The Program Specific Outcomes of the Two Year (Four semester) M.Sc. Physics Program:

Learning Outcomes

PSO1 The students would be able to realize various applications with a proper understanding of linear vector space and matrices, differential equations, special functions, series expansion and integral transforms. The students are enabled to understand the motion of a mechanical system using Lagrange and Hamilton formalisms, concept of central force motion and moving co-ordinate systems and theory of small oscillations.

PSO2 The students would be able to understand the concepts of Quantum mechanics and capable to solve problems such as hydrogen atom, determination of the energies and wave functions of first and second order. The students would be able to explain the ground state of hydrogen and helium molecules and analyse various transitions and their selection rules.

PSO3 The students would be able to explain basic physics and application of different types of electronic devices,design of switching circuits andanalysis of effect of doping in semiconductor materials, carrier concentration and mobility.Further, they will be able to implement Boolean expressions, design basic building blocks of ICs for different operations and develop building blocks for ICs using MOSFET. The students will be able to understand the fabrication process of solar cells, photodiodes, PMT's etc. and realize operational amplifier and related applications such as comparator, A/D & D/A convertor, oscillators etc.

PSO4 The students would be able to apply ensemble theory to complex problems, analyze the peculiar gas behaviour and explore the applications ofIsing Model and different approximations.Further, they would gain the knowledge about electrostatic and magnetic fields produced by static and moving charges in a variety of simple configurations and basics of theory of transmission lines and waveguides.

PSO5 The students will be able to differentiate between different lattice types, explain motion of electron in periodic lattice, understand lattice vibrations in solids and explain various types of magnetic phenomena and possible applications.In addition,they would be able to understand working and application of absorption and emission spectroscopy, DSC and Impedance spectroscopy for material characterization.

PSO6 The students will be able to explain Raman effect and different types of Raman spectra, Electronic spectra and electronic bands using Born Oppenheimer approximation and Frank Condon principle and origin of x-rays and different types of x-rays along with emission and absorption spectra. The students would be able to appreciate NMR, ESR and Mossbauer spectroscopy and related applications in the field of spectroscopy/material science/ lasers.

PSO7 Understanding the nature of a specific numerical problem, designing programs in FORTRAN language, new necessary basic knowledge of various software like Origin and MATLAB to acquire a vision for use of computer in research prospective.

PSO8 The students would be able to realize the nature of nuclear force and nuclear reactions with the understanding of the structure of the nucleusand different nuclear decays.They would gain basic knowledge about Elementary Particles, radioactivity, uses of radio-isotopes,radiation quantities and units along withinteraction of radiation with matter.

M.Sc. Physics (Two year Course)
Choice Based Credit System
Scheme of Examination
Session 2022-23

M.Sc. 1st Semester

Paper No.	Code	Nomenclature	Contact hours (L+T+P)	Credit	Max. Marks
Paper - I	22PHY21C1	Mathematical Physics	3+1+0=04	04	80+20
Paper – II	22PHY21C2	Classical Mechanics	3+1+0=04	04	80+20
Paper - III	22PHY21C3	Quantum Mechanics –I	3+1+0=04	04	80+20
Paper - IV	22PHY21C4	Physics of Electronic Devices	3+1+0=04	04	80+20
Paper – V	22PHY21CL1	Practical: General Physics -I	0+0+8=8	04	100
Paper - VI	22PHY21CL2	Practical: Electronics - I	0+0+8=8	04	100

Note:

- All papers in M.Sc. 1st semester are mandatory.
- Total Credits = 24 [Core (C) = 24]

M.Sc. Physics (Two year Course)
Choice Based Credit System
Scheme of Examination
Session 2022-23

M.Sc. 2nd Semester

Paper No.	Code	Nomenclature	Contact hours (L+T+P)	Credit	Max. Marks
Paper – VII	22PHY22C1	Statistical Mechanics	3+1+0=04	04	80+20
Paper – VIII	22PHY22C2	Quantum Mechanics -II	3+1+0=04	04	80+20
Paper – IX	22PHY22C3	Atomic & Molecular Physics	3+1+0=04	04	80+20
Paper – X	22PHY22C4	Solid State Physics	3+1+0=04	04	80+20
Paper – XI	22PHY22CL1	Practical: General Physics - II	0+0+8=8	04	100
Paper – XII	22PHY22CL2	Practical: Electronics - II	0+0+8=8	04	100
Paper – XIII	22PHY22O1	Open Elective - I	3+0+0=03	03	
Paper – XIV		Foundation Elective	2+0+0=02	02	

Note:

- Core Courses are mandatory for M.Sc. 2nd Semester students.
- Paper XIII will be chosen by M.Sc. Physics Students from the basket of Open Elective papers provided by the University.
- Paper XIV will be chosen by M.Sc. Physics Students from the pool of Foundation Electives provided by the University.
- Total Credits = 29
  [Core (C) = 24; Open Elective (O) = 03; Foundation elective (F)= 02]

M.Sc. Physics (Two year Course)
Choice Based Credit System
Scheme of Examination
Session 2023-24

M.Sc. 3rd Semester

Paper No.	Code	Nomenclature	Contact hours (L+T+P)	Credit	Max. Marks
Paper - XV	23PHY23C1	Nuclear & Particle Physics	3+1+0=04	04	80+20
Paper - XVI	23PHY23C2	Electrodynamics and Wave Propagation	3+1+0=04	04	80+20
Paper - XVII	23PHY23DA1	Condensed Matter Physics – I Or	3+1+0=04	04	80+20
Paper – XVIII	23PHY23DA2	Electronics - I Or	3+1+0=04	04	80+20
Paper - XIX	23PHY23DA3	Advanced Spectroscopy - I	3+1+0=04	04	80+20
Paper – XX	23PHY23DB1	Computational Physics –I Or	3+1+0=04	04	80+20
Paper – XXI	23PHY23DB2	Radiation Physics – I Or	3+1+0=04	04	80+20
Paper – XXII	23PHY23DB3	Experimental Techniques - I	3+1+0=04	04	80+20
Paper – XXIII	23PHY23CL1	Practical: General Physics–III	0+0+8=8	04	100
Paper – XXIV	23PHY23CL2	Practical: General Physics - IV	0+0+8=8	04	100
Paper – XXV	23PHY23CL3	Dissertation	0+0+16=16	08	200
Paper - XXVI	23PHY23O1	Open Elective Part - II	3+0+0=03	03	

Note:

- Dissertation (23PHY23CL3) will be opted by the students in lieu of Practicals: General Physics – (III and IV) (23PHY23CL1 & 23PHY23CL2)

- Paper XXVI will be chosen by M.Sc. Physics Students from the pool of Open Electives provided by the University.
- Total Credits = 27 [Core (C) =16; Discipline Specific Elective (D)=08; Open Elective (O) =03]

M.Sc. Physics (Two year Course)
Choice Based Credit System
Scheme of Examination
Session 2023-24

M.Sc. 4th Semester

Paper No.	Code	Nomenclature	Contact hours (L+T+P)	Credit	Max. Marks
Paper – XXVII	23PHY24C1	Physics of Laser and Laser Applications	3+1+0=04	04	80+20
Paper – XXVIII	23PHY24C2	Physics of Nano-materials	3+1+0=04	04	80+20
Paper - XXIX	23PHY24DA1	Condensed Matter Physics – II	3+1+0=04	04	80+20
		Or			
Paper – XXX	23PHY24DA2	Electronics - II	3+1+0=04	04	80+20
		Or			
Paper - XXXI	23PHY24DA3	Advanced Spectroscopy - II	3+1+0=04	04	80+20
Paper – XXXII	23PHY24DB1	Computational Physics – II	3+1+0=04	04	80+20
		Or			
Paper – XXXIII	23PHY24DB2	Radiation Physics – II	3+1+0=04	04	80+20
		Or			
Paper – XXXIV	23PHY24DB3	Experimental Techniques - II	3+1+0=04	04	80+20
Paper – XXXV	23PHY24DAL1	Practical : Condensed Matter Physics	0+0+8=08	04	100
		Or			
Paper – XXXVI	23PHY24DAL2	Electronics	0+0+8=08	04	100
		Or			
Paper XXXVII	23PHY24DAL3	Advanced Spectroscopy – I	0+0+8=08	04	100
Paper – XXXVIII	23PHY24DBL1	Practical: Computational Physics	0+0+8=08	04	100
		Or			
Paper – XXXVIX	23PHY24DBL2	Radiation Physics	0+0+8=08	04	100
		Or			
Paper –XL	23PHY24DBL3	Experimental Techniques	0+0+8=08	04	100

Note:

- Total Credits = 24
  [Core (C) = 08; Discipline Specific Elective (D) = 16]

Note:

- Certain Courses may have pre-requisites. Students should keep this in mind while opting for courses.
- Allotment of Discipline Specific Elective / Open Elective Courses /Dissertation will be based on the choicesindicated by the student, performance of the student in the earlier semester(s) andavailability of seats/faculty.
- Each theory paper will include 20% marks as internal assessment as per University rules.
- Break up of internal assessment marks:

Assessment Exam.	:	10 marks
Attendance	:	5 marks
Assignment/term paper & presentation	:	5 marks
Total	:	20 marks

- The distribution of percentage marks in practical papers will be as follows:

Experiment	60%
Viva	20%
Seminar	10%
Laboratory Report	10%
Total	100%

M.Sc. Dissertation Rules

Distribution/allotment of students to be done at the Department level. Dissertation work will be based on a small piece of research work or completion of experimental techniques or compilation of thematic research studies. The structure of the Dissertation could be any one of the given options:

Sr.No	Structure of Dissertation
1.	Acknowledgement
2.	Certificate of supervisor
3.	Introduction
4.	Review of Literature
5.	Materials & Methods /
6.	Results and Discussion
7.	Summary
8.	References

Last date of dissertation submission, fee, plagiarism policy, etc. will be as per university guidelines. Evaluation of Project work will be performed jointly by an external examiner (From the panel approved by PGBOS) and an internal examiner (Supervisor/Guide). The final marks will be the average of the marks given by the Internal and External examiners. The bifurcation of marks will be

Dissertation	80	Marks
Presentation	60	Marks
Viva-voce	60	Marks
Total	200	Marks

Three hard bound copies and one soft bound copy of the dissertation will be prepared (one copy forthe departmental record, one copy for the guide/supervisor, one copy forthe student and a soft bound copy for the library. Any patent /IPR based on experimental work will be in the name of student/s and guide/supervisor as an inventor. A publication based on dissertation work should be with the consent of guide only.

