GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3133904
Semester – III
Subject Name: Characterization Of Nanomaterials-I

Type of course: Instrumentation in Nano science and Nanotechnology

Prerequisite: Require basic knowledge of computer operation and computer language which helps student to understand characterisation of Nanomaterial using different instrumental software, Solid State Physics and basic knowledge of Nanomaterial are also require to understand basic properties of Nanomaterial.

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

Teaching and Examination Scheme:

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

Contents:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
Chapter 1	Structural Characterization 1.1 X-Ray Diffraction (XRD) 1.1.1 Bragg's Law 1.1.2 Instrumentation 1.1.3 Production of X-Ray, 1.1.4 Lau Conditions, Lau Method 1.1.5 Powder Method 1.1.6Sherer formulae (including numerical) 1.2 X-Ray photoelectron Spectroscopy (XPS) 1.2.1 Principle 1.2.2 Working, 1.3 Energy Dispersive X-Ray Analysis (EDAX) 1.3.1 Principle 1.3.2 Working	8	25%
Chapter 2	Microscopy 2.1 Light Microscopy 2.1.1 Optical Principles 2.1.1.aImage Formation 2.1.1.b Resolution 2.1.1.c Depth of Field 2.1.1.d Aberrations 2.2.2 Instrumentation 2.2.2.a Illumination System 2.2.2.b Objective Lens and Eyepiece 2.2 Scanning Electron Microscopy (SEM) 2.2.1Emission of different Electrons 2.2.1.a Backscattered Electrons	8	25%

	2.2.1.b Auger Electron 2.2.1.c X-Rays 2.2.1.d Secondary Electron(SE1,SE2) 2.2.1.eCathodoluminicsence 2.2.2 Insertion Volume 2.2.3 Samples and Sample Holder 2.2.4 Instrumentation 2.2.5 Transducers 2.2.6 Data Handling and Processing 2.2.7 Advantages and Disadvantages 2.2.8 Application. 2.3 Transmission Electron Microscopy 2.3.1 Instrumentation 2.3.1.a Electron Sources 2.3.1.bElectromagnetic Lenses 2.3.1.c Specimen Stage 2.3.2 Specimen Preparation 2.3.2.a Pre-Thinning 2.3.2.b Final Thinning 2.3.3 Image Modes 2.3.3.a Mass-Density Contrast 2.3.3.b Diffraction Contrast 2.3.3.c Phase Contrast		
Chapter 3	Scanning Probe Microscopy Techniques 3.1 Atomic Force Microscopy (AFM) 3.1.1Working 3.1.2Instrumentation 3.1.3Modes of Operation 3.1.3.aContact mode. 3.1.3.bNon-Contact Mode 3.1.3.cTapping Mode 3.1.4 Limitations of AFM 3.2 Scanning Tunnelling Microscopy (STM) 3.2.1Introduction to Quantum Tunnelling 3.2.2Working 3.2.3Instrumentation 3.2.4Properties of Cantilever 3.2.5Modes of Working 3.2.5.aConstant I 3.2.5.bConstant V. 3.3 Near Field Scanning Optical Microscopy (NSOM) 3.3.1Working	8	25%
Chapter 4:	Optical Thin Film Measurements, 4.1 Ellipsometry 4.1.1Principle 4.1.2Working and its types, 4.2 Resistivity and Conductivity Measurements 4.2.1Principle and working	8	25%

References Books:

1 Yang Leng, "Materials Characterization: Introduction to Microscopic and Spectroscopic Methods", John Wiley & Sons, 2009
2 R.W. Cahn, E.M. Lifshitz, "Concise Encyclopedia of Materials Characterization: Advances in Materials Sciences and Engineering", Elsevier, 2016
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. NikodemTomczak, KuanEng 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.
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.

Course Outcome:

Sr. No.	CO statement	Marks % weightage
CO-1	Get introduction of different and complicated techniques to characterized properties of Nanomaterials.	25
CO-2	Understand working principles and applications of Optical Microscopy, Scanning Electron Microscopy and Transmission Electron Microscopy Techniques.	**25**
CO-3	Understand working principles and applications of probing microscopy techniques.	**25**
CO-4	Understand principles and techniques involved in measurement of thin films.	**25**

Bloom's Taxonomy for Cognitive Domain	Marks % weightage
Recall	30
Comprehension	40
Application	30
Analysis	0%
Evaluate	0%
Create	0%

List of Experiments

Sr. No.	Topics
1.	Introduction to Origin –Data Entry, Graph plotting, Formula Entry and Fitting

2.	Powder X-Ray Diffraction - XRD : Structure Identification
3.	Powder X-Ray Diffraction - XRD: Composition and Phase Identification, Particle size calculation,
4.	Atomic Force Microscopy - AFM Light Microscopy Fluorescence: Surface analysis
5.	AFM Microscopy: 2D and 3D View, Roughness and Porosity analysis
6.	Transmission Electron Microscopy – TEM (Data analysis)
7.	To observe the size and shape of the nanosized sample using SEM