M.Sc. Part-I

PAPER – 01

MATHEMATICAL METHODS OF PHYSIC and CLASSICAL MECHANICS: 100

Group A:MATHEMATICAL METHODS OF PHYSICS
marks = 50 : no. of lectures required (NLP) = 50

UNIT – I

Vector Spaces and Matrices; linear independence; Bases; Dimensionality; Inner product; Linear transformations; Matrices; Inverse; Orthogonal and unitary matrices; Independent elements of a matrix; Eigenvalues and eigenvectors; Diagonalization; Complete orthonormal sets of functions.

L.P. : 07

Tensor Calculus : Cartesian tensors. Symmetric and antisymmetric tensors. Levi Vivitia tensor density. Pseudo tensors. Dual tensors. Dire4ct product and contraction. Dyads and dyadics. Covariant, Contravariant and mixed tensors. Christoffel symbols and differentiation of tensors.

L.P. : 06

Functions of a Complex variable : Complex algebra. Cauchy Reimann conditions. Cauchy's integral theorem. Cauchy's integral formula – its applications. Taylor's expansion. Analytic continuation. Laurent's expansion.

L.P. : 08

Calculus of Residues : Singularities. Poles. Branch points. Branch cuts. Residue theorem. Principal value – its applications.

L.P. : 04

UNIT – II

Group Theory : Introduction. Discrete groups. Continuous groups. Generators. SU(2), SU(3) and homogeneous Lorentz groups.

NLP : 5

Differential Equations : Second Order Differential Equations : Partial differential equations of theoretical physics. Separation of variables. Ordinary differential equations (ODE). Second order linear ODEs with variable coefficients. Singular points. Series solutions : Frobenius' method. Second solution.

NLP : 6

Nonhomogenheous equation. Green's function. Dirac delta function. Self adjoint differential equations. Eigen functions. Eigen values. Hermitian operators.

NLP : 2

PAP-01

Special Functions: Gamma functions. Incomplete Gamma functions. Bessel functions of first kind. Neumann function. Bessel function of second kind. Spehrical Besel function. Physical applications. Legendre functions. Multipole expansions; special properties. Associated Legendre functions. Spherical harmonics. Hermite functions. Lagguerre functions. Hypergeometric functions.

NLP: 7

Integral Transforms: Laplace transform; First and second shifting theorems; Inverse LT by partial fractions; LT of derivative and integral of a function; Fourier series; FS of arbitrary period; Half wave expansions; Partial sums; Fourier integral and transforms; FT of delta function.

NLP : 5

TEXT BOOKS :

1. G. Arfken : Mathematical methods for physicists. Academic Press Int. Ed. 1970 [ch 4, 6-11, 13-15].
2. J. Mathews and R.L. Walker : Mathematical methods of physics. India Book House Pvt. Ltd. [ch 4, 6-9, 16, appendix].
3. Spiegel (Schaum's Outline Series) : Complex Variables
4. A.W.Joshi : Matrices and Tensors for Physicists.

REFERENCE BOOKS :

1. H.O. Jeffreys and Lady Jefferys : Methods of mathematical physics. Cambridge Univ. Press. 3rd ed, 1978.
2. R.V. Churchill : Complex variables and applications.
3. D.R. Halmos : Finite dimensional vector spaces.
4. C. Harper : Introduction to mathematical physics.
5. P.M. Morse and H. Feshbach : Methods of theoretical physics. Vol 1 & 2. McGraw Hil.
6. D.T. Finkbeiner : Introduction to matrices and linear trans- formations.
7. P.K. Chattopadhyay : Mathematical methods of physics. Wiley Eastern.

Group B: CLASSICAL MECHANICS
marks = 50 : no. of lectures required (NLP) = 50

Unit - I

Preliminaries: Newtonian mechanics of one and many particle systems: conservation laws, work-energy theorem; open systems (with variable mass).

NLP-3

Constraints; their classification; D'Alembert's principle' generalized coordinates and generalized momenta, Lagrange's equations; Charged particles in electromagnetic field, gyroscopic forces; dissipative systems; Rayleigh dissipation function. Jacobi integral.

NLP-7

Rotating frames: Use of Lagrange's equation and expressions for inertial forces; terrestrial and astronomical applications of coriolis force, Foucault' pendulum. Gyroscopic motion and heavy symmetric top. NPL-4

Hamilton's principle, techniques of the calculus of variations, Derivation of Lagrange's equations from Hamilton's principle, conservation theorems and symmetry properties.

NLP-6

Small oscillations: formulation of the problem, the eigenvalue equation and the principal axis transformation, frequencies of free vibrations and normal coordinates, free vibrations of a linear triatomic molecule.

NPL-5

Unit-II

Lagendre transformations and the canonical equations Hamilton's canonical equations, Advantage of Hamilton's formulation, The Hamiltonian formulation of relativistic mechanics, Derivation of Hamilton's equations from variational principles. Principle of least action.

NPL-8

Canonical transformations: The equations of canonical transformation, infinitesimal canonical transformation, Poisson's brackets and other canonical invariants, angular momentum Poison's bracket relations,

NPL-6

Hamilton-Jacobi theory: The Hamiltom-Jacobi equation for Hamillton's principal function, Hamilton-Jacobi equation for Hamilton's characteristic function; action-angle variables

NPL-6

The transition from discrete to continuous system, the Lagrangian formulation for continuous system, the stress energy tensor and conservation theorems, Noether's theorem.

