SunRise University
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Recognized by UGC Act, 1956 u/s 2 (f)

MSC in Physics Revised Syllabus

1st Semester

PAPERS CODE	PAPERS NAME	INTERNAL	EXTERNAL	TOTAL
MSPH 101	Classical Mechanics & Mathematical Method in Physics	40	60	100
MSPH 102	Classical Electrodynamics and Electromagnetic theory	40	60	100
MSPH 103	APPLIED RADIATION PHYSICS	40	60	100
MSPH 104	Physics Practical	60	40	100
Total		**180**	**220**	**400**

2nd Semester

PAPERS CODE	PAPERS NAME	INTERNAL	EXTERNAL	TOTAL
MSPH 201	Quantum Mechanics, Atomic & Molecular Physics	40	60	100
MSPH 202	Electronics, Numerical Method & Computer Programming	40	60	100
MSPH 203	METHODS IN THEORETICAL PHYSICS	40	60	100
MSPH 204	Physics Practical	60	40	100
Total		**180**	**220**	**400**

3rd Semester

PAPERS CODE	PAPERS NAME	INTERNAL	EXTERNAL	TOTAL
MSPH 301	Advanced Quantum Mechanics & introductory Quantum Field Theory	40	60	100
MSPH 302	Nuclear Physics	40	60	100
MSPH 303	MOLECULAR BIOPHYSICS	40	60	100
MSPH 304	Physics Practical	60	40	100
Total		**180**	**220**	**400**

<u>**4^{th} Semester**</u>

PAPERS CODE	**PAPERS NAME**	**INTERNAL**	**EXTERNAL**	**TOTAL**
MSPH 401	Statistical & Solid-State Physics	40	60	100
MSPH 402	Microwave Electronics	40	60	100
MSPH 403	ANALOG COMMUNICATION SYSTEMS	40	60	100
MSPH 404	Physics Practical	60	40	100
Total		**180**	**220**	**400**

M.Sc. I year Physics Syllabus
Paper I -Classical Mechanics and Mathematical Methods in physics

SunRise University, Alwar

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UNIT-1
Constraints,Holonomic and non-holonomic constraints'-Alembert's Principle and Lagrange's equation ,Velocity dependant: potentials, simple applications of Lagrange formulation. Hamilton Principle,Calculus of variations, Derivation of Lagrange Equation from Hamilton's principle. Extension of Hamilton's principle for non-conservative and non-homonymic systems, Method of Lagrange's multipliers, conservation theorems, and symmetry properties,Noether's theorem. Conservation of energy, linear momentum and angular momentum as a consequence of homogeneity of time and space and isotropy of space
Generalized momentum,legendre transformation and the Hamilton equation of motion,simple applications of Hamiltonian formulation, cyclic coordinates ,routh procedure ,Hamiltonian formulation of relativistic mechanics, derivation of Hamilton canonical equation from Hamilton Variation principle. The principle of least action
UNIT-2
canonical transformation, integral invariant of Poincare,lagrange and passion as canonical invariants, equation of motion in Poisson bracket formulation formulation, Infinitesimal contact transformation and generators of symmetry liouvilee theorem Hamiltol Jacobbi equation and its application
Action angle variable adiabatic invariance of action variable: The Kepler problem in action angle variables, Theory of small oscillation in lagrangian formulation, normal coordinats and its applications, orthogonal transformation,eulerian angles, Euler theorem, Eigen Values of the inertia tensor, Euler equations. Force free motion of a rigid body.
UNIT-3
Coordinate transformation in N dimensional space :contravariant and covariant tensor,jacobian,relative tensor,pseudo tensors,algebra of tensors,Metric theorem ,Associated

tensors,reimannian space ,christoffelas symbols,transformation of christoffelas symbols covariant differentiation ,Ricci theorem ,divergence ,curl and laplacian in tensor form stress and strain tensors.hook law in tensor form,Lorentz covariance of Maxwell equation.klein gorden and dirac Equations,test of covariance of schrodinger equation

UNIT-4

Fourier Transforms: Development of the Fourier integral from the Fourier series, Fourier and inverse Fourier transform: simple applications: finite wave train, wave train with Gaussian amplitude ,Fourier transform of derivatives, solution of wave equation as an application, convolution thermo, intensity in term of spectral density for quasi-monochromatic EM waves, momentum represeation,application of hydrogen atom and harmonic oscillator problems. application of Fourier transform to diffraction theory, Diffraction pattern of two slits
Laplace transforms and their properties ,Laplace transform of derivatives and integrals of Laplace transform,laplace,convoulation thermo, impulsive function application of Laplace transform in

solving linear differential equations with constant coefficient with variable coefficient and linear partial differential equation

PAPER –ll CLASSICAL ELECTRODYNAMICS AND ELECTROMAGNETIC THEORY

Unit-l

Electrostatics: Electric field, Gauss Law, Differential form of Gaussian law. Another equation of electrostatics and the scalar potential, surface distribution of charges and dipoles and discontinuities in the electric field and potential. Poisson and Laplace equations, Green's Theorem, Uniqueness of the solution with the Dirichlet or Neumann boundary Conditions, Formal Solutions of electrostatic Boundary value problem with Green's function, Electrostatic potential energy and energy density. Capacitance
Boundary Value Problems in Electrostatics: Methods of Images, Point charge in the presence of a grounded conducting sphere, point charge in the presence of a charged insulated conducting sphere, point charge near a conducting sphere at a fixed potential, conducting sphere in a uniform electric field by method of images, Green function for the sphere, General solution for the potential, conducting sphere wit hemispheres at a different potentials, orthogonal functions and expansion. .т
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Multipoles, electrostatics of Macroscopic Media Dielectric: Multipole expansion, multipole expansion of the energy of a charge distribution in an external field, Elementary treatment of electrostatics with permeable media. Boundary value problems with dielectrics. Molar polarizability and electric susceptibility. Models for molecular polarizability, electrostatic energy in dielectric media.

