GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3172109
Semester – VII
Subject Name: Materials Characterization

Type of course: Engineering Science

Prerequisite: Knowledge of Engineering Materials, Metallurgy and basic science skills

Rationale: The Material Characterization course is to prepare students for careers in metallurgy engineering where knowledge of characterization techniques leading to the advancement of research and technology. Knowledge of characteristic features and their identification such as thermal properties, metallography, surface morphology, chemical properties, crystal structure etc. of the materials is must for a metallurgist to select a candidate material for a given engineering application as well as to provide solution of a given metallurgical task. This course will help students in their project work during graduation, to solve different metallurgical problems upon graduation while at the same time, provide a firm foundation for the pursuit of graduate studies in metallurgy engineering.

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	2	4	70	30	30	20	150

Sr. No.	Content	Hrs.
1	Importance of Material characterization, Classification of techniques for characterization.	**02**
2	Vacuum systems: Vacuum range, Vacuum Pumps: Rotary, Sorption, Turbomolecular, Diffusion, Ion, Cryo. Vacuum measurement gauge: Pirani, Penning, Ionization etc. Use of Vacuum systems in Material Characterization techniques.	**05**
3	Thermal Analysis techniques: Principle, Working and application of DTA, TGA, TMA and DSC.	**05**
4	Optical microscopy techniques: Metallurgical Microscopes, Aberration in Optical microscopy & its remedies, Polarized light in microscopy, Differential Interference Contrast Illumination, Hot Stage Microscopy, color metallography, Insitu metallography, and image analysis techniques.	**05**
5	Electron microscopy: Electron beam. Principle, Construction and Working of TEM, SEM, STEM, with their merits, limitations and applications. Techniques of replica preparation.	**05**
6	Atomic Microscopy: Field Ion Microscope, Working of AFM and STM with their merits, limitations and applications.	**05**

7	Spectroscopic Techniques for chemical analysis:, UV-Visual(UV-VIS), EDS & WDS, XRF, Atomic absorption spectrometer(AAS), Atomic Emission spectroscopy (AES).	**06**
8	Diffraction method: Brags Law, X-ray diffraction methods, determination of crystal structure, lattice parameter, crystallite size, merits and demerits	**05**
9	Surface characterization: XPS (ESCA), UPS, Auger Electron Spectroscopy, EPMA, LEED.	**04**
Total		**42**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
15%	**30%**	**40%**	**10%**	**05%**	**00**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. F. Weinberg Editor, Tools & Techniques in Physical Metallurgy, Vol. I & II, Marcel Dekker
2. John P. Sibilia, A guide to Material Characterization & Chemical Analysis, VCH Publishers, 1988.
3. J.M. Walls, Editor, Methods of Surface Analysis : Techniques & Applications, Cambridge University Press, 1990.
4. B.D. Cullity, Elements of X-ray diffraction, Addison-Wesley Publishing Company, INC,.
5. Bernhard Wounderlich, Thermal Analysis, Academic Press, INC, 1990.
6. B.L. Gabriel, SEM : A user's manual for materials Science, American Society for Metals
7. An Introduction to Materials Characterization by P. R. Khangaonkar, Penram International Publishing (India) Pvt. Ltd.

Course Outcome:

Sr. No.	**CO statement**	**Marks % weightage**
CO-1	Understand the principles and working of material characterization techniques.	50%
CO-2	Interpret different material characterization methods.	30%
CO-3	Identify appropriate methods of characterization for given material problems.	20%

List of Experiments:

1. To study introduction and importance of material characterization techniques.
2. To study different vacuum systems and measurement.
3. To study Thermogravimetric Analysis for oxidation rate measurement.
4. Demonstrate Optical microscope and its working.
5. To analyze the microstructure and measure the grain size using image analyzer.
6. To study principle and working of Scanning Electron Microscope.
7. To study working, merits, limitations and applications of AFM and STM.
8. To study X-ray Fluoroscopy.
9. To study the diffraction pattern using powder diffraction pattern and to predict the lattice parameter and structure of crystal.
10. Report writing on research lab visit / Expert lecture.

Major Equipment: Metallurgical Microscope, Image analyzer system, TGA, DSC, AFM, STM, SEM, TEM, XRD, XRF, etc.

List of Open Source Software/learning website:

1. www.nptel.iitm.ac.in
2. www.ocw.mit.edu
3. www.btechguru.com