DALHOUSIE UNIVERSITY

Faculty of Science Course Syllabus
Department of Chemistry
Intermediate Organic Chemistry
Physical Organic and Spectroscopy
CHEM3404
Fall 2022

Dalhousie University is located in Mi'kma'ki, the ancestral and unceded territory of the Mi'kmaq. We are all Treaty people.

Instructor(s): Professor Frances Cozens, Office room 410 Chemistry, Email: frances.cozens@dal.ca. Principal Instructor, day-to-day class inquires and all administrative matters for the CHEM3404 lectures. *Office Hours Monday and Wednesday from 12:35 to 1:25 pm or by appointment*. You are welcome to e-mail Dr. Cozens if you would like to make an appointment for a specific time. Please put CHEM3404 in the subject line.

Dr. Reinaldo Moya-Barrios, Office room 1053 Chemistry, Email: rbarrios@dal.ca. Laboratory Instructor, day-to-day supervision and all administrative matters for the CHEM3404 laboratories. *Office Hours Monday and Thursday 12:25 to 1:25 pm or by appointment. Via Teams or in-person*. You are welcome to e-mail Dr. Moya-Barrios if you would like to make an appointment for a specific time. Please put CHEM3404 in the subject line.

Lectures: Lecture material including lecture notes and relevant readings will be uploaded to Brightspace. The class will be delivered in an in-person format. In-person lectures are held in the Chemistry Building room 223, *Monday, Wednesday and Friday, 11:35 am- 12:25 pm*.

Laboratories: Sproull Organic Chemistry Laboratory, *Monday or Thursday 1:35 - 5:25 pm*. Labs run once a week for four hours. In-person labs start Monday, September 12 and continue weekly throughout the term.

The following pages constitute the syllabus for this course, CHEM3404. You can consider the syllabus to be a contract, which delineates responsibilities and expectations for both the students and the teaching team. You should review the syllabus thoroughly, refer to it as necessary throughout the term, and contact the instructors with any questions and/or concerns you may have. In order to complete CHEM3404 satisfactorily, a student must fulfil all the requirements as set down in this course syllabus.

Course Description: Credit hours: 3 Format: Lecture and Lab Hours weekly: 7
This course provides an introduction to spectroscopic techniques with an emphasis on proton and carbon NMR spectroscopy. Organic compound identification using spectroscopic information is emphasized. Concepts in physical organic chemistry are also described and are used to explain structure-reactivity relationships. The organic laboratory will focus on the separation and spectroscopic identification of organic compounds, and on experiments that introduce fundamental concepts in physical organic chemistry. The lectures and the laboratory components are well integrated to enhance learning outcomes in the topic areas.

Format:
In-person lectures and in-person labs. All components in the class will be conducted in-person, this includes lectures, labs and examinations.

Course Prerequisites:
PREREQUISITES: CHEM2401.03/2402.03 or equivalent (grade of C- or better). Having a strong understanding of second year organic chemistry is necessary for a successful outcome in CHEM3404. This class will be taught at the third-year level and is a material intensive course.

Course Objectives/Learning Outcomes:

Part 1: Module on Spectroscopy.

- understanding and utilizing IR spectroscopy, UV-Vis spectroscopy, high resolution mass spectrometry (HRMS), and proton and carbon NMR spectroscopies
- having the ability to interpret spectroscopic data for organic compound identification
- having the ability to identify complex NMR data for compound identification
- the laboratory will be utilized to enhance the learning outcomes

Part 2: Module on Physical Organic Chemistry.

- understand the effect of substituents in organic chemistry
- predict mechanisms and transition state structures
- discuss the complexities of nucleophilic substitution reactions
- recall structures and properties of selected reactive intermediates
- the laboratory will be utilized to enhance the learning outcomes

Course Materials

- **Lectures** Class lecture notes will be posted to Brightspace. These class lecture notes will be used for the in-person lectures. The lecture notes and are subject to change and the latest version of the lecture notes will be posted to Brightspace. All materials posted to Brightspace are under copyright rules and cannot be further distributed without prior consent of the course Instructors, this includes but is not limited to all online quizzes and lecture notes.