Unit – Il

Magnetostatics: Introduction and definition, Biot and Savart Law, the differential equations of magnetostatics and Ampere's law, Vector potential and magnetic induction for a current loop, Magnetic fields of a localized current distribution, Magnetic moment, Force and torque on and energy of a localized current distribution in an external induction, Macroscopic equations, Boundary conditions on B and H Methods of solving Bound value Problems in magnetostatics, Uniformly magnetized sphere, magnetized sphere in an external fields, permanent magnets, magnetic shielding, spherical shell of permeable material in an uniform field. Time varying fields, Maxwell's equations conservation laws Energy in a magnetic field, vector and scalar potentials, Gauge transformations, Lorentz gauge, coulomb gauge, Green function for the wave equation. Derivation of the equations of Macroscopic Electromagnetism, Painting's Theorem and conservation of energy and momentum for a system of charged particles and EM fields Conservation laws for macroscopic media. Electromagnetic field tensor, transformation of four potentials and four currents, tensor dissipation of Maxwell's equations.

Unit-III

Plane Electromagnetic Waves and Wave Equation Plane wave in a nonconducting medium, Frequency dispersion characteristics of dielectrics, conductors and plasmas, waves in a conducting or dissipative medium, superposition of waves in one dimension, group velocity, casualty connection between D and E. Kramers-Kroning relation.

Covariant Form of Electrodynamics Equations Mathematical properties of the space-time special relativity, Invariance of electric charge covariance of electrodynamics, Transformation of

electromagnetic fields. Radiation by moving charges Lienard-wiechert Potentials for a point charge. Total power radiated by an accelerated charge Larmour's formula and its relativistic generalization, Angular distribution of radiation emitted by an accelerated charge, Radiation emitted by a charge in arbitrary extremely relativistic motion. Distribution in frequency and angle of energy radiated by accelerated charges, Thomson scattering and radiation, Scattering by quasi free charges, coherent and incoherent scattering, Cherenkov radiation.

Unit - IV

Magneto-hydrodynamics and Plasma Physics: Introduction and definitions, MHD equations Magnetic diffusion viscosity and pressure; Pinch effect. instabilities in a pinched plasma column, Magneto-hydrodynamic waves; Plasma oscillations, short wave length limit of plasma oscillations and Debye shielding distance. Radiation damping, self fields. of a particle, scattering and absorption of radiation by a bound system: Introductory considerations, Radiative reaction force from conservation of energy. Abtaham Lorentz evaluation of the self force, difficulties with Abraham Lorentz model; Integro-differential equation of motion including radiation damping.. Line Breadth and level shift of an oscillator, Scattering and absorption of radiation by an oscillator, Energy transfer to a harmonically bound charge.

Reference Book:

J.D.Jackson :-Classical Electrodynamics

Panofsky and Philips Classical Electricity and Magnetism

Paper III

MPME-201: APPLIED RADIATION PHYSICS Credits: 3 (
This minor elective is open to M.Sc. students of Physics as well as other Departments)

Basic Nuclear Processes in Radioactive Sources:

Characteristics of nuclear radiations, alpha decay, beta decay, electron capture, gamma emission, annihilation radiation, neutron sources, source activity, radioactivity decay law, decay chains.

Passage of Radiation through Matter:
The cross section, interaction probability in a distance and mean free path, Stopping power of charge particles- Qualitative discussion of the Bethe-Bloch formula, Radiation length, Range of electrons, Interaction of photons, neutrons and charges particles.

Radiation Protection:

Dosimetric Units: The Roentgen, Absorbed dose, Relative Biological effectiveness (RBE), Equivalent dose, Effective Dose, Typical doses from sources (Natural, Environmental & Medical exposures), Radiation shielding and its safety (Gamma-rays, electrons, positrons, charged particles, Neutrons), Ethics of radiations.

Radiation Effects on Biological Systems:
High doses received in a short time, Low-level doses limits, direct ionization of DNA, radiation damage to DNA, Biological effects (Genetic, Somatic, Cancer and sterlity).

General Characteristics of Detectors:
Sensitivity, Detector response, Energy resolution, Response time, Detector efficiency, Dead time, Ionization mechanism and introductory idea about some detectors.

Reference Books:

1. A Primer in Applied Ra diation Physics: F.A. Smith.
2. Introduction to Experim ental Nuclear Physics: R.M. Singru.
3. Radiation Biophysics: E .L. Alpen.
4. Atom, Radiation and R adiation Protection: J. Turner.

