B.Tech IV Year I Semester

JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS) PULIVENDULA

19AME74e – MATERIAL CHARACTERIZATION

(Professional Elective-III)

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Course Objectives: The objectives of the course are to make the students learn about

- Familiarize the fundamentals in material characterization.
- Explain principles in X-ray diffraction and Stereographic projections.
- Describe the fundamental principles of characterization.
- Evaluate the uncertainty of observations and results from the different methods.
- Impart the methods of characterization for different material problems.

UNIT – 1: Basic crystallography and Need for Material Characterization **10 Hrs**

Basic crystallography and Need for Material Characterization - unit cells, Crystal structure, Primitive and Non- primitive cells, Symmetry elements and point group notations, Stereographic projections - Need for Material Characterization - Methodology for Material Characterization and Analysis.

Learning Outcomes:

At the end of this unit, the student will be able to

- Appraise the importance of materials structure **L5**
- Define the terminology of crystallography **L1**
- Demonstrate the characterization techniques **L2**

UNIT – II: Diffraction and Imaging **10Hrs**

Diffraction and Imaging - Phenomena of diffraction; Radiation-matter Interactions and response signals; X-ray diffraction: powder diffraction, phase identification, Scherrer formula, strain and grain size determination; Fundamentals of Imaging: magnification, resolution, depth of field and depth of focus aberration and astigmatism; X-Ray reflectivity.

Learning Outcomes:

At the end of this unit, the student will be able to

- Explain diffraction techniques **L2**
- Utilize fundamental imaging processes **L3**

UNIT – III: Optical microscopic & Spectroscopic Techniques **10Hrs**

Optical microscopic Techniques - Special microscopy techniques and applications: Bright field and dark field imaging; confocal microscopy; interference microscopy; polarized light microscopy; phase contrast microscopy. Scanning near field laser microscopy; Image processing and quantification.

Optical Spectroscopic Techniques - Principle, Working and Result Analysis of Fourier Transformation Infra-Red Spectroscopy; Raman Spectroscopy; UV-Vis Absorption Spectroscopy; Photoluminescence Spectroscopy - Ellipsometer Spectroscopy.

Learning Outcomes:

At the end of this unit, the student will be able to

- Identify the need for microscopy and types of microscopy. **L3**
- Summarize optical microscopy principles and working. **L2**
- Explain basic aspects of optical characterization methods. **L2**
- Explain the concepts of spectroscopy. **L2**

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UNIT – IV: Electron Microscopic Techniques **8 Hrs**

Electron Microscopic Techniques - Basics of Electron Microscopy - Introduction - Principle of SEM, Instrumentation, Contrast formation, Operational variables, Specimen preparation, imaging modes, Applications, Limitations – FE-SEM , FIB, EDAX. TEM - Introduction, Instrumentation, Specimen preparation: Mechanical thinning, electrochemical thinning, ion milling, sputter coating and carbon coating, replica methods. Image modes - mass density contrast, diffraction contrast, phase contrast, Applications, Limitations

Learning Outcomes:

At the end of this unit, the student will be able to

- Explain fundamentals of electron microscopy **L2**
- Outline thinning and coating processes **L2**
- Interpret techniques of polishing for image processing **L2**

UNIT – V: Thermal analysis **8Hrs**

Thermal analysis - Instrumentation, experimental parameters, Differential thermal analysis, Differential Scanning Calorimetry, Thermogravimetry, Dilatometry, Dynamic mechanical analysis-Basic principles, Instrumentation, working principles, Applications, Limitations.

Learning Outcomes:

At the end of this unit, the student will be able to

- Explain thermal stability techniques used for materials. **L2**
- Illustrate principles and working of different equipments used for thermal analysis **L2**

Text Books:

- Yang Leng, Materials Characterization: Introduction to Microscopic and Spectroscopic Methods, 2/e, Wiley Publications, 2013.

Reference Books:

1. D. Brandon and W.D. Kaplan, Microstructural Characterization of Materials, John Wiley and Sons, 2008.
2. S. Zhang, Lin Li and Ashok Kumar, Materials Characterisation Techniques, CRC Press, 2009.
3. B.D.Williams and C.B.Carter, Transmission Electron Microscopy –Springer, 2009.
4. E.J. Mittemeijer, Fundamentals of Materials Science - the microstructure-property relationship using metals as model systems, Springer, 2010.

Course Outcomes:

At the end of this Course the student will be able to

- Explain the production of characteristic x-rays **L2**
- Use the principles of diffraction (Bragg's Law) in determination of crystal structure determination **L2**
- Interpret the properties of electrons and the affect of accelerating potential **L2**
- Apply basic operational modes of a SEM and TEM **L2**
- Explain the formation of diffraction patterns in the electron microscopes **L2**

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