DEPARTMENT OF CHEMISTRY

Sophomore Organic Chemistry for non-Chemistry Majors

CHEMISTRY 331 ◊ ORGANIC CHEMISTRY I

GENERAL INFORMATION
Chemistry 331, Chemistry 332 and Chemistry 337 constitute the course sequence for pre-professional students (medicine, dentistry, optometry, pharmacy and other health professions), chemical engineering students and other students, not majoring in chemistry, who require a year of organic chemistry.

COURSE STRUCTURE
Four credit-hour course
Thirty one hour lectures
Ten one hour recitations

PREREQUISITES
One year of freshman chemistry
CH 121, CH 122, CH 123; or
CH 221, CH 222, CH 223

ACID-BASE CHEMISTRY IN ORGANIC CHEMISTRY
Bronsted-Lowry acids and bases
K_a values, pK_a values, equilibrium constants
Predicting the positions of acid-base equilibria
Predicting approximate pKa values
Ranking acids in order of acid strength; ranking bases in order of base strength
Acids and bases in organic chemistry
Lewis acids and bases
Nucleophiles and electrophiles
Mechanism of an acid-base reaction
-two-electron processes; the use of curved arrow notation

ALKANE
Nomenclature, structure and bonding, physical properties
Stereochemistry
-structural isomerism, stereoisomerism, conformational isomerism
Conformations of acyclic alkanes, cyclic alkanes including cyclohexane, monosubstituted cyclohexanes and disubstituted cyclohexanes
-torsional strain, steric strain, angle strain, ring strain
Conformational equilibria
-equilibrium constants, composition at equilibrium
Conversion to alkyl halides
-one-electron processes; chain reactions; reactive intermediates; energy diagrams; mechanistic aspects

ALKENES
Nomenclature, structure, bonding, physical properties
Stereochemistry
-configurational isomerism, chirality, optical activity
Conversion to Markovnikov alkyl halides
-hydrohalogenation, protonation, carbocations, carbocation rearrangements, regiochemistry/stereochemistry, mechanistic aspects
Conversion to Markovnikov alcohols
-hydration via the aqueous acid pathway, protonation, carbocations, carbocation rearrangements, regiochemistry/stereochemistry, mechanistic aspects
-hydration via the oxymercuration-demercuration pathway, mercurinium ions, organomercurial alcohols, regiochemistry/stereochemistry, mechanistic aspects
Conversion to anti-Markovnikov alcohols
-hydration via the hydroboration-oxidation pathway, alkylboranes, regiochemistry/stereochemistry, mechanistic aspects
Conversion to geminal-dihalides and halohydrins
-cyclic halonium ions, anti-addition, regiochemistry/stereochemistry, mechanistic aspects
Conversion to alkanes
-catalytic hydrogenation, syn-addition, stereochemistry, mechanistic aspects
Conversion to epoxides
-syn-addition, stereochemistry, mechanistic aspects
Conversion to geminal-diols
-using osmium tetroxide, using permanganate, stereochemistry, mechanistic aspects
Conversion to aldehydes, ketones &/or carboxylic acids
-oxidative cleavage using permanganate, ozonolysis

ALKYL HALIDES
Nomenclature, structure, bonding, physical properties
S_N1 and E1 reactions
-rate laws, substituent effects, leaving group effects, solvent effects, rearrangements, stereochemistry, mechanistic aspects, competition
-applications to synthesis
S_N2 and E2 reactions
-rate laws, nucleophilicity, steric effects, solvent effects, leaving group effects, stereochemistry, mechanistic aspects, competition
-applications to synthesis

