MANGALORE UNIVERSITY

Department of Materials Science

MSc Materials Science

MSS 553: **MATERIALS TESTING AND CHARACTERIZATION** (3 Credits)

Objectives: The objective of the course is to provide a brief idea about the requirements of characterization/testing of materials using various techniques. It also introduces vacuum techniques as most of the characterization as well as synthesis require clean environment.

Expected course outcomes: The students to be in a position to select suitable characterization techniques to study the given property of the materials, understand the basic working principles. The student is also expected to have a good understanding of creation and measurement of vacuum for various applications.

Unit I

Fundamentals of Vacuum Techniques: Basic concepts of pumping: Ideal gas - pressure, density, mean free path. Regions of gas flow. Conductance of a pipework -fundamental equation of vacuum technology. Vacuum pumps: Operating limits of a pump. Rotary, Vapour diffusion, Turbomolecular and Cryogenic pumps - a brief survey of working principles. Vacuum measurement: Thermal conductivity gauges - Pirani and thermocouple gauges.Ionisation gauges-Hot and cold cathode ionisation gauges- working principle and operating limits. Vacuum materials. 14 hours

Unit II

Non- Destructive Testing of Materials : Ultrasonics: Principles - Ultrasonic receivers and oscillators - transducers, probes. Reference and calibration blocks. Identification and seizing of defects.

X-Ray Radiography: Principles -Factors affecting contrast and resolution.

Neutron Radiography: Neutron sources and detectors. Methods- Criteria for evaluating flaw detection by neutron radiography method. Factors limiting the contrast. Comparison of X-ray and neutron radiography methods.

Mechanical Testing of Materials: Tensile and Compression tests- Brittle and ductile failure-

Universal Testing Machine. Hardness test - Indentation hardness- Brinell, Vicker and Rockwell hardness numbers. Impact test - Izode and Charpy tests. Fatigue test - A brief discussion. 14 hours

Unit III

Materials Characterisation - Electron Microscopy- Transmission Microscopy(TEM) - Principles, sample preparation. Kinamatic theory of contrast. Scanning Microscopy (SEM) - Principles, beam diameter, image contrast. Applications to microstructure determination.

Atomic and Molecular Spectroscopies: Atomic Absorption, Infra - Red, and Raman spectroscopies for the determination of impurities. Low Energy Electron Diffraction (LEED),

X-ray Photoelectron Spectroscopy (XPS/ESCA) and Auger Electron Analysis - Principles and applications for surface studies. Electron Probe Micro analysis (EPMA) and Energy Dispersive Analysis of X-Rays (EDAX) - Principles and applications for compositional analysis.

14 hours

References

1. Fundamentals of Vacuum Techniques – A Pipco et al (MIR, 1984)
2. Ultrasonics – B Carlin (Mc Graw Hill, 1960)
3. Handbook on Ultrasonic Testing of Materials – Ramesh B Parikh (Electronic & Engineering Co., 1984)
4. Principles of Neutron Radiography – N D Tyufyakov and A S Shtan (Amerind, 1979)
5. Modern Metallographic Techniques and Their Applications – V A Phillips (Wiley Interscience, 1971)
6. Applied X-Rays – George L Clark (Mc Graw Hill, 1955)
7. Testing of Metallic Materials – A V K Suryanarayana (Prentice Hall India, 1990)
8. Physical Metallurgy Part 1 – R W Cahn and P Haasen (Ed) (North Holland, 1983)
9. Instrumental Methods in Chemical Analysis – G W Ewing (Mc Graw Hill, 1975)