ENGG*2660 Biological Engineering Systems I
Winter 2016

UNIVERSITY of GUELPH

School of Engineering

(Revision 0: January 8, 2016)

---

1 INSTRUCTIONAL SUPPORT

1.1 Instructor

Manju Misra, Ph.D.
Office: RICHARDS 2511
Email: mmisra@uoguelph.ca, Tel: 519-824-4120 Ext 58935, 56766
Office Hours: Wednesdays 4:30 PM-5:30 PM

1.2 Teaching Assistant:

Laura MacNeil
Office: THRN 2105,
Email: macneill@mail.uoguelph.ca
Office Hours: Tuesdays 5:00 - 6:00 PM

---

2 LEARNING RESOURCES

2.1 Course Website

Course material, news, announcements, and grades will be regularly posted to the ENGG*2660 Courselink site. You are responsible for checking the site regularly.

2.2 Required Resources

Bioprocess Engineering Principles, P. M. Doran, (2nd Edition) 2013 Elsevier Ltd., ISBN: 978-0-12-220851-5

2.3 Recommended Resources

Molecular Cell Biology 6th Edition, Lodish, Harvey et al. W. H. Freeman and Company, NY, 2003

2.4 Additional Resources

Lecture Information: All the lecture notes will be posted on the web page.
Tutorial Information: The tutorial notes will also be posted on the web page.
Assignments: Download the assignments according to the schedule notified. All the solutions will be posted.
Miscellaneous Information: Other information related to this course may also be posted on the web page.

2.5 Communication & Email Policy: Please use lectures and tutorial 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.

---

3 ASSESSMENT

3.1 Dates and Distribution

Distribution	Grades %	Due dates
Assignment 1	6	February 1, 2016
Assignment 2	6	February 29, 2016
Assignment 3	6	March 21, 2016
Quiz 1	6	January 20 (Sec 02) /January 21 (Sec 01), 2016
Quiz 2	6	March 9 (Sec 02)/ March 10 (Sec 01), 2016
Term Project Abstract	2	February 12, 2016
Term Project Presentation	8	March 21-March 24, 2016
Term Project Report	10	March 31, 2016
Final Examination	50	April 16, 2016

Assignments will be handed out through Courselink. Students are encouraged to complete all of these assignments. Late assignments will receive a grade of 0. The questions will be marked

rigorously – i.e. solutions should be thoroughly and professionally presented. The teaching assistant will provide a review and help with questions before the quiz during tutorial sessions.

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

Passing grade: In order to pass the course, you must pass both the tutorial (assignments, quizzes) and term project in addition to the exam course portions. Students must obtain a grade of 50% or higher on the exam portion of the course in order for the rest (assignments, quizzes and term project) portion of the course to count towards the final grade.

Tutorial Work: You must attend and complete all tutorials. If you miss a tutorial due to grounds for granting academic consideration or religious accommodation, arrangements must be made with the teaching assistant to complete a makeup tutorial.

---

4 AIMS, OBJECTIVES & GRADUATE ATTRIBUTES

4.1 Calendar Description:

This course deals with the mathematical description and identification of biological systems through mass and energy balances, reactions in biological systems, biomedical, food, and bio-processing applications.

Prerequisite(s): ENGG*2400, MATH*2270, (1 of BIOL*1030, BIOL*1070, BIOL*1080, BIOL*1090, MICR*1020)

4.2 Course Aims:

Bioengineering is a broad discipline that integrates engineering principles with biological sciences. Applications include biochemical and food engineering bioresource engineering and biomedical

engineering. Systems identification and analysis are common to all of these areas and form the foundation for engineering design. We will focus on systems containing biological catalysts (e.g. cells, enzymes) and/or other reacting species. A range of bio-system examples will be studied including those pertaining to food and bioprocessing industries.

