Semester-III

BSc/Phy/SM/3/DSC201: Mathematical Physics – I

Credits: 4 | **Max. Marks: 100**
Lectures: 60 | **Final Term Exam.: 70**
Duration of Exam.: 3 Hrs. | **Internal Assessment: 30**

Objective: The course covers basics of differential equation, vector calculus, vector algebra, vector differentiation, vector integration, probability and errors. These topics are useful for the mathematical basis of electromagnetism, quantum mechanics and other courses.

Course Outcomes: After completing this course, students would be able to deal with mathematics that appears in other papers such as Classical Mechanics, Quantum Mechanics, Nuclear Physics, Condensed Matter Physics, etc.
CO1: Understanding of vector calculus and differentiation of physical quantities.
CO2: Understanding of vector integration and calculus of functions of more than one variable.
CO3: Understanding1stand 2nd order differential equations as well as plotting of curves, Taylor and Binomial series.
CO4: Understanding theory of probability and errors.

Note for the Paper Setter: *The question paper will consist of nine questions in all. The first question will be compulsory and will consist of seven short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

UNIT-I

Vector Calculus: Recapitulation of vectors: Properties of vectors under rotations, Scalar product and its invariance under rotations, Vector product, Scalar triple product and their interpretation in terms of area and volume respectively, Scalar and Vector fields.
Vector Differentiation: Directional derivatives and normal derivative, Gradient of a scalar field and its geometrical interpretation, Divergence and curl of a vector field, De and Laplacian operators, Vector identities.

UNIT-II

Vector Integration: Ordinary Integrals of Vectors, Multiple integrals, Jacobian, Notion of infinitesimal line, Surface and volume elements, Line, surface and volume integrals of Vector fields, Flux of a vector field, Gauss's divergence theorem, Green's and Stokes Theorems and their applications (no rigorous proofs)
Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials, Constrained Maximization using Lagrange Multipliers.

UNIT-III

Calculus: Recapitulation: average and instantaneous quantities Intuitive ideas of continuous, differentiable, functions and plotting of curves, Approximation: Taylor and binomial series (statements only).
First Order and Second Order Differential equations: First Order Differential Equations and Integrating Factor, Homogeneous Equations with constant coefficients, Wronskian and general solution, Statement of existence and Uniqueness Theorem for Initial Value Problems, Particular Integral.

UNIT-IV

Introduction to probability: Independent random variables, Probability distribution functions; Binomial, Gaussian, and Poisson distributions (with examples), Mean and variance, Dependent events: Conditional Probability, Bayes' Theorem and the idea of hypothesis testing.

Theory of Errors: Systematic and Random Errors, Propagation of Errors, Normal Law of Errors, Standard and Probable Error, Least-squares fit, Error on the slope and intercept of a fitted line.

Reference Books:

1. Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013,7th Edn., Elsevier.
2. Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
3. Mathematical Physics, H K Das, 2008, S Chand.
4. Mathematical Physics, B.S. Rajput, 2017, PragatiParkashan, Meerut.
5. Mathematical Methods in Physical Sciences, M.L. Boas, 2005, Wiley, New York.
6. Mathematical Methods for Physicists, G.B. Arfken, 2012, Elsevier, Netherlands.
7. Mathematical Physics, P.K. Chatopadhyay, 2004, New Age, New Delhi.

BSc/Phy/SM/3/DSC/202: Elements of Modern Physics

Credits: 4 **Max. Marks: 100**
Lectures: 60 **Final Term Exam.: 70**
Duration of Exam.: 3 Hrs. **Internal Assessment: 30**

Objective: The aim of this course is to aware the students about the developments in physics in the last century by introducing the concepts of quantization, dual nature of matter, basic quantum mechanics and cosmology.

Course Outcomes: Students will be awaredon foundations of modern physics, experiments forming basis of quantum mechanics, atomic structure, wave concepts, uncertainty principle and basic idea of cosmology.

Note for the Paper Setter: *The question paper will consist of nine questions in all. All questions carry equal marks. The first question will be compulsory and will consist of seven short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

UNIT – I

Introduction to electromagnetic spectra, Properties of Thermal Radiation, Spectral Distribution of Blackbody Radiation, Kirchhoff's Law, Stefan-Boltzmann Law and Wien's Distribution and Displacement law, Rayleigh-Jean's Law, Ultraviolet Catastrophe, Planck's postulates of black body radiation, Planck's Law of Blackbody Radiation and its experimental verification. Photoelectric effect, Einstein's explanation and its experimental verification (R. Millikan). Compton scattering, Pair production and annihilation, Bremsstrahlung effect, Cherenkov radiation. X-ray Spectra of atoms and its production.

UNIT – II

Atomic structure: Rutherford scattering, Rutherford's model and its drawbacks, Bohr atomic model; quantization rule, atomic stability, calculation of energy levels for hydrogen like atoms and their spectra, effect of nuclear mass on spectra, Correspondence principle, Franck-Hertz experiment. Wave properties of matter: De-Broglie wavelength and matter waves; Wave-particle duality, Davison and Germer experiment, wave packets, phase velocity, group velocity and their relations. Electron microscope. Uncertainty principle: Heisenberg's uncertainty principle; Estimating minimum energy of a confined particle using uncertainty principle, Energy-time uncertainty principle. Applications.

UNIT – III

Two slit interference experiment with photons, atoms and particles; linear superposition principle as a consequence; Matter waves and wave amplitude; Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of a wave function, probabilities and normalization; Probability and probability current densities in one dimension. Concept of wave function: Origin and probability interpretation of wave function, properties of wave-function. One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions, normalization; Quantum dot as example.

UNIT – IV

Cosmology: The Expansion of the Universe, The Cosmic Microwave Background Radiation, Dark Matter, The General Theory of Relativity, Tests of General Relativity, Stellar Evolution and Black Holes, Cosmology and General Relativity, The Big Bang Cosmology, The Formation of Nuclei and Atoms, Experimental Cosmology.

Reference Books:

1. Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
2. Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill
3. Modern Physics, Knneth S.Krane, John Wiley & Sons, Inc.
4. Modern Physics, Raymond A. Serway, Clement J. Moses, Curt A. Moyer, 2005, CENGAGE Learning.
5. Principles of Modern Physics, A.K. Saxena, 2007, Narosa Publi

BSc/Phy/SM/2/SEC/101 Electrical Circuits & Networks

BSc/Phy/SM/3/DSC/202–Physics Lab-V

Credits: 2 (Practical) **Max. Marks: 50**
Teaching per week: 4 Hrs. **Duration of Exam: 3 Hrs.**

Objective: The objective of this course is to impart practical knowledge through design and performance of experiments.

Course outcomes: After successfully completing the course, student will be able to:
CO1: get hands on experience with different instruments by measuring related physical quantities.
CO2: verify some fundamental principles, effects and concepts of physics through experimentation.
CO3: basic understanding on instruments, data observation, errors, along with practical's training to use and learn techniques, skills and tools for professional practices.

CO4: learn to present observations, results and analysis in suitable and presentable form.

List of Experiments

1. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light.
2. To determine the Planck's constant using LEDs of at least 4 different colours.
3. To determine the wavelength of laser source using diffraction of single slit.
4. To determine the wavelength of laser source using diffraction of double slits.
5. Comparing intensity of light sources and verify inverse square law.
6. Study the characteristics of photodiodes.
7. To determine the particle size of lycopodium powder.
8. To find the horizontal distance between two points using a sextant.
9. To compare the capacitances of two capacitors by deflection method.
10. To find the capacitance of a capacitor by discharging it through a voltmeter.
11. To compare the luminous intensities of two light sources using a photo-voltaic cell.
12. To determine the thermionic work function of tungsten using a directly heated diode.

Reference Books:

1. B.Sc. Practical Physics, C.L. Arora, 2005-2006, S. Chand Publisher, New Delhi
2. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
3. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition reprinted 1985, Heinemann Educational Publishers
4. A Text Book of Practical Physics, I.Prakash& Ramakrishna, 11th Ed., 2011,Kitab Mahal
5. A Course of Experiments with He-Ne laser, R.S. Sirohi, 2001, New Age International Publicaiton.
6. Experimental Physics, Gyan Prakash, 2012, Studium Press (India) Pvt. Ltd.

BSc/Phy/SM/3/DSC/203–Physics Lab-VI

Credits: 2 (Practical) **Max. Marks: 50**
Teaching per week: 4 Hrs. **Duration of Exam: 3 Hrs.**

Objective: The objective of this course is to impart practical knowledge through design and performance of experiments.

Course outcomes: After successfully completing the course, student will be able to:
CO1: get hands on experience with different instruments and measurements related physical quantities.
CO2: verify some fundamental principles, effects and concepts of physics through experimentation.
CO3:get basic understanding on instruments, data observation, errors, along with practical's training to use and learn techniques, skills and tools for professional practices.

CO4: learn to present observations, results and analysis in suitable and presentable form.

List of Experiments

1. Study of Franck-Hertz experiment.
2. To study the characteristics of solar cell.
3. Study of Zeeman Effect.
4. Determine wavelength of laser light by using vernier calipers/ engraved metal scale.
5. Distance measurement by triangularization method using laser.
6. To measure the divergence of laser beam.
7. To determine Boltzmann constant.
8. To determine the angular diameter of the Sun with the help of a sextant.
9. To determine the amplitude or the angular elevation of the Sun using a sextant.
10. To find the capacitance of a capacitor using flashing and quenching of a neon lamp.
11. To find the band gap of a semiconductor material.

Reference Books:

1. B.Sc. Practical Physics, C.L. Arora, 2005-2006, S. Chand Publisher, New Delhi
2. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
3. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition reprinted 1985, Heinemann Educational Publishers
4. A Text Book of Practical Physics, I.Prakash& Ramakrishna, 11th Ed., 2011,Kitab Mahal.
5. A Course of Experiments with He-Ne laser, R.S. Sirohi, 2001, New Age International Publication.
6. Experimental Physics, Gyan Prakash, 2012, Studium Press (India) Pvt. Ltd.

BSc/Phy/SM/3/MIC/201: Solid State Physics

Credits: 4 **Max. Marks: 100**
Lectures: 60 **Final Term Exam.: 70**
Duration of Exam.: 3 Hrs. **Internal Assessment: 30**

Objective: The aim of the course is to familiarize the students with the concepts of crystal structure, reciprocal lattice, bonding in solids, elastic constants and magnetic properties of solids. Course Outcomes: After completion of this course, students will be able to understand the basics of crystal structure, reciprocal lattice, bonding in solids, elastic constants and magnetic properties of solids. Students get knowledge on

CO1: elements of crystal structure.
CO2: reciprocal lattice and X-ray diffraction methods.
CO3: bonding in solids and elastic constants.
CO4: theory of magnetism, magnetic properties and superconductivity of materials.

***Note for the Paper Setter**: The question paper will consists of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

UNIT-I

Crystal Structure: Introduction to crystalline & amorphous solids, Crystal lattice and Translation Vectors, Unit cell and basis, Primitive and non-primitive lattices, Symmetry operations, Point groups and space groups, Bravais lattices in 2D and 3D, Lattice planes, Miller Indices, Interplanner spacing, Crystal structures: sc, bcc, fcc and hcp, Examples: NaCl, CsCl, Diamond and ZnS structure.

