MAHARSHI DAYANAND SARASWATI UNIVERSITY, AJMER

पाठ्यक्रम

SYLLABUS

SCHEME OF EXAMINATION AND COURSES OF STUDY

FACULTY OF SCIENCE

M.Sc. Physics

M.Sc. (Semester I & II)

(w.e.f. 2015-16)

M.Sc. (Semester III & IV)

(w.e.f. 2016-17)

महर्षि दयानन्द सरस्वती विश्वविद्यालय, अजमेर

NOTICE

1. Change in Statutes/Ordinances/Rules/Regulations Syllabus and Books may, from time to time, be made by amendment or remaking, and a candidate shall, except in so far as the University determines otherwise comply with any change that applies to years he has not completed at the time of change. **The decision taken by the Academic Council shall be final.**

सूचना

1. समय–समय पर संशोधन या पुनः निर्माण कर परिनियमों/अध्यादेशों/नियमों / विनियमों / पाठ्यक्रमों व पुस्तकों में परिवर्तन किया जा सकता है, तथा किसी भी परिवर्तन को छात्र को मानना होगा बशर्तें कि विश्वविद्यालय ने अन्यथा प्रकार से उनको छूट न दी हो और छात्र ने उस परिवर्तन के पूर्व वर्ष पाठ्यक्रम को पूरा न किया हो। **विद्या परिषद द्वारा लिये गये निर्णय अन्तिम होंगे।**

M D S UNIVERSITY, AJMER

M Sc (Physics) Syllabus

Semester Scheme

Scheme of Examination

First Semester

Four Theory Papers **Max marks: 400**

Paper -I	Classical Mechanics	3 hrs duration	100 marks
Paper -II	Classical Electrodynamics (I)	3 hrs duration	100 marks
Paper -III	Quantum Mechanics	3 hrs duration	100 marks
Paper -IV	Mathematical Methods in Physics	3 hrs duration	100 marks

Scheme of Examination

Second Semester

Four Theory Papers **Max marks: 400**

Paper -V	Classisical Electrodynamics (II)	3 hrs duration	100 marks
Paper -VI	Atomic & molecular Physics	3 hrs duration	100 marks
Paper -VII	Electronics	3 hrs duration	100 marks
Paper -VIII	Numerical methods and Computer Programming	3 hrs duration	100 marks

Practical: 12 hours duration Max marks 400

Electronics Lab/General & Computer Lab

Note: A combined practical examination (Maximum 400 marks with break up as below) shall be conducted at the end of semester II and IV. Thus examination of practical course in semester I shall be combined with Semester II and that of Semester III shall be combined with semester IV.

There will be two experiment of 6 hrs. Duration each selecting one from each lab for two days

The distribution of marks will be as follows:

1.	Two experiments(each of 120 marks)	-	240 marks
2.	Viva voce	-	80 marks
3.	Record	-	80 marks
	TOTAL	-	400 marks

Scheme of Examination

Third Semester

Four Theory Papers Max marks: 400

Paper -IX	Nuclear Physics I	3 hrs duration	100 marks
Paper - X	Statistical and Solid State physics	3 hrs duration	100 marks
Paper -XI	Advanced Quantum Mechanics (I)	3 hrs duration	100 marks

Paper -XII Elective paper-

Anyone out of the following special papers

3 hrs duration 100 marks

Paper XII (a) Microwave Electronics
Paper XII (b) Solid State electronics
Paper XII (c) Plasma physics -I
Paper XII (d) Energy Studies -I

Scheme of Examination

Fourth Semester

Four Theory Papers	Max marks: 400	
Paper -XIII Nuclear Physics II	3 hrs duration	100 marks
Paper - XIV Solid State physics	3 hrs duration	100 marks
Paper -XV Advanced Quantum Mechanics II	3 hrs duration	100 marks
Paper -XVI	3 hrs duration	100 marks

Elective paper-Anyone out of the following special papers
Paper XVI (a) Microwave Electronics (Only for students who opted Paper XII (a) in third semester)
Paper XVI (b) Solid State electronics (Only for students who opted Paper XII (b) in third semester)
Paper XVI (c) Plasma physics-II (Only for students who opted Paper XII (c) in third semester)
Paper XVI (d) Energy Studies –II (Only for students who opted Paper XII (d) in third semester)

Practical: 12 hours duration Max marks 400

For students opting Microwave electronics as special paper
Microwave Lab/Advanced physics Lab

OR

For students opting Solid state electronics as special paper
Solid state electronics Lab/Advanced physics Lab

OR

For students opting other special papers
Advanced physics Lab 1/Advanced physics Lab 2

Note: A combined practical examination (Maximum 400 marks with break up as below) shall be conducted at the end of semester II and IV. Thus examination of practical course in semester I shall be combined with Semester II and that of Semester III shall be combined with semester IV. There will be two experiment of 6 hrs. duration each, selecting one from each lab for two days. The distribution of marks will be as follows:

1.	Two experiments(each of 120 marks)	-	240 marks
2.	Viva voce	-	80 marks
3.	Record	-	80 marks
TOTAL			400 marks

Workload:

Each theory paper must be given 4 hrs. per week for theory. Practical must be given 20 hrs. per week per batch. Each laboratory batch for practical must not be of more than 10 students.

Criteria to Pass: The number of papers and the maximum marks for each paper/practical are shown in the scheme above. It will be necessary for a candidate to pass in the theory as well as in the practical part of a paper/subject separately.

A candidate for a pass at each of the Semester Examinations shall be required to obtain

(i) at least 36% marks in the aggregate of all the papers prescribed for the examination* and

(ii) at least 36% marks in Combined practical examination each year,

* provided that if a candidate fails to secure at least 25% marks in each individual paper at the examination and also in the Project work/Seminar, wherever prescribed, he/she shall be deemed to have failed at the examination notwithstanding his/her having obtained the minimum percentage of marks required in the aggregate for the examination.

(iii) Division shall be awarded only at the end of the examination of the final semester on the combined marks obtained in all semesters taken together, as noted below:
First division: on $\geq$ 60% marks and
Second division: on $\geq$ 48% marks.

(iv) Due Paper: If a candidate passes only in 2 papers in Semester I or III or in 3 papers in Semester II or IV, he/she will be allowed to appear in the due paper only with the students appearing in the same paper next year.

(v) Division after due paper: If a candidate clears any paper(s) prescribed for a semester's examination after a continuous period of three years, then for the purpose of working out his/her division the minimum passing marks only viz. 25% (36% in case of practical) shall be taken into account in respect of such paper(s)/practical(s) cleared after expiry of the aforesaid period of three years; provided that in case where a candidate requires more than 25% marks in order to reach the minimum aggregate as many marks out of those actually secured by him/her will be taken into account as would enable him/her to make up the deficiency in the requisite minimum aggregate.

Note: Non collegiate candidates are not eligible to appear in the examination, where practical is involved.

COURSE DETAIL - FIRST SEMESTER

Paper -I Classical Mechanics

3 hrs duration **100 marks**

Note: Syllabus of each question paper is divided into three units. The question paper is divided into three parts: Part-A, Part-B and Part-C (total 100 Marks).

Part-A (30 Marks) is compulsory and contains 10 questions (50 words each). At least three questions will be set from each unit. Each question carries 3 marks.

Part-B (25 Marks) 9 questions (100 words each) will be set taking 3 from each unit and candidate is required to attempt 5 questions taking at least one question from each unit but not more than 2 from any unit. Each question carries 5 marks.

Part-C (45 Marks) contains 06 questions two from each unit. Candidate is required to attempt three questions taking one from each unit. Each question carries 15 marks (400 words).

UNIT-I

Constraints, holonomic and non-holonomic constraints, D'Alembert's Principle andLagrange's Equation, velocity dependent potentials, simple applications of Lagrangian formulation. Hamilton Principle, Calculus of Variations, Derivation of Lagrange's equation from Hamilton's principle. Extension of Hamilton's Principle for non-conservative and non-holonomic 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.

UNIT-II

Generalized momentum, Legendre transformation and the Hamilton's Equations of Motion, simple applications of Hamiltonian formulation, cyclic coordinates, Routh's procedure, Hamiltonian Formulation of Relativistic Mechanics, Derivation of Hamilton's canonical Equation from Hamilton's variational principle. The principle of least action.

