POST GRADUATION DEPARTMENT OF APPLIED PHYSICS AND BALLISTICS, F. M. UNIVERSITY, BALASORE

SYLLABUS FOR THE COURSE M. SC. IN PHYSICS (SFC MODE)

2017 onwards

P.G. Department of Applied Physics and Ballistics

Syllabus structure (M. Sc. Physics)

(SFC Mode)

M.Sc. in Physics		
Semester	Marks	Credit
1st semester	300	24
2nd semester	300	24
3rd semester	300*	24
4th semester	300	24
Total	1200	96
*choice based credit paper is selected by the student of other PG Depts.		

P.G. Department of Applied Physics and Ballistics

Syllabus structure of M. Sc. Physics

(SFC MODE)

First Semester

Code	Name	Mark	Credit
APAB-101	Classical Mechanics	50	04
APAB-102	Mathematical Methods in Physics	50	04
APAB-103	Electronics & Computer Programming	50	04
APAB-104	General Instrumentations	50	04
APAB-105	Practical: Electronics	100	08
	Total	300	24

Second Semester

Code	Name	Mark	Credit
APAB-201	Statistical Mechanics	50	04
APAB-202	Quantum Mechanics	50	04
APAB-203	Fluid Dynamics	50	04
APAB-204 (B)	Atomic and Molecular Physics	50	04
APAB-205	Practical: Computational Physics:	100	08
	Total	300	24

Third Semester

Code	Name	Mark	Credit
APAB-301	Solid State Physics	50	04
APAB-302	Electrodynamics	50	04
APAB-303	Nuclear & Particle Physics:	50	04
APAB-304	**Modern Physics and Electronics**	50	04
APAB-305	Practical: Modern Physics & Material Science	100	08
APAB-306	Fakir Mohan Studies	100(Non Credit)	00 (Non credit paper)
	Total	400	24

M.Sc. in Physics

Fourth Semester (out of 3 special papers 1 special paper is mandatory)

Special Paper-II	Electronics
Special Paper-II	Nuclear & Particle Physics
Special Paper-III	Condensed matter physics

Special Paper-I (Electronics)

Code	Name	Mark	Credit
APAB-401(B)	Electrical circuit & Control:	50	04
APAB-402(B)	Optoelectronics & Optical Communication:	50	04
APAB-403(B)	Pulse & Digital circuit:	50	04
APAB-404 (B)	Advance electronics practical:	50	04
APAB-405 (B)	Project & Grand viva:	100	08
	Total	300	24

Special Paper-II (Nuclear and Particle Physics)

Code	Name	Mark	Credit
APAB-401(C)	Nuclear & Particle Physics-I	50	04
APAB-402(C)	Nuclear & Particle Physics-II	50	04
APAB-403(C)	Nuclear & Particle Physics-III	50	04
APAB-404 (C)	Seminar:	50	04
APAB-405 (C)	Project & Grand viva :	100	08
	Total	300	24

Special Paper-III (Condensed Matter Physics)

Code	Name	Mark	Credit
APAB-401(D)	Condensed Matter Physics-I	50	04
APAB-402(D)	Condensed Matter Physics-II	50	04
APAB-403(D)	Condensed Matter Physics-III	50	04
APAB-404 (D)	Seminar:	50	04
APAB-405 (D)	Project & Grand viva :	100	08
	Total	300	24

SEMESTER-I

PAPER-APAB-101 **Marks: 40**
SUB: CLASSICAL MECHANICS **Internal Marks: 10**
Total Marks: 50
Credits: 04

UNIT-I

Survey of the elementary particles: Mechanics of a particle-Mechanics of a system of particles – Constraints-D'Alembert's principle and Lagrange's equations-velocity dependent potentials and the dissipation function, simple applications of the Lagrange formulation. Variational Principle and Lagrange's Equations: Some techniques of the calculus of variations-Derivations of Lagrange's equations-from Hamilton's principle-Extension of Hamilton's principle to nonholonomic systems-Advantages of variational principle formulation-conservation theorems and symmetry properties.

UNIT-II

Two body Central force Problems ; Reduction to the equivalent one-body problem-The equations of motion and first integrals-The equivalent one-dimensional problems and classification of orbits-The virial theorem-The differential equation of orbit and integrable power-law potentials-conditions for closed orbits (bertrand's theorem)-The Kepler Problem Inverse square law of force-The motion in time in the Kepler problem-The Laplace-Runge-Lenz vector-Scattering in a central force field, Transformation of the scattering problem to the laboratory co-ordinates.

UNIT-III

The Kinematics of Rigid Body Motion: The independent co-ordinates of a rigid body-Orthogonal transformation-Formal properties of the transformation matrix, The Euler Angles, Euler's theorem on the motion of a rigid body-Finite rotations-Infinitesimal rotations-Rate of change of vector-The Coriolis force.

UNIT-IV

The Rigid Body Equations of Motion: Angular momentum and kinetic energy of motion about a point-Tensor and dyadics-The inertia tensor and the momentum of inertia-The eigen values of the inertia tensor and the principal axis transformation-Methods of solving rigid body problems and the Euler equations of motion Torque-Free motion of a rigid body-The heavy symmetrical top with one point fixed-Precession of the equinoxes and of satellite orbits-Precession of system of changes in a magnetic field.

