SHIVAJI UNIVERSITY, KOLHAPUR

B. Sc. Part-III (PHYSICS) Revised Syllabus with effect from June 2015

Semester V, Physics Paper- IX
Mathematical and Statistical Physics

UNIT I **(11)**

Orthogonal Curvilinear Co-ordinates:

Introduction to Cartesian, spherical polar and cylindrical co-ordinate systems, concept of orthogonal curvilinear co-ordinates, unit tangent vectors, arc length, area and volume elements in orthogonal curvilinear co-ordinate system, gradient, divergence, curl, del and Laplacian in orthogonal curvilinear co-ordinate system, extension of gradient, divergence, curl, del and Laplacian in Cartesian, spherical polar and cylindrical co-ordinate systems.

UNIT II **(12)**

Differential Equations:

Types of differential equations, degree, order, linearity, homogeneity of differential equations, Method of separation of variablesfor solving partial differential equations, solutions of Laplace equation in two dimension $\frac{\partial^2 \emptyset}{\partial x^2} + \frac{\partial^2 \emptyset}{\partial y^2} = 0$andwave equation$\frac{\partial^2 \psi}{\partial t^2} = \boldsymbol{c^2} \frac{\partial^2 \psi}{\partial x^2}$.

Basic Concepts in Statistical Physics:

Micro and macro states, micro canonical and canonical ensembles, phase space,accessible micro states, apriori probability, thermodynamic probability, probability distribution,most probable distribution, entropy and probability.

UNIT III **(11)**

Maxwell-Boltzman Statistics:

M-B distribution law, evaluation of constants α and β, molecular speeds(most probable, average and r.m.s. speeds), law of equipartition of energy.

Black Body Radiation:

Experimental study of black body radiation spectrum, expression for energy density,radiation pressure, relation for radiation pressure due to diffuse radiation in terms of energy density.

UNIT IV **(11)**

Quantum Statistics:

Bose-Einstein statistics, B-E distribution law, derivation of Planck's radiation formula, deductions of Rayleigh-Jean's law, Wien's distribution law, Wien's displacement law and Stefan's law from Planck's formula.

Fermi-Dirac Statistics, F-D distribution law, comparison between M-B, B-E and F-D statistics.

References:

1. Theory and problems of vector analysis- Schaum outline series- Murray R. Spiegel
2. Introduction of Classical Mechanics – R. G. Takawale and P. S. Puranik.
3. Mathematical Methods for Physics – Gorge Arfken.
4. Perspectives of Modern Physics –A. Beiser. IIIrdEdition.
5. Thermodynamics & Statistical physics – Sharma, Sarkar.
6. Statistical Mechanics – B. B. Laud.
7. Statistical & Thermal Physics – S. Loknathan.
8. Statistical Mechanics – Satya Prakash, J. P. Agarwal.
9. Elementary StatisticalMechanics- Kumar, Gupta.
10. An Approach to Statistical Physics- Debi Prasad Ray.
11. Treatise on Heat -Saha and Srivastav.

Semester-V, Physics Paper – X
Quantum Mechanics

UNIT I **(11)**

Schrodinger's Equation:

Physical interpretation of wave function,Schrodinger's time independent (steady state) and time dependent wave equations (one and three dimensional), General solution of Schrodinger's equation, Requirements of Eigen functions, Eigen values, Eigen value equation, Normalized, Orthogonal and Orthonormal wave functions, Probability current density (Continuity equation).

UNIT II **(11)**

Operators in Quantum Mechanics:

Definition of an operator, commutation relation in quantum mechanics, Position operator(x), Linear momentum operator (P), Commutation relation between x and P, Kinetic energy operator (T), Hamiltonian operator (H), parity operator (π), Hermitian operator, Expectation value of an operator, Angular momentum operator (L) – Components in Cartesian co-ordinate system(Lx, Ly, Lz), Commutation relation between components of L, Commutation relation between L^2 and components of L, Ladder (raising and lowering) operators L+ and L-, Eigen values of L^2 and Lz, Possible orientations of L w.r.t. Z- axis.

