# SHIVAJI UNIVERSITY, KOLHAPUR

B. Sc. Part-III ( PHYSICS ) Revised Syllabus with effect from June 2010

## Physics Paper – V

( Mathematical & Statistical Physics, Nuclear & Particle Physics )

### Section - I : Mathematical and Statistical Physics

UNIT I

**Orthogonal Curvilinear Co-ordinates : ( 12 )**

Introduction to Cartesian, spherical, polar and cylindrical co-ordinate system, concept of orthogonal curvilinear co-ordinates, gradient, divergence, curl, del and Laplacian in orthogonal curvilinear co-ordinate system, extension of these in Cartesian, spherical polar and cylindrical co-ordinate systems.

UNIT II

**1. Differential Equations : ( 05 )**

Types of differential equations, degree, order, linearity, homogeneity of differential equations, Method of separation of variables for solving partial differential equation, singular points of differential equations such as Legendre equation, Bessel equation.

**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 III

**1. Basic concepts in Statistical Physics : ( 06 )**

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

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

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

UNIT IV

**1. Quantum Statistics- I : ( 08 )**

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.

**2. Quantum Statistics-II : ( 03 )**

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. Differential equations ( 3rd edition ) – Shepley L. Ross.
5. Perspectives of Modern Physics – a. Beiser.
6. Thermodynamics & Statistical physics – Sharma, Sarkar.
7. Statistical Mechanics – B. B. Laud.
8. Statistical & Thermal Physics – S. Loknathan.
9. Statistical Mechanics – Satya Prakash, J. P. Agarwal
10. Elementary statistical mechanics – Kumar, Gupta.
11. An approach to Statistical Physics- Debi Prasad Ray.


## Section – II : Nuclear and Particle Physics

### UNIT V

1. Accelerator : ( 06 )

Need of accelerators, orbital accelerators, Cyclotron, 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 VI

1. Structure and Nuclear Properties : ( 10 )

Composition of nucleus, nuclear size, nuclear radius, nuclear spin, magnetic moment, packing fraction, electric quadrupole moment, mass defect, 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.

2. Nuclear Reactions : ( 03 )

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

### UNIT VII

Nuclear Energy Levels : ( 10 )

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

Beta decay :– experimental study of _ ray spectra, continuous nature of spectrum, end point energy, conservation theorems, neutrino hypothesis.

Gamma decay :– origin of _ rays ( nuclear and internal conversion ), orbital electron capture., nuclear energy levels.

UNIT VIII

1. Nuclear Energy Sources : ( 05 )

Controlled chain reaction and design factors of nuclear reactor, atomic energy in India, nuclear reactor, calculation of effective multiplication factor for homogeneous thermal reactor ( four factor formula).

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.


## Physics Paper - VI

## ( Solid State Physics, Solid State Devices, Energy Studies & Material Science )

## Section - I : Solid state Physics and Solid State Devices

UNIT I

Crystal Structure : ( 10 )

Crystal lattice, unit cell, Miller indices, inter planer spacing, symmetry elements of a cube, Bravais lattices, seven crystal systems, packing fraction, crystal structurescubic and HCP.

UNIT II

1. X – ray Diffraction by Crystals : ( 06 )

Reciprocal lattice and its properties, Bragg's law in reciprocal lattice, powder method of X- ray diffraction.

2. Lattice Vibrations : ( 06 )

Vibrations of one dimensional line of atoms, vibrations of diatomic linear lattice, acoustical and optical modes.

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, motion of electron in one dimensional periodic potential, effective mass of electron, distinction between metals, semiconductors and insulators, concept of hole, Hall effect.

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, operation and characteristics 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 ).


Section – II : Energy Studies and Material Science

UNIT V

1. Energy : ( 05 )

Energy, man and environment, energy and thermodynamics, some well known forms of energy, energy chains, energy resources, energy demands, age of renewable and alternatives.

