



# ENGG\*3160 Biological Engineering Systems II

01

Fall 2023

Section(s): C01

School of Engineering

Credit Weight: 0.50

Version 2.00 - September 06, 2023

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## 1 Course Details

### 1.1 Calendar Description

Mass transfer in biological systems: concepts; gas-liquid mass transfer; membrane transport processes; and heterogeneous reactions. Applications may include fermenter aeration, tissue perfusion, mass transfer limitations in biofilms, microbial flocs and solid tumours, protein recovery and drug delivery.

**Pre-Requisites:**

ENGG\*2230, ENGG\*2660

**Restrictions:**

This is a Priority Access Course. Enrolment may be restricted to the BIOE specialization in the BENG and BENG:C programs. See department for more information.

### 1.2 Timetable

**Lectures:**

M/W/F 10:30 AM - 11:20 AM, MCKN 318

**Tutorials (Weeks: 1-4 & 11-12):**

Monday 11:30 AM - 1:20 PM, THRN 1104

**Laboratory Experiments (Weeks: 6-10):**

Monday 11:30 AM - 1:20 PM, THRN 1104

### 1.3 Final Exam

Wednesday, December 13, 08:30 AM - 10:30 AM, TBD

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## 2 Instructional Support

### 2.1 Instructional Support Team

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|------------------------|-----------------------------|
| <b>Instructor:</b>     | Ashutosh Singh              |
| <b>Email:</b>          | asingh47@uoguelph.ca        |
| <b>Telephone:</b>      | +1-519-824-4120 x53048      |
| <b>Office:</b>         | RICH 3525                   |
| <b>Office Hours:</b>   | Open door or by appointment |
| <b>Lab Technician:</b> | Jacqueline Fountain         |
| <b>Email:</b>          | fountain@uoguelph.ca        |
| <b>Telephone:</b>      | +1-519-824-4120 x56676      |
| <b>Office:</b>         | THRN 1102                   |

### 2.2 Teaching Assistants

|                                  |  |
|----------------------------------|--|
| <b>Teaching Assistant (GTA):</b> | Venkata Vara Prasad Prudhvi Pasumarthi |
| <b>Email:</b>                    | pasumarv@uoguelph.ca                   |

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## 3 Learning Resources

### 3.1 Required Resources

#### Course Website (Website)

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

Course material, news, announcements, and grades will be regularly posted to the ENGG\*3160 Courselink site. You are responsible for checking the site regularly.

#### Heat and Mass Transfer: A Biological Context, Second Edition (Textbook)

A. K. Datta, CRC Press, 2nd Edition, Taylor & Francis Group, Boca Raton, FL, 2017

### 3.2 Recommended Resources

#### Transport Processes and Separation Process Principles (Textbook)

Christie John Geankoplis, Fourth Edition, Prentice Hall, ISBN 0-13-101367-X

### 3.3 Additional Resources

#### Lecture Information (Notes)

A summary of lecture notes will be posted on Courselink as they are finalized (prior to lectures).

#### Lab Information (Notes)

The lab manuals and lab schedule will be posted on the Courselink. You are responsible for printing the lab manuals and having them with you during the laboratory sessions.

**Home Assignments (Other)**

There will be approximately 11 problem sets posted in Courselink during the term. These problem sets will not be graded, but it is recommended that you do each problem set, as practice problems are the best way to learn the course. All solutions will be posted.

**Miscellaneous Information (Other)**

Other information related to the ENGG 3160 course will be posted on the Courselink site.

**3.4 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 <mail.uoguelph.ca> e-mail account regularly: e-mail is the official route of communication between the University and its student. You are encouraged to use [ENGG\*3160] in the subject line while emailing your GTA and instructor.

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**4 Learning Outcomes****4.1 Course Learning Outcomes**

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

1. Identify important biological heat and mass transfer processes, and derive the basic expressions for them based on mass conservation.
2. Understand and apply the process of diffusion and diffusive mass transport across biological systems
3. Determine steady state, transient and convective mass transfer in various geometries of practical importance
4. Evaluate the basic mass transfer models in applications such as hemodialysis, capillaries, lungs and relevant biological systems.
5. Conduct Mass Transfer in Biological Systems laboratory experiments through collecting and analyzing data using the appropriate instruments and write clear, concise and professional laboratory reports.
6. Demonstrate effective skills in teamwork during group activities; demonstrate respectful interactions with peers, lab technician, teaching assistants, and instructor, and also develop self-assessment skills.

**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       |
| 1.3 | Recall, describe and apply fundamental engineering principles and concepts   | 1, 3             |
| 1.4 | Recall, describe and apply program-specific engineering principles and concepts  | 1, 2, 4          |
| 2   | Problem Analysis   | 1, 2, 3, 4       |
| 2.1 | Formulate a problem statement in engineering and non-engineering terminology   | 1, 3             |
| 2.2 | Identify, organize and justify appropriate information, including assumptions  | 3, 4             |
| 2.3 | Construct a conceptual framework and select an appropriate solution approach   | 2, 3, 4          |
| 2.4 | Execute an engineering solution  | 2, 3, 4          |
| 3   | Investigation  | 5                |
| 3.3 | Analyze and interpret experimental data  | 5                |
| 3.4 | Assess validity of conclusions within limitations of data and methodologies  | 5                |
| 7   | Communication Skills   | 6                |
| 7.3 | Construct the finished elements using accepted norms in English, graphical standards, and engineering conventions, as appropriate for the message and audience | 6                |