TEXT BOOKS:

1 Classical Mechanics-Herbert Goldstein, Addison-Wesley/Narosa (Indian Student Edition)
2 Classical Mechanics-Rana and Joag, Tata-McGraw-Hill

REFERENCE BOOKS:

1 Classical Mechanics of particles and Rigid body-Kiran C. Gupta, New age Publishers
2 Classical Mechanics-J.D. Uppadaya
3 Classical mechanics – S.L.Gupta, Meenakshi prakashan, 1970, New Delhi.
4 Introduction to classical mechanics – R.G.Takwall and P.S.Puranik, Tata – McGrawHill, 1980, New Delhi.
5 An Introduction to Continuum Mechanics-M. E. Gurtin, Academic Press

PAPER-APAB-102 **Marks: 40**
SUB: Mathematical Methods in Physics **Internal Marks: 10**
Total Marks: 50
Credits: 04

UNIT-I

Functions of a Complex Variable: Analytic functions, Cauchy's Integral Theorem, Cauchy's Integral Formula, Taylor's Theorem, Laurent's Theorem, Singularities, Residues, Residue Theorem and Evaluation of Integrals, multi-valued function-branch point and branch cut, contour integration involving branch point,

UNIT-II

Linear Vector Space: Definition, Linear independence, basis and dimension, scalar product, dual vector, Cauchy-Schwarz inequality, orthonarmal basis, Scmidt orthogonalisation process

Matrices: Inverse of a matrix, orthogonal matrix, rotation, similarity transformation, Eigen-values and eigenvectors, secular equation, Cayley-Hamilton theorem, matrix diagonalisation

UNIT-III

Tensors: Cartesian tensor, covariant tensor, contravariant and mixed tensors, tensor algebra, the Kronecker delta and Levi-Civita symbol, tensors in Minkowski space, tensor calculus, tensors in general relativity, the Reimann-Christoffel symbol, Ricci and curvature tensor

Group theory: Basic concepts of groups, group representation, relevance to quantum mechanics, Lie group and Lie algebra, SU(2) groups and their representation, SO(3) groups and their representation.

UNIT-IV

Special Functions: Series solutions: Frobenius Method, Legendre polynomials, generating function, recurrence formulae, orthogonality properties, Bessel's function, generating function, recurrence formulae, orthogonality properties, Hypergeometic functions and their properties, Laguree polynomial and their properties

Integral Transform: Fourier series, Fourier Integrals, Fourier transforms, Convolution theorem, Laplace transform- derivatives, properties and applications to solution of differential equations

TEXT BOOKS:

1 Mathematical Methods for Physicist: G. B. Arfken, Hans. J. Weber,-Academic Press
2 Mathematical Physics: H. K. Dass, Rama Verma-S. Chand and Company Ltd.

REFERENCE BOOKS:

1 Matrices and tensors: A. W. Joshi
2 Numerical Methods using FORTRAN: C. Xavier-New Age International Publishers
3 Mathematical Physics: B. S. Rajput
4 Mathematical Physics: Satya Prakash
5. Introduction Mathematical Physics: Charlie Harper

PAPER-APAB-103
SUB: Electronics and Computer Programming

Marks: 40
Internal Marks: 10
Total Marks: 50
Credits: 04

UNIT-I

Network Analysis: Node & mesh analysis, Superposition theorem, Thevenin's theorem, Reciprocity theorem, Norton's theorem, Maximum power transfer theorem, Network Analysis using Laplace Transformation: Step response of series RL, RC, RLC, parallel RLC, Response of series RL, RC, RLC, and parallel RLC to exponential driving voltage.

UNIT-II

Semiconductor devices : P-N Junction Diode, diodes, Applications of Diode, rectifier circuits, Zener Diode, Transistors: Connections, Transistor as an amplifier, OP-AMP Basics, Virtual Ground, The Ideal Op Amp, Inverting and Non – Inverting configurations, Equivalent Circuit model, Op-amp application in Integration, differentiation and Summing Circuits, Differential Amplifier, Voltage Buffer.

UNIT-III

Digital Electronics: Number Systems, Binary Arithmetic, Boolean Algebra, Logic Gates, Simplification using Karnaugh map, Combinational Circuits: Adder, Subtractor, Multiplexer, decoder. Sequential Circuits: Flip Flops, Shift Registers, Counters and D/A and A/D Converters.

UNIT-IV

Numerical Computing: Programming in C: Constants, variables and data types, Operators and expressions, Input and Output, Decision making and branching, Looping, Arrays Characteristics of numerical computing, Trapezoidal Integration, Simpson's rules for Integration, Runge-Kutta Method and Newton-Raphson method in C .

TEXT BOOKS:

1. Network Analysis: M.E. Van Valkenburg
2. Network Analysis: G.K. Mithal
3. Digital Electronics and Computer Design: M. M. Mano (PHI)
4. Principles of Electronics: V.K. Mehta
5. Electronic Devices and Circuit Theory: Boylestad, Nashelsky
6. Let us C:- Yashavant Kanetkar (BPB Publications)
7. C Language and Numerical Mehods – C. Xavier
8. Numerical Techniques in C – E. Balguruswamy

PAPER-APAB-104
SUB: General Instrumentations

Marks: 40
Internal Marks: 10
Total Marks: 50
Credits: 04

Unit I

Transducers (Strain Gauges, temperature, pressure/vacuum, magnetic field, vibration, optical, and particle detectors), measurement and control; Signal conditioning and recovery, impedance matching, amplification (Op-amp based, instrumentation amp, feedback), filtering and noise reduction, shielding and grounding; lock-in detector, box-car integrator, modulation techniques.