NPL-5

Text Books:

1. H. Goldstein: Classical Mechanics
2. K. C. Kar: Classical Mechanics of Particles and Rigid Bodies

Reference Books:

1. Landau and Lifshitz: Mechanics
2. C. Lancczos. : The variational Principle of Mechanics
3. J. L. Synge: Classical Dynamics
4. E. T. Whittaker: Analytical Dynamics

PAPER – 02

CLASSICAL ELECTRODYNAMICS & SPECIAL RELATIVITY AND ELECTRONIC

Group A: CLASSICAL ELECTRODYNAMICS & SPECIAL RELATIVITY
Marks = 50 ; no of lectures =50

UNIT – I

Electrostatics: Multipolc expansion. Electrostatics with ponderable media. Boundary value problems. With dielectrics, Clausius-Mossoti equation, Model for molecular polarizability, Electrostatic energy for dielectric media.

NPL=7

Magnetostatics: Magnetic multipoles. Dipole-Dipole interaction. Fermi contact term.

NPL=3

Maxwell's equation(recapitulation) : Vector and Scalar Potential, Gauge Transformatiom: Lorentz and Coulomb Gauge, Poynting vector and theorem, Complex Poynting Vector. Inhomogeneous wave equation and its solution using Green's function.

NPL=6

Radiation from localized oscillating sources: Electric and Magnetic dipole radiation. Electric quadrupole radiation. Centre-fed linear antenna. NPL=5

Magnetohydrodynamics: Basic equations, Magnetic pressure and diffusion, Pinch effect, Alfven waveas.

NPL=4

UNIT-II

Radiation from accelerated charges: Retarded and advanced potentials. Lienard-Wiechert potentials. Radiation from uniformly moving charges and accelerated charges. Radiated power: Angular and frequency distribution; Larmor formulae. Synchrotron radiation. Bremsstrahlung. Thomson scattering. Radiation reaction and radiation damping: Abraham Lorentz method for self force.. Cerenkov radiation. NPL=10

Special Relativity: Relativistic addition of velocity and acceleration in vectorial form, Doppl;er effect, Thomas precession, four-momentum and four fource. NPL=5

Covariant formulation: Field tensor and its dual. Four current. Lorentz covariance of Maxwell equations. Invariants. Four vector potential. Gauge transformation. Lagrangianand Hamiltonian for the Maxwell field. Noethers theorem. Energy-Momentum tensor. Lagrangian and Hamiltonian for a charged particle in external electromagnetic fields.

NPL=10

Books: 1. J. D. Jackson: Classical ElectrodynamicsClassical Electro

2. W. K. H. Panofsky and M. Phillips: Classical Ectricity and Magnetism
3. D. J. Griffith: Introduction to Electrodynamics
4. M. N. O. Sadiku: Elements of Electromagnetics
5. D. K. Cheng: Field and Wave Electromagnetics

References:

1. L. D. landau and E. M. Lifshitz: Classical theory of Fields
2. A. Somerfield: Electrodynamics
3. A. R. Smith: Static and Dynamic Electricity.
4. E. C. Jordan and K. G. Balmain: Electromagnetic Waves & Radiating System

Group B: Electronics Marks = 50 ; no of lectures =50

Unit I

Bipolar devices: Carrier concentration in intrinsic semiconductor, Fermi level in intrinsic and extrinsic semiconductor, basic semiconductor equations, volt-ampere equation in pn diode, temperature dependence of VI characteristics of pn diode, dynamic diffusion capacitance, Ebers-Mole equation, expression for transistor alpha, (Integrated Electronics: J. Millman and C Halkias) NPL=4

Field-effect transistor: Ideal voltage controlled current source, JFET, MESFET, MOSFET (both enhancement and depletion type), structure, volt-ampere characteristics, the DC analysis of FET, the MOSFET as a resistance, the FET as a switch, the FET as an amplifier, small signal FET model. (Microelectronics : Millman abd Crabel) NPL= 4

Microwave device: Conception of negative resistance and its significance, the Tunnel diode, Gunn diode, p-i-n diode, Avalanche photo-diode, IMPATT, TRAPATT, BARITT diodes [Microwave Devices and circuits: S.Y. Liao] NPL= 4

Photonic device: Radiative and non-radiative transitions, Optical absorption, Principle photoconductive device, *quantum efficiency* and *photoconductive gain*, LED: Commercial LED material, LED construction, response time in LED, LED drive circuitry, photodiode, photovoltaic mode and photoconductive mode, diode laser, attainment of population inversion, photo-transistors, Optical feedback, optical gain threshold current for lasing. (Optoelectronics: J. Wilson and J.F.B. Hawkes) NPL=4

Memory device: Definitions and characteristics of ROM, EROM, EPROM, RAM, SRAM & DRAM; NMOS inverter, propagation delay in NOMOS inverter, the NMOS logic gates, the CMOS inverter, the CMOS logic gates, CCD, introduction to magnetic, optical and ferroelectric memories.(Microelectronics : Millman abd Crabel) NPL=4

Operational Amplifiers (OP_AMP) applications: Butterworth active filters of first and second order, RC phase shift oscillator, multivibrators (mon-stable and astable), logarithmic and antilogarithmic amplifiers, comparator, Schmitt trigger, triangular and square wave generators, high input impedance voltmeter. (Operational amplifier: Robert F. Coughlin and Fredrick F. Driscoll) NPL=4

