



# ENGG\*3470 Mass Transfer Operations

01

Winter 2022

Section(s): C01

School of Engineering

Credit Weight: 0.50

Version 2.00 - January 12, 2022

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## 1 Course Details

### 1.1 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.

**Pre-Requisites:** ENGG\*2230, ENGG\*3260, MATH\*2270

**Co-Requisites:** ENGG\*3430

### 1.2 Course Description

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

### 1.3 Timetable

**Lectures:**

02:30 PM - 03:50 PM; Tuesday & Thursday

**Tutorials:**

Sections 11, 21, 31: 7:00 PM - 7:50 PM Monday

Sections 12, 22, 32: 5:30 PM - 6:20 PM Wednesday

**Labs:**

Sections 11, 12: 12:30 PM - 2:20 PM, Tuesday

Sections 21, 22: 9:30 AM - 11:20 AM, Thursday

Sections 31, 32: 11:30 AM - 1:20 PM, Thursday

**Midterm:** 02:30 PM to 03:40 PM, Thursday, February 17

**1.4 Final Exam**

**Final Exam:** 11:30 AM to 1:30 PM (2022/04/21), TBD

**2 Instructional Support****2.1 Instructional Support Team**

<b>Instructor:</b>	Sheng Chang Ph.D., P.ENG
<b>Email:</b>	schang01@uoguelph.ca
<b>Telephone:</b>	+1-519-824-4120 x56619
<b>Office:</b>	RICH 2519
<b>Office Hours:</b>	Zoom meetings by appointment

<b>Lab Technician:</b>	Joanne Ryks
<b>Email:</b>	jryks@uoguelph.ca
<b>Telephone:</b>	+1-519-824-4120 x54087
<b>Office:</b>	THRN 1114

**2.2 Teaching Assistant**

Aneela Hayder    ahayder@uoguelph.ca

**3 Learning Resources****3.1 Required Resources****Course Website (Website)**

Lecture notes, project/lab instructions and practice questions will be posted on ENGG3470 Courselink site. The in-tutorial quizzes will be conducted online via courselink Quizzes.

## 3.2 Recommended Resources

### Principles and Modern Applications of Mass Transfer Operations (Textbook)

Jaime Benítez, 3rd Edition, Wiley, 2016.

### Mass Transfer Operations for the Practicing Engineer (Textbook)

Louis Theodore and Francesco Ricci, Wiley AIChE, 2010.

## 3.3 Course Contact Hours (Lectures, Labs, & Tutorials)

Lectures, labs and tutorials are the primary means to be used to support your learning in this course.

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# 4 Learning Outcomes

## 4.1 Course Learning Outcomes

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

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

## 4.2 Engineers Canada - Graduate Attributes (2018)

Successfully completing this course will contribute to the following:

#	Outcome	Learning Outcome
1	Knowledge Base	1, 2, 3, 4, 5
1.1	Recall, describe and apply fundamental mathematical principles and concepts	1, 2, 3, 4, 5
1.2	Recall, describe and apply fundamental principles and concepts in natural science	1, 2, 3, 4, 5
1.3	Recall, describe and apply fundamental engineering principles and	1, 2, 3, 4, 5

#	Outcome	Learning Outcome
	concepts	
1.4	Recall, describe and apply program-specific engineering principles and concepts	1, 2, 3, 4, 5
2	Problem Analysis	1, 2, 3, 4, 5
2.1	Formulate a problem statement in engineering and non-engineering terminology	1, 2, 3, 4, 5
2.2	Identify, organize and justify appropriate information, including assumptions	1, 2, 3, 4, 5
2.3	Construct a conceptual framework and select an appropriate solution approach	1, 2, 3, 4, 5
2.4	Execute an engineering solution	1, 2, 3, 4, 5
4	Design	2, 3, 4
4.3	Create a variety of engineering design solutions	2, 3, 4
4.4	Evaluate alternative design solutions based on problem definition	2, 3, 4

