UNIVERSITI TEKNOLOGI MARA

CHM557: ORGANIC CHEMISTRY

Course Name (English)	ORGANIC CHEMISTRY APPROVED
Course Code	CHM557
MQF Credit	4
Course Description	This course is a continuation of the study of Organic Chemistry begun in Introduction to Organic Chemistry. This course begins with an introduction to the use of infrared and nuclear magnetic resonance (NMR) spectroscopy in the determination of the structures of organic molecules. The chemistry and physical properties of carbonyl containing compounds such as aldehydes, ketones, carboxylic acids and carboxylic acid derivatives form the major part of the course. Reactions involving enolate anions as nucleophiles are discussed. The emphasis of this course is on the development of problem-solving skills in the context of structure features, synthesis and mechanism of reactions of carbonyl compounds. The chemistry of amines and an overview of carbohydrates are also included.
Transferable Skills	knowledge and practical skill in related field.
Teaching Methodologies	Lectures, Blended Learning, Lab Work, Discussion
CLO	CLO1 Discuss organic chemistry related to functional group interconversions and reaction mechanisms of various types of aldehydes, ketones, carboxylic acids, carboxylic acid derivatives and amines. CLO2 Display practical skills in laboratory experiments related to reduction, esterification, Aldol condensation and Robinson annulation reactions. CLO3 Demonstrate thinking and scientific skills related to organic chemistry.
Pre-Requisite Courses	No course recommendations

Topics
1. Aldehydes and Ketones I: Oxidation, Reduction and Synthesis 1.1) 1.1 Introduction: Nomenclature; Physical properties 1.2) 1.2 Reduction 1.3) 1.2.1 Catalytic Reduction 1.4) 1.2.2 Hydride Reducing Reagents: NaBH4, LiAlH4 1.5) 1.2.3 Complete Removal of Carbonyl group; Clemmensen and Wolf- 1.6) Kishner Reduction 1.7) 1.3 Synthesis of Aldehydes and Ketones through Reduction of Acid Chlorides and Esters 1.8) 1.3.1 Rosenmund Reduction 1.9) 1.3.2 DIBAL-H 1.10) 1.4 Synthesis of Aldehydes through Oxidation of Alcohols 1.11) 1.4.1 Oxidation of primary and secondary Alcohols 1.12) 1.4.2 Jones, Sarret and PCC Reagents 1.13) 1.4.3 Tollen's Test
2. Aldehyde and Ketone II: Nucleophilic Additions to the Carbonyl Group 2.1) 2.1 Reactivity of Carbonyl Group; Nucleophilic Addition 2.2) 2.2 Cyanohydrin Formation; Synthesis of ?-hydroxy acids and hydrolysis of nitriles 2.3) 2.3 Addition of Organometallic Reagents; Grignard and alky lithium reagents 2.4) 2.4 Addition of Water; Hydrates 2.5) 2.5 Addition of Alcohols; Acetals and Hemiacetals 2.6) 2.5.1 Cyclic Acetals 2.7) 2.5.2 Protecting Group using Acetals 2.8) 2.6 Addition of Amines 2.9) 2.6.1 Imines from 1o Amines 2.10) 2.6.2 Enamines from 2o Amines 2.11) 2.6.3 Enamines for Alkylation of Ketones

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2.12) 2.7 Wittig Reaction

3. Spectroscopy of Carbon Compounds
3.1) 3.1 Introduction to Spectrocopy and Structural Identification
3.2) 3.2 Infrared Spectroscopy
3.3) 3.3 Proton and Carbon-13 Nuclear Magnetic Resonance Spectroscopy

4. Carboxylic Acids
4.1) 4.1 Nomenclature; Physical Properties
4.2) 4.2 Synthesis of Carboxylic Acids
4.3) 4.2.1 Oxidation of 1o Alcohols
4.4) 4.2.2 Side chain Oxidation of Aromatic Compounds
4.5) 4.2.3 Carbonation of Grignard and Alkyl Lithium Compounds
4.6) 4.2.4 Hydrolysis of Nitriles
4.7) 4.3 Acidity of Carboxylic Acids
4.8) 4.3.1 Formation of Carboxylate Ion
4.9) 4.3.2 Protonation and Deprotonation
4.10) 4.3.3 Effects of Electron-withdrawing and Electron-donating Groups on
4.11) Acidity
4.12) 4.4 Decarboxylation of Carboxylic Acids

