ENGG*3160
Biological Engineering Systems II
Fall 2016

School of Engineering

(Revision 0, September 8, 2016)

1 Instructional Support

1.1 Instructor

Instructor: Ashutosh Singh, Ph.D.
Office: THRN 2342, ext. 53048
Email: asingh47@uoguelph.ca
Office hours: Open door or by appointment

1.2 Lab Technician

Technician: Jacqueline Fountain
Office: THRN 1102
Email: fountain@uoguelph.ca

1.3 Teaching Assistants

GTA	Email	Office Hours
Harjeet Singh Brar	brarh@uoguelph.ca	TBA

2 Learning Resources

2.1 Course Website

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

2.2 Required Resources

A. K. Datta, **Biological and Bioenvironmental Heat and Mass Transfer**, CRC Press, Taylor & Francis Group, Boca Raton, FL, 2002

2.3 Recommended Resources

1. Christie john Geankoplis, **Transport Processes and Separation Process Principles**, Fourth Edition, Prentice Hall, ISBN 0-13-101367-X
2. George A. Truskey, Fan Yuan, David Katz**, Transport Phenomena in Biological Systems**, Second Edition. Pearson Prentice Hall, ISBN 0-13-156988-0.

2.4 Additional Resources

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

Lab Information: 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: There will be approximately 10 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 information related to the ENGG 3160 course will be posted on the Courselink site.

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 <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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3 ASSESSMENT

3.1 Dates and Distribution

Assignments (0%): Approximately 10 Problem Sets. These are take-home problem sets and would 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%): 7-8 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%): The Purpose of performing the Lab in this course is to verify the concepts learned during the lectures. **Four tutorial classes (Week 7-10) will be reserved for the ENGG*3160 Labs**. The detail 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%): Midterm Exam (Open book exam)

Date: October 18, 2016 (Tuesday)

Time: 7:00 PM to 9:00 PM

Location: MCKN 309

Final Exam (45%): Final Exam (Open book exam)

Date: December 13, 2016 (Tuesday)

Time: 2:30 PM to 4:30 PM

Location: TBA

Note: An **Open Book** exam means that 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.

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. 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 not be accepted.

Passing grade: The passing grade of this course is 50% and every student must obtain a grade of 50% or higher in the Final Exam portion of the course in order for the midterm exam, laboratory write-up, and Quizzes portion of the course to count towards the final grade.

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4 AIMS, OBJECTIVES & GRADUATE ATTRIBUTES

4.1 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.

Prerequisite(s): ENGG*2230, ENGG*2660

4.2 Course Aims

Mass Transfer is a basic engineering science and has a broad application area ranging from biological systems to industrial processes including pharmaceutical, food and environmental processing. The main goals of this course are (a) to introduce mass transfer processes of biological and medical importance and the methods used to model them, (b) to present real-world engineering applications to give students a feel for engineering practice, and (c) to develop an intuitive understanding of the subject matter by emphasizing the physics and physical arguments.

To fulfil the course objective it is expected that the students can solve a first order differential equation and that they understand boundary conditions.

4.3 Learning Objectives (LO)

1. Identify important biological and biomedical mass transfer processes, and derive the basic expressions for them based on mass balance (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.

4.4 Graduate Attributes:

Graduate Attribute	Learning Objectives	Assessment
1. Knowledge Base for Engineering	1, 2, 3, 5, 6	Quizzes, Labs and Exams
2. Problem Analysis	1, 2, 3, 4, 5, 6	Quizzes, Labs and Exams
3. Investigation	5,6	Labs
4. Design	-	-
5. Use of Engineering Tools	5,6	Labs
6. Communication	5,6	Labs
7. Individual and Teamwork	5,6	Quizzes and Labs
8. Professionalism	-	-
9. Impact of Engineering on Society and the Environment	-	-
10. Ethics and Equity	-	-
11. Environment, Society, Business, & Project Management	5,6	Labs
12. Life-Long Learning	1, 2, 3, 4, 5, 6	Quizzes, Labs and Exams

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/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.

4.6 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*2660

Fundamental understanding and knowledge of analysis of mass, energy and momentum components learned in ENGG*2660 is essential to be able to solve differential equation based problems in ENGG*3160.