UNIT-II

Reciprocal lattice: Bragg's law, Fourier analysis of electron density, reciprocal lattice, Diffraction condition in reciprocal space, Laue's equations, Ewald construction, Brillioun zones and Weigner Seitz cell concepts, Brillioun zones construction, Reciprocal lattice (sc, bcc, fcc), Fourier analysis of basis, Atomic scattering factors, Geometrical structure factor, X-ray diffraction method: Laue, Rotating and powder crystal methods.

UNIT – III

Bonding in solids: Force between atoms, Cohesion of atoms and cohesive energy, Crystal of inert gases, Van der Waal interaction, Repulsive interaction, Equilibrium lattice constants, Ionic crystals, Lattice energy of ionic crystal, Madelung constant of ionic crystal, Covalent crystals, Metals, Hydrogen Bonds, Atomic radii. Elastic constants: Elastic strains, Stress components, Stiffness constants for cubic crystals, Elastic energy density, Bulk Modulus and Compressibility, Elastic waves.

UNIT – IV

Magnetic Properties: Origin of magnetism, Types of magnetism, Dia-, Para-, Ferri-, Ferro and anti-ferromagnetic materials, Langevin's Classical and quantum Theory of Dia– and Paramagnetic, Curie's law, Weiss's Theory of Ferromagnetism, Exchange interactions, Spin Hamiltonian and the Heisenberg model; Spin waves- magnons, Ferromagnetic domains: Magnetization curve, Bloch wall, Origin of domains. Superconductivity: Critical temperature, Critical magnetic field, Meissner effect, Type I and type II Superconductors, London's equation and Penetration depth, energy gap, BCS theory, Josephson effect.

Reference Books:

1. Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.
2. K.V. Keer, Principles of solid state physics, Wiley - Eastern, 1993.
3. Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning.
4. Solid State Physics, M.A. Wahab, 2011, Narosa Publications.
5. Introduction to Solid State Physics, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill.
6. Solid State Physics: An Introduction to Theory and Experiment by H. Ibach and H. Luth
7. Neil W Ashcroft and N David Mermin, Solid State Physics, Holt Saunders International Edn, 1976.
8. BD Cullity, Introduction to Magnetic Materials, Addison-Wesley, 1

Semester-IV

BSc/Phy/SM/4/DSC/204: Physics of Semiconductor Devices

Credits: 4 **Max. Marks: 100**
Lectures: 60 **Final Term Exam.: 70**
Duration of Exam.: 3 Hrs. **Internal Assessment: 30**

Objective: The course enables students to develop an in-depth understanding about the physics of semiconductors through an exposure of various types of semiconductor diodes, transistors, binary number systems and logic gates.

Course Outcomes: After completion of this course, students will be able to understand:

Note for the Paper Setter: *The question paper will consists of nine questions in all. The first question will be compulsory and will consist of seven short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the two units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

UNIT – I

Physics of Semiconductors: The Energy-Band theory of Crystals, Classification of materials, Direct and indirect band gap semiconductors, Intrinsic and extrinsic semiconductors, concept of effective mass, Donor and Acceptor impurities, mass action law, Carrier Concentrations; The Fermi Level, Charge densities in semiconductors, Electrical properties of Ge and Si, Generation and recombination of charges, Carrier diffusion, Continuity equation, Injected minority-carrier charge, The Potential variation within a graded semiconductor.

UNIT – II

Semiconductor Diodes: Open circuit p-n junction, V-I characteristics and their dependence, Ideal Diode, The Diffusion capacitance, Breakdown Diodes, Tunnel Diode, Semiconductor Photodiode, LED, Diode as circuit element, Load line, Piecewise linear diode model, p-n junction as rectifier (half, full and bridge rectifier), Ripples, Filters (capacitor, inductor and π-filters), Clipping and clamping circuits.

UNIT – III

Bipolar Junction Transistors (BJT): The junction transistor and its current components, I-V characteristics, Transistor as an amplifier, Type of transistors, Common-Base (CB), Common-Emitter (CE), Common-Collector (CC) configuration, characteristics of CE, CB and CC configurations, Ebers-Moll BJT Model, Phototransistor, Switching Transistor, Biasing for transistor, load line and Q point. Types of biasing, Fixed Bias circuits, Collector to base bias circuits, Bias circuit with emitter resistance, Voltage divider bias circuits.

UNIT – IV

Number System and Codes: Decimal, Binary, Hexadecimal and Octal number systems, base conversions, Binary, octal and hexadecimal arithmetic (addition, subtraction by complement method, multiplication), representation of signed and unsigned numbers, Binary Coded Decimal code. Logic Gates and Boolean algebra: Introduction to Boolean Algebra and Boolean operators: De Morgan’s Theorems, Boolean Laws, simplifications of Logic Circuits using Boolean Algebra, Positive and negative logic, Truth Tables of OR, AND, NOT, construction and symbolic representation of XOR, XNOR, Universal NOR and NAND gates (DTL, TTL gates).

Reference Book:

1. Semiconductor Physics and Devices: Donald A Neaman and Dhrubes Biswas, 4thEdition, McGraw Hill, India
2. Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
3. Basic Electronics and Linear Circuits, N. N. Bhargava et. al., 2ndEdition, McGraw Hill, India
4. Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
5. Solid State Electronic Devices, B. G. Streetman & S. K. Banerjee, 6thEdn.,2009, PHI Learning

BSc/Phy/SM/4/DSC/205: Classical and Statistical Mechanics

Credits: 4 **Max. Marks: 100**
Lectures: 60 **Final Term Exam.: 70**
Duration of Exam.: 3 Hrs. **Internal Assessment: 30**

Objective: The objective of the course is to provide a basic knowledge of constraints, planetary motion, Langrange's formulation of classical system of particles. The course also includes the basics of classical and quantum statistics.

Course Outcomes: After completion of this course, students will be able to understand the basics of classical and statistical mechanics. They will be having basic knowledge of.

CO1: two-body central force problem and Lagrangian dynamics.
CO2: rigid bodies- kinematics and dynamics.
CO3: introductory topics in statistical physics.
CO4: topics inclassical and quantum statistics.

Note for the Paper Setter: *The question paper will consists of nine questions in all. The first question will be compulsory and will consist of seven short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

UNIT – I

Two-body central force problem and Lagrangian Dynamics: Constraints & their classification, Generalized coordinates, D'Alembert's principle and Lagrange's equations, Simple applications of the Lagrangian formulation, Velocity-dependent potentials and the dissipation function, Hamilton's principle, Derivation of Lagrange's equations from Hamilton's principle, Cyclic coordinates, Conservation theorems and symmetry properties. Two –body central force problem: Reduction to the equivalent one-body problem, Equations of motion and first integrals, Equivalent 1-D problem and classification of orbits.

UNIT –II

Rigid Bodies- Kinematics and Dynamics: Independent coordinates of the rigid bodies, orthogonal transformations, Euler angles and Euler's theorem, Infinitesimal rotation, rate of change of a vector, Coriolis force, angular theorem, infinitesimal rotation, angular momentum and kinetic energy of a rigid body, the inertia tensor, principal axis transformation, Euler equations of motion, Torque free motion of rigid body, motion of asymmetrical top.

UNIT- III

Introduction to Statistical Physics: Laws of Thermodynamics, Entropy and Disorder, Statistical Definition of Entropy, Macroscopic and Microscopic Systems, Events (dependent, independent and mutually exclusive), statistical Probability, a-priori probability, probability theorems, Tossing of Coins, Permutations and Combinations, Distribution of N distinguishable and indistinguishable particles in boxes, Macro and Micro states, Thermodynamic potentials and Thermodynamic equilibriums, phase space, Liouville's Theorem, Density Matrix, Fluctuations, Three kinds of Statistics 75.

UNIT-IV

Classical and Quantum Statistics: Maxwell- Boltzmann Statistics applied to an ideal gas, M.B. velocity distribution law, Thermodynamical quantities, ideal Boltzmann gas, Monoatomic and Diatomic ideal gases, ideal paramagnetism, Bose- Einstein energy distribution law, Planck's Radiation Law, B-E Gas, Degeneracy and B.E. Condensation, Fermi- Dirac energy distribution Law, F.D. Gas and Degeneracy, Fermi Energy and Fermi Temperature, Zero point Energy, Zero point Pressure and average speed (at 0K) of electron gas, Specific heat Anomaly of metals and its solution, M.B. distribution as a limiting case of B.E. and F.D. distributions, Comparison of three Statistics.

Reference Books:

1. Classical Mechanics, 3rded.,2002 by H.Goldstein, C. Poole and J. Safko, Pearson Edition
2. Classical Mechanics of Particles and Rigid Bodies by K. C. Gupta, 2008, New Age International.
3. Classical Mechanics, N.C. Rana & P.S. Jaog, 2017, Tata MC Graw Hill, New Delhi.
4. Statistical Mechanics, R.K. Pathria& D. Beale, 2021, Elsevier Publication.
5. Statistical Mechanics, B.K. Agarwal & M. Eisner,2020, New Age International Publication.
6. Introduction to Statistical Mechanics, S.K. Sinha, 2005, Narosa Publication.

BSc/Phy/SM/4/DSC/206–Physics Lab-VIII

Credits: 2 (Practical) **Max. Marks: 50**
Teaching per week: 4 Hrs. **Duration of Exam: 3 Hrs.**

Objective: The objective of this course is to impart practical knowledge through hands on training of basic instruments.

Course outcomes: After successfully completing the course, student will be able to get:
CO1: exposure with various aspects of instruments and their usage through hands-on mode.
CO2: real work experience of various lab skills on related instruments in the profession.
CO3: basic understanding on instruments data observation, measurements, errors and analysis.
CO4: practical's training to use and learn techniques, skills and tools for professional practices.

List of Experiments:

1. To study the growth and decay of current in a L, R circuit using magnetic core inductor.
2. To determine the magnetic induction field between the pole pieces of an electromagnet with the help of a search coil and a ballistic galvanometer using a mutual inductance for calibration of ballistic galvanometer.
3. To determine the value of e/m for electron by long solenoid (Helical) method.
4. To determine e/m by magnetron method or small solenoid method.
5. To determine the electronic charge by Millikan's Method.
6. To determine the frequency of AC mains using a Sonometer and an electromagnet.
7. To find the value of B_H the Horizontal component of earth's magnetic field in the laboratory using a deflection and vibration magnetometer.
8. To find the value of M in the laboratory using deflection and vibration magnetometer.
9. To study the variation of magnetic field with distance along the axis of a circular coil carrying current by plotting a graph.
10. To study the induced emf as a junction of velocity of the magnet (simple method).
11. To study the induced emf as a junction of velocity of magnet.
12. To obtain the wave form of AC mains supply using a cathode ray oscilloscope.
13. To measure the AC voltage using a CRO and to calculate the deflection sensitivity in mm per rms volt.
14. To measure a dc voltage with the help of a CRO.
15. To demonstrate the phase difference in the case of resistance, inductance and capacitance and to measure their values using a CRO.
16. To measure the phase difference between current & voltage for CR and LR of AC circuit using a CRO.
17. Magnetic field measurement by using Helmholtz coil.

Reference Books:

1. B.Sc. Practical Physics: C.L. Arora, 2005-2006, S.Chand& Co. Ltd.
2. A text book in Electrical Technology - B L Theraja, 2006, S Chand and Co.
3. Performance and design of AC machines - M G Say, 2002, ELBS Edn.
4. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
5. Logic circuit design, Shimon P. Vingron, 2012, Springer.
6. Digital Electronics, SubrataGhoshal, 2012, Cengage Learning.