MPE-304: MOLECULAR BIOPHYSICS Credits: 3

Basic Concepts in Biophysics:

Elementary ideas about the DNA structure, sugar-phosphate backbone, nucleosides and nucleotides, three- dimensional DNA structure, RNA. Proteins: primary, secondary, tertiary and quaternary structures, enzymes and their catalytic activity, DNA and protein folding, DNA denaturation, replication, mutation, intercalation, neurotransmitters, membranes.

DNA and its Role:

Forces stabilizing DNA and protein structure, Theoretical quantum chemical and molecular mechanical methods, Treatment of intermolecular interactions, conformations, hydrogen bonding, stacking and hydrophobic interactions, importance of electrostatic interactions, biomolecular recognition, drug design.

Experimental Techniques:

Application of experimental techniques of light scattering, absorption and fluorescence spectroscopy, Nuclear magnetic resonance, Interaction of UV radiation with DNA, Photodimerization, Photodynamic action.

Reference Books:

1. Essentials of Biophysic s: P. Narayanan.
2. Basic Molecular Biolog y: Price.
3. Quantum Mechanics of Molecular Conformations: Pullman (Ed.).
4. Non-linear Physics of D NA: Yakushevich.
5. Biological Physics: Ne lson.

Quantum Mechanics, Atomic and Molecular Physics

UNIT-1

(a) States, Amplitude and Operators: States of a quantum mechanical system, representation of quantum-mechanical states, properties of quantum mechanical amplitude, operators and change of a state, a complete set of basis states, products of linear operators, language of quantum mechanics, postulates, essential definitions and commutation relations (b)Observables and Description of Quantum system: Process of measurement, expectation

Values, time dependence of quantum mechanical amplitude, observable with no classical

Analogue, spin dependence of quantum mechanical amplitude on position, the wave function,

Superposition of amplitudes, identical particles. Hamiltonian matrix and the time evolution of Quantum mechanical States: Hermit city of the Hamiltonian matrix, time independent perturbation of an arbitrary system, simple matrix examples of time independent perturbation, energy Eigen states of a two state system, diagonal zing of energy matrix, time independent perturbation of two state system the perturbative solution: Weak field and Strong field cases, general description of two state system, Pauli matrices, Ammonia molecule as an example of two state system.

UNIT-2

Transition between stationary States: Transitions in a two state system, time dependent perturbations - The Golden Rule, Phase space, emission and absorption of radiation, induced dipole transition and spontaneous emission of radiation energy width of a quasi-stationary state. The co-ordinate Representation: Compatible observables, quantum conditions and uncertainty relation, Coordinate representation of operators, position, momentum and angular momentum, time dependence of expectation values, The Ehemfest Theorem, the time evolution of wave function, the Schrodinger equation, energy quantization, periodic potential as an example. Symmetries and Angular Momentum:

a. Compatible observables and constants of motion, symmetry transformation and conservation laws, invariance under space and time translations and space rotation and conservation of momentum, energy and angular momentum.

b. Angular momentum operators and their Eigen values, matrix representations of the angular momentum operators and their Eigen states, coordinate representations of the orbital angular momentum operators and their Eigen state (Spherical Harmonics), composition of angular. momentum, Clash-Gordon Coefficients, tensor operators and Wigner Eckert theorem, commutation relations of J., J,, J, with reduced tensor operator, matrix elements of vector operators, time reversal invariance and vanishing of static electric dipole moment of stationary state.

UNIT-3

Hydrogen Atom: Gross structure energy spectrum, probability distribution of radial

and angular (1-1,2) wave functions (no derivation), effect of spin, relativistic correction to energy levels and fine structure, magnetic dipole interaction and hyperfine structure, the Lamb shift (only a qualitative description).
Interaction with External Fields: Non degenerate first order stationary perturbation method, atom in a weak uniform external electric field and first and second order Stark effect, calculation of the polarizability of the ground state of H-atom and of an Isotropic harmonic oscillator, Degenerate stationary perturbation theory. Linear Stark effect for H-atom levels, inclusion of spin orbit and week magnetic field. Zeeman effect, strong magnetic field and calculation of interaction energy.

UNIT-4

Systems with Identical Particles: Indistinguishability and exchange symmetry, many particle wave functions and Paull's exclusion principle, spectroscopic terms for atoms. The Helium atom, Variation method and its use in the calculation of ground state and excited state energy of Helium atom. The Hydrogen molecule, Heitler-London theory of H_2 molecule, WKB method for one dimensional problem, application to bound states (Bohr Somerfield quantization) and
the barrier penetration (alpha decay) problems.

Spectroscopy (Qualitative): General features of the spectra of one and two electron system
singlet, doublet and triplet characters of emission spectra, general features of alkali spectra,
rotation and vibration band spectrum of molecule, P,Q and R branches, Raman spectra for
rotational and vibrational transitions, comparison with infra-red spectra, general features of
Electronic spectra, Frank and Condon's principle.

