Western University
Faculty of Engineering

DEPARTMENT OF CHEMICAL AND BIOCHEMICAL ENGINEERING

CBE 2207B – APPLIED INDUSTRIAL ORGANIC CHEMISTRY
Course Outline 2025 - 2026

Description:

This course applies previously learned concepts in organic chemistry to describe chemical transformations that form the basis of industrial and environmental processes.

General Objectives

- Identify industrially relevant organic functional groups and their reactions; become familiar with the concepts needed to understand their reaction mechanisms and industrial production.
- Appreciate the geopolitical context driving the industrial production of organic commodities.
- Introduce basic concepts in kinetic and thermodynamic control of organic reactions.
- Develop a basic understanding of quantum mechanics for the description of spectroscopic (electronic and vibrational) properties of organic molecules.
- Develop intermediate skills in bench-scale laboratory work, purification and spectroscopic monitoring of organic processes.

Prerequisites:

CBE2206A/B or GPE 2213A/B

Open only to students registered in the Faculty of Engineering. Unless you have either the requisites for this course or written special permission from your Dean to enroll in it, you may be removed from this course, and it will be deleted from your record. This decision may not be appealed. You will receive no adjustment to your fees if you are dropped from a course for failing to have the necessary prerequisites.

Corequisites:

None

Antirequisite(s:)

GPE2214A/B CHEM 2213a/b or the former CBE 2216

Contact Hours:

3 lecture hours a week, 3 laboratory hours a week (0.5 course)

Instructor:

Required Texts:

None. However, an old edition of Organic Chemistry, by L. G. Wade. (8th suggested) might be useful, mainly for practicing problems. A textbook is not required for several reasons. First, **there is a lot of freely available high-quality material on the web and on the course website (Brightspace).** Secondly, organic chemistry textbooks do not cover in enough depth the material needed for the industrial and environmental components of the course. The instructor will provide suggested reading and problems from a variety of freely available sources.

Course Notes:

Selected course notes (**less than 50% of course content**) and a few videos presenting selected key course concepts 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. It is the responsibility of student to take notes during class.**

Laboratory

The laboratory section of this course consists of 4 experiments (total of 7 laboratory sessions) focused on problem solving, synthesis, purification and reaction monitoring challenges. Bench-scale experimentation will start on January 19th. Students will form groups of 2 to do the experiments. Evaluation of laboratory work will be carried orally, through the administration of quizzes and the marking of laboratory reports. **All group members will be evaluated by a TA and/or the course instructor before the laboratory session starts and/or during the laboratory work (lab performance).** Consult the lab schedule available on OWL® to identify the dates for report submissions.

Students must submit a of their WHMIS certificate before they can start the laboratory component of the course.

For this course laboratory safety goggles and a laboratory coat are required. Students are expected to abide by the safety rules and procedures described in the laboratory manual available on Brightspace. Students without safety goggles will not be allowed into the laboratory and will receive a mark of zero for that lab. More serious safety violations may result in your failure of this course.

Students must read the lab manual and study the material related to the laboratory session as indicated in the laboratory manual. A quiz can be administered at the beginning of some laboratory session. STUDENTS WHO ARRIVE LATE WILL NOT BE GIVEN EXTRA TIME. The mark on the quizzes will be used to calculate the laboratory component mark of the course

Units

SI units will be used.

Course content:

The course is divided into four main units, covering the second part of the general basis for industrial organic chemistry:

I. Section 1: Conjugated alkenes and introduction to spectroscopy (UV-Vis and FTIR)

- Classification of molecular systems with double bonds.
- Conjugated molecules and UV/Vis spectroscopy
- The Schrodinger equation for a particle in a box.
- The Diels Alder reaction
- Introduction to Infrared Spectroscopy
- Ozone as a conjugated molecule

II. Section 2: The chemistry and industrial production of alcohols

- Nomenclature of alcohols
- Methanol in the chemical industry: Economic and geopolitical considerations.
- Oxidation vs reduction in organic chemistry.
- The oxidation of alcohols.
- The methanol/ formaldehyde train and the industrial production of formaldehyde.
- Ethanol in the chemical industry: The pursue of a carbon neutral economy
- Tosylates.

Examination 1 ()

III. Section 3: Aldehydes and Ketones

- Nomenclature of ketones and aldehydes.
- Nucleophilic addition vs Electrophilic substitution in ketones and aldehydes
- Hydride addition and the Grignard Reaction
- The Wittig reaction.
- Enolate formation, and the thermodynamic vs kinetic control of chemical reactions.
- Direct enolate alkylation.
-The Aldol reaction.

Examination 2 ()

IV. Section 4: Benzene and Aromatic Compounds.

- Production of naphtha, gasoline and aromatic compounds in the Chemical Industry.

