SHIVAJI UNIVERSITY, KOLHAPUR
B. Sc. Part-III (PHYSICS) Revised Syllabus with effect from June 2013
Semester V Physics Paper – IX
(Mathematical & Statistical Physics)

UNIT I

Orthogonal Curvilinear Co-ordinates: (11)

Introduction to Cartesian, spherical polar and cylindrical co-ordinate systems, concept of orthogonal curvilinear co-ordinates, 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

Basic Concepts in Statistical Physics: (11)

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

UNIT III

1. **Maxwell-Boltzman Statistics**: (05)

M-B distribution law, evaluation of constants α and β, molecular speeds, law of equipartition of energy.

2. **Black Body Radiation**: (06)

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

Quantum Statistics (11)

Bose-Einstein statistics, BE distribution law, derivation of Planck's radiation formula, deductions of Rayleigh-Jean's law, Wien's law, Wien's displacement law and Stefan's law from Planck's formula, Fermi-Dirac statistics, FD distribution law, comparison of three statistics.

References:

1. Theory and problems of vector analysis - Schaum outline series- Murray R. Spiegel
2. Introduction to Classical Mechanics - R. G. Takawale and P. S. Puranik.
3. Mathematical methods for Physics – Gorge Arfken.
4. Perspectives of Modern Physics – A. Beiser.IIIrd Edition
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 statistical mechanics – Kumar, Gupta.
10. An approach to Statistical Physics- Debi Prasad Ray.
11. Treatise on Heat by Saha and Srivastav.

Semester V Physics Paper - X
Solid state Physics and Solid State Devices

UNIT I

Crystal Structure: (11)

Difference between crystalline and non crystalline solids, space lattice, basis and crystal structure, unit cell, symmetry elements of a cube, Bravais lattices two dimensional, three dimensional (seven crystal systems), Miller indices, relation among lattice constant, Miller indices and interplaner spacing, simple crystal structures - cubic (simple, BCC, FCC) and HCP (with respect to co-ordination number, atomic radius, atoms per unit cell, packing fraction).

UNIT II

X – Ray Diffraction by Crystals: (11)

Reciprocal lattice, Properties of reciprocal lattice (Reciprocal of the reciprocal lattice is direct lattice and volume of the unit cell of reciprocal lattice is inversely proportional to the volume unit cell of the direct lattice), Bragg's law in reciprocal lattice, powder method of X- ray diffraction in reciprocal lattice.

UNIT III

1. **Free Energy Theory**: (05)

Free electron model, Fermi-Dirac distribution, energy levels and energy density of orbital in one dimension.

2. **Band Theory of Solids**: (07)

Origin of energy bands, one electron approximation, Bloch theorem (statement only), motion of electron in one dimensional periodic potential (Kronig-Penny model), effective mass of an electron, distinction between metals, semiconductors and insulators, Hall Effect (Expression for Hall voltage and Hall coefficient).

UNIT IV

1. **Field Effect Transistor**: (06)

Types of FET, construction, working and characteristics of JFET, application of FET as VVR.

2. **Unijunction Transistor**: (05)

Construction, working and characteristics of UJT, concept of negative resistance of UJT, application of UJT as voltage sweep generator.

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. Principles of Electronics (7th edition) – V. K. Mehta (S. Chand).

Semester V Physics Paper – XI
Classical Mechanics

UNIT I

Introduction to Mechanics : (11)

Mechanics of a particle, conservation theorems for Linear momentum, Angular momentum and energy, mechanics of system of particles, concept of centre of mass, conservation theorems for many particle system (Linear momentum, Angular momentum and energy).

UNIT II

1. **Moving Co-ordinate System**; (07)

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).

2. **Coupled Oscillations**: (05)

Frequencies of coupled oscillatory systems, normal modes and normal co-ordinates, energy of coupled oscillations, energy transfer in coupled oscillatory system.

UNIT III

Langrangian Formulation: (11)

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

UNIT IV

Techniques of Calculus of Variation: (11)

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.

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. Takwale and P. S. Puranik.

Semester V Physics Paper – XII
Atomic Physics, Astronomy and Astrophysics

UNIT I

Doublet Fine Structure: (11)

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

Effects of Magnetic field on Atomic Spectra: (11)

Anomalous Zeeman effect and its explanation from vector atom model of one electron system in a weak magnetic field, Lande's g factor, the 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

1. **Molecular Spectra:** (08)

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

2. **Raman Effect**: (04)

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

UNIT IV

1. **Cosmology**: (04)

The Big-Bang theory, the steady state theory, the oscillating theory, The Hubble law, cosmological tests.

