**CHEM 234 Course Objectives**

**Lab 1 – Lab Safety**

1. review proper laboratory attire and demeanor
2. understand the importance and format of a properly written lab report
3. understand hazards associated with flammability
4. understand hazards associated with toxicity
5. understand hazards associated with highly corrosive materials
6. know proper disposal procedures for chemical waste
7. know proper disposal procedures for sharp objects (needles, broken glass)
8. discuss common causes of laboratory accidents and how to avoid them
9. learn proper behavior in case of an accident
10. discuss significance of personal health issues: anosmia, chemical allergies, hemophilia, color blindness

**Lab 2 – Sn2 Substitution s: Williamson’s Ether Synthesis**

1. define SN2 substitution reactions
2. apply this concept to a specific SN2 substitution, namely Williamson’s ether synthesis
3. use the curved arrow method to predict the outcome of a specific SN2 substitution, the preparation of 4-methylphenoxyacetic acid
4. implement a Williamson’s ether synthesis in the laboratory by preparing 4-methylphenoxyacetic acid
5. learn how to purify the acidic product obtained by using acid base partitioning
6. characterize the prepared 4-methylphenoxyacetic acid using IR spectroscopy and melting point

**Lab 3 – Carbocations, Friedel-Crafts Reactions**

1. discuss sources of carbocations in the laboratory
2. understand the mechanism of Friedel Crafts alkylations
3. know the scope and limitations of Friedel Crafts alkylations
4. develop a mechanism for a specific Friedel Crafts alkylation, namely the preparation of 1,4-di-t-butyl-3,5-dimethoxybenzene
5. develop a balanced reaction equation for a specific Friedel Crafts alkylation, namely the preparation of 1,4-di-t-butyl-3,5-dimethoxybenzene
6. carry out the preparation of 1,4-di-t-butyl-3,5-dimethoxybenzene in lab

**Lab 3 – Diels Alder Cycloaddition**

1. discuss the concept of cycloadditions, electron demand considerations and stereochemical outcomes
2. discuss scope and limitations of the Diels Alder cycloaddition
3. apply general concepts governing Diels Alder cycloadditions by predicting products for several model cases
4. formulate a mechanism and balanced reaction equation for the reaction of maleic anhydride with anthracene
5. implement the D.-A. reaction of maleic anhydride with anthracene in lab
6. characterize the resulting product with IR spectroscopy

**Lab 4 – Hydride Reduction**

1. define hydride donor and discuss applications of hydride donors in organic chemistry
2. apply general concepts governing the preparation of alcohols from ketones by hydride donor reduction to the specific case of the reduction of benzil to meso-hydrobenzoin
3. discuss the safe handling of hydride donors
4. derive a mechanism for the reduction of benzil to meso-hydrobenzoin and discuss the stereochemical outcome of this reaction
5. derive a balanced equation for the reduction of benzil to meso-hydrobenzoin
6. implement the reduction of benzil to meso-hydrobenzoin in the laboratory, learn how to apply hydride donors in practice
7. predict the products and stereochemical outcomes of similar reactions

**Lab 5 – Carbanions, Grignard reagents**

1. review the differences between carbanions and carbocations
2. review methods to prepare carbanions
3. discuss the preparation and significance of Grignard reagents
4. understand the chemical properties of Grignard reagents and identify classes of compounds they react with
5. discuss practical and safety aspects when preparing and handling organometallic reagents
6. prepare 1-butylmagensium bromide in lab
7. react 1-butylmagensium bromide with acetone, separate and purify the resulting alcohol
8. characterize the product using IR spectroscopy and compare the result to a reference spectrum

**Lab 6 – Fisher Esterification (a two week experiment)**

1. define nucleophilic acyl substitutions
2. discuss the Fisher esterification as a specific example of an acyl substitution
3. discuss the reversibility of Fisher esterifications
4. predict a mechanism for a specific Fisher esterification, the conversion of acetic acid and isoamyl alcohol to isoamyl acetate
5. discuss practical aspects of Fisher esterifications: catalysts, reaction rates as a function of temperature, methods to shift the equilibrium in the desired direction
6. prepare isoamyl acetate in lab
7. characterize isoamyl acetate by IR and interpret its IR spectrum
8. review the naming of esters and learn to distinguish esters from similar, “look-alike” functional groups

**Lab 7 – Nitration**

1. define electrophilic aromatic substitution, discuss the relative strengths of different electrophiles
2. discuss directing effects
3. investigate the nitronium cation
4. formulate a mechanism for the electrophilic nitration of methyl benzoate and predict what isomer will form in this reaction
5. derive a balanced reaction equation for the electrophilic nitration of methyl benzoate
6. highlight safety aspects associated with handling concentrated sulfuric and nitric acid
7. discuss practical aspects of nitration reactions, such as temperature control and isomer separation
8. carry out the electrophilic nitration of methyl benzoate
9. separate and characterize the nitration product

**Lab 8 – Mystery Reaction**

1. explore the structure and properties of the reactants used in this reaction
2. learn to manage a potential hazard, the formation of chloroacetone (“tear gas”) in a side reaction
3. carry out the mystery reaction with limited guidance to obtain an unknown product
4. characterize unknown product to determine the presence/absence of functional groups and its physical characteristics
5. develop a credible “short list” of structures, which may be a match for the unknown product
6. identify the unknown product based on its properties
7. propose a feasible mechanism and balanced equation to explain the formation of the proposed product

**Lab 9 – Unknowns Identification (a three week experiment)**

1. discuss the objective of identifying several unknown liquid and solid compounds
2. discuss the two strategies used to achieve such identifications: physical property determinations and chemical tests
3. implement testing of the physical properties (boiling points, melting points, IR spectra, solubilities in acidic and basic media) of the unknowns
4. make preliminary assignments of the range of compounds compatible with the measured physical properties, narrow down this short list as much as feasible
5. follow up with chemical tests for each unknown to determine the functional groups present
6. integrate the results from physical and chemical tests to make plausible structural assignments for all unknowns
7. formulate equations for all positive chemical tests and report the results