# ENGG*3470 Mass Transfer Operations
# Winter 2016

UNIVERSITY of GUELPH

School of Engineering

(Revision 0: January 1, 2016)

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# 1 INSTRUCTIONAL SUPPORT

## 1.1 Instructor


Instructor: Sheng Chang, Ph.D., P.Eng.
Office: THRN 2519, ext. 56619
Email: schang01@uoguelph.ca
Office hours: 3:00 am to 4:00 am, Monday


## 1.2 Lab Technician


Technician: Joanne Ryks
Office: THRN 114, ext. 54087
Email: jryks@uoguelph.ca

Technician: Ryan Smith
Office: THRN 114, ext. 53873
Email: rsmith17@uoguelph.ca


## 1.3 Teaching Assistants

| GTA | Email | Office Hours |
|---|---|---|
| Shoaib Saleem | saleems@uoguelph.ca | TBA on Courselink |

# 2 LEARNING RESOURCES

## 2.1 Course Website

Course material, news, announcements, and grades will be regularly posted to the ENGG*3470 Courselink site. You are responsible for checking the site regularly.

## 2.2 Required Resources

1. ENGG 3470 course lecture notes, posted on the courselink web page

## 2.3 Recommended Resources

1. Jaime Benítez, *Principles and Modern Applications of Mass Transfer Operations*, 2nd Edition, Wiley, 2009.
2. Louis Theodore and Francesco Ricci, Mass Transfer operations for the Practicing Engineer, Wiley AIChE, 2010.

## 2.4 Additional Resources

**Lecture Information**: All the lecture notes are posted on the ENGG 3470 courselink web page.

**Lab Information**: The lab instructions and the MSDS of chemicals will be posted on the ENGG 3470 courselink web page.

**Project Information**: Design project instructions will be posted on the ENGG 3470 courselink web page

**Assignments**: Assignment and practice questions are given with the Lecture notes.

## 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> email account regularly: e-mail is the official route of communication between the University and its student.

# 3 ASSESSMENT

## 3.1 Dates and Distribution

**Labs**: 20%

Lab 1 (10%): Feb 2 -Feb 10; THRN 1116

Lab 2 (10%): Feb 23– March 4; THRN 1116

**Note:** Both paper and electronic copies of the lab report are to be submitted. Hard copy is required to submitted in class and Electronic copies named by team member s' last names, should be submitted through the courselink drop box

See section 5.3 below for due dates

**Project**: 10%

Submission 1: Friday, April 1, Hard copy is required to submitted in class and electronic copies through courselink drop box

**Note**: Both paper and electronic copies are to be submitted, Electronic copies named by team member s' last names, should be submitted through the courselink drop box

**Quizzes:** 10%: ten quizzes will be given during the lecture time once a week through the i<Click system. The average of the top five grades will be accounted for the quiz grade.

**Midterm**: 25%

Feb 12, 12:20 pm to 2:20 pm, ROOM TBA

**Final Exam**: 35%

7:00 pm – 9:00 pm (2016/04/16), Room TBA to be shown on Webadvisor

## 3.2 Course Grading Policies

**Note: Missed Assessments**: If you are unable to meet an in-course requirement due to medical, psychological, or compassionate reasons, please email the course instructor. See the undergraduate calendar for information on regulations and procedures for Academic Consideration: http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml

**Note: 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**: The passing grade is 50%.

**Note: Missed midterm tests**: If you miss a test due to grounds for granting academic consideration or religious accommodation, the weight of the missed test will be added to the final exam. There will be no makeup midterm tests.

**Note: 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 Lab technician to complete a makeup lab.

**Note: Late Lab Reports**: Late submissions of lab reports will not be accepted.

# 4 AIMS, OBJECTIVES & GRADUATE ATTRIBUTES

## 4.1 Calendar Description

Application of mass transfer principles in natural and engineered systems. Mass transport in the multi-media fate of contaminants in and between air, water and land. Design and analysis of separation processes for emission and pollutant prevention.

*Prerequisite(s):* ENGG*2230, ENGG*3260, MATH*2270
*Co-requisite(s):* ENGG*3430

## 4.2 Course Aims

This course introduces students with theories of the mass transfer and operations. The main goals of this course are (1) to teach students the approaches to solving environmental engineering related mass transfer problems; and (2) to introduce the methods for process analysis and design of mass transfer operations.

## 4.3 Learning Objectives

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

1. Apply mass transfer theory to analyze interface mass transfer mechanisms and solve one dimension steady state mass transfer problems;
2. Utilize adsorption theory to analyze the adsorption equilibrium and kinetic problems, and design the fixed bed adsorption column for water or air purification;
3. Apply absorption theory to analyze and design packed absorption/stripping equipment for environmental pollutant removal;
4. Apply membrane filtration theory to analyze and design membrane filtration process for water purification;
5. Use box models to solve environmental mass transfer problems.