## 5 Teaching and Learning Activities

### 5.1 Lecture

**Topics:** Introduction to mass and energy conservation and transport phenomenon in biological systems, Introduction to modes of heat transfer and governing equations, Conduction: Steady state

**References:** Chapters 1-4

**Topics:** Conduction: Unsteady State; Introduction to convective heat transfer; Introduction to mass transfer, mass conservation and kinetics

|                    |   |
|--------------------|---|
| <b>References:</b> | Chapters 5-6 & 9  |
| <b>Topics:</b>     | Modes of mass transfer, fluid properties (viscosity, density, kinematic and dynamic viscosity), Phase equilibrium in mixtures, physical properties of the body fluids and cell membrane                 |
| <b>References:</b> | Chapter 10  |
| <b>Topics:</b>     | Governing equations, boundary conditions of mass transfer; Diffusion mass transfer, steady state diffusion; Mass transfer through biofilms, membrane, capillary transport, mass transfer through porous |
| <b>References:</b> | Chapters 11-12  |
| <b>Topics:</b>     | Hemodialysis, oxygen transport in human tissues   |
| <b>References:</b> | Chapter 12  |
| <b>Topics:</b>     | Introduction to unsteady state diffusion mass transfer  |
| <b>References:</b> | Chapter 13  |
| <b>Topics:</b>     | Mass transfer across the skin. Drug Delivery problems. Transfer of drugs or toxins across the skin  |
| <b>References:</b> | Chapter 14 + Notes  |
| <b>Topics:</b>     | Oxygen uptake by microorganisms (fermentation process); Heat (energy) transfer and analogies to mass transfer; Introduction to Pharmacokinetics   |
| <b>References:</b> | Chapter 14 + Notes  |

## 5.2 Lab

|                |                                   |
|----------------|-----------------------------------|
| <b>Topics:</b> | Tutorial (Week 1-4 & 11-12)       |
| <b>Topics:</b> | Laboratory 1, 2, 3, 4 (Week 6-10) |

## 5.3 Note

In order to explain the concepts of mass transfer in its most practical form this course has been tailored to provide a very basic introduction to heat transfer. This will help students to draw analogies between heat and mass transfer. The contents discussed in week 1-4 will be later elaborated in the course ENGG\* 3430 (Heat and Mass Transfer).

## 5.4 Other Important Dates

**Thursday, September 7, 2023:** First day of class

**Monday, October 9, 2023:** Thanksgiving holiday

**Tuesday, October 10, 2023:** Study break, no classes

**Thursday, November 30, 2023:** Make up for Study Day (Tuesday, October 10 Schedule)

**Friday, December 1, 2023:** Make up for Study Day (Monday, October 9 Schedule)

**Friday, December 1, 2023:** Last day to drop F23 one-semester courses and S23/F23 two-semester courses

## 6 Assessments

### 6.1 Marking Schemes & Distributions

| Name                  | Scheme A (%) |
|-----------------------|--------------|
| Assignments           | 0            |
| Tutorials and Quizzes | 10           |
| Labs                  | 20           |
| Midterm Exam          | 25           |
| Final Exam            | 45           |
| Total                 | 100          |

### 6.2 Assessment Details

#### Assignments (0%)

Approximately 11 Problem Sets. These are take-home problem sets and will be made available on the Courselink site every week. Students are encouraged to solve them and practice as much as possible.

#### Tutorials and Quizzes (10%)

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

6 tutorial sessions. Each tutorial will cover two parts. In the first part, your GTA will solve and discuss 1 problem and in the second part, you will be asked to solve a problem. At the end of the tutorial, you will submit your solution to the GTA for grading. You are encouraged to attend the tutorial section regularly. If you miss a tutorial, you won't be allowed to write it in any other section and you will receive an immediate **Zero** as the grade.

#### Labs (20%)

**Learning Outcome:** 5, 6

The purpose of performing the Lab of this course is to verify the concepts learned during the lectures. Five tutorial classes (Week 6-10) will be reserved for the ENGG\*3160 Labs. The detailed schedule will be posted on Courselink. You need to make groups of 3 students (including yourself) for performing the lab experiments. The lab reports will be due one

week after completion of the lab experiments. Each student will submit an individual lab report.

**Midterm Exam (25%)**

**Date:** Fri, Oct 13, 7:00 PM - 9:00 PM, ROZH 107

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

**Final Exam (45%)**

**Date:** Wed, Dec 13, 8:30 AM - 10:30 AM

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

## 6.3 Note

All assessments are open-book. An Open-Book exam means you are allowed to bring the course textbook but not your notes and problem set solutions (If you copy solutions to the problem sets into your textbook, you will not be allowed to use it during the exams). You are also allowed to use a non-programmable calculator during the exams.

## 6.4 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>

**Missed Midterm Exam:** 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 tests.

**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 teaching assistant to complete a makeup lab.

**Late Lab Reports:** Late submissions of lab reports will only be accepted with the approval of the course instructor, and will be subject to penalties.

**Passing grade:** The passing grade of this course is 50%.

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## 7 School of Engineering Statements

## 7.1 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.

## 7.2 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.

## 7.3 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.

# 8 University Statements

## 8.1 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.

## 8.2 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>



### 8.3 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>

### 8.4 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.

### 8.5 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>

## 8.6 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>

## 8.7 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.

## 8.8 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>

## 8.9 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).

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