Paper - II – Physics (Pre Ph.D. course)

Characterization of Materials

1. **Characterization techniques :**

Importance for characterization of materials, classification of characterization techniques, destructive and non-destructive techniques, electromagnetic spectrum, properties of electromagnetic radiation

2. **Raman Spectroscopy**

Characteristic properties of Raman lines, differences between Raman spectra and infrared spectra, mechanism of Raman effect, instrumentation, intensity of Raman lines, Application of Raman spectroscopy.

3. **UV-Vis-IR spectroscopy**

Range of IR absorption, requirement for IR radiation absorption, theory of IR absorption spectroscopy, linear molecules, symmetric molecules, asymmetric molecules, Instrumentation, FTIR-application, limitations

Color and light absorption, the chromospheres concept, theory of electronic spectroscopy-orbital's involved in electronic transitions, laws of light absorption,-Beer's and Lamberts law, Instrumentation, UV-spectrophotometer, sample and reference cells, application of UV-Vis spectroscopy, Band gap determination (Direct , Indirect) for thin films.

4. **X-ray diffraction**

Crystalline state, X-ray diffraction process, preliminary discussion and single crystal pattern, and their information content, structure and structure factor determination, particle size determination, crystallography by diffraction of radiations other than X-ray, application of X-ray diffraction measurement and analysis

5. **Surface spectroscopy**

Importance, X-ray photoelectron spectroscopy, Auger electron spectroscopy, loss spectroscopy, absorption and desorption, different energy analysis

6. **Electron Microscopy**

Scanning electron microscopy (SEM): signal detection, equipment, nature of SEM image, secondary electron emission: the distribution of emitted secondaries, selection of secondaries in SEM, secondary electron yield, effect of angle, voltage and field contrast, specimen charging effect, factors affecting resolving power of SEM, relation between working distance, final aperture size and beam divergence in SEM.

Energy dispersive X-ray spectroscopy (EDS): principle, instrumentation, sample analysis, limitations

Transmission electron microscopy (TEM): Constituent parts and their functions with attachments, selected area, high resolution, reflection and scanned diffraction, dark field electron microscopy, reflected electron microscopy, X-ray microanalysis quantitative interpretation of crystalline image contrast.

7. **Atomic Force Microscopy**

Operating principle, Different operating modes: Contact, tapping, non-contact, forces between the tips and surfaces, limitations of AFM.

Reference books:

1. Elements of X-ray diffraction
   D. Cullity, Addision-Wesely Publishing Comp, USA.
2. Encyclopedia of Materials Characterization, (Series)
   C Richard Brundle, Charles A Evans, Jr Shaun Wilson, Surface, Interfaces, Thin Films
3. SEM Characterization of Semiconductors
   D. B. Holt, and D.C. Joy, Academic Press, New Delhi
4. Fundamental of Molecular Spectroscopy.
   N. Banwell, Tata McGraw-Hill Publ. Company Ltd New Delhi
5. Electron Microscopes, J. A. Swift
6. Introduction to Diffraction in Materials Science and Engineering,
   Aaron D Krawitz, John Willey and Sons Inc
7. Atomic Force Microscopy,
   Cheryl R Blanchard, The Chemical Education, 1/vol.