Western Engineering

Department of Chemical & Biochemical Engineering

CBE 3315A – REACTION ENGINEERING
Course Outline - Fall 2025

Calendar Description
Chemical kinetics as applied to the large-scale manufacture of chemicals. An introduction to the factors which affect the design and size of chemical reactors, as well as the conditions under which they are to be operated for maximum efficiency.

Course Summary
The course synthesizes notions of stoichiometry, mass and energy balances and chemical kinetics into the key concepts of reactor design. The content extends previously learned material on kinetics and thermodynamic equilibrium to the analysis and engineering of chemical reactions and ideal reaction design. The key objective of this course is to present the general methodologies for the engineering of chemical reactions in a variety of reacting systems (chemical, biochemical/biological, macromolecular, etc.). Topics covered include kinetic analysis, rate laws, the general mole balance as well as isothermal and non- isothermal ideal reactor sizing.

Prerequisites
AM1413, Chemistry 1024A/B, CBE2224B.

Corequisite
None.

Antirequisite
None

Note: It is the **student's responsibility** to ensure that all Prerequisite and Corequisite conditions are met or that special permission to waive these requirements has been granted by the Program. The student may be dropped from the course or not given credit for the course towards their degree if they violate the Prerequisite, Corequisite or Antirequisite conditions.

Class and Laboratory Attendance Policy
Class attendance is mandatory and will be monitored. The instructor reserves the right to request debarring from the final examination to those students that miss more than 50% of the lectures + tutorials in the term.

Reference textbooks:
- *Chemical Reactions and Chemical Reactors* G. W. Roberts, Wiley, 2008
- *Fundamentals of Chemical Reaction Engineering*, M. Davis and R. Davis, McGraw Hill, 2005

Course content

I. Review of basic chemical kinetics, thermodynamics and mass balances (4 hours)
- Thermodynamics vs kinetics.
- The reaction rate and the rate law
- The activation energy and Arrhenius Law.
- Using the extent of reaction to monitor mass balances in a reacting system

II. Isothermal ideal reactors (16 hrs)
- The generalized mole balance equation
- The isothermal batch reactor
- Homogenous vs heterogeneous reacting systems
- Ideal isothermal continuous reactors: PFR and CSTR
- Reactor and reaction networks, yield, conversion, and selectivity.

III. Chemical kinetics: theoretical framework for a reaction rate and rate law (6 hours)
- Reaction rates and rate laws
- Elementary and reversible reactions
- Introduction to the analysis of kinetic data, integral and differential methods.
- Arrhenius Theory.
- Introduction to Transition State Theory.

IV. Non- isothermal ideal reactors (6 hrs)
- The combined mole and energy balances
- Ideal adiabatic reactors

Learning outcomes

Students successfully completing the course will be able to:

- Apply previously learned concepts in chemical equilibrium and thermodynamics to the description of chemical reacting systems.
- Rationalize the kinetic and thermodynamic consequences of reaction reversibility.
- Model simple chemical kinetics and recognize reaction limiting steps.
- Correlate batch reactor data using the differential and integral method of analysis.
- Synthesize rate laws using experimentally obtained reaction batch data and/or the pseudo-steady state approximation. *Note: this learning outcome is selected for the assessment of the graduate attribute "investigation" (IN3, LEVEL: Developed): an ability to conduct investigations of complex problems by methods that include appropriate experiments, analysis, interpretation of data, and synthesis of information to reach valid conclusions.*
- Use the mole balance equation to size and provide operating parameters for ideal continuous chemical reactors.

- Master the concepts of conversion, selectivity, and yield to describe chemical reactor operation.
- Identify and model reaction and reactor networks
- Qualitatively model the effect of temperature on reaction rates and ideal reactor operation.
- Assess the effect of temperature on non isothermal reactor operation
- Model ideal adiabatic and non adiabatic reactors
- Size and design an ideal packed bed reactor.
- Develop the skills to fairly evaluate the quality of peer's work and their own. *Note: this learning outcome is selected for the assessment of the graduate attribute "Life-long Learning" (LL1, LEVEL: Introduced): An ability to identify and to address their own educational needs in a changing world in ways sufficient to maintain their competence and to allow them to contribute to the advancement of knowledge.*
- Apply the concepts learned in the lectures to design and operate at steady state a simple CSTR reactor.

Course Notes

Only 50% of the course notes will be available for download from the course website. Solutions to the problems, materials used for discussions in class and tutorials will not be posted in the course website. It is expected that notes on these materials will be recorded by the students during the lecture and tutorials.

