Syllabus and Course Scheme
Academic year 2014-15

MASTER OF SCIENCE IN PHYSICS

UNIVERSITY OF KOTA
MBS Marg, Swami Vivekanand Nagar,
Kota - 324 005, Rajasthan, India
Website: uok.ac.in

M.Sc. (P) Physics Exam. -2015

Paper 1-Classical Mechanics and Mathematical Methods in Physics
Paper-II-Classical Electrodynamics
Paper III-Quantum Mechanics and Atomic & Molecular Physics
Paper-IV- Electronics, Numerical Methods and Computer Programming
Practical

M.Sc. (F) Physics - 2015

Paper-: V- Advanced Quantum Mechanics & Quantum field Theory
Paper-: VI – Nuclear Physics
Paper-: VII- Solid state Physics
Paper –VIII (A) Microwave Electronics
OR
Paper VIII (B)-High Energy Physics
OR
Paper VIII- (C) Solid State Electronics
Practical

M.Sc. (P) Physics Exam. -2015

Paper 1-Classical Mechanics and Mathematical Methods in Physics

Max. Marks: 100 **Duration: 3 hrs.**

Note- The question paper will contain three sections as under-

Section-A: One compulsory question having 10 parts with 02 parts from each unit, short answer in 20 words for each part. **Total marks: 10**

Section-B: 10 questions, 02 question from each unit, 05 questions will be attempted, taking one from each unit, answer approximately in 250 words. **Total marks: 50**

Section-C: 04 questions (question may have sub division) covering all units but not more then one question from each unit, descriptive type, answer in about 500 words, 02 question to be attempted.

Total marks: 40

UNIT-I

Holonomic and non-holonomic constraints, D'Alembert's principle, generalized coordinates. Lagarngian, Lagrange's equation and its applications, velocity dependent, potential in Lagrangian formulation, generalized momentum, Legendre transformation, Hamiltonian, Hamilton's Canonical equation, calculus of variation and its application to simple problems, Hamilton's variational principle.

UNIT-II

Derivation of Lagrange's and Hamilton's canonical equations from Hamilton's variational principle, extension of Hamilton's principle to non-conservative and non-holonomic systems, method of Lagrange's multipliers, conservation principle and Noeither's theorem, conservation of energy, linear momentum and angular momentum as a consequence of homogeneity of time and space and isotropy of space respectively.

UNIT-III

Canonical transformation, Integral invariants of Poincare, Lagrange's and Poisson brackets as canonical invariants, Equation of motion in Poisson bracket formulation, Infinitesimal canonical transformation and generators of symmetry, Liouville's theorem, Hamilton Jacobi equation and its applications.

Action-angle, variables adiabatic invariance of action angle variables, Kepler problem in action angle variables, theory of small oscillations in Lagrangian formulation, normal coordinates and its application, orthogonal transformation, Eulerian angles, Euler theorem, eigen values of the inertia tensor, Euler equations, Force free motion of rigid body.

UNIT-IV

Fourier transforms: Fourier integrals, Fourier's transform and inversion theorem, Fatling theorem, application of integral transforms to pulse propagation, Discrete Fourier transform, Fast Fourier transform, Laplace transform, Laplace transform of derivatives and integrals, derivatives integrals of Laplace transform, Laplace transform of periodic function, inverse Laplace transform, convolution theorem, impulsive functions, application of Laplace transform in solving linear differential equation with constant coefficients and with variable coefficients, linear partial differential equations.

UNIT-V

Analytic functions, Cauchy-Riemann conditions, Harmonic function, elementary complex functions and their properties, branches of multi valued function, mapping Z and Z complex integration, definite integrals, Cauchy Gaursat's theorem, Cauchy integral theorem, Indefinite integrals, Cauchy integral formula, derivatives of analytic functions, Morera's theorem, Fundamental theorem of algebra, analytic continuation.

Taylor's series, Laurent's series, integration and differentiation of power series, zeros of analytic functions, singular point, residues, Cauchy residue theorem, poles evaluation of improper integrals, Jordan's lemma integration around a branch point.