UNIT-III

Canonical transformation, integral invariant of Poincare: Lagrange's and Poisson brackets as canonical invariants, equation of motion in Poisson bracket formulation. Infinitesimal contact transformation and generators of symmetry, Liouvilee's theorem, Hamilton-Jacobi 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 coordinates and its applications.

Reference Books:

(1) Herbert Goldstein -Classical Mechanics, Narosa Publishing House

(2) Landau and Lifshitz -Classical Mechanics

(3) A. Raychoudhary -Classical Mechanics

Paper -II Classisical Electrodynamics (I)

3 hrs duration **100 marks**

Note: Syllabus of each question paper is divided into three units. The question paper is divided into three parts: Part-A, Part-B and Part-C (total 100 Marks).

Part-A (30 Marks) is compulsory and contains 10 questions (50 words each). At least three questions will be set from each unit. Each question carries 3 marks.

Part-B (25 Marks) 9 questions (100 words each) will be set taking 3 from each unit and candidate is required to attempt 5 questions taking at least one question from each unit but not more than 2 from any unit. Each question carries 5 marks.

Part-C (45 Marks) contains 06 questions two from each unit. Candidate is required to attempt three questions taking one from each unit. Each question carries 15 marks (400 words).

UNIT-I

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 electro static 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's function for the sphere, General solution for the potential, conducting sphere with hemispheres at different potentials.

UNIT-II

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.

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 magnetic induction, Macroscopic equations, Boundary conditions on B and H. Methods of solving Boundary 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.

UNIT-III

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, Poynting'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.

Reference Books:

1. J.D. Jackson: Classical Electrodynamics
2. Panofsky & Phillip: Classical electrodynamics and magnetism
3. Griffith: Introduction to Electrodynamics.
4. Landau & Lifshitz: Classical Theory of Electrodynamics
5. Landau & Lifshitz: Electrodynamics of continuous media

Paper -III Quantum Mechanics

3 hrs duration **100 marks**

Note: Syllabus of each question paper is divided into three units. The question paper is divided into three parts: Part-A, Part-B and Part-C (total 100 Marks).

Part-A (30 Marks) is compulsory and contains 10 questions (50 words each). At least three questions will be set from each unit. Each question carries 3 marks.

Part-B (25 Marks) 9 questions (100 words each) will be set taking 3 from each unit and candidate is required to attempt 5 questions taking at least one question from each unit but not more than 2 from any unit. Each question carries 5 marks.

Part-C (45 Marks) contains 06 questions two from each unit. Candidate is required to attempt three questions taking one from each unit. Each question carries 15 marks (400 words).

UNIT-I

(a)Origins of Quantum Physics : inadequacy of classical mechanics ,Particles versus Waves , Complementarity ,Principle of Linear Superposition , Indeterministic Nature of the Microphysical World

(b) Mathematical Tools of Quantum Mechanics :The Hilbert Space and Wave Functions, Dimension and Basis of a Vector Space , Dirac Notation ,Operators ,Hermitian Adjoint ,Projection Operators , Commutator Algebra, Uncertainty Relation between Two Operators ,Functions of Operators ,Inverse and Unitary Operators ,Eigenvalues and Eigenvectors of an Operator ,Infinitesimal and Finite Unitary Transformations ,Representation in Discrete Bases ,Matrix Representation of Kets, Bras, and Operators ,Change of Bases and Unitary Transformations ,Matrix Representation of the Eigenvalue Problem ,Representation in Continuous Bases ,Position Representation , Momentum Representation, Connecting the Position and Momentum Representations , Parity Operator ,Matrix and Wave Mechanics

UNIT-II

Postulates of Quantum Mechanics: The State of a System, Probability Density ,The Superposition Principle ,Observables and Operators ,Measurement in Quantum Mechanics , ,Expectation Values ,Complete Sets of Commuting Operators, Measurement and the Uncertainty Relations , Time Evolution Operator, Stationary States: Time-Independent Potentials ,Time Evolution of Expectation Values.

Angular Momentum: Orbital Angular Momentum ,General Formalism of Angular Momentum ,Matrix Representation of Angular Momentum ,Geometrical Representation of Angular Momentum ,Spin Angular Momentum ,Experimental Evidence of the Spin ,General Theory of Spin, Spin 1/2and the Pauli Matrices , Eigen functions of Orbital Angular Momentum

Addition of Angular Momenta: Addition of Two Angular Momenta-General Formalism ,Calculation of the Clebsch–Gordan Coefficients

UNIT-III

Three-Dimensional Problems: 3D Problems in Cartesian Coordinates ,The Harmonic Oscillator , 3D Problems in Spherical Coordinates ,Central Potential: General Treatment ,The Spherical Square Well Potential, The Isotropic Harmonic Oscillator

Identical Particles: Many-Particle Systems ,Interchange Symmetry ,Systems of Distinguishable Non interacting Particles ,Systems of Identical Particles ,Exchange Degeneracy ,Symmetrization Postulate ,Constructing Symmetric and Anti-symmetric Functions ,Systems of Identical Non-interacting Particles ,The Pauli Exclusion Principle

Reference Books:

Nouredine Zettili -----Quantum Mechanics: Concepts and Applications

Paper - IV Mathematical Methods in Physics

3 hrs duration **100 marks**

Note: Syllabus of each question paper is divided into three units. The question paper is divided into three parts: Part-A, Part-B and Part-C (total 100 Marks).

Part-A (30 Marks) is compulsory and contains 10 questions (50 words each). At least three questions will be set from each unit. Each question carries 3 marks.

Part-B (25 Marks) 9 questions (100 words each) will be set taking 3 from each unit and candidate is required to attempt 5 questions taking at least one question from each unit but not more than 2 from any unit. Each question carries 5 marks.

Part-C (45 Marks) contains 06 questions two from each unit. Candidate is required to attempt three questions taking one from each unit. Each question carries 15 marks (400 words).

UNIT-I

Orthogonal curvilinear coordinates, scale factors, expressions for gradiant, divergence and curl and their applications to cartesian, cylinderical and spherical polar coordinate system,

Coordinate transformation, transformation of covariant, contravariant and mixed tensors. Addition , multiplication and contraction of tensors, quotient Law, pseudo tensors. Metric tensors and its use in transformation of Tensors.

UNIT-II

Vector spaces and Matrices:Linear independence, Bases;Dimensionality, Inner product, Linear transformation, Matrices,Inverse orthogonal and unitary matrices;Independent elements of a matrix; eigen values and eigen matrix; Diagnolization: complete orthonormal sets of functions.

Differential equations and special functions: Second order linear differential equation with variable coefficients, solution by series expansion, Legendre, Bessel, Hermite and Lagaurre equations, physical application, generating function,reccurance relations.

UNIT-III

Integral transforms:Laplace transform, First and second shifting theorems, inverse L T by partial fractions; LT derivative and integral of a function; Fourier series: FS of arbitary period; half wave expansion;Partial sums;Fourier integral and transforms, FT of a delta function

Reference books:

1. Mathematical Methods for Physicists: George Arfken (Academic Press)
2. Applied Mathematics for Engineers and Physicists: L. A. Pipe (McGraw Hill)
3. Mathematical Methods - Potter and Goldberg (Prentice Hall of India)
4. Elements of Group Theory for Physicists: A.W. Joshi (Wiley Eastern Ltd.)
5. Mathematical Physics by Satya Prakash
6. Mathemetical Physics by B.S. Rajput

Second Semester

Paper -V Classical Electrodynamics –II

3 hrs duration **100 marks**

Note: Syllabus of each question paper is divided into three units. The question paper is divided into three parts: Part-A, Part-B and Part-C (total 100 Marks).

Part-A (30 Marks) is compulsory and contains 10 questions (50 words each). At least three questions will be set from each unit. Each question carries 3 marks.

Part-B (25 Marks) 9 questions (100 words each) will be set taking 3 from each unit and candidate is required to attempt 5 questions taking at least one question from each unit but not more than 2 from any unit. Each question carries 5 marks.

Part-C (45 Marks) contains 06 questions two from each unit. Candidate is required to attempt three questions taking one from each unit. Each question carries 15 marks (400 words).

UNIT-I

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

Magnetohydrodynamics and Plasma Physics : Introduction and definitions, MHD equations, Magnetic diffusion, viscosity and pressure, Pinch effect, instabilities in pinched plasma column, Magnetohydrodynamics waves, Plasma oscillations, short wave length limit of plasma oscillations and Debye shielding distance.