Unit II

Ordnance : Introduction, Classification (Small Arms, Mortar as, Guns, Howitzers, Rocket Launchers, Missiles), Classification based on specific tactical roles, Basic structure, Superstructure, Saddle, Cradle, Requirements of an Ideal Field Gun, Basic components and functional requirements, Certain definitions related to a barrel, Rifling, Rifling design considerations (Forms of twist, Rifling profile), Breech mechanism (breech ring, breech block, thrust surfaces, breech screw, carrier), Extractor, Obturation, Firing mechanism, Chamber.

Unit III

Gun Barrel and Design : Desired characteristics of a barrel, Stresses on barrels (Radial stress, Circumferential stress, Longitudinal stress, Torsional stress and Girder stress), Barrel construction (Wire wound, Composite, Mono block), Use of plastic region of the material and its application to auto frettaged method of gun construction, Comparison of different methods of gun construction, Basic gun design rules, Theories of elastic failures, von Misses-Hencky theory of failure including its derivation, Barrel wear (erosion, fatigue, causes and their reduction). (Interior ballistics 3.3) (Part2-Balistics-1-14.2/3).

Recoil systems (Functions, mechanism of recoil energy absorption), Buffer types (Valve key, Shallowing groove cylinder, Tapered rod, Rotating), Liquid for buffer, Cut off gear, Recuperator, Controls to run out, Soft recoil.

Fume extractor, Muzzle brake, Advantages and disadvantages, Droop, Balancing gears, Elevating and traversing gears, Carriages and mountings, Articulation, Spades, Forces and their behavior during firings, Stability, Jump, (Part2-Balistics-1-15.2)

Unit IV

Ammunition : Cartridge and make up of cartridges (BL, QF – fixed, separate), Cartridge cases (metallic & essential qualitative requirements, semi-combustible, combustible, relative merits & demerits), Means of ignition (ignition problem, percussion, electrical), classification and characteristics of projectile (ogive, nose, shoulder, body, driving band, base, boat tailing, bands, bourrelet)

Driving band attachment to body and engraving process, Forces on the Driving band, Requirements of a projectile (ballistic efficiency, tactical efficiency, shape), crh (simple and compound), fuze, Components of fuzes, Arming and safety arrangements in fuzes.

Reference Books and Materials:

1. A Course in Electrical and Electronic Measurements and Instrumentation – A.K. Sawhney, Dhanpat Rai & Co.
2. "Text Book of Ballistics and Gunnery", 1987 - War Office, UK.
3. "Element of Ordnance", 1982 – T.J Hayes, John Wiley, New York.
4. "Ballistics: Theory and Design of Guns and Ammunition", David E. Carlucci and Sidney S. Jacobson.
5. "Handbook of Artillery Weapons", 1987- Royal College of Military Science, UK
6. "e-Ballistics" by Gunther Dyckmans (Freely available in the internet).
7. Gene Slover's US Navy Pages (freely available in the internet).
8. "Engineering Design Handbook, Guns Series, Muzzle Devices", US Army Material Command, May 1968
9. "Engineering Design Handbook, Guns Series, Guns General", US Army Material Command, August 1964
10. "Engineering Design Handbook, Guns Series, Gun Tubes", US Army Material Command, February 1964
11. "Design of Towed Artillery Weapon Systems", US Army Material Command, March 1990.

PAPER-APAB-105
SUB: Electronics Practical **Total Marks: 100**
Credits: 08

List of Experiments

1. Study of Kirchhoff's Law (Loop and Node Analysis)
2. Study of Superposition Theorem
3. Study of Thevenin's, Norton's and Maximum Power transfer Theorem
4. To study working of Wheatstone bridge
5. To study the diode as a half wave rectifier with and without filter
6. To study the diode as a full wave rectifier with and without filter
7. To set up and study a Zener diode shunt regulator and to plot its line and load regulation characteristics
8. To study the DC Amplifier using Bipolar Transistor
9. Study of half adder, full adder, half subtractor and full subtractor
10. To study the behavior of S-R, J-K, MS-JK, D and T flip flop
11. To study and design of ripple counter, synchronous binary using JK flip flop
12. To study and design of Ring and Junction counter
13. To measure OPAMP Parameters
14. To study OPAMP as inverting and non-inverting amplifier
15. To design and test integrator circuit using OPAMP and to find usual frequency range for integrator.
16. To study differential amplifier using single OPAMP.

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SEMESTER-II

PAPER-APAB-201
SUB: STATISTICL MECHANICS

Marks: 40
Internal Marks: 10
Total Marks: 50
Credits: 04

UNIT-I

Statistical Thermodynamics: Macroscopic and microscopic states, connection between statistics and thermodynamics, classical ideal gas, entropy of mixing and Gibb's paradox. Ensemble Theory: Phase space, Liouville's theorem, microcanonical ensemble, examples, quantum states and phase space.
Canonical Ensemble: Equilibrium, partition function, energy fluctuation, equipartition and Virial theorem, harmonic oscillators, statistics of paramagnetism, Grand Canonical Ensemble: Equilibrium, partition function, density and energy fluctuation, correspondence with other ensembles, examples.

. UNIT-II

Formulation of Quantum Statistics: Quantum mechanical ensemble theory, density Matrix, statistics of various ensembles, examples. Ideal gas in different quantum mechanical ensembles. Systems of: monatomic, diatomic and polyatomic molecules.

UNIT-III

Ideal Bose gas: Photons and Planck's Law, Phonons, Bose-Einstein condensation, Thermodynamic description of phase transition, Phase transitions of second kind, Discontinuity of specific heat, Change in symmetry in a phase transition of second kind.