References:

1. Classical Mechanics: Goldstein
2. Classical Mechanics: L.P. Landau & H. M. Lifshitz
3. Classical Mechanics: A. Ray Chaudhary
4. Complex Variables & Functions: Churchill, Brown, Varchy
5. Applied Mathematics for Engineers and Physicist: Pipes & Harvill
6. Mathematical Methods: Potter &Goldberg
7. Mathematical Methods for Physicist: George Arkfen
8. Mathematical Physics: A. Ghatak (McMillan)

Paper-II-Classical Electrodynamics

Max. Marks: 100 **Duration: 3 hrs.**

Note- The question paper will contain three sections as under-

Section-A: One compulsory question having 10 parts with 02 parts from each unit, short answer in 20 words for each part. **Total marks: 10**

Section-B: 10 questions, 02 question from each unit, 05 questions will be attempted, taking one from each unit, answer approximately in 250 words. **Total marks: 50**

Section-C: 04 question (question may have sub division) covering all units but not more then one question from each unit, descriptive type, answer in about 500 words, 02 question to be attempted.

Total marks: 40

UNIT-I

Electrostatics: Electric field, Gauss law, differential form of Gauss 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 Dirichlet or Neumann boundary conditions, formal solution of the electrostatics boundary value problem with Green’s function, Electrostatics potential energy and energy density, capacitance.

Boundary Value Problems in Electrostatics: Method of images, point charge in the presence of a grounded conducting sphere, point charges in the presence of a charged insulated conducting sphere, point charges near a conducting sphere at a fixed potential, conducting sphere in an uniform electric field by method of images, Green function for the sphere, general solution for potential, conducting sphere with Hemispheres at different potential, orthogonal functions and its expansion.

UNIT-II

Multipoles, Electrostatics of Macroscopic Media Dielectrics: 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, molecular polarizability and electric susceptibility, models for molecular polarizability, electrostatic energy in dielectric media.

Magnetostatics: Differential equation of Magnetostatics and Ampere’s law, vector potential and magnetic induction for a circular current loop, magnetic field of a localized current distribution, magnetic moment, force and torque on and energy of a localized current distribution in an external magnetic field, macroscopic equations, boundary conditions on B & H, methods of solving boundary value problems in magnetostatics, uniformly magnetized sphere in an external field, permanent magnetic shielding, spherical shell of permeable material in an uniform field.

UNIT-III

Time Varying Fields, Maxwell's Equations, Conservation Laws: Energy in a magnetic field, vector and scalar potential, Gauge transformations, Lorentz Gauge, Coulomb Gauge, Green functions for the wave equation, derivation of the equations of macroscopic electromagnetism, Poynting's theorem and conservation of energy and momentum for a system of charged particles and E.M. fields, conservation laws for macroscopic media.

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, Causality in the connection between D and E, Kramers-Kroning relation.

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 wavelength limit on plasma oscillations and Debye shielding distance.

Covariant form of Electromagnetic Equations: Mathematical properties of the space time of special relativity, invariance of electric charge, covariance of electrodynamics, transformation of electromagnetic field.

Unit-V

Radiation by Moving Charges: Lienard-Wiechart 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.

Scattering and dispersion:-Introductory considerations, radiative reaction force from conservation of energy, Abraham Lorentz evaluation of the self force, difficulties with Abraham Lorentz model, integral-differential equation of motion including radiation damping, line breadth and level shift of an oscillator, scattering and absorption of radiation by an level shift of an oscillator, scattering and absorption of radiation by an oscillator, energy transfer to harmonically bound charge.

References:

1. Classical electrodynamics: J. D. Jackson
2. Classical Electricity and Magnetism: Panofsky &Philips
3. Introduction to Electrodynamics: Griffiths
4. Classical theory of fields: Landau & Lifishtiz
5. Electrodynamics of continuous Media: Landau & Lifishtiz

Paper III-Quantum Mechanics and Atomic & Molecular Physics

Max. Marks: 100 **Duration: 3 hrs.**

Note- The question paper will contain three sections as under-

Section-A: One compulsory question having 10 parts with 02 parts from each unit, short answer in 20 words for each part. **Total marks: 10**

Section-B: 10 questions, 02 question from each unit, 05 questions will be attempted, taking one from each unit, answer approximately in 250 words. **Total marks: 50**

Section-C: 04 questions (question may have sub division) covering all units but not more then one question from each unit, descriptive type, answer in about 500 words, 02 question to be attempted.