UNIT-II

Covariant Form of Electrodynamic Equations : Mathematical properties of the space-time special relativity, Invariance of electric charge covariance of electrodynamics. Transformation of electromagnetic field. Radiation by moving charges : Lienard-Wiechart Potential 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 quasifree charges, coherent and incoherent scattering, Cerenkov radiation.

UNIT-III

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, Abraham 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 Books :

1. Classical Electrodynamics : Jackson
2. Classical Electricity and Magnetism : Panofsky and Philips.
3. Introduction to Electrodynamics : Griffiths.
4. Classical Theory of Field : Landan and Lifshitz.
5. Electrodynamics of Continuous Media : Landau and Lifshitz.

Paper -VI Atomic And Molecular Physics

3 hrs duration **100 marks**

Note: Syllabus of each question paper is divided into three units. The question paper is divided into three parts: Part-A, Part-B and Part-C (total 100 Marks).

Part-A (30 Marks) is compulsory and contains 10 questions (50 words each). At least three questions will be set from each unit. Each question carries 3 marks.

Part-B (25 Marks) 9 questions (100 words each) will be set taking 3 from each unit and candidate is required to attempt 5 questions taking at least one question from each unit but not more than 2 from any unit. Each question carries 5 marks.

Part-C (45 Marks) contains 06 questions two from each unit. Candidate is required to attempt three questions taking one from each unit. Each question carries 15 marks (400 words).

UNIT-I

Gross structure of energy spectrum of hydrogen atom. Non degenerate first order perturbation method, relativistic correction to energy levels of an atom, atom in a weak uniform external electric field – first and second order Stark effect, calculation of the polarizability of the ground state of hydrogen atom and of an isotropic harmonic oscillator; degenerate stationary state perturbation theory, linear Stark effect for hydrogen atom levels, inclusion of spin orbit interaction and weak magnetic field, Zeeman effect, effect of strong magnetic field. Magnetic dipole interaction, hyperfine structure and Lamb shift (only qualitative description).

UNIT-II

Indistinguishability and exchange symmetry, many particle wave functions and Pauli's exclusion principle, spectroscopic terms for atoms.The helium atom, Variational method and its use in calculation of ground state energy. Hydrogen molecule, Heitler London method for hydrogen molecule. WKB method for one dimensional problem, application to bound states (Bohr Sommerfeld quantization) and the barrier penetration.

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 a molecule, P,Q and R branches. Raman spectra for rotational and vibrational transitions, comparison with infrared spectra – application to learning about molecular symmetry. General features of electronic spectra, Frank and Condon's principle.

UNIT-III

Laser cooling and trapping of atoms: The scattering force, slowing an atomic beam, chirp cooling, optical molasses technique, Doppler cooling limit, magneto optical trap. Introduction to the dipole force, theory of the dipole force, optical lattice. Sisyphus cooling technique – description and its limit. Atomic fountain. Magnetic trap (only qualitative description) for confining low temperature atoms produced by Laser cooling, Bose-Einstein condensation in trapped atomic vapours, the scattering length, Bose-Einstein condensate, coherence of a Bose-Einstein Condensate, The Atom Laser.

Reference Books :

1. G. Banewell – Atomic and Molecular spectroscopy
2. Christopher J. Foot – Atomic Physics, Oxford Master series, 2005
3. G.K. Woodgate, Elementray Atomic Structure, Second Edition Clarendon Press, Oxford.
4. T.A. Littlefield - Atomic and Molecular Physics.
5. Eistaberg and Rasmic- Quantum Physics of Atoms. Molecules Solids and Nuclear Particles.
6. Ashok Das and A.C. Melfessions. Quantum Mechanics; A Modem Approach (Gordon and Breach Science Publishers).
7. White - Atomic Spectra.
8. Herzberg- Molecular spectra.

Paper -VII Electronics

3 hrs duration **100 marks**

Note: Syllabus of each question paper is divided into three units. The question paper is divided into three parts: Part-A, Part-B and Part-C (total 100 Marks).

Part-A (30 Marks) is compulsory and contains 10 questions (50 words each). At least three questions will be set from each unit. Each question carries 3 marks.

Part-B (25 Marks) 9 questions (100 words each) will be set taking 3 from each unit and candidate is required to attempt 5 questions taking at least one question from each unit but not more than 2 from any unit. Each question carries 5 marks.

Part-C (45 Marks) contains 06 questions two from each unit. Candidate is required to attempt three questions taking one from each unit. Each question carries 15 marks (400 words).

UNIT-I

Operational Amplifiers: Differential amplifier - circuit configurations - dual input balanced output differential amplifier- DC analysis, inverting and non-inverting inputs, CMRR-constant current bias level translator. Block diagram of typical OP-Amp analysis. Open loop configuration, inverting and non-inverting amplifiers, Op-Amp with negative feedback, voltage series feedback, effect of feed back on closed loop gain, input 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. integrator and differentiator.

Oscillators and wave shapping Circuits: Oscillator Principle, Frequency stability response, the phase shift oscillator, Wein bridge oscillator, LC tunable oscillators, Multivibrators- Monostable, astable and bistable, Comparators, Square wave and triangle wave generation, clamping and clipping circuits.

UNIT-II

Digital Electronics: Combinational logic: Standard representations for logic functions, Karnaugh Map Representation of logical functions, Simplification of logical functions using K-Map, Minimization of Logical functions specified in Minterms / Maxterms or truth table, Don't care conditions, Adder (half and full), Subtractor (half and full), comparator, Multiplexers and their uses, Demultiplexer / Decoders and their uses. BCD arithmatics, Parity generators / Checkers, Code Converters, Priority Encoders, Decoder / Drivers for display devices, Seven Segment display device. ROM, Programmable Logic Array. Basic concepts about fabrication and characteristics of integrated circuits.

UNIT-III

Sequential Logic: Flip-Flops: one - bit memory, RS, JK, JK master slave, T and D type flip flops, shift resisters - synchronous and asynchronous counters, cascade counters, Binary counter, Decade counter. A/D and D/A conversion- Basic principles, circuitry and simple applications. Voltage regulators - fixed regulators, adjustable voltage regulators, switching regulators. Basic idea of IC 555 and its applications as multivibrator and sqaure wave generator. Opto-electronic Devices: Photo diode, Phototransistor, Light emitting Diode and their applications

Reference Books:

1. "Electronic Devices and Circuit Theory" by Robert Boylested and Louis Nashdsky, PHI, New Delhi - 110001, 1991.
2. "OP-AMP and Linear Integrated Circuits" by Ramakanth, A. Gayakwad, PHI, Second Edition 1991.
3. "Digital Principle and Applications" by A.P. Malvino and Donald P. Leach, Tata McGraw Hill Company, New Delhi, 1993.

Paper - VIII
Numerical methods and Computer Programming

3 hrs duration **100 marks**

Note: Syllabus of each question paper is divided into three units. The question paper is divided into three parts: Part-A, Part-B and Part-C (total 100 Marks).

Part-A (30 Marks) is compulsory and contains 10 questions (50 words each). At least three questions will be set from each unit. Each question carries 3 marks.

Part-B (25 Marks) 9 questions (100 words each) will be set taking 3 from each unit and candidate is required to attempt 5 questions taking at least one question from each unit but not more than 2 from any unit. Each question carries 5 marks.

Part-C (45 Marks) contains 06 questions two from each unit. Candidate is required to attempt three questions taking one from each unit. Each question carries 15 marks (400 words).

UNIT-I

Errors in Numerical Analysis: Source of Errors, 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 values and eigen vectors for symmetric matrices.

UNIT-II

Solution of Nonlinear 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 Newtons' method for the case of complex roots. Integration of a function. Trapezoiddal and Simpson's rules. Gaussian quadrature formula, Singular integrals, Double integration.

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.

UNIT-III

Programming in C: Character set, variables and constants, keywords, Instructions, assignment statements, arithmetic expression, comment statements, simple input and output, Boolean expressions, Relational operators, logical operators, control structures, decision control structure, loop control structure, case control structure, functions, subroutines.

Arrays and strings, structures, array of structures, Unions of structures, operations on bits, usage of enumerated data types. Bit-fields, Pointers to Function, Function returning Pointers.

Reference Books:

1. A Ralston and P. Rabinowitz: A First Course in Numerical Analysis, McGraw Hill (1985).
2. S.S. Sastry : Introductory Methods of Numerical Analysis, Prentice-Hall of India (1979).
3. Robert W. Sebesta: Concepts of Programming Language, Addison Wesley, Pearson Education Asia, 1999.
4. Deitel and Deitel: How to Program C, Addison Wesley, Pearson Education Asia, 1999.
5. Bryon Gottfried, Programming with C, McGraw Hill International.

