

COURSES OF STUDIES

For

2007-2008

MASTER IN SCIENCE PHYSICS



**RAVENSHAW UNIVERSITY
CUTTACK**

COURSES OF STUDIES

Master in Science Examination

There shall be 20 papers each carrying 50 marks as per the distribution given below. Theory and practical examination in each paper shall be of 3 hours and not less than 6 hours duration respectively.

SEMESTER - I	SUBJECTS	MARKS
Paper – I (PH-1.1.1)	Classical Mechanics	50
Paper – II (PH-1.1.2)	Mathematical Methods	50
Paper – III (PH-1.1.3)	Quantum Mechanics – I	50
Paper – IV (PH-1.1.4)	Practical Optics – I	50
Paper – V (PH-1.1.5)	Practical Electricity – I	50
SEMESTER - II	SUBJECTS	MARKS
Paper – VI (PH-1.2.6)	Electrodynamics and Plasma	50
Paper – VII (PH-1.2.7)	Electronics	50
Paper – VIII (PH-1.2.8)	Quantum Mechanics – II	50
Paper – IX (PH-1.2.9)	Practical Optics – II	50
Paper – X (PH-1.2.10)	Practical Electricity – II	50
Paper – XI (PH-1.2.11)	Seminar	100

PG - I
SEMESTER - I
PAPER - I (PH- 1.1.1)
CLASSICAL MECHANICS

FM- 50

Time : 3Hrs.

Unit - I

The Kinematics of Rigid Body Motion: Definition of rigid body, degrees of freedom, orthogonal transformation and properties of transformation matrix. The Euler angles, The Cayley-Klein parameters and related quantities, Euler theorem on the motion of a rigid body. Finite and infinitesimal rotations. Rate of change of Vector. The coriolis force effect.

The rigid body equations of motion : Angular momentum and kinetic energy of motion about a point. Tensors and diadics. The inertia tensor and the moment of inertia.. The Eigen values of the inertia tensor and the Principal axis transformation. Euler's equations of motion Torque free motion of a rigid body. The heavy symmetric top with one point fixed

Unit - II

The Hamilton equations of motion : Legendre transformation and the Hamilton equations of motion
Cyclic coordinates and conservation theorem. Routh's

procedure and oscillation about steady motion.
Derivation of Hamilton's equations from a variational principle. The principle of least action.

Canonical Transformation: The equations of canonical transformation and examples. Poisson's brackets and other canonical invariants. Equations of motion, infinitesimal canonical transformations and conservation theorems in the poisson bracket formulation. The angular momentum poisson bracket relations.

Unit – III

- (a) Hamilton – Jacobi Theory: Hamilton -Jacobi equations for i) principal function ii) characteristic functions
Harmonic oscillator problem as an example of the Hamilton- Jacobi method, separation of variables in the H - J equation. Action angle variables. The kepler problem in action angle variables.
- (b) Small oscillations: Potential, energy in quadratic approximation, conditions of oscillation, Lagrange's equation for degrees of freedom, oscillating systems, T matrix, V matrix and similarity transformation, normal frequencies and normal modes, normal coordinates with examples, free vibration of a linear tri atomic molecule.

Text Books:

- 1: Classical Mechanics : H. Goldstein (Addison-Wesley)
- 2: Mechanics : L.D. Landau and K.M. Lifshitz
- 3: Particle Dynamics : J.B. Marion
4. Classical Mechanics: Rana and Jog

PAPER – II (PH-1.1.2)**MATHEMATICAL METHODS****FM- 50****Time : 3Hrs.****UNIT –I**

Differential Equations and their solutions : Bessel's differential equation, power series solution, Bessel function, Recurrence relations, generating function.

Integral representation of J_n & Neumann function N_n
Asymptotic forms of J_n and N_n . Bessel functions of half odd order. Spherical Bessel function, and n Rayleigh's formula for J_n and N_n orthonormality of spherical Bessel functions.

