SEMESTER - IV

Paper - II : Applied Nuclear Techniques

Max. Marks: 55
Time: 3 Hrs.

Note: Nine questions will be set and students will attempt 5 questions. Question No. 1 will be compulsory consisting of 4 parts based on the conceptual aspects of the whole syllabus. The answers should not be in yes/no. In addition to Question No. 1 there will be four Units in the question-paper each containing two questions belonging to four Units in the syllabus. Students will select one question from each unit.

UNIT - I

Basic principle, working and applications of Van-de-Graff, Tandom and Pelletron Accelerators
Cyclotron, Focussing in Cyclotrons, Relativistic limitation, Variable energy cyclotron, Microtron.
Betatron Induction acceleration machine, Electron synchroton, Proton synchroton,
Medical application of accelerators, Mega volt therapy.

UNIT - II

Charged Particle Induced X-ray Emission (PIXE) spectrometry : Basic Principle, X-ray production process, Radiative and Non-radiative transitions, Coster Krönig transitions, continuous background, Brenmsstrahlung, PIXE set-up, Instrumentation, Beam preparation, collimation, Beam current measurement
Qualitative analysis: Energy calibration, comparison with standard. Quantitative analysis : Absolute method, Relative method, Relationship between X-ray intensities and concentrations, Limits of detection, Accuracy of analysis, Application of PIXE in air and water pollution industry, Archaeology, Biology, and Earth Science, External beam PIXE, Micro beam PIXE, Proton Microprobe, Micro beam applications.

UNIT - III

X-rays fluorescence spectrometry : Nature and origin of X-rays, characteristic X-ray, notation for spectrum, Continuous spectra, Duane - Hunt Law, Relationship between X-ray emission and atomic number,

Sources of X-rays : X-ray tube, Function and requirements, Radioisotope source,
XRF spectrometer, wave length dispersive devices, Energy dispersive devices, pulse height selection.
Data analysis identification of the peaks, equation for concentration of elements, Matrix effects, Absorption - enhancement effect, Detection limits. Application of XRF in various fields, Advantages and disadvantage of XRF.

UNIT - IV

Neutron Activation Analysis (NAA) : Introduction, Theory of activation method, Neutron energy distribution, Classification of neutron activation methods : Prompt γ-ray neutron activation, Delay γ-ray neutron activation. Radiochemical and instrumental NAA, Kinetics of activation.
Experimental considerations in activation methods : Irradiation conditions, Measurements of radioactivity, methods of standardisation, Classic relative method, Analysis of the gamma spectra, Applications NAA for semiconductor materials, Soil science, Geological science, Accuracy and sensitivity of NAA.

References

1. Instrumental methods of Analysis - Hobart H. Willard, et al. VIIed CBS Publishers.
2. Handbook of Analytical Instrumentation - RS Khandpur.
3. Principles of Instrumental Analysis - Douglas A Skoog et al. Saunders Golden Sunbrust series.
4. Particle Induced X-ray Emission spectroscopy - Ed Sten A.E. Johnson et al. John Willey and Sons, N.Y.
5. Principles and Practice of X-ray spectroscopy - Eugene P. Bertin Plenum Press.
6. An Introduction to X-ray Spectrometer R. JenKins, Heydon London Publication.
7. Neutron Activation Analysis - D. De Soete et al. Johan Wiley and Sons N.Y.
8. Activation Analysis : Vol. I and II - Z.B. Alfarsi CRC Press.