Queen’s University

ENCH-245 – Applied Organic Chemistry

Information – 2020 Winter Semester

Instructor: Professor P. Andrew Evans, CHE508
E-mail: Andrew.Evans@chem.queensu.ca
Telephone N°: (613) 533-6286

Office Hours: Monday 3:30 pm to 4:30 pm and Wednesday 12:30 pm to 1:30 pm
If the office hours are not sufficient or inconvenient, additional appointments can be scheduled via e-mail.

Several chapters from this textbook were covered in ENCH-211 and ENCH-212; namely, Chapters 2, 4, 5, 7, 8, 12, 14, 15, 16 and 17. You are responsible for all the assigned reading, which may be supplemented or amended during the course.

Lectures: Dunning Hall, Rm 14, Monday 8:30 am to 9:30 am
Stirling Hall, Rm A, Wednesday 8:30 am to 9:30 am
Stirling Hall, Rm A, Thursday 4:30 pm to 5:30 pm
The lecture material is available from the course website as PDF files. It is recommended that students read the assigned chapter prior to the lectures. The instructor may also provide additional handouts and notes during the course as deemed necessary.

Problems: Each chapter has a series of problems, which you are expected to complete. The answers to the questions are available in the “Solutions Manual” that supplements the textbook. You can also use other standard textbooks for additional problems.

Tutorial: Chernoff Hall, Rm 117, Thursday 6:30 pm to 8:00 pm

Laboratory: The laboratory portion of this course is supervised by Dr. Vlahakis. The laboratories are located in Chernoff Hall 118. The manual and supplies for the laboratory may be purchased from the Chemistry Stores. The first laboratory sessions are CHECK-IN, which begins January 6-9; Monday at 2:30 pm, Tuesday 8:30 am and 2:30 pm, depending on your specific section.

OnQ: Grades and relevant information will be posted on the onQ site for this course.

Examinations: Three examinations are scheduled on the following dates:
Mid-Term 1 - Thursday, Jan. 30 (during class at 4:30 pm)
Mid-Term 2 - Friday, Mar. 6 (in the evening at 6:00 pm)
Final – TBA
Queen’s University

Grade: The grade will be determined in the following manner:
- Laboratory (10 Experiments) 25%
- Mid-Term Exam 1 15%
- Mid-Term Exam 2 15%
- Final-Exam 45%

There are NO MAKE-UP EXAMS in ENCH-245. Please report midterm conflicts well in advance to the Instructor; your final exam will be worth more to compensate. NO EXCEPTIONS and NO RE-WRITES.

Students must pass both the lecture and laboratory components in order to pass the course. If a student does not pass both components of the course, he/she will effectively fail the course.

General Comments:
ENCH-245 is a course in Organic Chemistry offered to students in Engineering Chemistry and Chemical Engineering. The course material builds upon concepts learned in ENCH-211 and ENCH-212, which primarily focuses on the introduction to organic reactions and the mechanisms for some important chemical transformations. The types of transformations/mechanisms will be supplemented by examples of industrial chemical processes demonstrating the practical applications of these reactions. The laboratory is intended to provide experience in organic synthesis and insight into the practical manifestations of the theoretical component of the course.

ENCH-245 - Learning Outcomes:
Students should garner the following skills upon successfully completing the course:
1. Identify reactive sites in organic molecules to determine sites of nucleophilicity and electrophilicity in the context of reaction mechanisms and reactions.
2. Draw complete reaction mechanisms for important reactions having been able to decipher the appropriate class of mechanism.
3. Predict the outcomes of transformations based on specific reagents and products.
4. Apply the mechanistic details of many common useful reactions encountered in chemical laboratories/industry in related systems.
5. Develop competent laboratory skills for undertaking the synthesis of organic molecules.

ENCH 245 Course Material:
The following is a list of course topics and reading, which includes selected problems from the assigned textbook. You are responsible for ALL of this material.

