NORTHWESTERN POLYTECHNIC

SCIENCE DEPARTMENT

COURSE OUTLINE – Winter 2025

CH2610 (A3 & B3): Organic Chemistry I – 3 (3-1-3) 105 Hours for 15 Weeks

Northwestern Polytechnic acknowledges that our campuses are located on Treaty 8 territory, the ancestral and present-day home to many diverse First Nations, Metis, and Inuit people. We are grateful to work, live and learn on the traditional territory of Duncan's First Nation, Horse Lake First Nation and Sturgeon Lake Cree Nation, who are the original caretakers of this land.

We acknowledge the history of this land and we are thankful for the opportunity to walk together in friendship, where we will encourage and promote positive change for present and future generations.

INSTRUCTOR:	Dr. Melissa Gajewski	**PHONE:**	780-539-2023
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OFFICE HOURS:	By appointment		

CALENDAR DESCRIPTION:

The correlation of structure and chemical bonding in carbon compounds with the physical properties and chemical reactivity of organic molecules. Discussion will be based on functional groups with emphasis on hydrocarbons and derivatives that contain halogens, oxygen, sulfur and the hydroxyl group. Introduction to stereochemistry, three dimensional structure, reaction mechanisms, especially addition to double bonds, nucleophilic substitution and elimination reactions, and methods of structure determination. The study covers the functional group chemistry of alkanes, alkenes, alkynes, alcohols, ethers and sulfides.

PREREQUISITE(S):

CH1010 or CH1030 Notes: Credit will be granted for only one of CH1610 or CH2610.

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REQUIRED MATERIALS:

Recommended Resource Materials and Texts include:

1. Solomons, T.W.G., C.B. Fryhle, S.A. Snyder, Organic Chemistry, 12th Edition, Wiley, 2016, including access to the WileyPlus web site at: https://edugen.wiley.com/edugen/secure/index.uni ISBN: 978-1-118-87576-6
2. Organic Chemistry, 12e Study Guide / Student Solutions Manual (12th Edition); Craig B. Fryhle, Scott A. Snyder, Robert G. Johnson, Jon Antilla, Paperback, 744 Pages. Published 2016, ISBN: 978-1-119-07732-9
3. Molecular Models are highly recommended, namely:
    - Molecular Model Set for Organic Chemistry, Prentice Hall.
4. Sloan, J.P., Organic Chemistry Experiments, Chemistry 2610/2630, Grande Prairie Regional College, 2023/2024. Printed from course webpage
5. Safety glasses, and lab coat

DELIVERY MODE(S):

Lecture style presentation of material followed by practice problems/discussion in seminar. Laboratory provides hands-on experience.

LEARNING OUTCOMES:

The Learning Outcomes of CH2610, Organic Chemistry I, are that Students gain an understanding of:

- Atomic Structure, the Periodic Table of the Elements, Relative Electronegativities, Bonding.
- Functional Groups and Families of Organic compounds including.
    - o Hydrocarbons: Alkanes, Alkenes, Alkynes, Arenes, Cyclic Compounds.
    - o Alkyl Halides, Alcohols, Ethers, Amines, Aldehydes, Ketones, Carboxylic Acids,
    - o Esters, Amides, Carboxylate Salts, and Sulfides.
- Molecular Structure, Lewis Structures & 3-D Structures e.g., Line-Wedge-Dash 3-D Structures.
- Relative Acidity and Basicity of Organic Compounds.
- IUPAC Nomenclature of Organic Compounds & Conformations of Alkanes & Cycloalkanes.