ENGG*2230

Fundamental understanding of the fluid flow systems, units and dimensions, boundary layer (boundary conditions) theory and its application in heat and mass transfer learned in ENGG*2230 is essential to understand the basic mass transfer processes taking place in biological systems

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5 TEACHING AND LEARNING ACTIVITIES

5.1 Timetable

Lectures:			
Monday		12:30 PM – 01:20 PM	MACN 118
Wednesday		12:30 PM – 01:20 PM	MACN 118
Friday		12:30 PM – 01:20 PM	MACN 118
Tutorials (Weeks: 1-6 & 11-12):			
Tuesday	Sec 01	03:30 PM - 05:20 PM	TBA (THRN 1104)
Friday	Sec 02	08:30 AM - 10:20 AM	TBA (THRN 1104)
Laboratory Experiments (Weeks: 7-10):			
Tuesday	Sec 01	03:30 PM - 05:20 PM	THRN 1104
Friday	Sec 02	08:30 AM - 10:20 AM	THRN 1104
Midterm Exam:	October 18, 2016	07:00 PM- 09:00 PM	MCKN 309
Final Exam	December 13, 2016	02:30 PM – 04:30 PM	TBA

5.2 Lecture Schedule

The following table contains the tentative schedule of lecture topics.

Week	Topic
1-2	- Introduction to mass and energy conservation and transport phenomenon in biological systems. (Chapter 1) - Introduction to modes of heat transfer and governing equations (Chapter 2-3) - Conduction: Steady state (Chapter 4).
3-4	- Conduction: Unsteady State (Chapter 5) - Introduction to convective heat transfer (Chapter 6-7). - Introduction to mass transfer, mass conservation and kinetics (Chapter 9)
4-5	- 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 (Chapter 10).
6-7	- Governing equations, boundary conditions of mass transfer (chapter 11). - Diffusion mass transfer, steady state diffusion (Chapter 12). - Mass transfer through biofilms, membrane, capillary transport, mass transfer through porous media (Chapter 12).
7	- Hemodialysis, oxygen transport in human tissues (Chapter 12).
8	- Introduction to unsteady state diffusion mass transfer (Chapter 13).
9,10	- Convective mass transfer (Chapter 14)
10,11	- Mass transfer across the skin. Drug Delivery problems. Transfer of drugs or toxins across the skin (Chapter 14 + Notes).
12	- Oxygen uptake by microorganisms (fermentation process) (Chapter 14). - Heat (energy) transfer and analogies to mass transfer (Chapter 14). (Industrial Visit / Tutorial: TBD)
12	- Introduction to Pharmacokinetics (Instructional notes will be provided).

Note: In order to explain the concepts of mass transfer in its most practical form this course has been tailored to provide 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).

5.3 Lab Schedule

Week	Topic
1,2,3, 4, 6	Tutorial/Quiz
5	Thanksgiving (Possible demo of Microwave assisted extraction system)
7 and 8	Laboratory 1, 2
9 and 10	Laboratory 3, 4
11, 12	Industrial Visit: TBD/ Tutorial/Quiz/Review

5.4 Other Important Dates

Thursday, September 8, 2016: First day of class
Monday, October 10, 2016: Thanksgiving holiday
Tuesday, October 11, 2016: Study break, no classes
Friday, November 4, 2016: 40th class day, last day to drop classes
Friday, December 2, 2016: last day of class

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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 student's access to the lab. If this results in lab work not being completed, the student will receive a grade of 0.

All students must require a basic safety related training. Complete the online WHMIS (Workplace Hazardous Materials Information System) training before the first lab experiment session. Visit Environmental Heath and Safety website (http://www.uoguelph.ca/ehs/courses/login.cfm) for registration and additional information. Your GTA and Lab Technician may ask you to show them a copy of the WHMIS completion certificate anytime during your lab session.

6.1 Specific for ENGG*3160:

♣ At the beginning of your first lab experiment session (Week 7) the Biological Lab Technician and GTA will deliver a short lecture on the lab safety in general and specific to ENGG*3160. You must attend this safety lecture session and sign the signature sheet available in the lab.

♣ Your Lab Technician and GTA will train you before the first use of any critical instrument.

♣ You must read the experiment manuals carefully. You will find additional safety requirement related to specific excrements in the manuals. Follow them accordingly.

♣ You must read and follow safety rules posted on the door of the Biological Engineering Lab (THRN1104).

♣ Always wear safety glasses during lab time.

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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