CBE 3315A – REACTION ENGINEERING
2023-2024

Please notice this is the publicly available information for CBE3315A for the Fall 2023 term; **this is not** a course outline.
The course outline is posted in the OWL course site.

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.

Contact Hours/Location
See information on OWL site

Class and Laboratory Attendance Policy
See information on OWL site

Course Instructor

See information on OWL site

Undergraduate Coordinator
See information on OWL site

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. Chemical kinetics Part I: The reaction rate (6 hours)
- Introduction to Collision Theory.
- The activation energy and Arrhenius Law.
- Introduction to Transition State Theory.
- The physicochemical meaning of the rate law.

II. Chemical kinetics Part II: Analysis and evaluation of reaction rates (9 hours)
- Reaction rates and rate laws
- Elementary and reversible reactions
- Experimental parameters affecting the rate law
- The extent of reaction
- Introduction to the analysis of kinetic data, integral and differential methods.

IV. Isothermal ideal reactors (15 hrs)
- The generalized mole balance equation
- The batch reactor
- Homogenous vs heterogeneous reacting systems
- Ideal isothermal reactors: PFR and CSTR
- Reactor and reaction networks, yield, conversion, and selectivity.

V. Non- isothermal ideal reactors (3 hrs)
- The combined mole and energy balances
- Temperature and reaction reversibility
- Adiabatic vs non adiabatic operation of ideal 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. *Note: this learning outcome is selected for the assessment of the graduate attribute "Design" (D3, LEVEL: Developed): An ability to design solutions for complex, open-ended engineering problems and to design systems, components or processes that meet specified needs with appropriate attention to health and safety risks, applicable standards, and economic, environmental, cultural and societal considerations.*

Course Notes

See information on OWL site

Units

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

Evaluation

See information on OWL site

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
Design	D3: Demonstrate ability to select candidate engineering design solutions for further development	Question on Midterm examination.	D: Developed
Life-long Learning	LL 1 – Ability to assess limitations in knowledge and skills	Quiz 4	I: Introduced

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.

Pandemic Contingency plan

In the event of a COVID-19 resurgence during the course that necessitates the course delivery moving away from face-to-face interaction, all remaining course content will be delivered entirely online synchronously (i.e., at the times indicated in the timetable). The grading scheme will **not** change. Any remaining assessments will also be conducted online at the discretion of the course instructor following the recommendation of university authorities.

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

See information on OWL site

Marked assignments, projects, quizzes and exams
See information on OWL site

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 medical illness policy at:
https://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_medical.pdf.

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

If you miss the Final Exam, please contact the Academic Counselling office of your Faculty of Registration 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.

Notice

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

Consultation

See information on OWL site

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%