NIRMA UNIVERSITY

Institute:	Institute of Technology
Name of Programme:	MTech Semiconductor Technology
Course Code:	6EC352CC24
Course Title:	Semiconductor Characterization
Course Type:	Core
Year of Introduction:	2024-25

L	T	Practical component				C
		LPW	PW	W	S	
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Course Learning Outcomes (CLOs)

At the end of the course, students will be able to

1. analyse the testing of electrical and optical properties of semiconductors (BL3)
2. compare and verify the structural and mechanical properties of semiconductors with existing materials (BL4)
3. interpret and analyse data obtained from characterization experiments (BL5)
4. gain hands on experience on characterization tool and methodologies. (BL5)

	Contents	Teaching hours (Total 30)
Unit I	**Electrical Characterization Techniques** Electrical resistivity, noise in electrical measurements, four-point probe measurement, bandgap determination, Hall effect, carrier concentration and mobility, Hall coefficient for intrinsic and extrinsic semiconductors, capacitance voltage (C-V) profiling and current voltage (I-V) characteristics of MOS	**06**
Unit II	**Optical Characterization Techniques** Photoluminescence (PL) spectroscopy, defect identification, Raman spectroscopy, strain and composition analysis, UV visible spectroscopy	**05**
Unit III	**Advanced Optical Techniques** Ellipsometry, thin film thickness and optical constants, Fourier transform infrared (FTIR) spectroscopy, bonding information, impurity identification	**04**
Unit IV	**Structural Characterization Techniques** X-ray diffraction (XRD), crystal structure analysis, phase identification	**03**
Unit V	**Electron Microscopy Techniques** Scanning electron microscopy (SEM), surface morphology, failure analysis, transmission electron microscopy (TEM), atomic resolution imaging, defect and interface analysis	**04**
Unit VI	**Scanning Probe Microscopy Techniques** Atomic force microscopy (AFM), surface topology and roughness, mechanical properties, scanning tunnelling microscopy (STM), atomic resolution imaging, local density of states	**04**

Unit VII	**Spectroscopic Characterization Techniques** X-ray photoelectron spectroscopy (XPS), Auger analysis, chemical composition and states, surface analysis, secondary ion mass spectrometry (SIMS), elemental and isotopic analysis, depth profiling	**04**

Self Study:
The self-study contents will be declared at the commencement of the semester. Around 10% of the questions will be asked from self-study content.

Laboratory Work:
Laboratory work will be based on the above syllabus with a minimum of 10 experiments to be incorporated.

Suggested Readings/References:

1. Culity B. D., Elements of X-ray Diffraction, Addison-Wesley.
2. Grundy P. J. and Jones G. A., Electron Microscopy in the Study of Materials, Edward Arnold.
3. Egerton R. F., Physical Principles of Electron Microscopy, Springer.
4. Willard H. H., Merritt L. L. and Dean J. A., Instrumental Methods of Analysis, CBS publications.
5. Fultz B. and Howe J. M., Transmission Electron Microscopy and Diffractometry of Materials, Springer.

Details of Laboratory
Suggested List of Experiments

Sr. No.	Practical	No. of Hours
1.	Determination of Hall coefficient, mobility, charge carrier concentration and carrier type for a semiconducting material.	02
2.	To determine the energy band gap of a semiconductor using PN junction diode: Part 1	02
3.	To determine the energy band gap of a semiconductor using PN junction diode: Part 2	
4.	To study the V-I and V-R characteristics of a solar cell and calculate its efficiency.	02
5.	To find the band gap of the material of the given thermistor using post office box: Part 1	02
6.	To find the band gap of the material of the given thermistor using post office box: Part 2	02
7.	To determine the energy band gap of a semiconductor (Germanium) and its resistivity using four probe method: Part 1	02
8.	To determine the energy band gap of a semiconductor (Germanium) and its resistivity using four probe method: Part 2	02
9.	To measure the photoconductive nature and the dark resistance of the given light dependent resistor (LDR) and to plot the characteristics of the LDR.	02
10.	Determination of Fermi function for different temperature using GNU Octave (MAT Lab): Part 1	02
11.	Determination of Fermi function for different temperature using GNU Octave (MAT Lab): Part 2	02
12.	Determine the band gap energy of various semiconductor materials using both UV-Vis absorption and photoluminescence spectroscopy.	02

13.	To measure the dielectric constant of a semiconductor (Silicon wafer and silicon di oxide) material using capacitance measurements: Part 1	02
14.	To measure the dielectric constant of a semiconductor (Silicon wafer and silicon di oxide) material using capacitance measurements: Part 2	02
15.	Measurement of magnetic susceptibility by Quinke’s method	02