- **Textbook** "*Introduction to Spectroscopy, 4th or 5th Edition",* by Donald L. Pavia, Gary M. Lampman, George S. Kriz and James A. Vyvyan, 2009 or 2014. This book has a great deal of useful information. Excerpts from this book will be uploaded as topic reading for the Spectroscopy part of the class.

- **Textbook** "*Advanced Organic Chemistry, 5th Edition, Part A: Structure and Mechanisms*", by Carey and Sundberg, Springer, 2007 is a valuable reference book for this class. This book is **available online to Dalhousie students** in the library or logged-in via VPN. This book has a great deal of useful information and should be part of student resources. Excerpts from this book will be uploaded as topic reading for the Structure and Mechanisms part of the class.
  http://lib.myilibrary.com.ezproxy.library.dal.ca/Open.aspx?id=4318

- **Practice Problems** Practice problems will be available on Brightspace for both Spectroscopy and Physical Organic Chemistry modules. These problems are important to complete for the successful completion of CHEM3404. Answers will also be posted to Brightspace.

- **Quizzes** Quizzes associated with the learning outcomes for each topic will be available through Brightspace. Each quiz will be graded and contribute to your overall Quiz mark in CHEM3404. All quizzes must be completed during the timeframe available as posted on Brightspace. The quizzes have been developed to enhance the student's learning outcomes. As such working independently on the quizzes will help gain understanding in the topic area which can be transferred to the in-person assessments. Tentative release dates and due dates have been published to Brightspace and are subject to change during the term if necessary to keep synchronization with the lecture material.

Laboratory:

CHEM3404 Laboratory Manual, Fall 2022, available from the bookstore **(required)**

Bound hardcover laboratory notebook, available from the bookstore **(required)**

Safety glasses, available from the bookstore (**required,** including students with prescription glasses)

Approved laboratory coat, available from the bookstore (**required**)

All work must be independent.

- **WHMIS training**

  WHMIS, or the Workplace Hazardous Materials Information System, is a global harmonized system used to classify and label hazards and regulate handling procedures within industry and academic fields, especially those in science. Regardless of your chosen field of study within science being familiar with WHMIS is a significant asset. As such, the Department of Chemistry requires ALL students participating in their laboratory programs to complete WHMIS 2015 training provided by the Environmental Health and Safety Office. This training course is provided through the Dalhousie College of Continuing Education. Upon completion of your WHMIS 2015 course you will receive a Letter of Completion (as a PDF document) via email from the College of Continuing Education (cceehs@dal.ca) within 3 business days.

  Please ensure that you register and complete the WHMIS course well in advance of the letter submission deadline. Instructions on how to register for the course can be found on Brightspace. After you have received your Letter of Completion, please upload the PDF document to Brightspace.

  The due date for a fall term class to complete the WHMIS training is September 25, 2022.

- **Laboratory Safety 2022/23 course**

  All third and fourth-year students are required to complete the Laboratory Safety course developed by the Environmental Health and Safety Office and also provided through the Dalhousie College of Continuing Education.

  This online course was designed for all students, staff and faculty at Dalhousie working in laboratories that can potentially be exposed to a variety of hazardous products and processes. It covers the major elements of laboratory safety giving you a strong general foundation to understand the risks associated with working in a laboratory.

  According to the DCCE website, the course also addresses safe laboratory practices such as responsibilities; recognition and mitigation of laboratory hazards; working safely with chemicals; the use of engineering controls, administrative controls, and personal protective equipment; and emergency procedures.

  You can access these online courses on the Environmental Health and Safety link below:

  https://dalu.sharepoint.com/sites/ehs/SitePages/chemical-safety.aspx?_ga=2.64073327.1383638317.1662121124-589334829.1660307326

Just like for the WHMIS course, you will receive a Letter of Completion (as a PDF document) via email from the College of Continuing Education (cceehs@dal.ca). After you have received your Letter of Completion, please upload the PDF document to Brightspace.
The due date to complete the Laboratory Safety course is October 2, 2022.

