Chemistry 4473a
Modern Chemical Synthesis
Fall 2021

A Notice from the Registrar:

"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 in the event that you are dropped from a course for failing to have the necessary prerequisites."

Prerequisites: Chemistry 3373F or special Permission

Instructor:	Professor Brian L. Pagenkopf, Ph.D.
Lectures:	All lectures will be online
Class Times:	MWF 10:30 – 11:20 pm, ChB 115 Class time will be used for discussion of lecture, homework, assignments and exams
Office Hours:	After class and by appointment
Course email:	bpagenko@uwo.ca • Start the subject line with 4473 • You must use your @uwo.ca email

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Course Website

Students should check OWL (http://owl.uwo.ca) on a regular basis for news and updates. This is the primary method by which information will be disseminated to all students in the class. Students are responsible for checking OWL on a regular basis.

All course material will be posted to OWL: http://owl.uwo.ca.

If students need assistance, they can seek support on the OWL Help page. Alternatively, they can contact the Western Technology Services Helpdesk. They can be contacted by phone at 519-661-3800 or ext. 83800.

Course Description

The course will describe tools and strategies needed to design successful synthetic routes to complex organic molecules. The student will identify and design synthetic routes for key structural elements and be introduced to synthetic methods in a setting of problem solving and discussion.

Learning Outcomes:

- Understand advanced stereochemistry and principles for diastereoselective reactions.
- Utilize conformational analysis to predict reaction outcomes in a variety of carbonyl addition, alkylation and rearrangement reactions.
- Develop a greater repertoire of reducing agents and oxidants for improved chemoselectivity.
- Employ new skills to propose original syntheses of complex molecules.
- Be fluent in named reactions, such that you can provide a name associated with a reaction, or describe a reaction associated with a name.
- Be able to predict the regio- and stereo-chemistry of Diels-Alder reactions.

- Be able to propose original syntheses of molecules based primarily on the reactions and concepts learned.

Course material

This course will attempt to equip the students with a knowledge of advanced synthetic organic reactions, thereby giving the student the tools necessary to design synthetic schemes for complex target molecules. Course material will continue with “Organic Chemistry” by Clayden (the 3373 text), use “Strategic Applications of Named Reactions in Organic Synthesis” by Kürti and Czakó as a major source, and will draw on Andrew Myers' Harvard notes as well as the current literature.

Topics generally may or may not include some of the following: Diels-Alder cycloadditions, oxidations, diastereoselective reductions, asymmetric alkylations by several methods, asymmetric aldol reactions, asymmetric allylations, metathesis, (asymmetric) Diels-Alder, synthesis of heterocycles, radical reactions, topical issues, and miscellaneous reactions.

It is expected that you know reactions covered in 2273, 2283, and 3373. While such reactions wont be the focus of marked questions, knowing the available reactions may be key to success. It would be helpful to review past reactions.

Suggested Texts and Resources

- *Strategic Applications of Named Reactions in Organic Synthesis, by Kürti and Czakó* (Hopefully on reserve)
- *Organic Chemistry* by Clayden, Greeves and Warren, 2nd Ed, (former 3373 text)
- *Advanced Organic Chemistry*, 4th Edition, by Carey and Sundberg. This is an excellent text and is available free in electronic form through the UWO Library website. It has some good practice problems. Part B is most relevant to this course.
- Andrew Myers' Chem 204 notes from Harvard (OWL)
- David Evans Chem 206 notes from Harvard (OWL)
- *Modern Organic Synthesis*, by Dale Boger (OWL)

