

Faculty of Science Course Syllabus
Department of Chemistry
Chemistry 4401/5401 (CRN 10464/13041)
Synthesis in Organic Chemistry
Fall 2019

Instructors: **Lecture:** Dr. Alex Speed; aspeed@dal.ca; Office: Chemistry 413

Office Hours: I have an open door policy, you may find me by chance in my office (Chemistry 413) or you may set up a definite appointment by e-mail. If you visit me in my lab (Chemistry 418 or 228), you must wear safety glasses.

Lectures: Tuesday, Thursday 8:35-9:55 am Location Chemistry 226
September 3rd 2019 to December 3rd 2019

Course Description: A number of important organic reactions are examined in depth with particular attention to regioselectivity and the development of relative or absolute stereochemistry. Applications of these reactions in the synthesis of complex molecules are illustrated with recent examples from the literature.

Course Prerequisites: The prerequisite to this course is CHEM 3401 or an equivalent at another university. CHEM 3404 is helpful, but not required. **Organic synthesis is a cumulative discipline, and it is expected that you have retained knowledge of reactions and concepts covered in preceding courses.**

Cross Listing: CHEM 4401 and CHEM 5401 are the cross-listed classes for undergraduate students and graduate students respectively. Credit cannot be obtained for both CHEM 4401 and CHEM 5401. Students enrolled in CHEM 5401 will write tests with slightly different questions to CHEM 4401.

Class Content: The aim of this class is to provide the tools to understand advanced concepts in selectivity in organic chemistry. We will begin by discussing selectivity in radical-based reactions, then continue by discussing regioselectivity and stereoselectivity in pericyclic reactions. We will then explore acyclic stereocontrol of selected reactions through three-dimensional consideration of reagent approach and conformation. The course will finish with an introduction to modern asymmetric catalysis. We will refine concepts of chemoselectivity that have been taught in preceding organic courses. A theme throughout the course will be the use of these concepts in the synthesis of molecules of moderate complexity such as pharmaceuticals and select natural products.

Class Structure: The class will be delivered as a chalk talk. Occasionally literature references will be given for assigned reading. I will not repeat lectures for students who miss class.

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Course Materials

There is no required textbook for this course, however the following resources may be beneficial in the course:

- *“Organic Chemistry”* by Jonathan Clayden, Nick Greeves, Stuart Warren. Oxford University Press, 2nd Edition, 2012.
- **A comparable textbook is available online:**
“Advanced Organic Chemistry, Part B: Reactions and Synthesis”, 5th Edition, by Carey and Sundberg, Springer, 2007.

This book is available on-line courtesy of the Canadian Research Knowledge Network.

To Dal students in the library or logged-in, this text-book is available at the following URL:

<http://www.springerlink.com/content/978-0-387-68350-8/contents/>

- **for home use of this**, or any other Dalhousie Library resource, modify URL to include the proxy server as follows. If the URL starts with https://, remove this, otherwise an error will be encountered
<http://www.springerlink.com.ezproxy.library.dal.ca/content/978-0-387-68350-8/contents/>
- I encourage using molecular models to understand conformation and selectivity, and these will be permitted during examinations, however they are not required.
- Practice problems and their solutions will be made available on a weekly basis.
- Successful study habits in organic chemistry typically involve actively practicing drawing mechanisms for the reactions under study, rather than simply reviewing the mechanism and attempting to reproduce the mechanism for the first time under evaluation.

Useful Websites

Various websites are available containing information that complements that presented in the course, or may be of use in assignments.

- **Primary literature:**

There are many journals. A small set of important chemistry journals are shown below:

Home Access: See above for how to modify URLs to use Dalhousie’s proxy server. Otherwise you will encounter a paywall.

American Chemical Society Journals: <http://pubs.acs.org>

Royal Society of Chemistry Journals: <http://www.rsc.org/journals-books-databases/>

Angewandte: [http://onlinelibrary.wiley.com/journal/10.1002/\(ISSN\)1521-3773](http://onlinelibrary.wiley.com/journal/10.1002/(ISSN)1521-3773)

Dalhousie Scifinder http://libraries.dal.ca/research/sciences_research/sfs.html

Scifinder is a useful, although sometimes frustrating tool for searching the chemical literature

- **Databases**

<http://www.sigmaaldrich.com> Catalogue of large chemical supplier, with physical properties and select NMR spectra of compounds

http://sdfs.db.aist.go.jp/sdfs/cgi-bin/direct_frame_top.cgi Database of NMR spectra.

http://evans.rc.fas.harvard.edu/pdf/evans_pKa_table.pdf Convenient table of pKas

<http://www.chem.wisc.edu/areas/reich/pkatable/> Extensive database of pKas

<http://evans.rc.fas.harvard.edu/problems/index.cgi> Database of Challenging* problems

*Note that a number of the problems in the above database involve concepts outside the scope of this course, increasing their difficulty.

Course Assessment

Component	Weight (% of final grade)	Date
Three in-class tests	60 %	T, Oct 1 st ; T, Nov 5 th , Dec 3 rd
Final exam	40 %	(Scheduled during examination period by Class consensus)

For 4401:

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)		

For 5401:

The following grading scheme for graduate students will be used:

A+ (90-100)	B+ (77-79)	
A (85-89)	B (73-76)	F(<70)
A- (80-84)	B- (70-72)	

Course Policies

If you are ill or experiencing a personal emergency at the time of a midterm test, e-mail Dr. Speed to inform him of the situation, and fill out a Student Declaration of Absence (SDA) form on Brightspace when you are able. Note that as per University policy, only two SDA forms may be used per course per term. A sick note will not be required since this places a burden on the healthcare system. I do not typically offer make-up midterm tests, however in the case of excused absences for midterm test due to illness or another appropriate situation, the grading evaluation will remain 20% per midterm test, with the balance shifting to the final. Students suffering prolonged illness may wish to contact me or the Assistant Dean of Student Affairs to explore their options. Since I wish to recognize improvement, this alternate grading scheme may also be applied to a student showing substantial improvement on the final exam relative to in-class tests at my discretion (ie the lowest test will be dropped). For this to happen, the grade on the final exam would have to be higher than at least two of the midterm tests. Students who are ill for the final exam and produce a medical certificate will have an opportunity to write a make-up exam.

Course Content Includes:

Introduction:

- Multistep synthesis, and why do we care about controlling selectivity?

Part 1: Radical Chemistry

- Classical radical chemistry
- Photoredox chemistry
- Radical Arene functionalization

Part 2: Pericyclic Reaction

- FMO and Dewar-Zimmerman Analysis
- Cycloadditions
- Electrocyclic reactions
- Sigmatropic reactions
- Cheletropic Reactions

Part 3: Acyclic Stereocontrol

- Concepts of enantio- and diastereoselectivity
- Allylic Strain
- Enolate alkylation
- Directed reactions
- Carbonyl addition models
- The Zimmerman-Traxler and Ireland Models
- Selective Enolization
- Aldol Reaction
- Chiral Auxiliaries
- Asymmetric Allylation

Part 4: Asymmetric Catalysis

- Asymmetric reduction
- Asymmetric oxidation
- Asymmetric cycloadditions
- Kinetic Resolution
- Biocatalysis
- Organocatalysis
- Stereoselective Olefin Metathesis

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

Missed or Late Academic Requirements due to Student Absence (policy)

https://www.dal.ca/dept/university_secretariat/policies/academic/missed-or-late-academic-requirements-due-to-student-absence.html

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>