Name of the Programme: M. Sc -I (Analytical Chemistry)

Course Code: CHA-504 **Title of the course:** Instrumental Methods of Analysis

Number of Credits: 04

Effective from AY: 2022-23

Prerequisites for the course:	Students should have studied analytical chemistry courses at M.Sc. Chemistry in semester I	
Course Objective:	1. Introduction of various instrumental methods for analysis. 2. Understanding the utility of various instrumental methods as a qualitative and quantitative analytical tool.	
Content:	**1. Diffraction Techniques: X-ray and Neutron Diffraction** a. Introduction to X-rays; interaction of X-rays with matter; X-ray diffraction by crystals, Bragg's law. b. Powder X-ray diffraction: instrumentation and applications. Interpretation of powder X-ray diffraction pattern. calculation of lattice parameters. c. Powder diffraction file and other crystallography databases. d. Powder Neutron diffraction: theory, instrumentation and applications.	No of hours 15
	2. X-ray Spectroscopic Techniques: a. X-ray spectroscopy, theory of X-ray absorption and emission. b. X-ray fluorescence (XRF) spectroscopy: introduction, instrumentation, wavelength dispersive and energy dispersive XRF, applications. c. Energy dispersive X-ray (EDX) spectroscopy and Electron probe microanalysis (EPMA): introduction, instrumentation and their applications. d. Introduction to X-ray absorption near edge structure (XANES), Extended X-ray absorption fine structure (EXAFS) and their applications.	15
	3. Electron Spectroscopic Techniques: a. Introduction to Electron spectroscopy techniques. b. X-ray and UV Photoelectron spectroscopy (XPS, UPS): theory, instrumentation and their applications. c. Introduction to Auger electron spectroscopy (AES) and electron energy loss spectroscopy (EELS) and their applications.	5
	4. Microscopic Techniques: a. Optical microscopy: components of microscope, different types of optical microscopy techniques; significance and applications.	10

	b. Electron microscopy: Scanning electron microscopy (SEM), Transmission electron microscopy (TEM) and Scanning transmission electron microscopy (STEM) –Principle, instrumentation and applications. c. Atomic Force Microscopy (AFM): theory, instrumentation, operational modes and applications. d. Sample preparation for microscopy: Sample selection, sectioning, mounting, grinding, different polishing methods; microstructure – etching, heat tinting, different etching methods. e. SEM/TEM sample preparation: TEM grids, ion milling, electropolishing etc.	
	5. Molecular Fluorescence, Phosphorescence and Chemiluminescence Spectrometry: a. Fluorescence and phosphorescence: theory; factors influencing fluorescence and phosphorescence; instrumentation; spectrofluorometer and phosphorimeter; applications of photoluminescence methods b. Chemiluminescence: Introduction; instrumentation; measurement of chemiluminescence, gas phase chemiluminescence analysis, chemiluminescence titrations. Application in Organic and Inorganic Analysis. c. Electrochemiluminescence and Bioluminescence: theory and their applications.	10
	6. Automation of Analytical Methods: a. An overview of automated system, distinction between automatic and automated devices; advantages and disadvantages by automation. b. Process Control with automated instruments, discrete and continuous analysers, automatic instruments. Flow and Sequential Injection Analysis, Laboratory Information Management System.	5
Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.	
References / Readings:	1. A. R. West, Solid State Chemistry and Its Applications, 2nd Ed.; Wiley, 2014. 2. V. K. Pecharsky and P. Y. Zavalij, Fundamentals of Powder Diffraction and Structural Characterization of Materials, 1st Ed.; Springer, 2003. 3. D. A. Skoog, F. J. Holler and S. R. Crouch, Principles of Instrumental Analysis, 7th Ed.; Cengage, 2017. 4. T. G. Rochow and E. G. Rochow, An Introduction to Microscopy by Means of Light, Electrons, X-Rays, or Ultrasound, 2nd Ed.; Springer, 2012.	

	5. Y. Leng, Materials Characterization: Introduction to Microscopic and Spectroscopic Methods, 2nd Ed.; Wiley-VCH, 2013. 6. A. M. Garcia-Campana, Chemiluminescence in Analytical Chemistry, 1st Ed.; CRC Press. 2001. 7. R. F. Egerton, Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM, 2nd Ed.; Springer, 2016. 8. E. H. Kisi and C. J. Howard, Applications of Neutron Powder Diffraction, 1st Ed., Oxford Science Publications, 2008. 9. G. D. Christian, Analytical Chemistry, 6th Ed. Wiley, 2004.
Course outcomes:	1. Students will be able to explain theory and instrumentation of various instrumental methods of analysis. 2. Students will be able to judge suitability of different instrumental methods for qualitative and quantitative analysis. 3. Students will understand and will be able to apply various techniques of X-Ray analysis. 4. Students will understand and will be able to apply various microscopic techniques.

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