ALKYNES
Nomenclature, structure and bonding, physical properties
Preparations of alkynes
-via the double dehydrohalogenation of alkyl dihalides, mechanistic aspects
Conversion to Markovnikov vinyl halides, dihalides
-protonation, vinyl cations, regiochemistry/stereochemistry, mechanistic aspects
Conversion to ketones
-hydration via the mercuric ion catalyzed pathway, regiochemistry/stereochemistry, keto-enol tautomerism, mechanistic aspects
Conversion to alkanes and cis alkenes
-via catalytic hydrogenation, stereochemistry
Conversion to trans alkenes
-via metal-ammonia reduction to trans alkenes, stereochemistry, mechanistic aspects
Conversion to geminal dihalides, tetrahalides
-stereochemistry, mechanistic aspects
Chemistry acetylide ions
-preparations/properties, applications to synthesis

DEPARTMENT OF CHEMISTRY

Sophomore Organic Chemistry for non-Chemistry Majors

CHEMISTRY 332 ◊ ORGANIC CHEMISTRY II

GENERAL INFORMATION
Chemistry 331 (lecture), Chemistry 332 (lecture) and Chemistry 337 (lecture and laboratory) constitute the course sequence for pre-professional students (medicine, dentistry, optometry, pharmacy and other health professions), chemical engineering students and other students, not majoring in chemistry, who require a year of organic chemistry.

COURSE STRUCTURE
Four credit-hour course
Thirty one hour lectures
Ten one hour recitations

PREREQUISITES
One year of freshman chemistry
CH 121, CH 122, CH 123; or
CH 221, CH 222, CH 223
and
CH 331

ALCOHOLS AND ETHERS
Nomenclature, structure, bonding, physical properties
Conversion to alkyl halides and sulfonate esters
-mechanistic aspects, applications to synthesis
Conversion to alkenes
-via the acid-catalyzed dehydration of alcohols, E1 and E2 pathways, mechanistic aspects
Conversion to aldehydes and ketones
-oxidizing agents (Jones reagent, PCC)
-oxidation of primary alcohols to aldehydes and carboxylic acids, mechanistic aspects
-oxidation of secondary alcohols to ketones, mechanistic aspects
Chemistry of ethers
-epoxide ring opening, mechanistic aspects
-Williamson ether synthesis, mechanistic aspects
-acid-catalyzed cleavage of ethers, mechanistic aspects

ALDEHYDES AND KETONES
Nomenclature, structure, bonding, physical properties
Relative reactivities of aldehydes and ketones
Conversion to alcohols
-via the addition of hydride and organometallic reagents (preparations/properties of sodium borohydride, lithium aluminum hydride, Grignard reagents, acetylide ions, organolithium compounds), mechanistic aspects
Conversion to hydrates, hemiacetals, acetals
-via the addition of water and alcohols, acetals as protecting groups in synthesis, mechanistic aspects
Conversion to imines
-via the addition of ammonia and its derivatives, mechanistic aspects

AROMATICITY AND CHEMISTRY OF BENZENE
Nomenclature, structure, bonding, physical properties
Aromaticity
Electophilic aromatic substitutions
-halogenation, nitration, sulfonation, Friedel-Crafts alkylation, Friedel-Crafts acylation, mechanistic aspects
Clemmensen reduction
Wolff-Kishner reduction

CARBOHYDRATES
Nomenclature, structure, bonding, physical properties
Aldoses, ketoses
D sugars, L sugars
Furanoses, furanosides, pyranoses, pyranosides
Alpha and beta anomers
Oxidations
-conversion to aldaric acids
-conversion to aldonic acids
Reductions
-conversion to alditols
Reducing sugars, nonreducing sugars
Alpha-glycosidic linkages, beta-glycosidic linkage
the constituent sugar(s) of a disaccharide; a trisaccharide; a polysaccharide

CARBOXYLIC ACIDS AND ESTERS
Nomenclature, structure, bonding, physical properties
Chemistry of carboxylic acids
-esterification, metal hydride reduction, conversion to ketones, mechanistic aspects
Chemistry of esters
-acid-catalyzed hydrolysis, saponification, metal hydride reduction, conversion to alcohols, mechanistic aspects
Fatty acids
Waxes, triglycerides, fats, oils
Soaps

