VRET (Physics) Syllabi - 2018
Guru Ghasidas Vishwavidyalaya, Bilaspur

Note: 50 MCQ type (objective type) questions from Part A and 50 similar questions from Part B be set

Each question will be of 01 (One) Mark

PART A

Unit 1:

Fundamentals of Research: Aims and objectives of research, Types of research – basic, novel and applied research. Tools for searching research topic – books, journals, internet, discussions etc. Research hypothesis, Steps in research design. Research Aptitude : Qualities of a researcher, Logical reasoning, Test for intelligence , Basic mathematics. Ethics in research – plagiarism

Unit 2:

Elements of computational techniques: root of functions, interpolation, extrapolation, integration by trapezoid and Simpson's rule, Solution of first order differential equation using Runge- Kutta method. Basic architecture of computer, basic computer programming, C and Fortron.

Unit 3:

Research Methods: Synthesis techniques: Solid state reaction method, sol gel method, coprecipitation method, Chemical bath deposition, Spin coating, dip coating, Physics of thinfilm deposition by sputtering techniques, ion beam sputtering, DC Sputtering and RF Sputtering , Thermal Evaporation

Unit 4:

Research tools & Techniques: XRD, SEM, AFM, DTA, TGA, Raman spectroscopy, Hall effect, UV-VIS-near IR, Four probe method for dc resistivity measurements Opto-electronic devices (solar cells, photo-detectors, LEDs), Nuclear detectors: Scintillator counter, GM Counter, Proportional counter and PIN Diode Transducers (temperature, pressure/vacuum, magnetic fields, vibration, optical, and particle detectors, M-H Curve, Magnetization measurement

Unit 5:

Data interpretation and analysis. Precision and accuracy Error analysis, propagation of errors. Least squares fitting, Linear and nonlinear curve fitting, chi-square test. Dependent and independent variables, standard curve approximation (Taylor Series), Max'm and Min'm of curve, point of inflection.

PART B

Unit I

Dimensional analysis. Vector algebra and vector calculus. Linear algebra, matrices, Cayley-Hamilton Theorem. Eigenvalues and eigenvectors. Linear ordinary differential equations of first & second order, Special functions (Hermite, Bessel, Laguerre and Legendre functions). Fourier series, Fourier and Laplace transforms. Elements of complex analysis, analytic functions; Taylor & Laurent series; poles, residues and evaluation of integrals. Partial differential equations (Laplace, wave and heat equations in two and three dimensions).

Newton's laws. Dynamical systems, Phase space dynamics, stability analysis. Central force motions. Two body Collisions - scattering in laboratory and Centre of mass frames. Rigid body dynamics-moment of inertia tensor. Non-inertial frames and pseudoforces. Variational principle. Generalized coordinates. Lagrangian and Hamiltonian formalism and equations of motion. Conservation laws and cyclic coordinates. Periodic motion: small oscillations, normal modes. Special theory of relativity-Lorentz transformations, relativistic kinematics and mass–energy equivalence. Poisson brackets and canonical transformations. Hamilton-Jacobi theory.

Unit II

Wave-particle duality. Schrödinger equation (time-dependent and time-independent). Eigenvalue problems (particle in a box, harmonic oscillator, etc.). Tunneling through a barrier. Wave-function in coordinate and momentum representations. Commutators and Heisenberg uncertainty principle. Dirac notation for state vectors. Motion in a central potential: orbital angular momentum, angular momentum algebra, spin, addition of angular momenta; Hydrogen atom. Stern-Gerlach experiment. Time-independent perturbation theory and applications. Variational method. Time dependent perturbation theory and Fermi's golden rule, selection rules. Identical particles, Pauli exclusion principle, spin-statistics connection. WKB approximation. Elementary theory of scattering: phase shifts, partial waves, Born approximation.

Quantum states of an electron in an atom. Electron spin. Spectrum of helium and alkali atom. Relativistic corrections for energy levels of hydrogen atom, hyperfine structure and isotopic shift, width of spectrum lines, LS & JJ couplings. Zeeman, Paschen-Bach & Stark effects. Electron spin resonance. Nuclear magnetic resonance, chemical shift. Frank-Condon principle. Born-Oppenheimer approximation. Electronic, rotational, vibrational and Raman spectra of diatomic molecules, selection rules. Lasers: spontaneous and stimulated emission, Einstein A & B coefficients. Optical pumping, population inversion, rate equation. Modes of resonators and coherence length.

Unit III

Laws of thermodynamics and their consequences. Thermodynamic potentials, Maxwell relations, chemical potential, phase equilibria. Phase space, micro- and macro-states. Micro-canonical, canonical and grand-canonical ensembles and partition functions. Free energy and its connection with thermodynamic quantities. Classical and quantum statistics. Ideal Bose and Fermi gases. Blackbody radiation and Planck's distribution law. First- and second-order phase transitions. Diamagnetism, paramagnetism, and ferromagnetism Bose-Einstein condensation.

Bravais lattices. Reciprocal lattice. Diffraction and the structure factor. Bonding of solids. Elastic properties, phonons, lattice specific heat. Free electron theory and electronic specific heat. Response and relaxation phenomena. Drude model of electrical and thermal conductivity. Hall effect and thermoelectric power. Electron motion in a periodic potential, band theory of solids: metals, insulators and semiconductors. Superconductivity: type-I and type-II superconductors. Josephson junctions. Superfluidity. Defects and dislocations. Ordered phases of matter: translational and orientational order, kinds of liquid crystalline order. Quasi crystals.

Unit IV

Basic nuclear properties: size, shape and charge distribution, spin and parity. Binding energy, semi-empirical mass formula, liquid drop model. Nature of the nuclear force, form of nucleon-nucleon potential, charge-independence and charge-symmetry of nuclear forces. Deuteron problem. Evidence of shell structure, single-particle shell model, its validity and limitations. Rotational spectra. Elementary ideas of alpha, beta and gamma decays and their selection rules. Fission and fusion. Nuclear reactions, reaction mechanism, compound nuclei and direct reactions.

Classification of fundamental forces. Elementary particles and their quantum numbers (charge, spin, parity, isospin, strangeness, etc.). Gellmann-Nishijima formula. Quark model, baryons and mesons.

Unit V

Electrostatics: Gauss's law and its applications, Laplace and Poisson equations, boundary value problems. Magnetostatics: Biot-Savart law, Ampere's theorem. Electromagnetic induction. Maxwell's equations in free space and linear isotropic media; boundary conditions on the fields at interfaces. Scalar and vector potentials, gauge invariance. Electromagnetic waves in free space. Dielectrics and conductors. Reflection and refraction, polarization, Fresnel's law, interference, coherence, and diffraction. Dynamics of charged particles in static and uniform electromagnetic fields. Lorentz invariance of Maxwell's equation. Radiation- from moving charges and dipoles and retarded potentials.

Semiconductor devices (diodes, junctions, transistors, field effect devices, homo- and hetero-junction devices), device structure, device characteristics, frequency dependence and applications. Operational amplifiers and their applications. Digital techniques and applications (registers, counters, comparators and similar circuits). A/D and D/A converters. Microprocessor and microcontroller basics.). Impedance matching, amplification (Op-amp based, instrumentation amp, feedback)