M.Sc. I & II Semester Laboratory/ Practical Syllabus.

Note:- Students are required to perform at least eight experiments from the general laboratory and eight-experiments from Electronics Lab/General & Computer Lab.

Total number of experiments to be performed by the students during the I & II Semester should be at least 16. Few experiments other than listed below, may be set at the college level, but at par with the standard of M.Sc. class.

Group: A

1. To use a Michelson Interferometer to determine:
(I) the wave length of sodium yellow light
(II) the difference between the wave lengths of the two sodium D-lines.
(III) the thickness of a mica sheet.
2. To test the validity of the Hartmann's prism dispersion formula using the visible region of mercury spectrum.
3. To find the refractive index of air by means of a Fabry-Perot Etalon, the thickness between the plants being given.
4. Determination of wave length of Neon light taking Hg source as a standard source applying Hartmann formula.
5. Determine Stetan's constant.
6. X-ray diffraction by Telexometer.
7. Determination of Ionization potential of Lithium.
8. Determination of e/m of electron by Normal Zeeman Effect.
9. Determination of dissociation energy of Iodine (I) molecules by photography, the absorptions band of I in the visible region.
10. Using He-Ne laser light.
(I) Measure of wavelength with the help of ruler.
(II) Measure the thickness of the wire.
11. Testing goodness of fit of Poisson distribution to cosmic ray busts by Chi-square test.
12. To study Faraday effect using He-Ne laser.

Group: B Electronics Lab

1. Design of a Regulated Power supply.
2. Design of a Common Emitter Transistor Amplifier.
3. Experiment of Bias Stability.
4. A Stable, Monostable and Bistable Multivibrators.
5. Characteristics and applications of Silicon Controlled Rectifier.
6. Experiment on FET and MOSFET characterization and application as an amplifier.
7. Experiment on Uni-junction Transistor and its application.
8. Digital I : Basic Logic Gates, TTL, NAND and NOR.
9. Digital II : Combinational logic.
10. Flip-Flops.
11. Operational Amplifier (741)
12. Differential Amplifier.
13. Programming Exercises in FORTAN/C (Based on theory syllabus paper-VIII)
14. Simple Programming Exercises based on assembly language for microprocessor 8085.

Tutorial: Laboratory Practical Course-M.Sc. (I & II semester) Physics (Any eight)

1. Network Analysis-Thevenin and and Nortan's equivalent circuits.
2. Basics of P.N junction-Diffusion current Drift current, Junction width, Forward and reverse biasing. significance of Fermi level in stabilizing the junction.
3. Zener Diode-characteristics and voltage regulation.
4. Transistor biasing and stability.
5. Wein's bridge and phase shift oscillators.
6. Solving Boolean expressions.
7. Mechanism and production of electrical pulse through absorption of nuclear radiation in medium.
8. Dead time efficiency. counting techniques, energy resolution.
9. Lattice extinctions in X-ray diffraction.
10. Atomic scattering power and geometrical structure factor.
11. Effect of capacitance and load resistance on output of an amplifier.
12. Integrated circuit timer familiarization.
13. Op-amp differentiator.
14. Multiplexers and Demultiplexers.
15. Resistors and counters.
16. Radiation level and activity measurement.
17. Shielding, mass absorption coefficient.
18. Coincidence circuits. counters timers.
19. Coherence and its relevance in diffraction.
20. Identification of charge type by Hall voltage measurement.
21. How does four probe method solve the problem of contact resistance?

Third Semester

Paper -IX Nuclear Physics-I

3 hrs duration **100 marks**

Note: Syllabus of each question paper is divided into three units. The question paper is divided into three parts: Part-A, Part-B and Part-C (total 100 Marks).

Part-A (30 Marks) is compulsory and contains 10 questions (50 words each). At least three questions will be set from each unit. Each question carries 3 marks.

Part-B (25 Marks) 9 questions (100 words each) will be set taking 3 from each unit and candidate is required to attempt 5 questions taking at least one question from each unit but not more than 2 from any unit. Each question carries 5 marks.

Part-C (45 Marks) contains 06 questions two from each unit. Candidate is required to attempt three questions taking one from each unit. Each question carries 15 marks (400 words).

UNIT-I

Two Nucleon 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, noncentral and velocity dependent potential, Analysis of the ground state (3S1) of deuteron using a square well potential, range-depth relationship, Discussion of the ground state of deutron under noncentral force, D-state admixture.

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; the effective range theory (in neutron-proton scattering) and the shape independence of nuclear potential.

UNIT-II

A qualitative discussion of proton-proton scattering at low energy; General features of two-body scattering at high energy, effect of exchange forces.

Interaction of radiation and charged particle with matter (Not derivation) :

Law of absorption and attenuation coefficient photoelectric effect, Compton, scattering, pair production; Klein-Nishina cross sections for polarized and unpolarized radiation angular distribution of scattered photon and electrons, Energy loss of charged particles due to ionization, Bremstrahlung; energy target and projectile dependence of all three processes, Range-energy curves; Straggling.

UNIT-III

Experimental Techniques : Gas filled counters; Scintillation counter; Cerenkov counters; Solid state detectors; Surface barrier detectors,Multiwire proportion chambers; Nuclear emulsions, techniques of measurement and analysis of tracks; Proton synchrotron; Linear accelerators.

Reference Books:

1. J.M. Blatt and V.E. Weisskipf : Theoretical Nuclear Physics.
2. L.R.B. Elton : Introductory Nuclear Theory (ELBS Publicatio, London, 1959).
3. B.K. Agarwal : Nuclear Physics (Lokbharti Publication Allahabad. 1989).
4. R.R. Roy and B.P.Nigam : Nuclear Physics (Willey -Easter, 1979).
5. M.A. Preston & R.K. Bhaduri : Structure of the Nucleus (Addition-Wesley, 1975)
6. R.M. Singru : Introductory Experimental Nuclear Physics.
7. England- Techniques on Nuclear Structure (Vol I).
8. R.D. Evans : The Atomic Nucleus (Mc Graw Hills, 1955)
9. H. Enge. Introduction Nuclear Physics (Additon-Wesley, 1970).
10. W.E. Burcham : Elements of Nuclear Physics (ELBS. Longma)
11. B.L. Cohen : Concept of Nuclear Phsyics (Tata McGraw Hills, 1988).
12. E. Segre : Nuclei and Particles (Benjamin, 1977).
13. I. Kaplan : Nuclear Physics (Addison Wesley, 1963).

Paper -X Statistical And Solid State Physics

3 hrs duration **100 marks**

Note: Syllabus of each question paper is divided into three units. The question paper is divided into three parts: Part-A, Part-B and Part-C (total 100 Marks).

Part-A (30 Marks) is compulsory and contains 10 questions (50 words each). At least three questions will be set from each unit. Each question carries 3 marks.
Part-B (25 Marks) 9 questions (100 words each) will be set taking 3 from each unit and candidate is required to attempt 5 questions taking at least one question from each unit but not more than 2 from any unit. Each question carries 5 marks.
Part-C (45 Marks) contains 06 questions two from each unit. Candidate is required to attempt three questions taking one from each unit. Each question carries 15 marks (400 words).

UNIT-I

Basic Principles, Canonical and Grand Canonical ensembles : Concept of statistical distribution, phase space, density of states , systems and ensemble, entropy in statistical mechanics Connection between thermodynamic and statistical quantities micro canonical ensemble, equation of state, specific hear and entropy of a perfect gas, using microcanonical ensemble.
Canonical ensemble, thermodynamic functions for the canonical ensemble, calculation of means values, energy fluctuation in a gas, grand canonical ensemble, thermodynamic functions for the grand canonical ensemble, density fluctuations.

UNIT-II

Partition functions and Statistics : Partition functions and properties, partition function for an ideal gas and calculation of thermodynamic quantities, Gibbs Paradox, validity of classical approximation, determination of translational, rotational and vibration 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, Bose Einstein and Fermi-Dirac statistics and Planck's formula, Bose Einstein condensation, liquid He4 as a Boson system, quantization of harmonic oscillator and creation and annihilation of phonon operators, quantization of fermion operators.