STRUCTURE DETERMINATION
Degrees of unsaturation
Energy, wavelength, frequency
Infrared spectroscopy
-typical vibrational modes
-predicting/interpreting spectral features
-compound identification
Proton NMR spectroscopy
-shielding, deshielding
-chemically equivalent protons, non-chemically equivalent protons
-splitting, pitchfork diagrams
-predicting/interpreting spectral features
-compound identification

DEPARTMENT OF CHEMISTRY

Sophomore Organic Chemistry for non-Chemistry Majors

CHEMISTRY 337 ◊ ORGANIC CHEMISTRY LABORATORY

GENERAL INFORMATION
Chemistry 331 (lecture), Chemistry 332 (lecture) and Chemistry 337 (lecture and laboratory) constitute the course sequence for pre-professional students (medicine, dentistry, optometry, pharmacy and other health professions), chemical engineering students and other students, not majoring in chemistry, who require a year of organic chemistry.

COURSE STRUCTURE
Four credit-hour course
Ten four-hour labs
Nine eighty minute lectures (relevant chemistry and laboratory techniques)
Nine eighty minute lectures (topics listed below)

PREREQUISITES
One year of freshman chemistry
CH 121, CH 122, CH 123; or
CH 221, CH 222, CH 223;
and
CH 331, CH 332 or
CH 334, CH 335, CH 336

ENOLATE CHEMISTRY
Alkylation
Aldol condensation
Claisen condensation

RADICAL CHEMISTRY
Addition of hydrogen halides to alkenes
Radical polymerization

AMINES AND AMIDES
Nomenclature, structure and bonding, physical properties
Preparations and reactions

AMINO ACIDS
Classification, nomenclature
Acid-base properties of amino acids
Separation techniques
Electrophoresis and thin-layer chromatography

PROTEINS
Classification, structure
Peptide bonds; disulfide bonds
Peptide synthesis

LABORATORY TECHNIQUES
Melting point determination
Recrystallization
Extraction (solid-liquid; liquid-liquid)
Chromatography (column; TLC; GC)
Steam distillation
Preparation/handling of moisture-sensitive reagents
Spectroscopy (IR; NMR)

LABORATORY EXPERIMENTS

- *Melting point determinations*
  Techniques Melting point determination
- *Isolation/characterization of trimyristin from nutmeg*
  Techniques Solid-liquid extraction, simple distillation, melting point determination
- *Isolation/characterization of green-leaf pigments from spinach*
  Techniques Solid-liquid extraction, liquid-liquid extraction, column chromatography, TLC
- *Isolation/characterization of lactose*
  Chemistry Benedict's test
- *Isolation/characterization of essential oils from spices*
  Techniques Steam distillation, liquid-liquid extraction, IR, NMR
- *Synthesis of 1-butene, cis-2-butene and trans-2-butene via E1 dehydration of 2-butanol*
  Chemistry Dehydration alcohols
  Techniques GC
- *Synthesis of 1-butene, cis-2-butene and trans-2-butene via E2 dehydrohalogenation of 2-bromobutane*
  Chemistry Dehydrohalogenation of alkyl halides
  Techniques GC
- *Synthesis of salicylic acid via saponification*
  Chemistry Ester saponification
  Techniques Heating under reflux, recrystallization, melting point determination, IR, NMR
- *Synthesis of dibenzalacetone via an aldol condensation*
  Chemistry Aldol condensation
  Techniques Recrystallization, melting point determination, IR, NMR
- *Synthesis of benzoic acid via a Grignard reaction*
  Chemistry Grignard chemistry
  Techniques Prep/handling of moisture-sensitive reagents, liquid-liquid extraction, recrystallization, melting point determination, IR, NMR
- *Synthesis of 9,10-dihydroanthracene-9,10-α,β-succinic acid anhydride via a Diels-Alder reaction*
  Chemistry Diels-Alder reaction
  Techniques Vacuum filtration, recrystallization, IR, NMR
- *Asymmetric reduction of 1-phenyl-1,2-propanedione*
  Chemistry Asymmetric reduction
  Techniques TLC, liquid-liquid extraction, IR and NMR