Course Topics	**Lecture Equivalents**
Diels-Alder Reaction	4.1
Frontier molecular orbital theory, predicting regiochemistry, asymmetric Diels-Alder reactions	
Epoxidations	2.5
Peracids, directed epoxidations, ground state conformations, carbonyl epoxidation, sulfur ylides, cyclopropanation, asymmetric epoxidation, kinetic resolution, reactions of epoxides	
Dihydroxylation	1.3
Stereoselectivity, asymmetric dihydroxylation	
Rearrangments	1.8
Baeyer-Villiger reaction, benzyllic peroxide rearrangement, Beckman rearrangement, acyl azide rearrangements, Pummerer rearrangement	
Oxidations	1.4
Activated sulfoxide, sulfide and other oxidants	
Carbonyl Additions	2.8
Felkin-Anh model, Bürgi-Dunitz angle, hydrogen transfer reduction, chelation control, cyclic cations	
Reductions	5.9
Luche conditions, hydride donating reagents, chiral reagents, catalytic asymmetric reduction, Birch reduction, reductive carbonyl coupling	
Enolate Alkylations	6.3

pKa, tautomerization, aggregates, Ireland enolization model, asymmetric ketone and amide alkylation, amide derivatization

Metathesis 3.1

Ring closing, ring opening, cross, ring opening polymerization, enyne, relay ring closing

Protecting Groups 2.0

Alcohols, diols, acetals, silyl ethers

Evaluation

The final grade for the course will be determined by the following:

Class Participation **5%**

Assignments (3 points x 6) **15%**
Due by 10:30 am via OWL (1 point),
Resubmission due by 10 pm (in class participation required, 2 points)
September 17, October 1, October 13, October 25, November 15, December 3

Homework (5 x 6) **15%**
Due by 10:30 am via OWL (each 5 points)
September 24, October 8, October 27, November 10, November 26, December 8

Term Tests **30%**
- 15% Friday, October 15, in class, 50 minutes
- 15% Wednesday, November 17, in class, 50 minutes

Final Exam **35%**
C*umulative*; 3 hours: Time and location set by Registrar

Total ***100%***

Failure to write the midterm tests or final exam will result in a zero grade in the course, unless a valid excuse has been filed with the Dean's Office. It is the student's responsibility to ensure that medical notes for medical related absence or other acceptable documentation for other reasons are filed with the Dean's Office. Once notified by the Dean' office the instructor will make the appropriate accommodation.

If you are unable to meet a course requirement due to illness or other serious circumstances, you must seek approval for the absence as soon as possible. Approval can be granted either through a self-reporting of absence or via the Dean's Office/Academic Counselling unit of your Home Faculty. If you are a Science student, the Academic Counselling Office of the Faculty of Science is located in NCB 280, and can be contacted at scibmsac@uwo.ca.

Do not contact the instructor with details of the excuse.

For further information, please consult the university's policy on academic consideration for student absences:

https://www.uwo.ca/univsec/pdf/academic_policies/appeals/Academic_Consideration_for_absences.pdf

IMPORTANT: If the midterm tests are missed for valid reasons, the final examination will be reweighted to include the weight of the missed midterm test. There are no alternate midterm tests. In case of a conflict see the instructor.

If a student's performance on the final exam is better than on the term test the weighting of the two examinations may be altered to benefit the student at the instructor's discretion. If used, the same reweighing opportunity will be applied to all students where beneficial.

Students should check OWL (http://owl.uwo.ca) on a regular basis for news and updates. This is the primary method by which information will be disseminated to all students in the class. Students are responsible for checking OWL on a regular basis.

The Assignments and Homework

The *assignments* are designed to be practice problems. You must upload your work to OWL prior to class. Then during class the problems will be discussed, and you are expected to show where you went wrong, and what the right answer is. You will then upload the revised version. This is where some clearly differentiated space and use of color might be useful. To earn credit for the revision you must have been in class.

The *homework* is more challenging because the questions integrate several ideas. When working on homework it might be OK to discuss reactions with others but make certain you do not copy someone else's answers, route or strategy for a synthesis. These are often open-ended questions and plagiarism is obvious to the grader. These are also uploaded, but there is no option for revision.