1. Introduction to Reaction Mechanisms: Ch. 5 and 39 (review).
a. Ionic Reactions – Ch. 5; Problems 1, 2, 3, 4
Queen’s University

2. **Nucleophilic Addition & Substitution**: Ch. 6, 9, 10, 11, (15) and 22.
   a. Nucleophilic Addition to Carbonyl Groups – Ch. 6, pp 125–137; Problems 1, 2, 4, 7–10.
   b. Organometallic Reagents – Ch. 9; Problems 1, 2, 4, 5.
   c. Nucleophilic Alkyl Substitution – Ch. 15 (review); Problems 1, 2, 3, 5.
   d. Nucleophilic Acyl Substitution – Ch. 10; Problems 1, 2, 3, 4, 5, 6.
   e. Equilibria, Rates and Mechanisms – Ch. 12; Problems 2, 3, 7, 8, 10.
   f. Nucleophilic Acyl Addition/Condensation – Ch. 11; Problems 1, 2, 3, 4, 5.
   g. Conjugate Addition – Ch. 22, pp 498–513; Problems 2, 3, 4, 10.

3. **Enols and Enolates**: Ch. 20, 25 and 26.
   a. Alkylation of Enolates – Ch. 25; Problems 1, 2, 4, 5, 6.
   b. The Aldol Reaction – Ch. 26, pp 614–640; Problems 1, 3, 4, 6, 9.

4. **Electrophilic Addition to Alkenes**: Ch. 19; Problems 1, 2, 3, 5, 7.

5. **Electrophilic Aromatic Substitution**: Ch. 21 (extension to ENCH-212); Problems 2, 3, 4, 6. Multiple EAS reactions, commercial examples

6. **Oxidations and Reductions**: Ch. 23.
   Oxidation numbers/states, hydride reductions, metal-catalyzed hydrogenation and hydrogenolysis, dissolving metal reductions, carbonyl reductions (pp 528–534), oxidations (pp 544–547), oxidizing agents, oxidation of alkenes, oxidation of alcohols, Jones oxidation, Swern oxidation.

7. **CycloadDITIONS AND RearrangEMENTS**: Ch. 34; Problems 1, 2, 8, 11; Ch. 36; Problems 2, 8.
   a. Diels-Alder Reaction
   b. 1,3-Dipolar Cycloadditions
   c. Baeyer–Villiger Rearrangement
   d. Beckmann Rearrangement

8. **Free Radical Reactions**: Ch 37, pp 970–974 and 977–1002.
   Homolysis, structure of radicals, BDE, initiation, propagation, termination, cross-linking, radical addition, scission/fragmentation, atom abstraction, radical rearrangement, industrial examples, polymer modifications, oxidative degradation of polymers, halogenation of alkanes, free radical halogenation, and polymerization.

9. **Industrial Polymerization**:
Queen’s University

Lab Information – Department of Chemistry Policy on Missed Labs:
Laboratory work is an integral part of this course. All labs must be completed to pass the course. It is the responsibility of the student to notify the laboratory coordinator when a lab cannot be completed at the scheduled time ASAP. In exceptional circumstances, the following considerations will be given if a scheduled lab cannot be completed at the assigned time: whenever possible, provisions will be made for a make-up lab preferably shortly before or after the missed experiment that week only; the lab may be completed during the following academic year and a course mark of IN (incomplete) will be assigned until the work is completed. In rare circumstances, other accommodations may be made. For further information consult the Laboratory Coordinator.

Grading:
All components of this course will receive numerical percentage marks, which will include adjustments based on the average grade. The final grade you receive for the course will be derived by converting your numerical course average to a letter grade according to Queen’s Official Grade Conversion Scale below:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Numerical Course Average (Range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A+</td>
<td>90-100</td>
</tr>
<tr>
<td>A</td>
<td>85-89</td>
</tr>
<tr>
<td>A−</td>
<td>80-84</td>
</tr>
<tr>
<td>B+</td>
<td>77-79</td>
</tr>
<tr>
<td>B</td>
<td>73-76</td>
</tr>
<tr>
<td>B−</td>
<td>70-72</td>
</tr>
<tr>
<td>C+</td>
<td>67-69</td>
</tr>
<tr>
<td>C</td>
<td>63-66</td>
</tr>
<tr>
<td>C−</td>
<td>60-62</td>
</tr>
<tr>
<td>D+</td>
<td>57-59</td>
</tr>
<tr>
<td>D</td>
<td>53-56</td>
</tr>
<tr>
<td>D−</td>
<td>50-52</td>
</tr>
<tr>
<td>F</td>
<td>49 and below</td>
</tr>
</tbody>
</table>