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, Drude theory of light absorption in metals.
Band Theory : Bloch theorem, Kronig Penney model, effective mass of electrons, Wigner-Seitz approximation, NFE model, tight binding methcd and calculation of density for a band in simple cubic lattice, pseudo potential method.

Reference Books :

1. Huang : Statistical Mechanics
2. Reif : Fundamentals of Statistical and Thermodynamical Physics.
3. Rice : Statistical mechanics and Thermal Physics.
4. Kittel : Elementray statistical mechanics.
5. Kittel : Introduction to solid state physics.
6. Palteros : Solid State Physics.
7. Levy : Solid State Physics.

Paper -XI Advanced Quantum Mechanics (I)

3 hrs duration **100 marks**

Note: Syllabus of each question paper is divided into three units. The question paper is divided into three parts: Part-A, Part-B and Part-C (total 100 Marks).
Part-A (30 Marks) is compulsory and contains 10 questions (50 words each). At least three questions will be set from each unit. Each question carries 3 marks.
Part-B (25 Marks) 9 questions (100 words each) will be set taking 3 from each unit and candidate is required to attempt 5 questions taking at least one question from each unit but not more than 2 from any unit. Each question carries 5 marks.
Part-C (45 Marks) contains 06 questions two from each unit. Candidate is required to attempt three questions taking one from each unit. Each question carries 15 marks (400 words).

UNIT-I

Approximation Methods for Stationary States: Time-Independent Perturbation Theory ,Non-degenerate Perturbation Theory ,Degenerate Perturbation Theory ,The Variational Method, The Wentzel–Kramers–Brillouin Method ,General Formalism ,Bound States for Potential Wells with No Rigid Walls ,Bound States for Potential Wells with One Rigid Wall ,Bound States for Potential Wells with Two Rigid Walls ,Tunneling through a Potential Barrier

UNIT-II

Time-Dependent Perturbation Theory: The Schrödinger Heisenberg and Interaction Picture ,Time-Dependent Perturbation Theory , Transition Probability for a Constant and Harmonic Perturbation ,Adiabatic and Sudden Approximations , ,Interaction of Atoms with Radiation ,Classical Treatment of the Incident Radiation ,Quantization of the Electromagnetic Field ,Transition Rates for Absorption and Emission of Radiation ,Transition Rates within the Dipole Approximation ,The Electric Dipole Selection Rules ,Spontaneous Emission

UNIT-III

Scattering Theory ,Scattering and Cross Section ,Connecting the Angles and Cross Sections in the Lab and CM frames ,Scattering Amplitude of Spinless Particles, Scattering Amplitude and Differential Cross Section ,The Born Approximation,Partial Wave Analysis, Partial Wave Analysis for Elastic and Inelastic Scattering ,Scattering of Identical Particles

Reference Books :

1. Ashok Das and A.C. Milissiones : Quantum mechanics - A Modern Approach (Garden and Breach Science Publishers).
2. Eugen Merzbacher : Quantum Mechanics, Second Edition (John Wiley and Sons).
3. Bjorken and Drell : Relativistic Quantum Mechanics (McGraw-Hill)

Paper -XII Elective paper

-Anyone out of the following special papers

XII (a) Microwave Electronics

3 hrs duration **100 marks**

Note: Syllabus of each question paper is divided into three units. The question paper is divided into three parts: Part-A, Part-B and Part-C (total 100 Marks).

Part-A (30 Marks) is compulsory and contains 10 questions (50 words each). At least three questions will be set from each unit. Each question carries 3 marks.

Part-B (25 Marks) 9 questions (100 words each) will be set taking 3 from each unit and candidate is required to attempt 5 questions taking at least one question from each unit but not more than 2 from any unit. Each question carries 5 marks.

Part-C (45 Marks) contains 06 questions two from each unit. Candidate is required to attempt three questions taking one from each unit. Each question carries 15 marks (400 words).

UNIT-I

Introduction to Microwaves and its frequency spectrum,Application of Microwaves.

Wave guides:

(a)Rectangular wave guides: Wave equation and its solutions,TE & TM modes. Dominant mode and choice of waveguide dimensions,Method of excitation of wave guide.

(b) Circular waveguide: : Wave equation and its solutions, ,TE, TM & TEM modes

(c) Attenuation:Cause of attenuation in waveguides, wall current & derivation of attenuation constant. Q of the waveguide

UNIT-II

Microwave Communications: Advantages and disadvantages of microwave transmission , loss in free space, propagation of microwaves, atmospheric effects on propogation, Fresenl's zone problem,

ground reflection, fading sources, detectors, components, antennas used in microwave communication system.

Ferrites: microwave propogation in ferrites,Faraday rotation, devices employing Faraday rotation(isolator,gyrator,circulator). Introduction to single crystal ferromagnetic resonators, YIG tuned solid state resonators.

UNIT-III

Radar systems: Radar block diagram,operation radar,frequencies pulse considerations, radar range equation. Minimum detectable signal receiver noise signal to noise ratio. Integration of radar pulses,

Radar cross section, Pulse repetition frequency, Antennas parameters, system losses and propogation losses, radar transmitters, receivers antennas, displays

Reference Books:

1. Introduction to Microwave theory by Atwater(McGraw-Hill)
2. Microwaves by M.L. Sisodia & Vijay Laxmi Gupta
3. Microwave Principles by H.J. Reich (CBS)
4. Antenna Theory Part-I by R.E.Collinn & F.J. Zucker

Paper-XII (b) Solid State electronics:

3 hrs duration **100 marks**

Note: Syllabus of each question paper is divided into three units. The question paper is divided into three parts: Part-A, Part-B and Part-C (total 100 Marks).

Part-A (30 Marks) is compulsory and contains 10 questions (50 words each). At least three questions will be set from each unit. Each question carries 3 marks.

Part-B (25 Marks) 9 questions (100 words each) will be set taking 3 from each unit and candidate is required to attempt 5 questions taking at least one question from each unit but not more than 2 from any unit. Each question carries 5 marks.

Part-C (45 Marks) contains 06 questions two from each unit. Candidate is required to attempt three questions taking one from each unit. Each question carries 15 marks (400 words).

UNIT-I

Semiconductor Materials and Carrier Transport in Semiconductors: Energy Bands, Intrinsic carrier concentration. Donors and Acceptors. Direct and Indirect band semiconductors. Elemental(Si) and compound semiconductors (GaAs). Doping Calculation of Fermi level and conductivity of semiconductors.

UNIT-II

Carrier Drift, Carrier Diffusion, continuity equation. Ambipolar transport carrier Injection, Generation Recombination Processes-Direct, Indirect band gap semiconductors. Band to band trap assited and auger recombination, low and high injection. Quasi Fermi levels. Minority Carrier life time, Drift and diffusion of Minority carrier (Haynes-Shockley Experiment)

Semiconductor surfaces: Surface charge barriers, surface recombination. Amorphous semiconductors. Mobility edge band tails and dangling band states.

UNIT-III

Junction Devices: Basic fabrication steps. Diffusion of Impurities, thermal diffusion, constant total Dopant diffusion, ion implantation. Need for junctions. Junction Devices (i) p-n junction-Energy Band diagrams for homo and hetro junctions. Current flow mechanism in p-n junction. effect of indirect and surface recombination currents on the forward biased diffusion current, diode ideality factor, Breakdown mechanisms. p-n junction diodes-rectifiers(high frequency limit), ac response, diffusion capacitance, switching properties, P-I-N Diode.

Reference Books:

1. K. Seeger: Semiconductor Physics Springer Verlag.
2. John, P. Mckelvy: Solid State and Semiconductor Physics, Harper and Row.
3. A.G. Milnes: Semi-conductor Devices and Integrated Electronics, Von Non
4. S.M.Sze: Physic of Semiconductor Devices Wiley.
5. S. M. Sze VLSI Technology.

Paper- XII (c) Plasma physics I

3 hrs duration **100 marks**

Note: Syllabus of each question paper is divided into three units. The question paper is divided into three parts: Part-A, Part-B and Part-C (total 100 Marks).

Part-A (30 Marks) is compulsory and contains 10 questions (50 words each). At least three questions will be set from each unit. Each question carries 3 marks.

Part-B (25 Marks) 9 questions (100 words each) will be set taking 3 from each unit and candidate is required to attempt 5 questions taking at least one question from each unit but not more than 2 from any unit. Each question carries 5 marks.

Part-C (45 Marks) contains 06 questions two from each unit. Candidate is required to attempt three questions taking one from each unit. Each question carries 15 marks (400 words).

