

## PMM105: MATERIALS CHARACTERIZATION

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**Course Objective(s):** To understand the principles of optical and electron microscopy for study of macro and micro-structure of materials. To gain knowledge in understanding the tools and techniques for studying the substructure and atomic structure of materials. To build an expertise in characterization of engineering materials.

**Introduction:** Need of materials characterization and available techniques.

**Optical Microscopy:** Optical microscope - Basic principles & components, Different examination modes (Bright field illumination, Oblique illumination, Dark field illumination, Phase contrast, Polarised light, Hot stage, Interference techniques), Specimen preparation, Applications.

**Electron Microscopy:** Interaction of electrons with solids, scanning electron microscopy Transmission electron microscopy and specimen preparation techniques, Scanning transmission electron microscopy, Energy dispersive spectroscopy, Wavelength dispersive spectroscopy.

**Diffraction Methods:** Fundamentals of crystallography, X-ray diffraction techniques, Electron diffraction, Neutron diffraction.

**Surface Analysis:** Atomic force microscopy, scanning tunneling microscopy, X-ray photoelectron spectroscopy.

**Spectroscopy:** Atomic absorption spectroscopies, UV/Visible spectroscopy, Fourier transform infrared spectroscopy, Raman spectroscopy.

**Thermal Analysis:** Thermogravimetric analysis, Differential thermal analysis, Differential Scanning calorimetry.

### Laboratory Work:

Metallographic preparation and grain size measurement of metallic and ceramic samples. Determination of crystal structure and lattice parameters using X-rays diffraction technique, Determination of crystal structure and lattice parameter from electron diffractions, Study of the UV visible absorption spectra of inorganic substance, Thermal analysis of alloys, to study the thermal expansion coefficient of various specimen using dilatometer, Determination of functional group and nature of bonding by FTIR, Study of surface roughness and morphology of thin films by using AFM.

### Course Learning Outcomes (CLO):

Students will be able to:

1. Apply appropriate characterization techniques for microstructure examination at different magnification level;
2. Understand the crystal structure determination and phase analysis of the materials;
3. Able to examine the electronic structure, and the thermal behavior of the materials.

**Recommended Books:**

1. *Gabriel, B. SEM- A Users's Manual, Plenum Press (1985).*
2. *Cullity, B.D. Elements of X-Ray Diffraction, Addison Wesley (1967).*
3. *Smallman, R.E., and Bishop, R.J., Metals and Materials – Science, Processes, Applications, Butterworth-Heinemann (1995).*
4. *Sibilia J.P., A Guide to Materials Characterisation and Chemical Analysis, VCH (1988).*