Mental Health Resources: There are a variety of mental health resources and supports available for students at www.dal.ca/mentalhealth. If you wish to chat with a mental health professional, same-day counselling appointments are available at the Student Health and Wellness Centre on the 2nd floor of LeMarchant Place. Appointments can be made by calling 902-494-2171 or online at: www.dal.ca/studenthealth/bookonline

Student Code of Conduct: CHEM3404 is governed by the Dalhousie University's Student Code of Conduct and all provisions will apply. For more information on the student code of conduct click here: https://cdn.dal.ca/content/dam/dalhousie/pdf/dept/university_secretariat/policy-repository/Code%20of%20Student%20Conduct%20rev%20Sept%202021.pdf

Student use of Course Material: The course material for CHEM3404, including the lecture and the laboratory components, are designed for use as part of CHEM3404 and are the property of the instructors and are not to be copied or distributed in any way unless written consent is granted by the instructors.

Stay home if you feel unwell: If you are not feeling well, please do not come to the lecture or lab. Furthermore, if you are experiencing COVID symptoms, including a cough (new or worsening) or a fever please do not come to class or the lab.

Masks: Masks are mandatory within the classroom and labs following Dalhousie's mask mandate. There shall be NO eating in the classroom or the laboratory.

Websites:

Databases

- Web of Science Citation Databases (Chemistry search; Dalhousie library)
  http://apps.webofknowledge.com/UA_GeneralSearch_input.do?product=UA&search_mode=GeneralSearch&SID=4CqG4ooiIR25p7YLkk2&preferencesSaved=

- Scifinder Scholar (chemistry search; Dalhousie library)
  https://scifinder.cas.org/scifinder/login

- Spectral Database for Organic Compounds
  http://sdbs.db.aist.go.jp/sdbs/cgi-bin/cre_index.cgi

General Chemical Information:

- Chemical Institute of Canada (www.cheminst.ca/)
- Royal Society of Chemistry (www.rsc.org)
- American Chemical Society (www.acs.org & pubs.acs.org)

Course Assessment:

Online quizzes	15% total
Two midterm tests	15% each
Final examination	35%
Laboratory	20%
Total	**100%**

Dates of Assessments:

Online quizzes will be assigned throughout the term. The tentative dates are posted on Brightspace. Each topic will have an associated quiz that must be done within the time allowed for the quiz. The quizzes will each be open for a minimum of 6 days. Each quiz will be independently graded and the total grade for each of the two subject modules will be worth 7.5% for a total quiz mark of 15%. Online quizzes are open book and all class resources can be used. Online quizzes must be done independently.

Midterm 1 Monday, October 24, 2022 in class (topics included in module 1).

Midterm 2 Monday, November 28, 2022 in class (topics included in module 2).

The term tests will be held during regular class time.

Final Examination (time and place to be scheduled by the Registrar) will be a three-hour exam and will cover the entire course.

The in-class midterm tests and the regularly scheduled final examination are all "closed book."

Other course requirements

A minimum grade of 10/20 is required in the laboratory portion of CHEM3404 to pass the class.
A minimum grade 40% on the final examination is required to pass CHEM3404. A final exam mark of less than 40% will result in a grade of 'F' for CHEM3404.
Final examination will be a three-hour timed examination.
Final examination will be held in the regular exam scheduled time.

Conversion of numerical grades to Final Letter Grades follows the Dalhousie Common Grade Scale

A+ (90-100)	**B+** (77-79)	**C+** (65-69)	**D** (50-54)
A (85-89)	**B** (73-76)	**C** (60-64)	**F** (<50)
A- (80-84)	**B-** (70-72)	**C-** (55-59)	

Chemistry courses, unless stated otherwise, have a minimum grade requirement of C- for their prerequisite chemistry courses. Students with grades below C- in the prerequisite chemistry courses can only register with the permission of the instructor for the course.