Units

SI units will be the primary units used in lectures and examinations.

Evaluation

The final mark will be calculated as follows:

Assignments (4 total)	4%
Quizzes (5 total, 4% each, lowest mark dropped)	16%
Laboratory	20%
Midterm exam (**October 17th 10:30am-1:30pm**)	30%
Final exam	30%

Students must pass one of the two examinations to pass this course. Students who fail both exams will be assigned their aggregate mark or 48% if the aggregate mark is higher than 50%.

Midterm examination will be closed book: only handheld non-programmable calculators may be brought to the examinations. Notes, textbooks and other reference materials will not be allowed. **There will be no make-up assignments, quizzes, labs or exams.** If you are unable to complete an assignment, quiz, lab or exam due to medical or compassionate reasons, you must provide the appropriate documentation and the weighting of the final oral exam will be adjusted accordingly. Failure to provide the adequate documentation will result in a mark of 0 for the missing course

component.

Policy on the use of Mobile Devices

Given that this course covers complex topics requiring focused attention, a policy on electronic devices has been established to ensure a productive and collaborative learning environment for all.

Silent and Stowed: Prior to the beginning of each class, all mobile phones and other electronic devices should be silenced and put away. They are not to be kept on desks or laps, as their presence can be distracting to the instructor and your peers.

Non-Academic Use Prohibited: The use of electronic devices for non-academic purposes—including texting, web browsing, and social media—is not permitted during lecture time. The taking of photos of lecture slides is also prohibited unless explicit permission has been given.

Authorized Use: At specific times, the use of devices for in-class activities such as polls or quizzes may be authorized. Students will be informed when it is appropriate to use their devices for these purposes.

Emergency Situations: In the event that a student is expecting an urgent or emergency call, the instructor should be notified before class. If a call must be taken during class, it is to be done quietly outside the classroom.

Non-compliance with this policy will be documented. Repeated violations may result in a reduction of the course participation grade and may be subject to further disciplinary action in accordance with university academic regulations.

Academic consideration for missing course components

The Faculty of Engineering Policy Framework on Missed Classes, Late Work, and Academic Integrity can be found at:

https://www.eng.uwo.ca/undergraduate/academic-support-and-accommodations/UG-Policy-Framework-Missed-Classes-Late-Work-and-Academic-Integrity.pdf

Please note that BOTH the midterm and final examinations are central to the learning objectives for this course. Accordingly, students seeking academic consideration for this assessment will be required to provide formal supporting documentation. Students who are granted academic consideration for the midterm exam will have the weighting of the final exam adjusted to 60% to account for the missed midterm examination.

For the case of the quizzes, since the lowest mark will be dropped from the calculation of the

final course grade, the instructor will deny academic consideration requests supported only by self-attestation for these missed elements.

For the case of the laboratory reports, because the submission deadline for these reports already includes flexibility in the form of an automatic 48hr extension, the instructor will deny academic consideration requests supported only by self-attestation for reports which are submitted following the end of the period of flexibility.

Please note that academic consideration requests using formal supporting documentation (medical certificate, etc.) are handled by the Faculty of Engineering Undergraduate Services office.

Graduate Attribute Assessment for Accreditation by the Canadian Engineering Accreditation Board

Graduate Attribute	Indicator	Assessment tool	Assessment Level
Investigation	I-3 Demonstrate ability to analyze and interpret data to reach valid conclusions.	Project 1 and 2 Reports	D: Developed
Life-long Learning	LL 1 – Ability to assess limitations in knowledge and skills	Quiz 3 or 4	I: Introduced

Laboratory

The laboratory component is project-based; students will work in groups of 3 and are responsible for the development of their own experimental protocol. A total of 9 hours is allocated for the experimental part of Project 1 and 12 hours for Project 2. The group laboratory reports (1 per group) will be prepared in the form of a word document**. All individuals in the group are responsible and accountable for the content and delivery of the lab report.**

Repeating All Components of the Course

In accordance with Senate and Faculty Policy, students who have failed an Engineering course (i.e. <50%) must repeat all components of the course. **No special permissions will be granted enabling a student to retain laboratory, assignment or test marks from previous years.** Previously completed assignments and laboratories cannot be resubmitted for grading by the student in subsequent years.

Use of English

In accordance with Senate and Faculty Policy, students may be penalized up to 10% of the

marks on all assignments, tests, and examinations for the improper use of English. Additionally, poorly written work with the exception of the final examination may be returned without grading. If resubmission of the work is permitted, it may be graded with marks deducted for poor English and/or late submission.

