ENGG*6090*02 ST - Process Intensification
Fall 2016

UNIVERSITY

of GUELPH

School of Engineering

(Revision 0: Aug 23rd, 2016)

1 INSTRUCTIONAL SUPPORT

1.1 Instructor
Instructor: Emily Chiang, Ph.D., P.Eng.
Office: THRN 3507, ext. 58217
Email: chiange@uoguelph.ca
Office hours: by appointment

2 LEARNING RESOURCES

2.1 Course Website
Course material, news, announcements, and grades will be regularly posted to the ENGG*6090*02 Courselink site. You are responsible for checking the site regularly.

2.2 Required Sources

2.3 Recommended Resources


### 2.4 Additional Resources

**Lecture Information:** All the lecture notes will be posted on Courselink.

**Assignments:** To be distributed in class.

**Miscellaneous Information:** Supplementary information to the lecture notes will also posted on the course web page.

### 2.5 Communication & Email Policy

Please use lectures as your main opportunity to ask questions about the course. Office hours will be scheduled on request. 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 University of Guelph e-mail account regularly: e-mail is the official route of communication between the University and its students.

---

### 3 Assessment

#### 3.1 Dates and Distribution

**Assignments:** 40%

- Assignment 1: Week of Sept 26th, in class
- Assignment 2: Week of Oct 17th, in class
- Assignment 3: Week of Nov 14th, in class

**Individual Project:** 60%

Students will identify one or a combination of intensification technologies that can be applied to a process of interest (e.g. a process related the student's research topic, or a process selected in consultation with the instructor). The student will identify potential bottlenecks, apply principles of process intensification, and select the best suitable intensification technologies for the process. Students will incorporate throughput and quality requirements of the process and perform engineering calculations during the design phase. Students will then evaluate the design for engineering feasibility and sustainability.

- Project description and outline (10%): Week of Sept 19th
- Presentation (20%): Week of Oct 31st, in class
- Final report (30%): **due on Dec 9th**

**Note:** Both paper and electronic copies are to be submitted.
3.2 **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/graduate/current/genreg/sec_d0e1415.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 obtain a passing mark of at least 65% based on the individual assessments.

**Missed in-class assessments:** If you miss an in-class assessment due to grounds for granting academic consideration or religious accommodation, accommodations will be made for a make-up assessment sessions.

**Late submission of written assignments:** assignments and reports submitted within 48 hours past the deadline will be marked to a maximum grade of 60%, and those handed in beyond 48 hours will not be accepted.

4 **AIMS, OBJECTIVES & GRADUATE ATTRIBUTES**

4.1 **Course Description**

Introduction to the genesis, principles and application of process intensification. Survey of process intensification technologies, their theory and design principles. Identification of process inefficiencies and safety hazards, and evaluation of environmental impact and economics. Assessment, selection, design and feasibility study of intensified processes for optimization. Case studies are drawn from engineering systems such as chemical, mechanical, biological and environmental.

4.2 **Course Aims**

The course covers novel technologies and process modifications that can intensify and improve commercial processes to bring economical and environmental benefits to the industry and the society. Students will be exposed to 'out-of-the-box' concepts in processing technology, where knowledge from multi-disciplinary domains (e.g. physics, electronics, mechanics, thermodynamics, etc.) is incorporated in new solutions. Some examples are ultrasonication, microreactors, plasma technology, supercritical fluids, membrane separation, etc. For each technology, theory, application, feasibility and sustainability will be discussed. The goal is to provide students with the tools and methods that can be used to intensify existing processes or design more efficient new processes. More specifically, the aim is to enable students to: (i) recognize and explain technical challenges and limitations for a particular process, (ii) assess alternative technologies to improve the process, by upgrading process steps or re-designing the overall process, (iii)
evaluate the options to arrive at an optimal process configuration; and (iv) perform a feasibility design. The course evaluation will be in the form of presentations and reports.