- The electrophilic aromatic substitution mechanism.
- The nitration and halogenation of benzene.
- The impact of halogenated aromatic compounds in the environments: herbicides and pesticides.
- The Friedel Crafts reactions.
- Substitute effects on the orientation of the electrophilic aromatic substitution.
- Molecular design of organic compounds.

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Learning Outcomes:

Learning and applying organic chemistry concepts to industrial practice do not require a lot of memorizations, but the understanding of the key concept on how electronegativity differences affect the reactivity of molecules. The course will emphasize these key concepts, and it will be delivered in a way that will avoid the need of heavy memorization.
Specific learning objectives are:

- Identify the structure of alcohols, aldehydes, ketones and aromatic compounds and appreciate their relevance in the chemical industry.
- Predict the reactivity of alcohols, ketones and aldehydes in terms of electronegativity differences and molecular geometry of the C-O or C=O bond.
- Rationalize reaction mechanisms in terms of functional group electronic and geometric structure for alcohols, carbonyl and aromatic compounds.
- Master the concepts of oxidation and reduction in organic molecules.
- Develop fundamentals of quantum mechanics and understand its consequences for light absorption of conjugated molecules.
- Recognize the structure and reactivity of conjugated compounds and the use of Ultraviolet-Visible spectroscopy and FTIR spectroscopy to characterize their optical absorption behaviour. *Note: this learning outcome aligns with and is selected for the assessment of the graduate attribute "investigation" (IN3 & IN4, LEVEL: Introduced): an ability to conduct investigations of complex problems by methods that include appropriate experiments, analysis and interpretation of data, and synthesis of information to reach valid conclusions.*
- Rationalize the reactions used to synthesize aldehydes and ketones, and their reactivity, the reactions which they undergo and their industrial relevance.
- Recognize the molecular features that determine the log term impact of halogenated compounds in the environment. *Note: this learning outcome aligns with and is selected for the assessment of the graduate attribute "Impact of Engineering on Society and the Environment" (IESE1, LEVEL: Introduced): An ability to analyze social and environmental aspects of engineering activities. Such ability includes an understanding of the interactions that engineering has with the economic, social, health, safety, legal, and cultural aspects of society, the uncertainties in the prediction of such interactions, and the concepts of sustainable design and development and environmental stewardship*

Evaluation

Evaluations will focus on testing the understanding of fundamental concepts of organic chemistry, their applications to industrial practice and on applying this knowledge to problem solving. The final course mark will be determined as follows:

Laboratory (includes oral examinations, lab performance evaluation and lab report presentations)	**32%**
Participation	**12%**
Exams (3 in total, 28% each, lowest mark dropped)	**56%**
Exam 1	(28%)
Exam 2	(28%)
Exam 3 (date set by the Registar's)	(28%)

Exams will be 2 hours. Exams will be closed book. Calculators, notes, textbooks and other reference materials will not be allowed.

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%.

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

There will be no make-up labs assessments or exams. If you are unable to complete a lab assessment due to medical or compassionate reasons, you can use a self attestation form or provide the appropriate documentation, and the weighting of the other labs will be adjusted accordingly. Failure to provide the adequate documentation will result in a mark of 0 for the missing laboratory component. For the case of the laboratory report**, because the submission deadline 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.

For the case of the Exams, **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.

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

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.

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.	Laboratory oral evaluation	D: Developed
Impact of Engineering on Society and the Environment	IESE1: Ability to analyse the interactions of engineering with economic, social, health, safety, legal and cultural aspects of society.	Final Examination	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.

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, 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 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 Exam 3 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's responsibility nor the teaching assistant to archive or store unclaimed marked exams/laboratory reports.

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).

Sickness and Other Problems

Students should immediately consult with the Academic counselors in the Faculty of Engineering instructor or Associate Chair (Undergraduate) if they have problems that could affect their performance in the course. The student should seek advice from the Academic counselors in the Faculty of Engineering 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 either accommodation strategies or 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 Academic Counselling office of the Faculty of Engineering.

Use of Electronic Devices

The use of electronic devices is not allowed examinations. This includes, but is not limited to, calculators, cell phones and smart watches

Use of Generative Artificial Intelligence (AI)

Generative AI may be used as a supplementary resource for group projects or discussions; however, **students must refrain from using AI-generated content for reports or any other course deliverable submissions**.

Academic Offences

Scholastic offences are taken seriously, and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following Web site:

http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf

Gender-Based and Sexual Violence

Western is committed to reducing incidents of gender-based and sexual violence (GBSV) and providing compassionate support to anyone who is going through or has gone through these traumatic events. If you are experiencing or have experienced GBSV (either recently or in the past), you will find information about support services for survivors, including emergency contacts at the following website:
https://www.uwo.ca/health//gbsv/support/index.html

To connect with a case manager or set up an appointment, please contact support@uwo.ca.

Notice

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 = 100%