating command of language and graphical tools):** Demonstrate ability to articulate ideas in writing – using appropriate technical language, coherence, correct spelling and grammar and syntax, and effective graphical tools.

- **Design (DE4 level: Demonstrate ability to advance an engineering design to a defined end state - completion):** The completed design is presented to stakeholders both orally and in a written report.

Note: this learning objective aligns with and is selected for the assessment of the Graduate Attribute Economics and project management (EPM1 level): Demonstrate ability to incorporate economics into engineering project.

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Progress will depend on a number of factors including complexity of the selected process, availability of process information, industrial contacts established by group, etc. Initiative and creativity are required from every student. *This course draws on knowledge, skills and techniques learned in prerequisite and corequisite courses to solve practical engineering problems.*

*It is a finishing course: students need to demonstrate sound design and professional capabilities before they can graduate.*

### Prerequisites

CBE 3325A/B, CBE 3317Y or the former CBE 3397, CBE 3323A/B, CBE 2220A/B, CBE 2224A/B, CBE 3315A/B, CBE 3322A/B, and CBE 3324.

### Corequisites

Business Administration 2299 or registration in Option C of the Chemical Engineering program.
Anti-requisites
CEE 4441, ECE 4416, MME 4499, SE 4450, ES 4499.

Contact Hours
2 hours lecture, weekly tutorial and workshop hours about an hour per group, 1.0 full course.

Important note: In the event of a COVID-19 resurgence during the course that necessitates the course delivery moving away from face-to-face interaction, all remaining course content will be delivered entirely online, either synchronously (i.e., at the times indicated in the timetable) or asynchronously (e.g., posted on OWL for students to view at their convenience). The grading scheme will not change. Any remaining assessments will also be conducted online at the discretion of the course instructor.

Instructors
Dr. S. Barghi (coordinator), sbarghi2@uwo.ca
Dr. A. Prakash, aprakas2@uwo.ca

Undergraduate Assistant
Brandy Hunter (TEB 477) Telephone: 519-661-2111 ext.: 82131

Recommended Text

Reference Texts

Reference to other books and articles will be made at the appropriate time during the course.

Course Notes
Course notes, PPT presentations, Synchronous/asynchronous lectures will be available for download from the course website.
Depending on the circumstances related to COVID-19, in class lectures may be offered considering all safety measures.

Tutorials will be handled via ZOOM meetings on a weekly basis (all group members must participate).

The modeling and simulations packages will be available remotely, although the computer labs will be open to be used following the safety instructions developed by the university.

Examples will be available in the website as general guideline for each assignment.

All details with respect to the submission of the assignment, evaluation criteria, rubrics .... will be available prior to submission in the course website.

**Evaluation**

<table>
<thead>
<tr>
<th>Item</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Definition and Scope</td>
<td>5%</td>
</tr>
<tr>
<td>Detailed Flow Plan with Description (group (grp) mark)</td>
<td>10%</td>
</tr>
<tr>
<td>Short-cut Equipment Design (individual (ind.) mark)</td>
<td>15%</td>
</tr>
<tr>
<td>First Oral Presentation (50% ind. mark, 50% grp.)</td>
<td>10%</td>
</tr>
<tr>
<td>Final Oral Presentation (60% ind. mark, 40% grp.)</td>
<td>12%</td>
</tr>
<tr>
<td>First Design Report (50% ind. mark, 50% grp.)</td>
<td>15%</td>
</tr>
<tr>
<td>Final Design Report (60% ind. mark, 40% grp.)</td>
<td>30%</td>
</tr>
<tr>
<td>Individual performance*</td>
<td>3%</td>
</tr>
</tbody>
</table>

*Attendance in the meetings, workshop, on time delivery of assigned tasks, etc. (based on the TAs’ comments).

**Note**

Students must secure a passing mark (>50%) in both the final oral presentation and final design report to pass this course.

**1. Design Reports**

A design report is due from each group at the end of each term culminating the efforts of the group. The reports will be submitted online to the teaching assistant (TA) or the project supervisor. Format for design reports is given in the course guidebook in WebCT/OWL.

First Formal Report due: To be announced
(used to collect data for the following attributes/indicators: CS2(1), EE3(1))

Final Formal Report due: To be announced
(used to collect data for the following attributes/indicators: CS2(2), DE4(2), LL2, EPM1, EPM3, IN3, IT3, IN3(2), ET2(2), EE3(2), IESE3(2))
The penalty for late submission of the deliverables is 5% per day.

2. Oral Presentations
Two oral presentations will be made by each design group, one in each term. Each student will take part in the presentations. Presentation schedule will be distributed about two weeks before presentation weeks. Depending on the situation, the presentations may be handled remotely using ZOOM meetings or in class.

