



# GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3143905

Semester – IV

Subject Name: Characterization of Nanomaterials-II

**Type of course:** Instrumentation in Nano science and Nanotechnology

**Prerequisite:** Basic knowledge of computer operation and computer language (helps student to understand characterisation of Nanomaterial using different instrumental software), Solid State Physics, and Nanomaterials.

**Rationale:** The objective of this course is to make students familiar with different characterization techniques which are useful for studying physical, optical and biological properties of Nanomaterials.

**Teaching and Examination Scheme:**

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	4	5	70	30	30	20	150

Sr. No.	Contents	Teaching Hrs.	Module Weightage (%)
1	<b>Spectroscopy-I</b> 1.1 <b>UV-Visible Spectroscopy</b> 1.1.1 Lambert's Law 1.1.2 Beer's Law 1.1.3 Instrumentation and Working 1.1.4 Numerical based on % Transmittance to Absorbance 1.1.5 Determination of Band-Gap using UV-Visible Spectroscopy 1.2 <b>Fourier Transform Infrared Spectroscopy (FTIR)</b> 1.2.1 Principle 1.2.2 Working 1.2.3 Instrumentation 1.3 <b>Raman Spectroscopy</b> 1.3.1 Raman effect 1.3.2 Quantum Theory of Raman Effect 1.3.3 Transition Responsible for Raman Scattering 1.3.4 Instrumentation 1.3.5 Working	8	25
2	<b>Spectroscopy-II</b> 2.1 <b>Electron Spectroscopy for Surface Analysis</b> 2.1.1 Basic Principles 2.1.1.a X-ray Photoelectron Spectroscopy 2.1.1.b Auger Electron Spectroscopy 2.2 <b>Instrumentation</b> 2.2.1 Ultra-High Vacuum System 2.2.2 Source Guns 2.2.3 Electron Energy Analysers 2.3 <b>Secondary Ion Mass Spectroscopy</b> 2.3.1 Principle	8	25



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	2.3.2 Instrumentation		
3	<b>Thermal Characterization</b> 3.1 <b>Thermo Gravimetric Analysis</b> 3.1.1 Principle 3.1.2 Working 3.1.3 Instrumentation 3.2 <b>Differential Thermal Analysis</b> 3.2.1 Principle 3.2.2 Working 3.2.3 Instrumentation 3.3 <b>Differential Scanning Calorimetry (DSC)</b> 3.3 Principle, 3.3 Working 3.3 Instrumentation	8	25
4	<b>Magnetic Characterization</b> 4.1 <b>SQUID</b> 4.1.1 Introduction 4.1.1.a Superconductivity 4.1.1.b Meissonier Effect 4.1.1.c Flux Quantization 4.1.1.d The Josephson Effect 4.1.1.e Superconducting Quantum Interference Devices 4.1.2 Squid Operation and Performance 4.1.2.a The RF SQUID 4.1.2.b The DC SQUID 4.2 <b>VSM</b> 4.2.1 Introduction 4.2.2 Basic 4.2.2.a Ferromagnetic materials 4.2.2.b Magnetic Domain 4.2.2.c Hysteresis 4.2.2.d Demagnetization 4.2.2.e Magnetic Anisotropy 4.2.2.f Units 4.2.3 Equipment	8	25

## Reference Books:

1. R.W. Cahn, E.M. Lifshitz, "Concise Encyclopedia of Materials Characterization: Advances in Materials Sciences and Engineering", Elsevier, 2016
2. Yang Leng, "Materials Characterization: Introduction to Microscopic and Spectroscopic Methods", John Wiley & Sons, 2009
3. Richard Leach, "Fundamental Principles of Engineering Nanometrology", Elsevier, 2014.
4. Mauro Sardela, "Practical Materials Characterization", Springer, 2014.
5. Ewen Smith, Geoffrey Dent, "Modern Raman Spectroscopy: A Practical Approach", John Wiley & Sons, 2013.
6. Nikodem Tomczak, Kuan Eng Johnson Goh, "Scanning Probe Microscopy", World Scientific, 2011.
7. Ernst Meyer, Hans J. Hug, Roland Bennewitz, "Scanning Probe Microscopy: The Lab on a Tip", Springer Science & Business Media, 2013.



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8. Vladimir V. Tsukruk, Srikanth Singamaneni, "Scanning Probe Microscopy of Soft Matter: Fundamentals and Practices", John Wiley & Sons, 2012.
9. H. Weinstock, "SQUID Sensors: Fundamentals, Fabrication and Applications", Springer Science & Business Media, 2012.
10. Sam Zhang, Lin Li, Ashok Kumar, "Materials Characterization Techniques", CRC Press, 2008. Yang Leng, "Materials Characterization: Introduction to Microscopic and Spectroscopic Methods", John Wiley & Sons, 2009.

## Course Outcome

Sr. No.	CO statement	Marks % weightage
CO-1	Student will be able to demonstrate understanding of basic principles and use of various light-based spectroscopic techniques	25
CO-2	Student will be able to demonstrate understanding of basic principles and use of various electron spectroscopic techniques	25
CO-3	Student will be able to understand basic principles of thermal characterization of nanomaterials	25
CO-4	Student will be able to understand basic principles magnetic characterization of nanomaterials	25

Bloom's Taxonomy for Cognitive Domain	Marks % weightage
Recall	45
Comprehension	45
Application	10
Analysis	0
Evaluate	0
Create	0

## List of Experiments:

Sr. No	Topics
1.	Data analysis using FTIR spectroscopy (peak identification)
2.	Band gap measurement using UV
3.	Surface analysis of thin film using <b>MAGNETIC FORCE MICROSCOPY (MFM)</b>
4.	SQUID data analysis (magnetism)
5.	Data analysis of Impedance Spectroscopy