Paper Iv: Electronics, Numerical Method and Computer programming

UNIT-1

Operational Amplifiers: Differential amplifier circuit configurations-dual input, balanced output differential amplifier. DC analysis AC analysis, inverting and non inverting inputs, CMRR- constant current bias level translator. Block diagram of a typical Op-Amp-analysis. Open loop configuration, inverting and non-inverting amplifiers. Op-amp with negative feedback - voltage series feedback - effect of feedback on closed loop gain, input resistance, output resistance, bandwidth and output offset voltage voltage follower. Practical op-amp-input offset voltage -input bias current -input offset current, total output offset voltage, CMRR
frequency response. DC and AC amplifier, summing, scaling and averaging amplifiers, instrumentation amplifier, integrator and differentiator Oscillators and Wave Shaping Circuits: Oscillator Principle- Oscillator types. Frequency stability, response, The Phase shift oscillator, Wein bridge Oscillator, LC tunable oscillators,

UNIT-2

Multivibrators - Monostable and Astable, Comparators, Square wave and Triangle wave generation, Clamping and Clipping. Voltage regulators- fixed regulators, Adjustable voltage regulators, Switching regulators.
Digital Electronics: Combinational Logic The transistor as a switch; circuit Realisation

of OR AND,NOT, NOR and NAND gates, Exclusive OR gate, Boolean algebra De Morgan's theorems Adder, Subtractor, Comperator, Decoder / Demultiplexer Data selector/ multiplexer -Encoder. Sequential Logic: Flip-Flops: one-bit memory; The RS Flip-flop, JK Flip-Flop, JK master slave Flip-Flops, T Flip - Flop, D Flip Flop. Shift resisters synchronous and asynchronous counters cascade counters, Binary counter, Decade counter. Basic concepts about fabrication and characteristics of integrated circuits.

UNIT - 3

Errors in numerical analysis: Source of error, Round off error, Computer Arithmetic, Error Analysis, Condition and stability, Approximation, Functional and Error analysis, the method of, Undetermined Coefficients. Use of interpolation formula, Iterated

interpolation. Inverse interpolation, Hermite interpolation and Spline interpolation, Solution of Linear equations, Direct and Iterative methods, Calculation of eigen value and eigen vectors for symmetric matrices. Solution of Nonliner equation. Bisection method, Newton's method, modified Newton's method, method of Iteration, Newton's method and method of iteration for a system of causation Newton's method for the case of complex roots. Integration of a function: Trapezoidal and Simpson's rules. Gaussian quadrature formula, Singular integrals, Double integration.

UNIT-IV

Integration of Ordinary differential equation: Predictor - corrector methods, Runga Kutta method, Simultaneous and Higher order equations Numerical Integration and Differentiation of Data, Least-Squares Approximations, Fast Fourier Transform. Elementary probability theory, random variable, binomial, Poisson and normal distributions.

Some elementary information about Computer CPU, Memory, Input/Output devices, Super, Minland Micro systems, MS-DOS operating system. High Level Languages, Interpreter and Compiler. Programming Algorithm and Flowchart Fortran 77: Variable, Expression, jumping Bracching an looping statement Input/ Output statement Statement for handling Input/Output Files, Subroutine, External Function Special statements .COMMON ENTRY FORMAT, PAUSE, Equivalence Programming of simple problems involving use of interpolation, differentiation, Integration, matrix inversion and least square analysis.

Reference Book

1. Ryder-Electronic Fundamentals and applications.
2. Millman and Thub-Pulse, Digital and Switching waveforms
3. Millman and Helkias-Integrated Electronics.
4. Ryder-network Lines and Fields.
5 Bapat-Electronics Devices and Circuitrs.

LIST OF EXPERIMENTS FOR M.Sc. I year Physics

1. To design a single stage amplifier of
a given voltage gain and lower cut of frequencies
2. To determine Lo. Co. and Rf of a given coil and to study the variations of RF with frequency
3. To design a RC coupled two stage amplifier of a given gain and the cut off frequencies.
4. To study Hartley oscillator.
5. To Study Transistor bias Stability.
6. To design a Multivibrator of given frequency and study its wave shape
7. To study the characteristics of FET and use it 0 design an relaxation oscillator and measure its frequency.
8. To study the characteristics of an operational amplifier.
9. To study the characteristics of a UUT and use it to design a relaxation oscillator
10. To study the addition, integration and differentiation properties of an operational and measure its frequency.
11. Determine Planck constant using solar Cell.
12. To determine Planck constant and work function by a photo-cell.
13. To study regulated power supply using (A) Zener diode only Zener diode with a series transistor (c) Zener diode with a shunt transistor.

14. To verify Fresnel's formula;
15. To study the percentage regulation and variation of Ripple factor, with load for a full wave rectifier.
16. To study analog to digital and digital to analog conversion.
17. To study a driven mechanical oscillator.
18.To verify Hartmann's formula using constant deviation spectrograph.
19. To find e/m of electron using Zeeman effect.
20. To find Dissociation energy to I.
21. Study of CH Bands.
22. Salt Analysis / Raman effect (Atomic).
23. Design and study of pass filters.
24. Michelson Interferometer.
25. Fabry-parot Interferometer.
26. Determination of velocity of Ultrasonic waves.
27. Study of Elliptically polarized light by Babinet Compensator.
28. Verification of Cauchy's Dispersion relation.
29. Study of DC gate control characteristics and Anode current characteristics of SCR