2. Wind Energy : ( 06 )

Introduction, application of wind energy, wind energy quantum, wind power density, wind turbine efficiency, power of a wind turbine for a given incoming wind velocity, types of a wind turbine generator unit, planning of wind farm, horizontal axis propeller type wind turbine generator unit, mono, twin and three blade HAWT.

UNIT VI

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, prospectus of solar PV systems, power of a solar cell and solar PV panel.

UNIT VII

1. Biomass Energy : ( 05 )

Origin of biomass, biomass energy resources, biomass conversion processes, direct combustion of biomass ( incineration ), thermo dynamical conversion of biomass, biochemical conversion.

2. Ocean Energy : ( 06 )

Ocean energy resources, ocean thermal energy, ocean waves, ocean tides, ocean biomass resources, off- shore and on- shore ocean energy conversion technologies, their advantages and limitations, guidelines for ocean energy conversion plants, ocean energy routes.

UNIT VIII

1. Magnetism : ( 05)

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

2. Superconductivity : ( 07)

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

References :

1. Energy Technology – Non conventional, Renewable and Conventional – S. Rao and Dr. Parulekar.
( 1.1 – 1.4, 1.83, 1.9.1, 1.9.6, 1.10 – 1.12 and 1.14, 3.1 – 3.5, 3.10, 3.11, 3.14, 3.20, 4.19, 5.1 – 5.3 and 5.6, 8.1, 8.2, 8.5, 8.7, 8.9, 8.10, 9.3, 9.4, 9.5, 9.5.1, 9.5.2, 9.6, 11.1, 11.2, 11.4 – 11.9, 15.1, 15.2.1 – 15.2.5, 15.3, 15.4 and 15.5 )
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.



## Physics Paper – VII

## ( Classical Mechanics, Electrodynamics and Electromagnetic Waves )

## Section – I : Classical Mechanics ( Note : Vector treatment be used )

UNIT I

Introduction to Mechanics : ( 11 )

Mechanics of particles, conservation theorems for linear and angular momentum and energy. System of particles, concept of center of mass, conservation theorems for many
particles systems, system with variable mass – single stage rocket motion.

UNIT II

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 III

1. Techniques of Calculus of variation : ( 06 )

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

2. Coupled Oscillations : ( 06 )

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

UNIT IV

1. Moving Co-ordinate System ; ( 05 )

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. Rigid Body Motion : ( 06 )

Motion of rigid body in space, Euler's theorem, angular momentum and energy, Euler's equation 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. Takwale and P. S. Puranik.


Section – II : Electrodynamics and Electromagnetic Waves

UNIT V

Electrostatics and Charged Particle Dynamics : ( 10 )

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

UNIT VI

Time Varying Fields : ( 10 )

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

UNIT VII

Maxwell's Equations : ( 11 )

Bio-Savart's law, Ampere's law, derivative of _. B = 0 and _ x B = J, displacement current, Maxwell's correction to Ampere's law, Maxwell's equations for time dependents electric and magnetic fields in vacuum and material medium

UNIT VIII

.1. Electromagnetic Waves : ( 10 )

Wave equation for ( E ) and ( B ) fields in vacuum, plane wave solutions, orthogonality of E, B and propagation vector ( k ), plane e. m. waves in vacuum, dielectrics and conductors, attenuation of wave in metal ( skin depth ), Poyting's theorem, conservation of energy in e. m. fields.

2. Reflection and Refraction of E. M. waves : ( 04 )

Boundary conditions for e. m. field vectors, reflection and refraction of e. m. waves at a boundary of two dielectrics ( normal incidence only ), total internal reflection.

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.


## Physics Paper – VIII

## ( Atomic Physics, Astronomy, Astrophysics and Quantum Mechanics )

## Section – I : Atomic Physics, Astronomy and Astrophysics

UNIT I

1. Atomic Structure : ( 05 )

Pauli's exclusion principle, shells and sub shells of electrons, Explanation of periodic table.

2. Doublet Fine Structure : ( 07 )

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 : ( 08 )

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.