UNIT-I

Basic properties and occurrence. Definition of plasma. Criterla for plasma behaviour, Plasma oscillation. Quasineutrality and Debye Shielding. The plasma parameter. natural occurrence of plasmas. Astrophysical plasmas. Plasma in Magnetosphere and ionosphere. Plasma production and diagnostics. Thermal ionization. Saha equation. Brief discussion of methods of laboratory plasma production. Steady stage glow discharge, microwave breakdown and induction discharge, Double Plasma Machine. Elementary ideas about plasma diagnostics. Electrostatic and magnetic probes.

UNIT-II

Charged particle motion and drifts, Guiding centre motion of a charges particle. Motion in (i) uniform electric and magnetic field (ii) gravitational and magnetic fields. Motion in non-uniform magnetic field (i) grad B perpendicular to B, grad B drift and curvature drift (ii) grad B parallel to B and principle of magnetic mirror. Motion in non-uniform electric field for small Larmour radius. Time varying electric field and polarization drift. Time varying magnetic field adiabatic invariance of magnetic moment.

UNIT-III

Plasma fluid equations fluid equations; Conventive derivative Two fluid and single fluid equations. Fluid drifts perpendicular to B,diamagnetic drift.

Diffusion and Resistivity : Collision and diffusion parameters. Decay of a plasma by diffusion, ambipolar diffusion. Diffusion across magnetic field. Collision in fully ionized plasma. Plasma resistivity Diffusion in fully ionized plasmas. Solution of Diffusion equation.

Equilibrium and stability : Hydromagnetic equilibrium. Concept of magnetic pressure. Equilibrium of a cylindrical pinch. The Bennet pinch. Diffusion of magnetic field into a plasma. Classification of instabilities. Two stream instability. The gravitational instability. Resistive drift waves.

Referennce Books :

1. F.F. Chen : An Introduction to Plasma Physics (Plenum Press) 1977.
2. R.C. Davidson : Methods in Non-linear Plasma Theory (Academy Press) 1972.
3. W.B. Kunkel : Plasma Physics in Theory and Application (Mc Graw Hill)1966.
4. J.A. Bittencoms : Fundamentals of Plasma Physics (Pergamons Press). 1986.

Paper- XII (d) Energy Studies –I

3 hrs duration **100 marks**

Note: Syllabus of each question paper is divided into three units. The question paper is divided into three parts: Part-A, Part-B and Part-C (total 100 Marks).

Part-A (30 Marks) is compulsory and contains 10 questions (50 words each). At least three questions will be set from each unit. Each question carries 3 marks.

Part-B (25 Marks) 9 questions (100 words each) will be set taking 3 from each unit

and candidate is required to attempt 5 questions taking at least one question from each unit but not more than 2 from any unit. Each question carries 5 marks.

Part-C (45 Marks) contains 06 questions two from each unit. Candidate is required to attempt three questions taking one from each unit. Each question carries 15 marks (400 words).

UNIT-I

Solar Energy : Fundamentals of photovoltaic Energy Conversion Physics and Material Properties Basic to Photovoltaic Energy Conversion : Optical properties of Solids. Direct and indirect transition semiconductors, interrelationship between absorption coefficients and band gap recombination of carriers.

Types of Solar Cells, p n junction solar cell, Transport Equation, Current Density, open circuit voltage and short circuit current, Brief descriptions of single crystal silicon and amorphous silicon solar cells, elementary ideas of advanced solar cells e.g. Tandem Solar Cells. solid Liquid Junction Solar Cells, Nature of Semiconductor, Electrolyte Junction, Pricniples of Photoelectrochemcial solar Cells.

UNIT-II

Hydrogen Energy : Relevance in depletion of fossil fuels and enviromnental considerations. Hydrogen Production : Solar Hydrogen through Photoelectrolysis and Photocatalytic process. Physics and material characteristics for production of Solar Hydrogen. Storage of Hydrogen : Brief discussion of various storage processes, special features of solid state hydrogen storage materials, structural and electronic characteristics of storage materials. New Storage Modes.

UNIT-III

Safety and Utilisation of Hydrogen : Various factors relevant to safety, use of Hydrogen as Fuel, Use in Vehicular transport, Hydrogen for Electricity Generation, Fuel Cells, Elementary concepts of other Hydrogen Based devices such as Air Conditioners and Hydride Batteries. Other Renewable Clean Energies : Elements of Solar Thermal Energy, Wind Energy and Ocean Thermal Energy Conversion.

Reference Books:

1. Fonash : Solar Cell Devices - Physics.
2. Fahrenbruch & Bube : Fundamentals of Solar Cells Photovoltatic Solar Energy.
3. Chandra : Photoelectrochemical Solar Cells.
4. Winter & Nitch (Eds.) : Hydrogen as an Energy Carrier Technologies System Economy.

Fourth Semester

Paper -XIII NUCLEAR PHYSICS-II

3 hrs duration **100 marks**

Note: Syllabus of each question paper is divided into three units. The question paper is divided into three parts: Part-A, Part-B and Part-C (total 100 Marks).

Part-A (30 Marks) is compulsory and contains 10 questions (50 words each). At least three questions will be set from each unit. Each question carries 3 marks.

Part-B (25 Marks) 9 questions (100 words each) will be set taking 3 from each unit and candidate is required to attempt 5 questions taking at least one question from each unit but not more than 2 from any unit. Each question carries 5 marks.

Part-C (45 Marks) contains 06 questions two from each unit. Candidate is required to attempt three questions taking one from each unit. Each question carries 15 marks (400 words).

UNIT-I

Nuclear Shell Model: Single particle and collective motions in nuclei. Empirical evidences of magic numbers, 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; Nuclear isomerism.
Collective nuclear deformation-rotational and vibrational modes. Generalized nuclear deformation and Nielsson model.

UNIT-II

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 lepton caputre; electron energy spectrum and Fermi-Kurie plot; Fermi theory of beta decay (parity conserved selection rules Fermi and Gamow-Teller) for allowed transitions; ft-values; Forbidden transitions; Experimental verification of parity violation; The V-A interaction and experimental verification.

UNIT-III

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($l = 0$), continuum cross section; Statistical theory of nuclear reactions; The optical model, Stripping and pick-up reactions .

Reference Books :

1. M.A. Preston and R.K. Bhaduri : Structure of Nucleus, Addision Wesley,. 1975.
2. R.R. Roy and B.P. It Nigam, Nuclear Physics, Wiley-Eastern. 1979.
3. L.R.B. Elton: Introductory Nuclear Theory, ELeBS Pub. London, 1959.
4. B.K. Agrawal : Nuclear Physics. Lokbharati Publt., Allahabad 1989.
5. M.K. Pal-Nuclear Structure, Affiliated East-West Press, 1982.
6. J.B. Blatt and V.F. Weisskopf-Theoretical. Nuclear Physics.
7. H. Enge. : Introduction to Nuclear Physics, Addison - Wesley, 1970.
8. B.L. Cohen-concept of Nuclear Physics, Tata McGraw Hill, 1988.
9. W.E. Burchema - element of Nuclear Physics, ELBS, Longman, 1988.
10. R.D. Evans : The Atomic Nucleus, Mc Graw Hill, 1955.
11. E. Segre Nuclei and Particles, Benjamin, 1977.

Paper - XIV SOLID STATE PHYSICS

3 hrs duration **100 marks**

Note: Syllabus of each question paper is divided into three units. The question paper is divided into three parts: Part-A, Part-B and Part-C (total 100 Marks).
Part-A (30 Marks) is compulsory and contains 10 questions (50 words each). At

least three questions will be set from each unit. Each question carries 3 marks.
Part-B (25 Marks) 9 questions (100 words each) will be set taking 3 from each unit and candidate is required to attempt 5 questions taking at least one question from each unit but not more than 2 from any unit. Each question carries 5 marks.
Part-C (45 Marks) contains 06 questions two from each unit. Candidate is required to attempt three questions taking one from each unit. Each question carries 15 marks (400 words).

UNIT-I

Lattice Dynamics and Optical Properties of Solids : Interatomic forces and lattice dynamics and simple metals, ionic and covalent crystals. Optical phonons and dielectric constants. Inelastic neutron scattering. Mossbauer effect. Debye-Waller factor. Anharmonicity, thermal expansion and thermal conductivity. Interaction of electrons and phonons with photons. Direct and indirect transitions Absorption in insulators, Polarons, one-phonon absorption, optical properties of metals, skin effect and anomalous skin effect.