UNIT-IV

Ideal Fermi Gas: Thermodynamics, Pauli paramagnetism, Landau diamagnetism, DeHassVan Alphen Effect, thermionic and photoelectric emissions, white dwarfs.
Ising Model: Ising model,: definition of Ising Model, ID-Ising model.

TEXT BOOKS:

1. Statistical Mechanics-K: Huang
2. Statistical Mechanics- R. K. Patheria

REFERENCE BOOKS:

1 Elementary Statistical Physics- C Kittel
2 Statistical Mechanics-F: Mohling
3 Statistical Mechanics-Landau and Lifshitz.
4 Physics Transitions and Critical Phenomena-H.E. Stanley
5 Thermal Physics-C.Kittel
6 Fundamentals of Statistical and Thermal Physics-F.Reief

PAPER-APAB-202
SUB: QUANTUM MECHANICS

Marks: 40
Internal Marks: 10
Total Marks: 50
Credits: 04

UNIT-I

General Principles of Quantum Mechanics: Linear vector space, ket and bra vectors, scalar product of vectors and their properties, Linear operator, Adjoint Operators, Unitary Operators and transformations, Expectation values of dynamical variables and physical interpretation, Hermitian operators, Probability interpretation, degeneracy, Schimdt method of orthogonalization.

Mathematical Basics: Expansion Theorem, Completeness and Closure property of the basis set, Co-ordinate and Momentum representation, Compatible and incompatible observables, Commutator algebra, Uncertainty relation as a consequence of noncommutability, Minimum uncertainty wave packet

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UNIT-II

Quantum Dynamics: Time evolution of quantum states, time evolution operator and its properties, Schroedinger Picture, Heisenberg Picture, Interaction Picture, Equation of Motion, Operator Method of solution of Harmonic oscillator, Matrix representation and time evolution of creation and annihilation operator

UNIT-III

Rotation and Orbital Angular Momentum: Rotation Matrix, Angular momentum operators as the generators of rotation. L_x, L_y, L_z and L^2 in spherical polar co-ordinates, Eigen values and Eigen functions of L_z and L^2 (OP method), Spherical Harmonics, Matrix representation of L_+, L_- and L^2.

Spin ½ particles, Pauli spin matrices and their properties, Eigen values and Eigen functions, Spinor transformation under rotation.

Total Angular momentum J, Eigen value problem of J_z and J^2, Angular momentum matrices, Addition of angular momenta and C. G. Co-efficient, angular momentum states for composite systems in the angular momenta (1/2, ½) and (1,1/2).

UNIT-IV

Motion in Spherical Symmetric Field: Hydrogen atom, Reduction of two body problem to equivalent to one body problem, Radial equation, Energy eigenvaues and eigenfunctions, Degeneracy, radial probability distribution.

Free particle problem incoming and outgoing spherical waves, Expansion of plane waves in terms of spherical waves, bound states of a 3-D square well, particle in a sphere.

Approximation Methods: Time independent perturbation theory and application, variational method, WKB approximation, Time dependent perturbation theory, Fermi's Golden rule, selection rules.

Scatterings: Elementary theory of scattering, Phase shifts, Partial waves, Born approximations

TEXT BOOKS:

1. Quantum Mechanics-Joichan

REFERENCE BOOKS:

1 Quantum Mechanics- Gasorowicz
2 Quantum Mechanics-Ghatak and Loknathan

PAPER-APAB-203
SUB: FLUID DYNAMICS

Marks: 40
Internal Marks: 10
Total Marks: 50
Credits: 04

UNIT-I

Fluid Flow Concepts and Basic equations: Velocity field, acceleration of a fluid element, continuity equation, conservation of momentum , stream line functions, rotation of fluid element, Euler's equation.

Bernoulli's equation along a stream line and in rotational flow, Bernoulli's equation from thermodynamics ,static and dynamics pressure, Losses due to geometric changes:-Sudden expansion and contraction Venturimetre.

UNIT-II

Dimensional Analysis and Dynamic Similitude: Buckingham's Π Theorem, Dimensionless parameters, Euler's number, Reynold's number, Froude's number, Weber number, Model studies and wind tunnel tests.

UNIT-III

Viscous Effect: Normal stress shear stress, Navier-Stokes theorem, Flow through a parallel channel,Flow past a sphere, Terminal velocity order of magnitude analysis, Approximation of the Navier-Stokesequations.
Boundary layer concepts:-Momentum integral equation, velocity profile, Boundary layer thickness, SkinFriction effecter, Transverse component of velocity, Displacement thickness, momentum thickness.Drag:-Bluff badles, Aerofoil, Boundary layer control, entrance region.

UNIT-IV

Compressible flow: Perfection gas Relations:-Speed of propagation in gas, in isothermal and adiabatic condition, Mach number, Limits of incompressibility. Isentropic flow:-Laws of conservation, Static and stagnation values, flow through a duct of varying cross-section, mass flow rate, choking a converging passage, constant area adiabatic flow and Fanno like, constant area frictionless flow and Raleigh line.