M.Sc. Physics Semester I Paper I
Mathematical Physics 22PHY21C1

Theory Marks: 80
Internal Assessment Marks: 20
Time: 3 Hours

COURSE OUTCOMES

CO1 The students would get sufficient exposure /understanding of the linear vector space and applications of matrices to physical problems
CO2 The students would be able to solve problems based on differential equations
CO3 The analysis of special functions would equip a student for effective tackling of specific problems.
CO4 The students would be able to realize various applications with proper understanding of series expansion and integral transforms

Unit I

Vector spaces, Norm of a Vector, Linear independence & dependence, Basis and dimension, Isomorphism of Vector spaces, Scalar/Inner product of vectors, Orthonormal basis, Gram-Schmidt Orthogonalization process, Linear operators, Matrices, Cayley-Hamiltion Theorem, Inverse of matrix, Orthogonal, Unitary and Hermitian matrices, Eigenvalues and eigenvectors of matrices, Similarity transformation, Matrix diagonalization, Simultaneousdiagonalization and commutativity

Unit II

Second order linear differential equation with variable coefficients, Ordinary point, Singular point, Series solution around an ordinary point, Series solution around a regular singular point; the method of Frobenius, Wronskian and getting a second solution, Solution of Legendre's equation, Solution of Bessel's equation, Solutions of Laguarre and Hermite's equations

Unit III

Special functions, Generating functions for Bessel function of integral order $J_n(x)$, Recurrence relations, Integral representation; Legendre polynomials $P_n(x)$, Generating functions for $P_n(x)$, Recurrence relations, orthogonality, Rodrigue's Relation; Hermite Polynomials; Generating functions, Rodrigue's relation &orthogonality for Hermite polynomials; Laguerre polynomials; Generating function and Recurrence relations, Orthogonality, Rodrigue's Relation, The Gamma Function, The Dirac – Delta Function

Unit IV

Integral transform, Laplace transform, Properties of Laplace transforms such as first and second shifting property, Laplace Transform of Periodic Functions, Laplace transform of derivatives, Laplace Transform of integrals, Inverse Laplace Transform by partial fractions method, Fourier series, Evaluation of coefficients of Fourier series Cosine and Sine series, Applications of Fourier Series, Fourier Transforms, Fourier sine Transforms, Fourier cosine Transforms, Fourier transform of derivatives, Applications of Fourier Transforms

Note: The syllabus is divided into four units. Nine questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit. A student has to attempt five questions in all.

Text and Reference Books:

[1] Mathematical Physics by P.K. Chattopadhyay (T)

[2] Mathematical Physics by B. S. Rajput
[3] Matrices and Tensors for Physicists, by A. W Joshi
[4] Mathematical Physics by Mathews and Walkers
[5] Mathematics for Physicists by Mary L Boas

<u>M.Sc. Physics Semester I Paper II</u>
ClassicalMechanics22PHY21C2

Theory Marks: 80
Internal Assessment Marks: 20
Time: 3 Hours

<u>COURSE OUTCOMES</u>

CO1 Student would be able to describe and understand the motion of a mechanical system using Lagrange and Hamilton formalisms.
CO2 Students would become able to understand the concepts of central force motion and moving co-ordinate systems.
CO3 Student would get basic ideas about the theory of small oscillations and use of Poisson's bracket which will lead to understand the concepts of quantum mechanics.

<u>Unit I</u>

Survey of Elementary Principles and Lagrangian Formulation: Newtonian mechanics of one and many particle systems, Conservation laws, Constraints and their classification, Generalized coordinates and momenta, Principle of virtual work, D' Alembert's principle and Lagrange's equation, Velocity dependent potentials and dissipation function, Simple applications of Lagrangian formulation, Cyclic coordinates, Symmetries of space and time and conservation laws, Invariance of Lagrangian under Galilean transformation

<u>Unit II</u>

Moving coordinate systems and Motion in a central force field: Rotating frames, inertial forces, terrestrial applications of Coriolis force, Two body problem: Reduction to equivalent one body problem, Central force definition and characteristics, the equation of motion and first integrals, differential equation for the orbit, general analysis of orbits, condition for closure and stability of circular orbits, Kepler's laws and equations, Rutherford scattering.

<u>Unit III</u>

Legendre Transformation and Hamilton's equations of motion, Some techniques of calculus of variation, Variational principle, Hamilton's principle from D'Alembert's principle, Lagrange's equation from Hamilton's principle, Hamilton's equations from variational principle, variation and end points, Principle of least action and its forms, Hamilton-Jacobi equation and their solutions, Use of Hamilton-Jacobi method for the solution of Harmonic oscillator problem, Hamilton's principle function, Hamilton's characteristic function and their properties

<u>Unit IV</u>

Canonical transformations, Generating functions, Properties of Poisson bracket, Equation of motion in Poisson bracket, Angular momentum and Poisson bracket relations, Jacobi identity, Invariance of Poisson brackets using canonical transformations, Potential Energy and equilibrium: Stable, unstable and neutral equilibrium, One-dimensional Oscillator, Two coupled oscillators: Solution of differential equation to find normal coordinates and normal modes, Theory of small oscillations, Examples of coupled oscillators: Two coupled pendulum, double pendulum, Free vibrations of a linear triatomic molecule.

Note: The syllabus is divided into four units. Nine questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit. A student has to attempt five questions in all.

Text and Reference Books:

[1] Classical Mechanics by N C Rana and P S Joag (Tata Mcgraw Hill, 1991)
[2] Classical Mechanics by H Goldstein (Addison Wesley, 1980)
[3] Mechanics by A. Sommerfeld (Academic Press, 1952)
[4] Introduction to Dynamics by I Perceivaland D Richards (Cambridge Univ. Press, 1982)

M.Sc Physics Semester I Paper III
Quantum Mechanics –I22PHY21C3

Theory Marks:80
Internal Assessment Marks:20
Time: 3 Hours

COURSE OUTCOMES

CO1 Student would be able to understand the concepts of operators in Quantum mechanics.
CO2 Students would be able to apply Pauli spin matrices to explain angular momentum.
CO3 Students would be capable to solve problems such as hydrogen atom.
CO4 Students can determine energies and wave functions of first and second order.

Unit I

General formalism of Quantum Mechanics: States and operators; Representation of States and dynamical variables; Linear vector space; Bra Ket notation, Linear operators; Orthonormal set of vectors, Completeness relation; Hermitian operators, their eigenvalues and eigenvectors, The fundamental commutation relation; Commutation rule and the uncertainty relation; Simultaneous eigenstates of commuting operators; The unitary transformation; Dirac delta function; Relation between kets and wave functions; Matrix representation of operators; Solution of linear harmonic oscillator problem by operator methods

Unit II

Angular momentum operator: Angular momentum operators and their representation in spherical polar co-ordinates; Eigenvalues and eigenvectors of L^2, spherical harmonics; Commutation relations among L_x L_y L_z ; Rotational symmetry and conservation of angular momentum; Eigenvalues of J^2 and J_z and their matrix representation; Pauli spin matrices; Addition of angular momentum

Unit III

Solution of Schrodinger equation for three dimensional problems: The three-dimensional harmonic oscillator in both cartesian and spherical polar coordinates, eigenvalues,eigenfunctions and the degeneracy of the states; Solution of the hydrogen atom problem, the eigenvalues, eigenfunctions and the degeneracy

Unit IV

Perturbation Theory : Time independent perturbation theory; Non degenerate case, the energies and wave functions in first order the energy in second order; Anharmonic perturbations of the form λx^3 and λx^4 ; Degenerate perturbation theory; Stark effect of the first excited state of hydrogen.

Note: The syllabus is divided into four units. Nine questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit. A student has to attempt five questions in all.

Text and Reference Books:

[1] Quantum Mechanics by Ghatak and Loknathan
[2] Quantum Mechanics by Powell and Craseman
[3] Quantum Mechanics by S. Gasiorowicz
[4] Quantum Mechanics by A.P.Messiah
[5] Modern Quantum Mechanics by J.J.Sakurai
[6] Quantum Mechanics by L.I.Schiff
[7] Quantum Mechanics by Mathews and Venkatesan

M.Sc. Physics Semester-I Paper-IV

Physics of Electronic Devices 22PHY21C4

Theory Marks: 80
Internal Assessment Marks: 20
Time: 3 Hours

COURSE OUTCOMES

CO1 Students would get familiarity semiconductor materials and charge transport in semiconductors

CO2 Students would be able to appreciate the functioning and applications of various optoelectronic and memory devices.

CO3 Students would be able to explain the basic physics and application of different transistor types.

CO4 Students having familiarization with negative resistance devices and will be in a position to design switching circuits involving these device.

Unit I

Charge carriers in semiconductors: Energy bands, metals, Semiconductors and insulators, Direct and indirect band gap semiconductors, Variation of energy bands with alloy composition, Electrons and holes, effective mass, Intrinsic and extrinsic semiconductors, Concept of Fermi level, Electron and hole concentration at equilibrium, Temperature dependence of carrier concentrations, Compensation and space charge neutrality, Conductivity and mobility, Effect of temperature and doping on mobility, Hall effect, Invariance of Fermi level

Unit-II

Carrier transport in semiconductors: Optical absorption and luminescence, Carrier lifetime and photoconductivity, Direct/indirect recombination of electrons and holes, Traps and defects, Steady state carrier generation, Quasi Fermi levels, Diffusion and drift of carriers, Diffusion and recombination, Diffusion length, Haynes Shockley experiment, Gradient in quasi Fermi level, External and internal photoelectric effect

Unit-III

Diode physics and optoelectronic devices: P-N junction diode: Basic structure, Energy band diagram, Built-in potential, Electric field, Space charge width and qualitative description of current flow, Derivation of diode current equation, Zener diode: breakdown mechanisms, Voltage regulator circuit, Power diode, Varactor diode, Optoelectronic devices: Vacuum photodiode, Photo-multipliers tube, P-N junction photodiode, Pin photodiode, Avalanche photodiode, Phototransistor, Solar cell, Light emitting diode (LED), Diode laser: Condition for laser action and optical gain

Unit-IV

Transistors: Bipolar junction transistor (BJT),Transistor operating modes, Transistor action, Transistor biasing configurations and characteristics, Field effect transistors: Junction field effect transistor (JFET), Metal oxide semiconductor field effect transistor (MOSFET), Negative resistance devices: Tunnel diode, Backward diode, Uni-junction transistor, p-n-p-n devices and their characteristics, Silicon controlled rectifier and switch and their characteristics.

