Birla Institute of Technology & Science, Pilani
Hyderabad Campus

FIRST SEMESTER 2022-2023
Course Handout Part II

Date: 29-08-2022

In addition to part I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

Course No. : CHEM F337
Course Title : Green Chemistry and Catalysis
Instructor-in-charge : Prof. R. Krishnan

1. Course Description

Realizing the problems in the conventional chemical designs, production and disposal practices. Exploring the possibility through the suggested twelve green chemistry principles for alternative chemical processes for a safer and sustainable central science. Selected topics to be covered include the alternative starting materials, alternative synthesis and reagents, E-factor and the concept of atom economy, the role of catalysis, alternate energy sources (microwave & ultrasound), catalysis by solid acids and bases, bio-catalysis, catalytic reduction, catalytic oxidation, catalytic C–C bond formation, cascade catalysis, enantioselective catalysis, alternative reaction media, renewable raw materials, industrial applications of catalysis.

2. Scope and objective of the course

The objectives of this course are to provide the students with a fundamental understanding of Green Chemistry with an emphasis on the design, prepare and use of chemicals and protocols that have little or no pollution potential or environmental risk. The students will also be exposed to the development of latest technologies and methodologies for environmentally benign methods which are being practiced in industry.

- Know and realize the good and bad sides of the use and inappropriate use of chemicals in our daily life.
- Discover alternative methods for the targeted compound with less harmful effect on human and environment.
- Learn a set of suggested principles to tackle the problem in conventional way of designing and developing compounds.
- Appreciate the important roles of chemists in sustainable development for a better world.
- Exploring the Green Chemistry principles in daily life style.

3. Text Book

T1: Green Chemistry and Catalysis, Roger Arthur Sheldon, Isabel Arends, and Ulf Hanefeld, Wiley, 2007.

4. Reference Books

R1: Green Chemistry: Theory and Practice, Paul T. Anastas and John C. Warner, Oxford, 2000.
R2: New trends in Green Chemistry, V. K. Ahluwalia, M. Kidwai, New Age Publications, 2004.
R3: Green Organic Chemistry in Lecture and Laboratory, Ed., A. P. Dicks, CRC Press, 2012.

5. Course Plan:

Lec. No.	Topics to be covered	Learning Objectives	Learning outcome	Chapter in the Text Book
1-4	Introduction and Tools of Green	Definition and overview of the twelve principles of Green Chemistry, E factor and the concept of atom economy, Alternative feedstocks/starting	Importance of green chemical methods.	T1 1.1-1.3 Lecture

	Chemistry	materials, reagents, solvents, product/target molecule and catalysts.		notes
5-9	Solid acids and bases as catalyst and Biocatalysis	Acidic clays, Zeolites and Zeotypes, Solid Acids Containing Surface SO_3H Functionality, Heteropoly Acids, Anionic Clays: Hydrotalcites, Basic Zeolites, Organic Bases Attached to Mesoporous Silica, Catalysis by enzymes and microorganisms.	Advantages of catalytic methods.	T1 2.1-2.4
10-13	Catalytic reduction	Heterogeneous Reduction Catalysts: General Properties, Transfer Hydrogenation Using Homogeneous and Heterogeneous Catalysts, Chiral Homogeneous and Heterogeneous Reduction Catalysts, Biocatalytic Reductions, Enzyme and Whole Cell Technology for Biocatalytic Reduction.	Better methods for reduction reactions.	T1 3.1-3.5
14-17	Catalytic oxidation	Mechanisms of Metal-catalyzed Oxidations: General Considerations, Homolytic and Heterolytic Mechanisms, Direct Homolytic Oxidation of Organic Substrates, Catalytic Oxygen Transfer, Ligand Design in Oxidation Catalysis, Enzyme Catalyzed Oxidations.	Greener alternative methods for oxidation reactions.	T1 4.1-4.5
18-21	Catalytic C–C bond formation	Enzymes for Carbon–Carbon Bond Formation, Transition Metal Catalysis, organocatalysis.	Benign C-C bond formation.	T1 5.1-5.4
22-25	Catalysis in Novel Reaction Media	Choice of Solvent, Alternative Reaction Media and Multiphasic Systems, Two Immiscible Organic Solvents Aqueous Biphasic Catalysis, Fluorous Biphasic Catalysis, Supercritical fluids, Ionic liquids.	Alternative reaction mediums.	T1 7.1-7.9
26-29	Chemicals from Renewable Raw Materials	Carbohydrates, Chemical and Chemoenzymatic Transformations of Carbohydrates into Fine Chemicals and Chiral Building Blocks, Fats and Oils, Terpenes, Renewable Raw Materials as Catalysts, Green Polymers from Renewable Raw Materials.	Cheaper and sustainable raw materials.	T1 8.1-8.8
30-33	Cascade and Enantio-selective Catalysis	Dynamic Kinetic Resolutions by Enzymes Coupled with Metal Catalysts, Combination of Asymmetric Hydrogenation with Enzymatic Hydrolysis, Catalyst Recovery and Recycling, Immobilization of Enzymes: Cross-linked Enzyme Aggregates, enantioselective catalysis.	Greener enantioselective methods.	T1 9.1-9.6
34-37	Alternate Energy Sources	Applications of microwave & ultrasound energies in green synthesis.	Greener energies for synthesis.	Lecture notes
38-39	Green methods in Industry	Polysaccharide polymers, chemical from glucose, halide free synthesis of aromatic amines, alternative to Strecker synthesis, non-phosgene isocyanate synthesis.	Safer and greener alternatives.	Lecture notes

Evaluation Scheme: (**Total 200 Marks)**

Components	Duration	Marks (Weightage)	Date & Time	Nature of Component
Midsem Test	1.5 h	60 (30%)	04/11(3.30 - 5.00PM)	Closed Book
Assignments, Experiments, Presentation & Class tests	--	70 (35%)	Continuous	Open Book
Compre. Exam	3 h	70 (35%)	28/12 (AN)	Closed Book

Chamber Consultation Hours: To be announced through a notice.
Notices: Notices concerning the course will be displayed on the CMS.
Make-up policy: Make up would be considered only for very genuine reasons *such as institute deputation outside for sports/cultural fest, hospitalization (with appropriate documentary proof), marriage ceremony of own brother/sister*. There will not be any makeup possible for the surprise test class components.

Academic Honesty and Integrity Policy: Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

Instructor in charge
CHEM F337