Douglas College

EFFECTIVE: SEPTEMBER 2003
CURRICULUM GUIDELINES

A. Division: Science and Technology

Effective Date: September 2002

B. Department / Program
Area: Chemistry

Revision [X] New Course [ ]

If Revision, Section(s)
Revised: D,F,G,H,M,N,O,P,Q

Date of Previous Revision: June 1980

Date of Current Revision: June 15, 2002

C: CHEM 421 **D**: Organic Chemistry – Part II **E:** 5

Subject & Course No.	Descriptive Title	Semester Credits

F: Calendar Description: This is part two of a comprehensive second year organic chemistry course suitable for those majoring in chemistry/biochemistry or continuing on with studies in the Health Sciences. It begins with a review of the theory behind various spectroscopic methods of structure determination including ^{1}H and ^{13}C – N.M.R., mass, I.R., and U.V. spectroscopies and their use in solving combined structural problems. The course will then survey the reactivity and properties of functional groups not covered in Chemistry 321. These include Conjugated Unsaturated Systems, Aromatics, Phenols and Ary Halides, Aldehydes and Ketones, Carboxylic Acids, and Amines. The course ends with an extensive review of the nomenclature, properties, and reactivity of compounds of biological interest including Amino Acids and Proteins, Carbohydrates, and Lipids.

G: Allocation of Contact Hours to Type of Instruction / Learning Settings

Primary Methods of Instructional Delivery and/or Learning Settings:

Lecture/Laboratory

Number of Contact Hours: (per week / semester for each descriptor)

Lecture: 4 hours
Laboratory: 3 hours

Number of Weeks per Semester: 15

H: Course Prerequisites:

CHEM 321 (C or better)

I: Course Corequisites:

J: Course for which this Course is a Prerequisite

None

K: Maximum Class Size:

36

L: PLEASE INDICATE:

[ ] Non-Credit

[ ] College Credit Non-Transfer

[X] College Credit Transfer:

SEE BC TRANSFER GUIDE FOR TRANSFER DETAILS (www.bccat.bc.ca)

UBC 203+204 (with CHEM 321)
SFU SFU CHEM 282 (2) & SFU CHEM 286 (2) & SFU CHEM 1
U.Vic UVIC CHEM 232 (1.5)

M: Course Objectives / Learning Outcomes

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

1. given the formula, I.R., U.V., mass spect., ^{1}H and ^{13}C N.M.R.'s of an unknown organic compound, be able to determine the structure of that unknown.
2. given the structural formula of an organic compound, be able to predict the number of peaks, their chemical shift, splitting pattern and integration of a ^{1}H- N.M.R.
3. be able to draw the resonance structures of allylic radical and carbocation systems and draw the complete mechanism of an allylic substitution reaction.
4. given a list of potential dienes and dienophiles, be able to predict the product of any combination (including stereochemical details) and the relative speed of the reaction.
5. give experimental evidence showing that benzene is resonance stabilized.
6. to draw the molecular orbital diagrams for benzene, and the allyl cation and radical.
7. given a list of cyclic alkenes, be able to predict which will be expected to be aromatic or antiaromatic.
8. given benzene or a substituted aromatic and a suitable electrophile, be able to predict the structure of the major product by drawing a detailed reaction mechanism showing all resonance structures.
9. given an aldehyde or ketone and a suitable reagent, be able to predict if reaction will occur by addition to the carbonyl group or at the carbon alpha to the carbonyl group.
10. given the formulas of a substrate and a reagent(s) be able to predict the major product of the reaction, examples include Clemmenson and Birch Reduction, Kolbe Reaction, Claison Rearrangement, Wittig Reaction, Reformatsky Reaction, Aldol Reaction, etc. (complete list in course content).
11. be able to provide the complete mechanism for all the reactions covered in the course by drawing curved arrows and indicating the structures of all transition states and intermediates.
12. given the formula of an organic compound, give the IUPAC name, or the common name, if one exists.
13. given the structure of a desired synthetic target, and a list of allowed starting materials, be able to retrosynthetically design a synthesis of the target compound using reactions learned throughout the course.
14. understand and be able to explain how chiral amines can be used as resolving agents.
15. given the structure of any amino acid, be able to name it.
16. given the name of an amino acid, be able to draw the structure.
17. be able to draw a zwitter-ion, and predict the acid/base properties of any amino acids including the shape of its titration curve.
18. to describe and draw examples of primary through quaternary structure in proteins.
19. to classify and give the general name of any carbohydrate.
20. to draw the structure of a variety of carbohydrates including glucose, sucrose, fructose, amylose, cellulose, etc.
21. understand and explain the term mutarotation.
22. to define and describe the physical and structural differences between a fat and oil.
23. to draw the structure of isoprene and show how the simple terpenes are biosynthesized.
24. to draw the structure of a miscelle and explain how a deteregent cleans.
25. to draw the general structure of a steroid and comment on the biosynthetic pathway of cholesterol.

N: Course Content:

Spectroscopic Methods of Structure Determination: Electromagnetic Spectrum, U.V. Spectroscopy, I.R. Spectroscopy, ^{1}H-N.M.R. Spectroscopy, Combined Structural Problems, ^{13}C and Mass Spectrometry.