UNIT III **(12)**

One and Three Dimensional Problems:

Quantum mechanical treatment of particle in a rigid box (one and three dimensional), Step potential- reflection and transmission coefficients, Barrier potential - Tunneling effect (qualitative treatment), explanation of α- decay, Simple harmonic oscillator (operator method).

UNIT IV **(11)**

Hydrogen Atom:

Schrodinger's equation for hydrogen atom in spherical polar coordinates, Separation of angular and radial parts, Solution of radial Schrodinger's equation to obtain energy values, Significance of quantum numbers n, l, m_l and m_s .

References:

1. Perspective of Modern Physics – Arthur Beiser.
2. Introduction to Quantum Mechanics – P. T. Mathew.
3. Quantum Mechanics – J. Powell and B. Crusemann.
4. Quantum Mechanics - Ghatak and Loknathan.
5. Quantum Mechanics – S. L. Gupta, K. Kumar, H. V. Sharma.
6. A Text Book of Quantum Mechanics – P. M. Mathew, K. Venkateshwaran.
7. Quantum Mechanics – Bagade and Singh.
8. Quantum Mechanics – Chand Kiran Singh.
9. Introduction to Quantum Mechanics – Rojansk.
10. Quantum Mechanics – Chatwal and Anand.
11. Quantum Mechanics – A. P. French.
12. Introduction to Quantum Mechanics – Dicke-White.
13. Introduction to Quantum Mechanics – Pauling and Wilson.
14. Quantum Mechanics- V. K. Wagh and M. K. Yeole (NiraliPrakashan Pune)

Semester-V,Physics Paper – XI
Classical Mechanics

UNIT I **(11)**

Introduction to Mechanics:

Mechanics of particle, conservation theorems for linear momentum, angular momentum and energy, Mechanics of system of particles, concept of center of mass,conservation theorems for many particle system(linear momentum, angular momentum and energy).

UNIT II **(12)**

Moving Co-ordinate System:

Moving origin of co-ordinates, pseudo force, rotating co-ordinate system, Coriolis force, effect of Coriolis force in nature (Flight of missiles and formation of cyclones)

Coupled Oscillations:

Frequencies of coupled oscillatory systems,normal modes and normal coordinates, energy of coupled oscillations, energy transfer in coupled oscillatory system.

UNIT III **(11)**

Langrangian Formulation:

Constraints, degrees of freedom, generalized co-ordinates, principle of virtual work, D'Alembert's principle, Lagrange's equation from D'Alembert's principle,Applications of Langrange's equation to (i) A particle in space (Cartesian co-ordinates), (ii) Atwood's machine and (iii) A bead sliding on uniformly rotating wire(under force free condition).

UNIT IV **(11)**

Techniques of Calculus of Variation:

Hamilton's principle, deduction of Hamilton's principle from D'Alembert's principle, deduction of Langrange's equation from Hamilton's principle,Applications – (i) Shortest distance between two points in a plane, (ii)Brachistochrone problem.

Rigid body motion:

Motion of rigid body in space, Euler's theorem, angular momentum and kinetic energy, Euler's equations of motion.

References:

1. Classical Mechanics – H. Goldstein.
2. Classical Mechanics – N. C. Rana and P. S. Joag
3. Classical Mechanics – Gupta, Kumar and Sharma.
4. Classical mechanics – P.V. Panat
5. Introduction to Classical Mechanics- R.G.Takawale and P.S. Puranik

Semester-V,Physics Paper – XII
Atomic and Molecular Spectra, Astronomy and Astrophysics

UNIT I **(11)**

Doublet Fine Structure:

Optical spectral series, spectral notations, spectrum of sodium, doublet fine structure, selection rule for doublets, intensity rules for fine structure doublets, normal order of fine structure doublets, electron spin-orbit interaction, calculation of term value of fine structure level.

