PT – 401 NUCLEAR PHYSICS

FOR COLLEGE ONLY

Max. Marks: 85 Pass Marks : 29

Note: This paper has been divided into FIVE units. The paper will be set as per existing examination norms covering uniformly all the units and providing to the examinee sufficient choice in each unit.

Unit – I Nucleus and its Properties

The constitution of the nucleus and its general properties: Proton-electron hypothesis, Nucleus as a quantum system, Proton-neutron hypothesis, Nuclear mass, Basic components of mass spectroscopy, Mirror nuclei and isotopic spin (introductory), Packing fraction and binding energies, Nuclear radius- its determination and interpretation of results (experimental details not required), Natural radioactivity, successive radioactive transformation, radioactive equilibrium, Gamow theory of alpha decay, nuclear spin, parity, magnetic moments, electric dipole and quadrupole moments (experimental details not required).

Unit –II Two body Problems

Binding energies and the Saturation of nuclear forces, Charge independence of nuclear force, The ground state of the deuteron (central forces), Comparison with experimental data on deuteron, Spin dependence of nuclear force, Tensor force, Neutron-proton scattering at low energies (below 10MeV), Cross-section, Laboratory and center of mass coordinate systems, Scattering length, Spin dependence of nuclear force, Singlet and triplet potentials, Effect of chemical binding, Coherent scattering of neutrons by protons (scattering by ortho- and para-hydrogen), Proton-Proton scattering at low energies (elementary theory), Exchange forces (elementary Yukawa theory).

Unit –III Nuclear Models

Liquid drop model, Semi empirical mass formula, Isobaric mass parabolae, Nuclear fission, The mass and energy distributions of the fission products, The energy release in fission, Application of liquid drop model to fission, Magic numbers, Single particle model of the nucleus, Spin-orbit coupling, Application to prediction of spin and magnetic moments (Schmidt values).

Unit - IV Nuclear Decay

Beta particle spectra, The continuous spectrum, Neutrino hypothesis, Fermi theory of beta-decay (non-relativistic), Kurie plots, Comparative half lives, Allowed and forbidden transitions, Selection rules, Symmetry laws and the non-conservation of parity in beta-decay, Gamma transitions, Multipole moments (mathematical results of theory to be assumed), Selection rules, Internal conversion (qualitative only), Nuclear isomerism

Unit - V Nuclear Reactions

Conservation laws for nuclear reactions, Q-value, The compound nucleus, Independence hypothesis, Resonances, Single level Breit-Wigner formula, Direct reaction (introductory ideas about stripping and pick-up reactions),

Books Recommended:

1. Nuclear physics: Kaplan
2. Nuclear physics: Enge
3. Nuclear physics: Evans
4. Nuclear physics: Blatt and Wisskopf

PT – 402 INSTRUMENTATION AND COSMIC RAYS

Max. Marks: 85 Pass Marks : 29

Note: This paper has been divided into FIVE units. The paper will be set as per existing examination norms covering uniformly all the units and providing to the examinee sufficient choice in each unit.

Unit – I Measurement of Temperature

Temperature scales, mechanical temperature sensors, liquid filled sensors, platinum resistance thermometer, principle and construction of resistance thermometer circuits, thermistors and its measuring circuits, thermocouple and its circuits, solid state sensors, temperature measurement by radiation methods, optical pyrometers.

Unit – II X-Ray Spectroscopy and Crystal Growth Techniques

X-ray spectrum, X-ray generating equipment, monochromators, powder and single crystal diffractometer, X-ray absorption meter, basic properties and uses of ESCA, electron probe microanalyser.

Theories of crystal growth, Growth of Single crystals from melt, Czocharlski method, Concept of annealing and quenching, Thin film deposition, Vacuum evaporation and chemical vapour deposition

Unit – III Biomedical Instrumentation

Electrocardiography, ECG amplifiers, electrodes and leads, ECG recorder principles, types of ECG recorders, measurement of blood flow, magnetic blood flow recorder, ultrasonic blood flow meter, principles of ultrasonic measurement, basic modes of transmission, ultrasonic imaging.

Unit – IV Elements of high-resolution spectroscopy

Principles of Mossbauer spectroscopy, applications of Mossbauer spectroscopy: chemical shift, quadrupole effects, effect of magnetic field; spin resonance spectroscopy: nature of spinning particles, interaction between spin and magnetic field, Larmor precession; introduction to magnetic resonance spectroscopy and its applications.