7. Electronic Devices and circuits, S. Salivahanan& N. S. Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill.
8. Electronic circuits: Handbook of design and applications, U. Tietze, Ch. Schenk, 2008, Springer.
9. Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India.
10. Experimental Physics, Gyan Prakash, 2012, Studium Press (India) Pvt. Ltd.

BSc/Phy/SM/4/DSC/207–Physics Lab-IX

Credits: 2 (Practical) **Max. Marks: 50**
Teaching per week: 4 Hrs. **Duration of Exam: 3 Hrs.**

Objective: The objective of this course is to impart practical knowledge through design and performance of experiments.

Course outcomes: After successfully completing the course, student will be able to get
CO1: hands on experience with different instruments and measurements of related physical quantities.
CO2: verify some fundamental principles, effects and concepts of physics through experimentation.
CO3: basic understanding on instruments data observation, measurements, errors and analysis.

CO4: practical's training to use and learn techniques, skills and tools for professional practices.

List of Experiments:

1. To determine the frequency of an electric tuning fork by Melde's experiment.
2. To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped film.
3. To verify inverse square law of radiation using a photoelectric cell.
4. To determine wavelength of spectral lines of Hg source using plane diffraction grating.
5. To determine dispersive power and resolving power of a plane diffraction grating.
6. To find the polarization angle of laser light using polarizer and analyzer.
7. To verify Malus law of polarization.
8. Measurement of focal length of mirrors and lenses.
9. To find Brewster's angle.
10. Study Faraday law of induction.
11. To study the characteristics of a photo-voltaic cell (solar cell).
12. Study of optical fiber as a waveguide.
13. To determine the coefficient of increase of pressure of air at constant volume.
14. To find the melting point of wax using Joly's constant volume air thermometer.

Reference Books:

1. B.Sc. Practical Physics, C.L. Arora, 2005-2006, S. Chand Publisher, New Delhi
2. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
3. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
4. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
5. A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani Pub.
6. Experimental Physics, Gyan Prakash, 2012, Studium Press (India) Pvt. Ltd.

CDLU/Phy/4/DSC/208: Basics of Lasers

Credits: 4
Lectures: 60
Duration of Exam.: 3 Hrs.

Max. Marks: 100
Final Term Exam.: 70
Internal Assessment: 30

Course Objectives: The objective of the course on Lasers is to familiarize the students to the basic aspects of Laser Physics

Course Outcomes: After taking the course, students should be able to explain central concepts, laws and models in Laser physics, interpret basic experiments & can use basic law sand relations to solve related problems

Note: The question paper will consist of nine questions in all. Questionno.1 will contain five short answer type questions without any internal choice covering the entire syllabus and shall be compulsory. The remaining eight questions will be set from the four units with two questions from each unit. Candidate is required to attempt five questions in all with one compulsory question and one question from each unit.

Unit-I

Review of some basic concepts and principle of laser, Introduction to LASERS: Interaction of radiation with matter – induced absorption, spontaneous emission, stimulated emission. Einstein's co-efficient (derivation). Active material. Population inversion – concept and discussion about different techniques. Resonant cavity. Properties – coherency, intensity, directionality, monochromaticity and focussibility.

Unit-II

Properties of LASERS Gain mechanism, threshold condition for population inversion (derivation), emission broadening – line width, derivation of FWHM natural emission line width as deduced by quantum mechanics – additional broadening process: collision broadening, broadening due to dephasing collision, amorphous crystal broadening, Doppler broadening in laser and broadening in gases due to isotope shifts.

Unit-III

Types of LASERS (Solid, Liquid and Gas states): principle, construction, working and application: (i) Ruby LASER – (ii) Neodymium (Nd) LASERS. (iii) He-Ne LASER Liquid dye LASERS. semiconductor diode LASERS, homo-junction and hetero-junction LASERS.

Unit-IV

Applications: Introductory fiber optic communication, Holography: Principle, types, intensity distribution, applications. laser induced fusion. LASER spectroscopy. LASERS in industry: Drilling, cutting and welding. Lasers in medicine: Dermatology, cardiology, dentistry and ophthalmology.

References:

1. William T Silfvast, "Laser Fundamentals", Cambridge University Press, UK (2003).
2. B B Laud, "Lasers and Non linear Optics", New Age International (P) Ltd., New Delhi.
3. Andrews, "An Introduction to Laser Spectroscopy (2e)", Ane Books India (Distributors).
4. K R Nambiar, "Lasers: Principles, Types and Applications", New Age International (P) Ltd., New Delhi.
5. T Suhara, "Semiconductor Laser Fundamentals", Marcel Dekker (2004).

BSc/Phy/SM/4/MIC/202: Computational Physics: Fortan Programming

Credits: 4 | **Max. Marks: 100**
Lectures: 60 | **Final Term Exam.: 70**
Duration of Exam.: 3Hrs. | **Internal Assessment: 30**

Course Objectives: In this course, students will learn important concepts of Computational Physics.
Course Outcomes: The expected outcome is that student is familiar with different types of atomic and diatomic models andtheir spectra. Student will also be familiar with NMR and ESR techniques.

Note for the Paper Setter: *The question paper will consists of nine questions in all. The first question will be compulsory and will consist of seven short questions of2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the two units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

Unit-I

Introduction: Importance of computers in Physics, paradigm for solving physics problems for solution. Usage of linux as an Editor. Algorithms and Flowcharts: Algorithm: Definition, properties and development.

Unit-II

Flowchart: Concept of flowchart, symbols, guidelines, types. Examples: Cartesian to Spherical Polar Coordinates, Rootsof Quadratic Equation, Sum of two matrices, Sum and Product of a finite series,calculation of sin (x) as a series,

Unit –III

Scientific Programming: Some fundamental Linux Commands (Internal and External commands). Development of FORTRAN, Basic elements of FORTRAN: Character Set,Constants and their types, Variables and their types, Keywords, Variable Declaration and concept of instruction and program.

Unit-IV

Operators: Arithmetic, Relational, Logical and Assignment Operators. Expressions: Arithmetic, Relational, Logical, Character and Assignment Expressions. Fortran Statements: I/O Statements (unformatted/formatted), Executable and Non-Executable Statements, Layout of Fortran Program,

Reference Books:

- Introduction to Numerical Analysis, S.S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.
- Computer Programming in Fortran 77". V. Rajaraman (Publisher:PHI).
- LaTeX–A Document Preparation System", Leslie Lamport (Second Edition, Addison-Wesley, 1994).
- Gnuplot in action: understanding data with graphs, Philip K Janert, (Manning 2010)
- Schaum's Outline of Theory and Problems of Programming with Fortran, S Lipsdutz and A Poe, 1986Mc-Graw Hill Book Co.
- Computational Physics: An Introduction, R. C. Verma, et al. New Age International Publishers, New Delhi(1999)
- A first course in Numerical Methods, U.M. Ascher and C. Greif, 2012, PHI Learning

• Elementary Numerical Analysis, K.E. Atkinson, 3 r d Edn., 2007, Wiley India Edition.

Semester-V

BSc/Phy/SM/5/DSC/301: Mathematical Physics-II

Credits: 4 **Max. Marks: 100**
Lectures: 60 **Final Term Exam.: 70**
Duration of Exam.: 3 Hrs. **Internal Assessment: 30**

Note: The question paper will consist of nine questions in all. Question no. 1 will contain seven short answer type questions of 2 marks each without any internal choice covering the entire syllabus and shall be compulsory. The remaining eight questions will be set from the four units with two questions from each unit. Candidate is required to attempt five questions in all with one compulsory question and one question from each unit.

UNIT-I

Fourier Series: Periodic functions, Orthogonality of sine and cosine functions, Dirichlet Conditions(Statement only).Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients, Complex representation of Fourier series, Expansion of functions with arbitrary period, Expansion of non-periodic functions over an interval, Even and odd functions and their Fourier expansions Application, Summing of Infinite Series, Term-by-Term differentiation and integration of Fourier Series, Parseval Identity.

Some Special Integrals: Beta and Gamma Functions and its Relation, Expression of Integrals interms of Gamma Functions, Error Function (Probability Integral).

Dirac Delta function and its properties: Definition of Dirac delta function, Representation as limit of a Gaussian function and rectangular function, Properties of Dirac delta function.

UNIT-II

Frobenius Method and Special Functions: Singular Points of Second Order Linear Differential Equations and their importance, Frobenius method and its applications to differential equations, Legendre, Bessel, Hermite and Laguerre Differential Equations, Properties of Legendre Polynomials: Rodrigues Formula, Generating Function, Orthogonality, Simple recurrence relations, Expansion of function in a series of Legendre Polynomials.

Bessel Functions of the first Kind: Generating Function, simple recurrence relations, Zeros of Bessel Functions (Jo(x)andJ1(x))and Orthogonality.

UNIT-III

Complex Analysis : Brief Revision of Complex Numbers and their Graphical Representation. Euler's formula, DeMoivre’s theorem, Roots of Complex Numbers. Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions. Examples of analytic functions. Singular functions: poles and branch points, order of singularity, branch cuts. Integration of a function of a complex variable. Cauchy's Inequality. Cauchy’s Integral formula. Simply and multiply connected region. Laurent and Taylor’s expansion. Residues and Residue Theorem. Application in solving Definite Integrals.

UNIT-IV

Partial Differential Equations: Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical spherical symmetry. Wave equation and its solution for vibrational modes of a stretched string, rectangular and circular embranes, Diffusion Equation.

Reference Books:

1. Mathematical Methods for Physicists: Arfken, Weber,2005,Harris,Elsevier.
2. Fourier Analysis by M.R .Spiegel,2004,TataMcGraw-Hill.
3. MathematicsforPhysicists, SusanM.Lea,2004, ThomsonBrooks/Cole.

BSc/Phy/SM/5//DSC/302: Basic Quantum Mechanics

Credits: 4 **Max. Marks: 100**
Lectures: 60 **Final Term Exam.: 70**
Duration of Exam.: 3 Hrs. **Internal Assessment: 30**

Course Objectives: The course content covers foundations of quantum mechanics, Schrodinger wave equation and applications to one dimensional problems, Hydrogen Atom and time dependent and independent Schrodinger equation.

Course Outcomes: The students will be equipped with basics of quantum Mechanics, Schrodinger wave equationand its applications.

Note: The question paper will consist of nine questions in all. Question no. 1 will contain seven short answer type questions of 2 marks each without any internal choice covering the entire syllabus and shall be compulsory. The remaining eight questions will be set from the four units with two questions from each unit. Candidate is required to attempt five questions in all with one compulsory question and one question from each unit.

UNIT -I

Linear Vector Space and Matrix Mechanics: Vector spaces, Hilbert spaces, square integrable functions, Operators, Projection operator, Hermitian and Unitary operators, change of basis, Eigenvalue and Eigenvectors of operators, Infinitesimal and Finite Unitary operators, Dirac's bra and ket notation, commutators, Simultaneous eigenvectors, Parity operators, Matrix Mehanics and Wave Mechanics, Postulates of quantum mechanics, uncertainty relation. Harmonic oscillator in matrix mechanics, Time development of states and operators, Heisenberg and Schroedinger representations, Exchange operator.

UNIT-II

Schrodinger Wave Equation: wave function, Normalization, Probability current density,Expectation values, Eigen values and eigen functions, Time evolution of expectation values, stationary states, Ehrenfest Theorem, Degeneracy and orthogonality, Operator formalism and its algebra, Hermitian operators and their properties, Linearity and Superposition Principles, Matrix representation of an operator, Momentum and energy operators, Commutator, Wave Packets, Application to spread of Gaussian Wave packet, Time dependent Schrodinger equation and dynamical evolution of a quantum state, General solution in terms of linear combinations of stationary states.