UNIT II

Analog circuits: Bipolar transistor bias stabilization against variation of temperature, I_C, V_{BE} and β, emitter follower, hybrid-π common emitter transistor model and short circuit current gain. (Integrated Electronics: J. Millman and C Halkias). NPL= 4

Feedback amplifiers: Classification of amplifiers, the feedback concept, the transfer gain with feedback, input and output resistances in the case of voltage-series-, current-series-, voltage shunt-, and current shunt negative feedback, bandwidth expansion and reduction of noise by negative feedback. (Integrated Electronics: J. Millman and C Halkias)
NPL = 4

Power circuits and system: Large signal amplifiers, harmonic distortion, Class A, -B and –AB operation, efficiency of class A amplifier, Class A and –B Push pull amplifiers. (Integrated Electronics: J. Millman and C Halkias) NPL = 3

Power supply: Input regulation factor, output resistance, temperature coefficient; series voltage regulator preliminary and use of Darlington pair [(Integrated Electronics: J. Millman and C Halkias].

Monolithic IC regulators (LM 105, LM340, LM 317, μA 723, 78**, & 79** series and their basic principle).[R. F. Coughlin and F.F. Driscoll] NPL =5

Communication Electronics: Basic architecture of electronic communication. Amplitude Modulation: Ordinary AM generation demodulation; Generation of DSB signal and demodulation of DSB signal; Generation of SSB signal and demodulation of SSB signal; Generation of VSB signal and demodulation of VSB signal; Frequency translation and mixing , Frequency division multiplexing (FDM). Conception of angle modulation, Fourier spectra of angle modulated signal. [Analog and digital communications: H. P. Hsu]
NPL =9

PAPER - 03

STATISTICAL MECHANICS AND QUANTUM MECHANICS I

GROUP A : STATISTICAL MECHANICS
Marks : 50 Number of Lecture=50

UNIT – I

Foundations of statistical mechanics; specification of states of a system, contact between statistics and thermodynamics, classical ideal gas, entropy of mixing and Gibb's paradox.

NPL=7

Microcanonical ensomble, phase space, trajectories and density of states, Liouville's theorem, canonical and grand canonical ensembles; partiton function, calculation of statistical quantites, Energy and density fluctuations.

NPL=9

Density matrix, statistics of enseombles, statistics of indistinguishable partical, Maxwell-Boltzman, Fermi-Dirac and Bose Einstein statistics, properties of ideal Bose and Fermi gases, Bose-Einstein condensation.

NPL=9

UNIT - II

Cluster expansion for a classical gas, Virial equation of state, ising model, mean-field theories of the ising model in three, two and dimensions Exact solutions in one-dimension.

NPL = 9

Landau theory of phase transition, critical indices, scale transformation and dimensional analysis.

NPL=7

Correlation of space-time dependent fluctuations, fluctuations and transport phenormena, Brownian motion. Langeving theory, flucuation dissipation theorem. The Fokker-Planck equation.

NPL=9

Books:

F. Reif: Statistical and Thermal Physics
K. Huang: Statistical Mechanics
R. K. Pathria: Statistiacal Mechanics

Group B: Quantum Mechanics – I

Full Marks 50: Total Number of Lectures 50

UNIT-I

Introduction stating inadequacy of classical mechanics and necessity to introduce the concept of superposition principal of states of systems. The postulates of Quantum Mechanics. States as vectors and dynamical variables as linear operators on vector space. Degeneracy. Commuting observable. Compatibility and uncertainty relations. Basis states as eigen states of complete .set of commuting observables. Coordinate and momentum representstion of wave functions. NPL=10

Unitary transformation, Infinitesimal Unitary Transformation, Matrix representation of wave function and Operators. Time evolution operator. Space translation operator and identification of momentum as generator. Hamiltonian as the generator of time translation and Schrodinger equation. Schrodinger, Heisenberg and interaction picture. Heisenberg equation of motion . Symmetries and constants of motion .The density matrix. The equation of motion of the density matrix. NPL=10

Application of symbolic (operator) method to solve the eigenvalue problem of linear harmonic oscillator. Creation and destruction operator, Number operator and Fock space. NPL=5

UNIT –II

2-level systems, electron spin and photon polarization states. K0 – K0- system. Neutrino oscillation. Elementary concepts of Quantum Computer. NPL=5

Application of Schrodinger equation. Orbital angular momentum operator and its its eigenfunctions as spherical harmonics. Rigid rotator. Spherically symmetric potentials in three dimensinons. Free particle and its partial wave expansion. Three dimensional square well. The Hydrogenic atoms. Isotropic harmonic. NPL=10

Approximation Methods in Quantum Mechanics. WKB approximation and its application in tunneling processes. Variational Method. Time independent perturbation theory Rayleigh Scrhodinger method. Nondegenerate and degenerate cases. Anharmonic oscillator. Adiabatic and sudden approximation. NPL=10

Boobs:

J.J. Sakuraj- modern Quantum Mechanics,
B.H. Bransden and C.J. Joachain – Introduction to Quantum Mechanics, ELBS
A.K. Ghatak and S. Lohannathan – Quantum Mechanics

PAPER 04

COPUTER PRACTICAL

Group A: COMPUTER PROGRAMMING WITH BASIC AND ITS APPLICATIONS:

Full marks = 50 : Total no. of class hours in relation to **theory**, required = **25**
Total no. of **practical** class hour required = **50**
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Elementary ideas of Computer.
NLP : 05

Elementary ideas about DOS, windows and Office
NLP : 10

Elements of BASIC language: INPUT, OUTPUT statements, Transfer of control, GOTO statement. Conditional branching: IF - THEN statement. Multiple branching; ON - GOTO statement. Defining arrays - DIM statement. Entering input data - the READ and DATA statements. OPEN and CLOSE a data file; INPUT from and OUTPUT in a data file. FUNCTIONS and SUBROUTINES. The random number generator. String handling in Basic.