• Stereochemistry: Organic Molecules in 3-Dimensions, & Cahn-Ingold-Prelog Nomenclature.
• Isomers: Constitutional Isomers, Stereoisomers – Enantiomers & Diastereomers.
• Chiral Compounds and Optical Activity of Chiral Compounds existing as Pairs of Enantiomers.
• Introduction to use of "Curved Arrow Notation" & Resonance & Inductive Electronic Effects.
• Organic Reaction Mechanisms including:
    - o SN2, Substitution Nucleophilic Bimolecular. E-2, Elimination Bimolecular.
    - o SN1, Substitution Nucleophilic Unimolecular. E-1, Elimination Unimolecular.
    - o E+ Addition Mechanisms: Electrophilic Addition Mechanisms.
    - o Radical, R, Addition and Substitution Mechanisms.
    - o Syn-Additions, Anti-Additions, Nucleophilic Additions.
    - o Cleavage Reactions and Oxidation-Reduction Reactions
• Syntheses and Reactions of Alkanes, Alkenes, Alkynes, Alcohols, and Ethers.
• Introduction to Carbonyl Compounds, Organometallic Reagents and Conjugated Dines.
• A representative selection of molecules found in agricultural, biological, environmental,
industrial, medical, and pharmatheutical applications of organic chemistry, e.g., molecules
found in agrochemicals, fibres, food additives, perfumes, polymers, and prescription drugs.

TRANSFERABILITY:

Please consult the Alberta Transfer Guide for more information. You may check the transferability of this course at the Alberta Transfer Guide main page http://www.transferalberta.alberta.ca.

** For courses with alpha (letter) grading, a grade of D or D+ may not be acceptable for transfer to other post-secondary institutions. **Students are cautioned that it is their responsibility to contact the receiving institutions to ensure transferability.**

EVALUATIONS:

Examination Schedule and Composition of the Final Grade:

Midterm Exam # 1	20%
Midterm Exam # 2	20%
Final Exam to be scheduled	35%
Laboratory	20%

A passing grade in the lab component of the course is needed to pass the course.

GRADING CRITERIA:

Please note that most institutions will not accept your course for transfer credit **IF** your grade is **less than C-**.

Grading Chart for courses with Alpha Grading:

Alpha Grade	4-point Equivalent	Percentage Guidelines		Alpha Grade	4-point Equivalent	Percentage Guidelines
A+	4.0	95-100		C+	2.3	67-69
A	4.0	85-94		C	2.0	63-66
A-	3.7	80-84		C-	1.7	60-62
B+	3.3	77-79		D+	1.3	55-59
B	3.0	73-76		D	1.0	50-54
B-	2.7	70-72		F	0.0	00-49

COURSE SCHEDULE/TENTATIVE TIMELINE:

CHAPTER 1 – 2 lectures

1. Atomic Structure
2. Chemical Bonds: The Octet Rule
3. How to Write Lewis Structures
4. Formal Charges and How to Calculate Them
5. Isomers
6. How to Write and Interpret Structural Formulas
7. Resonance Theory
8. Quantum Mechanics & Atomic Structure
9. Atomic Orbitals and Electron Configuration
10. Molecular Orbitals
11. The Structure of Methane and Ethane: sp3 Hybridization

12. The Structure of Ethene (Ethylene): sp2 Hybridization
13. The Structure of Ethyne (Acetylene): sp Hybridization
14. A Summary of Important Concepts That Come from Quantum Mechanics
15. How to Predict Molecular Geometry: The Valence Shell Electron Pair Repulsion Model

CHAPTER 2 – 3 lectures

1. Hydrocarbons
2. Polar Covalent Bonds
3. Polar and Nonpolar Molecules
4. Functional Groups
5. Alkyl Halides or Haloalkanes
6. Alcohols and Phenols
7. Ethers
8. Amines
9. Aldehydes and Ketones
10. Carboxylic Acids, Esters, and Amides
11. Nitriles
12. Summary of Important Families of Organic Compounds
13. Physical Properties and Molecular Structure
14. Summary of Attractive Electric Forces
15. Infrared Spectroscopy
16. Interpreting IR Spectra