UNIT II **(11)**

Effects of Magnetic field on Atomic Spectra:

Anomalous Zeeman effect and its explanation from vector atom model of one electron system in a weak magnetic field, Lande's**g** factor, Paschen-Back effect, Paschen- Back effect in principal series doublets, selection rules for Paschen-Back effect, difference between Zeeman and Paschen-Back effect.

UNIT III **(12)**

Molecular Spectra:

Molecular bond, electron sharing, H_2^+ molecular ion, hydrogen molecule, rotational energy levels, rotational spectra, vibrational energy levels, vibrational spectra, vibration-rotational spectra.

Raman Effect:

Raman Effect, characteristic properties of Raman lines, difference between Raman spectra and infrared spectra, classical theory of Raman Effect.

UNIT IV **(11)**

Milky Way Galaxy and Solar System:

The Milky Way galaxy, origin of solar system, condensation theory, arguments for and against the theory, early history of planets, The Mars-planetary properties, evidence of geological activities, prospects for life on Mars, The Sun- surface of the Sun, Sunspots, Sunspot cycle.

Cosmology:

The Big-Bang cosmology, the steady state cosmology, the oscillating cosmology, Hubble law and cosmological test, other evidence of Big Bang cosmology.

References:

1. Atomic and Nuclear Physics – H. Semat and T. E. Albright.
2. Introduction to Atomic Spectra – H. E. White.
3. Introduction to Atomic & Nuclear Physics:H.E. White
4. Concept of Modern Physics – Arthur Beiser.
5. Perspective of Modern Physics – Arthur Beiser.
6. Atomic Physics: J.B.Rajam.

7. Spectroscopy (Atomic and Molecular) – Gurdeep Chatwal, Sham Anand.
8. Astronomy – Fundamentals and Frontiers – Robert Jastrow and M. H. Thompson
9. Astronomy – Frank Bash.

B. Sc. Part-III
Semester-VI, Physics Paper – XIII
Nuclear and Particle Physics

UNIT I **(11)**

Accelerators:

Need of accelerators, Cyclotron- construction, working, theory- expression for energy of cyclotron and its limitations, Principle of phase stable orbits, Synchrocyclotron- construction, working, advantages, disadvantages. Betatron- Principle, construction, working condition, expression of energy gain.

Nuclear Detectors:

Geiger-Muller counter-construction, working, ionization and discharge, avalanche of electrons, dead time and recovery time, quenching mechanism, uses and limitations of GM Counter. Bubble chamber- principle, construction, working, advantages,limitations. Scintillation counter- principle, construction, working and advantages. Wilson cloud chamber- principle, construction, working and advantages.

UNIT II **(11)**

Structure of Nucleus and its Properties:

Composition of nucleus, Nuclear size, Nuclear radius, Nuclear spin, Nuclear magnetic moment, Electric quadrupole moment, Mass defect, Packing fraction, Magic numbers, Binding energy, Binding energy per nucleon and its variation with mass number, Nucleus as a liquid drop, Liquid drop model of nucleus to obtain semi-empirical mass formula.

UNIT III **(11)**

Nuclear Energy Levels:

Alpha decay - α ray spectra, α disintegration energy, nuclear energy levelsof α emitters.

Beta decay- experimental study of β ray spectra, continuous nature ofβ ray spectrum, end point energy, conservation theorems, neutrino hypothesis.

Gamma decay - origin of γ rays (nuclear and internal conversion), orbital electron capture, nuclear energy levels.

UNIT IV **(12)**

Nuclear Reactions:

General scheme of nuclear reactions, Q value of reaction, calculation of Q value of reaction, exothermic andendothermic nuclear reactions, threshold energy, deuteron induced reactions, stripping reaction.

Elementary Particles:

Origin of Cosmic rays, soft and hard components of cosmic rays, elementary particles and their classification into leptons, mesons and baryons.