Note: The syllabus is divided into four units. Nine questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit. A student has to attempt five questions in all.

Text & Reference Books:

[1] Semiconductor Devices - Physics and Technology by S.M. Sze (Wiley).
[2] Solid State Electronic Devices by Ben G. Streetman (PHI).
[3] Semiconductor Physics and Devices by Donald A Neamen (Tata-McGraw Hill).
[4] Integrated Electronics by J. Millman and C.C. Halkias (Tata-McGraw Hill).
[5] Semiconductor Devices by Kanaan Kano (PHI).
[6] Semiconductor Optoelectronic Devices by Pallab Bhattacharya (Pearson)
[7] Semiconductor Device Fundamentals by Robert F Pierret (Addison-Wesley).
[8] Electronic Devices and Circuit Theory by Robert L. Boylestad (Pearson).

M.Sc. Physics Semester I Paper V
Practical:General Physics 22PHY21CL1

Max Marks: 100
Time: 3 Hrs.

COURSE OUTCOMES

CO1 Students would be able to determine the values of Stefan’s constant, Boltzmann constant and e/m ratio of electron and experimental errors in each case.
CO2 Students would be able to understand magnetization and related aspects in a ferromagnetic material.
CO3 Students get familiarized with advanced spectroscopy.
CO4 Students would be able to understand the different harmonics and their amplitudes in a Fourier series experimentally which provide direct connect between theory and experiment.

[1] To determine the dielectric constant of polar and non-polar liquids
[2] To determine the Magnetic susceptibility of a solid sample.
[3] To study B-H curve of a given ferrite sample and find energy loss in case of ferrite Core.
[4] Stefan’s constant by the black copper radiation plates (Electrical Method).
[5] To determine the heat capacity of solids
[6] To verify the existence of different harmonics and measure their relative amplitudes using Fourier Analysis kit
[7] To study of dielectric constant as a function of temperature and determine the Curie temperature

[8] To determine the dielectric constant of different solid samples
[9] Study of lead tin phase diagram
[10] To determine Boltzmann Constant (k) using I-V characteristics of Si/Ge P-N junction diode
[11] Dissociation Energy of I_2 molecule
[12] Measurement of minority carrier life time using Haynes Shockley experiment

Note: Out of the list as above, a student has to perform atleast 08 (eight) practical's in the semester

M.Sc. Physics Semester I Paper VI
Practical: Electronics 22PHY21CL2

Max. Marks: 100
Time:3 Hrs.

COURSE OUTCOMES

CO1 The students would get hands on experience on experiments and relation to theory
CO2 Theoretical results for different networks matched with experiments would enable students for complex circuits
CO3 The students would get equipped for applications based on solid state devices
CO4 The students would be able to differentiate between analog and digital electronics

[1] Design/study of a Regulated Power Supply.
[2] Design of a Common Emitter Transistor Amplifier.
[3] Transistor Biasing and Stability.
[4] To study the frequency response of a single state negative feedback amplification for various feedback circuit. Negative Feedback (voltage series/shunt and current series/shunt)
[5] To study rectifier and filter circuits and draw wave shapes.
[6] Study of Network theorems.
[7] To study the frequency variation in RC phase shift, Colpitts and Hartley Oscillators.
[8] Frequency response of RC coupled Amplifier.
[9] To study the characteristics of a junction transition and determination of FET parameters.
[10] FET and MOSFET characterization and application as an amplifier.
[11] Uni-junction Transistor and its application.
[12] Bridge Rectifier using SCR with DC and AC Gate

Note: Out of the list as above, a student has to perform atleast 08 (eight) practical's in the semester

M.Sc. Physics Semester II Paper VII
Statistical Mechanics22PHY22C1

Theory Marks: 80
Internal Assessment Marks: 20
Time: 3 Hours

COURSE OUTCOMES

CO1 The students are able to appreciate cellular nature of phase space and interface of Statistical Mechanics with Thermodynamics

CO2 Knowledge of ensemble theory would result in greater insight into solutions of various complex problems

CO3 The students would be able to analyse the peculiar gas behavior and are in a position to extend the treatment to complex problems

CO4 The students would be equipped to explore the applications of Ising Model and to understand different approximations.

Unit I

Phase space, Ensembles, Liouville theorem, conservation of extension, Equation of motion, Equal a priori probability, Statistical equilibrium, Microcanonical ensemble, Quantization of phase space, classical limit, symmetry of wave functions effect of symmetry on counting, Various distributions using micro canonical ensemble Entropy of an ideal gas, Equilibrium Conditions, Quasi – Static Process, Entropy of an ideal gas using Microcanonical Ensemble, Gibbs paradox, Sackur-Tetrode equation,Probability distribution and entropy of a two level system.

Unit-II

Entropy of a system in contact with a reservoir, Canonical ensemble, Ideal gas in a canonical ensemble, Equipartition of energy, Third law of thermodynamics, Photons, Grand canonical ensemble, Ideal gas in Grand Canonical ensemble, Comparison of various ensembles, Quantum distribution using other ensembles.

Unit III

Transition from classical statistical mechanics to quantum statistical mechanics, Indistinguishability and quantum statistics, identical particles and symmetry requirements, Bose Einstein statistics, Fermi Dirac statistics, Maxwell Boltzmann statistics. Bose Einstein Condensation, Thermal properties of B.E. gas, liquid Helium, Energy and pressure of F-D gas, Electrons in metals, Thermionic Emission, Saha Theory of Thermal Ionization

Unit IV

Cluster expansion for a classical gas, Virial equation of state, Van der Waals gas, Phase transition of second kind, Ising Model, Bragg Williams Approximation, Ising Model in one and two dimensions, fluctuations in ensembles, Energy fluctuation in quantum statistics, Concentration fluctuation in quantum statistics, One dimensional random walk, Brownian motion.

Note: The syllabus is divided into four units. Nine questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit. A student has to attempt five questions in all.

Text and Reference Books:

[1] Statistical Mechanics by K. Huang
[2] Statistical Mechanics by B.K. Aggarwal and M.Eisner
[3] Statistical Mechanics by R.K. Patharia
[4] Statistical Mechanics by DonaladA McQuarrie
[5] Statistical Mechanics by AvijitLahiri
[6] Statistical Mechanics R Kubo

M.Sc.Physics Semester II Paper VIII
Quantum Mechanics –II 22PHY22C2

Theory Marks: 80

Internal Assessment Marks: 20
Time: 3 Hours

COURSE OUTCOMES

CO1 Students would be able to explain ground state of hydrogen and helium molecules.
CO2 Students get enabled to analyze various transitions and their selection rules.
CO3 Students would be capable to understand 3D collisions.
CO4 Students would be capable to calculate spin states of identical particles.

Unit I

Variational methods: Ground state of Helium by both variational and perturbation methods; The hydrogen molecule; WKB approximation; Time dependent perturbation theory; Constant perturbation; Harmonic perturbation; Fermi's golden rule; Adiabatic and sudden approximation.

Unit II

Semi-classical theory of radiation: Transition probability for absorption and induced emission; Electric dipole transition and selection rules; Magnetic dipole transitions; Forbidden transitions; Higher order transitions; Einstein's coefficients.

Unit III

Collision in 3D and scattering: Laboratory and C.M. reference frames; scattering amplitude; Differential scattering cross section and total scattering cross section; The optical theorem; Scattering by spherically symmetric potentials; Partial waves and phase shifts; Scattering by a perfectly rigid sphere and by square well potential; Complex potential and absorption; The Born approximation.

Unit IV

Identical particles: The principle of indistinguishability; Symmetric andantisymmetric wave functions; Spin and statistics of identical particles; The Slater determinant; The Pauli exclusion principle; Spin states of a two-electron system; States of the helium atom; Collision of identical particles.

Note: The syllabus is divided into four units. Nine questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit. A student has to attempt five questions in all.

Text and Reference Books:

[1] Quantum Mechanics by Ghatak and Loknathan
[2] Quantum Mechanics by Powell and Crassman
[3] Quantum Mechanics by S.Gasiorowicz
[4] Quantum Mechanics by A.P.Messiah
[5] Modern Quantum Mechanics by J.J. Sakurai
[6] Quantum Mechanics by L.I..Schiff
[7] Quantum Mechanics by Mathews and Venkatensan.

M.Sc. Physics Semester II Paper IX
Atomic and Molecular Physics 22PHY22C3

Theory Marks:80
Internal Assessment Marks:20
Time: 3 Hours

COURSE OUTCOMES

The student will be expected to be able to explain:

CO1 Atomic spectra of one and two electron atoms.
CO2 The change in behavior of atoms in external applied electric and magnetic field.
CO3 Diatomic molecules and their rotational vibrational and rotational vibrational spectra.
CO4 Energy levels and spectrum in diatomic molecules

Unit I

One Electron systems and Pauli principle: Quantum states of one electron atoms, atomic orbitals, Hydrogen spectrum, Pauli principle, spectra of alkali elements, spin orbit interaction and fine structure in alkali spectra, Spectra of two electron systems, equivalent and non-equivalent electrons

Unit II

The influence of external fields, Two electron system Hyperfine structure and Line broadening:Normal and anomalous Zeeman effect, Paschen Back effect, Stark effect, Two electron systems, interaction energy in LS and JJ coupling, Hyperfine structure (magnetic and electric, only qualitative)

Unit III

Diatomic molecules and their rotational spectra:Types of molecules, Diatomic linear symmetric top, asymmetric top and spherical top molecules, Rotational spectra of diatomic molecules as a rigid rotator, energy levels and spectra of non-rigid rotor, intensity of rotational lines

Unit IV

Vibrational and Rotational Vibration spectra of Diatomic molecules:Vibrational energy of diatomic molecule, Diatomic molecules as a simple harmonic oscillator, Energy levels and spectrum, Morse potential energy curve, Molecules as vibrating rotator, vibration spectrum of diatomic molecules, PQR Branches

Note: The syllabus is divided into four units. Nine questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit. A student has to attempt five questions in all.

Text and Reference Books:

[1] Introduction to Atomic and Molecular Spectroscopy by V.K.Jain
[2] Introduction to Atomic spectra by H.E. White
[3] Fundamentals of molecular spectroscopy by C.B. Banwell
[4] Spectroscopy Vol I and II by Walker and Straughen
[5] Introduction to Molecular spectroscopy by G. M. Barrow
[6] Spectra of diatomic molecules by Herzberg
[7] Molecular spectroscopy by Jeanne. L. McHale
[8] Molecular spectroscopy by J.M. Brown
[9] Spectra of atoms and molecules by P. F. Bemath
[10] Modern spectroscopy by J.M. Holias

M.Sc. Physics SemesterII Paper X

Solid State Physics 22PHY22D1

Theory Marks: 80

Internal Assessment Marks: 20
Time: 3 Hours

COURSE OUTCOMES

The student will be expected to be able to:

CO1 Differentiate between different lattice types and explain the concept of reciprocal lattice and crystal diffraction using X-rays

CO2 Explain motion of electron in periodic lattice of solids under different binding conditions, concept of energy band and effect of same on electrical properties.

CO3 Lattice vibrations in solids and identity different types of defects in crystals

CO4 Explain various types of magnetic phenomena, superconductivity, Physics behind them and their possible applications.

Unit I

Crystalline solids, Lattice, The basis, Lattice translation vectors, Direct lattice, Two and three dimensional Bravais lattice, Conventional units cells of FCC, BCC, NaCl, CsCl, Diamond and cubic ZnS, Primitive lattice cell of FCC, BCC and HCP, Packing fraction: Simple Cubic, BCC, FCC, HCP and diamond structures, Interaction of x-rays with matter, Absorption of x-rays, elastic scattering from a perfect lattice, The reciprocal lattice and its application to diffraction techniques, Ewald's construction, The Laue, Powder and rotating crystal methods, Atomic form factor, Crystal structure factor and intensity of diffraction maxima, Crystal structure factors of BCC, FCC, monatomic diamond lattice, polyatomic CuZn.

Unit II

Vibration of one-dimensional mono and diatomic chains, Phonon momentum, Density of normal modes in one and three dimensions, Quantization of lattice vibrations, Measurement of phonon dispersion using inelastic neutron scattering, Point defects, Line defects and planer (stacking) faults, Fundamental ideas of the role of dislocation in plastic deformation and crystal growth, Observation of imperfection in crystals, X-rays and electron microscopic techniques.

Unit III

Electron in periodic lattice, Block theorem,Kronig-Penny model and band theory, Classification of solids, Effective mass, Weak-binding method and its application to linear lattice, Tight-binding method and its application to Simple cubic, BCC and FCC crystals, Concepts of holes, Fermi surface: Construction of Fermi surface in two-dimension, de Hass van Alfen effect, Cyclotron resonance, Magneto-resistance.

Unit IV

Weiss Theory of Ferromagnetism Heisenberg model and molecular field theory of ferromagnetism of spin waves and magnons, Curie-Weiss law for susceptibility. Ferriand Anti Ferro-magnetic order, Domains and Block wall energy, Occurrence of superconductivity, Meissner effect, Type-I and Type-II superconductors, Heat capacity, Energy gap, Isotope effect, London equation, Coherence length, Postulates of BCS theory of superconductivity, BCS ground state, Persistent current. High temperature oxide super conductors (introduction and discovery).

Note: The syllabus is divided into four units. Nine questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit. A student has to attempt five questions in all.

Text and Reference Books:

[1] Verma and Srivastava: Crystallography for Solid State Physics
[2] Azaroff: Introduction to Solids
[3] Omar: Elementary Solid State Physics
[4] Ashcroft&Mermin : Solid State Physics
[5] Kittel: Solid State Physics
[6] Chaikin and Lubensky: Principles of Condensed Matter Physics
[7] H. M. Rosenberg: The solid State.

M.Sc. Physics Semester II Paper XII
Practical: GeneralPhysics 22PHY22CL1

Max Marks: 100
Time: 4 Hrs.

COURSE OUTCOMES

CO1 Students would be able to determine the values of Stefan's constant, Boltzmann constant and e/m ratio of electron and experimental errors in each case.
CO2 Students would be able to understand magnetization and related aspects in a ferromagnetic material.
CO3 Students get familiarized with advanced spectroscopy.
CO4 Students would be able to understand the different harmonics and their amplitudes in a Fourier series experimentally which provide direct connect between theory and experiment.

[1] Determination of ionization potential of mercury
[2] Determination of e/m of electron by helical method
[3] To study of dielectric constant as a function of temperature and determine the Curie temperature
[4] To determine Planck's Constant (h) by measuring the voltage drop across light-emitting diodes (LEDs) of different colors
[5] To determine the value of energy levels using Frank-Hertz experiment
[6] Characteristics of Phototransistor
[7] Measurement of band gap energy for Ge crystal by measuring reverse saturation current of Ge diode as a function of temperature
[8] To calibrate a prism spectrometer with mercury lamp and hence to find the Cauchy's constants
[9] To determine refractive indices of liquids, transparent and translucent solutions and solids using Abbe-refractometer
[10] To study the velocity of sound and its variation with temperature using Ultrasonic interferometer.
[11] To study the characteristics (illumination, I-V, Power-load, Areal and Spectral characteristics) of a Solar cell
[12] To Measure the resistivity of Ge crystal using four probe method at different temperatures and hence find the band gap

M.Sc. Physics Semester II Paper XIII
Practical -Electronics 22PHY22CL2

Max Marks: 100
Time: 4 Hrs.

COURSE OUTCOMES

CO1 Students will be able to have functional knowledge about BJT's and FET's
CO2 Development of ability to design and analyze electronic circuits using discrete components
CO3 Students will be able to practically verify the frequency response of feedback amplifier single and multistage amplifiers
CO4 Measurement of various analog circuits and comparison of experimental results with theoretical analysis enables the student for problem solving.

[1] Digital I : Basic Logic Gates, NAND and NOR and Flip flops
[2] Astable, Monostable and BistableMultivibrater.
[3] Characteristics and applications of Silicon Controller Rectifier.
[4] Study of Emitter follower/Darlington Pair Amplifier model-C024
[5] To study the characteristics and frequency response of a push- pull amplifier
[6] To study the characteristics and frequency response of a Chopper Amplifier
[7] Wein Bridge and Phase shift oscillator.
[8] To study analog voltage comparator circuit
[9] To study the frequency response of a two stages
   a) Transformer coupled amplifier
   b) Choke coupled amplifier.
[10] Integrating & Differentiating Circuits
[11] Working of Half & Full Adders
[12] Working of Half & Full Subtractors

Note: Out of the list as above, a student has to perform atleast 08 (eight) practicals in the semester

M.Sc. Physics Semester III Paper XVI
Nuclear and Particle Physics 23PHY23C1

Theory Marks: 80
Internal Assessment Marks: 20
Time: 3 Hours

COURSE OUTCOMES

CO1 Students would be able to realize the nature of nuclear force and nuclear reactions.
CO2 Students would be able to understand the structure of the nucleus and would be able to find out the spin, parity, magnetic moments etc. of different nuclei.
CO3 Students would be able to understand different nuclear decays.
CO4 Students would gain basic knowledge about Elementary Particles and their interactions.

Unit-I

Two nucleon problem: Common potentials used for calculation of nuclear forces viz. Wigner, Majorana, Bartlett and Heisenberg potentials, The ground state of deuteron, Square well solution for the deuteron, Qualitative features of Nucleon – nucleon scattering, Effective range theory in n – p scattering and Significance of sign of scattering length; Meson theory of nuclear force (Qualitative discussion);Types of nuclear reactions: compound and direct nuclear reactions, Reaction cross – section, Reaction cross-section in terms of partial wave treatment, Balance of mass and energy in nuclear reactions, Q equation and its solution.

Unit-II

Liquid drop model: Similarities between liquid drop and nucleus, Semi-empirical mass formula, Mass Parabolas (Prediction of stability against β-decay for members of an Isobaric family), Stability limits against spontaneous fission, Merits and limitations of Liquid drop model; Shell model: Experiment evidences for shell effect, Magic numbers, Main assumptions of the single particle shell model, Spin-orbit coupling in single particle shell model, Estimation of spin, parities and magnetic moments of nuclei by single particle shell model.

Unit-III

Nuclear Decays: Alpha (α) decay, α- disintegration energy, Range of α-particles, Range – energy relationship for α-particles and Geiger – Nuttall law; Beta decay, Pauli's neutrino hypothesis, Fermi theory of beta decay, Curie plot, selection rules for beta decay, Fermi and Gamow-Teller Transitions, Detection and properties of neutrino; Gamma decay, Multipole transitions in nuclei, Angular momentum and parity selection rules; Internal conversion, Nuclear isomerism.

Unit-IV

Elementary Particle Physics: Classifications of elementary particles: fermions and bosons, particles and antiparticles; Fundamental interactions in nature; Type of interaction between elementary particles: Symmetry and conservation laws; Classification of hadrons: Strangeness, Hypercharge, Gelleman - Nishijima formula, Elementary ideas of CP and CPT invariance; Quark model, Baryon Octet, Meson Octet, Baryon Decuplet, Gell-Mann-Okubo formula for octet and decuplet, the necessity of introducing the colour quantum number, SU (2) and SU (3) multiples (qualitative only).

Note: The syllabus is divided into four units. Nine questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit. A student has to attempt five questions in all.

Text and Reference Books:

[1] Nuclear Physics Theory and Experiment by R.R. Roy and B.P. Nigam (New Age International (P) Limited, Publishers)
[2] Nuclear Physics- An introduction by S B Patel (New Age International (P) Limited, Publishers)
[3] Concepts of Modern Physics by Arthur Beiser, S Mahajan, and S Rai Choudhury (Mc Graw Hill Education)
[4] Introductory Nuclear Physics by Kenneth S. Krane (Wiley, New York)
[5] Introductory Nuclear Physics by Y.R. Waghmare (Oxford – IBH, Bombay)
[6] Nuclear Physics, 2nd addition by Kapaln (Narosa, Madras)
[7] Introduction to Nuclear Physics by F.A. Enge (Addison-Wesley)
[8] Nucleon Interaction by G.E. Brown and A.D. Jackson (North-Holland, Amsterdam)
[9] Nuclear and Particle Physics by S L Kakani and Shubhra Kakani (Viva Books)
[10] Introduction to High Energy Physics by P.H. Perkins (Addison-Wesley, London, 1982)
[11] Introduction to Elementary Particles by D. Griffiths (Harper and Row, New York, 1987)

M.Sc. Physics Semester III Paper XVII
Electrodynamics and Wave propagation 23PHY23C2

Theory Marks:80
Internal Assessment Marks:20
Time: 3 Hours .

COURSE OUTCOMES

CO1 Student would be able to formulate and solve electrodynamic problems in relativistic covariant form in four dimensional space.

CO2 Student would gain the knowledge about electrostatic and magnetic fields produced by static and moving charges in a variety of simple configurations.

CO3 Would be able to analyze the basics of theory of transmission lines and waveguides.

Unit I

Review of four-vector and Lorentz transformation in four dimensional space; Conservation of charge and four current density; Electromagnetic field tensor in four dimensions and Maxwell's equations; Lorentz invariants of electromagnetic fields; Dual field tensor; Transformation of electric and magnetic field vectors; Covariance of force equation.

Unit II

Radiating systems: Field and radiation of a localized source; Oscillating electric dipole; Centre fed linear antenna; Lienard-Wiechertpotential ; Electric and magnetic fields due to a uniformly moving charge and accelerated charge; Linear and circular acceleration and angular distribution of power radiated.

Unit III

Radiative reaction force; Scattering and absorption of radiation; Thompson scattering and Rayleigh scattering; Normal and anomalous dispersion; Ionoshere; Propagation of electromagnetic wave through ionosphere; Reflection of electromagnetic waves by ionosphere; Motion of charged particles in uniform **E** and **B** fields; Time varying fields.

Unit IV

Fields at the surface of and within a conductor; Wave guides; Modes in a rectangular wave guide; Attenuation in wave guides; Dielectric wave guides; Circuit representation of parallel plate transmission lines; Transmission line equations and their solutions; Characteristic impedance and propagation coefficient; Low loss radio frequency and UHF transmission lines.

Note: The syllabus is divided into four units. Nine questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit. A student has to attempt five questions in all.

Text and Reference Books

[1] Classical Electrodynamics by J.D. Jackson
[2] Introduction to Electrodynamics by D.J. Griffiths
[3] Electromagnetic by B.B. Laud
[4] Classical Electricity and Magnetism by Panofsky and Phillips
[5] Fundamentals of Electromagnetics by M.A. WazedMiah

M.Sc. Physics Semester - III Paper XVIII

Condensed Matter Physics –I 23PHY23DA1

Theory Marks:80
Internal Assessment Marks:20
Time: 3 Hours

COURSE OUTCOMES

CO1 The students would be able to understand the bonding in metals, ionic and covalent crystals and also their thermal expansion and thermal conductivity.
CO2 Proper understanding of various theoretical concepts of optical properties of solids.
CO3 The students would understand different phenomena, and theoretical analysis of superconducting materials along with their applications in SQUIDs magnetometer.
CO4 The students would be able to understand dielectric and ferroelectric properties of solids

Unit-I

Difficulties of the classical theory, Free electron model, The Fermi Dirac distribution, Electronic specific heats, Para-magnetism of free electrons, Thermionic and field enhanced emission from metals, Change of work function, The contact potential between two metals, Photo-electric effect, Electrical conductivity of metals: features, Drift velocity and relaxation time, Boltzmann transport equation, Somerfield theory of electrical conductivity, Electron phonon collisions, Electrical conductivity at low temperature, Thermal conductivity of metals and insulators.

Unit-II

Static dielectric constant, Electronic and ionic polarizabilities, Orientational polarization, Static Dielectric constant of gases and solids, Dielectric constant and polarizability, Clausius-Mossottirelation,Complex dielectric constant and loses, Dielectric relaxation, Classical theory of electronic polarization, Debye equations, Cole-cole plots and equivalent circuits, Ferroelectrics: Ferroelectric materials, Dipole theory of ferroelectrics, Ionic displacement in $BaTiO_3$ above curie temperature, Ferroelectric domains

Unit-III

The optical constants: Index of refraction, Damping constant(k), Characteristic penetration depth (w), Absorbance (a), Reflectivity (r), Transmittance (t) Hagen–rubens relation, Atomistic theory of the optical properties: Free electrons with & without damping, Reflectivity, Bound electrons, Discussion of the Lorentz equations, Contributions of free electrons and harmonic oscillators to the optical constants, Quantum mechanical treatment of the optical properties: Absorption of light by inter-band and intra-band transitions, Optical spectra of materials, Dispersion, Brief idea of spectroscopic ellipsometry.

Unit-IV

Ferromagnetism: Classical theory of ferromagnetism, Curie Weis law, Quantum theory ferromagnetism, Exchange energy, origin of domains and domain wall, Magnons: Dispersion relations, Thermal excitation and heat capacity, anti-ferromagnetism: Neel two sub lattice model, anti-ferromagnetic ordering, Ferri-magnetism: spin arrangement and two sub lattice model, Soft and hard magnetic materials and their uses, Colossal and Giant magneto-resistance.

Note: The syllabus is divided into four units. Nine questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit. A student has to attempt five questions in all.

Text & Reference Books

[1] Solid State Physics by A. J. Dekker (Macmillan)
[2] Introduction to Condensed Matter Physics By K.C. Barua (Narosa)
[3] Principle of Electronic Materials and Devices by S. O. Kasap(Tata McGraw Hill)

[4] Electronic Properties of Materials by Rolf E. Hummel (Springer)
[5] Solid State Physics by Ashcroft &Mermin (Cengage Learning).
[6] Introduction to Solid State Physics by Charles Kittel (Wiley).

M.Sc. Physics Semester -III Paper- XIX
Electronics – I 23PHY23DA2

Theory Marks:80
Internal Assessment Marks:20
Time: 3 Hours

COURSE OUTCOMES

After successful completion of the course, the students will be able to

CO1 understand about the transistor amplifiers and it low frequency response.
CO2 understand the feedback process in amplifiers and generation of signal through oscillator.
CO3 realize the performance of operational amplifier for various mathematical operationssuch as addition, subtraction, differentiation, integration etc.
CO4 understand circuit analysis and implementation of operational amplifier for various applications like comparator, A/D & D/A convertor, oscillators etc.

Unit I

Bipolar junction Transistor (BJT): Transistor action, Transistor biasing techniques and characteristics, Amplifying action, AC/DC load line, Transistor models and parameters, Equivalent circuits, Two-Port devices and Hybrid model, Transistor Hybrid model, Transistor h-parameters, Conversion for h-parameter for three Transistor Configurations, Analysis of a Transistor Amplifier Circuit for CE, CB, CC, Comparison of Transistor Amplifier Configurations, Linear Analysis of a Transistor Circuit, Miller's Theorem and its Dual, Cascading Transistor Amplifiers, classification of amplifiers, frequency response, RC coupled amplifier and its frequency response

Unit II

Feedback-positive and negative feedback, Effect of negative feedback on gain, Non-linear distortion, input resistance, Frequency response, Voltage series and shunt feedback, Current series feedback. Transistor Power amplifiers: Class A, Class B, Class A push pull and Class B push pull amplifier

Principle of oscillations, condition for sustained oscillation, RF Oscillators using BJT, Hartley, Colpitts, Crystal Oscillator (Principle of working and frequency oscillation); AF Oscillators using BJT: Wein Bridge, Phase shift Oscillators. Multivibrator (Astable, Bistable, Monostable)

Unit III

Differential amplifier, CMRR, circuit configuration, emitter coupled supplied with constant current, transfer characteristics, block diagram of Op. Amp. Off-set currents and voltages, PSRR, Slew rate, universal balancing techniques, Inverting and non-inverting amplifier, basic applications- summing, scaling, current to voltage and voltage to current signal conversion, differential dc amplifier, voltage follower, bridge amplifier, AC-coupled amplifier. Integration, differentiation, analog computation, Butterworth active filters circuits,

Unit IV

Comparators, AC/DC converters: Half wave & full wave rectifier, clamping circuits, Logarithmic amplifier, antilogarithmic amplifier, sample and hold circuits Digital to analog conversion –ladder and weighted resistor types, analog to digital conversion- counter type, regenerative comparator (Schmitt trigger), Oscillators using op-amp,: Feedback, Square wave generator, pulse generator, triangle wave generator. Sinusoidal oscillators: Phase shift, Colpitts, Hartley and Wein Bridge oscillator

Note: The syllabus is divided into four units. Nine questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit. A student has to attempt five questions in all.

Text and Reference books:

[1] Integrated Electronics by J. Millman and C.C.Halkias(Tata-McGraw Hill)
[2] Fundamental of Electronics by J.D.Ryder (Prentice Hall Publication).
[3] Electronics communication Systems by George Kennedy and Bernard George (McGraw Hill).
[4] Linear Integrated Circuits by D.RoyChoudhury and Shail Jain (Wiley Eastern Ltd)
[5] Solid State Electronic Devices by Ben G. Streetman ((Prentice Hall of India)
[6] Electronic Devices and Circuit Theory by Robert L. Boylestad (Pearson).
[7] Electronic Devices and Circuits, by David A. Bell (Oxford)

M.Sc Physics Semester- III Paper XXII
Advanced Spectroscopy – I 23PHY23DB3

Theory Marks: 80
Internal Assessment: 20
Time: 3 Hrs.

COURSE OUTCOMES

After successful completion of the course, the students will be able to

CO1 understand about the Raman effect and Raman spectra of diatomic molecules
CO2 understand the electronic spectra and various electronic transitions in a molecule
CO3 under about the infrared and Raman spectra of different molecules
CO4 understand the generation of X-rays and its spectrum.

Unit 1

Raman effect - quantum theory - molecular polarizability pure rotational Raman spectra of diatomic molecules - vibration rotation Raman Spectrum of diatomic molecules. Intensity alternation in Raman spectra of diatomic molecules.

Unit II

Electronic spectra of diatomic molecules, Born Oppenheimer approximation - vibrational coarse structure of electronic bands -progression and sequences, intensity of electronic bands - Frank Condon principle. Dissociation and pre- dissociation energy

Unit III

Rotational fine structure of electronic bands. Experimental set up for Raman spectroscopy - application of IR and Raman spectroscopy in the structure determination of simple molecules.

Unit IV

The origin of X-Rays, X-Ray emission spectra, Dependence of position of Emission lines on the atomic number, X-Ray emission (Doublet) spectra, Satellites, Continuous X-ray Emission, X-Ray Absorption spectra.

Note: The syllabus is divided into four units. Nine questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit. A student has to attempt five questions in all.

Text and Reference Books :

[1] Introduction to Atomic and Molecular Spectroscopy by V.K.Jain
[2] Introduction to Atomic spectra by H.E. White
[3] Fundamentals of molecular spectroscopy by C.B. Banwell
[4] Spectroscopy Vol I and II by Walker and Straughen
[5] Introduction to Molecular spectroscopy by G. M. Barrow
[6] Spectra of diatomic molecules by Herzberg
[7] Molecular spectroscopy by Jeanne . L. McHale
[8] Molecular spectroscopy by J.M. Brown
[9] Spectra of atoms and molecules by P. F. Bemath
[10] Modern spectroscopy by J.M. Holias

M.Sc Physics Semester - III Paper XX
Computational Physics – I 23PHY23DB1

Theory Marks:80
Internal Assessment Marks:20
Time: 3 Hours

COURSE OUTCOMES

CO1 Students would acquire a vision for use of computer inresearch prospective.

CO2 Students would be able to recognize the nature of a specific numerical problem and would develop the acumen for choosing an appropriate numerical technique to find its solution.

CO3 Students would be able to design Fortran programs to solve numerical computationally.

Unit I

Numerical Integration: Newton-cotes formulae: Trapezoidal rule, Simpson's 1/3 rule, error estimates in Trapezoidal rule and Simpson 1/3 rule using Richardson deferred limit approach; Gauss-Legendre quadrature method; Monte Carlo (mean sampling) method for single, double and triple integrals. Numerical Differentiation: Taylor Series method; Generalized numerical differentiation: truncation errors. Roots of Linear, Non-linear Algebraic and Transcendental equations: Newton-Raphson method; convergence of solutions. Curve Fitting: Principle of least square; Linear regression; Polynomial regression; Exponential and Geometric regression.

Unit II

Interpolation: Finite differences; Interpolation with equally spaced points; Gregory - Newton's Interpolation formula for forward and backward interpolation; Interpolation with unequally spaced points:Lagrangian interpolation, Solution of Simultaneous Linear Equations: Gaussian elimination method, Pivoting; Gauss- Jordan elimination method; Matrix inversion. Eigen values and Eigen vectors: Jacobi's method for symmetric matrix.

Unit III

Numerical Solution of First Order Differential Equations: First order Taylor Series method; Euler's method; Runge-Kutta methods; Predictor corrector method; Elementary ideas of solutions of partial differential equations, Numerical Solutions of Second Order Differential Equation: Initial and boundary value problems: shooting methods

UNIT IV

Computer basics and operating system: Elementary information about digital computer principles; basic ideas of operating system, DOS and its use (using various commands of DOS); Compilers; interpreters; Directory structure; File operators.

Introduction to FORTRAN 77:Data types: Integer and Floating point arithmetic; Fortran variables; Real and Integer variables; Input and Output statements; Formats; Expressions; Built in functions; Executable and non-executable statements; Control statements; Go To statement; Arithmetic IF and logical IF statements; Flow charts; Truncation errors, Round off errors; Propagation of errors, Block IF statement; Do statement; Character DATA management; Arrays and subscripted variables; Subprograms: Function and SUBROUTINE; Double precision; Complex numbers; Common statement; New features of FORTRAN 90.

Note: The syllabus is divided into four units. Nine questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit. A student has to attempt five questions in all.

Text and Reference Books

[1] Sastry : Introductory methods of Numerical Analysis.
[2] Rajaraman: Numerical Analysis.
[3] Ram Kumar : Programming with FORTRAN 77
[4] Press, Teukolsky, Vellering and Flannery : numerical Recipes in FORTRAN.
[5] Desai: FORTRAN programming and Numerical methods.
[6] Dorn and McCracken : Numerical Methods with FORTRAN IV case studies.
[7] Mathew : Numerical methods for Mathematics, Science and Engineering.
[8] Jain, Iyngar and Jain: Numerical methods for Scientific and Engineering Computation"
[9] Gould and Tobochnik : An Introduction to Computer Simulation methods part I and Part II.
[10] McCalla : Introduction to Numerical methods and Fortran programming.
[11] Verma, Ahluwalia and Sharma : Computation Physics : An Introduction.

M.Sc Physics Semester- III Paper XXI

Radiation Physics– I 23PHY23DB2

Theory Marks: 80
Internal Assessment: 20
Time: 3 Hrs.

COURSE OUTCOMES

After taking the course, students should be able to solve problems related to radiations and can explain

CO1 radioactivity and uses of radio-isotopes.
CO2 radiation quantities and units.
CO3 interaction of radiation with matter and neutrons.

Unit I

The Nucleus and Radioactivity: Atomic structure, Nuclear mass, Binding energy, binding energy curve and its interpretation, Isotopes, Isotones, Isobars, Nuclear size, Radioactivity, Modes of radioactive disintegration, Nature and properties of radioactive radiations, Radioactive decay, Half life time, Radioactive growth and decay, Radioactive equilibrium, Radioactive series, Radioactive branching, Radioactive dating, Artificial radioactivity, and Uses of radio-isotopes

Unit II

Other Sources of Radiations: X-rays: Characteristic X-rays, Bremsstrahlung (continuous) X-rays, X ray targets, and Clinical X ray beams; Cosmic rays: Discovery, Nature of a cosmic rays, soft and hard component, and Geometric effects on cosmic rays; Terrestrial radiations: Radon gas and Radioactive isotopes of lighter elements, Radiation quantities and units: Activity, KERMA, Exposure, Dose, Equivalent Dose, Effective Dose, Annual Limit on Intake (ALI), and Derived Air Concentration (DAC)

Unit III

Interaction of Radiation with Matter: Modes of interaction: ionization, excitation, elastic and inelastic scattering, Bremsstrahlung, Cerenkov radiation, concepts of specific ionization, mean free path; Interaction of Light Charged Particles with matter; Interaction of Heavy Charged Particles with matter; Interaction of Electromagnetic Radiations with matter: Photoelectric effect, Compton Scattering, and Pair production; Attenuation of Gamma Radiation: Linear and mass attenuation coefficient

Unit IV

Neutron Physics: Discovery of neutrons, Neutron sources, Neutron collimators, Properties of neutrons, Classification of neutrons according to energy, Neutron detectors: Slow neutron detectors (Boron trifluride proportional counter, Boron coated proportional counter, Helium-3 proportional counter, Fission counter, and Scintillation counters), Intermediate neutrons detectors, and Fast neutrons detectors, Neutron detection through slowing down of fast neutrons. Neutron monochromators, and nuclear fission

Note: The syllabus is divided into four units. Nine questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit. A student has to attempt five questions in all.

Text & Reference Books:

[1] Nulcear and Particle Physics by S. L. Kakani and ShubhraKakani
[2] Radiation Oncology Physics: a handbook for teachers and students; International Atomic Energy Agency Vienna, 2005
[3] Practical knowledge for Handling Radioactive Sources by Dr. Claus Grupen
[4] Introduction to Radiological Physics and Radiation Dosimetry by Frank Herbert Attlx

M.Sc Physics Semester- III Paper XXII
Experimental Physics– I 23PHY23DB3

Theory Marks: 80
Internal Assessment: 20
Time: 3 Hrs.

COURSE OUTCOMES

CO1 Student would be able to differentiate between amorphous and crystalline materials using x-ray diffraction

CO2 Student would be able to understand the working of x-ray diffractometer

CO3 Student would be able to get familiarization with electron spectroscopy for surface analysis and Scanning probe microscopy

CO4 Student would be able to understand nitty-gritty of electron microscopy techniques

Unit-I

Properties of x-rays: Production of and detection of x-rays, Continues and characteristic x-rays, Diffraction of x-rays by crystalline materials: Bragg's law, Diffractometer and Debye Scherer for diffraction experiment and collection of diffraction data, Intensity of diffracted x-rays: scattering by an electron, an atom and a unit cell, structure factor, Six factors affecting the relative intensity of diffraction peaks, Indexing of powder diffraction data of cubic crystal system, determination of lattice parameters, strain and crystallite size from powder diffraction data(Scherer formula and Williamson's Hall Plot Method)

Unit-II

Basic construction of scanning electron microscope and its various parts, Typical operating voltage, Signal generated during interaction of electron beam with material, resolution, magnification, Depth of field and focus, Imaging techniques in SEM: Secondary electron and back scattered electron, Chemical analysis using energy dispersive x-ray analysis(EDX)

Unit-III

Comparison of optical microscope with transmission electron microscope, Basic construction of transmission electron microscope and its various parts, typical operating voltages, Resolution and its relation with voltage, Magnification, Imaging modes in TEM: Bright field (BF), Dark field (DF) imaging, Selected area electron diffraction (SEAD) pattern of amorphous, polycrystalline materials, Indexing of SEAD pattern of simple cubic crystal system, Sample preparation for TEM: Powder and thin films

Unit-IV

Basic principle of x-ray photoelectron spectroscopy and Augerelectron spectroscopy, Instrumentation: Ultrahigh vacuum system, x-ray, electron and ion guns, Electron energy analyzers, Characteristics of electron spectra, Photoelectron spectra, Auger electron spectra, Basic principle of atomic force microscopy, brief idea of set up, different modes of AFM (contact &tapping mode) and their importance, basic principle of scanning tunneling microscopy, brief idea of set up/components, different modes of STM and its importance

Note: The syllabus is divided into four units. Nine questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit. A student has to attempt five questions in all.

Text and Reference Books:

[1] Evans, C., Brundle, R., & Wilson. S. (1992). Encyclopedia of Materials Characterization: Surfaces, Interfaces, Thin Films. Butterworth-Heinemann.
[2] Leng, Y. (2013). Materials Characterization: Introduction to Microscopic and Spectroscopic Methods. Wiley-VCH.
[3] Hummel, R.E. (2011). Electronic Properties of Materials. Springer.
[4] Goldstein, J., Newbury, D.E., Joy, D.C., Lyman, C.E., Echlin, P., Lifshin, E., Sawyer, L., Michael, J.R. (2003). Scanning Electron Microscopy and X-Ray Microanalysis. Springer.
[5] Cullity, B.D., & Stock, S.R. (2013). Elements of X-Ray Diffraction. Pearson.
[6] Kaufmann, E.N. (2003). Characterization of Materials (Vol 1 & 2). John Wiley and Sons.

[7] Carter, C.B., & Williams, D.B. (2016).Transmission Electron Microscopy Diffraction, Imaging, and Spectrometry (Carter, Barry, Williams, David B. Eds.)

M.Sc. Physics Semester III Paper XXIII
Practical:General Physics - I 23PHY23CL1

Max Marks: 100
Time: 3 Hrs.

COURSE OUTCOMES

CO1 Student will be able to conduct experiments, as well as to analyze and interpret data.
CO2 Student would be able to relate experiments with the theoretical aspects of the course.
CO3 Student would be able to learn working with basic laser systems.

[1] Dispersion relation in a periodic electrical circuit: an analog of monatomic and diatomiclattice vibration
[2] To determine the Lande- g factor of DPPH using ESR spectrometer.
[3] To determine the wavelength of He-Ne laser light using an engraved scale as a diffraction grating.
[4] Setting up a Fiber Optic Analog Link, Study of losses in Optical Fiber, Measurement of Propagation Loss and Measurement of Bending Loss.
[5] Study of characteristics of fiber optic LED &detector, measurement of numerical aperture and study of frequency modulation &demodulation using fiber optic link.
[6] To determine magneto resistance of a Bismuth crystal as a function of magnetic field
[7] To study hysteresis in the electrical polarization of a TGS crystal and measure the Curie temperature.
[8] Measurement of thickness of thin wire using He-Ne laser
[9] Measurement and analysis of fluorescence spectrum of I_2vapour
[10] To study the thermo-luminescence of F-centers in Alkali halides crystals
[11] Determination of e/m of electron by normal Zeeman effect using Febry Perot Etalon
[12] G.M. Counters – characteristics, dead time and counting statistics

Note: Out of the list as above, a student has to perform atleast 08 (eight) practical's in the semester

M.Sc. Physics Semester III Paper XXIV
Practical: General Physics - II 23PHY23CL2

Max Marks: 100
Time: 3 Hrs.

COURSE OUTCOMES

At the end of this laboratory course in general physics, students would be able to:

CO1 Realize monoatomic and diatomic linear chain of atoms using passive electrical components and able to find the cut off frequency and understand dispersion relation as well as energy gap.
CO2 Devise and understand various filter circuits and frequency response of push – pull amplifier.
CO3 Determine the band gap of semiconductor materials, magnetic susceptibility of magnetic materials and dielectric constants of liquids.

CO4 Comprehend fiber optic communication, different mechanism of signal loss and various type of pulse modulation.

[1] Verification of Hartmann formula for prism spectrogram
[2] Measurement of optical spectrum of an alkali atom
[3] Measurement of Hall Coefficient of given semiconductor, Identification of charge carrier type and estimation of carrier concentration
[4] To determine numerical aperture of an optical fiber and size of Lycopodium powder using semiconductor laser
[5] To determine the specific heat of Nano Fluids
[6] To study the characterization and phase transition using Nano fluid Interferometer
[7] Study of Energy band gap and diffusion potential of PN junction
[8] Study of NMR spectra using NMR spectrometer
[9] Characteristics of Opto-electronic devices
[10] Determination of thermal conductivity of given bar at different temperatures
[11] Measurement of thermoelectric power.
[12] Velocity of sound in air by CRO method.

Note: Out of the list as above, a student has to perform atleast 08 (eight) practical's in the semester

M.Sc. Physics Semester III Paper XXV
Project/Dissertation 23PHY23CL3

Max Marks: 200

Dissertation (23PHY23CL3) will be opted by the students in lieu of Practicals: General Physics – (III and IV) (23PHY23CL1 & 23PHY23CL2)

M.Sc. Physics Semester IV Paper XXVI

Physics of Laser and Laser Applications 23PHY24C1

Theory Marks:80
Internal Assessment Marks:20
Time: 3 Hours

COURSE OUTCOMES

CO1 Student would be able to understand the diversity of laser designs and various applications.
CO2 Understand the basic concepts of most of the commercially available lasers.
CO3 Student will get the knowledge about the basic principles which form the basis of nonlinear optics.

Unit I

Laser characteristics: Spontaneous and Stimulated Emission, Absorption, Einstein Coefficients and their relationship, Laser Idea, threshold condition for laser oscillations, Pumping Schemes, Properties of Laser Beams: Monochromativity, Coherence, Directionality, Brightness, Radiation Trapping Superradiance, Superfluorescence, Amplified Spontaneous Emission, Non-radiative delay.

Unit II

Pumping process: Optical pumping and pumping efficiency, Electrical pumping and pumping efficiency, Passive Optical Resonators, Types of Resonators, Stability Diagram, Different types of losses in optical Resonators. Rate Equations, Four-level Laser, Three-level Laser, Q Switching, Methods of Q-switching: Electro optical shutter, Kerr effect, Pockel effect in KDP crystal, mechanical shutter, Acousto - optic Q-switches, Mode locking, theory of mode locking, methods of mode locking (active & passive).

Unit III

Principle, working, characteristics and energy level diagram of various types of laser as Solid State Lasers; Ruby Laser, Neodymium laser, Gas lasers; Neutral Atom Gas Laser, Helium Neon Laser, Nitrogen Laser, Dye-Laser, Semiconductor Laser.

Unit IV

Multiphoton photo-electric effects, Two-photon, Three-photon and Multiphoton Processes Raman Scattering, Stimulated Raman Effect, Introduction to Applications of Lasers: Physics, Chemistry, Biology, Medicine, Material, working, optical communication, Thermonuclear Fusion, Holography, Military etc.

Note: The syllabus is divided into four units. Nine questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit. A student has to attempt five questions in all.

Text and Reference Books

[1] Introduction to Atomic and Molecular Spectroscopy by V.K.Jain
[2] Yariv Optical Electronics
[3] Demtroder: Laser Spectroscopy
[4] Letekhov : Non-Linear Spectroscopy
[5] Principles of Lasers by O. Svelto
[6] Lasers and Non-linear Optics by B.B. Laud.

M.Sc. Physics Semester IV Paper XXVII
Physics of Nano-materials 23PHY24C2

Theory Marks: 80
Internal Assessment Marks: 20
Time: 3 Hours

COURSE OUTCOMES

CO1 Students would be able to explain the properties of Nanomaterials/nanostructures.
CO2 Students get enabled to analyze the density of states in various nanostructures and related effect on optical properties.
CO3 Students get acquainted with important techniques for preparation of Nanomaterials/nanostructures.
CO4 Understanding quantitatively, the experimental results of x-ray diffraction, photoluminescence and Raman spectra of Nanomaterials opens up avenues of future research.

Unit I

Free electron theory (qualitative idea) and its features, Idea of band structure: Kronig Penny model, Metals, insulators and semiconductors, Concept of effective mass, Derivation of density of states in 3D, 2D, 1D and 0D systems, Density of states in bands, Variation of density of states with energy, Variation of density of states and band gap energy with size of crystal, Electronicstructure from Bulk to quantum dot, Excitons: Frenkel and Mott-Wannier excitons

Unit II

Physics of reduced dimensional systems and devices: Quantum confinement, Electron confinement in one, two and three dimensional infinitely deep square well potentials, Various low dimensional systems: Quantum well structure; Idea of quantum well structure, Electron wave function and energy in quantum well structure (infinite well approximation), Density of states and optical absorption in quantum well, Quantum wires: Electron wave function and energy, Density of states, Quantum dots: Electron wave function and energy, Density of states, idea of hetero-junction LED, Quantum well laser and quantum dot laser, Coulomb blockade and Single electron transistor

Unit III

Synthesis of Nanomaterials/Nanostructures: Bottom up and top down approaches for synthesis of nano materials, Synthesis of zero-dimensional nanostructures (Nanoparticles): Sol-Gel Process, Epitaxial core-shell nanoparticles, Ball milling, One-dimensional nanostructures (Nanowires, Nanorods, Nanotubes): Electrochemical deposition, Lithography, Two-dimensional nanostructures (Thin Films & Quantum wells): Molecular beam epitaxy (MBE), MOCVD, Cluster beam evaporation, Ion beam deposition, Chemical bath deposition technique

Unit IV

Characterization of Nanomaterials/Nanostructures: Effect of particle size and Strain on width of XRD peaks of nanomaterials, Determination of crystallite/particle size and strain in nanomaterials using Debye Scherer's formula and Williamson–Hall's plot, Transmission electron microscopy: Basic principle, Brief idea of set up, Sample preparation, Imaging modes (Dark & Bright Field), Photoluminescence (PL) spectroscopy: Basic principle and idea of instrumentation, Shift in PL peaks with particle Size, Determination of alloy composition in thin films of compound semiconductors, Estimation for width of quantum wells, Raman spectroscopy: Basic principle and idea of instrumentation, Variations in Raman spectra of nanomaterials with particle size, Study of Raman spectra of carbon nanotubes and graphene.

Note: The syllabus is divided into four units. Nine questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit. A student has to attempt five questions in all.

Text and Reference Books:

[1] Physics of Low Dimensional Semiconductors by John H. Davies (Cambridge Univ. Press).
[2] Introduction to Nano-technology by Charles P. Poole & Jr. Frank J. Owens (Wiley Inter-science).
[3] Quantum Mechanics for Nanostructures by Vladimir V. Mitin, Dmitry I. Sementsov&Nizami Z. Vagidov (Cambridge University Press).
[4] Nanostructures & Nanomaterials: Synthesis, Properties & Applications by Guozhong Cao (Imperial College Press).

[5] Introduction to Nano: Basics to Nanoscience and Nanotechnology by AmretashisSengupta&Chandan Kumar Sarkar (Editor) [Springer].
[6] Solid State Physics by A. J. Dekker (Macmillan).
[7] Essentials in Nano-science and nanotechnology by Narendra Kumar, SunitaKumbhat (Wiley)
[8] Encyclopedia of Materials Characterization: Surfaces, Interfaces, Thin Films by C. Richard Brundle and Charles A. Evans, Jr. (BUTTERWORTH-HEINEMANN).