Laguerre differential equation and its solution, Laguerre polynomial, Generating function for Laguerre, Rodrigue's formula, Recurrence relations, orthonormality condition, integral representation. Associated laguerre differential equation and its

solution, generating function. associated Laguerre polynomials, orthonormality relations. hypergeometric equation, solutions and properties, Gauss formula, Linear relationships of hypergeometric functions. Confluent hypergeometric function and properties, Integral representation, Relation of confluent hypergeometric functions with other special functions.

UNIT - II

Solution of non-homogenous equation : Green's function, symmetry of green's functions, Green's functions in 1D, 2D and 3D problems, eigenfunction expansion technique.

Complex variable: Residue theorem, it's application to evaluate definite intergrals.

Group theory : Representation of a group, Homomorphism and isomorphism continuous groups: Lie groups, generators and structure constants, SO(2), SO(3), SU (2) group. Their generators and irreducible representations, SU (2) and SO (3) nomo morphism.

UNIT- III

General tensor analysis : Contravariant and covarant vectors, Tensor of rank two . Tensor algebra (addtion, subtraction, outer product, inner multiplication), relative tensors, Kronecker delta and Levi-civita tensor density.

Symmetry property of tensors, Pseudotensors, Metric tensor and properties. Tensor forms of gradient, divergence, curl and the Laplacian.

Reference Books

1. Mathematical methods for Physicists : G.B. Arfken and H.J.
2. Mathematical Methods of Physics : J Mathews and R.L Walker
3. Mathematical Physics : P.K. Chattopadhyay

PAPER - III (PH-1.1.3) QUANTUM MECHANICS - I

FM- 50

Time : 3Hrs.

Unit - I

Linear vector, space, ket and bra vectors, scalar product vectors and their properties, Linear operators, adjoint operators, unitary operators. Expectation values of dynamical variables and physical interpretation, Hermitian operators. Eigen values and Eigenvectors probability interpretation, degeneracy, Schmidt method of orthogonalization.

Expansion theorem, completeness and closure property, the basis, set position eigenkets and position space wave function, Representation of momentum operator in the position space and the

energy eigenvalue equation. momentum eigenket and momentum space wave function. The co-ordinate operator in the momentum space and the eigenvalue equation. relation between position space wave function and momentum space wave function, energy operators in the momentum space formulation, relation between operators for position co-ordinate and momentum. compatible and incompatible observables, commutator algebra, uncertainty relation as a consequence of non-commutability. Minimum uncertainty wave eigenket.

UNIT - II

Representation of ket and Bra vectors and operator in matrix form unitary transformations of basis vectors and operators.

Time evolution of quantum states. Time evolution operator and its properties, Schrodinger picture, Heisenberg picture, interaction picture, equations of motion.

Operator method of solution of Harmonic oscillator problem, matrix, representations and expectation values of operators $N, a^-, a^+, x, p, x^2, p^2$. Time evolution of creation and annihilation operators.

Rotation and orbital angular momentum : Rotation matrix orbital, angular momentum operators as the generators of rotation. $\hat{L}_x, \hat{L}_y, \hat{L}_z$ and \hat{L}^2 and their commutator relations, raising and lowering operators, in spherical polar coordinates, Eigenvalues and eigen functions L^2 & L (operator method) matrix representation of

Spin angular momentum : Spin 1/2 particle's, Pauli spin particles and their properties. eigenvalues and eigenfunctions. for transformation under rotation

UNIT - III

Total angular momentum : Total angular momentum. Eigen value problem of L_x and L_y , Angular momentum matrices, addition of angular momentum and C.G. coefficients. C.G. coefficients for states with
i) $J_1 = 1$ and $J_2 = 1$
ii) $J_1 = 1$ and $J_2 = 0$.

Invariance & symmetry (Translations, rotations, parity, Time reversal) and conservation laws, Motion in a spherically symmetric field : The central force problem, Reduction of two body problem into equivalent one body problem. complete set of commutation observables (H, L^2, L_x) for the central force problem, radial equation. Behaviour of radial wave functions near the

origin and for large distances.