Course Policies

Emergencies: Missed or Late Academic Requirements due to Student Absence. Dalhousie students are asked to take responsibility for their own short-term absences (3 days or less) by contacting their instructor by email

prior to the academic requirement deadline or scheduled time and by submitting a completed Student Declaration of Absence to their instructor in case of missed or late academic requirements. https://www.dal.ca/campus_life/safety-respect/student-rights-and-responsibilities/academic-policies/Information%20for%20students/Information%20for%20faculty.html

The policy does not apply to final exams scheduled by the Registrar's Office.

Evaluations:
There will be no make-up midterm tests in CHEM3404. If you are ill or experiencing an extreme personal emergency at the time of a midterm test, email Dr. Cozens to inform her of the situation. In addition, **you must complete a Student Declaration of Absence**, as per the regulations in the Dalhousie University Calendar. In the case of an excused midterm test due to illness or another prearranged situation, the value of your final exam will be adjusted to account for the missing marks. No other grading options are supplementary assignments will be available. Students who are ill for the final examination will have an opportunity to write a make-up exam. Only one make up examination in CHEM3404 will be offered at or near the end of the examination period. (See the University Regulations published in the most recent undergraduate calendar).

Quizzes will be available for each topic and scheduled during the term. All quizzes must be completed in the class. There will be no alterations of grading for the quizzes. All laboratory work must be completed in CHEM3404. There will be no alterations of the grading scheme for the labs, unless agreed upon by the student and the Instructor.

The three-hour final examination will cover the entire course. A student may write a make-up final examination if the final examination was missed with a justifiable reason. The date and time of the make-up examination will be decided a few days after the CHEM3404 final examination has been written and will be at the end of the regular examination period. It is the responsibility of the student to contact the Instructor if the final exam is missed within 48 hours of the examination date. Failure to contact the Instructor will result in the grade of "INC" for CHEM3404. The University policy is that final examinations are not returned to students. Final examinations may only be viewed in person and cannot be viewed online.

Independent work. All graded work in CHEM3404 (class and laboratory material) must be done independently by each student enrolled in the class. Online resources can be used for quizzes, except all 'cheating' websites such as CHEGG.COM.

Copyright @. All material posted online for CHEM3404 is strictly copyrighted. No class material can be distributed in any way to a third party. All work must be the student's independent and individually prepared work. Student work that is not independently done will receive a **mark of 0 on the submitted material**. For the quizzes, utilizing online knowledge-based resources is allowed.

Communication. Communication regarding the running of CHEM3404 will take place via the Brightspace announcements. Please check the Brightspace page daily.

Email. It is your responsibility to read your Dalhousie email, as class notifications may occasionally be sent by email. For any correspondence in CHEM3404 please use email to contact Dr. Cozens or Dr. Moya-Barrios. Please put CHEM3404 in the subject line.

Academic Integrity. CHEM3404 is governed by Dalhousie University's Code of Student Conduct.

Course Content:

Lectures. The following topics are expected to be covered in CHEM3404 and are listed below. Lecture PowerPoint slides will be available on Brightspace.

Part 1: Module on Spectroscopy.

UV-Vis Spectroscopy
IR Spectroscopy
High Resolution Mass Spectrometry for molecular formula determination
Proton and Carbon NMR Spectroscopy
Advanced NMR, second order effects and coupling constants
Introduction to 2D NMR Spectroscopy (online only)

Part 2: Module on Physical Organic Chemistry.

Substituent effects - Hammett equations and other free energy relationships.
Energy Diagrams - Transition state structure and the Hammond Postulate.
Kinetic Isotope Effects - Origin and use in determining reaction mechanisms and transition state structure.
Nucleophilic Substitution Reactions - S_N1 and S_N2 reactions, leaving group ability, nucleophile ability.
Carbocations
Chemistry of radicals, carbenes and carbanions
Reaction kinetics, including reactivity and stability of carbocations.
Other reactive Intermediates
Other physical organic topics

Faculty of Science Course Syllabus (Section B)

Fall 2022

CHEM3404

University Policies and Statements

This course is governed by the academic rules and regulations set forth in the University Calendar and by Senate

Academic Integrity

At Dalhousie University, we are guided in all of our work by the values of academic integrity: honesty, trust, fairness, responsibility and respect (The Center for Academic Integrity, Duke University, 1999). As a student, you are required to demonstrate these values in all of the work you do. The University provides policies and procedures that every member of the university community is required to follow to ensure academic integrity.