PAPER I : ADVANCED QUANTUM MECHANICS AND INTRODUCTORY
QUANTUM FIELD THEORY

UNIT - I

Scattering (non-relativistic) Differential and total scattering cross-section partial wave analysis, solution of scattering problem by the method of partial wave analysis, expansion of a plane wave into a spherical wave and scattering amplitude, the optical theorem, Applications - scattering from a delta potential, square well potential and the

hard sphere scattering of identical particles, energy dependence and resonance scattering. Breit-Wigner formula, quasi stationary states The Lippman Schwinger equation and the Green's function approach for scattering problem. Bom approximation and its validity for scattering problem, Coulomb scattering problem under first Born approximation in elastic scattering Relativistic Formulation and Dirac Equation: Attempt for relativistic formulation of
quantum theory, The Klein-Gordon equation, Probability density and probability current density, solution of free particle KG equation in momenturn representation, interpretation of negative probability density and negative energy solutions.

UNIT -II

Dirac equation for a free particle, properties of Dirac matrices and algebra of gamma matrices, non-relativistic correspondence of the Pauli equation (inclusive of electromagnetic interaction). Solution of the free particle. Dirac equation, orthogonality and completeness relations for Dirac spinors, interpretation of negative energy solution. Symmetries of Dirac Equation: Lorentz covariance of Dirac equation, proof of covariance and derivation of Lorentz boost and rotation matrices for Dirac spinors, Projection operators involving four momentum and spin, Parity (P). Charge. conjugation (C), time reversal (T) and CPT operators for Dirac spinors, Bilinear covariants, and their transformations behaviour under Lorentz transformation, P.C.T and CPT, expectation values of coordinate and velocity. involving only, positive

energy solutions and the associated problems, Inclusion of t negative energy solution, Zitter bewegung, Klein paradox

UNIT -III

The Quantum Theory of Radiation: Classical radiation field, transversality condition, Fourier decomposition and radiation oscillators, Quantization of radiation oscillator, creation, annihilation and number operators; photon states, photon as a quantum mechanical excitations of the radiation field, fluctuations and the Uncertainty relation, validity of the classical descripleg, matrix elernant for ermission and absorption. spontaneous emission in the dipole approximation. Rayleigh scattering Thomson scattering and the -Raman effect, Radiation damping and Resonance fluorescence Scalar and vector fields Classical Lagrangian field theory Euler-Lagrange's equation, Lagrangian density for electromagnetic field. Occupation number representation for simple harmonic oscillator, linear array of coupled oscillators Second quantization of identical bosons, second quantization of the real Klein Gordan field and complex Klein-Gordan field. The occupation number representation for farmions, second quantization of the Dirac filed.

UNIT - IV

Path integral, theory of propagator, meson propagator, the fermion propagator
The electromagnetic interaction and gauge invariance, covariant quantization of the electromagnetic field, the photon propagator. S-matrix the S-matrix expansion, Wick's theorem, Diagrammatic representation in configuration space, the momentum representation, Feynman diagrams of basic processes, Feynman rules of QED. Applications of S.matrix formalism: the Coulomb scattering. Bhabha scattering. Moller scattering, Compton scattering and pair production.

Reference Books:
1. Ashok Das and A.C. Millissiones Quantum Mechanics A Modern. (Garden and Breach Science Publishers)
2. E. Merzbaker Quantum Mechanics, Second Edition
(John Wiley and sons)
3. Bjorken and Drell: Relativistic Quantum Mechanics (MGraw Hill) 4. J.J. Sakuri:
Advanced Quantum Mechanics (John Wiley)
5. F. Mandal & G. Shaw, Quantum Field Theory (John Wiley) 6. J.M. Ziman,
Elements of Advance Quantum Theory, (Cambridge University Press)
7 Lectures on quantum field theory Ashok Das (World Scientific press).

PAPER-II: NUCLEAR PHYSICS
UNIT-I

Nucleon-Nucleon Scattering and Potentials Partial wave analysis of the neutron proton scattering at low energy assuming central potential with square well shape, concept of the scattering length, coherent scattering of neutrons by protons in (ortho and para) hydrogen molecule; conclusions of these analyses regarding scattering lengths, range and depth of the potential, the effective range theory (in neutron proton scattering) and the shape independence of nuclear potential; A qualitative discussion of proton scattering at low energy General features of two-body scattering at high energy Effect of exchange forçes: Phenomenological Hamada
hard core potential and Red hard core and soft core potentials Main features of the One boson Exchange Potentials (OBEP) no derivation Two Núcleon system and Nuclear Forces General nature of the force between nucleons, saturation of nuclear forces, charge independence and spin dependence, General forms of two nucleon interaction, central, non-central and velocity dependent potentials, Analysis of the ground state (381)of deuteron using a square well potential, range-depth relationship, excited states of deuteron, Discussion of the ground state of deuteron under non central force, calculation of the electric quadrupole and magnetic dipole moments and the D-state admixture

UNIT-II

Nuclear shell model. Single particle and collective motions in nucleI Assumptions and justification of the shell model, average shell potential, spin orbit coupling, single particle wave functions and level sequence; magic numbers; shell model predictions for ground state parity; angular momentum, magnetic dipole and electric-quadrupole moments, and their comparison with experimental data; configuration mixing: single particle transition probability according to the shell model; selection rules approximate estimates for the transition probability and Weisskopf units: Nuclear isomerism. Collective nuclear models: Collective variable to describe the the cooperative modes of nuclear motion; Parametrization of nuclear surface; A brief description of the collective model Hamiltonian (in the quadratic approximation); Vibrational modes of a spherical nucleus, Collective modes of a deformed even-even nucleus and moments of Inertia, Collective spectra and electromagnetic transition in even nuclei and comparison with experimental data; Nilsson model for the single particle states in deformed nuclei.