Books recommended:

1. Quantum Mechanics : Sakurai
2. Quantum Mechanics : Schiff,
3. Quantum Physics : Gasiorowicz
4. Quantum Mechanics : Merzbacher
5. Introduction to Quantum Mechanics : Bransden & Joachain
6. Quantum Mechanics : Ghatak & Loknathan

PAPER –IV (PH-1.1.4)**PRACTICAL (OPTICS) – I****FM- 50****Time : 6 Hrs.**

Determination of μ_x, μ_y, μ_z and L

- (i) of Na light.
 - (ii) of Na doublet.
 - (iii) Thickness of mica film using Michelson interferometer.
2. Verification of Brewster's Law
 3. Study of rotativity of quartz.
 4. Verification of Fresnel's laws of reflection of polarized light.

PAPER –V (PH-1.1.5)**PRACTICAL (ELECTRICITY) – I****FM- 50****Time : 6 Hrs.**

1. Pentode characteristics

2. Power supply with and without zener.
3. Study of R.F. coil characteristics
4. Study of triode as amplifier
5. Study of coupled oscillating circuit
6. Maxwell's A.C. Bridge and determination of inductive, capacitive and ohmic impedance.
7. Anderson's Bridge.
8. Characteristics of LED.
9. Characteristics of a photo diode.

SEMESTER - II

PAPER- VI (PH-1.2.6)

ELECTRODYNAMICS AND PLASMA

FM- 50

Time : 3 Hrs.

UNIT - I Electrodynamics

Potential formulation of electrodynamics : Magnetic vector potential A and scalar potential. The wave equation for the potentials Gauge transformations. Coulombs, gauge and Lorentz gauge, Lorentz force law in potential form

Energy and momentum in electrodynamics: Newton's third law in electrodynamics, Poynting's theorem . Maxwell's stress tensor. conservation of momentum. Reflection and transmission of plane electromagnetic

waves at the boundary of two linear media (oblique incidence), Dispersion : The frequency dependence of . dispersion In non conductors. Cauchy's equations kramer kronig relations, Free electrons in conductors and plasmas. Guided waves : Wave guides. TE waves in a rectangular wave guide. The co-axial transmission line.

Unit - II

Dipole radiation : Retarded potentials. Electric dipole radiation, Magnetic dipole radiation, Radiation from an arbitrary distribution of charges and currents radiation from a point charge. Lienard Wiechert potentials. The fields of a point charge in motion, power radiated by a point charge. Radiation reaction and Abraham- Lorentz formula, physical origin of radiation reaction.

Relativistic electrodynamics : Magnetism as a relativistic phenomenon. Transformation of fields, electric field of a point charge in uniform motion. Magnetic field of a point charge in uniform motion. The field tensor. electrodynamics in tensor notation. Potential formulation of relativistic electrodynamics.

UNIT- III Plasma

Fundamental Concepts about Plasma : Plasma, the fourth state of matter, the distribution function, kinetic

ϵ, μ and σ

pressure in a partially ionized gas, mean free path and collision cross section, mobility of charged particles effect of magnetic field on the mobility of electrons, diffusion of electrons and ions, ambipolar diffusion, diffusion in a magnetic field, thermal conductivity, electron and ion temperature, dielectric constant of a plasma, Quasi neutrality of plasma, Debye - shielding distance, optical properties of plasma, magnetic susceptibility of a plasma.

Magneto hydrodynamics : The decay of charge and current in a conductor, magneto-hydrodynamic equations and their interpretation, Conditions for magneto hydrodynamic behaviour.

Text Books:

1. Foundations of electromagnetic theory : Ritz, Milford & Christy
2. Electricity and Magnetism : Panofsky and Phillips
3. Introduction to electrodynamics (PHI) : David J Griffiths
4. Plasma Physics : S.Sen

PAPER –VII (PH-1.2.7)
ELECTRONICS

FM- 50

Time : 3 Hrs.

