Physics - 2020-21

THE M.Phil / Ph.D ENTRANCE TEST SYLLABUS

[As per M.Phil. Ordinance no.13 and Ph.D. Ordinance no.11]

The Test will have the question paper in **two parts A and B.**

The Syllabus for **Part A**: **Research Methodology [Common to all subjects of faculty of Science** (i.e. 1. Physics 2. Mathematics 3. Statistics 4. Chemistry 5. Geology 6. Pharmacy)]. 50x1=50

Part-A shall consist of **50 objective type** compulsory questions of 1 mark each based on **Research Methodology**. It shall be of generic nature, intended to assess the research aptitude of the candidate. It will primarily be designed to test reasoning ability, data interpretation and quantitative aptitude of the candidate.

23/7/18

Sanjay K. Gupta

THE M.Phil./Ph.D. ENTRANCE TEST SYLLABUS : 2020-21

Syllabus for Part-A: Research Methodology 50×1=50

[Common to all subjects of faculty of Science (i.e.1. Physics 2. Mathematics 3. Statistics 4. Chemistry 5. Geology 6. Pharmacy)].

- Meaning of research, Objective of research, Types of research, Research approaches, Significance of research, Research methods versus research methodology, Research process, Criteria of good research.
- Research Problem, Selecting the problem, Necessity of defining the problem, Technique involved in defining problem.
- Meaning of Research Design, Need for Research Design, Feature of good Design, Important Concepts Relating to Research Design: Dependent and Independent variables, Extraneous Variable, Control, Confounded Relationship, Research Hypothesis, Experimental and Non-Experimental Hypothesis, Experimental and Control Groups, Treatments, Experiment, Experimental unit (s), Research Designs in Case of Exploratory Research Studies, Descriptive and Diagnostic Research Studies.

- Quantitative and Qualitative data, Classification of Measurement Scales: Nominal Scale, Ordinal Scale, Interval Scale, Ratio Scale. Goodness of Measurement Scale: Validity, Reliability and Practicality.

- Types of data: Primary and Secondary, Methods of Collecting Primary data: Observation method, Interview method, Collection of data through questionnaires, Collection of data through schedules, Difference between questionnaires and schedule, Collection of secondary data.

- Classification of data, Tabulation, Diagrammatic and Graphical representation of data: Bar chart, Pie chart, Box plot, Histogram, Frequency polygon, Frequency Curve, Ogive.

- Measure of Central Tendencies: Mean, Median, Mode .

  Measures of Variability: Range, Quartile Deviation, Standard Deviation and Coefficient of variation.

- Meaning of Correlation, Scatter diagram, Karl Pearson Coefficient of Correlation, Rank Correlation, Regression lines, Regression coefficients, Properties of regression coefficient. Normal Distribution and its Properties

- Testing of Hypothesis and Test of significance: Null and Alternative Hypothesis, Type I and Type II errors, Critical region, Level of significance, One-Tailed and Two- Tailed Tests, Large sample tests: Test of significance for single proportion, Difference of proportions, Single mean and difference of means, Chi –Square test of goodness of fit and independence of attributes. Small sample tests: t-test for single mean, t-test for difference between two sample means, Paired t-test for difference of means, F-test for equality of population variances.

- Analysis of Variance.

- Computer languages and Operating System(OS)-Assembly language, Machine language, MS-DOS and Windows.

- MS-Word and Power point presentation.

SCHOOL OF STUDIES IN PHYSICS
VIKRAM UNIVERSITY, UJJAIN
M.Phil. /Ph.D. ENTRANCE TEST SYLLABUS 2020-21
Syllabus for Part-B: Physics

Note:- Question paper of part-B shall consist of 50 objective type compulsory questions of 1 mark each. There will be no negative marking.

1. Mathematical Methods of Physics

Vector algebra and vector calculus, Linear ordinary differential equations of first & second order, Linear transformation, Matrices, Special functions (Hermite, Bessel, Laguerre and Legendre functions), Green's function, Fourier series, Fourier and Laplace transforms.

2. Classical Mechanics

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, Poisson brackets and canonical transformation, Symmetry, Invariance and Noether's theorem, Hamilton-Jacobi theory.

3. Thermodynamics and Statistical Mechanics

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, First- and second-order phase transitions, Ising model, Bose-Einstein condensation, Diffusion equation.

4. Electromagnetic Theory

Maxwell's equations in free space and linear isotropic media. Scalar and vector potentials, Electromagnetic waves in free space, dielectrics and conductors, Dynamics of charged particles in static and uniform electromagnetic fields, Dynamics of charged particles in time varying electromagnetic fields. Dispersion relations in plasma. Lorentz invariance

of Maxwell's equations, Lorentz invariance of Maxwell's equation, Radiation from moving charges and dipoles, Retarded potential and Leinard-Wiechert potential.

5. Quantum Mechanics

Schrödinger equation (time-dependent and time-independent), Eigenvalue problems (particle in a box, harmonic oscillator etc), Tunneling through a barrier, Commutators and Heisenberg uncertainty principle, Dirac notation for state vectors, Motion in a central potential: orbital angular momentum, angular momentum algebra, spin, Hydrogen atom, Stern-Gerlach experiment, Time independent perturbation theory and applications. Variational method, Time dependent perturbation theory and Fermi's golden rule, WKB approximation. Elementary theory of scattering: phase shifts, partial waves, Born approximation, Relativistic quantum mechanics: Klein-Gordon and Dirac equations, Semi-classical theory of radiation.

6. Condensed Matter Physics

Crystal structure and Reciprocal lattice, X-ray Diffraction, Normal modes of a mono-atomic and diatomic lattice, Acoustical and Optical modes of vibration, Band theory: periodic potential and Bloch's theorem, Fermi Surfaces, Density of levels, Schrodinger equation in a weak periodic potential, Tight binding method, Cellular method, Muffin-Tin potential, APW and OPW methods, The Semi-classical model of electron dynamics, The Semi-classical theory of conduction in metals, Defects and dislocations in solids, Excitons, Luminescence, Semiconductor band structure, Number of carriers in thermal equilibrium: Intrinsic and extrinsic cases, p-n junction in equilibrium. Type I and II superconductors, Meissner effect, London equation, BCS theory, Josephson tunneling, High Tc Superconductors.

7. Atomic and Molecular Physics

Zeeman, Paschen-Bach & Stark effects, Electron spin resonance, Nuclear magnetic resonance, chemical shift, Frank-Condon principle, Born-Oppenheimer approximation, Rotational and vibrational Raman spectra of diatomic molecules, selection rules. Lasers: spontaneous and stimulated emission, Einstein's A and B coefficients, Optical pumping, population inversion, Rate equation.