Student Services

GRANDE PRAIRIE REGIONAL COLLEGE

DEPARTMENT OF SCIENCE

CHEMISTRY 350 (1991-92)

INSTRUCTOR:	Dr. Som K. Pillay (Office: J 210; Tel: 539-2985)
PREREQUISITE:	CHEM 202 (or CHEM 200)
TRANSFER CREDIT:	U. of Alberta: CHEM 260, 6 Credits U. of Calgary: CHEM 350, 6 Credits
LECTURES:	MONDAYS, WEDNESDAYS & FRIDAYS 9:00 - 9:50 AM (J 203)
SEMINAR:	FRIDAYS 8.00 - 8.50 AM (J 201)
LABORATORY:	MONDAYS 3.00 - 5.50 PM (J 116)
TEXT BOOKS AND LABORATORY ITEMS:	L. G. Wade, Jr., Organic Chemistry, 2nd Ed., Prentice-Hall, Inc., 1991. Experiments in Organic Chemistry, Chemistry 350, University of Alberta, 1991. Hard-Cover Laboratory Note Books Lab Coats and Safety Glasses Molecular Model Set and Chemist's Triangle

COURSE EVALUATION

THEORY:

Assignments/Quizzes	10.0 %
First Mid-term Examination (October 25)	10.0 %
Christmas Examination (Week of December 9)	20.0 %
Second Mid-term Examination (February 21)	10.0 %
Final Examination (Week of April 20)	30.0 %
	80.0 %

Note: A Pass Grade is Essential for the Theory Component.

LABORATORY:

General Competence in the Laboratory, Experimental Results, Lab Reports and Lab Quizzes:	20.0 %

Note: A Pass Grade is Essential for the Laboratory Component.

COURSE OUTLINE

EMPHASIS IS PLACED ON UNDERSTANDING OF PRINCIPLES AND THE ABILITY TO USE PRINCIPLES TO SOLVE PROBLEMS.

1. STRUCTURE & BONDING (REVIEW):

Approximately two weeks of lectures and two weeks of seminars. The following topics are relevant, and the material should be known from CHEM 202 (or CHEM 200).

Atomic Orbitals; Electron Configuration; Molecular Orbitals & Bonding; Hybrid Orbitals; Delocalized Bonding & Resonance; Molecular Geometry; Electronegativity & Bond Polarity; Intermolecular Forces; Acid-Base Properties; Structural Formulas; Functional Group Classification of Organic Compounds.

Chapters: 1 & 2; Problem Sets: 1 & 2

2. INTRODUCTION TO STEREOCHEMISTRY:

Nomenclature of Alkanes; Conformations of Cyclic and Acyclic Compounds; Steric Strain; Bicyclic & Polycyclic Compounds; Strained Carbocycles; Geometrical Isomerism; Stereoisomerism; Chirality & Optical Activity; Fisher Projections; Absolute Configuration; The Cahn-Ingold-Prelog System of Nomenclature; Enantiomerism; Racemates; Meso-compounds; Torsional Asymmetry.

Chapters: 3 & 6; Problem Sets: 3 & 4

3. FREE-RADICAL SUBSTITUTION REACTIONS:

The Reaction Mechanism; Reaction Energetics & Kinetics; Structure & Stability of Free-Radicals; Halogenation of Alkanes.

Chapter: 4; Problem Set: 5

4. NUCLEOPHILIC SUBSTITUTION AND ELIMINATION REACTIONS:

Nomenclature of Alkyl Halides; The SN1 & SN2 Mechanisms; Carbocations; The Effect of Substrate Structure; Stereochemistry of Nucleophilic Substitution; The Effect of the Leaving Group; The Effect of the Attacking Nucleophile; The Effect of the Reaction Medium; Rearrangements.

The E1 & E2 Mechanisms; The Effect of Substrate Structure; The Effect of the Leaving Group; Basicity Versus Nucleophilicity; The Effect of the Medium; The Direction of Elimination; Stereochemistry of Elimination; Isotope Effects; Elimination versus Substitution; The Chemistry of Alkyl Halides.