Conjugated Unsaturated Systems: Introduction, resonance structures and the allyl radical and cation, allylic substitution reactions, alkadienes and polyunsaturated hydrocarbons, Diels-alder (1,4-Cycloaddition) reaction.

Aromatic Compounds: Introduction, Nomenclature of Benzene Derivatives, Structure and Stability of Benzene, Huckel's Rule, Other Aromatic Compounds, Birch Reduction.

Electrophilic Aromatic Substitution Reaction: General Mechanism, Halogenation of Benzene, Nitration of Benzene, Friedel-Crafts Alkylation and Acylation, Clemmenson Reduction, Substituent Effects on Reactivity and Orientation, Activating and Deactivating Groups.

Phenols and Aryl Halides: Nomenclature, Physical Properties, Synthesis of Phenols, Reactions of Phenols, Kolbe Reaction, Claisen Rearrangement, Aryl Halides and Nucleophilic Aromatic Substitution Reactions.

Aldehydes and Ketones and Addition Reactions to the Carbonyl Group: Nomenclature, Physical Propeerties, Synthesis of Aldehydes and Ketones, Nucleophilic Addition to Carbonyl Group, Addition of Water, and Alcohols, Hemiacetal and Hemiketal Formation, Acetal and Ketal Formation, Ammonia Derivatives, Wolff-Kishner Reduction, Wittig Reaction, Reformatsky Reaction, Baeyer Villiger Oxidation of Aldehydes and Ketones.

Aldol Reaction, Reactions at the α-Carbon: Introduction, Enol-Keto Tautomerization, Reactions of Enols and Enolates, The Aldol Reaction, Crossed Aldol Reactions, Claisen-Schmidt Reactions, Cyclizations via Aldol Condensations, Additions to α-β Unsaturated Carbonyl Compounds, Michael Additions.

Carboxylic Acids and their Derivatives: Introduction, Physical Properties, Nomenclature, Preparation of Carboxylic Acids, Esters, Amides, Acid Chlorides, Amides, Nitriles, Nucleophilic Substitution of Carboxylic Acid Derivatives, Lactones and Lactams, Hell-Volhard-Zelinski Reaction, Decarboxylation of Carboxylic Acids.

Amines: Nomenclature, Physical Properties, Amines as Resolving Agents, Preparation of Hoffman Rearrangement and Elimination, Reaction of Amines.

Amino Acids and Proteins: Classification and Nomenclature, Acid-Base Properties, Separation of Amino Acids, Peptide Bonds and Disulfide Bonds, Automated Peptide Structure.

Carbohydrates: Classification of Carbohydrates, D and L Notation, Aldoses and Ketoses, Stereochemistry of Glucose, Mutarotation, Monosaccharides, Disaccharides, Polysaccharides.

Lipids: Introduction, Fats and Oils, micelles, Fatty Acids, Waxes, Triacylglycerols, Phospholipids and Sphingolipids, Prostoglandins, Terpenes, Vitamin A, Steroids, Biosynthesis of Cholesdterol.

LABORATORY CONTENT

The following laboratory experiments will be selected from the following list and performed during the lab period:

1. Preparation and Preparation of a Diels-Alder Adduct
2. Analysis of an Unknown by NMR and IR
3. Multistep Synthesis: From Acetophenone of 3-Nitro Methyl Benzoate (Three Weeks)
4. Separation and Identification of Methyl Esters of Fatty Acids by Gas Chromatography (Two Weeks)
5. Carbohydrates: Hydrolysis of Sucrose, Polarimetry and Analysis of Sugar in Soft Drinks (Two Weeks)
6. Chemical Reactions of Amino Acids
7. Practical Lab Exam

O: Methods of Instruction

The course will be presented using lectures, problem sessions and class discussion. Films and other audio-visual aids as well as programmed material will be used where appropriate. Problems will be assigned on a regular basis, to be handed in and evaluated. The laboratory course will be used to illustrate the practical aspects of the course material. Close coordination will be maintained between laboratory and classroom work whenever possible. This will be accomplished by discussing laboratory experiments in class and, when necessary, by using the lab period for problem solving.

P: Textbooks and Materials to be Purchased by Students

Bruice, Paula Yuranis, *Organic Chemistry* 3rd Edition, Prentice Hall, 2001
Molecular Model Kit, HGS
Douglas College, *Chemistry 421 Laboratory Manual*

Q: Means of Assessment

The final grade assigned for the course will be based upon the following components:

1. **Lecture Material (70%)**
   - Two or three in-class tests will be given during the semester (30%)
   - A final exam covering the entire semester's work will be given during the final examination period (30%)
   - Any or all of the following evaluations, at the discretion of the instructor: problem assignments, quizzes, class participation [5% maximum] (10% in total)

2. **Laboratory 30%**
   - Written reports and pre-labs will be collected for each experiment and will be graded. These reports will be complete reports, to be handed in in the laboratory notebook. In addition, some written quizzes based on laboratory material will be evaluated (15%).
   - Qualitative/Quantitative results of experiments performed on unknown samples will be graded (5%).
   - Final Lab Exam – Practical (5%), - Written (5%).

R: Prior Learning Assessment and Recognition: specify whether course is open for PLAR

NO

Course Designer(s)	Education Council / Curriculum Committee Representative
Dean / Director	Registrar