2. **Milky Way Galaxy and Solar System**: (07)

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

References :

1. Atomic and Nuclear Physics – H. Semat and T. E. Albright.
2. Introduction to Atomic Spectra – H. E. White.
3. Concept of Modern Physics – Arthur Beiser.
4. Perspective of Modern Physics – Arthur Beiser. .
5. Spectroscopy (Atomic and Molecular) – Gurdeep Chatwal, Sham Anand.
6. Astronomy – Fundamentals and Frontiers – Robert jastrow and M. H. Thompson
7. Astronomy – Frank Bash.

Semester VI Physics Paper – XIII
Nuclear and Particle Physics

UNIT I

1. **Accelerator**: (06)

Need of accelerators, orbital accelerators, Cyclotron, expression for energy of cyclotron and its limitations, phase stable orbits, Syncrocyclotron, Betatron.

2. **Nuclear detectors**: (05)

Geiger-Muller counter, its construction and working, dead time, self quenching mechanism, bubble chamber, scintillation counter.

UNIT II

Structure of nucleus and its properties (11)

Composition of nucleus, nuclear size, nuclear radius, nuclear spin, magnetic moment, electric quadrupole moment, mass defect, packing fraction, 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, shell model(assumption, magic number and prediction).

UNIT III

Nuclear Energy Levels: (11)

Alpha decay: - α particle spectra, α disintegration energy, nuclear energy levels of α emitters.

Beta decay:–experimental study of β ray spectra, continuous nature of 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

1. **Nuclear Reactions**: (06)

General scheme of nuclear reactions, Q value of reaction, exothermic and endothermic nuclear reactions, threshold energy, cross section of nuclear reactions (qualitative), deuteron induced reactions, stripping reaction.

2. **Elementary Particles**: (06)

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. Electricity, magnetism and Atomic Physics – Yarwood.
4. Nuclear Physics – S. B. Patel.
5. Nuclear Physics – J. B. Rajam.
6. Nuclear Physics – Burcham.
7. Basic Concepts of Nuclear Physics – Cohen.

Semester VI Paper - XIV
Energy Studies and Material Science

UNIT I

1. **Energy**: (06)

Energy, different forms of energy, man and environment, conventional and non conventional energy sources, energy chains, energy demands.

2. **Wind Energy**: (06)

Applications of wind energy, wind energy quantum, wind power density, power of a wind turbine for a given incoming wind velocity, types of a wind turbine generator unit- horizontal axis and vertical axis propeller type wind turbine generator unit, mono, twin and three blade HAWT.

UNIT II

Solar Energy: (11)

Solar energy, essential subsystems in solar energy plant, solar energy chains, solar constant, clarity index, solar isolation, solar energy from satellite station through microwave to earth station, solar photovoltaic systems, merits and limitations of solar PV systems, prospects of solar PV systems, power of a solar cell and solar PV panel.

UNIT III

1. **Magnetism**: (05)

Type of magnetic materials, hysteresis, expression for energy loss in hysteresis, idea of ferrites.

2. **Superconductivity**: (06)

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

UNIT IV

Nanothechnology : (11)

Introduction of nanoscience and nanotechnology, properties of nanomaterials, synthesis of nanomaterials 1) Lithography (Top down approach) 2) Nucleation and growth (Bottom up approach), applications of nanoparticles (in brief).

References:

1. Energy Technology – Non conventional, Renewable and Conventional – S. Rao and Dr. Parulekar.
2. Solar Energy and Rural Development – S. H. Pawar, C. D. Lokhande and R. N. Patil.
3. Non Conventional Energy Sources – G. D. Rai (Khanna Publishers).
4. Solid State Physics – A. J. Dekker.
5. Solid state Physics – Charles Kittel.
6. Electricity and Magnetism – Khare and Shrivastava.
7. Electricity and Magnetism – S. G. Sterling.
8. Principles of nanotechnology – S. K. Kulkarni

Semester VI Physics Paper – XV
Electrodynamics and Electromagnetic Waves

UNIT I

1. Electrostatics and Charged Particle Dynamics: (11)

Statement and significance of Poisson's and Laplace's equations, motion of charged particles in (i) uniform electric field (E) (ii) uniform magnetic (B) fields (iii) crossed uniform electric (E) and magnetic (B) fields.

