No	Information of Characterization of Materials (2019-2020)	
1	Unit name:	Characterization of Materials
2	Code:	Met- 51051
3	Classification:	Engineering subject
4	Credit value:	3
5	Semester/ Year Offered:	1/5
6	Pre-requisite:	
7	Mode of delivery:	Lecture, Tutorial, Assignment
8	Assessment system and breakdown of marks:	
	Test	30%
	Mid-term/ final Examination	70%
9	Academic staff teaching unit:	1
10	Course outcome of unit: In this course, students will be able to - apply the varieties of microscopic and X-ray spectroscopic techniques. - identify the methodologies and applications various characterization techniques. - use the modern instruments for characterizing materials.	
11	Synopsis of unit: The course describes light microscopy, X-ray diffraction methods (XRD), transmission electron microscopy (TEM), scanning electron microscopy (SEM) and X-rays fluorescence for elementals analysis (XRF), atomic absorption spectroscopy (AAS), thermal analysis and non-destructive testing techniques. How to characterize and determine chemical compositions & to observe internal structure.	

12	Topic: Chapter 1 **Light Microscopy** Optical Principles Image Formation Resolution Effective Magnification Brightness and Contrast Depth of Field Aberrations Instrumentation, Illumination System, Objective Lens and Eyepiece Steps for Optimum Resolution Steps to Improve Depth of Field Specimen Preparation: Sectioning, Cutting, Microtomy, Mounting, Grinding and Polishing, Etching Imaging Modes Bright-Field and Dark-Field Imaging Phase-Contrast Microscopy Polarized-Light Microscopy Nomarski Microscopy Fluorescence Microscopy Confocal Microscopy Working Principles Three-Dimensional Images Chapter 2 **X-Ray Diffraction Methods** X-Ray Radiation Generation of X-Rays X-Ray Absorption Theoretical Background of Diffraction Diffraction Geometry Bragg's Law Reciprocal Lattice Ewald Sphere Diffraction Intensity Structure Extinction X-Ray Diffractometry Instrumentation Samples and Data Acquisition Sample Preparation Acquisition and Treatment of Diffraction Data Preferential Orientation Crystallite Size Residual Stress Applications Crystal-Phase Identification

	Quantitative Measurement Chapter 3 **Transmission Electron Microscopy** Instrumentation Electron Sources Thermionic Emission Gun Field Emission Gun Electromagnetic Lenses Specimen Stage Specimen Preparation Pre-thinning Final Thinning Electrolytic Thinning Ion Milling Ultramicrotomy Image Modes Mass–Density Contrast Diffraction Contrast Phase Contrast Selected-Area Diffraction (SAD) Selected-Area Diffraction Characteristics Single-Crystal Diffraction Identification of Crystal Phases Multicrystal Diffraction Images of Crystal Defects Dislocations Chapter 4 **Scanning Electron Microscopy** Instrumentation Optical Arrangement Signal Detection Detector Probe Size and Current Contrast Formation Electron–Specimen Interactions Topographic Contrast Compositional Contrast Working Distance and Aperture Size Acceleration Voltage and Probe Current Astigmatism Specimen Preparation Preparation for Topographic Examination Charging and Its Prevention Preparation for Microcomposition Examination Electron Backscatter Diffraction Applications of EBSD

	Environmental SEM Chapter 5 **X-Ray Spectroscopy for Elemental Analysis** Features of Characteristic X-Rays Types of Characteristic X-Rays Selection Rules Comparison of K, L, and M Series X-Ray Fluorescence Spectrometry Wavelength Dispersive Spectroscopy Analyzing Crystal Wavelength Dispersive Spectra Energy Dispersive Spectroscopy Detector Energy Dispersive Spectra Advances in Energy Dispersive Spectroscopy XRF Working Atmosphere and Sample Preparation Energy Dispersive Spectroscopy in Electron Microscopes Scanning Modes Qualitative and Quantitative Analysis Qualitative Analysis Quantitative Analysis Quantitative Analysis by X-Ray Fluorescence Chapter 6 **Thermal Analysis** Common Characteristics Thermal Events Enthalpy Change Instrumentation Experimental Parameters Differential Thermal Analysis and Differential Scanning Calorimetry Working Principles Differential Thermal Analysis Differential Scanning Calorimetry Temperature-Modulated Differential Scanning Calorimetry Experimental Aspects Sample Requirements Baseline Determination Effects of Scanning Rate Measurement of Temperature and Enthalpy Change Transition Temperatures Measurement of Enthalpy Change Calibration of Temperature and Enthalpy Change Applications Determination of Heat Capacity Determination of Phase Transformation and Phase Diagrams Applications to Polymers

	Thermogravimetry Instrumentation Experimental Aspects Samples Atmosphere Temperature Calibration Heating Rate Interpretation of Thermogravimetric Curves Types of Curves Temperature Determination Applications Chapter 7 **Atomic Absorption Spectrometry (AAS)** Introduction Basic principle Flame AAS Atomic Absorption Spectrometry with graphite furnace (GFAA) Chapter 8 **Non-destructive testing Methods**
14	Main Reference - Materials Characterization- An introduction to Microscopic and Spectroscopic Methods, Yang Leng, 2nd edition
15	Additional references: - Elements of Physical Metallurgy, Albert G. Guy and John J. HREN, 3rd Edition - Solid State Chemistry and Its Applications