Structure & Nomenclature of Alkenes; Stability of Alkenes; Dehydration of Alcohols; Dehalogenation of Vicinal Dihalides.

Chapters: 5 & 7; Problem Sets: 6, 7 & 8

5. ELECTROPHILIC ADDITION TO CARBON-CARBON MULTIPLE BONDS:

The Mechanism of Electrophilic Addition; Structure & Reactivity; Orientation and Stereochemistry of Addition; Addition of X_2, HX, H_2O, HOX, and H_2; Hydroboration; Oxymercuration; Alkoxymercuration; Addition of Carbenes; Polymerization; Oxidation Reactions.

Structure & Nomenclature of Alkynes; Acidity of Alkynes; Acetylide Ions as Nucleophiles; Addition Reactions of Alkynes.

Structure & Nomenclature of Dienes; Addition to Conjugated Dienes; The Diels-Alder Reaction.

Chapters: 8, 14 & 15; Problem Sets: 9 & 10

6. ALCOHOLS:

Structure & Nomenclature; Acidity of Alcohols & Phenols; Organometallic Reagents in Alcohol Synthesis; Metal Hydride Reduction of Carbonyl Compounds; Oxidation of Alcohols; Alcohols as Nucleophiles & Electrophiles; The Lucas Test; Dehydration of Alcohols; Pinacol Rearrangement; Periodic Acid Cleavage of Glycols.

Chapters: 9 & 10; Problem Sets: 11 & 12

7. **INTRODUCTION TO SPECTROSCOPY:**

Principles of UV, IR NMR & MS and their Applications to Structural Elucidation of Organic Molecules.

Chapters: 11, 12 & 15; Problem Set: 13

8. **ETHERS AND EPOXIDES:**

Structure & Nomenclature; Synthesis & Reactions of Ethers and Epoxides.

Chapter: 13; Problem Set: 14

9. **ELECTROPHILIC AND NUCLEOPHILIC AROMATIC SUBSTITUTION:**

Structure and Stability of Aromatic Compounds; Aromaticity; Huckel's Rule; Nomenclature of Aromatic Compounds.

Electrophilic Aromatic Substitution: The Arenium Ion Mechanism; Reactivity in Substituted Benzene Rings; Directing Effects of Substituents; Nitration; Halogenation; Sulfonation; Diazonium Coupling; Friedel-Crafts Alkylation & Acylation.

Nucleophilic Aromatic Substitution: The Addition-Elimination Mechanism; The Elimination-Addition Mechanism; Benzyne Intermediates; Oxidation & Reduction Reactions of Aromatic Compounds.

Chapters: 16 & 17; Problem Sets: 15 & 16

10. **AMINES:**

Nomenclature; Structure & Basicity; Amines as Nucleophiles; The Hofmann Elimination; The Cope Elimination; Arenediazonium Salts; Semi-Pinacol Rearrangement; The Hofmann Rearrangement.

Chapter: 19; Problem Set: 17

11. NUCLEOPHILIC ADDITION TO THE CARBONYL GROUP:

Nomenclature of Aldehydes and Ketones; Review of Synthesis of Ketones and Aldehydes; Structure and Reactivity of the Carbonyl Group; Addition of HCN, Water, Alcohols, Thiols, and Amines; Addition of Organometallic Reagents; Oxidation and Reduction of Aldehydes and Ketones;

Chapter: 18; Problem Set: 18

12. NUCLEOPHILIC ACYL SUBSTITUTION:

Nomenclature of Carboxylic Acids and Their Derivatives; The Tetrahedral Mechanism; Structure and Reactivity; The Chemistry of Carboxylic Acids, Acid Chlorides, Anhydrides, Esters, & Amides; Organometallic Reagents; Reduction Reactions.

