Bachelors with Chemistry as Major
8th Semester
Title of the course: Instrumental Methods in Chemistry

Course Code: CHM822J3**Credits:** Theory-4, Tutorials-2

Theory (4 credits: 60 Hours) **Max. Marks**: 100, **Min Marks:** 36

Course Objectives:

- To introduce students to some common instrumental methods used in analytical investigations in chemistry.
- To introduce the basic concepts of chromatography and various chromatographic methods used in chemistry laboratories.
- To introduce some basic construction and working of diffractometer.
- To introduce the basic concepts of various Thermal methods and microscopic techniques with their use in chemical investigations.

Learning outcomes:

- Students shall learn the basic concepts of chromatography and various chromatographic techniques.
- Students shall learn how chromatography can be used for analytical investigations
- Students will learn the basic concepts ofatomic/absorption spectroscopy and X-ray diffraction methods and their use for chemical analysis.
- Students shall learn about different microscopic and thermal techniques to appreciate the power of these techniques for materialcharacterization.

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Unit 1.Chromatographic Methods (15 hours)

Basic principles of chromatography, types of chromatography.

Gas-Liquid chromatography: Principle, columns and stationary phase, resolution and instrumentation.

HPLC: Theory, column efficiency, extra column and band broadening, temperature effects and diffusion. Chiral chromatography, chiral stationary phases. Applications of HPLC.

Ion exchange and size exclusion chromatography: Principle, mechanism of separation and applications. Elementary concepts of ion exchange chromatography, size exclusion chromatography, affinity chromatography, chiral chromatography, super-critical fluid chromatography, planer chromatography.

Unit II. Atomic and Molecular Absorption spectroscopy (15 hours)

Basic principles of atomic spectroscopy, origin of atomic spectroscopy, production of atoms and ions, atomic emission/absorption spectrometry, atomic fluorescence spectrometry, atomic mass spectrometry. Molecular absorption spectrometry, UV/Visible molecular absorption spectroscopy, IR -absorption spectroscopy, Molecular fluorescence spectroscopy, theory of molecular fluorescence, instrumentation, application of fluorescence methods. Instrumentation - single beam and double beam spectrophotometer; fluorimeter – construction, principle and working.

Unit III.X-Ray Diffraction methods **(15 hours)**

Generation of X-rays, X-ray diffraction (XRD), Laue method, Rotating crystal method and Powder method, Applications: determination of grain size/crystallite size using X-ray line broadening studies (Scherrer's formula), Determination of crystallite size distribution using X-ray line shape analysis, X-ray diffractometer (construction and working).

Unit IV. Thermaland MicroscopicMethods **(15 hours)**

Thermal methods: TGA, DTA and DSC – Principles and applications.
Electron Microscopic Techniques: Principles of electron microscopy, Scanning Electron Microscopy (SEM), Strengths and limitations of electron microscopy, Transmission Electron Microscopy (TEM),and Atomic Force Microscopy (AFM). General construction of the electron microscope.

Suggested Readings/ Text/References

1. Fundamental of light microscopy and electronic imaging, D.B. Murphy, Wiley-Liss, 2001.
2. Microstructural Characterization of Materials – D. Brandon and W.D. Kaplan, John Wiley and Sons. 3. Scanning Electron Microscopy & X-Ray Microanalysis, J. Goldstein et.al, Springer, 2003.
3. Materials Characterisation Techniques, S. Zhang, Lin Li and Ashok Kumar, CRC Press, 2009.
4. X-ray Structure Determination- A Practical Guide by G. H. Stout and H. L. Jensen, MacMillan.
5. Contemporary Crystallography, M. J. Buerger, McGraw-Hill, N.Y. 1970.
6. Crystal Structure Analysis- A Primer J. P. Glusker and K. N. Trueblood, OUP, N.Y. 1985.
7. Instrumental methods of analysis Willard, Merrit and Dean.
8. Instrumental approach to chemical analysis: A. K. Srivastava and P. C. Jain: S. Chand
9. Fundamentals of Analytical Chemistry by Skoog, West, Holler and Crouch.

Tutorials (2 credits: 60 Hours) Max. Marks: 50, Min Marks: 18

1. Use given GC/MS data to identify drug metabolite in blood.
2. Utilize given IR, AAS, and fluorescence data to identify the organic functionalities and probes.
3. Use the given X-ray data to identify the crystallographic system.
4. Data interpretation of TEM micrograph.