Total marks: 40

UNIT-I

States Amplitudes and Operators: States of a quantum mechanical system, representation of quantum mechanical states, properties of quantum mechanical amplitude, operators and change of state of a complete set of basic states, product linear operators, language of quantum mechanics, postulates, essential definition and consequent relations.

Observable and Description of Quantum System: Process of measurement**,** expectation values, time dependent of a quantum mechanical amplitude, Observables with no classical analogue, Spin dependence of quantum mechanical amplitude on position, the wave function, superposition of amplitudes, Identical particles.

Hamiltonian Matrix and time evolution of quantum mechanical states:-Hermiticity of the Hamiltonian Matrix, Time independent perturbation of an arbitrary system, Simple matrix examples of time independent perturbation, Energy eigen states of two state system, Diagonalizing of energy matrix, Time independent perturbation of a two state system, Perturbative solution: weak field and strong field cases, General description of a two state system, Pauli matrices, Ammonia molecule as an example of two state system.

Unit -II

Transition Between Stationary States: Transition in two state system, Time dependent perturbation-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 observable, quantum conditions and uncertainty relations, co-ordinate representation of operators: position, momentum and angular momentum, time dependence of expectation values, The Schrodinger equation, energy quantization, periodic potential as an example.

UNIT-III

Symmetries and Angular Momentum: Symmetry transformation and conservation laws, Invariance under space and time translations and space rotation; Conservation of momentum, energy and angular momentum.

Angular momentum operators and their eigen values, Matrix representation of angular momentum operators and their eigen states, Coordinate representation of the orbital angular momentum operators and their eigen states (spherical harmonics), Composition of angular momentum. Clebsch-Gordon coefficient, Tensor operators and Wigner Echart theorem, Commutation relations J_+, J_- and J with reduced spherical tensor operator, Matrix elements of vector operators, Time reversal invariance and vanishing of static electric dipole moment of stationary state.

UNIT-IV

Hydrogen Atom: Gross structure energy spectrum probability distribution of radial and angular (l =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 methods, 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 weak magnetic field, Zeeman effect, Strong magnetic field and calculation of interaction energy.

Unit-V

Systems with Identical Particles: Indistinguishability and exchange symmetry, Many particles wave function and Pauli's exclusion principle, Spectroscopic terms for atoms, The Helium atom, Variational method and its use in the calculation of ground state and excited state energy, Helium atom, Hydrogen molecule, Hitler London methods for H_2 molecule, WKB method for one dimensional problem, Application to bound states (Bohr Sommerfield quantization) and the barrier penetration (Alpha decay problems).

Spectroscopy (Quantitative): General feature of spectra of one and two electron system, Vibration band spectrum of a molecule, P.Q & R branches, Raman spectra for rotational and irrotational transitions, comparison with infrared spectra, General features of electronic spectra, Frank Condon principle.

References:

1. Quantum Mechanics-A Modern Approach : Ashok Das & A.C. Melissions
2. Quantum Mechanics: P.A.M. Dirac
3. Quantum Mechanics (2nd ed.): E. Merzbecker
4. Quantum Mechanics- Non relativistic theory: L.P. Landau &H. M. Lifshitz
5. Quantum Mechanics: Thankapann (New Age International pub.)
6. Quantum Mechanics- Theory & Applications: A. Ghatak & S. Loknathan
7. Atomic Spectra: White
8. Molecular Spectra: Heretzberg
9. Atomic and Molecular Physics: T.A. Littlefield
10. Elementary Atomic Structure: G. R. Woodgate
11. Quantum Physics Atoms, Molecules, Solid & Nuclear Particles: Eistenberge & Resnick

Paper-IV Electronics, Numerical Methods and Computer Programming

Max. Marks: 100 **Duration: 3hrs**

Note- the question paper will contain three sections as under-

Section-A: One compulsory question having 10 parts with 02 parts from each unit, short answer in 20 words for each part. **Total marks: 10**