Total number of lectures required: 10 (theory)

<u>50 hours of Practical will be conducted in relation to above coomands</u>

Group B: COMPUTER PROGRAMMING WITH FORTRAN AND
ITS APPLICATIONS:

Full marks = 50 : Class hours in relation to **theory**, required = 25
Total no. of **practical** class hour required = **50**

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Elements of FORTRAN language: Integer and Real arithmatics. Numerical INPUR and OUTPUT. Formatted INPUT OUTPUT and field specifications. Transfer of controls. If - GOTO statements. DO loops. Nested DO loops. Arrays, subscripted variables. DIMENSION statement. FUNCTIONS and SUBROUTINES. DATA statement. INPUT from and OUTPUT in data files. Structured FORTRAN.

Total number of lectures required: 10 (theory)

Numerical Analysis: Theory: Solution of nonlinear equations; functional iteration; bisection method; secant method; Newton - Raphson method. Interpolation: Linear interpolation; Newton'e method; Lagrange's interpolation; numerical differentiation, Numerical integration, Riemann, trapezoidal and Simpson's rules; Romberg integration; Gaussian quadrature formula. Solution of linear simultaneous equations - Gauss elimination; Gauss - Jordan elimination. Matrix algebra; eigen values and eigenfunctions of matrices.

Elementary statistical estimations; frequency distribution; simple regression; linear least square fitting; correlation coefficient. Solutions of ordinary differential equations (ODE); solution of ODE as an initial value problem; Euler's method; Runga Kutta method; predictor corrector method.

Total number of lectures required: 10 (theory)

Internet Lab.: Introduction to Internet, Application of Internet :- Browsing, Uploading, Downloading, Telnet, FTP, E.Mail, Interactive Session, Chat room.

Total number of lectures required: 5 (theory)

<u>Practical hours required for Unit-I, Unit-II and Unit-III :- 50</u>

PAPER 05

ELECTRONIC DESIGN PRACTICAL

Group A: Digital Design, Marks: 50, Number of periods : 65

Phase 1

1. Construct a power supply of ± 12 V / ± 15 Volts using regulator ICs. Make a facility of using = +5V in the same bread board.

1. Design and implement the following LOGIC GATES using discrete components like resistance, capacitor, diodes and transistors

 a. OR Gate, b. AND Gate c. NOT Gated. d. NOR Gate e. NAND Gate
f. XOR Gate g. XNOR gate.

2. Verify De Morgan's Theorems using discrete components.

Phase 2

EXPERMENT USMG IC 74**

1. (A+B). (B+C). (C+A)_ = AB + CD +CA
2. (A+ B). (A+C) = AC + AB
3. (A+B) (A+ C) = A + BC
4. WITH BASIC GATES IMPLEMENT TWO FORMS XOR FUNCTIONS and VERIFY THE TRUTH TABLE.
5. WITH BASIC GATES IMPLEMENT TWO FORMS XNOR FUNCTION and VERIFY THE TRUTH TABLE.
6. IMPLEMENT TWO- INPUT OR GATE USING AND and NOT gates and VARIFY THE TRUTH TABLE.
7. IMPLEMENT TWO-INPUT AND GATE USING OR and NOT GATES AND VERIFY THE TRUTH TABLE
8. CONSTRUCT Y = AB + AB and VERIFY ITS TRUTH TABLE

Phase 3

EXPERMENT USING IC 74**

1. Construction of NOT gate using NAND gates only.
2. Construction of AND gates using NAND gates only.
3. Construction of OR gates using NAND gates only.
4. Construction of NOT gate using NOR gates only.
5. Construction of OR gates using NOR gates only.
6. Construction of AND gates using NOR gates only.
7. Construction of XOR gate using NAND gates only.

Phase 4

Experiments with Linear ICs

1. To construct HALF ADDER using AND gate and XOR.
2. To construct a FULL ADDER using OR, AND and XOR gates.
3. To study the 4-bit PARALLEL ADDER using FULL ADDERs
4. To construct and study a HALF SUBTRACTOR.
5 Construct and study a FULL SUBTRACTOR.
6. To study a 4-bit SUBTRACTOR using FULL ADDERs.
7. To study 4-bit SUBTRACTOR/ ADDER using mode control.

Group B: Analog Design, Marks: 50, Number of periods : 60

Phase 1

Transistor Based

1. Design of common emitter amplifier and study of its bandwidth
2. Design of an emitter follower and study of its bandwidth
3. Design of a coupled amplifier using the above two configurations and to study its frequency response.

Phase 2

Use of Linear IC 741/536

1. USE AS A BUFFER

a) Study the frequency response curve with INPUT VOLTAGES: 200 mV, 1V and 5V

b) Keep the frequency fixed at 100 Hz and study the variation of output voltage with input c) Repeat (ii) with fixed frequecies 10 kHz and 100 kHz.

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2. **USE AS NON- INVERTING & INVERTING AC AMPLIFIER:**
Take gain at any desired value from 10 to 20

a) Study the frequency response curve with INPUT VOLTAGES: 200mV, 1V and 5V
b) Keep the frequency fixed at 100 Hz and study the variation of output voltage with input
c) Repeat (ii) with fixed frequencies at 10kHz &100 kHz
d) Study the GAIN-BANDWIDTH product considering gains equal to 1, 10, 20, 40, 60, 80 and 100.

Phase 3

STUDY OF `ACTIVE FILTERS '(HIGH PASS, LOW PASS, BAND PASS AND BAND STOP):

(a) first order with designing details
(b) second order with designing details

Phase 4

HALF- WAVE & FULL-WAVE RECTIFIERS:
Design and construction and study of the distortion with respect to variation of input voltage and frequency

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M.Sc. Part-II

PAPER 06

QUANTUM MECHANICS II AND NUCLEAR & PARTICLE PHYSICS

Group A: QUANTUM MECHANICS II
Marks 50. Total Number of Lectures 50

UNIT – I

Rotational Symmetries in Quantum Mechanics and Rotaion operators operators. Spin and Orbital angular momentum as generators of . Addition of Angular momentum and Clebsch Gordon Coefficients. Tensor Operators, Wigner-Eckart theorem and its application.

Scattering Theory: Formal theory scattering amplitude, differential and total cross section, Optical theorem. Born approximation. Scattering from spherically symmetric potential and partial wave analysis.

Time dependent perturbation theory: Interaction picture. Induced emission and absorption of radiation. Sponteneous emission. Einstein's A and B coefficients.

UNIT - II

Relativistic quantum mechanics, Klein Gordon equation and its inadequacy, Dirac equation for free particles, charge and current density, plane wave solutions. Dirac spinor and gamma matrices, spin and magnetic moments.Negative energy states and hole theory. Charge conjugation. Hydrogen atom in Dirac theory.

Classical relativistic field theory :Symmetries and invariance principles, Noether theorem, energy momentum tensors. Gauge Transformation and guage symmetry. Elements of Quantum field theory. Identical particles, bosons and fermions. Quantisation of free scalar, Dirac and electromagnetic fields.

Interacting fields. S-matrix, Wick's theorem and reduction of S-matrix. Feynman diagrams and calculation of S-matrix amplitudes. Simple examples.

Books:
E. Merzbacher : Quantum mechanics
J. J. Sakurai: Advanced Quantum Mechanics
A. Messiah: Quantum Mechanics, Vol II
L. H. Ryder: Quantum Field Theory

Pap-06

References:
S. Gasiorowicz: Quantum Physics
L. I. Sciff: Quantum Mechanics
J.G. Taylor: Quantum Mechanics: an introduction
K. S. Rao and V. Rajeswari: Quantum theory of angular momentum
C. Itzykson and J. B. Zuber: Quantum field Theory

Group B: NUCLEAR & PARTICLE PHYSICS
Marks 50. Total Number of Lectures 50

UNIT – I

Basic nuclear concepts: Mass, charge, binding energy, size of nuclei, semi-empirical mass formula, stability of nuclei, cross-section, angular momentum, conservation laws and constant of motion.

NPL=4

Nucleon-nucleon interaction, exchange forces and tensor forces, nucleon-nucleon scattering, effective range theory, spin dependence of nuclear forces, charge independence and charge symmetry of nuclear forces, isospin formalism, Yukawa interaction.

NPL=6

Direct and compound nuclear mechanisms, cross-section in terms of partial wave amplitude.

NPL=4

Nuclear models: liquid drop model, Bohr-Wheeler theory of fission, experimental evidence of shell effects, shell model, spin-orbit coupling, magic numbers, angular momenta and parities of nuclear ground states, qualitative discussion and estimates of transition rates, magnetic moments and Schmidt lines, collective model of Bohr and Mottelson.

NPL=7

Basic idea about interaction of alpha, beta and gamma rays with matter, basic idea about nuclear detectors, cyclotron and Van de Graff generator.

NPL=4
Pap-06

UNIT II

Nuclear decay: alpha decay, half lives, Gammow's theory; beta decay- Fermi's theory of beta decay, shape of the beta spectrum, total decay rates, angular momentum and parity selection rules, comparative half lives, allowed and forbidden transitions, selection rules and parity violation: Gamma decay, multiple transitions in nuclei, angular momentum and parity selection rules, internal conversion, nuclear isomerism.

NPL=12

Elementary Particles: Types of interaction between elementary particles, Hadrons and leptons, symmetry and conservation laws, Elementary ideas of CP and CPT invariance, Classification of hadrons, Lie algebra, SU(2), SU(3) multiplets, Quark model, Gell Mann-Okubo mass formula for octets and decuplet hadrons, charm, bottom and top quarks.

NPL=13

Books:
W. E. Burchman: Elements of Nuclear Physics
W.S.C. Williams: Nuclear and Particle Physics
I. S. Hughes: elementary particles

Reference Book:
H.A. Enge: Introduction to Nuclear Physics
B.L. Cohen: Concepts of Nuclear Physics
R.R.Roy and B. P.Nigam: Nuclear Physics
S. Gasiorowicz: Elementary particle Physics
F. Halgen and A. D. martin: Quarks and Leptons
D. Griffith: Introduction to Elementary Particles
J. M. Blatt and V. F. Weisskopf: Theoretical Nuclear Physics

PAPER 07

CONDENSED MATTER PHYSICS and ATOMIC AND MOLECULAR PHYSICS

Group A : CONDENSED MATTER PHYSICS
Full marks = 50 : Total no. of lectures required (NLP) = 50

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UNIT – I

NLP = 25

Crystal Physics: Crystalline solids, unit cells and direct lattice. Two and three dimensional bravis lattices, closed packed structures

NLP : 6

Interaction of X – rays with matter, absorption of X-rays. Elastic scattering from a perfect lattice. The reciprocal lattice and its applications to diffraction techniques. The Laue, powder and rotating crystal methods. Crystal structure factor and intensity of diffraction maxima. Extinctions due to lattice centering.

NLP : 4

Point defects, line defects and planar (stacking) faults. The role of dislocations in plastic deformation and crystal growth. The observation of imperfections in crystals. X – ray and electron microscopic techniques.

NLP : 3

Lattice dynamics: Vibrations of monatomic and diatomic lattices. Accoustical and Optical phonons. Quantization of lattice vibration: phonon momentum. Debye theory. Thermal expansion. Lattice theory.

NLP : 4

Dielectric Functions and Ferroelectric : Dielectric functions of the electron gas. Plasmons. Electrostatics screening. Metal insulator transition. Electron electron interactions. Claussius Mossoti relation. Polarization. Ferroelectric crystals. Phase transition.

NLP : 5

Optical Processes and Excitons : Kramers Kronig relations. Interband electronic transitions and excitons. Raman effect in crystals. Energy effect in crystals. Energy loss of fast particles in a solid.

NLP : 3

UNIT – II

Free Electron Fermi Gas : Free electron theory of metals. Density of states. Fermi energy at finite temperature. Fermi temperature and wave vector. Electronic specific heat. Magnetoresistance. Cyclotron resonance. Hall effect. Landau levels.

NLP : 7

Band Theory of Solids : Nearly free electron model. Energy gap. Bloch functions. Kronig Penny model. Number of states in a bond. Effective mass of an electron in a crystal. Metals, semiconductors and insulators. Tight binding approximation . Band structure in Si, Ge and alloys.

NLP : 6

Magnetic Properties : Diamagnetism. Quantum theory of paramagnetism. Cses of rare earth and iron group ions. Crystal field splitting. Paramagnetic properties of solids. Paramagnetism. Curie Weiss law. Heisenberg's theory. Saturation magnetization. Magnons. Ferromagnetic and antiferromagnetic systems. Domains. Magnetic bubble domains.

NLP : 7

Superconductivity : Meissner effect. Heat capacity. Microwave and infrared properties. Isotope effect. London's eqation. BCS theory (qualitative ideas). Flux quantization. Single particle tunneling. Josephson tunneling. High T_c superconductivity (qualitative).

NLP : 5

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TEXT BOOKS :

1. C. Kittel : Introduction to Solid State Physics. Wiley Eastern Ltd. 1979.
2. Dekker : Solid State Physics.

REFERENCE BOOKS :

1. R. J. Elliot and A. F. Gibson : An introduction to Solid State Physics and its Applications.

2. A. C. Rose-Innes and E. H. Rhoderick : Introduction to Super- conductivity. Pergamon. 1969.
3. A.O.E. Animalu : Intermediate Quantum Theory of Crystal Solids. PHI. 1978.
4. J. M. Ziman : Principles of the Theory of Solids. CUP Vikas Students Edition. 1979.
5. J. D. Patterson : Introduction to the Theory of Solid State Physics. Addison Wesley. 1971.
6. C. Kittel : Quantum Theory of Solids. John Wiley. 1963.
7. N. W. Ashcroft and N. D. Mermin : Solid State Physics. CBS Publishing. 1981.
8. D. Wagner : Introduction to the Theory of Magnetism. Pergamon. 1972.
9. J. Crangle : The Magnetic Properties of Solids. Edward Arnold. 1977.
10.J. R. Scriefer : Theory of Superconductivity. Benjamin. 1964.
11.C. M. Kachhave : Solid State Physics : Tata McGraw Hill. 1990.
12.Chrisman : Solid State Physics. Addison Wesley.

GROUP B : ATOMIC AND MOLECULAR PHYSICS

Full marks = 50 : Total number of lectures required = 50

UNIT – I
NLP : 25

Quantum states of one electron atoms – Atomic Orbitals – Hydrogen spectrum – Pauli's principle. Transition rates and Slection rules. Fine structure of hydrogen and alkali spectra. Quantum defect in alkali spectra.

NLP : 6

Normal and anomalous Zeeman effect – Paschen Back effect – Stark effect – Lamb shift.

NLP : 4

Two electron systems – Role of Pauli exclusion principle – Spectra of He atoms. Singlet and Triplet series. Independent particle model. Excited states.

NLP : 4

Many Electron Atoms: Equivalent and non – equivalent electrons – LS coupling and JJ coupling. Hund's rule. Hyperfine structure (qualitative) – Line broadening mechanisms (general ideas)

NLP : 4

LASERS : Spontaneous and Stimulated emission – Einstein coefficients – Population inversion. Rate equation – Threshold conduction for laser oscillation – Pumping schemes – Role of resonant cavity – Three and four level systems – He-Ne laser, CO_2 laser, Semiconductor laser, Laser induced reactions and isotope separations. LASER as a probe for studying excited states of atoms.

NLP : 7

UNIT – II

Molecular Structure : Born Oppenheimer approximation for diatomic molecules. Rotation and vibrations of diatomic molecules. Electronic structure of diatomic molecules. Molecular orbital method. Heitler London method.

NLP : 5

Rotational spectra : Diatomic, linear symmetric top, asymmetric top and spherical top molecules. Rotational spectra of diatomic molecules as a rigid rotor. Energy levels and spectra of non rigid rotor. Intensity of rotational lines. Isotopic effect. Stark effect and Stark modulated microwave spectrometer (qualitative).

NLP : 5

Vibrational energy of diatomic molecules. Diatomic molecule as a simple harmonic oscillator. Energy levels and spectrum. Morse potential energy curve. Molecules as vibrating rotator. Rotational - Vibrational spectrum of diatomic molecule – PQR branches. Isotopic effect. IR spectrometer (qualitative).

NLP : 5

Raman effect. Quantum theory. Molecular polarisability. Pure rotational Raman spectra of diatomic molecules. Vibration rotation Raman spectrum of diatomic molecules. Intensity alterations in Raman spectra of diatomic molecules.

NLP : 3

Mossbauer effect : Resonance fluorescence. Kramors Heisenberg formula. Mossbauer effect. Elementary theory of recoil less emission (absorption) of gamma rays. Shift and splitting of Mossbauer lines. Isomer shift. Quadrupole interactions. Magnetic hyper-fine interactions. Line broadening.

NLP : 7

TEXT BOOKS:

1. **H.E.White :** Introduction to Atomic Spectra –
2. **B.H.Bransden and C.J.Joachain :** Physics of Atoms and Molecules. Longman 1983.
3. **C.N.Banwell :** Fundamentals of Molecular Spectroscopy. Tata – McGraw Hill.
4. **G.M.Barrow :** Introduction to Molecular Spectroscopy, McGraw Hill.
5. **A.K.Ghatak :** Laser. Tata – McGraw Hill

REFERENCE BOOKS:

1. **G.Herzberg :** Molecular Spectra and Molecular Structure. Vol. . Van Nostran 1950.
2. **B.W.SHore and D.H.Menzel :** Principles of Atomic Spectra. John Wiley.
3. G.M.Barrow : Introduction to Molecular Spectroscopy, McGraw Hill.
4. Spectroscopy ; Vol I, II and III Walker and Straughen.
5. Molecular Spectroscopy – J.M.Hollas.

PAPER 08

[SPECIAL PAPER (Theory)]

ADVANCED ELECTRONICS-I &
ADVANCED ELECTRONICS-II

Group A: ADVANCED ELECTRONICS-I

Marks : 50, Number of Lectures : 50

UNIT - I

Sweep Generators: General features of time-base signal, Methods of generating time-base waveform----exponential sweep circuit, negative resistance switches, Miller and bootstrap time-base generators. [Pulse, Digital and Switching waveforms: J. Millman H. Taub]
NLP = 4

Silicon Controlled Rectifier (SCR): The four layer diode, pnpn characteristics, V-I characteristics of three terminal SCR, SCR control circuit [pulse control, power control, over voltage protection circuit], the triac and diac.] (Integrated Electronics: J. Millman and C Halkias). NLP= 6

Pulse amplifier: Response to a pulse, bandwidth requirement, rise time and sag of the pulse, Shunt-peaked video amplifier. High and low frequency compensation.[Electronic Fundamentals and applications: J. D. Ryder] NLP = 4

Television: Television system and standard, Scanning, blanking and synchronizing pulses, Television camera (B & W picture and colour picture), Tonal and Colour characteristics of pictures, Composite B 7 W and colour video signals, block diagram of colour TV transmitter and receiver.[Electronic communication systems: G. Kenedy].
NLP = 6

Waveguides: Reflection of waves from conducting plane, the rectangular waveguide TM and TE waves), Cylindrical waveguides (the TEM waves in coaxial line), attenuation in duides due to imperfect conductors. [Networks, lines and fields: J. D. Ryder]
NLP = 5

Unit II

Optoelectronics: Liquid crystal display---dynamic scattering LCD, field effect LCD electrical characteristics of liquid crystal and numeric displays, PhotoFET, optoelectronic coupler consisting of LED and photo transistor. [Electronic Devices and Circuits: D. A. Bell].
NPL = 4

Analog to Digital Conversion: Sampling theorem (low pas signal and band pass signal), Natural sampling and flat top sampling, Signal recovery through holding, Pulse-Amplitude modulation(PAM), Pulse width Modulation (PWM), Channel BW for PAM signal, Quantization of sampled signal, Quantization error, Pulse code modulation (PCM), Differential pulse code modulation (DPCM), Delta modulation(DM), Adaptive delta modulation(ADM), CVSD, Line code and spectral shaping [Principles of communication systems: H. Taub and D. L. Schilling]. NLP = 6

Digital Modulation Technique: PSK, BPSK, DPSK, QPSK, DCPSK, ASK, QASK, BFSK, FSK, MSK. [Principles of communication systems: H. Taub and D. L. Schilling].

NLP = 3

Mathematical representation of noise: Sources of noise, a frequency domain representation of noise, the effect of filtering on the probability density of Gaussian noise, spectral components of noise, response of a narrow band filter to noise, effect of noise on the power spectral density of noise, superposition of noises, mixing involving noise, linear filtering, noise bandwidth, quadrature components of noise, power spectral density of $n_c(t)$ and $n_s(t)$ in phase and quadrature components, probability density of $n_c(t)$ and $n_s(t)$ and their time derivatives. [Principles of communication systems: H. Taub and D. L. Schilling].