UNIT -III

Interaction of radiation and charged particle with matter (No derivation): Law of Absorption and attenuation coefficient; Photoelectric effect, Compton scattering, pair production; Klein-Nishima cross sections for polarized and un-polarized radiation. angular distribution of scattered photon and electrons, Energy loss of charged particles due to lonization, Bremstrahlung: energy target and projectile dependence of all three processes, Range-energy curves; Straggling. Nuclear Reactions. Theories of Nuclear Reactions, Partial wave
analysis of reaction Cross section; Compound nucleus formation and breakup, Resonance scattering and reaction- Breit- Wigner dispersion formula for S-waves (= 0), continuum cross section; statistical theory of nuclear reactions, evaporation probability and cross section for specific reactions: The optical model, Stripping and pick-up reactions and their simple theoretical description (Butler theory) using plane wave Born approximation (PWBA) Short comings of PWBA nuclear structure studies with deutron stripping (d.p) reactions.

UNIT - IV

Nuclear gamma and beta decay: Electric and magnetic multipole moments and gamma decay probabilities in nuclear system (no derivations),Reduced transition probability, Selection rules; internal conversion and zero, zero transition.
General characteristics of weak interaction nuclear beta decay and legon capture Electron energy spectrum and Fermi- Kune piot Femmi theory of bata decay party conserved selection rules Fermi and Gammaw-Teter) for allowed transitions f values General interaction Hamiltonian for bata decay with parity conserving and non conserving terms: Forbidden transitions Experimental verification of party violation: The V-A interaction and experimental evidence Experimental Techniques Gas filled counters Scintiliator counter Cerenkov counters, Solid state detectors: Surface barrier detectors. Electronic circuits used
with typical nuclear detectors
Multiwire proportion chambers, Nuclear emulsions, techniques of measurement and analysis of tracks: Proton synchrotron: Linear accelerations; Acceleration of heavy ions

Reference Books.

1 J. M Blatt and V.E Weisskipf: Theoretical Nuclear Physics
2. Statistical theory of nuclear reactions, Exaparation probability and cross section for specific
reaction.
3. L.R.B Elton: Introductory Nuclear Theory, ELBS Pub London, 1959 4. B.K. Agrawl: Nuclear Physics, Lokbharti Pub, Allahabad. 1989
5. M.K. Pal: Nuclear Structlire, Affiliated East-West Press, 1982). 6. RR Roy and B.P.Nigam, Nuclear Poysics, Willey-Easter, 1979
7. M.A. Preston & RK Bhaduri-Structure of the Nucleus, Addision Wesley, 1975
8. RM. Singru: Introductory Experimental Nuclear Physics
9. England - Techniques on Nuclear Structure (Vol D 10. RD. Evans-TheAtomicNucleus (McGraw-Hills, 1955)
11. H. Enge -Introduction to Nuclear PeYsic- Addition-Wesley, 1970
12. W.E. Burcham- Elementsof NuclearPhysics,ELBS, Longman, 1988 13. B.L. Cohen - Concpt of Nuclear Physics Tata Mc-Graw Hilis, 1988
14. E Segre - Nuclel, Particles Benjamin, 1977

15. I. Kaplan- Nuclear Physics, Addison Wesley, 1963
16. D. Hallidy - Introductory Nuclear Physics, Wiley, 1955.
17. Harvey - Introduction of Nuclear Physics and Chemistry

MPS-301 (A): ANALOG COMMUNICATION SYSTEMS Credits: 4

Microwave Electronics:
Microwave characteristic features & Application, Waveguides and Cavity Resonators, Two cavities Klystron, Reflex Klystron, Semiconductor Gunn diode characteristics. Microwave antenna, Detection of microwave, Dielectric constant measurement, Isolator and circulator, PIN diode modulator, Directional coupler.

Radar Communication:
Basic Radar systems, Radar range equation and performance factor, Radar Cross-section, Pulsed Radar system, Duplexer, Radar Display, Doppler Radar, CWIF Radar, FMCW Radar, Moving Target Indicator (MTI), Blind Speeds.

Analog Signal Transmission:
Introduction, Amplitude, Frequency & phase modulation, AM, FM, Modulating and Demodulating circuits, AM, FM Receivers functioning (BLOCK diagram) and Characteristic Features, Pulse modulation, Sampling processes, PAM, PWM and PPM modulation and demodulation, Quantization processes, Companding and Quantization noise, PCM, Differential PCM and Delta Modulation systems, Comparison of PCM and DM, Time division multiplexing.

Satellite Communication:
Principle of Satellite Communication, Satellite frequency allocation and band spectrum, Satellite orbit, trajectory and its stability, Satellite link design, Elements of Digital Satellite Communication, Multiple Access technique, Antenna system, Transponder, Satellite Applications.