First Formal Oral Presentation: To be announced
(used to collect data for the following attributes/indicators: CS3(1), IT2(2))

Final Formal Oral Presentation: To be announced
(used to collect data for the following attributes/indicators: CS3(2), DE4(1), IN3(1), ET2(1))

Note: If a group member does not participate in the presentations, the allocated time will be reduced. For those who are not able to participate in group presentation (for a legitimate reason(s)), individual meetings will be held and the student(s) will present his/her work to the judges.

3. Detailed Flow Plan with Description
Each design team will hand in a detailed flow plan of the process drawn on a 60cmX90cm sheet together with a description of the process to its section Teaching Assistant by the due date (to be determined).
(used to collect data for the following attributes/indicators: DE3, IT2(1))

4. Project Definition and Scope
(used to collect data for the following attributes/indicators: DE1, IN1, IESE3(1))

4. Equipment Design (preliminary/shortcut)
(used to collect data for the following attributes/indicators: DE2, IT2(1))

**Units**
SI units will be generally used in lectures and examinations.

**Repeating All Components of the Course**
In accordance with Senate and Faculty Policy, students who have failed an Engineering course (i.e. <50%) must repeat all components of the course. No special permissions will be granted enabling a student to retain laboratory, assignment or test marks from previous years. Previously completed assignments and laboratories cannot be resubmitted for grading by the student in subsequent years.

**Use of English**
In accordance with Senate and Faculty Policy, students may be penalised up to 10% of the marks on all assignments, tests, and examinations for the improper use of English. Additionally, poorly written work with the exception of the final examination may be returned without grading. If resubmission of the work is permitted, it may be graded with marks deducted for poor English and/or late submission.
**Cheating**
University policy states that cheating is a scholastic offence. The commission of a scholastic offence is attended by academic penalties, which might include expulsion from the program. If you are caught cheating, there will be no second warning (see Scholastic Offence Policy in the Western Academic Calendar).

**Plagiarism**
Students must write their essays and assignments in their own words. Whenever students take an idea or a passage from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. Plagiarism is a major academic offence (see Scholastic Offence Policy in the Western Academic Calendar).

The University of Western Ontario has software for plagiarism checking. Students may be required to submit their work in electronic form for plagiarism checking.

**Attendance**
*Attendance at all lectures, tutorials and laboratories is mandatory.* Any student who, in the opinion of the instructor, is absent too frequently from class, or workshop/tutorial periods will be reported to the Dean (after due warning has been given). On the recommendation of the Department concerned, and with the permission of the Dean, the student will be debarred from making final oral presentation and submission of final design report.

**Conduct**
Students are expected to arrive at lectures on time, and to conduct themselves during class in a professional and respectful manner that is not disruptive to others.

**Sickness and Other Problems**
Students should immediately consult with the instructor or Department Chair if they have any problems that could affect their performance in the course. Where appropriate, the problems should be documented. The student should seek advice from the Instructor or Department Chair regarding how best to deal with the problem. Failure to notify the Instructor or Department Chair immediately (or as soon as possible thereafter) will have a negative effect on any appeal.

Please contact the course instructor if you require material in an alternate format or if any other arrangements can make this course more accessible to you.

You may also wish to contact Services for Students with Disabilities (SSD) at 661-2111 x 82147 for any specific question regarding an accommodation.

**Notices**
Students are responsible for regularly checking their Western email and notices posted in front of chief instructor’s offices.
Consultation
Students are encouraged to discuss problems with their teaching assistant and/or instructor in tutorial sessions. Office hours will be arranged for the students to see the instructor and teaching assistants. Other individual consultation can be arranged by appointment with the appropriate instructor.

Accreditation (AU) Breakdown
Complimentary Studies = 25%
Engineering Design = 75%
INSTRUCTIONS FOR STUDENTS UNABLE TO WRITE TESTS OR EXAMINATIONS OR SUBMIT ASSIGNMENTS AS SCHEDULED

If, on medical or compassionate grounds, you are unable to write term tests or final examinations or complete course work by the due date, you should follow the instructions listed below. You should understand that academic relief will not be granted automatically on request. You must demonstrate to your department (or the Undergraduate Services Office) that there are compelling medical or compassionate grounds that can be documented before academic relief will be considered. Different regulations apply to term tests, final examinations, and late assignments. Please read the instructions carefully.