UNIT -III

Problems in One- Dimension: Discrete and continuous spectrum, Symmetric Potentials and Parity, Free Particle, Potential Step, Potential Barrier and well, 1-D infinite square well potential,Simple harmonic oscillator: Energy levels and energy eigenfunctions using Frobenius method; Hermite polynomials; ground state, zero point energy, 1-d Finite potential well problem, Reflection and transmission (tunnel effect) of wavepacket from rectangular potential well.

UNIT -IV

Quantum theory of Hydrogen atom: Schrodinger equation for H-atom, Separation of variables, Quantum numbers, Electron probability density, Radiative transition, Selection rules, Angular momentum operators and their Commutation relations, Schrodinger equation in spherical symmetric potential, Stern-Gerlach experiment

Identical particles : Symmetric and antisymmetric wave functions, distinguishability of identical particles, the exclusion principle, the connection with statistical mechanics, collisions of identical particles, Spin angular momentum: connection between spin and statistics, Atomic levels of Helium atoms as an example of two electron system.

Reference Books:

1. Quantum Mechanics byJ.L. Powell and B. Crasemann
2. Quantum Mechanics by D.J Griffith, Pearson publication
3. Quantum Mechanics by A. Ghatak & Loknathan, Mackmilan India Ltd.
4. Quantum Physics by S. Gasiorowicz , Wiley

BSc/Phy/SM/5/DSC/303: Atomic and Molecular Spectroscopy

Credits: 4 **Max. Marks: 100**
Lectures: 60 **Final Term Exam.: 70**
Duration of Exam.: 3 Hrs. **Internal Assessment: 30**

Note for the Paper Setter: *The question paper will consists of nine questions in all. The first question will be compulsory and will consist of seven short questions of 2 marks covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the two units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

Unit-I

One electron system: Quantum states of an electron in an atom, Electron Probability density, Space Quantization, Electron Spin, Stern-Gerlach experiment, Spectroscopic terms and selection rules, Spin – orbit interaction energy, Quantum mechanical relativity correction, Hydrogen fine structure, Hyperfine structure, Pauli exclusion principle, Exchange symmetry of wave function.

Unit-II

Two electron system: Atomic states arising due to two electron valence system: L-S and J-J coupling for equivalent non-equivalent electrons, Helium atom and its spectra: Ortho and para modification, Interaction with external field: Zeeman effect, Paschen-Back effect, Stark effect and their important example, Characteristics X-ray Spectra: Kossel's Explanation and Moseley Law.

Unit-III

Vibration-rotational spectra of diatomic molecules: Types of molecules, Diatomic linear symmetric-top, Asymmetric-top and Spherical-top, The diatomic molecule as rigid rotator, Harmonic oscillator, Non rigid rotator, Anharmonic oscillator and vibrating rotator (energy levelsand infrared spectra), Isotopic effect on vibrational-rotational spectra, Intensity of rotation-vibration spectra, Raman spectra of diatomic molecules.

Unit-IV

Electronic spectra: Resolution of the eigen function, Electronic and total energy: Born-Oppenheimer approximation, Classification of electronic states, Vibrational structure of electronic transitions, Rotational fine structure, P, Q, R branches of a band, The Fortrat parabola, Intensity of electronic bands, Franck-Condon principle: Absorption & emission, Isotopic effect on electronic states.

Text/Reference Books:

1. H. E. White: Introduction to Atomic Spectra (McGraw-Hill Inc. US)
2. G. Herzberg : Atomic Spectra and Structure –Vol - I & II (D.Van Nostrand Company Inc. 6thed.)
3. G. Herzberg : Molecular Spectra and Structure
4. C.N. Banwell : Fundamentals of Molecular Spectroscopy (McGraw-Hill Higher ed.)
5. Raj Kumar : Atomic and Molecular Spectra: Laser (5th ed. Kedar Nath Ram Nath, Merrut, India)
6. K. P. R. Nair : Atom Molecules and Laser (Alpha Science International Ltd. USA)
7. Bransden and Joachain : Physics of Atom & Molecules (2nd ed. Prentice Hall)
8. Huber and Hertzberg : Molecular Spectra and Molecular Structure (Springer)
9. S. N. Ghoshal : Atomic Physics (S-Chand, 1sted.)
10. G. Aruldhas : Molecular Structure and Spectroscopy (PHI learning

BSc/Phy/SM/3/DSC/304: Analog Systems and Applications

Credits: 4 **Max. Marks: 100**
Lectures: 60 **Final Term Exam.: 70**
Duration of Exam.: 3 Hrs. **Internal Assessment: 30**

Note: *The question paper will consist of nine questions in all. Questionno.1 will contain seven short answer type questions without any internal choice covering the entire syllabus and shall be compulsory. The remaining eight questions will be set from the four units with two questions from each unit. Candidate is required to attempt five questions in all with one compulsory question and one question from each unit.*

UNIT-I

Ideal constant-voltage and constant-current Sources, Kirchhoff's Current Law & Kirchhoff's Voltage Law, Mesh & Node Analysis, Thevenin theorem, Norton theorem, Star Delta Transformation, Superposition theorem, Reciprocity Theorem, Maximum Power Transfer theorem, Applications to dc circuits.

UNIT-II

Concept of feedback in amplifier, Type of feedback, Small signal amplifiers, Analysis of stage amplifier by Graphical and Equivalent Circuit methods, Requirement of multistage amplifiers, Gain of multistage amplifier, Coupling of two stages, Frequency response of RC-coupled amplifiers, Distortion in amplifier, Classification of amplifiers, Power amplifier, Push-pull amplifier,

UNIT-III

Graphical Analysis of the CE Configuration, Two-port Devices and the Hybrid Model, Transistor Hybrid Model, Conversion Formulas for the Parameters of the Three Transistor Configurations, Analysis of a Transistor Amplifier Circuit Using h Parameters, The Emitter Follower, Comparison of Transistor Amplifier Configurations, Linear Analysis of a Transistor Circuit, Cascading Transistor Amplifiers, Simplified Common-emitter Hybrid

UNIT-IV

Integrated Circuits(IC): Fabrication and Characteristics: Integrated circuit Technology, Basic monolithic IC, Epitaxial Growth, Masking and Etching, Diffusion of impurities, Transistors for Monolithic circuits, Monolithic diodes, Integrated resistors, Integrated capacitors and inductors,

Reference Books:

1. Basic Electronics and Linear Circuits, N. N. Bhargava et. al., 2nd Edition, McGraw Hill Education, India
2. A text book in Electrical Technology, B.L. Theraja, S. Chand & Co.
3. Circuit and Networks,2ndEdition, A Sudhakar and Shyammohan S Palli,Tata McGraw-Hill
4. Integrated electronics by Jacob Millman, Christos Halkias, Chetan Parikh, McGraw Hill Education, India

BSc/Phy/SM/5/DSC/304 Basic Instrumentation Skills

Credits: 04 (Theory) **Max.Marks: 100**
Lectures: 60 **Final Term Exam: 70**
Duration of Exam.: 3 Hrs. **Internal Assessment :30**

Objective: The objective of this course is to impart knowledge of basic instruments.

Course outcomes: After successfully completing the course, student will be able to:

CO1: Exposure with various aspects of instruments and their usage through hands-on mode.

CO2: Experience of various Instrumentation Skills in the profession.

CO3: Basic understanding on instruments data observation, measurements, errors and analysis.

CO4: Training to use and learn techniques, skills and tools for professional practices.

Note for the Paper Setter: *The question paper will consists of nine questions in all. The first question will be compulsory and will consist of seven short questions of 2 marks each covering the whole syllabus. In addition, four more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

Unit-I

Basic of Measurement: Instruments accuracy, precision, sensitivity, resolution range etc. Multimeter: Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance. Electronic Voltmeter: Advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity.

Unit-II

Principles of voltage, measurement (block diagram only). Specifications of an electronic Voltmeter/ Multimeter and their significance. AC millivoltmeter: Type of AC millivoltmeters: Amplifier- rectifier, and rectifier- amplifier. Block diagram ac millivoltmeter, specifications and their significance

Unit-III

Cathode Ray Oscilloscope: Block diagram of basic CRO. Construction of CRT, Electron gun, electrostatic focusing and acceleration (Explanation only– no mathematical treatment), brief discussion on screen phosphor, visual persistence & chemical composition. Time base operation, synchronization. Front panel controls.

Unit-IV

Specifications of a CRO and their significance. Use of CRO for the measurement of voltage (dc and ac frequency, time period. introduction to digital oscilloscope, probes. Digital storage Oscilloscope: Block diagram and principle of working. Block diagram, explanation and specifications of function generator**.**

Reference :

1. A text book in Electrical Technology - B L Theraja - S Chand and Co.
2. Performance and design of AC machines - M G Say ELBS Edn.
3. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
4. Logic circuit design, Shimon P. Vingron, 2012, Springer.
5. Digital Electronics, SubrataGhoshal, 2012, Cengage Learning.
6. Electronic Devices and circuits, S. Salivahanan& N. S.Kumar, 3rd Ed., 2012, Tata Mc-GrawHill.
7. Electronic circuits: Handbook of design and applications, U.Tietze, Ch.Schenk, 2008,Springer .

Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India.

BSc/Phy/SM/5/MIC/301:PHYSICSLAB-X

Credits: 2 (Practical) **Max. Marks: 50**
Teaching per week: 4 Hrs. **Duration of Exam: 3 Hrs.**

List of Experiments:

1. Study frequency response of R-C Coupled Amplifier
2. Study characteristics of a Push-Pull Amplifier
3. Study a LC/RC Oscillator using transistors
4. Study of Analog Communication System.
5. Study of NPN transistor as Amplifier.
6. Study of PNP transistor as Amplifier.
7. Study of Tunnel Diode characteristics.
8. Study of h-parameter of a transistor.
9. To determine the frequency and amplitude of phase shift oscillator.
10. To draw the output waveform and determine the frequency of output waveform of Colpitt oscillator using DSO.
11. To determine the frequency and amplitude of Harley oscillator.
12. To study Class A, Class B Amplifier.

Reference Books:

1. Basic Electronics: Atext lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-GrawHill.
2. Modern Digital Electronics, R.P. Jain, 4th Edition, 2010, Tata McGraw Hill.

