ST.JOSEPH'S COLLEGE FOR WOMEN (AUTONOMOUS), VISAKHAPATNAM

VII SEMESTER B.Sc. HONOURS CHEMISTRY Time: 4Hrs/Week

Code CH7204(3) Revised Syllabus Under CBCS 2020-21 Marks: 100

Green Chemistry

I.

Course Objective: To introduce students to the principles of Green synthesis and Green Analysis

Course Outcomes:

By the end of the course Students will be able to:

- Understand the twelve principles of green chemistry and will build the basic understanding of toxicity, hazard and risk of chemical substances·
- Understand stoichiometric calculations and relate them to green chemistry metrics.
- They will learn about atom economy and how it is different from percentage yield.
- Learn to design safer chemical, products and processes that are less toxic, than current alternatives. Hence, they will understand the meaning of inherently safer design for accident prevention and the principle "what you don't have can't harm you"
- Understand benefits of use of catalyst and bio catalyst, use of renewable feed stock which helps in energy efficiency and protection of the environment, renewable energy sources, and importance led reactions in various green solvents.
- Appreciate the use of green chemistry in problem solving skills, critical thinking and valuable skills to innovate and find out solution to environmental problems. Thus the students are able to realize that chemistry can be used to solve rather than cause environmental problems.
- Green chemistry is a way to boost profits, increase productivity and ensure sustainability with absolute zero waste. Success stories and real-world cases also motivate them to practice green chemistry.

II. Syllabus:

Unit I: Introduction to Green Chemistry 12 hours

What is Green Chemistry? Some important environmental laws, pollution prevention Act of 1990, emergence of green chemistry, Need for Green Chemistry. Goals of Green Chemistry. Limitations / Obstacles in the pursuit of the goals of Green Chemistry.

Unit II: Principles of Green Chemistry and Designing a Chemical synthesis 14 hours

Twelve principles of Green Chemistry and their explanation with examples Special emphasis on the following:

• Prevention of Waste/ by products; maximum incorporation of the materials used in the process into the final products, Environmental impact factor, waste or pollution prevention hierarchy• Green metrics to assess greenness of a reaction, e.g. Atom Economy, calculation of atom economy of the rearrangement, addition, substitution and elimination reactions.

• Prevention/ minimization of hazardous/ toxic products reducing toxicity

• Risk = (function) hazard x exposure

• Designing safer chemicals with minimum toxicity yet has the ability to perform the desired functions

• Green solvents: super critical fluids with special reference to carbon dioxide, water as a solvent For organic reactions, ionic liquids, fluorous biphasic solvent, PEG, solventless processes,solvents obtained from renewable resources and how to compare greenness of solvents

• Energy requirements for reactions – alternative sources of energy: use of microwaves, ultra sonic energy and photochemical energy

• Selection of starting materials; should be renewable rather than depleting, Illustrate with few examples such as biodiesel and polymers from renewable resources (such as green plastic)

• Avoidance of unnecessary derivatization – careful use of blocking/protecting groups

• Use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; catalysis and green chemistry, comparison of heterogeneous and homogeneous catalysis, bio catalysis, a symmetric catalysis and photocatalysis.

Unit III: Examples of Green Synthesis/ Reactions 12 hours

• Green Synthesis of the following compounds: adipic acid, catechol, disodium imino diacetate (alternative to Strecker synthesis).

• Green Reagents: Non-phosgene Isocyanate Synthesis, Selective Methylation using di methyl carbonate.

• Microwave assisted solvent free synthesis of copper phthalocyanine

• Microwave assisted reactions in water: Hofmann Elimination, methyl benzoate to benzoic acid And Decarboxylation reaction

• Ultrasound assisted reactions: sono chemical Simmons-Smith Reaction (Ultrasonic alternativeto Iodine)

Unit IV: **12 hours**

Real world case studies based on the Presidential green chemistry awards of EPA

• Surfactants for Carbon Dioxide – replacing smog producing and ozone depleting solvents with CO2 for precision cleaning and dry cleaning of garments.

• A new generation of environmentally advanced wood preservatives: Getting the chromium and Arsenic out of pressure treated wood.

• An efficient, green synthesis of a compostable and widely applicable plastic (polylactic acid)made from corn.

• Healthier Fats and oils by Green Chemistry: Enzymatic Inter esterification for production of No Trans-Fats and Oils.

• Development of Fully Recyclable Carpet: Cradle to Cradle Carpeting.

• Using a naturally occurring protein to stimulate plant growth, improve crop quality, increase yields, and suppress disease.

Unit V: Future Trends in Green Chemistry **10 hours**

Oxidation reagents and catalysts; Bio mimicry and green chemistry, Biomimetic, Multifunctional Reagents; mechanochemical and solvent free synthesis of inorganic complexes; co crystal controlled solid state synthesis(C2S3); Green chemistry in sustainable development.

III. Suggested Co-Curricular Activities

1) Training of students by related industrial experts.
2) Assignments, Seminars and Quiz (on related topics), collection of relevant videos and material.
3) Visits of abilities, firms, research organizations etc.
4) Invited lectures and presentations on related topics by field/industrial experts.

IV. Suggested Text Books:

1) Anastas, P.T.; Warner, J.C.(1998),**Green Chemistry, Theory and Practice,** Oxford University Press.
2) Cann , M. C. ; Connely, M. E.(2000), **Real-World cases in Green Chemistry,** AmericanChemical Society, Washington.
3) Matlack, A.S.(2001),**Introduction to Green Chemistry,** Marcel Dekker.

4) Alhuwalia,V. K.; Kidwai, M.R.(2005),**New Trends in Green chemistry**, Anamalaya Publishers

V. References:

1. Kirchoff, M.; Ryan, M.A. (2002), **Greener approaches to undergraduate chemistry experiment.** American Chemical Society, Washington DC.
2. Sharma, R.K.; Sidhwani, I.T.; Chaudhari, M.K.(2013), **Green Chemistry Experiments: A monograph,** I.K. International Publishing House Pvt Ltd. New Delhi.
3. Pavia, D.L.; Lamponam, G.H.; Kriz, G.S.W. B.(2006),**Introduction to organic Laboratory Technique-A Micro-scale approach**,4th Edition, Brooks-Cole Laboratory Series for Organic chemistry.