CHAPTER 3 -2 lectures

1. Acid–Base Reactions
2. How to Use Curved Arrows in Illustrating Reactions
3. Lewis Acids and Bases
4. Heterolysis of Bonds to Carbon: Carbocations and Carbanions
5. The Strength of Brønsted–Lowry Acids and Bases: K_a and pK_a
6. How to Predict the Outcome of Acid–Base Reactions
7. Relationships between Structure and Acidity
8. Energy Changes
9. The Relationship between the Equilibrium Constant, K_{eq} , and the Standard Free-Energy Change, $\Delta G°$
10. Acidity: Carboxylic Acids versus Alcohols
11. The Effect of the Solvent on Acidity
12. Organic Compounds as Bases

13. A Mechanism for an Organic Reaction
14. Acids and Bases in Nonaqueous Solutions
15. Acid–Base Reactions and the Synthesis of Deuterium- and Tritium-Labeled Compounds

CHAPTER 4 – 3 lectures

1. Introduction to Alkanes and Cycloalkanes
2. Shapes of Alkanes
3. How to Name Alkanes, Alkyl Halides, and Alcohols: the IUPAC System
4. How to Name Cycloalkanes
5. How to Name Alkenes and Cycloalkenes
6. How to Name Alkynes
7. Physical Properties of Alkanes and Cycloalkanes
8. Sigma Bonds and Bond Rotation
9. Conformational Analysis of Butane
10. The Relative Stabilities of Cycloalkanes: Ring Strain
11. Conformations of Cyclohexane: The Chair and the Boat
12. Substituted Cyclohexanes: Axial and Equatorial Hydrogen Groups
13. Disubstituted Cycloalkanes: Cis–Trans Isomerism
14. Bicyclic and Polycyclic Alkanes
15. Chemical Reactions of Alkanes
16. Synthesis of Alkanes and Cycloalkanes
17. How to Gain Structural Information from Molecular Formulas and the Index of Hydrogen Deficiency

CHAPTER 5 – 2 lectures

1. Chirality and Stereochemistry
2. Isomerism: Constitutional Isomers and Stereoisomers
3. Enantiomers and Chiral Molecules
4. Molecules Having One Chirality Center Are Chiral
5. How to Test for Chirality: Planes of Symmetry
6. Naming Enantiomers: The R,S-System
7. Properties of Enantiomers: Optical Activity
8. The Synthesis of Chiral Molecules
9. Molecules with More than One Chirality Center
10. Fischer Projection Formulas
11. Stereoisomerism of Cyclic Compounds

12. Separation of Enantiomers: Resolution
13. Compounds with Chirality Centers Other than Carbon
14. Chiral Molecules That Do Not Possess a Chirality Center

CHAPTER 6 – 3 lectures

1. Alkyl Halides
2. Nucleophilic Substitution Reactions
3. Nucleophiles
4. Leaving Groups
5. Kinetics of a Nucleophilic Substitution Reaction: An S_N2 Reaction
6. A Mechanism for the S_N2 Reaction
7. Transition State Theory: Free-Energy Diagrams
8. The Stereochemistry of S_N2 Reactions
9. The Reaction of *tert* –Butyl Chloride with Water: An S_N1 Reaction
10. A Mechanism for the S_N1 Reaction
11. Carbocations
12. Stereochemistry of S_N1 Reactions
13. Factors Affecting the Rates of S_N1 and S_N2 Reactions
14. Organic Synthesis: Functional Group Transformation Using S_N2 Reactions

CHAPTER 7 -2 lectures

1. The (E)–(Z) System for Designating Alkene Diastereomers
2. Relative Stabilities of Alkenes
3. Cycloalkanes
4. Synthesis of Alkenes: Elimination Reactions
5. Dehydrohalogenation
6. The E1/E2 Reaction
7. Elimination and Substitution Reactions Compete with Each Other
8. Elimination of Alcohols: Acid-Catalyzed Dehydration
9. Carbocation Stability and the Occurrence of Molecular Rearrangements
10. The Acidity of Terminal Alkynes
11. Synthesis of Alkynes by Elimination Reactions
12. Terminal Alkynes can be Converted to Nucleophiles for Carbon-Carbon Bond Formation
13. Hydrogenation of Alkenes
14. Hydrogenation: The Function of the Catalyst

