Minor Programme for All Branches

Theme: Chemistry for Engineering Application

Course Code: CYOM1304/ CYOM1404/ CYOM1504/ CYOM1604	Spectroscopic Methods of Analysis and Chromatographic Techniques	Credits:04 (L:T:P:3:1:0)

Prerequisites: -

Course Outcome

COs	Outcomes
CO1	Familiarising the students with the basic concepts of spectroscopy.
CO2	Enabling the students to learn about the principles, instrumentation and applications of vibrational (infrared and Raman) spectroscopy.
CO3	Enabling the students to learn about the principles, instrumentation and applications of UV-visible spectroscopy.
CO4	Enabling the students to learn about the principles, instrumentation and applications of ^{1}H NMR spectroscopy.
CO5	Enabling the students to learn about the principles, instrumentation and applications of mass spectrometry.
CO6	Enabling the students to learn about the principles, instrumentation, types and applications of chromatographic techniques.

Module	Content	Lectures
1.	**Introduction to Spectroscopy:** Electromagnetic radiation, atomic and molecular energy levels, absorption and emission of electromagnetic radiation, interaction of electromagnetic radiation with molecules, complexity of spectra and the characteristics of spectral lines (intensity, width), signal to noise ratio, resolution.	5
2.	**Vibrational Spectroscopy:** a) Infrared Spectroscopy Molecular vibrations; factors influencing vibrational frequencies: vibrational coupling, hydrogen bonding, electronic effects, bond angles; instrumentation: Fourier transform infrared spectroscopy (FTIR), absorbance and transmittance scales; applications of infrared spectroscopy: identification of functional groups. b) Raman Spectroscopy Raman effect and origin of Raman spectroscopy, types of Raman spectra, applications of Raman spectroscopy, difference between Raman and IR spectra	10

3.	**UV-Visible Spectroscopy:** Color and light absorption: chromophore concept; theory of electronic spectroscopy: orbitals involved in electronic transitions; Beer's and Lambert's law; instrumentation; sampling: sample and reference cells, solvents and solutions, solvent effects on electronic transitions.	5
4.	**^{1}H NMR Spectroscopy:** NMR phenomenon: spinning nucleus and effect of external magnetic field, precessional motion and precessional frequency, energy transitions, theory of nuclear magnetic resonance; chemical shift: measurement, internal standards, units; factors influencing chemical shifts: electronegativity, anisotropic effects; choice of solvents in ^{1}H NMR: solvent shifts - concentration and temperature effects, hydrogen bonding; integrals in ^{1}H NMR; spin-spin coupling: theory, magnitude of coupling constant J, spin-spin splitting systems, chemical and magnetic equivalence in NMR	7
5.	**Mass Spectrometry:** Basic principles; isotope abundances: structure and recognition of molecular ion peak, molecular formula from molecular ion; fragmentation processes: basic fragmentation types and rules, factors influencing fragmentations.	3
6.	**Chromatographic Techniques:** Basic principles and instrumentation; types-gas chromatography GC, liquid chromatography LC in columns (high pressure liquid chromatography HPLC) and on plane surfaces (paper and thin layer chromatography TLC), ion-exchange chromatography; applications of chromatographic techniques (GC, TLC, HPLC, ion-exchange chromatography).	10

Books

1. Organic Spectroscopy. William Kemp, 3rd edition.
2. Spectroscopic Identification of Organic Compounds. Silverstein, Bassler and Morril.
3. Introduction to Spectroscopy. Pavia, Lampman, Kriz.
4. A Handbook of Chromatography. Nikalje, Anna Pratima; Bhosale, Dileep (2017).
5. Chromatography: Principles and Instrumentation. Mark F. Vitha (2016).
6. Chromatography: Concepts & Contrasts. James M. Miller, 2nd edition, Wiley.
7. Principles and practice of Chromatography. Raymond P. W. Scott.
8. Chromatographic Methods. A. Braithwaite and J. F. Smith