Fluid Metrology: Pressure measurement, Velocity measurement, Turbulence measurement, Viscosity measurement,

TEXT BOOKS:

1 Fluid Mechanics, A.K. Mohanty, PHI
2 Fluid Dynamics, R.V. Mises, Springer

REFERENCE BOOKS:

1 Foundation of Fluid Mechanics , S. W .Yuan, PHI
2 Text Book of Fluid Mechanics, R. S. Khurmi, S. Chand
3 Perspective in Fluid Dynamics, Batchelor, Cambridge

PAPER-APAB-204(B) **Marks: 40**
SUB: ATOMIC AND MOLECULAR PHYSICS **Internal Marks: 10**
Total Marks: 50
Credits: 04

Unit-I

General discussion in Hydrogen spectra: Atomic spectra, Bohr's postulates, Bohr's Model of one-electron atom, unquantised states and continuous spectra, Bohr's Model and absorption spectra, correction for finite nuclear mass, variation in Rydberg constant due to finite nuclear mass, discovery of heavy hydrogen, comparison of H and He^+ spectra, Wilson-Sommerfeld quantisation rules, de-Broglie's Interpretation of Bohr's quantisation law, Bohr's correspondence principle, Sommerfeld's extension of Bohr's Model, Sommerfeld's relativistic correction, shortcomings.
Orbital Magnetic Dipole moment: Bohr Magneton, Behaviour of Magnetic Dipole in External Magnetic Field, Lamour Precession, space quantisation, Electron spin, Vector model of atom, spectroscopic terms and their notations, Stern-Gerlach experiments, spin-orbit interaction , quantum mechanical relativity correction, hydrogen fine structure.

Unit II

Identical Particles, exchange symmetry of wave functions, Formulation of Pauli's exclusion principle, Symmetry character of various particles, Slater determinant, Exchange force, spectrum of Helium, Prohibition of Inter combinations.
Multi-electron atoms in Schroedinger's Theory, Results of Hartree Theory, Atomic orbitals and Hund's rule, the periodic table.
Atoms with several optically active electrons, L-S Coupling, Lande Interval Rule, Normal and Inverted Multiplets, Determination of spectral terms for L-S coupling, Order of terms and fine structure levels, selection rules, j-j coupling, selection rules.

Unit III

Spectra of Alkali Metals, Ritz combination principle, Explanation of the spectra, Absorption spectra, resonance line, fine structure in alkali spectra, calculation of level splitting due to spin orbit interaction, intensity ratio of doublets. Spectra of alkaline earth metals, vector model of two-valence electron atom, interaction energy, regularities in complex spectra.
Normal and Anomalous Zeeman effects, Paschen-Back effect, Transition from weak to strong field, examples, The stark effect in Hydrogen, hyperfine structure of spectral lines, Zeeman effect in hyperfine structure, Back-Goudsmit effect in Hyperfine structure.

Unit IV

X-ray spectra, Kossel's explanation of characteristic X-ray spectra, X-ray emission spectra and the Moseley law, Fine structure in X-ray emission spectra, screening doublets, X-ray absorption spectra, Auger effect.
Types of molecular spectra and molecular energy states, The Born-Oppenheimer approximation, Pure rotational spectra, Vibrational-rotational spectra, The Raman spectra: classical and quantum theory.

TEXT BOOKS:

1. Raj kumar, *Atomic and Molecular Spectra:Laser*
2. H. E. White, *Introduction to Atomic Spectra*, Tata McGraw Hill (1934).
3. G.Aruldhas 'Molecular Spectroscopy'.
4. C. L. Banwell and E. M. McCash. 'Fundamentals of Molecular Spectroscopy' Tata- McGraw-Hill.

References:

1. G. Herzberg. 'Molecular Spectroscopy (Diatomic Molecules)' Van-Nostrand.
2. G. M. Barrow. 'Molecular Spectroscopy'. McGraw-Hill.
3. J.Michael Hollas. ' Modern spectroscopy'. John-Wiley & sons.
6. Bransden and Joachin. 'Atoms and Molecules'
7. G. K. Woodgate, *Elementary Atomic Structure*, Clarendon Press (1989).
8. F. L. Pilar, *Elemntary Quantum Chemistry*, McGraw Hill (1990).

PAPER-PHY-205
SUB:COMPUTATIONAL PHYSICS **Total Marks: 100**
Credits: 08

EXPERIMENT LIST: (FORTRAN / C)

1 To find largest or smallest of a given set of numbers
2 To generate and print first hundred prime numbers
3 To find sum of AP and GP
4 To find transpose of Matrix
5 Matrix Algebra
6 Evaluation of Log and exponential
7 Solution of Quadratic Equation
8 Numerical Differentiations
9 Numerical Integration by Trapezoidal Method
10 Numerical Integration by Simpson Method
11 Evaluation of Gamma Function
12 Solution of Second order differential equation by Range-Kutta Method
13 Finding roots of an equation by Newton-Raphson Iteration method
14 Least Square fitting of linear equations
15 Solution of system of linear equation

MATLAB

MATLAB Fundamentals, MATLAB's opening window features, Getting started with MATLAB, M – file, control statements of M – file programming, Matrix manipulation, creating a function file.

SEMESTER-III

PAPER-APAB-301
SUB: SOLID STATE PHYSICS

Marks: 40
Internal Marks: 10
Total Marks: 50
Credits: 04

UNIT-I

Crystal Physics: Types of lattices, Miller indices, simple crystal structures, crystal diffraction, Bragg's law, Reciprocal lattice (sc, bcc, fcc), Laue equations, structure factor, Atomic form factor, Types of crystal binding, cohesive energy of ionic crystals, Madelung constant, Inert gas crystals, Vander Waal, London equation, Metal crystals, Hydrogen bonded crystals. Defects in crystals; Point and line defects.
Lattice vibration and thermal properties: Einstein and Debye models; continuous solid; linear lattice; acoustic and optical modes; dispersion relation; attenuation; density of states; phonons and quantization; Brillouin zones; thermal conductivity of metals and insulators.