References:

1. Nuclear Physics – Kaplan.
2. Nuclear Physics – D. C. Tayal.
3. Atomic Physics – Yarwood.
4. Introduction to Nuclear Physics- H. AEnge (Addition Wesley co.)
5. Nuclear Physics – S. B. Patel.
6. Nuclear Physics – J. B. Rajam.
7. Nuclear Physics – Burcham.
8. Basic Concepts of Nuclear Physics – Cohen.
9. Atomic and Nuclear Physics – N. Subramanayam and Brijlal
10. Nuclear Physics – Rajkumar
11. Nuclear Physics – B.N.Shrivastav

Semester-VI, Paper - XIV
Energy Studies and Materials Science

UNIT I **(11)**

Renewable energy resources:

Energy, Classification of energy resources, age of renewable and alternatives, energy demands, wind energy, wind energy chains, wind energy quantum, wind power density, power of wind turbine for a given incoming wind velocity, Efficiency factor of wind turbine(P-H graph), types of a wind turbine generator unit, horizontal axis propeller type wind turbine generator unit.

UNIT II **(11)**

Solar Energy:

Solar energy, Solar energy spectrum(UV,Visible and IR), thermal route, photovoltaic route, essential subsystems in solar energy plant, solar constant, clarity index, solar insolation, solar energy from satellite station through microwave to earth station, solar photovoltaic systems, merits and limitations of solar PV systems, prospectus of solar PV systems, power of a solar cell and solar PV panel.

UNIT III **(12)**

1. Atomic Disorder in Materials:

Impurities in solids, Solid solution in metals, Rules of solid solubility, Imperfection in crystals, Defects in solids-point, line, surface and volume, Atomic diffusions- definition, mechanism, Fick's laws.

2. Superconductivity:

Idea of superconductivity, Critical temperature, effect of magnetic field, Meissner Effect, Type – I and Type – II superconductors

UNIT IV **(11)**

Nanotechnology:

Introduction of nano-science and nanotechnology, synthesis of nano-materials by 1) Mechanical method, 2) Evaporation based methods – sputter deposition and chemical vapor deposition (CVD), 3) Chemical method – growth of nano-particles, synthesis of metal and semiconductor nano-particles by colloidal route method, Applications of nano-particles(in brief)

References:

1. Energy Technology – Non conventional, Renewable and Conventional – S.Rao and Dr. Parulekar.
2. Non conventional Energy sources - G. D. Rai (4th edition), Khanna Publishers,Delhi.
3. Solar Energy - S.P. Sukhatme (second edition), Tata Mc.Graw Hill Ltd, New Delhi.
4. Solar Energy Utilization-G. D. Rai (5th edition), Khanna Publishers,Delhi.
5. Non Conventional Energy Sources – G. D. Rai (KhannaPublishers).
6. Nanotechnology: Principles and Practices- Sulbha K Kulkarni (2nd Edition,Capital Publishing Co. New Delhi.
7. Elements of Material Science and Engineering-I.H.Vanvlach (4^{th} Edition)
8. Material Science and Engineering- V. Raghva
9. Material science and metallurgy for Engg.-Kodigire V. D. Everest publication house, Pune
10. Material Science and Engg. - 5^{th} Edition- V. Raghavan PHI Learning Pvt. Ltd. Delhi
11. Solid state Physics 7^{th} edition- S. O. Pillai New Age International Publishers New Delhi.

Semester-VI, Physics Paper- XV
Electrodynamics and Electromagnetic Waves

UNIT I **(11)**

Electrostatics and Charged Particle Dynamics:

Poisson's and Laplace's equations and theirphysical significance, Laplace's equation in one dimension and its solution(Cartesian co-ordinate), motion of charged particle in (i)uniform electric field $\vec{E}$ (ii)uniform magnetic field $\vec{B}$ (iii)crossed uniform electric $\vec{E}$ and magnetic $\vec{B}$ fields.

UNIT II **(11)**

Time Varying Fields:

E.M.F., motional e.m.f. ,electromagnetic induction – Faraday's law (integral and differential forms), Lenz's law, self and mutual inductance, Neumann's formula, applications to transformers and solenoid, energy in magnetic field.

