BMEE319E	Advanced Materials Characterization Methods	L	T	P	C
		3	0	2	4
Pre-requisite	**BMEE209L, BMEE209P**	**Syllabus version**			
		1.0			

Course Objectives

1. To provide insight into the structural information using various characterization technique.
2. To understand theory and practice of diffraction phenomena.
3. To understand the various characterization techniques available for metallic materials.

Course Outcomes

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

1. Describe the various specimen preparation methods for microscopic and spectroscopic techniques.
2. Explain the diffraction phenomena and indexing of materials.
3. Demonstrate different structural information by various microscopy.
4. Elucidate the operation of SEM, TEM and EBSD.
5. Explain the advanced characterization techniques such as *insitu* and other combined techniques.
6. Apply advanced lighting, thermal, chemical and imaging techniques for materials characterization.

Module:1	**Structural Analysis**	**5 hours**

Specimen Preparation Techniques – Polishing and Etching, Development of microstructure, Grain Size Measurements, Quantitative Metallography.

Module:2	**Diffraction and Imaging**	**7 hours**

Crystallography, Bragg's Law, Radiation Interaction and Response Signals, X-Ray Diffraction, XRD Analysis, Phase Analysis, Powdered and Textured Diffraction Fundamentals of Imaging: magnification, resolution, depth of field and depth of focus, aberration and astigmatism; X-Ray reflectivity, Edward sphere, Kikuchi pattern, Indexing, Texture of materials.

Module:3	**Microscopy and Spectroscopy**	**7 hours**

Basic principles of operation (optical, SEM, AFM, TEM), Principles of Optical and Electron Microscopy, Estimation and comparison of grain size, grain boundary area through various microscopes, Volume fraction, Structure revealed through various microscopy and comparison. Basic principles of operation of EDS, WDS, EPMA, and ToF SIMS.

Module:4	**Advanced Characterization Techniques**	**7 hours**

Introduction to Orientation Imaging Microscopy (OIM), 3-Dimensional FIB/EBSD, Insitu testing facilities, Nano indentation, Combined spectroscopy and microscopy techniques, Temperature related measurement (TG+DTA) and DSC, Thermomechanical physical simulator, Gleeble, Neutron diffraction techniques.

Module:5	**Surface Properties**	**6 hours**

Microscopic Methods for Characterizing Surface Properties, Spectroscopic Methods for Characterizing Surface Properties.

Module:6	**Electrical Characterization Techniques**	**5 hours**

Electrical resistivity in bulk and thin films, Hall effect, Magnetoresistance.

Module:7	**Magnetic Characterization Techniques**	**6 hours**

Introduction to Magnetism, Measurement Methods, Measuring Magnetization by Force, Measuring Magnetization by Induction method. Types of measurements using magnetometers: M-H loop, temperature dependent magnetization, time dependent magnetization, Measurements using AC susceptibility, Magneto-optical Kerr effect, Nuclear Magnetic Resonance, Electron Spin Resonance.

Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Books				
1.	Materials Characterization, 2019, Volume 10, ASM Handbook.			
2.	Dalip Singh Verma, Latif Ullah Khan Shalendra Kumar, Sher Bahadar Khan, Handbook of Materials Characterization, , 2018, Springer International Publishing.			
Reference Books				
1.	Ranganathan N., Materials Characterization Modern Methods and Applications, 2016, CRC press.			
Mode of Evaluation: CAT, Written assignment, Quiz, FAT				
Indicative Experiments				
1.	Metallographic preparation of metallic specimens			
2.	Grain Size determination by linear intercept methods			
3.	Observation of structures by optical microscopy and Scanning Electron Microscopy			
4.	Demonstration and Indexing of XRD peaks			
5.	XRD peak identification by various methods: manual, database and software			
6.	Study of fracture surface of materials by Scanning Electron Microscopy			
7.	Image formation (bright and dark) and interpretation by Scanning Electron Microscopy			
8.	Demonstration of Nano Indentation and X-Ray Diffraction Residual stress			
9.	Demonstration of Spectroscopic analysis (ICPMS and XPS)			
10.	Demonstration of Transmission Electron Microscopy and Electron Backscattered Diffraction			
		Total Laboratory Hours		**30 hours**
Text book				
Lab manual prepared by the Faculty member				
Mode of assessment: Continuous assessment, FAT, Oral examination				
Recommended by Board of Studies	09-03-2022			
Approved by Academic Council	No. 65	Date	17-03-2022	