5th SEMESTER
DISCIPLINE SPECIFIC ELECTIVES (DSEs)
OPTION-I
ICH516DA: INDUSTRIAL CHEMISTRY – GREEN CHEMISTRY

CREDITS: THEORY: 4, PRACTICAL: 2

Unit-I: Green Chemistry-Theory **(15 hours)**

Introduction: Need for Green Chemistry and the role of chemists.Tools of Green Chemistry:- Selection of starting materials, Catalysts, Alternative Solvents, Appropriate reagents, Percentage atom utilization. Microwaves and Sonication. Twelve principles of Green Chemistry with their explanations and examples.

Unit-II: Designing a chemical synthesis **(15 hours)**

Designing a green synthesis using these principles; Prevention of Waste/ byproducts; maximum incorporation of the materials used in the process into the final products (Atom Economy); prevention/ minimization of hazardous/ toxic products; designing safer chemicals – different basic approaches to do so; selection of appropriate auxiliary substances (solvents, separation agents), green solvents, solvent less processes, immobilized solvents and ionic liquids; energy requirements for reactions - use of microwaves, ultrasonic energy

Unit-III: Green Chemistry-Practice **(15 hours)**

Microwave assisted reactions in water: Hofmann Elimination, Hydrolysis (of benzyl chloride, benzamide, n-phenyl benzamide, methylbenzoate to benzole acid), Oxidation (of toluene, alcohols).

Microwave assisted reactions in organic solvents: Esterification, Fries rearrangement, Orthoester Claisen Rearrangement, Diels-Alder Reaction, Decarboxylation.

Alkylations, oxidation, reduction, coupling reaction, Cannizaro reaction, Strecker synthesis, Reformatsky reaction.

Unit IV Trends in Green Chemistry **(15 hours)**

Microwave assisted solid state reactions: Deacetylation, Deprotection. Saponification of esters.

Ultrasound assisted reactions: Esterification, saponification, substitution reactions,

Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; oncovalent derivatization; Green chemistry in sustainable development

Books recommended

1. Green Chemistry- Environment Friendly Alternatives; Rashmi Sanghi & M. M Srivastava; Narosa; 2007.
2. Green Chemistry- An Introductory Text; IInd Edn.; Mike Lancaster; RSC; 2010.
3. Green Chemistry- Theory and Practice; P. T. Anastas and J. C. Warner; oxford; 2000.
4. Green Cheistry-Environmentally Benign Reactions. V. K .Ahluwalia. Ane books Pvt. Limited.
5. Green Chemistry. Mohit Books International. New Delhi-110002.

B.Sc. Vth-Semester –Industrial Chemistry

Title: Laboratory course in Green Chemistry

Course No: DSE – 6E (Lab)
Course Weightage: 02 Credits

1. Microwave assisted Oxidation of alcohol using aqueous H_2O_2.
2. Microwave assisted Aspirin synthesis using natural acidic catalyst.
3. Synthesis of bio-diesel from vegetable oils.
4. One pot synthesis of chalcone epoxide via Claisen Schmidt condensation and Epoxidation.
5. A green precipitation reaction.
6. Cocrystal controlled Solid-state synthesis.
7. Determination of mercury in milk by Cold Vapour Atomic Fluorescence.
8. Nitration of phenol using $Cu(NO_3)_2$.
9. Solventless and One-pot synthesis of Cu(II) phthalocyanine complex.
10. Separation of organic dyes by TLC using green solvents.
11. Separation of Metal ions by TLC using green solvents.
12. Separation of food dyes using green solvents by TLC.
13. Separation of Amino acids by TLC using green solvents.
14. Separation and identification of Sugars by TLC using green solvents.
15. Identification of surfactants in commercial products using green solvents.

Books Recommended:

1. Green Chemistry Laboratory Manual for General Chemistry. Sally A. Henry; CRC Press, 2015.
2. Green Chemistry. 2nd Ed. Edited by V. K. Ahluwalia; CRC Press 2012.
3. Experiments in Green and Sustainable Chemistry.H. W. RoeskyD.Kennepohl (Editors); Wiley 2009.

5th SEMESTER
DISCIPLINE SPECIFIC ELECTIVES (DSEs)
OPTION-II

ICH516DB: INDUSTRIAL CHEMISTRY - INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS

CREDITS: THEORY: 4, PRACTICAL: 2

Unit I Introduction to spectroscopic methods of analysis (12 Contact hours)

(i) Properties of Electromagnetic radiations:

The Electromagnetic spectrum. General nature of electromagnetic waves; wave parameters, radiant power (Intensity), superposition of waves, diffraction, transmission, dispersion, refraction, reflection, scattering and polarization of radiation. Absorption, emission, fluorescence and phosphorescence.