4.3 Learning Objectives

At the successful completion of this course, the student will have demonstrated the ability to:

1. Identify inefficiencies, safety hazards, economic pressures and environmental impacts of a processing operation.
2. Recognize which process intensification principle(s) can be exploited to improve the process.
3. Source a variety of process technologies that can be used to intensify reaction kinetics, separations and/or transport phenomena, or that reduce hazardous chemical inventory, waste/emissions generation and/or processing cost.
4. Assess the developmental stage or industrial take-up of an intensification technology based on evaluation of scientific and engineering literature (e.g. journals and patents), and industrial benchmarking.
5. Select suitable intensified process technologies to replace existing process equipment, or redesign the overall process to minimize inefficiencies, make the process inherently safer, reduce the environmental impact of the process, and assess the potential economic impact of the changes.
6. Evaluate different process options based on qualitative and quantitative measures to arrive at an optimal design choice.
7. Perform preliminary design of the main unit operations of the intensified process to assess engineering and economic feasibility.
8. Identify processes and opportunities for intensification.
9. Work with multi-disciplinary group members, drawing on each other’s strength, to develop an intensification solution to an inefficient process.
10. Concisely and articulately present the design rationale of the intensification exercise.

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/D2L 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 for tests and project.

4.5 Students’ Learning Responsibilities

Students are expected to take advantage of the learning opportunities provided during lectures and tutorials. 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.
5  TEACHING AND LEARNING ACTIVITIES

5.1  Timetable

Lectures: TBD  Room: TBD

5.2  Lecture Schedule

<table>
<thead>
<tr>
<th>Weeks</th>
<th>Lecture Topics</th>
<th>References</th>
<th>Learning Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction to process intensification (PI)</td>
<td>Class Notes</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Identifying process inefficiencies and hazards</td>
<td>Class Notes</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Temporal domain of PI</td>
<td>Class Notes</td>
<td>2, 3</td>
</tr>
<tr>
<td></td>
<td>Spatial domain of PI</td>
<td>Class Notes</td>
<td>2, 3</td>
</tr>
<tr>
<td>3</td>
<td>Thermodynamic domain of PI</td>
<td>Class Notes</td>
<td>2, 3</td>
</tr>
<tr>
<td></td>
<td>Functional domain of PI</td>
<td>Class Notes</td>
<td>2, 3</td>
</tr>
<tr>
<td>4</td>
<td>Selection and evaluation methods</td>
<td>Class Notes</td>
<td>4, 5, 6</td>
</tr>
<tr>
<td></td>
<td>Process design principles</td>
<td>Class Notes</td>
<td>5, 7</td>
</tr>
<tr>
<td>5</td>
<td>Mid-term presentation</td>
<td>-</td>
<td>1-10</td>
</tr>
<tr>
<td></td>
<td>Mechanical and chemical examples of PI</td>
<td>Class Notes</td>
<td>8</td>
</tr>
<tr>
<td>6</td>
<td>Environmental and biological examples of PI</td>
<td>Class Notes</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Barriers and opportunities for PI</td>
<td>Class Notes</td>
<td>8</td>
</tr>
</tbody>
</table>

5.3  Other Important Dates

Drop Date: The last date to drop one-semester courses, without academic penalty, is Nov 6th, 2015. 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:

https://www.uoguelph.ca/registrar/calendars/graduate/current/sched/sched-dates-f10.shtml

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. The Academic Misconduct Policy is detailed in the Graduate Calendar: https://www.uoguelph.ca/registrar/calendars/graduate/2014-2015/genreg/sec_d0e1780.shtml

6.1 Resources

The Academic Misconduct Policy is detailed in the Graduate Calendar: https://www.uoguelph.ca/registrar/calendars/graduate/2014-2015/genreg/sec_d0e1780.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

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

For more information, contact CSD at 519-824-4120 ext. 56208 or email csd@uoguelph.ca or see the website: http://www.uoguelph.ca/csd/

8 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.
9 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:
https://www.uoguelph.ca/registrar/calendars/graduate/2015-2016/