15. Hydrogenation of Alkynes

CHAPTER 8 – 2 lectures

1. Addition Reactions of Alkenes
2. Electrophilic Addition of Hydrogen Halides to Alkenes: Mechanism & Markovnikov's Rule
3. Stereochemistry of the Ionic Addition to an Alkene
4. Addition of Water to Alkenes: Acid-Catalyzed Hydration
5. Alcohols from Alkenes through Oxymercuration–Demercuration: Markovnikov Addition
6. Alcohols from Alkenes through Hydroboration–Oxidation: Anti-Markovnikov Syn Hydration
7. Hydroboration: Synthesis of Alkylboranes
8. Oxidation and Hydrolysis of Alkylboranes
9. Protonolysis of Alkylboranes
10. Electrophilic Addition of Bromine & Chlorine to Alkenes
11. Stereospecific Reactions
12. Halohydrin Formation
13. Divalent Carbon Compounds: Carbenes
14. Oxidation of Alkenes: Syn 1,2-Dihydroxylation
15. Oxidative Cleavage of Alkenes
16. Electrophilic Addition of Bromine & Chlorine to Alkynes
17. Addition of Hydrogen Halides to Alkynes
18. Oxidative Cleavage of Alkynes

CHAPTER 11 – 1 lecture

1. Structure & Nomenclature
2. Physical Properties of Alcohols and Ethers
3. Important Alcohols & Ethers
4. Synthesis of Alcohols from Alkenes
5. Reactions of Alcohols
6. Alcohols as Acids
7. Conversion of Alcohols into Alkyl Halides
8. Alkyl Halides from the Reaction of Alcohols with Hydrogen Halides
9. Alkyl Halides from the Reaction of Alcohols with PBr_3 or $SOCl_2$
10. Tosylates, Mesylates, and Triflates: Leaving Group Derivatives of Alcohols
11. Synthesis of Ethers

12. Reactions of Ethers
13. Epoxides
14. Reactions of Epoxides
15. Anti 1,2-Dihydroxylation of Alkenes via Epoxides
16. Crown Ethers

CHAPTER 13 – 2 lectures

1. The Stability of the Allyl Radical
2. The Allyl Cation
3. Resonance Theory Revisited
4. Alkadienes & Polyunsaturated Hydrocarbons
5. 1,3-Butadiene: Electron Delocalization
6. The Stability of Conjugated Dienes
7. Ultraviolet–Visible Spectroscopy
8. Electrophilic Attack on Conjugated Dienes: 1,4-Addition
9. The Diels–Alder Reaction: a 1,4-Cycloaddition Reaction of Dienes

CHAPTER 14 – 1 lecture

1. Nomenclature of Benzene Derivatives
2. Reactions of Benzene
3. The Kekulé Structure for Benzene
4. The Thermodynamic Stability of Benzene
5. Modern Theories of the Structure of Benzene
6. Hückel's Rule: The $4n + 2$ p Electron Rule

STUDENT RESPONSIBILITIES:

Attendance of all lectures and seminars is strongly recommended. Laboratory attendance to each specific experiment is compulsory. A doctor's medical note is required for all excused absences. Students must maintain an overall average of 50% or better to pass this course. You are encouraged to participate in class discussions and ask questions. Help is available outside class time on an "as needed" basis

STATEMENT ON ACADEMIC MISCONDUCT:

Academic Misconduct will not be tolerated. For a more precise definition of academic misconduct and its consequences, refer to the Student Rights and Responsibilities policy available at https://www.nwpolytech.ca/about/administration/policies/index.html.

**Note: all Academic and Administrative policies are available on the same page.