

**Department of Materials Science and Engineering
Indian Institute of Technology Kanpur**

Course Name: *Structure and Characterization of Materials*
Credits: 3-0-0-0-4
Course No: MSE 615

Prerequisite: None
Category: Compulsory course for all M.Tech. students of MSE Department, to be offered in odd semester

Course Contents:

Basic crystallography and crystal structures (8 Lectures hours)	Lecture Hours
Periodic patterns, Lattices, Motif, Unit cells, Crystal structure, Primitive and Non-primitive cells	1
Symmetry elements and point group notations	1
Crystal systems and Bravais lattices	1
Crystallographic directions and planes, Miller indices and Weiss zone law	1
Streographic projections	1
Bonding in materials and atomic packing in metals, co-ordination number concepts	1
Covalent bonding, glasses and polymers	2
Crystal defects and their significance (12 Lectures hours)	Lecture Hours
Point defects and their role in materials Processing, performance and failure	1
Ionically bonded structures: Pauling's rules and some examples	2
Point defects: thermodynamics, schottkey and Frenkel defect, Kroger-Vink notation, defect interactions	2
Dislocations, burgers vector, types of dislocations	1
Dislocation movement, slip systems, energetics of dislocations and their interactions	2
Planar defects: stacking faults, grain boundaries (low angle and high angle), anti-phase domain boundaries, Twinning	2
Surface defects with relevance to thin films	1
Non-equilibrium structures such as metallic glasses	1
Diffraction and Imaging (14 Lectures hours)	Lecture Hours
Phenomena of diffraction	1
Radiation-matter Interactions and response signals	1
X-ray diffraction: powder diffraction, phase identification, Scherrer formula, strain and grain size determination	2
Fundamentals of Imaging: magnification, resolution, depth of field and depth of focus, aberration and astigmatism	1
Optical microscopy, stereology basics and quantitative analysis	2
Fundamentals of SEM: imaging modes, image contrast, illustrative applications	2
Imaging with TEM: Contrast mechanisms, BF, DF, Weak beam DF images	1
TEM application in crystal defect analysis	1

Electron diffraction in TEM and applications	1
STM, AFM and nanoindentation	2
Spectroscopic Techniques (4 Lectures hours)	Lecture Hours
Fundamental basis of Spectroscopic analysis	1
EDS and WDS, EPMA applications	1
X ray Photon Spectroscopy and Auger electron spectroscopy	1
SIMS and EELS	1
Thermal Analysis Techniques (2 Lectures hours)	Lecture Hours
DSC/DTA/TGA/Dilatometry	2
TOTAL LECTURE HOURS	40

References:

1. Crystals and Crystal structures, R.J.D. Tilley, John Wiley and Sons, 2006
2. Materials Science and Engineering – W.D. Callister, Jr.Wiley India(P) Ltd., 2007
3. Materials Science and Engineering, G.S. Upadhyaya and Anish Upadhyaya, Viva books, 2010
4. Fundamentals of Materials Science-the microstructure-property relationship using metals as model systems, E.J. Mittemeijer, Springer, 2010
5. Microstructural Characterization of Materials – D. Brandon and W.D. Kaplan, John Wiley and Sons, 2008
6. Science of Microscopy, P.W. Hawkes and J.C.H. Spence, Springer, 2007
7. Scanning Electron Microscopy & X-Ray Microanalysis, J.Goldstein et.al, Springer, 2003
8. Transmission Electron Microscopy – B.D.Williams & C.B.Carter, Springer, 2009
9. Surface Analysis methods in materials science, Editors: D.J.O’Connor, B.A. Sextton, R.St. C. Smart, Springer, 2003.
10. Materials Characterisation Techniques, S. Zhang, Lin Li and Ashok Kumar, CRC Press, 2009