Characterization of Materials

Programme : **PhD** Year : -- Semester : --
Course : **Elective** Credits : **4** Hours : **52/60**

Course Context and Overview (100 words):

An impressively large number of powerful characterization techniques are nowadays being used by physicists, engineers, chemists, and biologists in order to solve analytical research problems; especially those related to the investigation of the properties of new materials for advanced applications. This course will provide the aspiring post-graduate/research students with the flavor of a large number of characterization techniques along with the key information that is sufficient to permit them to carry out independent research using these characterization techniques.

Prerequisites Courses:
Nil

Course outcomes (COs):

On completion of this course, the students will have the ability to:
CO1 understand the essentials of the modern technologies for materials and device characterizations.
C02 The students will acquire detail knowledge on the working principles of different types of analytical tools.
C03 The students will acquire knowledge on a variety of advanced characterization techniques for understanding micro and nanoscale properties.
C04 The students will acquire knowledge on the sophisticated instruments involved in understanding the wide range of mutually interacting processes, mechanisms, and materials.

Course Topics:

Topics	**Lecture hours (60)**
UNIT - I **Structure analysis techniques: XRD, XRF, LEED and RHEED EXAFS, XPS etc.**	15
UNIT - II **Microscopy techniques: SEM, TEM, HRTEM, AFM, MFM, RBS etc.**	15
UNIT – III **Optical characterization techniques: UV-VIS spectroscopy, Fourier transform infrared spectroscopy, Photoluminescence spectroscopy, Raman spectroscopy,**	7
UNIT – IV **Thermal characterization techniques: DTA, TGA, DSC**	3

UNIT – V **Electrical characterization techniques: I-V, C-V, Hall effect, Impedance spectroscopy.**	5
UNIT – VI **Magnetic characterization techniques: Vibrating Sample magnetometer, Mössbauer Spectroscopy, Nuclear Magnetic Resonance, Electron Magnetic resonance**	10
UNIT – VII **Other techniques: Optical Profilometry, Ellipsometry, Mass Spectrometry**	5

Textbook references :

Text Book : Advanced Techniques for Materials Characterization by A. K. Tyagi, Mainak Roy, S. K. Kulshreshtha and S. Banerjee.

Reference books :

1. Materials Characterization Techniques Sam Zhang, Lin Li, Ashok Kumar;CRC press, (2008)
2. Transmission Electron Microscopy; D.B. Williams and C.B. Carter, Plenum Press (2004)
3. Modern ESCA The Principles and Practice of X-Ray Photoelectron Spectroscopy, Terry L.Barr, CRC press, (1994)
4. Materials Characterization Techniques, S Zhang, L. Li and Ashok Kumar, CRC Press (2008).
5. Physical methods for Materials Characterization, P. E. J. Flewitt and R K Wild, IOP Publishing (2003).
6. Characterization of Nanophase materials, Ed. Z L Wang, Wille-VCH (2000).
7. Elements of X-Ray Diffraction, B.D. Cullity and A. R. Stock, 3rd Edition, Pearson Publishing (2013)
8. Advanced Techniques for Materials Characterization, Materials Science Foundations (monograph series) A. K. Tyagi, Mainak Roy, S. K. Kulshreshtha and S. Banerjee;, Volumes 49 – 51 (2009)
9. Encyclopedia of Materials Characterisation Editors: c.r. Brundle, C.A. Evens, Jr, S. Wilson, Butterworth- Heinmann, Boston (1992)
10. Additional Resources (NPTEL, MIT Video Lectures, Web resources etc.) : will be provided as and when required

Evaluation Methods:

Item	Weightage
Assignments	20%
Presentations	30%
Final Examination	50%

Note: The course Experimental Techniques for Materials Characterization (ETMC) is offered to M.Sc. Physics students. A modified and updated version of the course (Characterization of Materials) is floated to PhD program.

Course Instructor: Dr. Manish Kumar Singh