NEW: Requests for Academic Consideration using the Self-Reported Absence Form

If you experience an unexpected illness or injury or an extenuating circumstance (48 hours or less) that is sufficiently severe to temporarily render you unable to meet academic requirements (e.g., attending lectures or labs, writing tests or midterm exams, completing and submitting assignments, participating in presentations) you should self-declare using the online Self-Reported Absence portal. This option should be used in situations where you expect to resume academic responsibilities within 48 hours or less.

Each student will be allowed a maximum of two self-reported absences between September and April and one self-reported absence between May and August. Self-reporting may not be used for final exams or assessments (e.g. midterm exams, tests, reports, presentations, or essays) worth more than 30% of any given course.

For full instructions about the Self-Reporting System refer to the Academic Calendar:
http://westerncalendar.uwo.ca/PoliciesPages.cfm?PctCategoryID=1&Command=showCategory&Keyword=report&SubHeadingID=327&SelectedCalendar=Live&ArchiveID=SubHeadings&327

A. GENERAL REGULATIONS & PROCEDURES (other than self-reported absences)

1. All first-year students will report to the Undergraduate Services Office, SEB 2097, for all instances.

2. If you are an upper-year student and you are missing a test/assignment/lab or examination that is worth LESS THAN 10% of your mark, you should report to your department office to request relief. If your course work is worth MORE THAN 10% of your final grade, you will report to the Undergraduate Services Office, SEB 2097.

3. Check the course outline to see if the instructor has a policy for missed tests, examinations, late assignments, or attendance.

4. Documentation must be provided as soon as possible. If no one is available in your department office or the Undergraduate Services Office, leave a message clearly stating your name & student number and reason for your call. The department telephone numbers are given at the end of these instructions.

5. If you decide to write a test or an examination you should be prepared to accept the mark you earn. Rewriting tests or examinations or having the value of a test or examination reweighted on a retroactive basis is not permitted.

B. TERM/MIDTERM TESTS (other than self-reported absences)

1. If you are in first year and you are unable to write a midterm/term test, contact the Undergraduate Services Office, SEB 2097 PRIOR to the scheduled date of the test.

2. If you are an upper-year student and you are unable to write a midterm/term test, inform your instructor PRIOR to the scheduled date of the test. If the instructor is not available, leave a message for him/her at the department office. If the test is worth LESS THAN 10% of your mark, you should report to your department office to request relief. If the test is worth MORE THAN 10% of your final grade you will report to the Undergraduate Services Office, SEB 2097 to request relief.

3. Be prepared to provide supporting documentation to the Department Chair and/or the Undergraduate Services Office (see next page for information on documentation).

4. Discuss with the instructor if and when the test can be rescheduled. N.B. The approval of the Chair or the Undergraduate Services Office is required when rescheduling midterm/term tests.
C. **FINAL EXAMINATIONS** (cannot be self-reported)

1. If you are unable to write a final examination, contact the Undergraduate Services Office PRIOR TO THE SCHEDULED EXAMINATION TIME to request permission to write a Special Final Examination. If no one is available in the Undergraduate Services Office, leave a message clearly stating your name & student number.

2. Be prepared to provide the Undergraduate Services Office with supporting documentation (see next page for information on documentation) the next day, or as soon as possible (in cases where students are hospitalized). The following circumstances are not considered grounds for missing a final examination or requesting special examinations: common cold, headache, sleeping in, needing time off and travel arrangements.

3. In order to receive permission to write a Special Examination, you must obtain the approval of the Chair of the Department and the Associate Dean and in order to apply you must sign a “Recommendation for a Special Examination Form” available in the Undergraduate Services Office. The Undergraduate Services Office will then notify the course instructor(s) and reschedule the examination on your behalf.

**PLEASE NOTE:** It is the student’s responsibility to check the date, time and location of the Special Examination.

D. **LATE ASSIGNMENTS**

1. Advise the instructor if you are having problems completing the assignment on time (prior to the due date of the assignment).

2. Be prepared to provide documentation if requested by the instructor (see reverse side for information on documentation).

3. If you are granted an extension, establish a due date. The approval of the Chair of your Department (or the Assistant Dean, First Year Studies, if you are in first year) is not required if assignments will be completed prior to the last day of classes.

4. i) Extensions beyond the end of classes must have the consent of the instructor, the department Chair and the Associate Dean, Undergraduate Studies. Documentation is mandatory.

   ii) A Recommendation of Incomplete Form must be filled out indicating the work to be completed and the date by which it is due. This form must be signed by the student, the instructor, the department Chair and the Associate Dean, Undergraduate Studies.

E. **SHORT ABSENCES**

If you miss a class due to a minor illness or other problem, check your course outline for information regarding attendance requirements and make sure you are not missing a test, laboratory or assignment. Cover any readings and arrange to borrow notes from a classmate.