Information: https://www.dal.ca/dept/university_secretariat/academic-integrity.html

Accessibility

The Advising and Access Services Centre is Dalhousie's centre of expertise for student accessibility and accommodation. The advising team works with students who request accommodation as a result of a disability, religious obligation, or any barrier related to any other characteristic protected under Human Rights legislation (Canada and Nova Scotia).

Information: https://www.dal.ca/campus_life/academic-support/accessibility.html

Student Code of Conduct

Everyone at Dalhousie is expected to treat others with dignity and respect. The Code of Student Conduct allows Dalhousie to take disciplinary action if students don't follow this community expectation. When appropriate, violations of the code can be resolved in a reasonable and informal manner—perhaps through a restorative justice process. If an informal resolution can't be reached, or would be inappropriate, procedures exist for formal dispute resolution.

Code: https://www.dal.ca/dept/university_secretariat/policies/student-life/code-of-student-conduct.html

Diversity and Inclusion – Culture of Respect

Every person at Dalhousie has a right to be respected and safe. We believe inclusiveness is fundamental to education. We stand for equality. Dalhousie is strengthened in our diversity. We are a respectful and inclusive community. We are committed to being a place where everyone feels welcome and supported, which is why our Strategic Direction prioritizes fostering a culture of diversity and inclusiveness

Statement: http://www.dal.ca/cultureofrespect.html

Recognition of Mi'kmaq Territory

Dalhousie University would like to acknowledge that the University is on Traditional Mi'kmaq Territory. The Elders in Residence program provides students with access to First Nations elders for guidance, counsel and support. Visit or e-mail the Indigenous Student Centre (1321 Edward St) (elders@dal.ca).

Information: https://www.dal.ca/campus_life/communities/indigenous.html

Important Dates in the Academic Year (including add/drop dates)

https://www.dal.ca/academics/important_dates.html

University Grading Practices

https://www.dal.ca/dept/university_secretariat/policies/academic/grading-practices-policy.html

Faculty of Science Course Syllabus (Section C)

Fall 2022

CHEM3404

Student Resources and Support

Advising

General Advising https://www.dal.ca/campus_life/academic-support/advising.html

Science Program Advisors: https://www.dal.ca/faculty/science/current-students/academic-advising.html

Indigenous Student Centre: https://www.dal.ca/campus_life/communities/indigenous.html

Black Students Advising Centre: https://www.dal.ca/campus_life/communities/black-student-advising.html

International Centre: https://www.dal.ca/campus_life/international-centre/current-students.html

Academic supports

Library: https://libraries.dal.ca/

Writing Centre: https://www.dal.ca/campus_life/academic-support/writing-and-study-skills.html

Studying for Success: https://www.dal.ca/campus_life/academic-support/study-skills-and-tutoring.html

Copyright Office: https://libraries.dal.ca/services/copyright-office.html

Fair Dealing Guidelines https://libraries.dal.ca/services/copyright-office/fair-dealing.html

Other supports and services

Student Health & Wellness Centre: https://www.dal.ca/campus_life/health-and-wellness/services-support/student-health-and-wellness.html

Student Advocacy: https://dsu.ca/dsas

Ombudsperson: https://www.dal.ca/campus_life/safety-respect/student-rights-and-responsibilities/where-to-get-help/ombudsperson.html

Safety

Biosafety: https://www.dal.ca/dept/safety/programs-services/biosafety.html

Chemical Safety: https://www.dal.ca/dept/safety/programs-services/chemical-safety.html

Radiation Safety: https://www.dal.ca/dept/safety/programs-services/radiation-safety.html

Scent-Free Program: https://www.dal.ca/dept/safety/programs-services/occupational-safety/scent-free.html

Dalhousie COVID-19 information and updates: https://www.dal.ca/covid-19-information-and-updates.html