4.3 Learning Objectives

Upon successful completion of this course, students will be able to:

1. Identify and analyse mass and energy transformations in biological systems.
2. Develop mathematical models for biological systems and analyse their dynamic behaviour.
3. Integrate fundamental principles of microbiology and biochemistry with quantitative analysis to solve engineering 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	Quizzes, Assignments, Final Exam, Project
2. Problem Analysis	1,2,3	Assignments, Final Exam and Project
3. Investigation	1,2,3	Project
4. Design	-	-
5. Use of Engineering Tools	1,2,3	Assignments and Final Exam
6. Communication	3	Project & Final Exam
7. Individual and Teamwork	1,2,3	Project
8. Professionalism	-	-
9. Impact of Engineering on Society and the Environment	-	-
10. Ethics and Equity	1,2,3	Assignments, Final Exam and Project
11. Environment, Society, Business, & Project Management	1,2,3	-
12. Life-Long Learning	1,2,3	Quizzes and Project

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*2120: Materials Science: Fundamentals of materials science are reviewed in this class.

ENGG*2400: Engineering Systems Analysis: This course uses techniques and tools developed in ENGG*2400 to analyse mass, energy and momentum components of biological systems.

BIOL*1070, BIOL*1080, BIOL*1090, MICR*2420: Concepts of biodiversity, cell and molecular biology and microbiology are covered that are helpful for fundamental understanding of this course.

Follow on courses:

ENGG*3160: Biological Engineering Systems II: Fundamental learning from ENGG*2660 course is essential to understand mass transfer processes of biological importance.

ENGG*41X: Fourth year engineering design IV projects will integrate bioprocess principles used in ENGG*2660 course.

5 TEACHING AND LEARNING ACTIVITIES

5.1 Timetable

Lectures:

Monday	12:30 PM – 1:20 PM	ROZH, Room 105
Wednesday	12:30 PM – 1:20 PM	ROZH, Room 105
Friday	12:30 PM – 1:20 PM	ROZH, Room 105

Tutorial:

Thursday (sec 01)	08:30AM - 09:20AM	CRSC, Room 403
Wednesday (sec 02)	08:30AM - 09:20AM	ROZH, Room 108

5.2 Lecture Schedule

Week	Lecture Topics	Learning Objectives
1-2	Introduction to cell mechanisms, characteristics, physiology and growth requirements	2,3
3-5	Bioprocess engineering introduction: • units and dimensions • intensive and extensive properties • concentration definitions Material balances: • steady state and equilibrium conditions • conservation of mass • types of material balance, simplification of the general mass balance equation, procedure for material balance calculations • material balances with recycle, bypass, purge streams • stoichiometry of cell growth and product formation, biomass yield, theoretical oxygen demand	2,3
6-7	Energy balances: • thermodynamics and Entropy • general energy balance • enthalpy calculations in non-reactive processes including change in temperature, change of phase, mixing and solution • Steam tables • procedure for energy balance calculations without reaction • enthalpy changes due to reaction • heat of reaction for processes with biomass production including thermodynamics of cell growth • energy balance equation for cell cultures	2,3
8-9	Bioprocess reaction kinetics, system energy analysis: • reaction thermodynamics, yield, and rate • reaction kinetics for biological systems and cell cultures • enzymatic reactions • yields in cell cultures • introduction to bioreactors	2,3

10-11	Overview of unit operation and downstream processing: • introduction to process flow diagrams • mixing (different designs of mixers, mixing in fermenters, effects of mixing on cell cultures) • heat transfer equipment and heat exchangers • extraction cell removal operations (filtration, centrifugation, membrane filtration) • cell disruption • precipitation • drying	2,3
12	Overview on sustainable bioprocessing: • waste and pollutants in bioprocessing • introduction to life cycle analysis • disposable bioreactors	1,2,3

5.3 Other Important Dates

Monday, January 11, 2016 – Classes Begin

Monday, February 15, 2016 – Reading Week Begins

Friday, March 11, 2016 – Drop date – 40th Class

Friday, March 25, 2016 Holiday--NO CLASSES SCHEDULED

Friday, April 8, 2016 – Classes Conclude

5.4 Disclaimer

The instructor reserves the right to change any or all of the above in the event of appropriate circumstances, subject to the University of Guelph Academic Regulations.

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.

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.

6.1 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

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: http://www.uoguelph.ca/registrar/calendars/index.cfm?index