UNIT - I

- (a) Power electronics: SCR, FET, MOSFET, DIAC, TRIAC
(Principle, construction , operation with characteristics

and application)

- (b) Oscillators: Klystron oscillator (principle, description, and operation) Multivibrator, Astable, Monostable, Bistable (Principle, Description and Operation)
Operational amplifier: Differential amplifier (Circuit configuration and properties, ideal operational amplifier input and Output impedances)
Application of OP-AMP : Inverting amplifier, Non inverting amplifier, adder, subtractor, integrator, differentiator, logarithmic amplifier, comparator (Principle, basic circuit operation and theory)

Unit – II

Single equation loops, voltage, source, constant voltage source, constant current source. Maximum power transfer theorem. Thevenin's theorem Norton's theorem. (Digital Electronics) Number system:

Binary, Octal and hexadecimal numbers (basic characteristics and interconversion) gray. Code (interconversion between gray, Code and binary code) binary algebra- addition , subtraction multiplication and division.

Logic operations: Nor gate: NAND gate. Exclusive OR gate, Exclusive NOR gate. (Logic symbol, truth

table and circuit with operation)

Logic families: RTL, DTL, TTL (Description and operation) CMOS, Sequential circuit - SR flipflop clocked SR flipflop.

JK flipflop, master, slave, JK flipflop (Principle and operation)

UNIT – III

(b) Different types of Radiowave propagation - Description and basic theory

AM and FM transmitter (Block diagram study) FM receiver (Block diagram study) with emphasis on function of limiter and discriminator

Antenna: Basic antenna action, current and voltage distribution in linear antenna, dipole antenna, power radiator , radiation resistance and directional pattern.

Different types of antenna: (Only descriptive study of practical antenna) Horn antennas, Reflector antennas, Yagi antenna.

Books

1. Handbook of Electronics : Gupta Kumar
2. Principles of Electronics (Vol - III) : B.V.N. Rao

3. Digital Electronics : Gothmann.

PAPER – VIII (PH-1.2.8)

QUANTUM MECHANICS - II

FM- 50

Time : 3 Hrs.

UNIT –I

Stationary state perturbation theory, Rayleigh schrodinger method for nondegenerate case. First and second order perturbation, anharmonic oscillator, general theory for the degenerate case. Removal of degeneracy linear and quadratic stark effect. Normal and anomalous Zeeman effect. Fine structure of spectral lines for H. like atoms variational method, the ground state of He – atom

UNIT –II

- (a) W.K.B. method. connection formulas, Bohr sommerfeld quantization rule Harmonic oscillator and cold emission
- (b) Time dependent perturbation theory : Transition probability constant and harmonic perturbation. Fermi's golden rule, electric dipole radiation and selection rules.

UNIT – III

The free particle problem, expansion of plane waves in

terms of spherical waves, bound states of a three dimensional square well. Particle in a spherical box. The 3D harmonic oscillator. Bound states of Hydrogen atom, energy eigen values and eigenfunctions, Degeneracy, radial probability distribution

Scattering amplitude and scattering cross section, Born approximation, application to coulomb and screened coulomb potentials

Partial wave analysis for elastic and inelastic scattering optical theorem, Black dis scattering, scattering from a hard sphere, resonant scattering from a square well potential.

PAPER –IX (PH-1.2.9)**PRACTICAL (OPTICS) –II****FM- 50****Time : 6 Hrs.**

1. Determination of thickness of air film between half silvered plates by measurement of Fabry – perot rings
2. Analysis of elliptically polarized light using Babinet compensator
3. Determination of rydberg constant by the use of prism spectrograph/plane transmission grating.
4. Measurement of wavelength of Na light using Bi-prism.

PAPER – X (PH-1.2.10)**PRACTICAL****ELECTRICITY – III****FM- 50****Time : 6 Hrs.**

1. Basic Logic gates
2. Rectifier with different filters
3. Transistor as Amplifier
4. Study of Hartely oscillator
5. Lecher's wire
6. calibration of oscilloscope
7. Wwave shaping
8. Characteristics of a light dependant Resistor
9. Study of colpitt's oscillators.

PAPER – XI (PH-1.2.11)**FM -100****SEMINAR**