NPL =6

Noise in Pulse-Code and Delta-Modulation systems: PCM transmission, calculation of quantization noise, the output signal-power in PCM, the effect of thermal noise, the output signal-to-noise ratio in PCM, Delta modulation(DM), quantization noise in DM, the output signal power in DM, the DM output-signal-to-quantization-noise ratio, the effect of thermal noise in Delta modulation, output signal-to-noise ratio in DM. [Principles of communication systems: H. Taub and D. L. Schilling]. NPL = 4

Group B: ADVANCED ELECTRONICS-II

Marks : 50, Number of Lectures : 50

Unit I

Simplifying Logic Circuit & Mapping & code conversion**: Sum-of-product and product of sum (using De Morgan's theorem, using NAND and using NOR logics), Karnaugh Maps, Don't care combinations, Hybrid logic, Minimization of multiple output circuit, variable spacing, Quine-McClusky method, function minimization of multiple output circuits. Encoding , decoding BCD to decimal & BCD to seven-segment code. (Digital principles: R. L. Tokheim, Schaum's Outline Series). NPL = 4**

Registers and counters **:Buffer register, data transmission shift register, serial in serial out shift register, serial in parallel out shift register, parallel in serial out shift register and parallel in parallel out shift register, bi-directional shift register, universal shift register, dynamic shift register,**

applications of shift registers: Up/down ripple counter, effect of propagation delay in ripple counter, up/down synchronous counter, ring counter. NPL = 7

Data transmission: Baseband signal receiver, Bit error rate, Optimum filter, White noise, Matched filter and probability error, Coherent reception, Correlation, PSK, FSK, non-coherent detection of OOK and FSK, Differential PSK, QPSK, Calculation of error probability for OOK, BPSK, BFSK and QPSK. NPL = 5

Computer Communication system: Types of networks, Design features of a communication network---TYMNET, ARPANET, ISDN, LAN NPL = 4

Mobile Radio and Satellite: Time Division Multiple Access (TDMA), Frequency Division Multiple Access (FDMA), ALOHA, Slotted ALOHA, Carrier Sense Multiple Access (CSMA), Poison distribution, protocol, Mobile network system, Cell structures, hand-off procedure and frequency reverse scheme, GSM system. NLP = 5

UNIT II

Microprocessors: NLP = 25

Architecture: Internal microprocessor architecture, Real mode and protected mode of addressing, memory paging.
Addressing modes: Data addressing modes, Program addressing modes, Stack memory addressing modes.
Instruction set: Data movement instructions, Arithmetic and logic instructions, Program control instructions, Assembler details.
Programming the microprocessor: Modular programming, using the keyboard and Video display, Data conversion, Disc files, Example programs.
Hardware specifications: Pin-0ut and the pin functions, clock generators(8284A), Bus buffering and latching, Bus timing, Ready and Wait states, Minimum mode versus maximum mode.
Memory Interlace: Memory devices, Address decoding, 8088,80188 (8-bit) memory interface, 8086, 80186, 80286, 80386 (16-bit) memory interface, 80386Dx and 80486 (32-bit) memory interface, Dynamic RAM.
Basic I/O Interface: Introduction to I/O interface, I/O port address decoding.
Direct Memory Access: Basic DMA operation, 8237 DMA controller, Shared bus operation, Disk memory systems and Video displays

PAPER 09

THE ADVANCED LABORATORY

Group A: Advanced Practical 1
Marks : 50, Classes Required = 65

1. Determination of g-factor using ESR
2. Variation of Resistivity by 4-probe method
3. Determination of Hall Co-efficient
4. Determination of Junction Capacitance
5. e/m of electrons
6. Q- value of LCR circuit using OP_AMP (Series and parallel)
7. Absorption co-efficient by spectro-photometer
8. Michelson Interferometer using LASER

Group B: Advanced Practical 2
Marks : 50, Classes Required = 60

Microprocessor / Project

PAPER 10

ELECTRONICS SPECIAL PRACTICALS

Group A : Marks :50, Classes required : 65

1. **RS Flip-flop** with and without clock pulse (**NOR & NAND** latch)
2. ***Gated*** SR Latch & ***edged-triggered*** SR Flip-flop
3. The **D-latch**: ***gated*** D-latch & ***edged-triggered*** D Flip-flop
4. **JK** Flip-flop/ JK ***master-slave*** Flip-flop
5. **SHIFT-REGISTER**

6. **Ripple counter**
7. **Parallel counter**
8. **Decade counter**
9. Positive and negative **CLAMPER** using OP_AMP
10. Positive and negative **CLIPPER** using OP_AMP
11. **COMPARATOR & ZERO-crossing** device.
12. **SCHMITT TRIGGER** using OP_AMP

Group B : Marks :50, Classes required : 65

1. **Square-wave** generator
2. **Triangular wave** generator
3. **LOGARITHMIC** amplifier
4. **Digital-to-Analog** converter
5. Use of timer IC555 as **mono-stable** vibrator
6. Use of timer IC555 as **astable vibrator**
7. Use of timer IC555 **Sequential Timer**
8. Study of **CMOS astable multivibrators** : Symmetrical, non-symmetrical output and astable with independently variable mark and space.
9. Study of **CMOS Schmitt Trigger**: symmetrical and non-symmetrical
10. Use of **Phase-Lock-Loop** (PLL)
11. **Voltage Controlled Oscillator** (VCO)
12. **Demodulation of FM** wave using VCO