UNIT-II

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, excitions, photoconductivity, photo-luminescence. Points line, planar and bulk defects, colour centres, F-centre and aggregate centres in alkali halides.

UNIT-III

Magnetism : Larmor diamagnetism. Paramagnetism, Curie Langevin and Quantum theories. Susceptibility of rate earth and transition metals. Ferromagnetism : Domain theory, Weiss molecular field and exchange, spin waves: dispersion relation and its experimental determination by inelastic neutrons scattering, heat capacity Nuclear Magnetic resonance : Conditions of resonance, Bloch equations. NMR-experiment and characteristics of an absorption line.
Superconductivity :
(a) Experimental Results : Meissner effect, heat capacity, microwave and infrared properties, isotope effect, flux quantization, ultrasonic attenuation, density of states nuclear spin relaxation, Giaver and AC and DC Josephson tunnelling.
(b) Cooper pairs and derivation of BCS Hamiltonian, results of BCS Theory (no derivation)

Reference Books :

1. Kittel : Introduction to Solid State Physics, 5th Edition (John Wiley).
2. Levy-Solid State Physics.
3. Patterson - Solid State Physics.
4. Mckelvy - Solid State and Semi-conductor Physics.

Paper -XV Advanced Quantum Mechanics (II)

3 hrs duration **100 marks**

Note: Syllabus of each question paper is divided into three units. The question paper is divided into three parts: Part-A, Part-B and Part-C (total 100 Marks).
Part-A (30 Marks) is compulsory and contains 10 questions (50 words each). At least three questions will be set from each unit. Each question carries 3 marks.

Part-B (25 Marks) 9 questions (100 words each) will be set taking 3 from each unit and candidate is required to attempt 5 questions taking at least one question from each unit but not more than 2 from any unit. Each question carries 5 marks.

Part-C (45 Marks) contains 06 questions two from each unit. Candidate is required to attempt three questions taking one from each unit. Each question carries 15 marks (400 words).

UNIT-I

Relativistic Formulation and Dirac Equation : Attempt for relativistic formulation of quantum theory, The Klein-Gordon equation, Probability density and probability current density, solution free particle K.G. equation in momentum representation, interpretation of negative probability density and negative energy solutions. 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 and hole theory.

UNIT-II

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 negative energy solution, Zitterbewegung, 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 description, matrix element for emission and absorption, spontaneous emission in the dipole approximation.

Reference Books :

1. Nouredine Zettili -----Quantum Mechanics: Concepts and Applications
2. Ashok Das and A.C. Milissiones : Quantum mechanics - A Modern Approach (Garden and Breach Science Publishers).
3. Eugen Merzbacher : Quantum Mechanics, Second Edition (John Wiley and Sons).
4. Bjorken and Drell : Relativistic Quantum Mechanics (McGraw-Hill)

Paper -XVI Elective paper-

Anyone out of the following special papers

Paper-XVI (a) Microwave Electronics

(Only for students who opted Paper XII (a) in third semester)

3 hrs duration **100 marks**

Note: Syllabus of each question paper is divided into three units. The question paper is divided into three parts: Part-A, Part-B and Part-C (total 100 Marks).

Part-A (30 Marks) is compulsory and contains 10 questions (50 words each). At least three questions will be set from each unit. Each question carries 3 marks.

Part-B (25 Marks) 9 questions (100 words each) will be set taking 3 from each unit and candidate is required to attempt 5 questions taking at least one question from each unit but not more than 2 from any unit. Each question carries 5 marks.

Part-C (45 Marks) contains 06 questions two from each unit. Candidate is required to attempt three questions taking one from each unit. Each question carries 15 marks (400 words).

UNIT-I

Microwave device: Klystrons, Magnetrons and travelling Wave tubes, Velocity modulation, Basic Principles of two cavity Klystrons and Reflex Klystrons. Principle of operation of magnetrons. Helix travelling Wave tube, Wave Modes. Transferred electron devices . Gunn effect, Principle of operation. Mode of operation, Read diode, IMPATT diode, TRAPATT diode.

UNIT-II

Satellite communications: orbital satellites, geostationary satellites. orbital patterns, look angles, orbital spacing, satellite systems. link modules.

Parametric Amplifier: Varactor, Equation of Capacitance in Linearly graded & abrupt p-n junction, Manley Rowe relations, Parametric up convertor and Negative resistance parametric amplifier, use of circulator, Noise in Parametric amplifiers.

UNIT-III

Microwave Antennas: Introduction to antenna parameters, Magnetic Currents, Electric and Magnetic current sheet, Field of Huygens's source, Radiation from a slot antenna, open end of a wave guide and electromagnetic Horns. Parabolic reflectors, Lens Antennas.

Microwave Measurements: (a) Microwave Detectors: Power, Frequency, Attenuation, Impedance using Smith Chart, VSWR, Reflectrometer, Directivity, Coupling using direction coupler.(b) Complex permittivity of Solids, liquids and powders and its measurement using shift of minima method.

Reference Books :

1. 'Microelectronics" by Jacob Millman, Mc Graw-Hill International Book Co. New Delhi. 1990.
2. "Optoelectronics Theory and Practice Edited by Alien thabbal Mc Graw-Hill Book Co. New York.
3. "Microwaves by K.C. Gupta. Wiley Eastern Ltd. New Delhi 1983.
4. "Advanced Electronics Communications systems" by Wayne Tomasi. Phi Edn. Electromagnetic & Radiating Systems: Jorden & Balmain.

Paper-XVI (b) Solid State electronics

(Only for students who opted Paper XII(b) in third semester)

3 hrs duration **100 marks**

Note: Syllabus of each question paper is divided into three units. The question paper is divided into three parts: Part-A, Part-B and Part-C (total 100 Marks).

Part-A (30 Marks) is compulsory and contains 10 questions (50 words each). A

least three questions will be set from each unit. Each question carries 3 marks.
Part-B (25 Marks) 9 questions (100 words each) will be set taking 3 from each unit and candidate is required to attempt 5 questions taking at least one question from each unit but not more than 2 from any unit. Each question carries 5 marks.
Part-C (45 Marks) contains 06 questions two from each unit. Candidate is required to attempt three questions taking one from each unit. Each question carries 15 marks (400 words).

UNIT-I

Metal-semiconductor (Schottky) Junction: Energy band diagram, current flow mechanisms in forward and reverse bias, thermionic and diffusion currents. effect of interface states. Applications of Schottky diodes, (ii) Metal-Oxide Semiconductor (MOS) diodes. Energy band diagram, depletion and inversion layer. High and low frequency capacitance Voltage (C-V) characteristics. Smearing of C-V curve, Flat band shift. Applications of MOS diode.

UNIT-II

Bipolar Transistor and Thyristors : General characteristics of BJT, factors controlling current gain, frequency performance, switching of bipolar transistors. Basic coincepts of PNPN structures, thyristor turn on turn off and power consideration, triacs.

UNIT-III

Microwave Devices:
Tunnel diode, High field effect in two valley semiconductors transfer electron devices (Gunn diode), Avalanche Transit time devices (Read, Impatt diodes)
JFETS, MESFETS and MOSFETS: JFET Modelling including saturation velocity effects, GaAs MESFET, MOSFET, surface space. charge region under non equilibrium condition, Channel conductance, basic characteristics current, voltage and device parameters.

Reference Books:

1. K. Seeger: Semiconductor Physics, Springer Verlag.
2. John, P. Mckelvy: Solid State and Semiconductors, Physics, Harper and Row.
3. A.G. Milnes: Semi-Conductor Devices and Integrated Electronics, Von Non
4. S.M.Sze : Physic of Semiconductor Devices Wiley.
5. S.M. Sze: VLSI Technology

Paper-XVI (c) Plasma physics-II

(Only for students who opted Paper XII (c) in third semester)

3 hrs duration **100 marks**

Note: Syllabus of each question paper is divided into three units. The question paper is divided into three parts: Part-A, Part-B and Part-C (total 100 Marks).
Part-A (30 Marks) is compulsory and contains 10 questions (50 words each). At least three questions will be set from each unit. Each question carries 3 marks.
Part-B (25 Marks) 9 questions (100 words each) will be set taking 3 from each unit and candidate is required to attempt 5 questions taking at least one question from each unit but not more than 2 from any unit. Each question carries 5 marks.

