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/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/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/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: Classical Electrodynamics

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

Objective: This course aims to introduce the student to topics in Electrostatics, magnetostatics and Electromagnetic Theory, The course reviews and builds on the students' knowledge of conductors, dielectrics, magnetic fields and Maxwell's equations and includes a study of wave propagation in variousmedia.

Course Outcomes:

CO1: A student having taken this course will have fair knowledge of conductors and dielectrics and will beable to solve the potential and electric field problems.

CO2: It will help the students to build analogy between electrostatics and magnetostatics.

CO3: Students will have fair knowledge of conservation laws and gauges used in electrodynamics.

CO4: A sound knowledge of electromagnetic waves in various bound and unbound media will help the students to solve the difficult problems of electrodynamics

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

Electrostatics in Vacuum: Coulomb's Law, Gauss's Law, Scalar potential, conductors and their properties. Electric field inside a cavity carved in a conductor. Laplace and Poisson's equations. Electrostatic potentials,

Multipole Expansion: Multipole expansion of the scalar potential of a charge distribution. Dipole moment,quadrupole moment. Electrostatics of Dielectrics: Dielectrics, Induced dipoles, atomic polarizability, Polarization, Boundcharges, Clasusius-Mossetti relations, Energy of charges in dielectic media. Boundary value Problems:Uniquencess theorm, Method of images with examples. Boundary conditions for electric field.

Unit-II

Magnetostatics: currents and equation of continuity, Biot-Savart's law, Ampere's law, Differentialequations of magnetostatics, Vector potential, Magnetostatic energy. Ohm's law. Boundary conditions formagnetic field at the interface.Time Varying Fields and Maxwell Equations: Faraday's law of induction, Displacement current, Maxwell equations, Energy and energy density of the electromagnetic field.

Unit-III

Electrodynamics: Scalar and vector potentials, Gauge transformations, Lorentz and Coulomb gauges,

Conservation of energy, Poynting's theorem, Conservation of momentum. EM waves in various unboundedmedia: Wave equation, plane waves in free space and isotropic dielectrics, polarization, energy transmitted by a plane wave, Waves in conducting media, skin depth, EM waves in rarefied plasma and their propagation in ionosphere.

Unit-IV

EM Waves in Various Bounded Media-Applications: Reflection and refraction of EM waves at plane dielectrics interface, Fresnel's amplitude relations. Reflection and transmission coefficients. Polarization byreflection. Brewster's angle, Total internal reflection, Wave guide: Derivation of field equations between parallel plates and propagation parameters, TE and TM waves, Rectangular wave guides and cavity resonators. Radiation from Localized Time Varying Sources: Solutions of the inhomogeneous waveequation in the absence of boundaries. Fields and radiation of a localized oscillating source. Electric dipole and electric quadrupole fields, centre fed linear antenna.

Text and Reference Books

1. Text/Reference Books:
2. 1. Puri, S. P. (2011). Classical Electrodynamics. India: Alpha Science International Ltd.
3. 2. Griffiths, D. J. (2008). Introduction to Electrodynamics. New Delhi: Prentice Hall India.
4. 3. Jackson, J. D. (1998). Classical Electrodynamics. New Delhi: Wiley Eastern.
5. 4. Laud, B. B. (2011). Electromagnetics. New Delhi: New Age International Publisher.
6. 5. Guru, B. S. & Hiziroglu, H. R. (2004). Electromagnetic Field Theory Fundamentals. Cambridge:
7. Cambridge University Press.
8. 6. Kakani, S. L. & Hemrajani, C. (2011). Electromagnetics. New Delhi: CBS Publishers.
9. 7. Schwartz, M. (1987). Principles of Electrodynamics. New York: Dover Publications.
10. 8. Panofsky & Phillips. (1962). Classical electricity and magnetism. New Delhi: Addison-Wesley
11. publishing.
12. 9. Marion, J. B. & Heald, M. A. (1965). Classical Electromagnetic Radiation. San Diego: Academic
13. Press.

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:

1. Characterization of nanophase materials, Zhon Ling Wang (Wiley-VCH Verlag GmbH, 2000)
2. Physical Properties of Semiconductors, C. M. Wolfe, J.R.N.Holonyak and G.E.Stillman (Prentice Hall International Inc., London, 1989).
3. 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

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)

BSc/H/Phy/8/RP/401-Research Project

Credits :12 **MM:300**