Attendance

Attendance to lectures, tutorials and laboratory sessions is mandatory and will be monitored. Any student who, in the opinion of the instructor, is absent too frequently from class or tutorial periods will be granted a mark of zero for course participation and will be reported to the Dean (after due warning has been given). On the recommendation of the Department concerned, and with the permission of the Dean, the student will be debarred from taking the final exam in the course.

Marked assignments, projects, quizzes and exams

All marked materials (except for the final examination) will be made available to the students within 10 business days of the examination or laboratory report deadline. Marked exams will be returned during lecture hours. Students are required to pick up and archive their marked materials. It is not the instructor responsibility nor the teaching assistant to archive or store unclaimed marked exams/laboratory reports.

Academic Consideration for Student Absence

If, on medical or compassionate grounds, you are unable to write term tests or final examinations or complete course work by the due date, you should follow the instructions provided by the Faculty of Engineering. You should understand that academic relief will not be granted automatically on request. You must demonstrate to the Undergraduate Services Office that there are compelling medical or compassionate grounds that can be documented before academic relief will be considered. Different regulations apply to term tests, final examinations, and late assignments.

For further information, please consult the University's policy of Academic Consideration

https://registrar.uwo.ca/academics/academic_considerations/index.html

The University medical illness policy at:
https://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_medical%2015JUN.pdf

The Student Medical Certificate is available at
https://www.uwo.ca/univsec/pdf/academic_policies/appeals/medicalform_15JUN.pdf

If you miss the Final Exam, please contact the Engineering Academic Counselling office as soon as you are able to do so. They will assess your eligibility to write the Special Examination (the

name given by the University to a makeup Final Exam).

You may also be eligible to write the Special Exam if you are in a "Multiple Exam Situation" (e.g., more than 2 exams in 23-hour period, more than 3 exams in a 47-hour period).

Note: missed work can only be excused through one of the mechanisms above. Being asked not to attend an in-person course requirement due to potential COVID-19 symptoms is not sufficient on its own.

Cheating

University policy states that cheating is a scholastic offence. The commission of a scholastic offence is attended by academic penalties, which might include expulsion from the program. If you are caught cheating, there will be no second warning (see Scholastic Offence Policy in the Western Academic Calendar).

Plagiarism

Students must write their reports and assignments in their own words. Whenever students take an idea, or a passage from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. Plagiarism is a major academic offence (see Scholastic Offence Policy in the Western Academic Calendar). The University of Western Ontario has software for plagiarism checking. Students may be required to submit their work in electronic form for plagiarism checking.

Sickness and Other Problems

Students should immediately consult with the instructor or Associate Chair (Undergraduate) if they have problems that could affect their performance in the course. The student should seek advice from the Instructor or Associate Chair (Undergraduate) regarding how best to deal with the problem. Failure to notify the Instructor or the Associate Chair (Undergraduate) immediately (or as soon as possible thereafter) will have a negative effect on any appeal.

Accommodation and Accessible Education

The instructor and teaching assistants are not qualified to propose neither accommodation strategies nor produce alternative formats for course content aimed at addressing specific accessibility requests. Please contact the Accessible Education office at 661-2111 x 82147 (http://academicsupport.uwo.ca/accessible_education/index.html) for any specific question or request regarding accommodation. The instructor will try to implement accommodation strategies suggested by the Accessible Education office, upon receiving adequate training and resources aimed at addressing the specific student's request.

When a course requirement conflicts with a religious holiday that requires an absence from the University or prohibits certain activities, students should request accommodation for their absence in writing at least two weeks prior to the holiday to the course instructor and/or the Academic Counselling office of their Faculty of Registration. Please consult University's list of

recognized religious holidays (updated annually) at:
https://multiculturalcalendar.com/ecal/index.php?s=c-univwo.

Communication

Students are responsible for regularly checking their Western email and notices posted on the Brightspace course site.

Consultation

Office hours will be arranged for the students to see the instructor. Other individual consultation during business hours can be arranged by appointment.

Email policy

Students wishing to communicate with the instructor by email should write "CBE3315A question" on the subject line. Email queries linked to the course are checked only twice a day during business hours. Students should allow a minimum of 2 business days to get a reply. The course instructor, teaching assistants and laboratory technician do not monitor email outside business hours.

Accreditation (AU) Breakdown

Basic Science = 40%
Engineering Science = 40%
Engineering Design= 20%