UNIT III **(11)**

Maxwell's Equations:

Biot-Savart's law, Equation of continuity, Ampere's law(Integral and differential forms), derivation of $\vec{\nabla}.\vec{B}=0$ and $\vec{\nabla}\times\vec{B}=\vec{J}$, displacement current, Maxwell's correction to Ampere's law, Maxwell's equations for time dependent electric and magnetic fields in vacuum and dielectric medium**,** physical significance of Maxwell's equations.

UNIT IV **(12)**

Electromagnetic Waves:

Wave equation for $\vec{E}$ and $\vec{B}$ fields in vacuum, plane wave solutions, transverse nature of electromagnetic waves, orthogonality of $\vec{E}$, $\vec{B}$ and propagation vector $\vec{k}$, plane electromagnetic waves in vacuum, attenuation of wave in metal (qualitative treatment only),skin depth, Poynting's theorem, conservation of energy in electromagnetic fields, Boundary conditions for electromagnetic field vectors.

References:

1. Introduction to Electrodynamics (3rd edition) - David J. Griffith.
2. Foundations of Electromagnetic Theory-John R. Reitz, Frederick J.Milford, Robert W. Christy.
3. Classical Electrodynamics - S. P. Puri.
4. Classical Electrodynamics - J. D. Jackson.
5. Electromagnetics - B. B. Laud.
6. Electrodynamics - Kumar & Gupta

Semester-VI, Physics Paper - XVI
Solid State Physics

UNIT I **(11)**

Crystal Structure:

Crystalline and non crystalline solids, space lattice, basis andcrystal structure, Unit cell-primitive and non-primitive, Bravais lattices- space groups and crystal structures, symmetry elements of cubic system, Miller indices, relation between lattice constant, interplaner spacing and Miller indices, Simple crystal structures - Cubic (SC, BCC, FCC) and hexagonal close packed (HCP) (with respect to coordination number, atomic radius, atoms per unit cell, packing fraction).

UNIT II **(11)**

X – Ray Diffraction by Crystals:

Reciprocal lattice, Properties of reciprocal lattice, Bragg's law in reciprocalLattice (Ewald's construction), Powder method of X- ray diffraction and analysis of cubic crystal structure.

UNIT III **(11)**

Lattice vibrations:

Elastic vibrations of linear one dimensional mono-atomic lattice, Expression for frequency and dispersion curve, Elastic vibrations of linear one dimensional diatomic lattice –optical and acoustical excitations in ionic crystals, Experimental determination of dispersion relations.

UNIT IV **(12)**

Free Electron Theory of Metals and Band Theory of Solids: Somerfield's free electron model for electrical conductivity of metals, Fermi-Dirac distribution, Origin of energy bands- valence band, conduction band, Band gap energy, distinction between metals, semiconductors and insulators, Hall Effect-Hall voltage and Hall Coefficient.

Solid State Device:

Timer (IC555)-Block diagram, function of each block, pin configuration, Applications-Astable, Monostable and Bistablemultivibrator.

References:

1. Solid State Physics – S. O. Pillai (Wiley Eastern Ltd.)
2. Solid State Physics – A. J. Dekker.
3. Solid State Physics – C. M. Kachhava (TMH).
4. Solid State Physics – Charles Kittel.
5. Solid State Physics – R. L. Singhal.
6. Electronic devices and circuits – Millman and Halkias(TMH).
7. Linear Integrated Circuits- K.R. Botkar.

B. Sc. – III Practicals

List of Experiments

Group I: General Physics, Heat and Sound

1. Resonance Pendulum.
2. S. T. of a soap film.
3. S. T. by Fergusson's modified method.
4. Y/η using flat spiral spring.
5. Y by Koenig's method.
6. Y by Cornu's method.
7. Stefan's fourth power law.
8. Thermal conductivity – Lee's method.
9. Velocity of sound using CRO and microphone.
10. Temperature of flame.

Group II: Optics

1. Cardinal points by turn table.
2. Cardinal points by Newton's method.
3. Thickness of thin film.
4. Diffraction due to single slit using sodium / laser source.
5. Diffraction due to cylindrical obstacle.
6. Diffraction at straight edge.
7. Lloyd's single mirror.
8. Diameter of Lycopodium powder.
9. Spherical aberration /μ by total internal reflection
10. Absorption spectrum of a liquid ($KMnO_4$ solution).

