

UNIVERSITY OF CALGARY  
DEPARTMENT OF CHEMISTRY  
**COURSE SYLLABUS**  
**WINTER 2015**

**Chem 353 syllabus**

**Optical properties:** optical rotation, optical purity, enantiomeric excess. Diastereomers

**Electrophilic addition reactions of alkenes and alkynes.** Markovnikov's rule: empirical, basis, application. Stereochemistry (syn / anti / not specific additions), product stereochemistry.

**Alkenes:**

Review preparations via elimination of alkyl halides and alcohols.

Reactions: heterogeneous cat. hydrogenation, hydrohalogenation (HX, inc. radical HBr), hydration ( $H_3O^+$ ,  $BH_3$ , oxymercuration), halogenation, halohydrin (HOX,  $X_2 / H_2O$ ), epoxidation with peracids, ozonolysis (oxid and red work ups), dihydroxylation ( $KMnO_4$  and cat.  $OsO_4$ )

**Alkynes:** internal and terminal subtypes.

Review preparations via elimination and alkylation reactions.

Reactions: reductions (cat.  $H_2$ , Lindlar's cat., dissolving metal ( $Na/NH_3$  and  $Na/THF$  then  $MeOH$ ), halogenation, hydrohalogenation (HX and excess HX), hydration ( $H_3O^+$ , tautomerisation). Hydroboration.

**Organic synthesis:** analysis and design. Basic retrosynthetic principles.

**Dienes and allylic systems:** terminology, structure, bonding, subtypes, preparation.

Addition reactions with HX,  $X_2$ , Diels-Alder. Kinetic and thermodynamic control.

**Epoxides:** Reactions with nucleophiles. Regioselectivity for unsymmetrical epoxides based on reaction conditions and pathway.

**Aromatic systems:**

benzene: structure, bonding, physical and chemical properties, reactivity implications.

aromaticity, resonance energy, criteria for aromaticity (inc. heteroaromatic and ions), the Huckel rule.

**Electrophilic aromatic substitution reactions of benzene systems:** Nitration, alkylation, acylation, sulfonation, halogenation. Scope and limitations.

**Substituent effects** : activating or deactivating, directing effects. Implications on properties (e.g. reactivity, acidity/basicity)

**Reactions of aromatic substituents:** review radical, nucleophilic substitutions, eliminations.

Oxidation of alkyl groups. Reduction of nitro groups. Diazotisation. Reaction of diazonium salts.

Synthesis of disubs. and poly subs. benzenes considering directing effects etc.

**Introduction to organometallic compounds**, esp. Grignard and related reagents (org. lithium, cuprates), hydride reagents ( $LiAlH_4$  and  $NaBH_4$ ). Structure, reactivity.

Preparations of alcohols from carbonyl groups by reaction with organometallics and hydride reagents.

Relative reactivity of carbonyl containing functional groups.

Reactions of alcohols with carboxylic acid derivatives to give esters.

Oxidation of alcohols (chromium reagents)

Diols: properties, preparation and reactions of.

**Nucleophilic addition reactions of aldehydes and ketones:**

hydration, alcohols to give acetals and ketals (talk about these as protecting groups), cyanohydrins, organometallic reagents inc. hydrides, the Wittig reaction, reactions with primary amine derivatives.

**Carboxylic acids and derivatives:** structure, bonding, physical and chemical properties, preparations.

Reactions: Nucleophilic acyl substitution of carboxylic acid derivatives for interconversion reactions (esp.

preparations of acid derivatives and hydrolysis of acid derivatives) and reactions with organometallic and hydride reagents.

**Enols and enolates of aldehydes, ketones and esters:** acidity, preparation.

Reactions as nucleophiles in alkylation and condensation reactions (aldol, Claisen, Dieckmann). Active methylene compounds. Decarboxylation of beta-keto systems.

As time allows : Conjugate additions to conjugated ketones and aldehydes.

**Laboratory experiments** (10 weeks of expts)

Molecular models (stereochemistry)

Distillation

Polymers and plastics

Synthesis of Biodiesel

Selectivity using sodium borohydride

Grignard reaction

Aldol reaction

Identification of unknowns (3 weeks)