## 4.4 Graduate Attributes

Successfully completing this course will contribute to the following CEAB Graduate Attributes:

| Graduate Attribute | Learning Objectives | Assessment |
|---|---|---|
| 1. Knowledge Base for Engineering | 1, 2, 3, 4, 5 | Assignment , Exams |
| 2. Problem Analysis | 1, 2, 3, 4, 5 | Assignment, Exams, Project |

| | | |
|---|---|---|
| 3. Investigation | 1, 2, 3, 4, 5 | Labs, Assignment |
| 4. Design | 2, 3, 4, 5 | Project |
| 5. Use of Engineering Tools | 2. 3 | Labs, Project |
| 6. Communication | 1,2. 3 | Labs, Project |
| 7. Individual and Teamwork | - | - |
| 8. Professionalism | - | - |
| 9. Impact of Engineering on Society and the Environment | 1, 2, 3, 4, 5 | Project |
| 10. Ethics and Equity | - | - |
| 11. Environment, Society, Business, & Project Management | - | - |
| 12. Life-Long Learning | - | - |

## 4.5 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 for tests and project.

## 4.6 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.

## 4.7 Relationships with other Courses & Labs

**Previous Courses:**

**ENGG*2230**: Fluid Mechanics; mass and energy conservation of fluid systems and the concept of boundary layer

**ENGG*3260**: Thermodynamics: thermodynamic principles of the chemical equilibrium and kinetics

**ENGG*3430:** Heat and Mass Transfer: Heat and mass transfer analogies

**MATH*2270**: Applied Differential Equations: Mathematics to solve mass transfer problems

**Follow-on Courses:**

**ENGG*4260**: Water and Wastewater treatment Design: mass transfer mechanisms and design principles of unit operations used for water and wastewater treatment

**ENGG*4330**: Air Pollution Control: mass transfer mechanisms and design methods of air purification processes.

# 5 TEACHING AND LEARNING ACTIVITIES

## 5.1 Timetable

**Lectures**:

| | | | |
|---|---|---|---|
| Monday | | 1:30 pm – 2:20 pm | MCKN 115 |
| Wednesday | | 1:30 pm – 2:20 pm | MCKN 115 |
| Friday | | 1:30 pm – 2:20 pm | MCKN 115 |

**Tutorials:**

| | | | |
|---|---|---|---|
| Monday | 01011<br>01021<br>01031 | 10:30 am– 11:20 am | MCKN 315 |
| Thursday | 01012<br>01022<br>01032 | 3:30 pm – 4:20 pm | MINS 037 |

**Laboratory:**

**Lab1**

| | | | |
|---|---|---|---|
| Tuesday<br>Feb 2, Feb 9 | 01031<br>01032 | 10:30 am -12:20 pm | THRN1116 |
| Wednesday<br>Feb 3, Feb 10 | 01021<br>01022 | 10:30 am -12:20 pm | THRN1116 |
| Friday<br>Feb 5 | 01011<br>01012 | 11:30am - 1:20 pm | THRN1116 |

**Lab 2**

| | | | |
|---|---|---|---|
| Tuesday<br>Feb 23, March 1 | 01031<br>01032 | 10:30 am -12:20 pm | THRN1116 |
| Wednesday<br>Feb 24, March 2 | 01021<br>01022 | 10:30 am -12:20 pm | THRN1116 |
| Friday<br>Feb 26, March 4 | 01011<br>01012 | 11:30am - 1:20 pm | THRN1116 |

### 5.2 Lecture Schedule

| Lectures | Lecture Topics | References | Learning Objectives |
|---|---|---|---|
| 1-5 | Molecular diffusion and transport (1.5 weeks) | Chapter 1,2 | 1 |
| 5-12 | Inter-face mass transfer (2.5 weeks) | Chapter 3 | 1 |
| 13-18 | Adsorption (1.5 weeks) | Chapter 9<br>9.3, 9.4 | 2 |
| 19-24 | Absorption/stripping operation (2 weeks) | Chapter 4 , 5 | 3 |
| 25-28 | Membrane filtration (1.5 weeks) | Lecture notes | 4 |
| 29-36 | Environmental transport phenomena (3 weeks) | Lecture notes | 5 |

### 5.3 Project and Lab Schedule

| Week | Topic | Due |
|---|---|---|
| 4-6 | Aeration and oxygen transfer coefficient | Week 7, February 26 in Class |
| 7-8 | Ion exchange column adsorption | Week 10, March 21 in Class |
| 7-10 | Design project | Week 11, April 1 in Class |

### 5.4 Other Important Dates

Monday, January 11 2016: First day of class
Monday, February 15– Friday, February 19, 2016: Winter Break
Friday, March 11: Fortieth class day, last day to drop one semester course
Friday, April 8 2016: Class concluded

## 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.

If the laboratory rules are not followed, consequences will include removing access to the lab. If this results in lab work not being completed, the student will receive a grade of 0.

# 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 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/

# 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