Group III: Electricity and Magnetism

1. Self inductance by Owen's bridge.
2. Self inductance by Maxwell's bridge.
3. Self inductance by Rayleigh's method.
4. Measurement of B_H , B_V and angle of dip using Earth inductor.
5. Hysteresis by magnetometer method.
6. High resistance by leakage.
7. Resistance of B. G. by half deflection method.
8. Calibration of wire – Carey Foster's method.
9. e / m by Thomson method.
10. Absolute capacity of a condenser.

Group IV: Electronics

1. UJT as voltage sweep generator.
2. Astablemultivibrator using IC 555.
3. IC-555 as a monostablemultivibrator.
4. OP AMP as inverting amplifier.
5. OP AMP as comparator–Schmitt trigger/Study of variable D.C. supply using IC-LM317
6. I-V characteristics of solar cell.
7. Crystal oscillator.
8. Determination of Planck's constant
9. Negative feedback amplifier
10. Band gap energy / temperature sensor using semiconductor diode

Group V: Skill Testing Experiments

Group V-A

1. Study of divergence of LASER beam.
2. Polar graph using photo cell / photo voltaic cell.
3. Measurement of wave length of LASER beam using plane diffraction grating.

4. Schuster's method and optical leveling of a spectrometer.
5. Obtaining Biprism fringes without lateral shift.
6. Measurement of distance between two coherent sources in biprism.
7. Comparison of capacities by measuring throws separately.
8. Testing of electronic components.
9. Hysteresis by CRO.
10. Study of Lissajeous figures using CRO.

Group V-B

1. P. O. box- Measurement of resistance of galvanometer (Kelvin's method).
2. Study of time base circuit.
3. Determining of the radius of capillary bore using mercury thread.
4. Determining Lattice constant using given XRD powder pattern.
5. Estimation of errors for given experimental data and formula.
6. Measurement of phase shift of RC network using CRO.
7. Study of half and full adder.
8. Computer skill testing III (MS Office- Excel).
9. Computer skill testing IV (MS Office – Power point Presentation).
10. Use of Internet (Creating Email Account, sending and receiving Email, browsing Web Pages)

Group VI: Assessment of Annual Work of a Student

1. Certified Laboratory Journal.
2. Study Tour Report.
3. Seminar Report (2 Seminars) / Project work.

Revised Scheme of Practical Examination for B. Sc. Part – III

1. Practical examination will be conducted annually.
2. Practical examination will be conducted for three days per batch.
3. The examination will be conducted in two sessions per day and each session will be of three hours duration.
4. Every candidate should perform one experiment each from Groups I to IV and oneexperiment each from Group V-A and Group V-B (total 6 experiments).
5. Study tour up to seven days anywhere in India is compulsory.
6. At least eighty percent practical should be completed by the student
7. The marks distribution for practical is as below.

Practical groups	**Marks**
Group I	30
Group II	30
Group III	30
Group IV	30
Group V-A, Group V-B ,(15+15)	30
Group VI I) Certified laboratory journal II) Study Tour Report III) Seminar Report / Project Report	 20 10 20

Equivalence

Sr. No.	**Pre-revised Syllabus**	**Revised Syllabus**
1	Sem-V, Paper - IX	Sem-V, Paper – IX
2	Sem-V, Paper- X	Sem-VI, Paper – XVI
3	Sem-V, Paper – XI	Sem-V, Paper – XI
4	Sem-V, Paper – XII	Sem-V, Paper – XII
5	Sem-VI, Paper - XIII	Sem-VI, Paper - XIII
6	Sem-VI, Paper – XIV	Sem-VI, Paper – XIV
7	Sem-VI, Paper – XV	Sem-VI, Paper – XV
8	Sem-VI, Paper – XVI	Sem-V, Paper – X

Nature of Question papers (Theory)

COMMON NATURE OF QUESTION FOR THEORY PAPER MENTIONED SPERATELY: