University of Waterloo, Department of Chemical Engineering

CHE 361 – Bioprocess Engineering

Winter 2024

Instructor: Prof. David Simakov dsimakov@uwaterloo.ca
Office hours: E6-2020 (arrange by email)

Teaching Assistant: Danny Kang, danny.kang@uwaterloo.ca
Office hours: E6-4118 (arrange by email)

Schedule:	Lectures:	Tuesday,	01:30 – 03:20 PM,	E6 2024
		Thursday,	01:30 – 02:20 PM,	E6 2024
	Tutorials:	Thursday,	02:30 – 03:20 PM,	E6 2024

Course Materials & Description:

Lecture slides, tutorials, assignments, and solutions: LEARN (https://learn.uwaterloo.ca/).

Textbooks: M.L. Shuler, F. Kargi, M. Delisa, Bioprocess Engineering: Basic Concepts, Prentice Hall, 2017; H.W. Blanch, D.S. Clark, Biochemical Engineering, CRC Press, 1997

Description: This course starts from reviewing basic aspects of biochemistry and molecular biology focusing on gene expression and metabolic regulation. After that the course introduces the concepts of ***enzyme catalysis*** and ***microbial growth*** and applies these concepts to the ***design of bioreactors***. Topics include ***enzyme kinetics, cell growth kinetics, and bioreactor design & analysis***. Rate expressions for biochemical reactions are derived and material balances are developed for bioreactors operated in different modes, including batch, fed-batch, continuous stirred tank reactor, recycle, and perfusion. Transport (mass and heat transfer) considerations for bioreactors are introduced. Downstream processing associated with biological systems and recovery of biological products are discussed.

Course Learning Outcomes:

- ***Demonstrate competence*** in the ***fundamental concepts*** of biological sciences and biochemical/bioprocess engineering.
- ***Apply*** biological and chemical engineering concepts to ***design*** and ***analysis*** of bioreactor systems.

Course Requirements & Grading:

Homework	20%	* *All assignments will have identical grade weights.*
Midterm exam	30%	
Final exam	50%	**** Students must pass the final examination to pass the course.***

Deadlines & Examination Dates:

Homework Assignments (tentative dates):

January 19, 2024; February 02 and 16, 2024; March 01, 15, and 29, 2024; April 05, 2024.

** **No assignments will be accepted past the due date.** Handwritten homework assignments are to be submitted to the assignment boxes on the 5th floor of Engineering 6. Marked assignments will be returned to students in the classroom (during lecture or tutorial hours).*

Midterm Examination:	February 29, 2024 (tentative date)
Final Examination:	Scheduled by Registrar's Office

CHE 361 – Bioprocess Engineering

Outline of concepts covered and anticipated timeline

Week 1: Introduction & Basic Principles
Week 2: Gene Expression & Metabolic Regulation
Week 3: Enzyme Kinetics
Week 4: Enzymatic Reactor Design
Week 5: Microbial Growth
Week 6: Bioreactor Design: Stoichiometry & Mass Balances
Week 7: Batch & CSTR Bioreactors
Week 8: Chemostat Bioreactor
Week 9: Fed-Batch & Perfusion Bioreactors
Week 10: Transport in Bioreactors
Week 11: Bioprocess Design
Week 12: Bioprocess Design

E-mail correspondence:

According to University policy all official correspondence with students must be done through uwaterloo.ca e-mail (http://www.adm.uwaterloo.ca/infocist/emailuse.html). E-mails received from other e-mail addresses (like gmail, hotmail, yahoo, etc.) will be ignored.

Academic integrity: In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility. [Check the Office of Academic Integrity for more information.]

Grievance: A student who believes that a decision affecting some aspect of their university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70, Student Petitions and Grievances, Section 4. When in doubt, please be certain to contact the department's administrative assistant who will provide further assistance.

Discipline: A student is expected to know what constitutes academic integrity to avoid committing an academic offence, and to take responsibility for their actions. [Check the Office of Academic Integrity for more information.] A student who is unsure whether an action constitutes an offence, or who needs help in learning how to avoid offences (e.g., plagiarism, cheating) or about "rules" for group work/collaboration should seek guidance from the course instructor, academic advisor, or the undergraduate associate dean. For information on categories of offences and types of penalties, students should refer to Policy 71, Student Discipline. For typical penalties, check Guidelines for the Assessment of Penalties.

Appeals: A decision made or penalty imposed under Policy 70, Student Petitions and Grievances (other than a petition) or Policy 71, Student Discipline may be appealed if there is a ground. A student who believes they have a ground for an appeal should refer to Policy 72, Student Appeals.

Note for students with disabilities: AccessAbility Services, located in Needles Hall, Room 1401, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with AccessAbility Services at the beginning of each academic term.

Turnitin.com: Text matching software (Turnitin®) may be used to screen assignments in this course. Turnitin® is used to verify that all materials and sources in assignments are documented. Students' submissions are stored on a U.S. server, therefore students must be given an alternative (e.g., scaffolded assignment or annotated bibliography), if they are concerned about their privacy and/or security. Students will be given due notice, in the first week of the term and/or at the time assignment details are provided, about arrangements and alternatives for the use of Turnitin in this course.

It is the responsibility of the student to notify the instructor if they, in the first week of term or at the time assignment details are provided, wish to submit alternate assignment.