UNIT-II

Quantized free electron theory: Fermi energy, wave vector, velocity and temperature, density of states. Electronic specific heats. Pauli spin paramagnetism. Sommerfeld's model for metallic conduction. AC conductivity and optical properties, plasma oscillations. Hall effects.
Intrinsic and extrinsic semiconductors: carrier concentration and Fermi levels of intrinsic and extrinsic semi-conductors Bandgap. Direct and indirect gap semiconductors. Hydrogenic model of impurity levels.
Energy bands in solids: The Bloch theorem. Bloch functions. Review of the Kroning-penney model. Brillouin zones. Number of states in the band. Band gap in the nearly free electron model. The tight binding model. The fermi surface. Electron dynamics in an electric field. The effective mass. Concept of hole. (elementary treatment)

UNIT-III

Dielectrics: Polarizability; Clausius-Mossotti formula; Dielectric constant; ferroelectrics.
Magnetic properties of solids: Diamagnetism, Langevin equation. Quantum theory of paramagnetism. Curie law. Hund's rules. Paramagnetism in rare earth and iron group ions. Elementary idea of crystal field effects. Ferromagnetism. Curie-Weiss law. Heisenberg exchange interaction. Mean field theory. Antiferromagnetism. Neel point. Other kinds of magnetic order. Nuclear magnetic resonance.

UNIT-IV

Superconductivity: Experimental facts, occurrence, effect of magnetic fields, Meissner effect, entropy and heat capacity, energy gap, microwave and infrared properties, type-I and type-II superconductor, theoretical explanation, thermodynamics of superconducting transition, London equation, coherence length, BCS Theory, single particle Tunneling, Josephson Tunneling, DC and AC Josephson effects, High temperature super conductors-SQUIDS.

Texts:

1. H. P. Myers, *Introduction to Solid State Physics,* Viva books (1998).
2. M.A. Omar, *Elementary Solid State Physics,* Addison-Wesley (1975).
3. C. Kittel, *Introduction to Solid State Physics,* John Wiley (1996).

References:

1. A. J. Dekker, *Solid State Physics*, Macmillan (1986).
2. N. W. Ashcroft and N. D. Mermin, *Solid State Physics*, HBC Publ., (1976).
3. F.C.Phillips: *An introduction to crystallography* (wiley)(3rd edition)
4. Charles A Wert and Robb M Thonson: *Physics of Solids*
5. J. P. Srivastava: *Elements of solid state physics* (Prentice Hall India; 2nd edition).
6. Christmaan-*solid state physics* (academic press)
7. John Singleton: *Band theory and Electronic properties of Solids* (Oxford University Press; Oxford Master Series in Condensed Matter Physics).
8. Ibach & Luth: *Solid State Physics*

PAPER-APAB-302
SUB: ELECTRODYNAMICS

Marks: 40
Internal Marks: 10
Total Marks: 50
Credits: 04

UNIT-I

Maxwell's Equations: Green function solution of Maxwell's equation, Lorentz and Coulomb Gauge, Gauge invariance, Plane waves in a non conducting medium, Linear and circular polarization, Stoke's parameters, frequency dispersion characteristics of dielectrics, conductors and plasma, waves in dispersive medium, Kramer-Kroning relations.

UNIT: II

Microwave Propagation: Cylindrical cavities and wave guides Mode in a rectangular wave guide, Resonant cavities.

UNIT: III

Radiation, Scattering and Diffraction: Fields and radiation of localized oscillating source, Electric dipole, Magnetic dipole and electric quadrupole, Field radiation, Center-fed linear antenna with sinusoidal current, scattering by small dielectric sphere in long wave length limit, Rayleigh scattering, Thompson scattering, Kirchhoff's formulation of diffraction by a circular aperature.

UNIT-IV

Covariant Formulation: Four vector notation, Relativistic particle kinematics and dynamics, covariant form of Maxwell equations, Maxwell field tensor, Transformation of electromagnetic field components, Lagrangian of a charged particle in an external EM field and EL equations.

Radiation by a moving Charge: Lienard-Weichert potential and field for a point charge, Total power radiated by an accelerated charge, Lamour's formula, angular distribution of radiation from an accelerated charge.

TEXT BOOKS:

1 Classical Electrdynamics-J.D Jackson
2 Introduction to Electrodynamics- Griffith

REFERENCE BOOKS:

1 Introduction to Electrodynamics-A.Z. Capri and P.V. Panat
2 Principles of Optics- M. Born and E. Wolf

PAPER-APAB -303 **Marks: 40**
SUB: NUCLEAR AND PARTICLE PHYSICS **Internal Marks: 10**
Total Marks: 50
Credits: 04

UNIT-I

Nuclear size and shape: Nuclear radii and charge distributions, nuclear binding energy, electric andmagnetic moments. **Nuclear Nuclear Models:** Liquid drop model, semi-empirical mass formula, Bohr-Wheeler theory of fission, Experimental evidences for shell effects, Shell model, Spin-orbit coupling, Magic numbers, Angular momenta and parities of nuclear ground states, Qualitative discussion and estimate of transition rates, magnetic moments and Schmidt lines, Collective model of Bohr and Mottelson.

UNIT-II

The Two-Nucleon Problem: The Ground state of deuteron, excited state of deuteron, n-p scattering at lowenergies, tensor forces and deuteron problem, p-p scattering at low energies.

Nuclear Force: Central and non-central forces, Force dependent on Isospin, Exchange force, chargedependence and charge symmetry of Nuclear force, Mirror Nuclei.

UNIT-III

Nuclear Reaction: Energetic of Nuclear reaction, Compound nuclear theory, Resonance scattering, Brit-Wigner formula, Nuclear Fusion, Alpha decay, Fermi's theory of Beta decay, Selection Rules for allowed transition, Parity violation.

UNIT-IV

Particle Accelerators and Detectors: G-M Counter, Scintillation Detectors, Semiconductor detectors. Radiation **Hazards and Protection:** Radiation Hazards, Radiation dose, Monitoring of radiations, Hazards of Laboratory contamination and precautions, Shielding Materials.

Particle Physics: Basic forces, Classification of Elementary particles, Spin and Parity, Determination of Isospin, Strangeness, Lepton and Baryon Number, Conservation Laws, Gellmann-Nishijima Scheme, Meson and Baryon Octet, Elementary Ideas of SU(3), Symmetry Quark Model.

TEXT BOOKS:

1 Nuclear Physics: R.R.Roy and B.P Nigam
2 Introductory Nuclear Theory: L. R. B. Elton
3 Elementary Particle Physics: M.J.Longo
4 Nuclear Physics Experiments: J. Verma

REFERENCE BOOKS:

1 Theoretical Nuclear Physics: Blatt and Weisskopf
2 Nuclear Physics: D. C. Tayal
3 Particle Physics: R. Omens
4 Nuclear Physics: Pandey and Yadav
5 Nuclear Physics: I. Kaplan
6 Concepts of Nuclear Physics: L. Cohen
7 Introduction to Nuclear and Particle Physics: R. C. Verma

PAPER-APAB -304 **Marks: 40**
SUB: Modern Physics & Electronics **Internal Marks: 10**
(CBCS Paper for non-Physics student) **Total Marks: 50**
Credits: 04

UNIT-I

Quantum Mechanics: Wave properties of Particles, the wave equation, Schrodinger equation, Expectation Values, Particle in a box, finite Potential well, Tunnel effect, harmonic oscillator, Quantum theory of hydrogen atom.

UNIT-II

Nuclear Structure: Nuclear Composition, some nuclear properties, stable nuclei, binding energy, liquid drop model, Shell model, Meson theory of nuclear forces
Nuclear Transformations: Radioactive Decay, half life, radioactive series, alpha decay, beta decay, gamma decay, cross section, nuclear reactions, nuclear fission, nuclear reactors, nuclear fusion in stars, fusion reactors

UNIT-III

The Solid State: Crystalline and Amorphous Solids, Ionic crystals, Covalent crystals, Van der Waals Bond, Metallic Bond, Band theory of solids, semiconductor devices, energy bands: alternative analysis, Superconductivity, Bound electron pairs

UNIT-IV

Network Analysis using KCL, KVL, Norton's Theorem, Thevenin's Theorem and Maximum power transfer theorem, Sinusoidal Alternating Currents and Voltages, Inductance and Capacitance in AC circuits, Resonance, Power factor, Detailed theory of Transformer,

TEXT BOOKS:

1. Ghoshal S.N., Atomic and nuclear physics, Vol.2., S. Chand and Company, Delhi, 1994.
2. Evans R.D., Atomic nucleus, Tata Mc Grow Hill, New Delhi, 1976.
3. Penrose R., Road to Reality, Vintage Books, 2007.
4. Ladd M.F.C. and Palmer R.A., Structure determination by X-ray crystallography, Plenum Press, USA, 2003.
5. De Gennes P.G. and Prost J., The physics of liquid crystals, 2nd Edn., Clarendon Press, Oxford, 1998.
6. Arthur Beiser, Concepts of modern physics, 5th Edn., McGraw-Hill, New York, 1997.
7. Halliday D., Resnick R. and Merryl J., Fundamentals of physics, Extended 3rd Edn., John Wiley, New York, 1988.
8. Chattopadhyay D, Rakhit P. C, Quantum Mechanics, Statistical Mechanics & Solid state Physics, S. Chand & Company Pvt. Ltd., New Delhi
9. A Text Book Of Electrical Technology by BL Theraja and AK Theraja, S. Chand, and Company, New Delhi

PAPER-APAB-305 PRACTICAL
SUB: MODERN PHYSICS and MATERIAL SCIENCE LABORATORY

Total Marks: 100
Credits: 08

EXPERIMENT LIST:

1 Study of thermal properties of solid using HEAT CAPACITY KIT.

2 Study of B-H loop of a ferromagnetic specimen by using B-H Curve UNIT.

3 Determine the Curie temperature of a ferroelectric/ferromagnetic material by using CURIE TEMPERATURE KIT.

4 Measurement of ultrasonic velocity in solids and Young's Modulus of those solids in YOUNG'S MODULUS KIT.

5 Study of Lattice Dynamic KIT.

6 Study of particle size by using LASER Apparatus

7 Measurement of Acoustic signal using data acquisition system .

8 Forbidden gap calculation.

9 Plank's constant measurement

10 Hall effect study.

11 Study of impressibility of a fluid by using Ultrasonic interferometer.

SEMESTER-IV

PAPER-APAB-401(B)-SP-Electronics **Marks: 40**
SUB: Electrical Circuits and Control **Internal Marks: 10**
Total Marks: 50
Credits: 04

UNIT-I

Circuit components, KCL, KVL, Circuit analysis methods: nodal analysis, mesh analysis, basic network theorems, Superposition theorem, Thevenin's Theorem, Norton's theorem, Reciprocity theorem, Milliman's theorem, Maximum Power Transfer Theorem.

UNIT-II

Laplace transforms of unit step, shifted unit step, ramp and impulse functions. Response of RL, RC, RLC series circuits, series and parallel resonance, bandwidth, Q-factor. Low pass, High pass, R –C filters.Low, high, bandpass and band elimination filters.