## 5 Teaching and Learning Activities

### 5.1 Lecture

**Topics:**

Lectures 1-5: Molecular diffusion

Lectures 6-7: Phase equilibrium

Lecture 8-10: Mass transfer equation

Lectures 11-13: Adsorption

Lectures 14-19: Absorption/stripping operation/design

Lecture 20-21: Membrane filtration

Lectures 22: Air-water mass transfer

Lecture 23: Final review

**Learning Outcome:** 1, 2, 3, 4, 5

## 5.2 Lab

**Topics:** **Lab1:** Aeration and Oxygen Transfer

### **Schedule**

Sections 11, 12: 12:30 PM - 2:20 PM, Feb. 8, Tuesday

Sections 21, 22: 9:30 AM - 11:20 AM, Feb.10, Thursday

Sections 31, 32: 11:30 AM - 1:20 PM, Feb. 10, Thursday

**Learning Outcome:** 1

**Topics:** **Lab 2:** Ion exchange/column adsorption lab

### Schedule

Sections 11, 12: 12:30 PM - 2:20 PM, March 8, Tuesday

Sections 21, 22: 9:30 AM - 11:20 AM, March 10, Thursday

Sections 31, 32: 11:30 AM - 1:20 PM, March 10, Thursday

**Learning Outcome:** 1, 2

## 5.3 Other Important Dates

January 10 (Monday): Classes commence  
 February 19 (Saturday) - February 27 (Sunday): Winter break  
 Monday, April 8 (Friday): Classes concluded

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## 6 Assessments

### 6.1 Marking Schemes & Distributions

In-tutorial quizzes: 10 %

Project report: 10%

Lab reports: 10 %

Midterm: 35%

Final Exam: 35%

### 6.2 Assessment Details

#### **In-tutorial quizzes (10%)**

**Date:** Start from week 3, remote

**Learning Outcome:** 1, 2, 3, 4, 5

Six in-tutorial quizzes, in total, will be given during the tutorial sections of weeks 3, 4, 5, 8, 9, and 10 (excluding the winter break week). The top 4 grades will be counted towards the final grade of this course.

#### **Labs (10%)**

**Learning Outcome:** 1, 2

Lab 1: Aeration and oxygen transfer lab (report due on March 4, 11:59 PM) : 5%

Lab 2: Ion exchange/column adsorption lab (report due on March 25, 11:59 PM): 5%

Students are required to submit a report for each lab individually. The lab/report instructions will be posted on Courselink. The lab reports must be submitted to the Courselink Dropbox prior to the report due time.

#### **Absorption/Stripping operation process design (10%)**

**Learning Outcome:** 1, 2, 3

Absorption/stripping operation process design (report due on April 7, 11:59 PM)

You need to form a group of two to work on the design project. Each group submit one report and the project instruction will be posted on Courselink. The project reports must be submitted to the Courselink Dropbox prior to the report due time.

**Midterm (35%)****Date:** Thu, Feb 17, 2:30 PM - 3:40 PM, TBD**Learning Outcome:** 1, 2**Final Exam (35%)****Date:** Thu, Apr 21, 11:30 AM - 1:30 PM, TBD**Learning Outcome:** 1, 2, 3, 4, 5

## 7 Course Statements

### 7.1 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. 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>

**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:** To pass the course students must obtain a grade of 50% or higher.

**In-tutorial quizzes:** If you miss three in-tutorial quizzes due to grounds for granting academic consideration or religious accommodation, the weight of your in-tutorial quizzes will be reduced to 7.5 % and the other 2.5% of the tutorial quiz weight will be transferred to the final exam . If you miss more than 3 in-tutorial quizzes due to grounds for granting academic consideration or religious accommodation, the entire weight of your in-tutorial quizzes will be added to the final exam. There will be no makeup for the in-tutorial quizzes.

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

**Lab Work:** If you can not complete the labs and lab reports due to grounds for granting academic consideration or religious accommodation, the weight of your labs will be transferred to your final exam. Late submissions (without instructor permission based on suitable grounds and documentation) will not be accepted.