Part-C (45 Marks) contains 06 questions two from each unit. Candidate is required to attempt three questions taking one from each unit. Each question carries 15 marks (400 words).

UNIT-I

Waves in plasma : Electron plasma waves. Ion Waves, Electrostatic electron oscillations perpendicular to B, upper hybride oscillations. Electrostatic ion waves perpendicular to B, ion cyclotron waves, Lower hybride oscillations. Electromagnetic waves in field free plasma. Electromagnetic waves perpendicular to B. Cut offs and resonances, Electromagnetic waves parallel to magnetic field, Hydromagnetic waves. Magnetosonic waves.

UNIT-II

Kinetic Theory, Boltzmann and Vlasov Equation, Derivation of multifulid equations, Vlasov equation, Linearization of Valsove Maxwell equations. High Frequency plasma waves, Landau damping, A Physical derivation of Landau damping, Low frequency ion acoustic waves, Ion Landau damping.

UNIT-III

Non-linear effects : Non-linear effects in plasmas. The Sagdeov potential, Derivation of KdV equation for ion acoustic waves. Soliton solution in one dimension. elementary ideas about the pondermotive force and parametric instability. Oscillating two stream instability, Non-linear Landau damping.
Controlled thermonuclear fusion and other plasma applications : Potentials and problems of controlled thermonuclear fusin. Ignition temperature and Lawson criteria. Magnetic confinement. Simple discussion of Tokomak, stellarators, multipoles and Z pinch. Idea about intertial confinement and laser fusion. Methods of plasma heating and problms of fusion. Basic principle and working of MHD power generator, Plasma applications in industry, Plasma torches.

Reference Books :

1. F.F. Chen. : An Introduction to Plasma Physics (Plenum Press) 1974.
2. R.C. Davidson : Methods in Non-linear Plasma Theory (Academic Press) 1972.
3. J.A. Bittencomt : Fundamentals of Plasma Physics (Pergamon Press) 1988
4. C. Uberoi : Introduction to Unmagnetized Plasma (Prentice Hall) 1988.

Paper-XVI (d) Energy Studies –II.

(Only for students opted Paper XII (d) in third semester)

3 hrs duration **100 marks**

Note: Syllabus of each question paper is divided into three units. The question paper is divided into three parts: Part-A, Part-B and Part-C (total 100 Marks).
Part-A (30 Marks) is compulsory and contains 10 questions (50 words each). At least three questions will be set from each unit. Each question carries 3 marks.
Part-B (25 Marks) 9 questions (100 words each) will be set taking 3 from each unit and candidate is required to attempt 5 questions taking at least one question from each unit but not more than 2 from any unit. Each question carries 5 marks.
Part-C (45 Marks) contains 06 questions two from each unit. Candidate is required to attempt three questions taking one from each unit. Each question carries 15 marks

(400 words).

UNIT-I

Heat conduction : Differential equation of heat conduction, Initial and boundary conditions. methods of solving heat conduction problems : separation of variable method for one dimension, The Greens' functions method, Integral transform method for finite and infinite ranges. Problems with and without internal heat generation. Measurement techniques for thermal conductivity and their comparative study (static and dynamic), Guarded not plate method, Thermal probe, parallel wire.

Convective and Radiative Heat Transfer : Theory of convective heat transfer, Laminar and turbulent flow, Boundary layer theory. Heat exchangers : basic thermal sign methods. Heat pipes, Design considerations. Applications of heat pipes. Direct and diffused thermal radiation. Radiative properties of real surfaces. Radiation exchange between surfaces. Atmospheric attenuation, solar radiation measurements solar radiation geometry.

UNIT-II

Solar Energy collectors : Flat Plate solare energy collectors. Selective absorber surfaces. Transparent plates. Collector energy losses. Thermal analysis of collectors. Air heating collectors. Collector performance testing. Concentrating collectors. Thermal analysis of concentrating collectors. Tracking requirements.

UNIT-III

Thermal Energy Storage and Solar Thermal Devices : Storage of solar energy. Water storage. Stratification fo water storage, Packed bed storage. Phase change storage. Solar pond. Chemical storage. Solar space conditioning- Energy requirements in buildings, Passive system architecture, Performance and design; coiling processes. Vapor compression refrigeration cycle, Absorption refrigeration cycle, Performance of solar absorption air conditioning. Solar energy process economics.

Reference Books :

1. Heat Condution : M. Necati Ozisik-John Wiley & Sons.
2. Hand Book of Heat transfer Application : Edited by Warren M. Rohsenow, James P. Harnou and Fjup N. Ganic.
3. Conduction of Heat in Solids : H.S., Carslas and J.C.Jsegar, Oxford Clarendon Press 1959.
4. Heat and Mass Transfer : A Luikov, Mir Publichers Moscow.
5. Thermal conductivity of Solids : J.E. Parrot and Audrey D. Stuckers : Pion Limited, London.
6. Solar energy Thermal Processs : Dluffie and Backman. Wiley & Sons. New York.
7. Solar Energy Engg. : Jui Sheng Haieh,Prentic Hall, New Jersey.
8. Solar Energy : S.P, Tata McGraw Hill, New Delhi.

M.Sc. Physics (III & IV Semester)
Laboratory/Practical Syllabus

Note:- Students are required to perform at least eight experiments from the general laboratory and eight-experiments from micro wave/Electronic Devices laboratory.

Total number of experiments to be performed by the students during the III & IV Semester should be at least 16. Few experiments other than listed below, may be se at the college level, but at par with the standard of M.Sc. class.

A. General Laboratory Course

1. Determine fine structure constant using sodium doublet
2. Verify Cauchy's relation & determination of constants.
3. To determine e/m for an electron by Zeeman effect.
4. Determine the dissociation energy of Iodine molecule.
5. Determine of energy of a given ray from Re-De sourse.
6. Find out the percentage resolution of given scintillation spectrometer using Csm
7. Find out the energy of a given 9mm x-ray source with the help of a scintilla tion spectrometer.
8. Plot the Gaussian distribution curve for a radioactive source.
9. To study the frequency and phase characteristics of band pass filter.
10. Study the wave from characteristics of transistorised astable symmetircal mult vibrator using CRO & determine its frequency by various C & R.
11. Artificial transmission line.
12. Determine the dielectric constant of turpentine oil with the help of Leacher wire system.
13. To determine velocity of waves in water using ultrasonic interferometer.
14. To determine the magnetic susceptibility of two given samples by Gouy's method.
15. Determination of Lande's 'g' factor for IRRH crystal using electron spin resonance spectrometer.

Any other experiments of the equivalent standard can be set

B. Microwave Laboratory Course:

1. To study the characteristics curve of Klystron.
2. To study the mode characteristics of reflex Klystron and hence to determine mode number. Transmit time, Electronics, tuning rage, electronic tuning sensitivity
3. To study the E-Plane radiation pattern of pyramidal horn antenna and compute the beam width 0' [Antenna.
4. To study the H plane radiation pattern of pyramidal horn antenna and compute the Directional gain of the Antenna.
5. To determine the dielectric constant of a given sample at Microwave frequency.
6. To determine the dielectric constant of Benzene using plunger technique at room temperature.
7. To determine the unknown impedance using slotted line section Smith chart in the K-band.
8. To study the microwave absorption in dielectric sheets.

Any other experiments of the equivalent standard can be set

C. Electronic Devices Laboratory Course:

1. To determine e/m of an electron by magnetron valve method

2. To determine e/k using transistor characteristics.
3. To study dark and illumination characteristic of p-n-junction solar cell and to determine
(i) Its internal series resistance
(ii) Diode ideality factor
4. To study the characteristics of following semiconductor devices
(i) VDR
(ii) Photo transistor
(iii) LDR
(iv) LED
5. To study the characteristics of MOSTET and MOSFET amplifier.
6. To study dark and illumination characteristics of p-n-junction solar cell and to determine its (i) Maximum power available (ii) Fill factor
7. To study capacitance variation of p-n-junction with bias voltage in reverse bias and determination of built in potential and other related parameters.
8. To study temperature characteristics of a thermistor and determination of activation energy.
9. Studies on life-time measurements in p-n-junctions by various methods. (VOC decay method/reverse recovery method)
10. Resistivity measurements by Vander-Paw method and magneto resistance

Any other Experiments of the equivalent standard can be set.

Advanced Physics Lab-I/ Advanced Physics Lab-II: Laboratory work based on curriculum of elective papers taken in the Semester - III combined with Semester IV

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