Course Type	Course Code	Name of Course	L	T	P	Credit
DE	NPHD523	CHRACTERIZATION TECHNIQUES	3	0	0	3

Prerequisite: Condensed Matter Physics, Spectroscopy.

Course Objective

To make students acquaint with advanced materials characterization tools required for scientific research and development field.

Learning Outcomes

After completing the course, students will learn

- Basic principles and working of each technique.
- Methodology of data recording, analysis and interpretation of observations.
- How and when a particular technique needs to be used to get required information.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	**Microstructure Characterization techniques:** Light microscopy-bright field, dark field, phase contrast illumination, Ellipsometry, Spectral reflectance, Scanning Electron Microscope (SEM), Transmission electron microscope (TEM), Atomic force microscopy (AFM), Scanning tunnelling microscopy (STM).	6	In this section students will learn basics of instrumentation used to get microstructural information of samples.
2	**Spectroscopic techniques:** Spectrophotometry, Luminescence spectroscopy, Fourier Transform Infrared (FTIR) spectroscopy, Raman spectroscopy, Surface plasmon resonance (SPR) spectroscopy, Dynamic light scattering (DLS), Inductively Couple Plasma Mass Spectroscopy (ICPMS).	9	This section devotes to the spectroscopic tools used in characterization of various samples. Student will learn several important spectroscopic tools.
3	**Compositional characterization techniques:** X-ray and Ultra-violet Photoelectron Spectroscopy (XPS and UPS), Energy Dispersive X-ray analysis (EDAX), X-ray Fluorescence Spectroscopy (XRF), Rutherford Backscattering Spectroscopy (RBS), Inductively Coupled Plasma Mass Spectrometry (ICPMS).	8	Students in this section will learn techniques used to get compositional information of the samples.
4	**Crystalline Structure characterization techniques:** X-ray diffraction (XRD), Transmission Electron diffraction (TED).	2	It introduces X-ray based crystal structure analysis
5	**Electrical characterization techniques:** Measurement of resistivity by four-probe method, Impedance and ferroelectric measurements, flow cyclic voltammetry.	4	Student will learn basic electrical property measurement tools
6	**Characterization of Mechanical Properties:** Micro / Nanoindenter, Nanoindentation and bending tests by AFM, Frictional Force Microscopy.	5	It introduces techniques to get mechanical strength of the sample.
7	**Magnetic characterization techniques:** Vibrating Sample Magnetometer (VSM), Superconducting Quantum Interference Device (SQUID), and Magnetic Force Microscopy (MFM).	4	In this section students will learn magnetic property measurement tools
	Total	**42**	

Text Books:

1. Microstructural characterization of materials, D. Brandon and W. Kaplan, John Wiley and Sons, 2013.
2. Surface Characterization Methods: Principles, Techniques and Applications; Milling; CRC Press; 1999.
3. ASM Handbook: Volume 10: Materials Characterization; George M. Crankovic; ASM International; 1986.

Reference Books:

1. Encyclopaedia of Materials Characterization - Surfaces, Interfaces, Thin Films; Brundle, Richard, Evans and Shaun; Elsevier; 1992.
2. Characterization of Semiconductor Materials - Principles and Methods; McGuire; William Andrew Publishing / Noyes; 1989.
3. Optical Techniques for Solid-State Materials Characterization, Rohit P. Prasankumar, Antoinette J. Taylor, CRC Press, 2010.
4. Foundation of Spectroscopy. Simon Duckett and Bruce Gilbert. Oxford University Press. 2005.
5. Elements of X-ray Diffraction, Cullity B D., Stock S R, Prentice Hall, Inc. 2001.
6. Principles of Thermal Analysis and Calorimetry, Peter J. Haines, RSC, 2002.