

ENGG*4380 Bioreactor Design

Winter 2017



(Revision 0: January 9, 2017)

1 INSTRUCTIONAL SUPPORT

1.1 Instructor

Instructor: Manickavasagan Annamalai (Manick), Ph. D., P. Eng.
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Email: mannamal@uoguelph.ca
Office hours: By appointment

1.2 Lab Technician

Technician: Jacqueline Fountain
Office: THRN 1102 , ext. 56676
Email: fountain@uoguelph.ca
Office hours: During lab time

1.3 Teaching Assistant

GTA: Fatima Haque
Email: fhaque@uoguelph.ca
Office hours: During lab time

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

Clickers for quizzes

2.3 Recommended Resources

1. Bioreactors - Design, Properties and Applications. Editors: P.G. Antolli and Z. Liu. 2012. Nova Science Publishers Inc, New York, USA.
2. Basic Bioreactor Design. K. V. Riet and J. Tramper. 1991. CRC Press, New York, USA.
3. Principles of Fermentation Technology (Third Edition). P.F. Stanbury, A. Whitaker and S.J. Hall. 2017. Elsevier Ltd., Cambridge, MA, USA.
4. Fermentation Technology. K. K. Machve. Mangalam Publications, New Delhi, India.
5. Industrial Microbiology: An Introduction. M. J. Waites, N. L. Morgan, J. S. Rockey and G. Higton. 2001. Blackwell Science Ltd, London, United Kingdom.

2.4 Additional Resources

Lecture Information:

All lecture notes will be posted on CourseLink.

Lab Information:

All the necessary lab resources will be posted on CourseLink.

Assignments:

All the Assignment requirements and information will be posted on CourseLink.

Project Information:

All the project requirements and information will be posted on CourseLink.

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 uoguelph.ca e-mail account regularly: e-mail is the official route of communication between the University and its students.

3 ASSESSMENT

3.1 Dates and Distribution

Assessment item	Worth	Due date	Submission format
Clicker quiz 1	10%	Jan 31	in class
Clicker quiz 2	10%	Feb 28	in class
Clicker quiz 3	10%	Mar 21	in class
Clicker quiz 4	10%	April 4	in class
Assignment 1	10%	Feb 20	electronic on Courselink
Assignment 2	10%	Mar 15	electronic on Courselink
Project - Oral presentation	20%	April 3, 4, and 6	in class
Project - Report	20%	April 6	electronic on Courselink

Partner and Project Selection Process

- Project work will be completed in teams of 4 to 5 students
- Project topic should be decided by the group and submitted before Feb 07

Assignment

- Assignments will be posted in the Courselink two weeks before the submission date

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 the final exam portion of the course portions. Students must obtain a grade of 50% or higher on the exam portion of the course in order for the remaining portions of the course to count towards the final grade.

Missed quiz/test: If you miss a quiz/test due to grounds for granting academic consideration or religious accommodation, the weight of the missed quiz/test will be added to the final exam. There will be no makeup quizzes/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 instructor to complete a makeup lab.

Late Lab Reports: Not applicable

4 AIMS, OBJECTIVES & GRADUATE ATTRIBUTES

4.1 Calendar Description

This course describes the engineering and biological skills required in the modeling and design of batch and continuous type bioreactors. Microbial growth kinetics, aeration and agitation equipment, instrumentation and control, heat and mass transfers in bioreactors will be discussed in detail.

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 project that combines research study, experimental work, mathematical modeling, equipment design, and project management.

4.3 Learning Objectives

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

1. Describe and specify reactors used in the industrial bioprocesses
2. Develop mathematical models for bioreactors, and analyze 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, 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	Communication	4, 6	Labs, Project
7	Individual and Teamwork	3,4,5,6	Quizzes, 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	Environment, Society, Business, & Project Management	2,4,6	
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*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	Tuesday	8:30 am to 9:50 am	MINS Room 101
	Thursday	8:30 am to 9:50 am	MINS Room 101
Laboratory	Monday	8:30 am to 10:20 am	THRN Room 1104

5.2 Lecture Schedule

Week	Lecture Topics	Learning Objectives
1	Introduction to bioreactor	1,2
2, 3	Microbial growth kinetics	1,2,3,4
4, 5, 6	Bioreactor design	1,2,3,4
7, 8	Instrumentation and control in bioreactors	3,4,5
9, 10	Aeration and agitation in bioreactors	3,4,5
11	Heat and mass transfer in bioreactors	4,5
12	Project presentation and report submission	3,4,6

5.3 Tutorial/Demo Lab Schedule

Will be announced in CourseLink or in class

5.4 Lab Schedule

Will be announced in CourseLink or in class.

5.5 Other Important Dates

January 09, Monday:	First day of class
February 20 (Monday) to 24 (Friday) :	Winter break
March 10, Friday :	Drop date - 40th class
April 07, Friday:	Last day of classes

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.

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](tel: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>