

Title: Advanced Organic Chemistry and Inorganic Chemistry

Instructor: Malay Patra

Lectures: 36 Lectures, one and half hour each

Evaluation: Attendance, 8 Assignments, 2 Surprise Quiz and 2 Written Exams

Days: Monday and Thursday, 9:30 AM

First lecture: October 12, 2020

Prescribed Text:

1. Advanced Organic Chemistry, Francis A. Carey and Richard J. Sundberg, Part B: Reactions and Synthesis
2. Organic Chemistry: Second Edition, Jonathan Clayden, Nick Greeves, Stuart Warren
3. Advanced Inorganic Chemistry, F. Albert Cotton, 6th Edition
4. The Organometallic Chemistry of the Transition Metals, Robert H. Crabtree, 5th Edition
5. Inorganic Chemistry, 5th edition, Shriver and Atkins

Course Overview

This course aims at providing a comprehensive insight into advanced organic and inorganic chemistry starting with a brief overview of basic concepts and then delving into details of reactions and principles. In the organic chemistry section emphasis will be on designing reaction schemes based on retrosynthetic analysis, the chemistry of protecting groups, asymmetric synthesis and catalysis, use of chiral auxiliaries, and bio-conjugation chemistry. Taking cue from asymmetric catalysis, topics in inorganic coordination chemistry and organometallic chemistry will be covered. One-third of the course material will be devoted to recent advances in the development of catalysts, supra-molecular chemistry, photochemistry, combinatorial chemistry, solid-phase synthesis, and biological applications. The detailed course syllabus is given below.

Course Syllabus**Section 1: Functional Group Interconversion**

- 1.1 Introduction to Functional group interconversion and Protection Groups
- 1.2 Conversion of Alcohols to alkylating agents
- 1.3 Introduction of Functional groups, substitution at Saturated Carbon
- 1.4 Interconversion of carboxylic acid derivatives
- 1.5 Installation and removal of protecting groups
- 1.6 Applications: solid phase peptide synthesis and bio-conjugation reactions

Section 2: Electrophilic additions and reductions on C-C multiple bonds

- 2.1 Electrophilic Addition to Alkene
- 2.2 Addition to Double bond via Organoborane Intermediates
- 2.3 Hydroalumination, carboalumination, hydrozirconation
- 2.4 Hydrogen addition reactions and catalytic hydrogenation
- 2.5 Epoxidations and ring opening
- 2.6 Reaction of Alkynes
- 2.7 Special topics: Using Si, Al, and B based reagents (e.g. DIBAL, L-selectride, K-selectride, RedAl etc.), Reduction using molecular hydrogen-Frustrated Lewis Pair, examples of functional group selective reduction.

Section 3: Reactive Intermediates and rearrangements

- 3.1 Carbonium ions, carbanions, and radicals: formation and rearrangement
- 3.2 Baldwin' rules for ring-closure
- 3.3 Rearrangement reactions

Section 4: Methodologies for the construction of 3-7 membered rings

- 4.1 Diels-Alder reactions

4.2 Metal catalyzed cyclopropanation reactions (including Simmons Smith reaction)

4.3 [2+2] and [2+2+2]-cycloaddition reactions

4.4 Nazarov cyclizations

4.5 Ring expansion and ring contraction reactions

4.6 Aza macrocycle synthesis

Section 5: d-block elements and Organometallic compounds

5.1 Coordination Complexes, d^n counting for Transition metals

5.2 Elimination and Addition Reactions

5.3 Examples of organometallic reagents

5.4 Coupling reactions: Kumada coupling, Suzuki-Miyaura coupling, Hiyama coupling, Sonogashira coupling, Negishi coupling, Stille coupling, Buchwald-Hartwig Coupling, Heck reaction, Click Reactions.

5.5 Oxidation reactions

Section 6: Asymmetric Synthesis

6.1 Sharpless epoxidation and dihydroxylation, Jacobsens epoxidation

6.2 Corey's oxazaborolidine catalyzed reduction

6.3 Noyori's BINAP reduction

6.4 SAMP, RAMP, Evans oxazoline.

Section 7: Principles of retrosynthetic analysis and Multistep synthesis

7.1 Linear and convergent synthesis

7.2 Synthesis under steric control, Regio- and stereoselective synthesis

7.3 Application of chiral auxiliaries

7.4 Case studies: Multistep synthesis of natural products and drugs

Section 8: Organic Spectroscopy

8.1 UV-Visible

8.2 IR

8.3 NMR

8.4 Application of spectroscopy in organic synthesis

Section 9: Special topics

9.1 Combinatorial approaches to synthesis

9.2 Light induced reactions

9.3 Chemistry behind detection kits of COVID 19

9.4 Imaging of Metals in biological system

9.5 Detection of diseases using fluorescent and radio-tracers

9.3 Bioinorganic medicinal chemistry