Solapur University, Solapur

B.Sc. Part III PHYSICS

(New Syllabus) with effect from June 2015

(Theory Course)

SEMESTER FIVE

Paper IX: Mathematical Physics & Statistical Physics……..50 Marks

Paper X: Solid state Physics ……..50 Marks

Paper XI: Classical Mechanics ……50 Marks

Paper XII: Nuclear Physics ……50 Marks

Total ……200 Marks

SEMESTER SIX

Paper XIII: Electrodynamics ……50 Marks

Paper XIV: Materials Science ……50 Marks

Paper XV: Atomic, Molecular Physics and Quantum Mechanics. ……50 Marks

Paper XVI: Electronics & Instrumentation ……50 Marks

(B) Total ……200 Marks

(Practical Course)

ANNUAL - (AT THE END OF SECOND SEMESTER)

Group (I to VI) experiments (25 * 6) …… ……...……150 Marks

Assessment Part of Practical Course ……..50 Marks

i) Certified Journal ……..……20 Marks

ii) Four tutorials ……..…….05 Marks

iii) Seminar report ……..….. ….10 Marks

iii) Tour report / Project report….15 Marks

Total ……50 Marks

(C) Total ……200 Marks

Grand total of B Sc. III course (A) + (B) + (C) = 200 + 200 + 200 = 600 Marks

NB: One practical examiner will give the marks of journal and tutorials (20+05) and other examiner will give the marks for seminar report and Tour Project report (10+15).

Semester V

Paper IX: Mathematical physics and Statistical physics

1. **Vector:** **(6)**
   - 1.1 Line integral
   - 1.2 Surface integral
   - 1.3 Volume integral
   - 1.4 Gauss divergence theorem
   - 1.5 Stoke's theorem
   - 1.6 Green's theorem
2. **Orthogonal Curvilinear Coordinates** **(8)**
   - 2.1 Introduction to Cartesian, Spherical polar and Cylindrical Coordinate system
   - 2.2 Concept of Orthogonal Coordinate system
   - 2.3 Gradient in Orthogonal Coordinate system
   - 2.4 Divergence in Orthogonal Coordinate system
   - 2.5 Curl in Orthogonal Coordinate system
   - 2.6 Laplacian Operator in Orthogonal Coordinate system
   - 2.7 Extension of Orthogonal Coordinate system in Cartesian, Spherical polar and Cylindrical Coordinate system
3. **Basic Concept in Statistical Physics** **(8)**
   - 3.1 Micro and Macro States
   - 3.2 Micro canonical and Canonical Ensemble
   - 3.3 Phase Space
   - 3.4 Accessible microstates
   - 3.5 A Priory Probability
   - 3.6 Thermodynamic Probability
   - 3.7 Probability Distribution
   - 3.8 Entropy and Probability

4. Maxwell Boltzman Statistics (7)

4.1 Maxwell Boltzman Distribution Law

4.2 Evaluation of constants α and β

4.3 Molecular Speeds

4.4 Thermodynamic functions in terms of partition function

5. Quantum statistics I (9)

5.1 Bose Einstein Statistics

5.2 Bose Einstein Distribution Law

5.3 Experimental study of black body radiation

5.4 Derivation of Plank's radiation formula

5.6 Deduction of Wein's Formula from Plank's radiation formula

5.7 Deduction of Rayleigh's Jeans Law from Plank's radiation formula

5.8 Deduction of Wein's Displacement Law from Plank's radiation formula

5.9 Stefan's Law from Plank's radiation formula

6. Quantum statistics II (7)

6.1 Fermi Dirac Distribution Law

6.2 Application to free electrons in metals

6.3 Electron energy Distribution

6.4 Fermi Energy

6.5 Electronic Specific heat of metals

6.6 Comparison of M.B., F.D. and B.E. statistics

Reference Books:

1. Theory and problems of vector analysis- Schaum outline series- Murray R, Spiegel
2. Mathematical methods for physics – George Arfken
3. Thermodynamics and statistical physics – Sharma, Sarkar
4. Statistical Mechanics –B.B. Laud
5. Statistical and thermal physics – S. Loknathan
6. Statistical Mechanics – Satya Prakash, J.P. Agrawal
7. Elementary Statistical Mechanics – Kumar, Gupta
8. An approach to Statistical Physics – Debi Prasad Ray

Semester V

Paper X: Solid state Physics

1. Crystallography: **(09)**

1.1Crystal lattice

1.2 Unit cell

1.3 Bravis lattices (2-D, 3-D),

1.4 Inter-planer spacing,

1.5 Miller indices,

1.6 Packing fraction,

1.7 Some crystal structures viz. Cubic, HCP and NaCl.

2. X- ray Diffraction by Crystals: **(07)**

2.1 Reciprocal Lattice and its properties,

2.2 Bragg's Law in reciprocal lattice,

2.3 Powder method of X-ray diffraction for crystal structure,

3. Free electron Theory: **(8)**

3.1 Free electron model (Drude Lorentz model),

3.2 Sommerfield's theory,

3.3 Fermi-Dirac distribution,

3.4 Energy density of orbital in one dimension.

4. Band theory of solids: **(08)**

4.1 Origin of energy bands,

4.2 One electron approximation,

4.3 Motion of electron in one dimensional periodic potential (Kronig Penny model),

4.4 Effective mass of electron,

4.5 Difference between metals semiconductors and insulators,

4.6 Hall Effect.

5. Magnetism materials: **(7)**

5.1classification of magnetic materials,

5.1.1Dimagnetic material

5.1.2 Paramagnetic material

5.1.3 Ferromagnetic material

5.1.4 Anti-ferromagnetic material

5.1.5 Ferri-magnetic and ferrites,

5.2 Energy loss in the hysteresis,

6. Superconductivity: **(6)**

6.1 Superconductor

6.2 Type I and Type II superconductors

6.3 Critical temperature,

6.4 Effect of magnetic field

6.5 Meissner effect,

6.6 Application of superconductor

Reference Books:

Solid State Physics – S.O. Pillai (wiley easten Ltd)

Solid State Physics - A. J. Dekker

Solid State Physics - Charles Kittel

Solid State Physics - R.L. Singhal

Solid State Physics – Saxena and Gupta

Semester V

Paper – XI: Classical Mechanics

1. **Mechanics of a particle and system of particles:** (7)

1.1 Mechanics of a particle using vector algebra and vector calculus,

1.2 Conservation theorems for linear momentum, angular momentum and energy of a particle.

1.3 Mechanics of a system of particles, concept of centre of mass.

1.4 Conservation theorems for linear momentum, angular momentum and energy of a system of particles.

1.5 Application of Newton's law of motion - Projectile motion in resistive medium

2. **Lagrangian Formulation:** (10)

2.1 Limitations of Newtonian Formulation

2.2 Introduction of Lagrangian Formulation

2.3 Constraints

2.4 Degrees of freedom

2.5 Generalised coordinates

2.6 Principle of virtual work

2.7 D'Alembert's Principle

2.8 Lagrange's equation from D'Alembert's Principle.

2.9 Application of Lagrange's equation to

i) A particle in space (Cartesian coordinates)

ii) Atwood's Machine and

iii) A bead sliding on uniformly rotating wire

iv) Simple Pendulum

v) Simple harmonic Oscillator

3. **Moving Coordinate systems:** (8)

3.1 Moving origin of coordinates

3.2 Pseudo forces

3.3 Potating coordinate systems

3.4 Coriolis force

3.5 Foucault's pendulum

3.6 Effects of Coriolis force in nature

3.7 Effect of Coriolis force on freely falling body.

4. **Techniques of Calculus of Variation:** **(6)**

4.1 Hamilton's principle

4.2 Deduction of Lagrange's equations from Hamilton's principle

4.3 Applications

i) Shortest distance between two points in a plane

ii) Brachistochrone problem

iii) Minimum surface of revolution

5. **Coupled Oscillations:** (6)

5.1 Frequencies of coupled oscillatory system

5.2 Normal modes and normal coordinates

5.3 Energy of coupled oscillations

5.4 Energy transfer in coupled oscillatory system.

6. **Motion of rigid body** : (8)

6.1 Motion of rigid body in space

6.2 Euler's theorem

6.3 Angular momentum and energy

6.4 Euler's equations of motion

6.5 Motion of a symmetric top (without nutation).

References:

1. Classical Mechanics : Herbert Goldstein
2. Classical Mechanics : N. C. Rana and P.S.Joag
3. Introduction to classical Mechanics : R. G. Takawale and P.S. Puranic
4. Clasical Mechanical : Gupta , Kumar and Sharma
5. Classical Mechanics : P.V.Panat

Semester V

Paper XII : Nuclear Physics

1. Particle Accelerators: (8)

1.1 Need of accelerator

1.2 Cyclotron

1.3 Limitations of cyclotron

1.4 Phase stable orbit

1.5 Synchrocyclotron

1.6 Betatron

2. Nuclear radiation detectors (7)

2.1 Classification of detectors

2.2 Geiger Muller counter

i. Construction and working

ii. Dead time, recovery time and resolving time

iii. Self quenching mechanism

2.3 Bubble chamber

2.4 Scintillation counter

3. Nuclear structure and properties (10)

3.1 Composition of nucleus

3.2 Nuclear radius

3.4 Nuclear spin

3.5 Nuclear magnetic moment

3.6 Electric quodrupole moment

3.7 Mass defect

3.8 Binding energy

3.9 Packing fraction

3.10 Liquid drop model of nucleus

3.11 Semi-empirical mass formula

4. Nuclear reactions (6)

4.1 General scheme of nuclear reactions

4.2 Q value of nuclear reactions

4.3 Threshold energy

4.4 Cross section of nuclear reactions (qualitative)

4.5 Stripping reactions

4.6 Pick-up reactions

5. Nuclear Energy levels (8)

5.1 Alpha decay- α disintegration energy

5.2 α particle spectra

5.3 Nuclear energy levels

5.4 Beta decay –Experimental study of β decay

5 .5 Continuous β ray spectrum

5.6 Pauli's neutrino hypothesis

5.7 Nuclear energy levels from β decay

6. Elementary Particles (6)

6.1Types of interactions

6.2 Classification of elementary particles

6.3 Properties of particles

6.4 Quarks ,types of quarks

Reference Books:

1.Nuclear Physics : Irving Kaplan (Addison Wesley)

2. Nuclear Physics : S.N. Ghoshal (S.Chand Publising Co.)

3. Nuclear Physics : D.C.Tayal (Himalayan Publishing House)

4. Nuclear Physics : J.B.Rajam (S.Chand Publising Co.)

5.Concepts of Modern Physics : Arthur Beiser (Tata McGraw Hill Publishing)

6.Atomic and Nuclear Physics : N. Subhramanyam & Brijlal(S.Chand Pub. Co.)

7. Concepts of Nuclear Physics : B.L.Cohen (Tata McGraw Hill Publishing)

Semester VI

Paper XIII: Electrodynamics

1. Electrostatics and Charged particle dynamics: (10)

1.1 Coulomb's Law.

1.2 Divergence and Curl of Electrostatic Fields: Gauss's Law; Gauss law in differential form.

1.3 Electric Displacement: Gauss's Law in Dielectrics. Linear Dielectrics: Susceptibility, Permittivity, Dielectric Constant.

1.4 Poisson's and Laplace's equations

1.5 Applications of Poisson's and Laplace's equation to spherical systems

1.6 Motion of charged particles in constant electric (E) field.

1.7 Motion of charged particles in constant magnetic (B) field.

1.8 Motion of charged particles in constant crossed uniform electric and magnetic fields.

2. Time varying fields: (7)

2.1 Electromotive force (E.M. F.) (ε)

2.2 Electromagnetic induction-Faraday's law.

2.3 Lenz's law.

2.4 Faraday's laws-Integral & Differential forms.

2.5 Self inductance.

2.6 Application to – solenoid.

2.7 Mutual inductance.

2.8 Application to transformer.

3. Maxwell's equations: (10)

3.1 Magnetic Susceptibility and Permeability.

3.2 Biot - Savart's law.

3.3 Derivation of $\nabla . \vec{B} = 0$

3.4 Ampere's Circuital law

3.5 Derivation of $\nabla \times \vec{B} = \mu_0 \vec{J}$ OR Differential form of Ampere's law.

3.6 Equation of continuity.

3.7 Displacement current.

3.8 Maxwell's correction to Ampere's law.

3.9 Maxwell's equations for time dependent electric and magnetic fields in vacuum.

3.10 Maxwell's equations for time dependent electric and magnetic fields in material medium.

3.11 Physical significance (Integral form)of Maxwell's Equation .

4. Electromagnetic waves: (7)

4.1 Conservation of energy in electromagnetic fields and Poynting's theorem.

4.2 Conservation of momentum in electromagnetic fields.

4.3 Wave equations for electric and magnetic fields in vacuum

4.4 Plane wave solutions, orthogonality of $\vec{E}, \vec{B}$ and propagation vector $\vec{k}$

4.5 Plane E. M. waves in Dielectric

4.6 Plane E. M. waves in conductors Attenuation of wave in metal (skin depth)

5. Reflection and Refraction of E. M. waves: (6)

5.1 Boundary conditions for e. m. field vectors $(\vec{D}, \vec{B}, \vec{E} \& \vec{H})$

5.2 Reflection and refraction of e. m. waves at a boundary of two dielectrics (Normal incidence only).

5.3 Total internal reflection.

5.4 The frequency dependence of ε, μ and σ .

6. Radiation from Electric Dipole: (5)

6.1 Electric dipole

6.2 Retarded time and retarded potential

6.3 Electric dipole radiation

6.4 Radiation reaction for Electric dipole.

References:

1. Introduction to Electrodynamics (third edition) – David. J. Griffith's.
2. Introduction to Electrodynamics (second edition) – David. J. Griffith's.
3. Classical Electrodynamics – S. P. Puri
4. Classical Electrodynamics – J. D. Jackson.
5. Electrodynamics – B.B. Laud.
6. Foundations of Electromagnetic theory – Reitz and Milford.

Semester VI
Paper XIV -Materials Science

1. Materials and their properties: (8)

1.1-Classifications of materials

1.2-Organic, inorganic and biological materials

1.3-Properties of materials

1.3.1-Mechanical properties

1.3.2-Thermal properties

1.3.3-Optical properties,

1.3.4-Electrical properties

1.3.5-Magnetic properties.

2. Polymer materials: (12)

2.1-Polymers,

2.2-Polymerization mechanism,

2.3-Degree of polymerization,

2.4-Classification of polymers,

2.5-Fabrication process,

2.6-Thermoplastics and thermosetting polymers,

2.7-Co-polymers,

2.8-Polymer crystallinity,

2.9-Defects in the polymers.

2.10-Mechanical properties of polymers, deformations, Reinforced polymers,

2.11-Applications of polymers.

3. Ceramic Materials: (6)

3.1-Classification of ceramics,

3.2-Structure of ceramics,

3.3-Ceramic processing,

3.4-Properties of ceramics,

3.5-Applications of ceramic materials.

4. Composite Materials: (6)

4.1 Fabrication of composites

4.2 Characterizations of composites,

4.3 Particle-Reinforced composites,

4.4 Fibre-Reinforced composites,

4.5 Applications of composites.

5. Nanostructured materials: (7)

5.1-Synthesis of nanostructured materials (Different types)

5.2- Formation of thin film by chemical bath deposition method

5.3-Characterizations of nanostructured materials,

5.4-Properties of nanostuctured materials,

5.5-Nanostructure of carbon.

5.6- Applications of nanomaterials.

6. Biomaterials: (6)

6.1-Biomechanism,

6.2-Classification of Biomaterials,

6.3-Processing of Biomaterials,

6.4-Properties of Biomaterials,

6.5-Applications of Biomaterials

References:

1. Material science by S.L. Kakani, Amit Kakani, New age international publishers.
2. Materials science and engineering, V. Raghavan, 5th edition, PHI
3. Materials science by R.S. Khurmi, S. Chand
4. Materials science, G.K. Narula, K.S. Narula, V.K. Gupta, Tata McGraw-Hill.
5. Nanotechnology: An Introduction to Synthesis, Properties and Applications of Nanomaterials, by Thomas Varghese & K.M. Balakrishna, Atlantic publication
6. Introduction to nanoscience and nanotechnology, by Chattopadhyay K.K., Banerjee A.N., PHI
7. Materials science – V. Rajendran & A. Marikani (TMHl).
8. Elements of material Science & engineering.- I.H.Van Vlack (4th Edition.).

Semester VI

Paper XV Atomic, Molecular Physics and Quantum Mechanics

1. **Atomic Spectra** **(6)**
   - 1.1 Review of Quantum numbers.
   - 1.2 Electronic configuration of alkali metals.
   - 1.3 Doublet fine structure of Alkali metals.
   - 1.4 Optical spectral series.
   - 1.5 Spectral notations.
   - 1.6 Spectrum of Sodium.
   - 1.7 Selection rules.
   - 1.8 Intensity rules.
2. **Effects of Magnetic and Electric fields on Atomic Spectra:** **(6)**
   - 2.1 Anomalous Zeeman effect and its explanation from vector atom model of a one electron system in a weak magnetic field.
   - 2.2 Lande g factor.
   - 2.3 Paschen Back effect.
   - 2.4 Paschen Back effect in principal series doublet.
   - 2.5 Selection rules for Paschen Back effect.
   - 2.6 The Stark effect of hydrogen.
   - 2.7 Weak field Stark effect in Hydrogen.
   - 2.8 Strong field Stark effect in hydrogen.
3. **Molecular Spectra and Raman Effect:-** **(10)**
   - 3.1 The Molecular bond, rotational energy levels.
   - 3.2 Rotational spectra, vibrational energy levels.
   - 3.3 Vibrational spectra.
   - 3.4 Vibration-rotation spectra, Electronic spectra of diatomic molecules.
   - 3.5 Intensity of vibrational electronic spectra.
   - 3.6 Franck-Condon principle.
   - 3.7 Raman Effect.
   - 3.8 Characteristic properties of Raman lines.
   - 3.9 Classical theory of Raman Effect.

4. **Quantum Mechanics**: (5)
   - 4.1 Heisenberg's Uncertainty Principle (Statement), and its similarity with concept of matter waves.
   - 4.2 time dependent and time independent Schrödinger Wave equations.
   - 4.3 Physical significance of ψ.
   - 4.4 Eigen Values and Eigen Functions.
   - 4.5 Probability current density (Qualitative idea only).
5. **Application of Schrodinger's time independent wave equation: (10)**
   - 5.1 Particle in a Box (One and three dimensional cases) its eigen Values and eigen functions.
   - 5.2 Step potential, Potential Barrier, Potential Well.
   - 5.3 Statement and boundary conditions.
   - 5.4 Schrodinger's equations in different regions.
   - 5.5 Discussion of results. (Only Qualitative treatment for all the three cases.).
   - 5.6 Linear Harmonics Oscillator – Eigen Values and Eigen functions.
   - 5.7 Zero point Energy.
6. **Operators: (8)**
   - 6.1 Operator's in Quantum Mechanics.
   - 6.2 Expectation values and properties.
   - 6.3 Angular Momemtum Operator.
   - 6.4 Commutation properties for its components.
   - 6.5 (Lx, Ly , Lz) Commutation for L^2 and Lz operators and their Eigen values.
   - 6.6 Schrodinger's equation for Hydrogen atom.
   - 6.7 Separation of radial and angular parts.

References:

1. Atomic Spectra – H.E. White
2. Molecular Spectroscopy - Banwell
3. Molecular Spectroscopy – Hertzberg
4. Quantom Mechanics - J. Powell and B. Creassman
5. Introduction to Quantum Mechanics - Pauling and Wilson
6. Elements of Quantum Mechanics - Kamal Singh and S.P. Singh.
7. Perspectives of Modern Physics – Arther Beiser

Semester VI

Paper XVI Electronics & Instrumentation

1. Operational Amplifier: - (9)

1.1 Block diagram of OP-AMP

1.2 Characteristics of OP-AMP

1.3 CMRR

1.4 OP-AMP parameters

1.5 OP-AMP as inverting amplifier

1.6 Non inverting amplifier

1.7 Adder

1.8 Substractor

1.9 Differentiator

1.10 Integrator

1.11 Comparator

1.12 Schmitt's trigger

2. Timer: - (6)

2.1 Functional Block diagram of IC 555, its Pin connections

2.2 Operating modes

2.2.1 Monostable

2.2.2 Astable

2.3 Applications of timer IC 555 as

2.3.1 Linear ramp generator

2.3.2 Square wave generator

2.3.3 Voltages to frequency converter

3. Power Electronics: - (10)

3.1 Four layer PNPN diode

3.2 SCR construction and working

3.3 Characteristics of SCR,

3.4 Turn ON and Turn OFF methods of SCR,

3.5 Applications of SCR to control the speed of DC motor,

3.6 Construction, working and characteristics of Diac.

3.7 Construction, working and characteristics of Triac

3.8 Applications of Diac and Triac.

4. Display Devices **(7)**

4.1 Classification of Displays

4.2 Light emitting Diode displays

4.3 Liquid crystal Displays and its Important Features

4.4 Gas Discharge plasma Displays

4.5 Segmented gas discharge displays

4.6 Segmental displays using LEDS

5:-Transducers and sensors **(7)**

5.1 classifications of Transducers

5.2 characteristics of transducers

5.3 selection criteria for transducer

5.4 Temperature Transducers- Resistance temperature detector

5.5 optical transducer- photo conductors (LDR), Photodiode

5.6 Sensor- Dry reed relay and

5.7 A.C. Servomotor sensors

6. Electron Microscopy **(6)**

6.1 Resolution and Magnification of Electron microscope

6.2 construction, working of SEM

6.3 Application of SEM

6.4 construction and working of TEM

6.5 Application of TEM

References:

1. Electronic principles – Malvino & Leech

2. Basic Electronic – Grob

3. Electronic Circuits and devices – Allan Mottershed

4. Linear Op – Amp – Ramakanth Gaikwad

5. Electronic principles – V.K.Mehta

6. Electronic Instrumentation by H.S. Kalsi

Practical Groups

Group I: General Physics:

1. Resonance Pendulum
2. S.T. of a Soap film
3. S.T. by Ferguson's modified method
4. Y and η using Flat Spiral Spring
5. Y by Koenig's method
6. S.T. by ripple method
7. Stefan's fourth power law
8. Velocity of sound using C.R.O. and Microphone
9. Y by Cornu's method
10. Logarithmic decrement

Group II: Optics:

1. Cardinal points by turn table
2. Cardinal points by Newton's method
3. Diffraction due to cylindrical obstacle
4. Lloyd's single mirror
5. Diameter of lycopodium powder
6. Resolving power of prism
7. μ by total internal reflection
8. Elliptically and circularly polarized light
9. Study of XRD Spectra of any material
10. Spherical aberration of thick lens

Group III: Electricity and Magnetism:

1. Self inductance by owen's bridge
2. Self inductance of a coil by Rayleigh's method
3. Measurement of B_H, B_V and θ using earth inductor
4. Hysteresis by CRO
5. Hysteresis by magnetometer
6. High resistance by leakage method
7. Absolute capacitance of condenser by B.G. method
8. Calibration of bridge wire carry fosters bridge method
9. e/m by Thomson tube method
10. Determination of cell constant and equivalent conductivity at infinite dilution

Group IV: Electronics and Instrumentation

1. Astable multi vibrator using IC555
2. OP-AMP as inverting amplifier
3. OP-AMP as comparator –Schmitt's trigger
4. OP-AMP as adder and subs tractor
5. SCR firing by UJT
6. Temperature Transducer
7. RS and JK flip flops
8. FET as VVR
9. Seven Segment Display
10. Study of mono-stable operation of IC 555

Group V: Use of computer and Internet

1. To make resume by MS words
2. To create mail merge letter (Application letter)
3. To create work sheet of students mark sheet
4. To draw graph or chart
5. How to create power point presentation
6. To create photo album by Power point presentation
7. To search any file by using search engine
8. To search any research paper or book and download from search engine
9. To open received mail , download attached file
10. To create poster of your seminar presentation by power point presentation
11. From origin plot graph, calculate slope and make calculation

Group VI: Applied Physics

1. Velocity of sound using CRO and Micro phone
2. Estimation of efficiency of GM Counter
3. Determination of Beta particle range and maximum energy
4. Hall effect
5. Determination of resistivity by Four probe method
6. Thermo electric power of thin film
7. Determination of yield point and the breaking point of elastic material
8. Band gap energy / temp. Sensor using semiconductor diode
9. Thermocouple
10. Thermister