5. Derivatives of Carboxylic Acid
5.1) 5.1 Nomenclature of Acid Derivatives
5.2) 5.1.1 Acid Chlorides
5.3) 5.1.2 Acid Anhydrides
5.4) 5.1.3 Esters
5.5) 5.1.4 Amides
5.6) 5.2 Acyl Functional Group Interconversion; Nucleophilic Acyl Substittution
5.7) 5.2.1 Reactivity of Carbonyl of the Acyl Groups
5.8) 5.2.2 Reactions of Acid Chlorides and Acid Anhydrides (no catalyst); Hydrolysis, Alcoholysis, Aminolysis.
5.9) 5.2.3 Reactions of Esters and Amides (with catalyst); Fischer Esterification, Transesterification and Hydrolysis.
5.10) 5.3 Acylation of Enamines
5.11) 5.4 Miscellaneous Reactions of Acid Derivatives
5.12) 5.4.1 Esters with Organometallic Reagents
5.13) 5.4.2 Reduction of Esters and Acid Chlorides

6. Reactions of alpha-Hydrogen
6.1) 6.1 Acidity of alpha-Hydrogens: Enolate Anions; Keto and Enol Tautomers
6.2) 6.2 Alkylation and Halogenation Reactions
6.3) 6.2.1 Akylation of Ketones
6.4) 6.2.2 Halogenation; ?-Bromination and haloform reactions
6.5) 6.3 Aldol Condensation
6.6) 6.3.1 Mechanism; Addition of Enolate Anions to Carbonyls; Dehydration of Product
6.7) 6.3.2 Crossed Aldol Condensation and Synthetic Applications
6.8) 6.3.3 Cyclization via Aldol Condensation; Formation of Rings
6.9) 6.4 Claisen Condensation
6.10) 6.4.1 Mechanism of Claisen Ester Condensation
6.11) 6.4.2 Dieckmann Condensation
6.12) 6.5 Conjugate Addition of ?,?-unsaturated Carbonyl Compounds; Michael
6.13) Addition
6.14) 6.6 Robinson Annulation
6.15) 6.7 Acetoacetic Ester and Malonic Ester Synthesis; Formation of Enolates, Alkylation, Hydrolysis and Decarboxylation

7. Carbohydrates
7.1) 7.1 Carbohydrate Structures; Fischer Projections; D and L Notations
7.2) 7.2 Cyclization of Monosaccharides; Furanose and pyranose rings
7.3) 7.3 Haworth Projections and Chair Forms; Anomers
7.4) 7.4 Converting Fischer Projections to Haworth Projections
7.5) 7.5 Mutarotation
7.6) 7.6 Reactions of Carbohydrates
7.7) 7.6.1 Reduction and Oxidation
7.8) 7.6.2 Conversion to Acetal; Formation of glycosides
7.9) 7.7 Disaccharides and Polysaccharides

8. Amines
8.1) 8.1 Nomenclature; Structure; Classification; Physical Properties;
8.2) 8.2 Basicity of Amines
8.3) 8.3 Biologically Important Amines
8.4) 8.4 Synthesis of Amines
8.5) 8.4.1 Gabriel Synthesis
8.6) 8.4.2 Reductive Amination
8.7) 8.4.3 Hoffmann Rearrangement
8.8) 8.5 Reactions of Amines
8.9) 8.5.1 Reaction with Nitrous Acid
8.10) 8.5.2 Replacement Reaction of Arenediazonium Salts

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Assessment Breakdown	%
Continuous Assessment	60.00%
Final Assessment	40.00%

Details of Continuous Assessment

Assessment Type	Assessment Description	% of Total Mark	CLO
Assignment	One Assignment	20%	CLO3
Test	One Test	20%	CLO1
Written Report	One Lab Report	20%	CLO2

Reading List

Recommended Text

- **Solomons and Fryhle 2007, *Organic Chemistry*, 9 Ed., Wiley**

Article/Paper List

This Course does not have any article/paper resources

Other References

- **Book McMurry, J. 2011, *Organic Chemistry*, Brooks and Cole**
- **Book Smith, J. G 2007, *Organic Chemistry*, McGraw Hill**
- **Book Wade, L. G 2020, *Organic Chemistry***
- **Book Seyhan Ege 2004, *Organic Chemistry: Structure and Reactivity* , Houghton Mifflin**
- **Book Pavia, Lampman, Kriz and Engel 2009, *Introduction to Organic Laboratory Techniques: A Small Scale Approach, .* , Thomsom Brooks/Cole**

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