UNIT II

2. Time Varying Fields: (11)

E. M. F., electromagnetic induction– Faraday's law (integral and differential forms), Lenz's law, mutual and self inductance, applications to transformer and solenoid, energy in magnetic field.

UNIT III

Maxwell's Equations : (11)

Bio-Savart's law, Ampere's law, derivation of $\nabla.B=0$ and $\nabla xB=J$, displacement current, Maxwell's correction to Ampere's law, Maxwell's equations for time dependent electric and magnetic fields in vacuum and dielectric medum.

UNIT IV

Electromagnetic Waves: (12)

Wave equation for (E) and (B) fields in vacuum, plane wave solutions, orthogonality of E, B and propagation vector (k), plane electromagnetic waves in vacuum, attenuation of wave in metal (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. Classical Electrodynamics – S. P. Puri.
3. Classical Electrodynamics – J. D. Jackson.
4. Electrodynamics – B. B. Laud.

Semester VI Physics Paper - XVI
Quantum Mechanics

UNIT I

Schrodinger's Equation: (11)

Physical interpretation of wave function, requirements of wave function time dependent and time independent Schrodinger's wave equations (one and three dimensional), probability current density, eigen values and eigen functions, expectation values.

UNIT II

Applications of Schrodinger's Equation: (11)

Applications of Schrodinger's time independent wave equation to a particle in a rigid box (one and three dimensional), step potential-reflection and transmission coefficients, potential barrier penetration (qualitative treatment only).

UNIT III

Hydrogen Atom (11)

Schrodinger's equation for hydrogen atom, separation of radial and angular parts, solution of radial Schrodinger's equation to obtain energy values, significance of quantum numbers n, l, m_l and m_s .

UNIT IV

Operators in Quantum Mechanics: (12)

Definition of operators, Linear momentum operator (p), kinetic energy operator (T), Hamiltonian operator (H), parity operator (π) and angular momentum operator(L) in Cartesian co-ordinates, commutators, commutator brackets involving position, linear momentum and angular momentum operators, raising and lowering operators L_+ and L_-, Eigen values of L^2 and L_z.

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.

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 and 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 aberratio /M by total internal Reflection
10. Absorption spectrum of a liquid (KMnO4 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 (Worsnop and Flint).

Group IV: Electronics

1. UJT as voltage sweep generator.
2. Astable multivibrator using IC 555.
3. OP AMP as inverting amplifier.
4. OP AMP as comparator–Schmitt trigger/Study of variable D.C. supply using IC-317
5. I V characteristics of solar cell.

6. Use of Internet(Creating Email Account, sending and receiving Email, browsing Web Pages)
7. Crystal oscillator.
8. Characteristics of FET.
9. FET as VVR.
10. Band gap energy / temperature sensor using semiconductor diode/IC-555 as a monostable multivibrator.

Group V: Skill Testing Experiments

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.
11. P. O. box- Measurement of resistance of galvanometer (Kelvin's method).
12. Study of time base circuit.
13. Determining of the radius of capillary bore using mercury thread.
14. Determining Lattice constant using given XRD powder pattern.
15. Estimation of errors for given experimental data and formula.
16. Measurement of phase shift of RC network using CRO.
17. Computer skill testing I (Programming in C).
18. Computer skill testing II (MS Office - Word).
19. Computer skill testing III (MS Office- Excel).
20. Computer skill testing IV (MS Office – Power point Presentation).

Group VI: Assessment of Annual Work of a Student

1. Certified Laboratory Journal.
2. Study Tour Report.
3. Seminar Report (2 seminars).

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 **any two** experiments from Group V (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	32
Group II	32
Group III	32
Group IV	32
Gr. V	(16+16) 32
Gr.VI I) Certified laboratory journal II) Study Tour Report III) Seminar Report	 20 10 10

Equivalence

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

Nature of question paper

Theory

Time 2 hours Marks 40

Question 1: Multiple choice question (Compulsory) 8 marks
(Three alternatives for each question)

Question 2: (Attempt any two out of three) 16 marks
(Long answer type)

Question 3: (Attempt any four out of six) 16 marks
(Short answer type)

<u>For internal evaluation of 10 marks</u>

One tutorial/project of 10 marks for each paper for semester V and semester VI.