Technical Requirements

If proctored exams and interactive zoom "office hours" are needed due to COVID, then a stable internet connection, computer with working microphone and/or webcam are required.

Proctortrack Onboarding

There will be a Proctortrack "onboarding" opportunity prior to the first midterm. Onboarding registers you on Proctortrack (which is separate from OWL but integrated into OWL), tests your hardware/software configuration, and allows you to rehearse scanning and uploading a document. Any difficulties can be worked out prior to the first midterm. Failure to participate in early onboarding means the time for registration will be subtracted from your exam time.

Remote Proctoring

Tests and examinations in this course will be conducted Proctortrack, but we will use Zoom as a backup. When Zoom is used for exam invigilation, you will be required to keep your camera on for the entire session, hold up your student card for identification purposes, and share your screen with the invigilator if asked to do so at any time during the exam. The exam session using Zoom will not be recorded.*

Proctortrack will require you to provide personal information (including some biometric data). The session will be recorded. By taking this course, you are consenting to the use of this software.

More information about remote proctoring is available in the Online Proctoring Guidelines at the following link: https://www.uwo.ca/univsec/pdf/onlineproctorguidelines.pdf

Completion of this course will require you to have a reliable internet connection and a device that meets the system and technical requirements for both Zoom and Proctortrack. Information about the system and technical requirements are available at the following links:

https://www.proctortrack.com/tech-requirements/

https://support.zoom.us/hc/en-us

* Please note that Zoom servers are located outside Canada. If you would prefer to use only your first name or a nickname to login to Zoom, please provide this information to the instructor in advance of the test or examination.

Statement on 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

Most relevant to this course is to complete the assignments on your own. Do not work in teams. Submitting as your own work a published synthesis would be considered a serious offense. Submitting substantially identical approaches as another student may be a serious offense in some cases.

Statement on Use of Electronic Devices

No electronic devices are allowed during quizzes, tests or exams. If tests are moved to an online format, then a scanning device, such as a smartphone, can be used to scan and upload your exam.

The website for Registrarial Services is http://www.registrar.uwo.ca.

In accordance with policy, http://www.uwo.ca/its/identity/activatenonstudent.html,
the centrally administered e-mail account provided to students will be considered the individual's official university e-mail address. It is the responsibility of the account holder to ensure that e-mail received from the University at his/her official university address is attended to in a timely manner.

Support Services

Please contact the course instructor if you require lecture or printed material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Student Accessibility Services (SAS) at 661-2147 if you have any questions regarding accommodations.

The policy on Accommodation for Students with Disabilities can be found here:

https://www.uwo.ca/univsec/pdf/academic_policies/appeals/Academic%20Accommodation_disabilities.pdf

The policy on Accommodation for Religious Holidays can be found here:

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

Learning-skills counsellors at the Student Development Centre (http://www.sdc.uwo.ca) are ready to help you improve your learning skills. They offer presentations on strategies for improving time management, multiple-choice exam preparation/writing, textbook reading, and more. Individual support is offered throughout the Fall/Winter terms in the drop-in Learning Help Centre, and year-round through individual counselling.

Students who are in emotional/mental distress should refer to Mental Health@Western (http://www.health.uwo.ca/mental_health) for a complete list of options about how to obtain help.

Additional student-run support services are offered by the USC, http://westernusc.ca/services

This course is supported by the Science Student Donation Fund. If you are a BSc or BMSc student registered in the Faculty of Science or Schulich School of Medicine and Dentistry, you pay the Science Student Donation Fee. This fee contributes to the Science Student Donation Fund, which is administered by the Science Students' Council (SSC). One or more grants from the Fund have allowed for the purchase of equipment integral to teaching this course. You may opt out of the Fee by the end of September of each academic year by completing the online form linked from the Faculty of Science's Academic Counselling site. For further information on the process of awarding grants from the Fund or how these grants have benefitted undergraduate education in this course, consult the chair of the department or email the Science Students' Council at ssc@uwo.ca.