Chapters: 20 & 21; Problem Sets: 19 & 20

13. CARBANIONS:

Stability & Structure of Carbanions; Enols and Enolate Ions; Halogenation of Ketones; Alkylation of Enolate Anions; Enamine Synthesis; The Cannizzaro Reaction; The Wittig Synthesis; The Aldol Condensations; The Claisen Ester Condensations; Ambident Nucleophiles; Acetoacetic Ester Synthesis; Malonic Ester Synthesis; The Michael Reaction; The Robinson Annulation.

Chapter: 22 ; Problem Set: 21

SPECIAL TOPICS

14. BIOMOLECULES:

A. **Carbohydrates** - Structure and Nomenclature of Carbohydrates; Chemistry of Monosaccharides; Nucleosides and Nucleotides; Glycolysis.

B. **Proteins:** - Structure, Properties and Synthesis of Aminoacids; Proteins & Enzymes; Nucleic Acid & Protein Synthesis.

Chapters: 23 & 24; Problem Set: 22

LECTURE SESSION

Regular attendance of lectures/seminars is essential to achieve a good understanding of the course material. You are encouraged to ask questions and to participate in class discussions. Help is also available outside the class room. **NO APPOINTMENTS ARE NEEDED**.

TENTATIVE LECTURE SCHEDULE

FALL SEMESTER

WEEK OF	TOPICS
Sept. 2	Introduction
9	Review: Structure & Bonding
16	,,
23	Introduction to Stereochemistry
30	,,
Oct. 7	Free-Radical Substitution Reactions
14	Nucleophilic Substitution & Elimination Reactions
21	,,
28	,,
Nov. 4	Electrophilic Addition to Carbon-Carbon Multiple Bonds
11	,,
18	The Chemistry of Alcohols
25	,,
Dec. 2	Introduction to Spectroscopy
9	* FIRST TERM FINAL EXAM *

TENTATIVE LECTURE SCHEDULE

WINTER SEMESTER

WEEK OF	TOPICS
Jan. 6	Introduction to Spectroscopy
13	Ethers & Epoxides
20	Electrophilic & Nucleophilic Aromatic Substitution
27	"
Feb. 3	The Chemistry of Amines
10	Nucleophilic Addition to Carbonyl Group
17	"
24	* WINTER BREAK *
Mar. 2	Nucleophilic Acyl Substitution
9	"
16	Carbanions
23	"
30	Special Topics
Apr. 6	"
13	* REVIEW *
20	* FINAL EXAM *

READING AND PROBLEM ASSIGNMENTS

Problem solving is an essential part of this course. It will guide your study in the right direction and also will help you to monitor your performance in the course.

Approximately ten questions will be assigned as home work every week. However, you are encouraged to solve as many additional problems as you can. It is important that you work out these problems independently. Seek help with the ones you cannot solve yourself. Unless instructed otherwise, Assignments are due on Mondays at 9.00 AM. **NO LATE ASSIGNMENTS ARE ACCEPTED. DON'T ASK!**

FALL SEMESTER

PROBLEM SET #	CHAPTER*	PROBLEMS
1	1	23 a,d,e,h,j,k, 32, 34, 35, 37-41, 43-46
2	2	24, 25 d-i, 27, 28, 30-34, 36-41
3	3	31, 32 b-d, f-h, k, 35, 37, 39, 40-43
4	6	29, 30, 33-35, 37, 38, 40-42, 45, 46
5	4	33-35, 37, 39, 42-44, 46-49
6	5	39-42, 44, 46, 48, 50-54
7	5	35, 55-57, 59-64, 66
8	7	20-22, 25, 27, 29, 31-33, 36,37
9	8	40, 41 a, c-e, g, 42, 49-51, 53, 54, 57, 59, 61, 62
10	14 15	28-30, 32, 34, 36, 38, 40-43, 45 26, 28, 29, 30, 32
11	9	28-30, 32, 34-37, 39, 41-43
12	10	39-41, 45, 48-52, 54 a, b, e-g, 55, 56

