Faculty of Science Course Syllabus
Department of Chemistry
Intermediate Organic Chemistry
Physical Organic and Spectroscopy
CHEM3404
Fall 2021

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, Virtual Office frances.cozens@dal.ca. Principal Instructor, day-to-day class inquiries and all administrative matters for the CHEM3404 lectures. Office Hours Via Teams - 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. Travis Lundrigan, Virtual Office travis.lundrigan@dal.ca. Laboratory instructor, day-to-day supervision and all administrative matters for the CHEM3404 laboratories. Office Hours Via Teams – by appointment. You are welcome to e-mail Dr. Lundrigan 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, relevant readings and videos will be uploaded to Brightspace. The class will be delivered in a blended format with both online and in-person lecture components. In-person lectures are held in the Killam Library room 4106, Monday, Wednesday and Friday, 12:35 - 1:25 pm. In-person classes tentatively to start Monday, September 20.

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 Thursday, September 9 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 fulfill 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. 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.

Format
Blended online and in-person lectures and in-person labs.
Course Prerequisites:
PREREQUISITES: CHEM 2401.03/2402.03 or equivalent (grade of C- or better).

Course Objectives/Learning Outcomes:

1) Spectroscopy
   - understanding and utilizing IR spectroscopy, UV-Vis spectroscopy, High Resolution Mass Spectrometry and Proton and Carbon NMR spectroscopy
   - 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

2) Physical Organic Chemistry
   - understand the effect of substituents in organic chemistry
   - predict mechanisms and transition state structures
   - fully appreciate 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 lectures notes will be posted to Brightspace. These class lecture notes will be used for the in-person lectures and the video recordings. The video recordings will be supplemental to the in-person lectures and may contain slightly different material. Topics 1 and 2 will be presented online only. Note: The posted lecture notes and videos are subject to change. The latest version of the lecture notes and videos will be posted to Brightspace. All material posted to Brightspace is 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 slides.

- **Textbook** "Introduction to Spectroscopy, 4th or 5th Edition", by Donald L. Pavia, Gary M. Lampman, George S. Kriz and James A. Vvyyan, 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.
  

- **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. Some problems will be explained via video presentations.

- **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.
Laboratory:

- CHEM3404 Laboratory Manual, Fall 2021 (required)
- Bound hardcover laboratory notebook (required)
- Safety glasses (required, including students with prescription glasses)
- Approved laboratory coat (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. After you have received your Letter of Completion please upload the PDF document to the Brightspace site. Instructions on how to register for the course and upload your letter of completion can be found on the Brightspace Site. **The due date for a fall term class to complete the WHMIS training is September 26, 2021, 11:30 pm.**

**Laboratory Safety 2021/22 course**

Starting this Fall, 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.

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 the Brightspace site. **The due date to complete the Laboratory Safety course is October 3, 2021.**

You can access these online courses on the Environmental Health and Safety link below: [https://www.dal.ca/faculty/open/programareas/sustainenviro/ehs.html](https://www.dal.ca/faculty/open/programareas/sustainenviro/ehs.html)

**Stay home if you feel unwell:** If you are not feeling well, please do not come to the lab or lecture. If you experience symptoms of COVID-19, including a cough (new or worsening) or a fever, you should complete a COVID-19 self-assessment and schedule a COVID-19 test through the province.
Masks: For the safety and comfort of your classmates, please wear your masks within the classroom until otherwise noted. There shall be NO eating in the classroom or the laboratory.

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

Websites:
Databases
• Web of Science Citation Databases (Chemistry search; Dalhousie library)

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

• Spectral Database for Organic Compounds
  http://sdb.sdb.db.aist.go.jp/sdb/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 20% total
• Two midterm tests 15% each
• Final examination 30%
• 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 10% for a total quiz mark of 20%. Online quizzes are open book and all class resources can be used.

Midterm 1 Friday, October 22, 2021 in class (topics included in module 1).

Midterm 2 Friday, November 26, 2021 in class (topics included in module 2).

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 term tests and the regularly scheduled final examination are all “closed book.” The final examination (time and place to be scheduled by the Registrar) will be a three-hour exam and will cover the whole course. The term tests will be held during regular class time.

Other course requirements

A minimum grade of 11/20 is required in the laboratory portion of CHEM3404 to pass the class.

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

<table>
<thead>
<tr>
<th>Numerical Grade</th>
<th>Letter Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>A+ (90-100)</td>
<td>A+ (85-89)</td>
</tr>
<tr>
<td>B+ (77-79)</td>
<td>B (73-76)</td>
</tr>
<tr>
<td>C+ (65-69)</td>
<td>C (60-64)</td>
</tr>
<tr>
<td>D (50-54)</td>
<td>F (&lt;50)</td>
</tr>
<tr>
<td>A- (80-84)</td>
<td>B- (70-72)</td>
</tr>
<tr>
<td>B- (70-72)</td>
<td>C- (55-59)</td>
</tr>
</tbody>
</table>

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](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, please 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. If you are too ill to write the final examination in this class, please arrange for a medical certificate, as per the regulations in the Dalhousie University Calendar. Students who are ill for the final exam will have an opportunity to write a make-up exam. (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.

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. The University policy is that final examinations are not returned to students.

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. Lundrigan. Please put CHEM3404 in the subject line.

Delayed Classes. In the case of a weather-related closure, internet or power interruptions, online content may be delayed.

Course Content:
Lectures. The following topics are expected to be covered in CHEM3404 and are listed below. Class video lectures will be available on Brightspace. In-person lectures will tentatively start on Monday, September 20, 2021. The topics on UV-Vis spectroscopy and IR spectroscopy will be based on online material. Topic 1 and Topic 2 material is available on Brightspace.

Part 1: Module on Spectroscopy. Topics to be included are:
- UV-Vis Spectroscopy
- IR Spectroscopy
- High Resolution Mass Spectrometry for molecular formula determination
- Proton and Carbon NMR Spectroscopy
- Introduction to 2D NMR Spectroscopy

Part 2: Module on Physical Organic Chemistry. Topics to be included are:
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
- Reactivity and stability.
Other reactive Intermediates
- Chemistry of radicals, carbenes and carbanions
- Any other physical organic topic
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](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](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.


**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](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](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](https://www.dal.ca/academics/important_dates.html)

**University Grading Practices**

[https://www.dal.ca/dept/university_secretariat/policies/academic/grading-practices-policy.html](https://www.dal.ca/dept/university_secretariat/policies/academic/grading-practices-policy.html)
Faculty of Science Course Syllabus (Section C)

Fall 2021
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

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