UNIT-III

Open loop and closed loop control systems, Mathematical modeling of physical systems, Block diagram representation of systems – Block diagram reduction methods – Closed loop transfer function, determination of signal flow graph. Mason's gain formula – Examples.

UNIT-IV

Test signals – time response of first order and second order systems – time domain specifications – types and order of systems – generalized error co-efficient – steady state errors – concepts of stability – Routh-Hurwitz stability.

Bode plot, Root locus technique, Elementary state variable formulation, state transition matrix and response for linear time invariant systems.

TEXT BOOKS:

1. A course in Electrical Circuit Analysis – Soni and Gupta, Dhanpat Rai
2. Control System Engineering, 3rd Edition, New Age International Edition, 2002- Nagrath & Gopal,
3. Network and systems – D Roy Choudhury

REFERENCE BOOKS:

1. Network analysis – M.E Van Valkenberg, PHI
2. Network analysis – G.K. Mittal
3. Automatic Control Systems, 7th Edition – Prentice Hall of India, 2002, Benjamin.C.Kuo,
4. Modern Control Engineering, Prentice Hall of India, 4th Edition, 2003, Ogata.K

PAPER-APAB-402(B)-SP-Electronics Marks: 40
SUB: Optoelectronics and Optical Communication Internal Marks: 10
Total Marks: 50
Credits: 04

UNIT-I

Optical Processes in Semiconductors: Electron- hole Pair formation and recombination- band to band recombination- absorption in semiconductors- exciton absorption - donor-acceptor and impurity band absorption- absorption in quantum wells - radiation in semiconductors-Luminescence from quantum wells- time resolved photo luminescence.

UNIT-II

Semiconductor Junctions : The hetrojunction- LED structure - heterojunction LED - Edge emitting LED- I-VCharacteristics -Spectral and frequency response

Photodetectors: Junction photo diodes- PTN-APD- Photo transistor- modulated barrier photo diode – Schottky barrier - MSM photo diode- multicavity Photo diodes - Basic Principles of Solar cells.

UNIT-III

Switching Devices and Opto-electronic ICs : Electro optic modulators - Optical switching and logic devices - application of OEIC' S- materials and processing for OEIC'S - Integrated transmitters and receivers – guided wave devices

UNIT-IV

Fiber Optic Communication Optical fibre - Characteristics and fundamental parameters - Propagating modes -low loss fibres - transmission distance with optical fibres - examples of optical transmission techniques - instrumentation and control with optical fibres.

TEXT BOOKS:

1. Semiconductor opto electronic devices-Pallab Bhattacharya PHI, 1995.
2. Opto Electronics - Wilson and Hawker
3. Optical Fibre Communication - Snematsu and Toa (John Wiley and sons)

REFERENCE BOOKS:

1. Opto Electronics - Texas Instruments.
2. Opto Electronics - Jasprit Singh
3. Fibre Optic Communication - R.L.Keiser.

PAPER-APAB-403(B)-SP-Electronics **Marks: 40**
SUB: Pulse and Digital Circuits **Internal Marks: 10**
Total Marks: 50
Credits: 04

UNIT-I

Linear Wave shaping : High pass, low pass RC circuits, their response for sinusoidal, step, pulse, square and ramp inputs. RC network as differentiator and integrator, RL and RLC circuits and their response for step input, Ringing circuit.

Non-Linear Wave shaping: Diode clippers, Transistor clippers, clipping at two independent levels, Transfer characteristics of clippers, Emitter coupled clipper, Comparators, applications of voltage comparators, clamping operation, clamping circuits using diode with different inputs,

UNIT-II

Switching Characteristics of Devices: Diode as a switch, piecewise linear diode characteristics, Transistor as a switch, Break down voltage consideration of transistor, saturation parameters of Transistor and their variation with temperature, Design of transistor switch, transistor-switching times.

UNIT-III

Multivibrators: Analysis and Design of Bistable, Monostable, Astable Multivibrators and Schmitt trigger using transistors

Time base Generators: General features of a time base signal, methods of generating time base waveform, Miller and Bootstrap time base generators – basic principles, Transistor miller time base generator, Transistor Bootstrap time base generator, Current time base generators.

UNIT-IV

Combinational Digital Circuits: Number systems and codes, De-Morgan laws, Boolean Algebra, K-map and simplification of Boolean functions using K-map, Implementation of various Boolean functions. Design of Adders, Multiplexers, Decoders, BCD to 7 segment Decoder

Sequential Digital Circuits: Clocked S-R Flip-Flop, J-K Flip-Flop, Master Slave J-K Flip-Flops, T and D Flip-Flops, Shift registers, Synchronous and Asynchronous Counters, Ring and Johnson Couters.

TEXT BOOKS:

1 Pulse, Digital and Switching Circuits, J Millman and Taub, TMH, 2003.
2 Solid State Pulse Circuits,David A Bell, 4th Ed, PHI,
3 Digital Electronics and Computer Design – M.M. Mano, PHI

REFERENCE BOOKS:

1 Pulse and Digital Circuits, MS Prakash Rao,TMH, 2006.
2 Pulse & Digital Circuits, Anand Kumar, PHI
3 Pulse, Digital circuits and Computer fundamentals, R Venkataraman

PAPER-APAB-404(B)-SP-Electronics (PRACTICAL) **Total Marks: 50 (4 Credits)**

SUB: Practical: Advanced Electronics Lab

PAPER-APAB-405(B)-SP-Electronics

SUB: PROJECT& Grand-Viva **Total Marks: 100**
Credits: 08