Course Type	Course Code	Name of Course	L	T	P	Credit
DE	NPHD525	EXPERIMENTAL PHYSICS	3	0	0	3

Prerequisite: Condensed Matter Physics, Atomic and Molecular Physics.

Course Objective
• To teach research scholars some of the fundamental and applied concepts of experimental methods of physics at research level. • To train and prepare these research scholars for handling the research activity in advanced fields of the experimental physics.
Learning Outcomes
After attending the course, the scholars will earn numerous fundamental and higher-level concepts of vacuum generation and measurement techniques, materials' synthesis and fabrication, measurements and characterization techniques, accelerators for fusion techniques, and low temperature methods likely to be useful especially in forefront areas of experimental research.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	**Vacuum Generation and Measurement Techniques:** Introduction to vacuum, gas law; Rotary vane pump, Turbomolecular pump, Cryo pump; Pirani gauge, Penning gauge.	4	Introducing the general concept of vacuum, employing these concepts for their generation and measurement techniques.
2	**Fundamentals of Synthesis and Fabrication of Materials:**Classification of powders; Synthesis of powders:Sol-gel, Hydrothermal, Combustion techniques; Synthesis of thin films: Spin-coating, Dip coating, Thermal and electron beam evaporation, Pulsed laser deposition; General concept of lithography, Photolithography, Electron beam lithography; Clean room.	7	Comprehensive dissemination of the laboratory synthesis knowledge and experimental practices for the different methods of materials' synthesis and fabrication in the form of crystalline, amorphous, liquid, powder and thin films.
3	**Study of Crystal Structure:**X-ray diffraction (XRD), Transmission Electron diffraction (TED)	2	Adequate elaboration for studying the crystal structure of varying categories of materials through XRD and TED.
4	**Microscopic Techniques:** Optical Microscopes (Bright field, Confocal, Super-resolution), Scanning Electron Microscope, Transmission Electron Microscope, Scanning Probe Microscopes.	5	Extensive explanation on the fairly discrete structural analysis of different class of materials through various microscopic techniques.
5	**Spectroscopic Techniques:** UV-Vis, Fluorescence, IR and FTIR, Photo-Acoustic, Laser Induced Breakdown, Raman, Twyman-Green interferometer as a special case of Michelson Interferometer for testing of optical components, Lateral shearing interferometers and its applications such as testing. Collimation of a lens, laser speckle techniques and its applications.	7	Elaborately specific discussion on different varieties of the spectroscopic techniques and its application for the structural analysis of materials.
6	**Surface and Compositional Analysis Methods:**EDAX, XPS.	2	Discussion on the working principle of EDAX and XPS and its application in surface and compositional analysis of materials.
7	**Dielectric Characterization:**Complex impedance spectroscopy, Analysis of Nyquist plot, Various RC network schemes, Analysis of CV curves, ac conductivity, Charging-discharging cycle of capacitors.	4	Imperative explanation on the various basic and advanced concepts related to dielectric properties of materials and relevant phenomenon.
8	**Electrochemical Measurements:** Different potentiometric / galvanometric techniques.	2	Discussion on different methods to measure electrochemical properties of materials.
9	**Methods for studying electrical, magnetic, thermal properties.**	4	Elaborated discussion on the mode and methods for studying several electrical, magnetic and thermal properties of materials.
10	**Accelerator and Fusion Techniques:** Pelletron, Linear accelerator, Cyclotron, Synchrotron, Tokamac; Applications in High energy physics, Materials science and Particle therapy.	3	Discussion about the various accelerator devices and their applications
11	**Low Temperature Methods:** Temperature measurement and control; Cryostats and cooling methods.	2	Moderate discussion on the fairly low temperature measurement techniques, related concepts and equipment.
	Total	**42**	

Text Books:

1. Nanostructures and Nanomaterials - Synthesis, Properties and Applications; Guozhong Cao, World Scientific, 2004
2. Thin Film Phenomena; Chopra; McGraw-Hill; 1969
3. Surface Characterization Methods: Principles, Techniques and Applications; Milling; CRC Press; 1999
4. Principles of Fluorescence Spectroscopy; J. R. Lakowicz, Third Ed., Springer, 2006.