CDLU/Phy/5/MIC/302: PHYSICSLAB-XI

Credits: 2 (Practical) **Max. Marks: 50**
Teaching per week: 4 Hrs. **Duration of Exam: 3 Hrs.**

Experiments:

1. To determine laser beam parameters using a He- Ne/diode laser source.
2. To study the characteristics of LED and Laser diode.
3. To study characteristics of Fiber optic photo-detectors.
4. Design and evaluation of a
(a) Laser diode linear Intensity Modulation system.
(b) Laser diode digital IM system.
5. To study various characteristics of PN junction: Reverse saturation current and material constant. To determine the temperature coefficient of junction and energy band gap.
6. Determination of applied magnetic field and resonance frequency (or g-factor) of a given sample using Electron spin resonance spectrometer.
7. To determine the value of forbidden energy gap of a diode and LED.
8. To verify inverse square law of radiation using photodiode.
9. Demonstration of spatial coherence of laser beam/ wavelength of sodium or white light using diffraction grating.
10. To study the Fraunhofer diffraction pattern
(a) of a circular aperture and to measure its diameter.
(b) anddetermine the slit width.
11. To determine the refractive index of a thin glass plate using Michelson interferometer.(Virtual Lab)
12. Verification of Malus law / polarization characteristics of laser light.
13. Find out the value of Planck's constant
(a) using LED.
(b) using Photocell.
14. With the help of Abbe refractometer,
(a) determine the polarizability of the given liquid samples at a given temperature.
(b) study the variation of refractive index with
(i) temperature of the liquid sample (ii) wavelength of the light source
15. To determine the thickness of a thin glass transparent plate using Michelson interferometer.(Virtual Lab)

Text/Reference Books:

1. S.Nagabhushana & N.Sathyanarayana :Lasers and optical instrumentation (I.K. International)
2. Ajay Ghatak : Optics (Tata Mc Graw Hill)
3. C. C. Davis : Lasers and Electro-optics (Cambridge University Press)
4. S.P.Singh : Practical Physics Vol.I & II (Pragati Parkashan)
5. Gyan Prakash: Experimental Physics (Studium Press)
6. R.S. Sirohi : A Course of Experiments with He -Ne Laser (New AgeInternational)

BSc/Phy/SM/5/INT/301-Internship

Credits:100 **MM:100**

SEMESTER-VI

BSc/Phy/SM/6/DSC/305: Nuclear Physics

Credits: 4
Lectures: 60
Duration of Exam.: 3 Hrs.

Max. Marks: 100
Final Term Exam.: 70
Internal Assessment: 30

Note for the Paper Setter: *The question paper will consists of seven questions in all. The first question will be compulsory and will consist of seven short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the two units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

Unit-I

Introductory concepts and nuclear forces: Basic nuclear properties: size, shape, charge distribution, spin and parity, moments and statistics, binding energy, Fundamental forces of nature, charge independence and charge symmetry of nuclear forces, Isospin, deuteron problem: ground state of deuteron, magnetic dipole and electric quadruple moments of the deuteron.

Unit-II

Nuclear models: Weizsacher's semi-empirical mass formula, liquid drop model of the nucleous, mass parabolas: prediction of stability against β-decay for members of an isobaric family. Shell model of the nucleus: evidences that led to the shell model, assumptions of the single particle shell model, spin orbit coupling of an electron bound in an atom,

Unit-III

Nuclear decay and reactions: Disintegration energy of spontaneous α-decay, Alpha decay paradox- barrier penetration, Fermi's theory of β-decay, Selection rules for β-decay, Parity non-conservation in α β-decay, γ-ray emission- selection rules, Internal conversion, Types of nuclear reactions, Balance of mass and energy in nuclear reactions, Q-value equation and its solution.

Unit-IV

High energy physics: Classification of elementary particles, Conservation laws & symmetries: conservation of baryon and lepton numbers, concept of isospin, isospin multiplets, isospin & strangeness conservation and violation in different types of interactions, Gell–Mann–Nishijima formula, Baryons octet ($1/2^+$) and decuplet ($3/2^+$), Quark structure of hadrons and quark flavours, Introductory concept of colour quantum number and gluons, Charge conjugation (C) and parity (P) operators, C & P non-conserving property of neutrino, CPT theorem.

Reference Books:

1. Physics of AtomicNuclei, Vladimir Zelevinsky, Wiley-VCH,2017
2. The Atomic Nucleus, J.M. Reid, Penguin Books,1972
3. KennethS.Krane, Introductory Nuclear Physics, Wiley,NewYork,1988
4. R.R.Royand B.P.Nigam,NuclearPhysics,Wiley-EasternLtd.,1983
5. NuclearPhysics,S.B.Patel,NewAgepublication
6. BasicIdeasand ConceptsinNuclearPhysics:K.Heyde,(OverseasPressIndia)(2005).
7. NuclearPhysics:ExperimentalandTheoretical:H.S.Hans,(NewAcademicScienceLtd.,SecondRevisededition)(2010).

BSc/Phy/SM/6/DSC/306: Classical Mechanics

Credits: 4 **Max. Marks: 100**
Lectures: 60 **Final Term Exam.: 70**
Duration of Exam.: 3 Hrs. **Internal Assessment: 30**

Course Objective: The objective of the course is to providea basic knowledge of Kepler's laws of planetary motion, Hamiltonian dynamics and theory of small oscillations so that they can apply these methods to solve real world problems. The multi-disciplinary topic 'Chaos' will enable the students to learn the techniques to handle the problemsfrom the field of non-linear dynamics.

Course Outcomes: After completion of this course, students will be able to understand the basics of Two Body problem, Hamiltonian Dynamics, Poisson Brackets relations and small oscillations. In addition to this student will be familiarwith the basic of non-linear dynamics.

Note: The question paper will consist of nine questions in all. Question no. 1 will contain seven short answertype questions without any internal choice covering the entire syllabus and shall be compulsory. The remaining eight questions will be set from the four units with two questions from each unit. Candidate is required to attempt five questions in all with one compulsory question and one question from each unit.

UNIT –I

Two-body central force problem and Hamiltonian Dynamics: Virial theorem, Differential equationfor the orbit, stability of orbit under central force, conditions for closed orbits, The Kepler's laws of planetary motion and their deduction, Scattering in a central force field,Legendre transformations and the Hamilton equations of motion, Routh's procedure, The physical significance of the Hamiltonian, Derivation of Hamilton's equations from a variational principle, The principle of Least Action.

UNIT –II

Poisson and Lagrangian bracket: The equations of canonical transformation, Examples of canonical transformations, The integral invariants of Poincare, Poisson brackets, Special cases of Poisson brackets, Poisson theorem, Poisson bracket relations, Jacobi's identity and its derivation, Lagrange brackets and its properties, Relationship between Poisson and Lagrange brackets and its derivation, Infinitesimal contact transformation, Angular momenta and Poisson bracket Relations, Liouville's Theorem.

UNIT –III

H-J Theory and theory of small oscillations: Hamilton-Jacobi equation for Hamilton's principal function, Harmonic Oscillator problem, action and angle variables, problem of harmonic oscillator using action angle variable, Theory of small oscillations: Formulation of the problem, Eigenvalue equation and the principle axis transformation, frequencies of free vibrations and normal coordinates, free vibrations of a linear triatomic molecule.

UNIT –IV

Introductory non-linear dynamics: Classical Chaos: Linear and nonlinear systems, periodic motion, Perturbation and Kolmogorov-Arnod-moser theorem, dynamics in phase space; Phase Trajectories- Singular Points, Phase Trajectories of Linear Systems, Phase Trajectories of Nonlinear Systems, Attractors, Chaotic Trajectories and Liapunov exponents, Poincare Maps, Bifurcation.

Reference Books:

1. Classical Mechanics, 3rd ed.,2002 by H.Goldstein, C. Poole and J. Safko, Pearson Edition
2. Classical Mechanics of particles by Classical Mechanics by John R. Taylor 2005, University Science Books.
3. Chaos and Integrability in nonlinear dynamics: An introduction (1989) by Michael Tabor
4. Nonlinear dynamics: Integrability, Chaos and patterns (2003) by M. Lakshmanan and S.Rajasekar

BSc/Phy/SM/6/DSCC/307: Digital Systems and Applications

Credits: 4 **Max. Marks: 100**
Lectures: 60 **Final Term Exam.: 70**
Duration of Exam.: 3 Hrs. **Internal Assessment: 30**

Course Objective: The aim of the course is to familiarize the students with the basic ideas about digital systems and applications.
Course Outcomes: After completion of this course, students will be able to understand the various types of digital systems and their use for practical applications in different fields.

Note: *The question paper will consist of nine questions in all. Question no. 1 will contain seven short answer type questions of 2 marks each without any internal choice covering the entire syllabus and shall be compulsory. The remaining eight questions will be set from the four units with two questions from each unit. Candidate is required to attempt five questions in all with one compulsory question and one question from each unit.*

UNIT -I

Integrated Circuits (Qualitative treatment only): Active & Passive components. Discrete components. Wafer. Chip. Advantages and drawbacks of ICs. Scale of integration: SSI, MSI, LSI and VLSI (basic idea and definitions only). Classification of ICs. Examples of Linear and Digital lCs.

UNIT –II

Digital Circuits: Difference between Analog and Digital Circuits. Binary Numbers. AND, OR and NOT Logic Gates (realization using Diodes and Transistor), and logic gates application as Parity Checkers. **Boolean algebra:** Fundamental Products. Idea of Minterms and Maxterms. Conversion of a Truth table into Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map. **Data processing circuits**: Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders.

UNIT -III

Arithmetic Circuits: Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors, 4-bit binary Adder/Subtractor. **Sequential Circuits:** SR, D, and JK Flip-Flops. Clocked (Level and Edge Triggered) Flip-Flops. Preset and Clear operations. Race-around conditions in JK Flip-Flop. M/S JK Flip-Flop. **Timers**: IC 555: block diagram and applications: Astable multivibrator and Monostable multivibrator.

UNIT -IV

Shift registers: Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in-Parallel-out Shift Registers (only up to 4 bits). **Counters (4 bits):** Ring Counter. Asynchronous counters, Decade Counter. Synchronous Counter. **Shift registers:** Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in-Parallel-out Shift Registers (only up to 4 bits).
Counters(4 bits): Ring Counter. Asynchronous counters, Decade Counter. Synchronous Counter.

Reference Books:

1. Digital Principles and Applications, A.P. Malvino, D.P.Leach and Saha, 7th Ed., 2011, Tata McGraw
2. Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.
3. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
4. Digital Systems: Principles & Applications, R.J.Tocci, N.S.Widmer, 2001, PHI Learning
5. Logic circuit design, Shimon P. Vingron, 2012, Springer.
6. Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
7. Microprocessor Architecture Programming & applications with 8085, 2002, R.S. Goankar, Prentice Hall.

BSc/Phy/SM/6/DSC/308: Introduction to Materials

Credits: 4 | **Max. Marks: 100**
Lectures: 60 | **Final Term Exam.: 70**
Duration of Exam.: 3 Hrs. | **Internal Assessment: 30**

Course Objective: The aim of the course is to familiarize the students with the basic ideas about preparation properties and applications of nanomaterials, ceramic materials, polymers and composite materials.

Course Outcomes: After completion of this course, students will be able to understand the various types of materials and their applications in different fields.

Note: The question paper will consist of nine questions in all. Question no. 1 will contain seven short answer type questions without any internal choice covering the entire syllabus and shall be compulsory. The remaining eight questions will be set from the four units with two questions from each unit. Candidate is required to attempt five questions in all with one compulsory question and one question from each unit.

UNIT-I

Nanomaterials: Introduction, Bottom up and Top Down approach, Classification of nanostructures: Zero dimension, one dimension and two dimensional nanostructures, Smart materials. Nanostructure fabrication by Physical Methods: Physical Vapor deposition: evaporation, sputtering, Lithography: Photolithography, Electron Beam Lithography.

UNIT -II

Ceramic materials: Introduction, Fabrication and processing of ceramics, types and general properties of ceramic materials, glass-forming constituents, glass ceramics, Processing of glass ceramics and its advantages, perovskite structure of mixed oxides, lime, cement, cement concrete, reinforced cement concrete (RCC), chemically bonded ceramics.

UNIT -III

Polymers: Introduction, Polymer types and Polymer synthesis & processing, General Properties and Applications of Thermosetting Plastics; Elastomers-types and applications, conducting polymers and their applications.

