

Course type	Course code	Name of the course	L	T	P	Credit
DE	NECD514	Advance Material and Device Characterization	3	0	0	9

#### Course Objective

The course aims to provide a systematic understanding of different characterization methods required to investigate and engineer emerging nano-devices for future electronics applications.

#### Learning Outcomes

Basic understanding, parameter extraction and analysis of electrical, optical, and thermal properties of materials and devices

Module No.	Topics to be covered	Lecture Hours	Learning Outcome
1	<b>Overview</b> Why characterization, Different levels and types of devices and their characterization.	6	An overview of the need for device characterization.
2	<b>Electrical characterization:</b> An overview of carrier transport. Basics of electrical probe station, Power supply and SMUs. DC and RF measurements. IV & CV characteristic and extraction of device parameters. Two probes, four probes, Hall bar, Van der Pauw, and TLM methods. Schottky barrier height, contact resistance, and pinning factor extractions. Electroluminescence and trap analysis. Deep-level transient spectroscopy (DLTS).	9	Comprehensive understanding of electrical characterization of different devices.
3	<b>Optical Characterization:</b> Photons and phonons in material, photoluminescence, fluorescence and phosphorescence. Basics of Raman and Photoluminescence (PL) spectroscopy. Time-resolved PL and Raman. Investigating different electronic materials using Raman and PL. UV-VIS-NIR spectroscopy, FTIR spectroscopy. Optoelectronic device characterization.	9	Understanding of optical characterization of materials for device applications.
4	<b>Material Characterization:</b> Diffraction Techniques: X-ray diffraction, Electron Diffraction. Electron Microscopies: Scanning electron microscopy, Transmission electron microscopy, Energy dispersive x-ray and Electron probe micro-analysis, XRF. XPS and UPS. Scanning probe microscopy: AFM, KPFM and conductive AFM.	9	An Overview of different material characterization techniques.
5	<b>Thermal Characterization:</b> An overview of thermal transport. Pump and probe methods, Optothermal Raman. Thermoreflectance, SThM.	8	Overview of thermal characterization of materials and devices.
<b>Total</b>		<b>42</b>	

#### Text Books:

1. Dieter K. Schroder, "Semiconductor Material And Device Characterization", Third Edition, A John Wiley & Sons, Inc., Publication.

#### Reference Books:

1. Yang Leng, Materials Characterization: Introduction to Microscopic and Spectroscopic Methods, 2013 Wiley-VCH Verlag GmbH & Co.
2. Rohit P. Prasankumar, Antoinette J. Taylor, "Optical Techniques for Solid-State Materials Characterization", CRC Press, 1st Edition