GAUUTAM BUDDHA UNIVERSITY, GREATER NOIDA

SYLLABUS FOR PhD. APPLIED PHYSICS: GBU-ET

RESEARCH METHODOLOGY

Nature and Purpose of Research: Meaning of research, aim, Nature and scope of research, Prerequisites of research, Types of research: Exploratory, Descriptive and Experimental.

Research Problem: Types of research problems, Characteristics of a good research problem, Hypothesis: Meaning and types of hypothesis, Research proposal or synopsis.

Research Methods: Qualitative and Quantitative

Review of Literature: Purpose of the review, Identification of the literature, organizing the literature.

Data Collection and Analysis: Types of data, Methods of data collection, Sample and Population, Sampling Techniques, Characteristics of a good sample, Tools of Data Collection: Observation method, Interview, Questionnaire, various rating scales, Characteristics of good research tools.

Descriptive Statistics: Tabulation, Organization, and Tabulation and Graphical Representation of Quantitative data, Measures of Central Tendencies: Mean, Median, Mode Measures of Variability: Range, Quartile Deviation, Standard Deviation, and Coefficient of variation. Normal Probability Distribution: Properties of normal probability curve, Skewness and Kurtosis, Data analysis with Statistical Packages (MS-Excel, SPSS), Hypothesis Testing, Generalization and Interpretation.

Research Report: Structure and Components of Research Report, Types of Report, Characteristics of Good Research Report, Bibliographical Entries, Research Ethics

APPLIED PHYSICS

Mathematical Method of Physics:

Vector Algebra and vector calculus; Linear algebra, matrices, Cayley Hamilton theorem, eigenvalue problems; .Linear differential equations; Special functions (Hermite, Bessel, Laguerre and Legender); Fourier series, Fourier and Laplace transforms; Elements of complex analysis: Laurent series-poles, residues and evaluation of integrals; Elementary ideas about tensors; Introductory group theory, SU(2),O(3); Elements of computational techniques: roots of functions, interpolation, extrapolation, integration by trapezoid and Simpson"s rule, solution of first order differential equations using Runge-Kutta method; Finite difference methods; Elementary probability theory, random variables, binomial, Poisson and normal distributions.

Electromagnetic theory:

Electrostatics: Gauss" Law and its applications; Laplace and Poison 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 fields at interface; Scalar and vector potential; Gauge invariance; Electromagnetic wave in free space, dielectrics, and conductors; Reflection and refraction, polarization, Fresnel's Law, interface, coherence, and diffraction; Dispersion relations in plasma; Lorentz invariance of Maxwell's equations; Transmission lines and wave guides.

Quantum Mechanics:

Wave-particle duality; Wave function in coordinate and momentum representation; Commutators and Heisenberg's uncertainty principle; Matrix representation; Dirac's bra and ket notation; Schrodinger equation (time-dependent and time-independent); Eigen value problem such as particle-in-a-box, harmonic oscillator, etc.; Tunneling through a barrier; Motion in a central potential; Orbital angular momentum, Angular momentum algebra, spin; Addition of angular momenta; Hydrogen atom, spin-orbit coupling, fine structure; time independent perturbation theory and applications; Variational method; WKB approximation; Time dependent perturbation theory and Fermi's Golden Rule; Selection Rules; Semi-classical theory of radiation; Elementary theory of scattering, phase shifts, partial waves, Born approximation; Identical particles, Pauli's exclusion principle, spin-statistics connection; Relativistic quantum mechanics: Klein Gordon and Dirac equations.

Thermodynamic and Statistical Physics:

Laws of thermodynamics and their consequence; Thermodynamic potentials, Maxwell relations; Chemical potential, phase equilibria; Phase space, micro-and macro states; Microcanonical, canonical and grand-canonical ensembles and partition functions; Free energy and connection with thermodynamic quantities; First-and second—order phase transitions; Classical and quantum statistics, ideal Fermi and Bose gases; Principle of detailed balance; Blackbody radiation and Planck's distribution law; Bose-Einstein condensation; Random Walk and Brownian motion; introduction to non-equilibrium processes; Diffusion equations.

Electronics:

Semiconductor device physics, including diodes, junctions, transistors, field effect devices, laomo and hetero junction devices, device structure, device characteristics, frequency dependence and applications; Optoelectronics devices, including solar cells, photo detectors, and LEDs; High frequency devices, including generators and detectors; Operational amplifiers and their applications; Digital techniques and applications (registers, counters, comparators, and similar circuits); A/D and D/A converters; Microprocessors and microcontroller basics.

Experimental Techniques and data analysis: Data interpretation and analysis; Precision and accuracy, error analysis, propagation of errors, least squares fitting, linear and nonlinear curve fitting, chi-square test; Transducers (temperature, pressure/vacuum, magnetic field, vibration, optical, and particle detectors), measurement and control; Signals conditioning and recovery, impedance matching, amplification (Op-amp based, instrumentation; amp feedback), filtering and noise reduction, shielding and grounding; Fourier transforms; lock-in detector, box-in car integrator, modulation techniques.

Atomic and Molecular Physics:

Quantum slats of an electron in an atom; Electro spin; Stern-Gerlach experiment; Spectrum of Hydrogen, helium and alkali atoms; Relativistic corrections for energy levels of hydrogen; Hyperfine structure and isotopic shift; width of spectral lines; LS&JJ coupling; Zeeman, paschen Back & Stark effect; X-ray spectroscopy; Electron spin resonance, Nuclear magnetic resonance, chemical shift; Rotational, vibrational, electronic, and raman spectra of diatomic molecules; Frank—Condon principle and selection rules; Spontaneous and stimulated emission, Einstein A & B coefficients; Lasers, optical pumping, population inversion, rate equation; Modes of resonators and coherence length.

Condensed Matter Physics:

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; Diamagnetism, paramagnetism, and ferromagnetism; Electron motion in a periodic potential, band theory of metals, insulators and semiconductors; Superconductivity, type-I and type-11 superconductors, Josephson Junctions; Defects and dislocations; Ordered phase of matter, translational and orientational order, kinds of liquids crystalline order; Conducting polymers; Quasicrystals.