(ii) Instruments for optical spectroscopy:

Components of optical instruments: radiation sources; continuous sources, line sources, lasers. Wavelength selectors, sample holders. Radiation detectors; photon detectors; vacuum phototubes, photomultiplier tubes, photoconductivity detectors, silicon diode detectors. Signal processors and read outs.

Unit II Molecular Spectroscopy 15L

(i) UV-Visible –Near IR spectroscopy:

UV-Visible- Near IR regions of EMS. Transmittance, absorbance, Beer-Lambert law, limitations to the applicability of the Beer's law, molecular electronic excitations (π-π^*, n-π^*, d-d transitions, charge transfer transitions, intra-ligand transitions). Fluorescence, phosphorescence.

Instrumentation: Light sources, wavelength dispersion (gratings, prisms, interference filters, lasers). Sample holders, detection of signals (photocells, photo multipliers, diode arrays). Sensitivity and S/N ratio. Single and double beam instruments.

(ii) Infrared spectroscopy:

Theoretical principles, vibrational modes and IR absorption process, selection rules. Vibrational IR region (4000-400cm^{-1}); group frequency region, the fingerprint region, metal-ligand absorption region, IR peak positions of some common functional groups of organic molecules-IR correlation tables.

Instrumentation: Light sources, infrared detectors, sample preparation techniques; liquids, solids. Dispersive IR spectrometer. Fourier transfer spectrometer(FTIR), construction and advantages.

Unit III Atomic spectroscopy 15L

Sample atomization; continuous atomizers, discrete atomizers. Sources of atomic spectra; atomic absorption spectra, atomic emission spectra, atomic fluorescence spectra. Flame atomization (fuel and oxidants), Electrothermal atomization.

Atomic absorption spectroscopy; radiation sources-hollow cathode lamps, instruments-single beam spectrophotometer, double beam spectrophotometer. ***Flame emission spectroscopy***; instrumentation, spectrophotometer, photometer.

Unit IV Chromatographic techniques 15L

(i) Introduction to chromatography:

Basic Concept of chromatography; mobile phase and stationary phase. Classification of chromatographic methods, chromatogram, partition coefficients, retention times, retention volumes, the capacity factor, the selectivity factor, theoretical plates and efficiency, Van Deemter equation, column resolution.

(ii) Gas chromatography:

Principle of Gas Chromatography. *Instrumentation*; carrier gas, sample injection systems, column configuration and column ovens. Detectors; flame ionization detectors, thermal conduction detectors, electron capture detectors etc. Columns; packed columns, solid support

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materials, particle size; open tubular columns. The stationary phase materials.

(iii) Liquid chromatography:

HPLC, column efficiency in liquid chromatography. *Instruments for liquid chromatography*; mobile gas reservoirs, solvent treatment system, pumping systems, liquid chromatographic columns, detectors.

Books Recommended

1. Principles of Instrumental Analysis - 6th Edition by Douglas A. Skoog, F. James Holler, and Stanley Crouch (ISBN 0-495-01201-7)
2. 2 Instrumental Methods of Analysis, 7th ed, Willard, Merritt, Dean, Settle.
3. P.W. Atkins: Physical Chemistry.
4. G.W. Castellan: Physical Chemistry.
5. C.N. Banwell: Fundamentals of Molecular Spectroscopy.
6. Brian Smith: Infrared Spectral Interpretations: A Systematic Approach.
7. W.J. Moore: Physical Chemistry.

B.Sc. V Semester- Industrial Chemistry

Title: Laboratory Course in Instrumental Methods of Chemical Analysis

Course No: DSE – 6E (Lab)

Course Weightage: 02 Credits

Note: *The suggested experiments cannot be conducted in our colleges because of lack of instrumental facilities. However, I may suggest the following few experiments.*

1. Determination of concentration of an acidic solution by pH metric titrations.
2. Determination of the isoelectric pH of a protein.
3. Potentiometric titration of a Chloride-Iodide Mixture.
4. The standardization of an Fe(II) solution with a standard dichromate solution over Pt and Calomel assembly.
5. Determination of concentration of Ce (IV) sulfate solution with a standard Fe(II) Solution over Pt and calomel assembly.
6. Determination of λ_{max} of Potassium permanganate ($KMnO_4$)solution.
7. Determination of Fe(II) in a sample of well water with thiocyanate as complexation agent, spectrophotometrically.
8. Determination of Aluminum in a given sample solution, spectrophotometrically.
9. Determination of concentration of sodium in an aquous solution by using a flame photometer.
10. Separation of permanganate and dichromate ions from a binary mixture on an alumina column.

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2. Instrumental Methods of Analysis, 7th ed, Willard, Merritt, Dean, Settle.