School of Science

CHEM 211

Organic Chemistry II

Term: Winter 2022 (202101)

Number of Credits: 3

Course Outline

INSTRUCTOR: Kailey Wright
E-MAIL: kwright@yukonu.ca
OFFICE LOCATION: A2410

COURSE DESCRIPTION

Building upon the concepts of functional group, syntheses design and reaction mechanisms introduced in the first term, students investigate the structure and reactions of aldehydes and ketones, carboxylic acids and their derivatives, dienes and conjugated systems, benzene and its derivatives, amines, and organometallic compounds. Students are introduced to the essential instrumental techniques of infrared spectroscopy, nuclear magnetic resonance spectroscopy, and mass spectrometry with an emphasis on interpretation and structure elucidation. The mandatory labs further develop the students' hands-on skills including some of the instrumental methods covered in class.

COURSE REQUIREMENTS

Prerequisite(s): CHEM 210 with a minimum grade of C.

Students are expected to come to this course with an understanding of the concepts covered in CHEM 210. Reactions and mechanisms from CHEM 210 may be used in this course but they will not be reviewed during this course.

EQUIVALENCY OR TRANSFERABILITY

Receiving institutions determine course transferability. Find further information at:
https://www.yukonu.ca/admissions/transfer-credit

LEARNING OUTCOMES

Upon successful completion of the course, students will be able to:

- interpret spectroscopic data to determine the structure of simple organic molecules
- recognize common classes of organic molecules and be familiar with their physical and chemical properties
- accurately predict the outcomes of common reactions involving carbonyl compounds, carboxylic acid and its derivatives, aromatic compounds, amines, and organometallic compounds
- use electron arrows to describe reaction mechanisms for common reactions involving carbonyl compounds, carboxylic acid and its derivatives, aromatic compounds, amines, and organometallic compounds
- design multistep organic syntheses using reactions that students know
- carry out common organic laboratory procedures using standard organic laboratory equipment

COURSE FORMAT

Weekly breakdown of instructional hours

Lectures: 2 hours. Tutorials: 1 hour (incorporated into the lecture times). Labs: 3 hours. It is expected that this course will require 4-6 hours of homework, studying, report writing, and additional reading outside of these times. It is important to note that the time required will vary substantially by individual.

Delivery format

Lectures and Tutorial: This portion of the course will be delivered **in person** during the scheduled time. Material is regularly posted on Moodle, the course LMS. This material will include assignments, course announcements, links to content in the (free) online textbook, suggested practice problems, and other online resources or interesting material related to the course. If a student misses class they are expected to contact the instructor or their colleagues with questions about any material they have missed.

Laboratory: Three hours per week of face-to-face instruction, delivered in the Chemistry lab at Ayamdigut campus (A2803). Students will be expected to hand in a report after each laboratory session. More details are available in the Laboratory Manual, which will be provided at your first session.

EVALUATION

Assignments	10%
Test 1	15%
Test 2	15%
Final Exam	30%
Laboratory Work	30%
Total	100%

Students must receive a pass (50%) in BOTH the lecture and laboratory components in order to receive a pass in the course. Additionally, students must have attended, completed, and graded at least 75% of the laboratory work, regardless of circumstance. This ensures that a passing mark also reflects a competency on the bulk of the course material.

Assignments: There will be 5 assignments due on an approximately bi-weekly basis. Assignments will consist of various questions or problems related to the course material. Students will have at least one week to complete each assignment. Late assignments will receive a mark of 0 after graded assignments have been returned to the class.

Tests and Examinations: There will be two term tests held during scheduled class time. Each test is worth 15% of the final grade. The final exam, worth 30% of the final grade, will take place during the University's exam period. The final format, date, and venue will be announced as soon as it is known.

Laboratory Component: The labs are a mandatory component of the course. Unless excused by the instructor, absence from a lab will result in a mark of zero for that lab. In order to receive a passing grade in the lab, a student must attend lab sessions and complete the experiments and the written report. If a lab period is missed, the report cannot be submitted unless arrangements are made with the instructor. The specific expectations and evaluation criteria for the lab are detailed in the lab manual.

COURSE WITHDRAWAL INFORMATION

Refer to the YukonU website for important dates.

TEXTBOOKS & LEARNING MATERIALS

As a step to making education more affordable, we will be using LibreText and BC Open Textbooks as our textbooks. Some copies of traditional textbooks will be placed on reserve in the library. All other resources on Moodle are provided digitally under the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License and can be printed as you see fit. You will need access to a computer or other suitable device, as internet access is required for this course.