UNIT -IV

Composite Materials: Introduction and Classification of Composites, Isotropic, Anisotropic, and Orthotropic Materials, Laminates, Advantages and Disadvantages of Composite Materials, Applications of composite materials

Reference Books:

1. Introduction to Nanotechnology – Charles P. Poole Jr. and Frank J. Owens, Wiley India Pvt.Ltd., 2007.
2. Nanomaterials – Guozhong Cao, Imperial College Press, 2004.
3. W. D. Kingery, Introduction to Ceramics, Second Edition, Wiley & Sons, New York, 1999.
4. V. R. Gowariker, N. V.Viswanathan, and JayadevSreedhar, Polymer Science, New Age International (P) Limited publishers, Bangalore, 2001

5. C. A. Harper, Handbook of Plastics Elastomers and Composites, Third Edition, McGrawHill Professional Book Group, New York, 1996.
6. Fundamentals of Polymers by Anil Kumar and Rakesh K Gupta, McGraw-Hill, 1997
7. Miller, Tara, 1998, Introduction to Composites, 4th Edition, Composites Institute, Society of the Plastics Industry, New York, NY.
8. KK Chawla. Fibrous Materials. Cambridge University Press, 1998.
9. Composite Materials An Introduction R.P.L.Nijssen

BSc/Phy/SM/6/MIC/303:Physics Lab-XII

Credits: 2 (Practical) **Max. Marks: 50**
Teaching per week: 4 Hrs. **Duration of Exam: 3 Hrs.**

List of Experiments:

1. Introduction to Digital Electronics lab- nomenclature of digital ICS, specifications, study of the data sheet, concept of V_{cc} and ground, verification of the truth tables of logic gates using TTL ICS.
2. Implementation of the given Boolean function using logic gates in both sop and pos forms.
3. Verification of state tables of RS, JK, T and D flip-flops using 3 NAND & nor gates.
4. Implementation and verification of decoder/de-multiplexer and 4 encoder using logic gates.
5. 5 Implementation of 4x1 multiplexer using logic gates.
6. Implementation of 4-bit parallel adder using 7483 IC.
7. Design and verify the 4-bit synchronous counter.
8. Design and verify the 4-bit asynchronous counter.
9. To design and verify operation of half adder and full adder.
10. To design and verify operation of half subtractor.
11. To design & verify the operation of magnitude comparator. 32-33 12 To study and verify NAND as a universal gate.

References:

1. Brian Holdsworth, Clive Woods, "Digital Logic Design", Elsevier India Pvt. Ltd., 2005.
2. Samir Palnitkar, "Verilog HDL, A Guide to Digital Design and Synthesis", Prentice Hall of India Pvt. Ltd., 2005. Modern Digital Electronics by R.P.Jain

BSc/Phy/SM/6/MIC/304: Physics Lab-XIII

Credits: 2 (Practical) **Max. Marks: 50**
Teaching per week: 4 Hrs. **Duration of Exam: 3 Hrs.**

Note: Each student should perform at-least seven experiments. The students are required to calculate the error involved in a particular experiment. Each student should follow up precautions.

List of Experiments:

1. To determine the Hall coefficient of a semiconductor sample.
2. TO Find Resistivity by Four Probe Method
3. Determine the relaxation time (EPR) for a given sample and find the value of ‘g’.
4. Determine the wavelength of the microwave output of a given reflex klystron oscillator and also to determine its repeller mode pattern.
5. Calibrate a cooper resistance thermometer and use it to measure temperature from 77 K to room temperature.
6. Calibrate a silicon resistance thermometer and use it to measure temperature from 77 K to room temperature.
7. Determine the specific heat of a given sample at room and liquid nitrogen temperature. 13. Determine the Curie temperature of a given ferroelectric material.
8. Programming and interfacing with a given microprocessor.
9. Measurement of the critical temperature of a HTc-sample.

Reference Books

1. Optical Properties of Photonic Crystals, K. Sakoda (Springer, 2001)
2. The Rietveld method, R.A.Young (IUCR-Oxford University Press, 1995)
3. Fundamentals of Crystallography, C.Giacovazzo (IUCR-Oxford University Press, 2002)
4. Characterization of nanophase materials, Zhon Ling Wang (Wiley-VCH Verlag GmbH, 2000)
5. Physical Properties of Semiconductors, C. M. Wolfe, J.R.N.Holonyak and G.E.Stillman (Prentice Hall International Inc., London, 1989).
6. Handbook on Semiconductors, Vol. 1-4., T.S. Moss, Ed., by S.P.Keller (NorthHolland, Amsterdam, 1980)

Semester-VII

BSc/Phy/SM/7/DSC/401: –Mathematical Physics

Credits: 4 Max. Marks: 100

Lectures: 60 Final Term Exam.: 70

Duration of Exam.: 3 Hrs. Internal Assessment: 30

Objective: The aim and objective of the course is to familiarize the students with the mathematical techniques necessary to approach problems in advanced physics courses. The knowledge of Special functions (Bessel, Hermite, Laguerre, Legendre), concepts of Complex analysis, Fourier analysis, Laplacetransforms, tensor analysis, Green's function, integral transform are helpful to approach problems inadvanced physics courses and research.

Course Outcomes: At the end of the course, the students will be able to:

CO1: Understand and apply the mathematical methods to solve quantitative problems in the study of physics

and engineering. Enhance their problem solving ability and critical thinking.

CO2: Demonstrate contour integrals in relevant problems in Physics.

CO3: Enable to apply integral transform to solve mathematical problems of interest in physics. Can use

Fourier transforms as an aid for analyzing experimental data.

CO4: Explain basic, preliminary concepts related to Green's function method and group of elements. Formulate and express a physical law in terms of tensors, and simplify it by use of coordinate transforms.

Note for the Paper Setter: The question paper will consists of nine questions in all. The first question will be compulsory and will consist of seven short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.

Unit-I

Introduction to gradient, divergence and curl operator and their physical significance. Matrices: Inverse Matrix, Orthogonal, Unitary and Hermitian Matrices, Independent elements of Orthogonal and Unitary Matrices, Matrix diagonalization, Eigen values & Eigen vectors. Introductory ideas of Fourier series and integrals transform, Fourier transform, Laplace transform: Ist and IInd shifting theorem and important applications of Fourier and Laplace transform.

Unit-II

Special functions, Frobenious method for series solutions, Legendre equation and its solution: generating function, recurrence relations, Orthogonality of Pn(x), Bessel equation: Bessel's functions of first kind, generating function, recurrence relations, Orthogonality of Bessel Functions, Hermite's and Laguerre's equation: generating functions, recurrence relations, Orthogonality.

Unit-III

Function of complex variables, Cauchy Riemann conditions, Cauchy integral theorem and formula, Taylor and Laurent's Series, Cauchy's residue theorem, Singular points and evaluation of residues, Jordans lemma, Evaluation of real definite integrals.

Unit-IV

Introductory group theory, Group representation by matrices: SU (2), O(3). The elements of the group of Schrodinger equation. Elementary probability theory, random variables, binomial, Poisson and normal distributions. Central limit theorem. Green's function, Tensors.

Text/Reference Books:

1. Arfken, G. B. (2012). Mathematical Methods for Physicists. Netherlands: Elsevier.

2. Boas, M. L. (2005). Mathematical Methods in the Physical Sciences.New York: Wiley.

3. Rajput, B. S. (2017). Mathematical Physics. Meerut: Pragati Prakashan.

4. Goyal, J.K. (2016). Laplace and Fourier Transforms. Meerut: Pragati Prakashan.

5. Prakash, S. (2005). Mathematical Physics. New Delhi: Sultan Chand & Sons.

BSc/Phy/SM/7//DSC/403: Fundamental of Electronics

Credits: 4 | **Max. Marks: 100**
Lectures: 60 | **Final Term Exam.: 70**
Duration of Exam.: 3 Hrs. | **Internal Assessment: 30**

Course Objectives: The objective of this course is to introduce students about important electronic devices being used in vital practical applications. It includes Field effect transistors, Operational Amplifiers, Oscillators etc. In addition the topics of various number systems and their arithmetic, basic logic gates and simplification techniques for Boolean Expressions will enable the students to enter into the fascinating world of digital electronics.

Course Outcomes: After completion of this course, students will be able to understand the basics of FETs, Op-Amp and their characteristics along with applications in various electronic devices The students will be able to design different types of oscillators. Combinational and sequential digital systems will be used to understand the applications in day-to-day life

Note: The question paper will consist of nine questions in all. Question no. 1 will contain seven short answer type questions of 2 marks each without any internal choice covering the entire syllabus and shall be compulsory. The remaining eight questions will be set from the four units with two questions from each unit. Candidate is required to attempt five questions in all with one compulsory question and one question from each unit.

Unit I

The Junction Field Effect Transistor: Basic structure & Operation, pinch off voltage, single ended geometry of JFET, volt – ampere characteristic, Transfer Characteristics. FET parameters, Biasing of the FET and setting of Q point using load line. MOSFET: Enhancement MOSFET, Threshold Voltage, Depletion MOSFET, Biasing of MOSFET, comparison of p & n channel FETs, FET small signal model, JFET low frequency common source and common drain amplifiers, FET application as Voltage Variable Resistor (VVR)

Unit II

Differential Amplifier: Circuit configuration, dual input balanced output different amplifier, D.C. & A.C. analysis, Inverting and Non-inverting inputs, CMRR, Differential Amplifier using constant current bias, current mirror, level translator. Operational Amplifier: Block diagram, ideal electrical characteristics, equivalent circuit, transfer characteristics, Open loop OP-AMP configuration: Differential, inverting & non-inverting amplifier, OP-AMP with negative feedback (a) Voltage series feedback: Effect of feedback on closed loop voltage gain, Input resistance, output resistance, band width, output offset voltage. Voltage follower; (b) Voltage shunt feedback: Effect of feedback on closed loop voltage gain, Input resistance, output resistance, band width, output offset voltage.

Unit III

OP-AMP Applications: DC and AC amplifier (with offset null circuitry and external offset voltage compensating networks), summing, scaling, averaging (Non-inverting, Inverting and differential configuration), Integrator, Differentiator, Electronic analog computation, comparator. Oscillators: principles, Types, frequency stability, Phase shift oscillator, Wein-bridge oscillator, Square wave, Triangular wave and pulse generator

Unit IV

Digital operation of system: Introduction to OR, AND & NOT gates Ex-OR gate, De Morgan's Laws, NOR & NAND DTL Logic, Binary adder, Digital Comparator, Decoder/Demultiplixer, Data selector/Multiplixer-Encoder, ROM and its applications. Flip-Flops: R-S, J-K, Master slave, T & D type flip flop, shift Register, Synchronous & Asynchronous Counter.

Text and Reference Books:

1. Ramakanth A. Gayakwad: OP-Amps & Linear integrated Circuits, Second Edition, 1991
2. J. Millman et al: Integrated Electronics, 2nd Edition
3. Integrated Electronics by Millman and Halkias (Tata McGraw Hill), 2010.
4. Digital Design : Priciples and Practices, John F. Wakerly, 4th Ed.
5. Digital Principles and Applications by Malvino and Leach (Tata McGraw Hill), 2010
6. Semiconductor Devices: Physics and Technology by S.M. Sze (John Wiley), 2007.
7. Digital Computer Electronics : Albert P. Malvino, Jerald A Brown (TataMcGraw Hill) 3rd ed. 2004.