Section-B: 10 questions, 02 question from each unit, 05 questions will be attempted, taking one from each unit, answer approximately in 250 words. **Total marks: 50**

Section-C: 04 questions (question may have sub division) covering all units but not more then one question from each unit, descriptive type, answer in about 500 words, 02 question to be attempted. **Total marks: 40**

Unit-I

Linear Small Signal and Direct Coupled Amplifier:-R.C. Coupled C.E. Amplifier and its response in different frequency ranges, effect of cascading expression of bandwidth in low and high frequency ranges, emitter follower, tuned amplifier(small signal) single and double tuned amplifiers, Differentials amplifier, common mode rejection ratio, operational amplifier and its basic applications.

Wave Shaping Circuits: Exponential circuit response, differentiation and integration by R.C. and L.R circuits, clipping or limiting circuit, clamping circuit, general feature of a time base signal, thyratron sweep circuits, circuits to improve linearity, Miller and Boot strap sweep circuits.

Unit-II

Logic and Integrating Circuits: Boolean algebra, binary counting, counting to a base other then two, binary counter, conversion of binary counter in a decade counter, Decoder, logic gates : NOT, OR, AND, NAND and their circuits, Micro electronic devices, basic concepts about fabrication and characteristics of integrated circuits.

Multivibrators: Astable, monostable, and bistable multivibrators, frequency of a stable vibrator, frequency control and synchronization, triggering of bistable, Blocking oscillator.

Unit-III

Errors in Numerical Analysis: - Computer arithmetic, sources of errors, Round off errors, Errors analysis, Condition and stability, Approximation, functional and errors analysis, The method of Undetermined coefficients.

Interpolation:- Interpolation, Finite differences, Gauss central difference formula, Newton's formula for interpolation, Lagrange's interpolation formula, Double interpolation, Numerical differentiation, Newton and Starling's formula, Solution of linear systems, Direct and iterative, Eigen value problems.

Unit-IV

Solution of Non-Linear Equation: Bisection method, Newton's Method, Modified Newton's method, Method of integration, Newton's method and method of integration for a system of equations, Newton's method for the case of complex roots, Integration of functions: Trapezoidal and Simpson's rules, Gaussian quadrature formula, singular integrals, Double integration.

Unit-V

Integration of Ordinary Differential Equation:- Predictor Corrector method, Runga-Kutta methods, Simultaneous and higher order equations, Numerical integration and differentiation of Data, Least squares approximation, computer simulation, Monte Carlo method, Curve fitting.

One Advanced Level Language:

BASIC: Variable expressions, jumping, branching and looping statements, input/output statements, sub-routing commands for plotting a graph statement for handling input /output files, programming of simple problems.

OR

FORTRAN 77/90: Variable expressions, Jumping, branching and looping statement for handling input/output files, Sub-routine, External function, Special statements COMMON, ENTRY, FORMAT, PAUSE, EQUIVALENCE, Programming of simple problems.

References:

1. Electronics-fundamentals and Applications : Ryder
2. Integrated Electronics : Millman & Halkias
3. Pulse digital and switching Waveforms : Millman & Taub
4. Network-Line and Fields : Ryder
5. Electronics Devices and Circuits : Bapat
6. Programming in Basic : B. Balguruswamy (McGraw Hill-1985)
7. Introductory Methods of Numerical Analysis : S.S. Sastry
8. A first course in Numerical Analysi : A. Ralston & P. Rabinowitz (McGraw Hill-1985)

M.Sc (P) Physics Practical Scheme:

The examination will be conducted for two days, 6-hrs.each day. The distribution of the marks will be as follows:

a.	Two experiments	125 marks
b.	Record	25 marks
c.	Viva-voce	25 marks
d.	Seminar	25 marks
	Total -	200 marks
	Minimum Pass Marks	72 marks

(write up with references are to prepared and submitted during exam.)

List of Experiments :

1. Use of Michelson's 'Interferometer to determine:
   i. Wave length of monochromatic light.
   ii. D_1 for sodium doublet.
   iii. Thickness of the given mica sheet.
2. Use Fabery parot's interferometer to determine:
   i. Wave length of sodium light.
   ii. D_1 for sodium doublet.
3. Verify Fresnel's Laws.