Calculator Policy:
Calculators acceptable for use during quizzes, tests and examinations are intended to support the basic calculating functions required by most Arts and Science courses. For this purpose, the use of the Casio 991 series calculator is permitted and is the only approved calculator for Arts and Science students. This calculator sells for around $25 at the Queen's Campus Bookstore, Staples and other popular suppliers of school and office supplies.
Queen’s University

Academic Integrity:
Academic integrity is constituted by the five core fundamental values of honesty, trust, fairness, respect and responsibility (see: www.academicintegrity.org). These values are central to the building, nurturing and sustaining of an academic community in which all members of the community will thrive. Adherence to the values expressed through academic integrity forms a foundation for the "freedom of inquiry and exchange of ideas" essential to the intellectual life of the University (see the Senate Report on Principles and Priorities http://www.queensu.ca/secretariat/policies/senate/report-principles-and-priorities).

Students are responsible for familiarizing themselves with the regulations concerning academic integrity and for ensuring that their assignments conform to the principles of academic integrity. Information on academic integrity is available in the Arts and Science Calendar (see Academic Regulation 1 http://www.queensu.ca/artsci/academic-calendars/regulations/academic-regulations/regulation-1), on the Arts and Science website (see https://www.queensu.ca/artsci/students-at-queens/academic-integrity), and from the instructor of this course. Departures from academic integrity include plagiarism, use of unauthorized materials, facilitation, forgery and falsification, and are antithetical to the development of an academic community at Queen's. Given the seriousness of these matters, actions, which contravene the regulation on academic integrity carry sanctions that can range from a warning or the loss of grades on an assignment to the failure of a course to a requirement to withdraw from the university.

Copyright on Course Material:
This material is copyrighted and is for the sole use of students registered in ENCH-245. This material includes in-class handouts, emailed information and all documents and information provided on the course onQ site. This material shall not be distributed or disseminated to anyone other than students registered in ENCH-245. Failure to abide by these conditions is a breach of copyright, and may also constitute a breach of academic integrity under the University Senate’s Academic Integrity Policy Statement.

Accessibility Statement:
Queen’s is committed to an inclusive campus community with accessible goods, services, and facilities that respect the dignity and independence of persons with disabilities. Course materials are available in an accessible format or with appropriate communication supports upon request.

Please contact Meredith Richards in the Department of Chemistry in one of the following ways:

Email: ugadm@chem.queensu.ca
Phone: 613-533-6000 extension 75518
In person: Chernoff 200
Accommodations Statement:
Queen's University is committed to achieving full accessibility for persons with disabilities. Part of this commitment includes arranging academic accommodations for students with disabilities to ensure they have an equitable opportunity to participate in all of their academic activities. If you are a student with a disability and think you may need accommodations, you are strongly encouraged to contact Student Wellness Services (SWS) and register as early as possible. For more information, including important deadlines, please visit the Student Wellness website at: http://www.queensu.ca/studentwellness/.

Location and Timing of Final Examinations:
As noted in Academic Regulation 8.2.1, “the final examination in any class offered in a term or session (including Summer Term) must be written on the campus on which it was taken, at the end of the appropriate term or session at the time scheduled by the Examinations Office.” The exam period is listed in the key dates prior to the start of the academic year in the Faculty of Arts and Science Academic Calendar and on the Office of the University Registrar’s webpage. A detailed exam schedule for the Fall Term is posted before the Thanksgiving holiday; for the Winter Term it is posted the Friday before Reading Week and for the Summer Term the window of dates is noted on the Arts and Science Online syllabus prior to the start of the course. Students should delay finalizing any travel plans until after the examination schedule has been posted. Exams will NOT be moved or deferred to accommodate employment, travel/holiday plans or flight reservations.

Academic Considerations for Students in Extenuating Circumstances:
The Senate Policy on Academic Consideration for Students in Extenuating Circumstances (http://www.queensu.ca/secretariat/sites/webpublish.queensu.ca.uslcwww/files/files/policies/senateandtrustees/Academic%20Considerations%20for%20Extenuating%20Circumstances%20Policy%20Final.pdf) was approved in April, 2017. Queen’s University is committed to providing academic consideration to students experiencing extenuating circumstances that are beyond their control and which have a direct and substantial impact on their ability to meet essential academic requirements. The Faculty of Arts and Science has developed a protocol to provide a consistent and equitable approach in dealing with requests for academic consideration for students facing extenuating circumstances, which can be found at: http://www.queensu.ca/artsci/accommodations.