BSc/Phy/SM/7/DSC/404: Quantum Mechanics -I

Credits: 2 **Max. Marks: 100**
Lectures: 60 **Final Term Exam.: 70**
Duration of Exam.: 3 Hrs. **Internal Assessment: 30**

Course Objectives: The primary objective of this course is to develop familiarity with the physical concepts and facility with the mathematical methods of quantum mechanics. A secondary, but still very important objective is to cultivate your skills at formulating and solving physics problems. This course will introduce Schrodinger Equations, Heisenberg Uncertainty Principle, Dirac's bra-ket formulation of quantum mechanics and make students familiar with various approximation methods applied to atomic, nuclear and solid-state physics and to scattering, which include: Time-independent perturbation theory and variational method.
Course Outcomes: After the course students should be able to understand the general concepts and principles of quantum mechanics: the Schrödinger equation, the wave function and its physical interpretation, stationary and non-stationary states, time evolution and expectation values. They can independently solve the Schrödinger equation for simple one-dimensional systems -- the ones explicitly taught, as well as similar new ones. The solution can be used to compute probabilities, expectation values, uncertainties and time evolution.

Note for the Paper Setter: *The question paper will consists of nine questions in all. The first question will be compulsory and will consist of seven short questions of 2 marks covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the two units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

Unit-I

The Schrodinger equation: Time dependent and time independent forms, Probability current density, expectation values, Ehrenfest's theorem, Gaussian wave packet and its spreading. Exact statement and proof of the uncertainty principle, Time independent equation, eigenvalues and eigenfunctions, Degeneracy and orthogonality. Applications of Schrodinger equation for 1 d Box, Tunneling problem & Linear Harmonic Oscillator.

Unit-II

Operator formalism in quantum mechanics, Hermitian operators and their properties, Vector representation of States-Bra and Ket algebra, relationship between kets and wave functions, Linear harmonic oscillator problem, coherent states, annihilation and creation operators, Matrix representation of an operator, Unitary transformation

Unit-III

The angular momentum operators and their representation in spherical polar coordinates, solution of Schrodinger equation for spherically symmetric potentials, spherical harmonics, Hydrogen atom, Angular momentum matrices and Pauli spin matrices.

Unit-IV

Time independent perturbation theory: Nondegenerate case, first and second order perturbations, Degenerate case, removal of degeneracy in second order. First order Stark effect in hydrogen, The Variational Method: expectation value of the energy, application to excited states, ground state of helium.

Text and Reference Books :

1. **L.I.Schiff** **Quantum Mechanics**
2. **B.Craseman and J.D. Powell** **Quantum Mechanics**
3. **Ghatak & Loknathan** **Quantum Mechanics**

BSc/Phy/SM/7DSC/402: Research Methodology

Credits: 4
Lectures: 60
Duration of Exam.: 3 Hrs.

Max. Marks: 100
Final Term Exam.: 70
Internal Assessment: 30

Course Objectives: This course aims to cover the fundamental principles involved in the methods of research. The focus is on the teaching undergraduate students about direct and indirect methods of accurate measurements of fundamental physical quantities.

Course Outcomes: After completion of this course, students will be familiar with the methods of research.

Note: The question paper will consist of nine questions in all. Question no. 1 will contain seven short answer type questions of 2 marks each without any internal choice covering the entire syllabus and shall be compulsory. The remaining eight questions will be set from the four units with two questions from each unit. Candidate is required to attempt five questions in all with one compulsory question and one question from each unit.

Unit-I

Introduction: Concept of research; characteristics features of research, Types of research, objectives of research, Review of Literature. Scope of research, validity and reliability of research, Process of research: steps involved in research process, selecting a research topic, Planning and designing research, Criteria of good research, Rules and principles of scientific methods, Hypothesis, Data collection, Analysis and interpretation of data, Experimental techniques.

Unit II

Errors & Curve Fitting: Errors- Round off error, Truncation error, Machine error, Random error, Propagation of errors. Loss of Significance: Significant digits, Computer caused loss of significance, avoiding loss of significance in subtraction, least square curve fitting: The principle of least square fitting, Linear regression, Polynomial regression, Fitting exponential and trigonometric functions.

Unit III

Hypothesis: Meaning of hypothesis, Importance of hypothesis, Types of hypothesis, Source of hypothesis, Characteristics of hypothesis, Use of hypothesis in research, Different form of hypothesis, Difficulties in the formation of hypothesis, Testing of hypothesis, Test of significance, Steps in testing, Student's t- distribution, Ftest, Chi-Square ( ) test.

Unit-IV

Preparation of Dissertation: writing a scientific paper, Journal impact factor, citation index, seminar, conference and workshops, Types and layout of research, Precautions in preparing the research dissertation, Bibliography and annexure, Discussion of results, Draw conclusions, Giving suggestions and recommendations to the concerned persons.

Text and Reference Books:

1. K. Prathapan
2. C.R. Kothari : Research Methodology for Scientific Research (IK International) : Research Methods, Methods & Techniques (Second Revised Edition)
3. P.B. Patil and U.P. Verma : Numerical Computational Methods (Narosa Pub. House)
4. S.S. Sastry : Introductory Methods of Numerical Analysis (PHI)
5. Santosh Gupta : Research Methodology and Statistical Techniques (Deep Publication)

BSc/Phy/SM/7/DSC/405:PHYSICS LAB-XIV

Credits: 4 (Practical) **Max. Marks: 100**
Teaching per week: 8 Hrs. **Duration of Exam: 4 Hrs.**

Objective: The objective of this course is to impart practical knowledge through design and performance of experiments.

Course outcomes: After successfully completing the course, student will be able to:
CO1: Hands on experience with different instruments and appreciate the beauty of different concepts and related experiments in Physics.
CO2: Verify some fundamental principles, effects and concepts of physics through experiments. Gaining knowledge related to CRO.
CO3: Perform experiments related to A.C. mains, D.C. voltage and current.
CO4: Learn to present observations, results and analysis in suitable and presentable form.

List of Experiments

1. Study of OP-AMP (Inverting Amplifier, Non-Inverting Amplifier, Differential amplifier, Current Controlled voltage source, Voltage Controlled Current source, CMRR)
2. To study the frequency response of low-pass, high-pass and band-pass filters and Reject Filter using OPAMP.
3. Study of OP-AMPfor mathematical operations (Adder, Subtractor, Differentiator Integrator, Logarithm amplifier).
4. Study of OP-AMP as Wave Form Generator (Square and Triangular wave generator).
5. Study of OP-AMP as Oscillators.
6. Study of V-I characteristics of JFET and MOSFET.
7. Study of transistor as multiplexer and demultiplexer.
8. Study of integrator and differentiator using passive components.
9. Study of flip flops (R-S, J-K, D, T type).
10. To generate and find the frequency of saw-tooth waves using UJT.
11. To study analog to digital and digital to analog convertor.
12. To study Multi-vibrators: mono stable, astable (free-running).
13. Study of shift registers and its applications.
14. Study of counters

Reference Books:

1. A text book in Electrical Technology - B L Theraja - S Chand and Co.

2. Performance and design of AC machines - M G Say ELBS Edn.
3. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
4. Logic circuit design, Shimon P. Vingron, 2012, Springer.
5. Digital Electronics, SubrataGhoshal, 2012, Cengage Learning.
6. Electronic Devices and circuits, S. Salivahanan& N. S.Kumar, 3rd Ed., 2012, Tata Mc-GrawHill.
7. Electronic circuits: Handbook of design and applications, U.Tietze, Ch.Schenk, 2008,Springer .
   Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India.

CDLU/Phy/7/MIC/401: PHYSICSLAB-XV

Credits: 4 (Practical) **Max. Marks: 100**
Teaching per week: 8 Hrs. **Duration of Exam: 4 Hrs.**

Experiments:
Hall Effect Experiment

a) To determine the Hall voltage developed across the sample material.

b) To calculate the Hall coefficient and the carrier concentration of the sample material.

2. Study of magneto- resistance.

3. Determination magnetic susceptibility with a Gouy Balance.

4. To determine the ionization potential of mercury.

5. To study ESR.

6. To Study the characteristics of Solar Cell.

7. To study the phenomenon of magnetic hysteresis and calculate the resistivity,

coercivity and saturation magnetization of a material using a Hysteresis loop tracer.

8. To determine band-gap of a semiconductor material.

Text/Reference Books:

1. S.Nagabhushana & N.Sathyanarayana :Lasers and optical instrumentation (I.K. International)
2. Ajay Ghatak : Optics (Tata Mc Graw Hill)
3. C. C. Davis : Lasers and Electro-optics (Cambridge University Press)
4. S.P.Singh : Practical Physics Vol.I & II (Pragati Parkashan)
5. Gyan Prakash: Experimental Physics (Studium Press)
6. R.S. Sirohi : A Course of Experiments with He -Ne Laser (New AgeInternational)

SEMESTER-VIII

BSc/Phy/SM/7/DSC/406: Electrodynamics and Plasma Physics

Credits: 4 | **Max. Marks: 100**
Lectures: 60 | **Final Term Exam.: 70**
Duration of Exam.: 3 Hrs. | **Internal Assessment: 30**

Course Objectives: The main objective of this course is to understand of theoretical fundamentals of Electrodynamics and physics of plasma i.e. electromagnetic fields the one side and the interaction of charges and currents with field on other side. This includes solutions of the free wave equations, solutions with stationary sources and solutions to the equations with time dependent charge and current distributions. This also emphasis on the study of the radiation phenomena and basic concepts of plasma.

Course Outcomes: The intention of this part of the lectures is to analyze the fundamentals of electrodynamics on the basis of Maxwell's equations. The idea is to examine solutions of Maxwell's equations under different types of conditions. Ability to analyze electromagnetic problems and to apply mathematical methods for solving.

Note: The question paper will consist of nine questions in all. Question no. 1 will contain seven short answer type questions of 2 marks each without any internal choice covering the entire syllabus and shall be compulsory. The remaining eight questions will be set from the four units with two questions from each unit. Candidate is required to attempt five questions in all with one compulsory question and one question from each unit.

Unit 1

Energy stored in an electric and magnetic field. Maxwell's equations, power flow in an electromagnetic field and pointing theorem. Electromagnetic waves in a homogeneous medium-solution for free space conditions. Uniform plane waves, the wave equations for a conducting medium, Sinusoidal time variations, Maxwell's equations using phasor notation. Wave propagation in a loss less medium, wave propagation in a conducting medium, wave propagation in a good dielectric. Lorentz Invariance in Maxwell's Equations

Unit 2

Polarization: Linear, elliptical and circular Polarization, Direction cosines.Reflection and refraction of plane waves: Reflection by a perfect conductor – normal and oblique incidence. Reflection by a perfect dielectric – normal and oblique incidence. Power loss in a plane conductor.Dispersion and Scattering; Coherent and Incoherent Scattered Light, Polarization of Scattered Light, Dispersion in Solids, Liquids and gases.

Unit 3

Wave Equation for Vector and Scalar Potential and Solution Retarded Potential and Lienard – Wicehert Potential, Electric and Magnetic fields due to a Uniformly Moving Charge and An Accelerated Charge, Bremsstrahlung, Synchrotron Radiation and Cerenkov Radiation, Reaction Force of Radiation.

Unit 4

Elementary Concepts: Plasma Oscillations, Debye Shielding, Plasma Parameters, Magnetoplasma, Plasma Confinement. Waves Guides: Rectangular, Parallel Plane & Dielectric Slab Wave guide, Concept of Cut off frequency, Lippman Fringes, TE, TM & TEM modes.

