First Course Handout

CSO203: Inorganic Molecules, Materials & Medicines

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Lecture Days: MWTh: 9:00 to 9:50 (L03) Tutorial Day: F 9:00 to 9:50 (L03)

Course Contents:

Module I: Life with Oxygen

The aim of this module is to understand how our life depends on oxygen. We will start with the fundamentals related to dioxygen and the need for its activation. We will then talk about its usefulness in various biological activities and applications.

Module II: Metals and Medicine

Dmitri Ivanovich Mendeleev in 1869 delivered a remarkable contribution to arranging chemical elements in the Periodic table. This module starts with Nature's selection of elements from the Periodic Table. It will provide a brief overview of metals used in ancient times and today as therapeutic and diagnostic agents. Will discuss the Rosenbergs' accidental landmark discovery of cisplatin as a blockbuster anticancer drug. Lectures will also provide the mechanistic action of the drug and the current status.

Module III: Electron Transfer Process

Nobel Prize in Chemistry in 1983 was given to Henry Taube for his outstanding work on the mechanisms of electron transfer reactions, especially in metal complexes. We will discuss various electron transfer processes and how our lives are dependent on them!

Module IV: Catalysis and Sustainability

The module begins by exploring catalysis, a field recognized with numerous Nobel Prizes, emphasizing the critical role of catalysts and their design. It will cover the fundamentals of organometallic chemistry, showing how these principles inform the understanding and design of homogeneous catalytic processes. The course will examine the catalytic activity of key catalysts and their industrial applications, alongside recent advances in Green Chemistry, focusing on sustainable chemical synthesis and processes.

The discussion will then move to biocatalytic conversions, treating enzymes as large ligands with unique surfaces, and exploring the surface chemistry of supported catalysts. The course will also address polymer production, introducing polymer chemistry and properties, and examining synthetic routes and innovations for improved materials. Special attention will be given to enhancing sustainability in polymer synthesis, particularly through novel catalysts for free radical polymerization. Besides, we may also briefly study the circular economy and how it helps in the recycling or upcycling of polymers. The final section will integrate these topics through case studies, emphasizing the role of catalysts in designing sustainable chemical processes.

Module V: Electrochemistry and its applications

Electrochemistry is an important subject that discusses the fundamentals of the electrochemical charge transfer process of inorganic, organic, bioorganic, and many other materials. This module aims to discuss basic principles of redox process (oxidation/reduction), electron transfer kinetics, and mass-transport. Several models of charge transfer at electrode/electrolytes and the determination of electrochemical kinetic parameters will be the key topic of discussion. The practical use of electrochemistry towards energy storage devices, and biosensors will be discussed.

Module VI: Supramolecular Chemistry

Supramolecular chemistry, popularly known as "chemistry beyond the molecule", discusses various non-covalent interactions. The Nobel Prize in Chemistry was awarded jointly to Donald J. Cram, Jean-Marie Lehn, and Charles J. Pedersen in 1987, for their study of molecular recognition and high-order assemblies formed by noncovalent interactions. This module will discuss fundamentals of Supramolecular chemistry, including host–guest interactions and self-assembling process, and various applications. Further, this aspect will be extended to understand molecular machines, and rotors.

Module VII: Graphene and carbon nanotubes

Graphene is a two-dimensional (2D) carbon allotrope. In 2004, the graphene was isolated and characterized by Andre Geim and Konstantin Novoselov using a piece of graphite and adhesive tape. For this discovery, Geim and Novoselov were awarded the Nobel Prize in Physics in 2010. This module will highlight the structure of graphene, electrical property, mechanical property, and different applications.

Sumio Iijima, a Japanese physicist who invented the carbon nanotubes. Carbon nanotube (CNT) is made of carbon with a diameter in the nanometre range and is often cited for his discovery of carbon nanotubes. They are one of the allotropes of carbon. This section will focus on the broad classes of carbon nanotubes (i) single-walled carbon nanotubes, (ii) and multi-walled carbon nanotubes and their various applications in chemistry, materials science, and drug-delivery.

Reference Books:

[1] Inorganic Chemistry-Principles of Structure and Reactivity, 4th Edn., J. E. Huheey, E. A. Keiter and R. L. Keiter, Harper-Collins, NY, 1993

[2] Advanced Inorganic Chemistry, 6th Edn., F. A. Cotton, G. Wilkinson, C. A. Murillo and M. Bochmann, Wiley, 1999

[3] Concepts and Models of Inorganic Chemistry, 3rd Edn., B. Douglas, D. McDaniel and J. Alexander, John Wiley, New York. 1993

[4] Chemistry of the Elements, 2nd Edn., N. N. Greenwood and A. Earnshaw, Pergamon, Oxford, 2005

[5] Shriver and Atkins Inorganic Chemistry, 5th Edn., Oxford University Press, 2009.

[6] Bioinorganic Chemistry, I. Bertini, H. B. Gray, S. J. Lippard & J. S. Valentine, Viva Books Pvt. Ltd., 2004.

[7] Organotransition Metal Chemistry: From Bonding to Catalysis, 1st Edn., J. Hartwig, 2010

[8] P. T. Anastas and T. C. Williamson (1998). *Green chemistry – frontiers in benign chemical synthesis and processes*. Oxford University Press.

[9] Electrochemical Methods: Fundamentals and Applications; by Allen J. Bard, and Larry R. Faulkner, 2001, 2nd Edition, Wiley.

[10] Supramolecular Chemistry, J-M. Lehn, VCH, Weinheim, 1995

[11] Iijima, Sumio; "Helical microtubules of graphitic carbon", Nature, 1991, 354 (6348): 56–58

Grading Scheme:

Letter Grades: Letter grades will be awarded based on the total out of 100 percent.

Exam schedule*	**Marks**
Quiz 1 (**2nd Sept, L 7, 18:15 to 18:45**)	20
Mid-Sem (**as per the DoAA scheduled**)	50
Quiz 2 (**6th Nov, L 7, 18:15 to 18:45**)	20
End-Sem (**as per the DoAA scheduled**)	50
Attendance	10
Total marks:	**150**

Course Guidelines

1. **Attendance Policy:**
    - Minimum 75% attendance (lectures) required to sit for Mid- and End-semester exams.
2. **Examinations:**
    - The DOAA will announce Mid- and End-semester schedules.
    - No makeup exams for the Quiz and Mid-Semester exams.
    - End-semester makeup exams are only for valid medical cases approved by SUGC/SPGC/DOAA.
3. **Classroom Rules:**
    - No electronic gadgets during lectures/tutorials.
    - If carrying a mobile, keep it switched off or on silent mode.
    - Laptops are not permitted during class time.

Working Saturdays (as per the DoAA academic calendar)* Please note that **August 9**, and **November 1**, 2025, **Monday** schedule will follow. **August 23**, and **November 8**, 2025, **Friday** schedule will follow.