ENGG*4380 Bioreactor Design
Winter 2014

School of Engineering

(Revision 1: January 3rd, 2014)

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1 INSTRUCTIONAL SUPPORT

1.1 Instructor

Instructor: Emily Chiang, Ph.D, P.Eng
Office: THRN 3507, ext. 58217
Email: chiange@uoguelph.ca
Office hours: TBA on Courselink or by appointment

1.2 Lab Technician

Technician: Carly Fennell
Office: THRN 3403, ext. 56676
Email: gennc@uoguelph.ca

1.3 Teaching Assistants

GTA	Email	Office Hours
Sahar Hemmati	hemmati.sahar@gmail.com	TBA on Courselink

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2 LEARNING RESOURCES

2.1 Course Website

Course material, news, announcements, and grades will be regularly posted to the ENGG 4380 Courselink site. You are responsible for checking the site regularly.

2.2 Required Resources

No textbook will be mandatory. Students are encouraged to make use of textbooks used in earlier courses as well as textbooks that are available from the library.

2.3 Recommended Resources

1. Biological Reaction Engineering: Dynamic Modelling Fundamentals with Simulation Examples. 2nd edition. Irving J. Dunn, Elmar Heinzle, John Ingham, Jiří E. Přenosil. Wiley, Germany 2003.
2. Biochemical Engineering Fundamentals. 2nd edition. James E. Bailey and David F Ollis. McGraw-Hill 1986.
3. Basic Bioreactor Design. K. van't Riet and J. Tramper. Marcel Dekker, Inc., New York 1991.
4. Bioprocess Engineering Basic Concepts. 2nd edition.. Michael L. Shuler and Fikret Kargi, Prentice Hall, Upper Saddle River, NJ 2002.
5. Bioprocess Engineering Principles Pauline Doran, Academic Press, London, 1995.
6. Modern Biotechnology: Connecting Innovations in Microbiology and Biochemistry to Engineering Fundamentals. N.S. Mosier and M.R. Ladisch. John Wiley & Sons, Inc. 2009.

2.4 Additional Resources

Lecture Information: All the lecture notes will be posted on Courselink.

Lab Information: All the lab notes will be posted on Courselink.

Project Information: All the project requirements will be posted on Courselink.

2.5 Communication & Email Policy

Please use lectures and lab 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> e-mail account regularly: e-mail is the official route of communication between the University and its students.

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3 ASSESSMENT

3.1 Dates and Distribution

Quizzes (Personal): 5 in class quizzes, 20%

Quiz dates: Jan 22nd, Feb 12th, March 5th, March 17th, March 26th

Lab Performance (Personal): An average of evaluations from the instructor, the lab technician, the TA and team members, 20%

Design Project (Group): 60%

Presentation 1: Fri Feb 14th (in lab), 10%
Submission 1: Wed Feb 26th, 10%
Final Presentation: Mon Mar 31st and Wed April 2nd (in class), 10%
Final Report: Thu April 17th, 30%
Note: Both paper and electronic copies are to be submitted

3.2 Course Grading Policies

Missed Quizzes: If you are unable to meet an in-course requirement due to medical, psychological, or compassionate reasons, please email the course instructor. Please see below for specific details and consult 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: Students must obtain a grade of 50% or higher on the quizzes and the lab performance portions of the course in order for design project portion of the course to count towards the final grade.

Missed Presentations: Late presentations will not be accepted

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 Reports: Late submissions of reports will not be accepted.

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4 AIMS, OBJECTIVES & GRADUATE ATTRIBUTES

4.1 Calendar Description

Topics in this course include: modeling and design of batch and continuous bioreactors based on biological growth kinetics and mass balances; gas-liquid mass transfer for aeration and agitation; instrumentation; and control.

Bioreactor design is an integral part of bioprocess engineering. Bioreactors are controlled environments for microbiological and biochemical reactions to produce value-added products or to treat waste streams. Typical processes include fermentations to produce antibiotics, wine and yoghurt, enzymatic reactors to create ingredients such as high fructose corn syrup and natural bio-systems such as composting operations

and biofilters. Design of bioreactors requires integration of microbiology, biochemistry, process engineering and economic analysis.

Prerequisite: ENGG*3160 Biological Engineering Systems II

4.2 Course Aims

This course introduces students to modelling and design of batch and continuous bioreactors based on biological growth kinetics and mass balances. Additional design topics include: mass transfer, biological reaction, instrumentation and control. The students will put into practice what they learn in the classroom through a group design project that combines research study, experimental work, mathematical modeling (Berkeley Madonna), equipment design, and project management.

4.3 Learning Objectives

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

1. Describe and specify reactors used in industrial bioprocesses.
2. Develop mathematical models for bioreactors and analyse their behaviour (dynamic and steady state).
3. Specify operating parameters for optimal performance of ideal bioreactor systems.
4. Design complete bioreactor systems including instrumentation and control components.
5. Plan and conduct biological experiments with the aim of generating engineering data for process design.
6. Work in a team environment, designate and accept responsibilities, manage time and resources, and communicate results.

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	Quizzes, Project
2. Problem Analysis	2, 3, 5	Quizzes, Labs, Project
3. Investigation	1, 2, 3, 4, 5	Labs, Project
4. Design	1, 2, 3, 4	Project
5. Use of Engineering Tools	2, 4	Labs, Project
6. Individual and Teamwork	3, 4, 5, 6	Quizzes, Labs, Project
7. Communication	4, 6	Labs, Project
8. Professionalism	5, 6	Labs, Project
9. Impact of Engineering on Society and the Environment	4	Project
10. Ethics and Equity	6	Project

11. Economics & Project Management	2, 4, 6	Project
12. Life-Long Learning	5, 6	Labs, 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*2560: reactor type, analysis techniques, mass balance.

ENGG*2660 and ENGG* 3160: mass and energy balances; mass transfer, reactions in biological systems; bio-processing applications.

ENGG*3150: kinematic and kinetic analysis techniques; electromyography; techniques in laboratory instrumentation and biomedical applications.

ENGG*3830: Analysis and design of unit processes, rheology and non-Newtonian fluid dynamics of biological materials.

5 TEACHING AND LEARNING ACTIVITIES

5.1 Timetable

Lectures:

Monday		08:30 – 09:50	MACN, Room 201
Wednesday		08:30 – 09:50	MACN, Room 201
Laboratory:			
Friday	Sec 01	09:30 - 11:20	THRN 1104

5.2 Lecture Schedule

Lectures	Lecture Topics	References	Learning Objectives
1-2	Introduction to bioreactor design		1,2
3-6	Bioreactor Operation		1,2
7-11	Biological Kinetics		1,2
12-14	Bioreactor Modelling		2, 3, 4
15-17	Mass Transfer		2, 3, 4
18-19	Bioprocess Control and Instrumentation		2, 3, 4
20-22	Commercial Operations		1, 2, 3, 4
23-24	Final Presentation		3, 4, 6

5.3 Lab Schedule

Week	Topic
1	Introduction to the Design Project
2	Lab Equipment and Safety Training
3	Preparation
4-5	Equipment and apparatus set-up
6	Presentation 1
7	Experiment
8	Experiment
9	Experiment
11	Experiment
12	Experiment

5.4 Other Important Dates

Monday, January 6 2014: First day of class
Monday, February 17 – Friday, February 21 2014: Winter Break
Friday, March 7: drop date – 40th class
Friday, April 4 2014: last day of class

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.

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