F. **EXTENDED ABSENCES**

If you are absent more than one week or if you get too far behind to catch up, you should consider reducing your workload by dropping one or more courses. (Note drop deadlines listed below). You are strongly encouraged to seek advice from your Academic Counsellor in the Undergraduate Services Office.

G. **DOCUMENTATION**

If you consulted an off-campus doctor or Student Health Services regarding your illness or personal problem, you must provide the doctor with a Student Medical Certificate to complete at the time of your visit and then bring it to the Department (or the Undergraduate Services Office). This note must contain the following information: severity of illness, effect on academic studies and duration of absence. Regular doctor’s notes will not be accepted; only the Student Medical Certificate will be accepted.

**In Case of Serious Illness of a Family Member:** Provide a Student Medical Certificate to your family member’s physician to complete and bring it to the Department (or the Undergraduate Services Office if you are in first year).

**In Case of a Death:** Obtain a copy of the death certificate or the notice provided by the funeral director’s office. You must include your relationship to the deceased and bring it to the Department (or the Undergraduate Services Office if you are in first year).

**For Other Extenuating Circumstances:** If you are not sure what documentation to provide, ask the Departmental Office (or the Undergraduate Services Office if you are in first year) for direction.

**Note:** Forged notes and certificates will be dealt with severely. To submit a forged document is a scholastic offence (see below).
H. ACADEMIC CONCERNS

1. You need to know if your instructors have a policy on late penalties, missed tests, etc. This information may be included on the course outlines. If not, ask your instructor(s).

2. You should also be aware of attendance requirements in some courses. You can be debarred from writing the final examination if your attendance is not satisfactory.

3. If you are in academic difficulty, check out the minimum requirements for progression in the calendar. If in doubt, see your Academic Counsellor.

Calendar References: Check these regulations in your 2019 Western Academic Calendar available at www.westerncalendar.uwo.ca.

Self-Reporting Absences:
http://westerncalendar.uwo.ca/PolicyPages.cfm?PolicyCategoryID=1&Command=showCategory&PolicyCategoryID=1&SelectedCalendar=Live&ArchiveID=Page_12

Absence Due to Illness:
http://westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=1&SelectedCalendar=Live&ArchiveID=Page_10

Academic Accommodations for Students with Disabilities:
http://westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=1&SelectedCalendar=Live&ArchiveID=Page_12

Academic Accommodations for Religious or Holy Days:
http://westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=1&SelectedCalendar=Live&ArchiveID=Page_16

Course Withdrawals:
http://westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=1&SelectedCalendar=Live&ArchiveID=Page_14

Examination:
http://westerncalendar.uwo.ca/PolicyPages.cfm?PolicyCategoryID=5&Command=showCategory&PolicyCategoryID=1&SelectedCalendar=Live&ArchiveID=Page_14

Scheduling of Term Assignments:
http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=5&SelectedCalendar=Live&ArchiveID=Page_14

Scholastic Offences:
http://westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=1&SelectedCalendar=Live&ArchiveID=Page_14

Student Medical Certificate:
http://www.ams.uwo.ca/files/undergraduate/forms/icmc.pdf

Engineering Academic Regulations:
http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=1&SelectedCalendar=Live&ArchiveID=Page_14

Note: These instructions apply to all students registered in the Faculty of Engineering regardless of whether the courses are offered by the Faculty of Engineering or other faculties in the University.

Add Deadlines:
- First term half course (i.e., “A” or “F”) - September 13, 2019
- Full course and full-year half course (i.e., “E”, “Y” or no suffix) - September 13, 2019
- Second term half course (i.e., “B” or “G”) - January 14, 2020

Drop Deadlines:
- First term half course (i.e., “A” or “F”) - November 12, 2019
- Full course and full-year half course (i.e., “E”, “Y” or no suffix) - November 30, 2019
- Second term half or second term full course (i.e., “B” or “G”) - March 7, 2020

Contact Information:

Undergraduates Services Office: SEB 3097 Phone: 519-661-2139 E-mail: undergrad@uwo.ca
Chemical & Green Process Engineering: TRS 477 Phone: 519-661-1381 E-mail: cgeb@uwo.ca
Civil Engineering: SEB 3005 Phone: 519-661-2139 E-mail: civ@uwo.ca
Computer, Electrical, Mechanical Systems & Software Engineering: TEB 379 Phone: 519-661-2750 E-mail: cemsse@uwo.ca
Integrated Engineering: ACER 2410 Phone: 519-661-8725 E-mail: iem@uwo.ca
Mechanical Engineering: SEB 3902 Phone: 519-661-4122 E-mail: mem@uwo.ca

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