DCS Graduate Level Course

Organic and Inorganic Chemistry

Core Course

Course Instructors: Ankona Datta

Lectures: Thirty two lectures, one hour each

Evaluation: 10 Assignments, and 2 Written Exams

Prescribed Text:

1. Advanced Organic Chemistry, Francis A. Carey and Richard J. Sundberg, Part B: Reactions and Synthesis

2. Advanced Inorganic Chemistry, F. Albert Cotton, 6th Edition

3. The Organometallic Chemistry of the Transition Metals, Robert H. Crabtree, 5th Edition

4. 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, metal-organic frameworks, 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 including protecting group strategy

1.2 Conversion of Alcohols to different functional groups

1.3 Introduction of different Functional group in selective positions of un-activated carbon centers

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: Addition and reduction reactions of unsaturated homo- and hetero-nuclear bonds

2.1 Metathesis of homo- and hetero-nuclear sigma bond with different substituent's across unsaturated homo- and hetero-nuclear bonds.

2.2 Hydroalumination, carboalumination, hydrozirconation reactions

2.3 Hydrogen addition reactions and catalytic hydrogenations using transition metal catalyst.

2.4 Reductions using DIBAL-H, L-selectride, K-selectride, and Red-Al reagents including selective reduction.

Section 3: Reactive Intermediates

3.1 Carbonium ions, carbanions, and radicals: formation and rearrangement

3.2 Technique and strategy for isolation and trapping of reaction intermediates

3.3 Overview of some the reaction mechanism based on reaction intermediates

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

4.7 Baldwin’ rules for ring-closing reactions

4.8 Special topic: Coordination Complexes in Inorganic Chemistry

Section 5: Basics of Organometallic chemistry

5.1 d^n electron counting

5.2 Elimination and Addition Reactions involving transition metal complexes and their consequence on catalytic process

5.3 Syntheses and application of organometallic reagents

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

Section 6: Asymmetric Synthesis

6.1 Sharpless epoxidation and dihydroxylation, Jacobsen's 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

Section 8: Chemistry of Main group Elements (involving their usual oxidation states)

8.1 Group 13, 14, and 15 elements: Boranes, Siloxanes, cyclophosphazenes, cyclophosphazanes, poly silanes, and poly phosphazenes.

8.2 Group 16 elements: Sulfur and selenium

Section 9: Chemistry and Applications of f-block elements

9.1 Organo-lanthanide reagents

9.2 Applications in fluorescence imaging

Section 10: Special Topics

10.1 Homogeneous catalysis and catalysts: Alkene isomerization. Hydrogenation, Hydroformylation, Monsanto acetic acid process, Alkene polymerization, Cross coupling reactions, Metathesis, C-H activation and functionalization, Oxidation of olefins, Metal Clusters and catalysis.

10.2 Supramolecular constructs and metal-organic frameworks

10.3 Combinatorial approaches to synthesis

10.4 Light induced reactions

10.5 Synthesis in engineered micro-organisms