***TEXT: L. G. Wade, Jr., Organic Chemistry, 2nd Ed., Prentice-Hall, Inc., 1991.**

READING AND PROBLEM ASSIGNMENTS

WINTER SEMESTER

PROBLEM SET #	CHAPTER*	PROBLEMS
13	11 12	17 28, 30, 32-34, 38, 39-41
14	13	25-28, 31, 33, 38, 39, 41
15	16	25, 26, 28, 31-36, 43
16	17	43-48, 51-54, 56-59
17	19	37, 38, 40, 42, 44, 45, 47, 51, 52, 55
18	18	31, 35, 36, 39, 41, 43, 44, 48, 49, 53, 54, 56, 57
19	20	23-27, 29, 30, 32, 33, 35-41
20	21	39, 45, 46, 49, 51-54, 56, 58, 60, 62, 63
21	22	63, 64, 66-68, 70-73, 76, 78
22	23 24	TBA

*TEXT: L. G. Wade, Jr., Organic Chemistry, 2nd Ed., Prentice-Hall, Inc., 1991.

LABORATORY SESSION

Laboratory sessions start at 3.00 PM sharp. Surprise Lab Quizzes will be administered at the beginning of the laboratory period. All students are expected to come to the laboratory well prepared in the experiment that is to be performed and on time.

Students are expected to attend all laboratory periods. Absences due to illness must be substantiated by presenting suitable evidence to the Instructor/Lab Technician. An opportunity to make-up a lab will be given only for excused absences.

The laboratory experiments are designed to allow a well-prepared student to finish all the work within the allotted time. If necessary, melting points and weights of dry samples may be measured between 1500 and 1730 hours on tuesdays. You may complete any other unfinished part of the experiment during the regular laboratory period the following week. **IT IS YOUR RESPONSIBILITY TO COMPLETE THE LAB ON TIME.**

LABORATORY REPORT:

You must record everything you do and observe as you carry out your experiment. Use a hard-cover laboratory note book for this purpose. Do not copy the procedure from the laboratory manual. Keep your note book neat. Your notebook will be checked periodically.

Formal lab reports should be written using the format given in your laboratory manual. The lab report should be handed in with your samples at the beginning of the next laboratory period. **NO LATE LAB REPORTS ARE ACCEPTED.**

TENTATIVE LABORATORY SCHEDULE

DATE	EXPERIMENT*
Sept. 16	1. CHECK-IN & HYDROLYSIS OF METHYL SALICYLATE
23	2. RECRYSTALLIZATION & THERMOMETER CALIBRATION
30	3. MIXTURE MELTING POINTS & THE IDENTIFICATION OF AN UNKNOWN ALDEHYDE OR KETONE
Oct. 7	4. TRIMYRISTIN FROM NUTMEG
14	7. STEREOCHEMISTRY
21	* **NO LAB (MID-TERM EXAM)**
28	5. THE SEPARATION OF ACIDS, BASES AND NEUTRAL COMPOUNDS
Nov. 4	6. ,,
11	* **NO LAB**
18	8. ALKANES, ALKENES & AROMATIC HYDROCARBONS
25	9. A DIBASIC ACID FROM A CYCLIC ALKENE
Jan. 6	10. THE DIELS-ALDER REACTION & RECRYSTALLIZATION OF AN UNKNOWN
13	12. Chromatography
20	13. SODIUM BOROHYDRIDE REDUCTION OF A KETONE
27	14. GRIGNARD REACTION
Feb. 3	16. ELECTROPHILIC & NUCLEOPHILIC AROMATIC SUBSTITUTION
Feb. 10	15. ASPIRIN FROM SALICYLIC ACID & SOAP FROM TRIMYRISTIN
17	* **NO LAB**
24	* **WINTER BREAK - NO LAB**
Mar. 2	17. THE SYNTHESIS OF METHOXYCHLOR
9	18. QUALITATIVE ORGANIC ANALYSIS
16	19. ,,
23	20. ,,
30	* Check-out *

*TEXT: Experiments in Organic Chemistry, Chemistry 350, University of Alberta, 1991.