**Design project:** If you can not complete the design project report for granting academic

consideration or religious accommodation, the weight of your design project will be transferred to your final exam. Late submissions (without instructor permission based on suitable grounds and documentation) will not be accepted.

**Teamwork:** Teamwork is required for the completion of the design project of this course. It is expected that you are an active member of the team and provided an approximately equal contribution to the submitted work. If it becomes apparent that this is not the case then the instructor may assign a substantially different (lower) grade for a member of the team.

## 7.2 Relationships with other Courses & Labs

### Previous Courses:

**ENGG\*2230:** Fluid Mechanics: mass and energy conservation of fluid systems and the concept of boundary layers.

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

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

### Co-current Courses:

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

### 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 and design methods of air purification.

## 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 grounds for Academic Consideration are detailed in the Undergraduate and Graduate Calendars.

Undergraduate Calendar - Academic Consideration and Appeals

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml>

Graduate Calendar - Grounds for Academic Consideration

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml>

Associate Diploma Calendar - Academic Consideration, Appeals and Petitions

<https://www.uoguelph.ca/registrar/calendars/diploma/current/index.shtml>

## 9.3 Drop Date

Students will have until the last day of classes to drop courses without academic penalty. The deadline to drop two-semester courses will be the last day of classes in the second semester. This applies to all students (undergraduate, graduate and diploma) except for Doctor of Veterinary Medicine and Associate Diploma in Veterinary Technology (conventional and alternative delivery) students. The regulations and procedures for course registration are available in their respective Academic Calendars.

Undergraduate Calendar - Dropping Courses

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-drop.shtml>

Graduate Calendar - Registration Changes

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/genreg-reg-regchg.shtml>

Associate Diploma Calendar - Dropping Courses

<https://www.uoguelph.ca/registrar/calendars/diploma/current/c08/c08-drop.shtml>

## 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 make a booking at least 14 days in advance, and no later than November 1 (fall), March 1 (winter) or July 1 (summer). Similarly, new or changed accommodations for online quizzes, tests and exams must be approved at least a week ahead of time.

For Guelph students, information can be found on the SAS website

<https://www.uoguelph.ca/sas>

For Ridgetown students, information can be found on the Ridgetown SAS website

<https://www.ridgetownc.com/services/accessibilityservices.cfm>

## 9.6 Academic Integrity

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 encourages academic integrity. 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.

Undergraduate Calendar - Academic Misconduct

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml>

Graduate Calendar - Academic Misconduct

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml>

## 9.7 Recording of Materials

Presentations that are made in relation to course work - including lectures - cannot be recorded or copied without the permission of the presenter, whether the instructor, a student, 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 that apply to undergraduate, graduate, and diploma programs.

Academic Calendars

<https://www.uoguelph.ca/academics/calendars>

## 9.9 Disclaimer

Please note that the ongoing COVID-19 pandemic may necessitate a revision of the format of course offerings, changes in classroom protocols, and academic schedules. Any such changes will be announced via CourseLink and/or class email.

This includes on-campus scheduling during the semester, mid-terms and final examination schedules. All University-wide decisions will be posted on the COVID-19 website (<https://news.uoguelph.ca/2019-novel-coronavirus-information/>) and circulated by email.

## 9.10 Illness

Medical notes will not normally be required for singular instances of academic consideration, although students may be required to provide supporting documentation for multiple missed assessments or when involving a large part of a course (e.g.. final exam or major assignment).

## 9.11 Covid-19 Safety Protocols

For information on current safety protocols, follow these links:

- <https://news.uoguelph.ca/return-to-campus/how-u-of-g-is-preparing-for-your-safe-return/>
- <https://news.uoguelph.ca/return-to-campus/spaces/#ClassroomSpaces>

Please note, these guidelines may be updated as required in response to evolving University, Public Health or government directives.

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