Reference Books:
1. Communication System : Simon Haykin.
2. Electronics communica tion: Roddy and Coolen.
3. Microwave and Radar E ngineering: M. Kulkarni.
4. Digital and analog com munication systems : K.San Shanmugam.
5. Satellite Communicatio n: Pratt and Bostiern.
6. Microwave: K.C. Gupt a

METHODS IN THEORETICAL PHYSICS Credits: 3

Path-integral Formalism:
Path-integral formalism in Quantum mechanics, applications to free particle and linear harmonic oscillator; Connection with statistical mechanics.

Foundations in Quantum Mechanics:
Statistical interpretation of Schrodinger’s wave functions, Hidden variable and Copenhagen interpretation; EPR paradox and Bell’s theorem; Geometrical phase and Aharanov-Bohm effect; Quantum measurement, No-clone theorem, schrodinger’s Cat and Quantum Zeno paradox.

General theory of Relativity and Cosmology:

Tensors, metrics and geodesics, dyadics, covariant and contravariant derivatives, Christoffel’s symbol and Levi- civita symbol; Einstein’s equation and Schwarzchild’s solution; Applications in cosmology, Black-holes.

Constraints and Gauge Theory:
Hamilton Method, Constraints (first class and second class); Gauge theory, gauge invariance and related physics.

Reference Books:

1. Techniques and Applic ations of Path Integration: L.S. Schulman.
2. Introduction to Quantum Mechanics: D.J. Griffiths.
3. Gravitation and Cosmo logy: S. Weinberg.
4. Classical Dynamics: E. C.G. Sudarshan and N. Mukunda.
5. Lectures on Quantum M echanics: P.A.M. Dirac.

PAPER-III: STATISTICAL AND SOLID STATE PHYSICS

UNIT I

Basic Principles, Canonical and Grand Canopical ensembies: Concept of statistical atribution, phase space oensity of states, Lou's theorem systorns d ensemble entropy in statistical mechanica Connection between thermodyanic and statistical quantities micro canonical ensembie, equation of state, specific neat and entropy of a perfect gas, using micro canonical ensemble. Canonical ensemble thermodynamic functions for the canonical ensemble, calculation of mean values energy fluctuation in a gas, grand Canonical ensemble, thermodynamic functions for the grand canonical ensemble, density fluctuations

Partition functions and Statistics Partition functions and Properties, partioon function for an ideal gas and calculation of thermodynamic quantities, Gibbs Paradox validity of classical approximation, determination of translational, rotational and vibrational contributions to the partition function of an ideal diatomic gas Specific heat of a diatomic gas, ortho and para hydrogen Identical particles and symmetry requirement, difficulties with Maxwell-Boltzmann statistics: quantum distribution functions

UNIT-II

Bose-Einstein and Fermi-Dirac statistics, Boson statistics and Planck's formula Bose Einstein condensation, liquid He as a Boson system, quantization of hannonic oscillator and creation and annihilation of Phonon operators, quantization of fermion operators.

Band Theory Block theorem, Kronig Penny model, effective mass of electrons, Wigner-Seitz approximation, NFE model, tight binding method and calculation of density for a band in simple cubic lattice, pseudo potential method.

Semiconductors: law of mass action, calculation of impurity conductivity, ellipsoidal energy surfaces in Si and Ge, Hall effect, recombination mechanism, optical

transitions and Schockely- Read theory excitons, photoconductivity, photo
Luminescence Points line, planar and bulk
defects, colour centres, F-centre and aggregate centres in aikall halides
UNIT -III
Theory of Metals: Fermi- Dirac distribution function, density of states, temperature dependence of Fermi energy, specific heat use of Fermi Dirac statistics in the calculation of thermal conductivity and electrical conductivity, Widemann -Franz ratio, susceptibility, width of conduction band, Drude theory of light, absorption in metals.
Lattice Vibrations and Thermal Properties: Interrelations between elastic constants C11, C12 and C44 wave propagation and experimental determination of elastic constant of cubic crystal, vibrations of linear mono and diatomic lattices, Determination of phonon dispersion by inelastic scattering of neutrons.
UNIT-IV
Magnetism Lamor diamagnetism. Paramagnetism, Curie Langevin and Quantum theories Susceptibility of rare earth and transition metals Ferromagnetism: Domain theory. Veins molecular field and exchange, spin waves: dispersion relation and its experimental determination by inelastic neutrons scattering, heat capacity. Nuclear Magnetic resonance: Conditions of resonance, Black equations NMR-experiment and characteristics of an absorption line. Superconductivity (a) Experimental results Meissner effect, heat capacity, microwave and infrared properties, isotope effect, flux utrasonic attenuation density of stales meal spin and AC and DC. Josephson tunnelings (5) Coops, pars and Hamitonian, results of BCS theory (no decvation)
Reference Books
1 Huag Statistical Mechanics
2. Ref Fundamentals of Statistical and Thermodynamical Physics 3 Rice Statistical mechanics and Thermal Physics

4 Kite Elementary statistical Mechanics
5. Kittie Introduction to Solid State Physics
6 Patterson Solid State Physics
7. Levy Solid State Physics
8. Mckelvy Solid State and Semi-conductor Physics