The Laboratory Manual for Chemistry 210 will be provided. You will need to provide your own notebook for use as a Lab Notebook. This must be a separate notebook, not the one you are using for course notes. More information will be provided in the first lab session.

Students will need to provide their own safety glasses. These MUST be clear (not tinted) and ANSI Z87.1 (or later) or CAS 94.1 (or later) certified; this information will be on the packaging. These are the same kind of safety glasses required in the Trades and can be purchased wherever such safety equipment is sold. Laboratory coats are mandatory, and students can purchase these online ahead of time, or during their first lab period for $20. Masks must be worn at all times and should be brought with you. Ensure it is a mask that is comfortable for you to wear correctly for the full 3 hour lab session.

ACADEMIC INTEGRITY

Students are expected to contribute toward a positive and supportive environment and are required to conduct themselves in a responsible manner. Academic misconduct includes all forms of academic dishonesty such as cheating, plagiarism, fabrication, fraud, deceit, using the work of others without their permission, aiding other students in committing academic offences, misrepresenting academic assignments prepared by others as one's own, or any other forms of academic dishonesty including falsification of any information on any Yukon University document.

Please refer to Academic Regulations & Procedures for further details about academic standing and student rights and responsibilities.

ACADEMIC ACCOMMODATION

Reasonable accommodations are available for students requiring an academic accommodation to fully participate in this class. These accommodations are available for students with a documented disability, chronic condition or any other grounds specified in section 8.0 of the Yukon University Academic Regulations (available on the Yukon University website). It is the student's responsibility to seek these accommodations by contacting the Learning Assistance Centre (LAC): LearningAssistanceCentre@yukonu.ca.

TOPIC OUTLINE (specific dates of topic coverage are subject to change)

Week	Unit	Topic

1, 2	10	Nuclear Magnetic Resonance Spectroscopy
		- how NMR works – the theory
		- interpretation of HNMR spectra
		  - shielding and deshielding of protons
		  - chemical shifts
		  - spin-spin coupling and splitting patterns
		  - HNMR spectra and rate processes
		- interpretation of CNMR

2	11	Mass Spectrometry - how MS works – the theory - the mass spectrum - determination of molecular formulas and weights - fragmentation
3	12	Conjugated unsaturated systems - allylic substitution - allyl radicals - allyl cations - 1,3-butadiene - UV-vis spectroscopy - 1,4-addition - Diels-Alder reaction

4	13	Aromatic compounds
		- benzene
		  - nomenclature
		  - stability
		- Huckel's Rule
		- heterocyclic aromatic compounds
		- spectroscopy

4, 5	14	Reactions
		- electrophilic substitution reactions
		  - halogenation
		  - nitration
		  - sulfonation
		  - Friedel-Crafts alkylation and acylation
		  - Clemmensen and Wolff-Kishner reductions
		- substituent effects
		- alkenylbenzenes
		- nucleophilic substitutions

6, 7	15	Aldehydes and Ketones
		- nomenclature
		- properties
		- synthesis
		- nucleophilic addition to the carbonyl group
		  - addition of alcohols
		  - addition of amines
		  - addition of HCN
		  - addition of Ylides
		- oxidation
		- analysis and spectroscopy

8, 9	16	carboxylic acids and their derivatives - nomenclature and properties - preparation - acyl substitution - acyl chlorides - carboxylic acid anhydrides - esters - amides - decarboxylation of carboxylic acids - tests for acyl

10, 11	17, 18	Enols and enolates
		- acidity of carbonyl compounds
		- keto and enol tautomers
		- reactions involving enols and enolates
		  - synthesis of methyl ketones
		  - synthesis of substituted acetic acids
		  - synthesis of enamines
		  - the Claisen condensation
		  - acylation of ketone enolates
		  - aldol reactions
		  - addition to α,β-unsaturated aldehydes and ketones
		  - the Mannich reaction

12	19	Amines
		- nomenclature
		- structure and properties
		- basicity
		- preparation
		- reactions
		  - with nitrous acid
		  - replacement reactions of arenediazonium salts
		  - coupling reactions with arenediazonium salts

		- reactions with sulfonyl chlorides - synthesis of sulfa drugs - analysis - eliminations involving ammonium compounds
13	20	Phenols and aryl ethers - structure and physical properties - synthesis - reactions - phenols as acids - other O-H group reactions - cleavage of alkyl aryl ethers - Claisen rearrangement - Quinones

*Specific dates of topic coverage may be subject to change. Some topics may not be covered depending on time constraints.