Qualitative description of AFM, SEM and TEM.

Unit – V Cosmic Rays

Nature, composition, charge and energy spectrum of primary cosmic rays, production and propagation of secondary cosmic rays, Rossi curve, cascade showers, physical properties of elementary particles, fundamental interactions and conservation laws, associated production and strangeness, leptons and hadrons, Quark model-SU (2) and SU (3) multiplets, Gellmann-Okubo mass formula.

BOOKS RECOMMENDED:

1. Instrumentation devices and systems: G.S.Rangan et al
2. Handbook of X-ray: Kelbel
3. Biomedical Instrumentation: L.Cromwell et al
4. Plasma Physics: F.F.Chen

PT – 403 STATISTICAL MECHANICS

Max. Marks: 85 Pass Marks : 29

Note: This paper has been divided into FIVE units. The paper will be set as per existing examination norms covering uniformly all the units and providing to the examinee sufficient choice in each unit.

Unit – I Microcanonical Ensemble

Concept of phase spaces, Liouville's theorem, Concept of Gibb's ensembles: microcanonical ensemble, canonical and grand canonical ensembles, Thermodynamical potential functions and their relations, Partition function of micro-canonical ensembles and its application to (a) classical ideal gas (b) Gibb's paradox, Sackur Tetrode equation.

Unit – II Canonical Ensemble

Canonical ensemble, Maxwell Boltzmann distribution, Maxwell's distribution of velocities and speeds, Boltzmann energy equipartition theorem, Rotational and vibrational partition function, Their application to diatomic molecules.

Unit – III Grand Canonical Ensemble – I

Grand canonical partition function, Derivation of Bose Einstein statistics, Weak and strong degeneracy, Applications of Bose Einstein statistics to Bose Einstein condensation and phase transition, Thermodynamical properties of an ideal Bose Einstein gas, Liquid helium and its properties, Two fluid model for liquid helium .

Unit – IV Grand Canonical Ensemble – II

Grand canonical partition function and derivatives of FD statistics, Application of FD statistics to (a) FD degeneracy of electron gas in metals, Boltzmann transport equation and its application to Sommerfeld theory of electrical conductivity and thermal conductivity: Weidemann-Franz law.

Unit – V Fluctuations

Elementary discussion of fluctuations, Fluctuations in ensembles: (Microcanonical, canonical, grand canonical), One-dimensional random walk problem, Brownian motion, Electrical noise: (Nyquist theorem).

BOOKS RECOMMENDED

1. Statistical Mechanics: ESR Gopal
2. Statistical Mechanics: Huang
3. Statistical Mechanics: Mendle

PT – 404A INTEGRATED ELECTRONICS

Max. Marks: 85 Pass Marks : 29

Note: This paper has been divided into FIVE units. The paper will be set as per existing examination norms covering uniformly all the units and providing to the examinee sufficient choice in each unit.

Unit – I Materials for Integrated Circuits

Electronic grade Silicon, Purification of metallurgical grade Silicon, Float zone crystal growing method, Czochralski method, Silicon lapping and polishing and Wafer preparation, Vapor phase epitaxy, Liquid phase epitaxy, Oxidation: thermal, dry and wet, Plasma oxidation.

Unit - II Integrated circuit fabrication technology

Optical lithography, photo mask, photo resist and process of lithography, idea of electron beam and X-ray lithography, wet chemical etching, reactive plasma etching

Unit - III Growth of Thin Films

Evaporation theory, physical vapour deposition method, design construction of high vacuum coating unit, flash electron beam evaporation system, idea of DC sputtering system, idea of thick film circuits.

Unit - IV Diffusion and Ion Implantation

Doping by diffusion, Idea of diffusion profile, Error function and Gaussian profile methods, Ion implantation, advantages and disadvantages of ion implantation, Neutron doping, Basic monolithic integrated circuit, Fabrication of integrated and thin film resistor and capacitors: their equivalent circuits, Integrated inductor.

Unit – V Monolithic circuit fabrication

Fabrication of monolithic diodes in various configuration, fabrication of integrated transistors, Idea of buried layer, fabrication, Monolithic circuit layout design rules, isolation method, Monolithic FET, MOS FET processing, advantages and limitations of MOS devices, CCD devices, Idea of large and medium scale Integration.

Books Recommended:

1. Fundamentals of Electronics: Millman and Halkias
2. Fundamentals of Electronics. Botkar