UNIT III

1. Molecular Spectra : ( 07 )

The molecular bond, electron sharing, the $H_2^+$ molecular ion, the hydrogen molecule,rotational energy levels, rotational spectra, vibrational energy levels, vibrational spectra, vibration-rotation spectra.

2. Raman Effect : ( 05 )

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

UNIT IV

1. Cosmology : ( 03 )

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

2. Milky Way Galaxy and Solar System : ( 10 )

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.
( Chap. 9.2, 9.11, 9.12, 9.16.9.17, 16.18, 16.19, 16.20 )
2. Introduction to Atomic Spectra – H. E. White.
( Chap. 8.1 – 8.3, 8.5, 8.6, 10.2 – 10.5, 10.7 – 10.9, 16.3 – 16.6, 20.1 – 20.2, 20.4 – 20.6 ).
3. Concept of Modern Physics – Arthur Beiser.
( Chap. 7.4 – 7.6, 8.1 – 8.4, 8.6, 8.7 )
4. Perspective of Modern Physics – Arthur Beiser. ( Chap. 14.1, 14.3, 14.7 ).
5. Spectroscopy ( Atomic and Molecular ) – Gurdeep Chatwal, Sham Anand.
( Chap. 4.1 – 4.3 ).
6. Astronomy – Fundamentals and Frontiers – Robert jastrow and M. H. Thompson
( Chap. 9, 12, 14, 15, and 19 )
7. Astronomy – Frank Bash ( Page Nos. 66 – 69, 100, 101 and 127 – 129 ).

Section – II : Quantum Mechanics

UNIT V

Schrodinger's Equation : ( 10 )

Time dependent and time independent Schrodinger's wave equations ( one and three dimensional ), physical interpretation of wave function, requirements of wave function, probability current density.

UNIT VI

Applications of Schrodinger's Equation : ( 13 )

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, quantum mechanical tunneling( one dimensional - qualitative discussion ), harmonic oscillator ( one dimensional ).

UNIT VII

Operators in Quantum Mechanics : ( 12 )

Defination of operators, Linear momentum operator ( p ), kinetic energy operator ( T ), Hamiltonian operator ( H ), parity operator ( _ ) 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 $L^-$, energy eigen values and eigen functions, expectation values.

UNIT VIII

Hydrogen Atom : ( 08 )

Schrodinger's equation for hydrogen atom, separation of radial and angular parts, solution of radial Schrodinger's equation to obtain energy values Eigen values of $L^2$ and Lz, different possible orientations of L with respect to Z-axis., 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.


## B. Sc. – III ( Revised Syllabus ) 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 _ 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.
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. Geiger-Mueller counter – plateau curve.
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. Resistance of B. G. by half deflection method.
8. Comparison of capacities by measuring throws separately.
9. Testing of electronic components.

10. Hysteresis by CRO.
11. Study of Lissajeous figures using CRO.
12. P. O. box- Measurement of resistance of galvanometer ( Kelvin's method).
13. Study of time base circuit.
14. Determining of the radius of capillary bore using mercury thread.
15. Determining Lattice constant using given XRD powder pattern.
16. Estimation of errors for given experimental data and formula.
17. Measurement of phase shift of RC network using CRO.
18. Computer skill testing I ( Programming in C ).
19. Computer skill testing III ( MS Office – Word and 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 (4 Seminars, per paper one).

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

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

| | | |
|---|---|---|
| Total Marks of Practicals | | **200** |
| Gr. I:- | | 32 Marks |
| Gr.II | | 32 |
| Gr.III | | 32 |
| Gr. IV | | 32 |
| Gr. V (16+16) | | 32 |
| Gr.VI | | 40 |
| I) | Certified laboratory journal:- | 20 |
| II) | Study Tour Report :- | 10 |
| III) | Seminar Report :- | 10 |

**Equivalence**

| Sr.No. | Pre-revised Syllabus | Revised Syllabus |
|---|---|---|
| 1 | Paper - V | Paper - V |
| 2 | Paper – VI | Paper – VI |
| 3 | Paper – VII | Paper – VII |
| | Paper - VIII | Paper - VIII |