Text and Reference Books

1. Panofsky and Phillips Classical Electricity and Magnetism
2. Bittencourt Plasma Physics
3. Chen Plasma Physics
4. Jackson Classical Electrodynamics
5. Griffiths Electromagnetic Theory
6. Jordan & Balme Electromagnetic Waves
7. B.B. Laud Electromagnetic New Age Publication

BSc/Phy/SM/8/DSC/407: Condensed Matter Physics

Credits: 4 | **Max. Marks: 100**
Lectures: 60 | **Final Term Exam.: 70**
Duration of Exam.: 3 Hrs. | **Internal Assessment: 30**

Course Objective: The aim of the course is to familiarize the students with the concepts of lattice vibrations and free electron theory, Band theory, dielectric and ferroelectric properties of materials, and Superconductivity.

Course Outcomes: After completion of this course, students will be able to understand the concepts of lattice vibrations and free electron theory, Band theory, dielectric and ferroelectric properties of materials, and Superconductivity.

Note: The question paper will consist of nine questions in all. Question no. 1 will contain seven short answertype questions without any internal choice covering the entire syllabus and shall be compulsory. The remaining eight questions will be set from the four units with two questions from each unit. Candidate is required to attempt five questions in all with one compulsory question and one question from each unit.

UNIT – I

Lattice vibrations: Vibrations of crystals with monatomic basis- Dispersion relation, First Brillouin zone, Group velocity, Two atoms per primitive basis- acoustical and optical modes; Quantization of lattice vibration: Phonons, Phonon momentum, Inelastic scattering of neutrons by phonons, Phonon heat capacity, Planck distribution, Density of states in 1D and 3D, Dulong and Petit's law, Debye and Einstein theories of Density of states.

UNIT – II

Free electron theory of metals: Free electron gas models: energy levels and density of orbitals in 1D and 3D, Fermi Dirac distribution, Heat capacity of the electron gas, Experimental heat capacity of metals, Thermal effective mass, Electrical conductivity and Ohm's law, Kronig Penny model, wave equation of electron in a periodic potential, Number of orbitals in a band, Velocity and Effective mass of electron, Distinction between metals, semiconductors and insulators.

UNIT – III

Dielectric Properties of materials: Polarization, Local electric field at an atom, depolarization field, electric susceptibility, polarizability, Clausius-Mossotti relation, electronic polarizability, Structural phase transitions, ferroelectric crystals and its classification, soft optical phonons, Landau theory of phase transition, First and second order transitions, Anti-ferroelectricity, Curie-Weiss law, Ferroelectric domains, PE hysteresis, Piezoelectric effect, Pyroelectric effect.

UNIT – IV

Superconductivity: Experimental Results, Critical Temperature, Critical magnetic field, Meissner effect, Type I and type II Superconductors, London's Equation and Penetration Depth, Thermodynamically and optical properties: energy gap, heat capacity and entropy, Isotope effect,BCS theory, BCS ground state, Flux quantization, persistent current,Josephson effect, Macroscopic quantum interference, High TC superconductors.

Reference Books:

1. Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.

2. K.V. Keer, Principles of solid state physics, Wiley - Eastern, 1993.

3. Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning.

4. Solid State Physics, M.A. Wahab, 2011, Narosa Publications.

5. Introduction to Solid State Physics, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill.

BSc/Phy/SM/8/DSC/408: Electronic Devices and Fabrication of Integrated circuits and Systems

Credits: 4 **Max. Marks: 100**

Lectures: 60 **Final Term Exam.: 70**

Duration of Exam.: 3 Hrs. **Internal Assessment: 30**

Course Objective: The aim of the course is to familiarize the students with the concepts of lattice Photoelectric and other Electronic Devices, Negative Resistance Devices, Fabrication of Electronic Devices.

Course Outcomes: After completion of this course, students will be able to understand the concepts of Photoelectric and other Electronic Devices, Negative Resistance Devices, Fabrication of Electronic Devices.

Note: The question paper will consist of nine questions in all. Question no. 1 will contain seven short answer type questions without any internal choice covering the entire syllabus and shall be compulsory. The remaining eight questions will be set from the four units with two questions from each unit. Candidate is required to attempt five questions in all with one compulsory question and one question from each unit..

Unit I Photoelectric and other Electronic Devices

Zener Diode, Power Diode, Photodiode, Varactor Diode, Light Emitting Diode (LED), Solar Cell, Transistor Register, Piezo-electric Crystals, Diode Lasers, Condition for Laser Action, Optical Gain, Memory Devices: Register, Random Access Memory, Read Only Memory.

Unit II Negative Resistance Devices

Tunnel Diode, Backward Diode, Unijunction Transistor, p-n-p-n devices, p-n-p-n characteristics Thyristor, Silicon Controlled switch, SCS Characteristics, L Addition four Layer Devices. Basic Circuit Principles for NR Switching Circuits: Monostable, Bystable and Astable Operations.

Unit-III Fabrication of Electronic Devices

Thin film Deposition Techniques: Vacuum pumps and gauges - pumping speed, throughout.

Effective conductance control. Chemical vapor Deposition (CVD), MOCVD, PEMOCVD

(Plasma enhanced chemical vapor deposition).

Unit-IV Physical vapor Deposition : Thermal Evaporation, Molecular Beam Epitaxy (MBE), Sputtering and Laser Ablation. Lithography, Etching and Micro-machining of Silicon, Fabrication of integrated Circuits and Integrated Micro - Electro - Mechanical - Systems (MEMS)

Text and Reference Books :

Semiconductor Devices - Physics and Technology by S.M .Sze ,Wiley (1985)

Introduction to Semiconductor Devices by M.S. Tyagi, John Wiley & Sons

Measurement, Instrumentation and Experimental Design in Physics and Engineering
by M.Sayer and A. Mansingh, Prentice Hall, India (2000)

Optical electronics by Ajoy Ghatak and K. Thygarajan, Cambridge Univ. Press.

Semiconductor Electronics by A.K.Sharma ,New Age International Publisher(1996)

Laser and Non-linear optics by B.B.Laud. ,Wiley Eastern Limited (1985)

Pulse, Digital and Switching Waveforms by Jacob Millman and Herbert Taub ,
Mc Graw Hill Book Company (1965)

BSc/Phy/SM/8/DSC/409: Quantum Mechanics-II

Credits: 4 **Max. Marks: 100**
Lectures: 60 **Final Term Exam.: 70**
Duration of Exam.: 3 Hrs. **Internal Assessment: 30**

Course Objectives: The course on advanced quantum mechanics deals with exactly solvable problems. Perturbation theory is applied to light-matter interaction and transport problems such as scattering and tunneling, Green's function approach is introduced to understand open quantum systems. To make understand the idea of Spin and statistics. The Dirac operator formalism is developed and used for perturbation theory. The course will conclude with a discussion of the Klein-Gordon and Dirac equations, and the recent interest in Majorana Fermions.

Course Outcomes: After introducing the tools and ideas, the students gain familiarity and intuition by learning to handle the real life problems. The search for exact solutions lead to the study of genuinely many-particle excitations of the quantum field such as polarons, excitons, polaritons, and Cooper pairs. The course is made to understand What exactly is spin? Why do particles of integer spin behave one way while particles of half odd integer spin behave in another?

Note: The question paper will consist of nine questions in all. Question no. 1 will contain seven short answer type questions without any internal choice covering the entire syllabus and shall be compulsory. The remaining eight questions will be set from the four units with two questions from each unit. Candidate is required to attempt five questions in all with one compulsory question and one question from each unit.

UNIT-I

WKB Approximation: The WKB method for one-dimensional problems, Application to barrier penetration, The WKB method for three dimensional problems. Time-dependent perturbation theory: harmonic perturbation; Fermi's golden rule, adiabatic and sudden approximations.

UNIT-II

Basic concept of scattering, Scattering amplitude, differential and total scattering cross sections, scattering by spherically symmetric potentials, partial waves and phase shifts, scattering by a perfectly right sphere and by square well potential. Born approximation and its application to scattering of electrons by atom. Neumann equation and its solution, Neumann series and Bessel function.

UNIT-III

Identical particles : Symmetric and antisymmetric wave functions, distinguishability of identical particles, the exclusion principle, the connection with statistical mechanics, collisions of identical particles, Spin angular momentum : connection between spin and statistics, spin matrices and eigenfunctions. Spin functions for a many electron system. Atomic levels of Helium atoms as an example of two electron system.

UNIT-IV

Semiclassical theory of radiation: Transition probability for absorption and induced emission, Electric dipole and forbidden transitions, selection rules. Relativistic quantum mechanics : The Klein – Gordon equation, the Dirac equation, probability current density, plane wave solutions.

Text and Reference Books :

1. L.I.Schiff Quantum Mechanics , McGraw-Hill

2. B.Craseman and J.D. Powell Quantum Mechanics, Addison Wesley
3. S.Gasiorowicz Quantum Physics , Wiley

BSc/Phy/SM/8/DSC/410:Physics Lab-XVI

Credits: 4 (Practical) **Max. Marks: 100**
Teaching per week: 8 Hrs. **Duration of Exam: 4 Hrs.**

List of Experiments:

1. Study of P-E hysteresis loop for ferroelectric ceramic.
2. Determination of Rydberg constant.
3. To determine the Coupling Coefficient of a Piezoelectric crystal.
4. Thermo-luminescence studies.
5. High temperature superconductivity experiment.
6. Study of Zeeman Effect.
7. Linear and mass attenuation coefficients for the 662 keV gamma for Al, Cu and Pbmaterials
8. Linear and mass attenuation coefficients for the beta particles of Sr90 source for Al, Cu and Pb materials
9. Study of Energy Resolution of scintillation Detector as a function of $E\gamma$
10. Measurement of alpha spectra of alpha radioactive sample using a semiconductor detector and vacuum chamber
11. Study of detection efficiency of scintillation Detector as a function of $E\gamma$ using different Sources

References:

3. Characterization of nanophase materials, Zhon Ling Wang (Wiley-VCH Verlag GmbH, 2000)
4. Physical Properties of Semiconductors, C. M. Wolfe, J.R.N.Holonyak and G.E.Stillman (Prentice Hall International Inc., London, 1989).
5. Handbook on Semiconductors, Vol. 1-4., T.S. Moss, Ed., by S.P.Keller (NorthHolland, Amsterdam, 1980)

BSc/Phy/SM/8/MIC/402: Physics Lab-XVII

Credits: 4 (Practical) **Max. Marks: 100**
Teaching per week: 8 Hrs. **Duration of Exam: 4 Hrs.**

Note: Each student should perform at-least seven experiments. The students are required to calculate the error involved in a particular experiment. Each student should follow up precautions.

List of Experiments:

1. To determine wavelength and angular divergence of LASER beam.
2. Demonstration of Temporal coherence and measurement of wavelength of laser light using Michelson interferometer.
3. Measurement of refractive index using Brewester angle.
4. Febry-Parrot interferometer.
5. Study of spectrum of iodine vapour and deduce force constant for the iodine molecule .
6. To study modulation and demodulation (Amplitude and frequency).
7. To study and perform Pulse Amplitude Modulation and Demodulation.
8. To study and perform Pulse Width Modulation and Demodulation.
9. To study and perform Pulse Position Modulation and Demodulation.

Reference Books

7. Optical Properties of Photonic Crystals, K. Sakoda (Springer, 2001)
8. The Rietveld method, R.A.Young (IUCR-Oxford University Press, 1995)
9. Fundamentals of Crystallography, C.Giacovazzo (IUCR-Oxford University Press, 2002)