Course Type	Course Code	Name of Course	L	T	P	Credit
DC	NFMC518	Materials Characterization	3	1	0	4

Course Objective

- Equip students with the fundamental theories of probing signals
- Equip students with the physics of various characterization tools
- Equip students with the instrumentation of various characterization tools
- Analysis and Interpretation of results

Learning Outcomes

- Identification of suitable characterization techniques for metals and minerals
- Application of results for structure-property correlation

Unit No.	Topics to be Covered	Lecture Hours	Tutorial Hours	Learning Outcome
1.	Introduction to material characterization, necessity of characterization, methods of analysis	2	0	Students will be able to understand the necessity of characterization of materials and ways to analyze them.
2.	Materials characterization using X-Rays:Properties of X-Rays, Detection of X-Rays, X-Ray Diffraction- Principle, Intensity, Pattern Indexing- Crystal structure and Phase identification, Applications (Single Line profile method, Rietveld Method, Determination of Phase Diagram, Defect analysis, Measurement of lattice parameter, crystallite size, strain, residual stress).	8	3	Students will know various characterization techniques based on X Ray.
3.	Microscopy Technique-I: Optical Microscopy- Components of optical microscope, Lens Aberrations, principle of image formation in a metallurgical optical microscope, Polarized Light Microscopy, Phase-contrast Microscopy, Differential Interference Contrast (DIC or Nomarski) Microscopy, Quantitative Metallography	6	3	Students will know sample preparation and characterization techniques based on optical microscopy.
4.	Microscopy Technique-II: Electron Microscopy - Electron-sample Interaction, Scanning Electron Microscope (SEM) – Components and their function, Signals and detection, Imaging and performance of SEM modes, Interaction Volume, Image formation and Contrast in an SEM, Electron Backscattered diffraction,	6	2	Students will know sample preparation and characterization techniques based on electron microscopy.
5.	Microscopy Technique-III: Electron Microscopy - Transmission Electron Microscope (TEM) - Components and their function, TEM sample preparation, Electron Diffraction, Diffraction pattern and its analysis, contrast mechanism	4	1	Students will know sample preparation and characterization techniques under transmission mode and diffraction pattern analysis
6.	Introduction to spectroscopy: EDS, WDS, XPS, XRF (UV-vis, FTIR and Raman), Auger electron spectroscopy, AES, AAS.	3	1	Students will know various characterization techniques based on spectroscopy.

7.	Thermal stability analysis: thermogravimetric analysis (TGA) and differential scanning calorimetry (DSC).	4	1	Students will know various thermal characterization techniques.
8.	Mechanical property characterization: principles and characterization of tensile, compressive, hardness, fatigue, and fracture toughness properties.	6	2	Students will know various mechanical characterization techniques.
9.	Special Characterization Techniques: QEMSEM, Atomic Force Microscopy, Magnetic Force Microscopy, Atom Probe tomography	3	1	Students will know various special characterization techniques.
	Total	**42**	**14**	

Text Books:

1. Yang Leng. *Materials Characterization: Introduction to Microscopic and Spectroscopic Methods*, 2nd Edition, Wiley-VCH Verlag GmbH and Co., 2013.
2. B. D. Cullity, *Elements of X-Ray Diffraction, Addison-Wesley Publishing*, 3rd Edition, 2014.
3. William D. Callister Jr., David G. Rethwisch, *Materials Science and Engineering: An Introduction*, John Wiley and Sons, 5th Edition, 2015.
4. Charles Brundle, Charles Evans (Jr.) and Shaun Wilson, *Encyclopedia of Materials Characterization*, Elsevier, 1992.

Reference Books:

1. Joseph Goldstein, Dale Newbury, Patrick Echlin, David Joy, Charles Lyman, Eric Lifshin, Linda Sawyer and Joseph Michael, *Scanning Electron Microscopy and X-Ray Microanalysis*, Kluwer Academic/ Plenum Publishers, 3rd Edition, 2003.
2. Peter J Goodhew, John Humphreys and Richard Beanland, *Electron Microscopy and Analysis*, Taylor and Francis, 3rd Edition, 2001.
3. C. Suryanarayana and M. G. Norton, *X-Ray Diffraction: A Practical Approach*, Springer, 1st Edition, 1998.