VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY

Jnana Sagara Campus, Vinayakanagara, Cantonment, BALLARI - 583 105.

Department of Studies in Physics

Ph.D. Entrance Test Syllabus (2021-22)

Part A: Research Methodology (40 Marks)

Unit – 1: Introduction to Research methodology

Introduction, Meaning of Research, Objectives of Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India. Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem.

Unit - 2: Review of Literature and Research Design

Place of the literature review in research - Bringing clarity and focus to research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, Review of the literature- searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed.

Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs.

Unit - 3: Interpretation, Report Writing and funding agencies

Meaning of Interpretation, Techniques of interpretation, Precautions in interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Mechanics of Writing a Research Report, Precautions for writing research proposals.

A brief idea about the funding agencies such as DAE-BRNS, DST, ISRO, CSIR and UGC.

Unit - 4 : Numerical methods for Research in Physics

Roots of equations: Newton-Raphson method. Interpolation: Newton's interpolation method. Linear algebraic equations: Gauss elimination method, LU decomposition and matrix inversion and diagonalization. Curve fitting: Least squares regression method. Numerical Integration: Simpson's 1/3 rule and Gaussian quadrature. Ordinary differential equations: Runge-Kutta method and Euler method.

Part B: Core Syllabus – Physics (60 Marks)

Unit 1: Mathematical Methods of Physics

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. Elementary probability theory, random variables, binomial, Poisson and normal distributions. Central limit theorem.

Unit 2: Classical Mechanics

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.

Unit 3: Quantum Mechanics

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.

Unit 4: Electromagnetic Theory

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.

Unit 5: Thermodynamic and Statistical Physics

Laws of thermodynamics and their consequences. Thermodynamic potentials, Maxwell relations, chemical potential, phase equilibria. Phase space, 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.

Unit 6: Electronics

Semiconductor devices (diodes, junctions, transistors, field effect devices, homo- and hetero-junction devices), device structure, device characteristics, frequency dependence and applications. Opto-electronic devices (solar cells, photo-detectors, LEDs). 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.

References Books:

1. Research Methodology: Methods and Techniques, C.R. Kothari, Gaurav Garg, New Age International 4th Edition, 2018.
2. Research Methodology a step-by step guide for beginners, Ranjit Kumar, SAGE Publications Ltd 3rd Edition, 2011.
3. Classical Mechanics by J.C. Upadhyaya.
4. Classical Mechanics by Herbert Goldstein.
5. Advanced Engineering Mathematics by Erwin Kreyszig.
6. Mathematical Physics by H.K. Das.
7. Introduction to Quantum Mechanics by D.J. Griffith.
8. Quantum mechanics concept and applications by N. Zettili.
9. Thermodynamics by Garg, Bansal and Ghosh.
10. Statistical Mechanics by R.K Pathria.
11. Fundamentals of Statistical Mechanics and Thermal Physics by F. Reif.
12. Introduction to Electrodynamics by David J. Griffiths.
13. Semiconductor Physics by Streetman.
14. Electronic devices and circuit theory by Boylestad and Nashelsky.
15. Op-Amps and Linear Integrated Circuits by Ramakant A. Gayakwad.
16. Digital Fundamentals by Flyod.

Note:

1. Ph.D. Entrance test is for 100 Marks (1 marks each) and MCQ type.
2. Research methodology (Part A) carries 40 marks and Core syllabus - Physics (Part B) carries 60 marks.

*****