Certificate Course /Professional Certificate Course

Advanced Instrumentation and Analytical Methods for Material Science

(Science and Engineering)

Duration: 48 Hours

Credit Score: 4 (PG & Research Scholars)

Credit Score: 2 (UG)

Objectives

1. To introduce undergraduate, postgraduate students, and Ph.D. scholars in Science and Engineering disciplines to the fundamental principles and applications of advanced instrumentation in materials science research.
2. To familiarize students with the analytical methods and techniques commonly employed in the characterization of materials, including their principles, capabilities, and limitations.
3. To provide students with hands-on experience and in-depth knowledge of sophisticated instruments enabling them to effectively utilize these tools in their research endeavors.

4 credit modules

Unit 1: Microscopic Techniques

Microscopy (SEM, FESEM, TEM, USB Travelling Microscope, 3D Optical Profilometer, AFM)- Principles, difference between SEM, FESEM and TEM, sample preparation, handling, sputtering, Electron Diffraction Spectroscopy, elemental mapping-EDS, interpretation of data of all the above techniques.

Unit 2: X-Ray Diffraction

Debye-Scherrer's equation, Powder XRD and Crystalline XRD analysis, Principle-Instrumentation-sampling - Operating procedures -interpretation of data

Unit 3: Spectral Techniques

UV Spectrophotometer, Spectrophotometer with color lab, Fourier-Transform Infrared spectroscopy (FTIR), Atomic Absorption Spectroscopy (AAS), Inductively Coupled Plasma Mass Spectrometry (ICP-MS), Photoluminescence & Raman Spectroscopy- Principle, Instrumentation, Sample preparation, Instrument operating procedure, and Interpretation of data.

Unit 4: Surface and Thermoanalytical Techniques

Thermo Gravimetric Analysis **(**TGA), Differential Scanning Calorimeter, Contact angle, Surface area analyzer (BET) and Ellipsometer - Principle, Instrumentation, Sample preparation, Instrument operating procedure, and Interpretation of data.

Unit 5: Common Techniques

Design of Experiments, DLS and ZETA, Turbidity meter, Texture Analyzer, Nano spray Drier, Plasma Coater, and Electrochemical Workstation – Principle, operation procedure and application.

2-credit modules

Unit 1: Microscopic Techniques

Microscopy (FESEM, USB Travelling Microscope, 3D Optical Profilometer) - Principles, Instrumentation and application.

Unit 2: Spectral Techniques

UV Spectrophotometer, Spectrophotometer with colour lab, Fourier-Transform Infrared spectroscopy (FTIR), and Atomic Absorption Spectroscopy (AAS) - Principle, Instrumentation and application

Unit 3: X Ray Diffraction, Thermal and Common Techniques

X-Ray Diffraction (XRD) and Thermo Gravimetric Analysis **(**TGA), Turbidity meter, Texture Analyzer, Nano spray Drier, Plasma Coater, Contact angle, and Ellipsometer - Principle, Instrumentation, and application.

Course Outcome

1. Comprehensive knowledge of Instrumentation principles and practices.
2. Proficiency in utilizing analytical methods for material analysis and interpretation.
3. Trained in sample preparation and proficient handling of sophisticated instruments in the field of Instrumentation.
4. Understanding the intricacies of material science interpretation and its application in research endeavors.

References:

1. Veerakumari. Bioinstrumentation. MJP Publishers; 2019 June 6. (***https:// books.google.co.in/books?hl=en&lr=&id=bbWbDwAAQBAJ&oi=fnd&pg=PT23&dq***).
2. Bhushan B. Introduction to Nanotechnology. Springer Handbook of Nanotechnology. 2017:1-9. (***DOI.org/10.1007/978-3-662-54357-3***).
3. Nasrollahzadeh M, Sajadi SM, Sajjadi M, Issaabadi Z. An Introduction to Nanotechnology. InInterface Science and Technology 2019 Jan 1 (Vol. 28, pp. 1-27). Elsevier. (***PMID: 32486364, Doi: 10.3390/nano10061072***).
4. Bunaciu AA, UdriŞTioiu EG, Aboul-Enein HY. X-ray diffraction: Instrumentation and Applications. Critical Reviews in Analytical chemistry. 2015 Oct 2; 45(4):289-99. (***PMID: 25831472, DOI: 10.1080/10408347.2014.949616***).
5. Lespes, G. Nanoanalytics: Analytical Methods for Characterization of nano- and micro-objects. Environ Sci Pollut Res 26, 5235–5237 (2019). (***PMID: 30715694 DOI: 10.1007/s11356-019-04235-w***).
6. Adams F, Van Vaeck L, Barrett R. Advanced Analytical Techniques: Platform for Nano Materials Science. Spectrochimica Acta Part B: Atomic Spectroscopy. 2005 Jan 10; 60(1):13-26.(***DOI.org/10.1016/j.sab.2004.10.003***).
7. Poole, Charles P., and Frank J. Owens. "Introduction to Nanotechnology." (2003): 145-150. (***DOI: 10.1373/clinchem.2003.025817***).
8. Roco MC. Nanoparticles and Nanotechnology Research. Journal of Nanoparticle Research. 1999 Mar 1; 1(1):1. (***DOI.org/10.1023/A:1010093308079***).