PAPER-IV MICROWAVE ELECTRONICS
UNIT-1

Introduction to microwaves and its frequency spectrum. Application of microwaves
Wave guides (a) Rectangular wave guides: Wave Equation & its solutions, TE&TM modes: Dominant mode and choice of wave guide Dimensions
Methods of excitation of wave guide (D) Circular wave guide-wave equation & its solutions, TE TM & TEM modes.
(c) Attenuation Cause of attenuation in wave guides, wall current & derivation of

attenuation constant, Q of the wave guide. Resonators: Resonant Modes of rectangular and cylindrical cavity resonators Q of the cavity resonators, Excitation techniques Introduction to Microstrip and Dielectric resonators, Frequency meter.

UNIT-2

Farrites: Microwave propagation in ferrites, Faraday rotation. Devices employing Faraday rotation (isolator, Gyrator, Circulator). Introduction to single crystal ferromagnetic resonators YIG tuned solid state resonators Microwave Measurement:
(a) Microwave Detectors: Power, Frequency, Attenuation, Impedance Using smith chart, VSWR, Reflectometer, Directivity coupling using direction coupler (0) Complex permittivity of material & its measurement definition of complex of Solids, liquids and powders using shift of minima method
Microwave tubes: Space charge spreading of an electron beam Beam focusing Kystrons Velocity Modulation Two Cavity Klystron Rafax Klystron Efficiency of Klystrons Magnetrons types & description

UNIT-III

Theoretical relations between Electric & Magnetic field of oscillations Modes of oscillation & operating characteristics Gyrotrons Constructions of different Gyrotrons,Field-Particle Interaction in Gyrotron

(a) Avalanche Transit Time Device: Read Diode, Negative resistance of an avalanching p-n Junction diode IMPATT and TRAPATT Oscillator (b) Transferred Electron Device: Gunn effect, two valley, model, High field Dotrutins, Different Modes for Microwave generation
(c) Passive Devices: Termination (Short circuit and matched terminations) Attenuator, phase changers, E&H plane Tees, Hybrid Junctions Directional coupler Parametric Amplifier Vaructor, Equation of Capacitance in Linearly graded & abrupt pn-junction. Manely Rowe relations, parametric up convertor and Negative resistance parametric amplifier-use of circulator, Noise in parametric amplifiers

UNIT -IV

Microwave Anternas: Introduction to antenna parameters, Magnetic Currents, Electric and magnet current sheet, Field of Huygen's source, Radiation from a slot antenna, open end of a wave guide and Electromagnetic Horns. Prabolic reflectors, Lens antennas. Radiation fields of Microstrip wave guide, Microstrip wave guide. Microstrip antenna calculations, Microstrip design formulas. Microwave Communication:
(a) LOS microwave systems, Derivation of LOS communication range, OTH microwave systems, Derivation of field strength of tropospheric waves. Transmission interference and signal damping, Duct propagation. (b) Satellite Communication: Satellite frequencies allocation, Synchronous satellites, Satellite orbits, Satellite location with respect to earth and look angle, earth coverage and slant range, Eclipse effect, Link calculation, Noise consideration, Factors affecting satellite communication.

Reference Books:

1. Electromagnetic waves & Radiating Systems: Jorden & Balmain
2. Theory and application of microwaves by A.B. Brownwell & RE. Beam (McGraw)
3. Introduction to microwave theory by Atwater (McGraw Hill).

4. Principles of microwave circuit by G C. Montgomery (Mc Graw Hill) 5. Microwave Circuits & Passive Devices by ML Sisodia and G.S. Raghuvanshi

LIST OF EXPERIMENTS FOR M.Sc. FINAL

LIST OF EXPERIMENTS
1. To determine half-life of a radio isotope using GM counter,
2. To study absorption of particles and determine range using at least two sources of a GM counter and to study statistical nature of
3. To study characteristics radioactive decay
4. To study spectrum of y-particles using Gamma ray-spectrometer. 5. To calibrate a scintillation spectrometer and determine energy of y-rays from an unknown source.
6. (a) To study variation of energy resolution for a Nal (T) detector.
(b) To determine attenuation coefficient (u) for rays from a given source.
7 To study Compton scattering of X-rays and verify the energy shift formula
8. To study temperature variation of resistivity or a semi-conductor and to obtain band gap using four probe method.
9. To study hall effect and to determine hall coefficient.
10. To study the variation of rigidity of a given specimen as temperature.
11 To study the Dynamics of a lattice using electrical analogue
12 To ESR and determine g factor for a given spectrum
13 To determine ultrasonic velocity and to obtain compressibility for a given liquid
14 Study the characteristics of a Reflex klystron and calculate the mode number E.T.S and transit time
15 Study the simulated L.C,.R transmission line and to find out the value for ZO experimentally from the graph
16 Study the radiation pattern of a given pyramidal horn by plotting it on a polar graph paper. find the half power beam width and calculate its gain
17 Find the dielectric constant of a given solid for three different lengths by using slotted section
18 find the dielectric constant of a given liquid using slotted section of k- band
19verificaton of Braggs law using microwaves.
20Determination of dielectric constant of a liquid by lecher