M.Sc. Physics Semester IV Paper XXVIII
Condensed Matter Physics –II 23PHY24DA1

Theory Marks:80
Internal Assessment Marks:20
Time: 3 Hours

COURSE OUTCOMES

At the end of this theory course in **Condensed Matter Physics**, students would be able to

CO1 Explain the concepts different types of bonding in solids
CO2 Understand some key and hot topics of condensed matter physics
CO3 Have understanding of exotic solids and their important applications.
CO4 Appreciate the few characterization techniques of nanomaterials

Unit-I

Crystals of inert gases: Van der Waals-London interaction,Repulsive interaction,Equilibrium lattice constants, Cohesive energy, Ionic crystals, Electrostatic or Madelung energy**,** Evaluation of the Madelung constant, Covalent crystals,Hydrogen bonds**,** Atomic radii**,** Ionic crystal radii,Synthetic carbon allotropes, Fullerene, Carbon Nanotubes (CNTs): Classification, physical structure, Electronic,optical, mechanical properties of CNTs, CNTs based FETs, Graphene: Electronic structure of Graphene, Properties and few applications

Unit-II

Special topics in condensed mater: Integral and fractional quantum Hall effect: electron in a strong magnetic field, Landau levels and their degeneracy, simple explanation of IQHE; Metal- Insulator transitions: Mott- Hubbard and impurity induced; Landau theory of Fermi liquid, Mott variable range hopping, Bose- Einstein condensation.

Unit-III

Glasses: Glass formation, Types of glasses and glass transition, Radial distribution function and amorphous semiconductors, Electronic structure of amorphous solids, Localized and extended states, Mobility edges, Density of states and their determination, Transport in extended and localized states, Optical properties of amorphous semiconductors,Polymers:Structure of polymers, polymerization mechanism, characterization techniques, optical, electrical, thermal and dielectric properties of polymers

Unit-IV

X-ray diffractometer: Indexing of x-ray diffraction data of poly-crystalline materials,Determination of lattice parameters, crystallite size, Texture analysis, Electron Diffraction: Basics of electron microscopes, electron beam specimen interaction,Scanningelectron microscopy and Transmission electron microscopy, Imaging modes, Transport measurements: Two probe, four probes - Vander Pauw techniques, Scanning probe techniques: Principles of STM and AFM.

Note: The syllabus is divided into four units. Nine questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit. A student has to attempt five questions in all.

Text & ReferenceBooks

[1] Solid State Physics by A. J. Dekker (Macmillan)
[2] Solid State Physics by Ashcroft &Mermin (Cengage Learning).
[3] Introduction to Solid State Physics by Charles Kittel (Wiley).
[4] Applied Solid State Physics by Rajnikant (Wiley).
[5] Solid State Physics: Structure and Properties of Materials by M.A. Wahab (Wiley).
[6] Elements of X-Ray Diffraction by B.D. Cullity (Pearson)
[7] Materials Characterization: Introduction to Microscopic and Spectroscopic Methods. By Leng, Y. (Wiley-VCH.)

M.Sc Physics Semester IV Paper XXIX
Electronics – II 23PHY24DA2

Theory Marks:80
Internal Assessment Marks:20
Time: 3 Hours

COURSE OUTCOMES

After successful completion of the course, the students will be able to

CO1 express numbers, alphabets, special characters etc. in binary representation, perform mathematical operation in digitally and application of different codes.

CO2 implement Boolean expression with basic gates and design circuits to achieve desired output.

CO3 design basic building blocks of ICs for different electronics operations such as addition, subtraction, code generation, data register, counting etc.and develop various building blocks for ICs using MOSFET as MOS devices

CO4 Understand the various types of modulation and microwave devices

Unit I

Binary numbers, Octal numbers, Hexadecimal numbers, Inter-conversions of numbers. Binary addition, subtraction, multiplication, division, Hexadecimal addition, subtraction, Octal addition, subtraction signed numbers, 1’s complement arithmetic, 2’s complement arithmetic, 9’s complement arithmetic, BCD code and arithmetic, Gray code, excess-3 code.

Positive and negative logic designations, OR gate, AND gate, NOT gate, NAND gate, NOR gate, XOR gate, Circuits and Boolean identities associated with gates, Boolean algebra-DeMorgans Laws, Sum of products and product of sums expressions, Minterm, Maxterm, K-maps, don’t care condition, deriving SOP and POS expressions from truth tables.

Unit II

Combinational Digital circuits: Binary adders:half adders & full adders,Decoders, Multiplexer, Demultiplexer, Encoders, ROM and its application (binary, BCD, Excess-3 Code, Gray Code & BCD to seven segment), Digital comparator, Parity checker and generator

Sequential Digital Circuits: 1-bit memory, Flip-Flops- RS, JK, master slave JK, T-type and D-type flip flops, Shift-register and applications, Asynchronous counters and Synchronous counters

Unit III

Metal oxide semiconductor field effect transistors, enhancement mode transistor, depletion mode transistor, p-channel and n-channel devices, MOS invertors- static inverter, dynamic inverter, two phase inverter, MOS NAND gates, NOR gates, complementary MOSFET technology, CMOS inverter, CMOS NOR gates and NAND gates, MOS shift register and RAM

Unit IV

Fundamentals of modulation, Frequency spectra in AM modulation, power in AM modulated class C amplifier, Efficiency modulation, frequency conversion, SSB system, Balanced modulation, filtering the signal for SSB, phase shift method, product detector, Pulse modulation, Microwave Devices: Resonant Cavity, Klystrons and Magnetron

Note: The syllabus is divided into four units. Nine questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit. A student has to attempt five questions in all.

Text and Reference books:

[1] Integrated Electronics by J. Millman and C.C. Halkias (Tata McGraw Hill).
[2] Digital Electronics by William Gothmann (Parentice Hall of India)
[3] Digital logic by J. M.Yarbrough (Thomson Publication).
[4] Electronic Fundamentals And Applications by John D. Ryder (Prentice-Hall)
[5] Foundation for Microwave Engineering by Robert E. Collin (Wiley)
[6] Digital Principles and Applications by Donald P leach, Albert Paul Malvino (McGraw-Hill)

M. Sc Physics Semester IV Paper XXIX
Advanced Spectroscopy – II23PHY24DA3

Theory Marks: 80
Internal Assessment Marks: 20
Time: 3 Hours

COURSE OUTCOMES

After successful completion of the course, the students will be able to

CO1 understand about the NMR and Mossbauer spectroscopy
CO2 explain about the electron spin resonance and its spectra
CO3 get understanding about the Laser spectroscopy and related applications
CO4 Understand the time resolve spectroscopy and related phenomenon

Unit 1

NMR: The principle of NMR, NMR spectrometer, Types of NMR, Types of nuclei viewed from the stand point of NMR, High Resolution and Broad line NMR, Relaxation mechanisms, chemical shift; spin-spin coupling. Applications of NMR spectroscopy.

Mossbauer Spectroscopy: Mossbauer Spectrometer, Isomer nuclear transition, Resonance fluorescence, Mossbauer effect, Mossbauer nuclei, Isomer shift, quadrupole splitting, Magnetic hyperfine structure. Applications of Mossbauer spectroscopy.

Unit II

ESR spectrometer, substances which can be studied by ESR, Resonance condition. Description of ESR by Precession, Relaxation mechanisms, Features of ESR spectra (a) the g factor (b) Fine structure (c) hyperfine structure (d) ligand hyperfine structure. Applications of ESR

Unit – III

Laser Spectroscopy, Detection Methods, Doppler-Limited Techniques, Time-Resolved Atomic and molecular Spectroscopy, Ultrafast Spectroscopy, High-Power Laser Experiments,High-Resolution Laser Spectroscopy,Cooling and Trapping of Ions and Atoms.

Laser-Spectroscopic Applications:1 Diagnostics of Combustion Processes, Laser Remote Sensing of the Atmosphere, Laser-Induced Fluorescence and Raman Spectroscopy in Liquids and Solids, Laser-Induced Chemical Processes and Spectroscopic Aspects of Lasers in Medicine

Unit IV

Time-resolved spectroscopy: Time-resolved fluorescence spectroscopy, Polarization in time-resolved fluorescence spectroscopy, Time-resolved fluorescence Stokes shift, Time-resolved four-wave mixing experiments, Third-order nonlinear response function, Pump-probe spectroscopy, Transient absorption spectra of excited electronic states, Time-resolved vibrational spectroscopy, Transient grating and photon echo experiments, Transient grating spectroscopy, Photon echo spectroscopy, Two-dimensional spectroscopy

Note: The syllabus is divided into four units. Nine questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit. A student has to attempt five questions in all.

Text and Reference Books

[1] S K Dogra - Molecular Spectroscopy-McGraw-Hill Education (2012)
[2] Svanberg S. - Atomic and Molecular Spectroscopy (2004, Springer)
[3] Spectroscopy Vol I and II by Walker and Straughen
[4] Introduction to Molecular spectroscopy by G. M. Barrow
[5] Spectra of diatomic molecules by Herzberg
[6] Molecular spectroscopy by Jeanne . L. McHale
[7] Molecular spectroscopy by J.M. Brown
[8] Spectra of atoms and molecules by P. F. Bemath
[9] Modern spectroscopy by J.M. Holias

M.Sc. Physics Semester IV Paper XXX

Computational Physics – II 22PHY24DB1

Theory Marks:80
Internal Assessment Marks:20
Time: 3 Hours

COURSE OUTCOMES

CO1 Students would be able to understand framework of computer languages
CO2 Students would be able to solve numerically various physical problems
CO3 Students would gain the necessary basic knowledge of application of MATLAB for problem solving

Unit - I

Random numbers: Random number generators, Mid-square methods, Multiplicative congruential method, mixed multiplicative congruential methods, modeling of radioactive decay. Hit and Miss Monte-Carlo methods, Monte-Carlo calculation of π, Monte-Carlo evaluation of integration, Evaluation of multidimensional integrals, chaotic dynamics: Some definitions, the simple pendulum, Potential energy of a dynamical system, Un-damped motion, Damped motion, Driven and damped oscillator.

Unit-II

Numerical solution of Radial Schrodinger equation for Hydrogen atom using Forth-order Runge-Kuttamethod(when Eigen value is given), Algorithms to simulate interference and diffraction of light, Simulation of charging and discharging of a capacitor, current in LR and LCR circuits, Computer models of LR and LCR circuits driven by sine and square functions, Simulation of Planetary motion, Simulation of projectile motion

Unit –III

MATLAB – I: Introduction, working with arrays, creating and printing plots, Interacting Computations: Matrices and Vectors, Matrices and Array Operations, built in functions, plotting simple graphs Programming in MATLAB: Script files, function files, Compiled files, p-code, variables, loops, branches, and control flow, Input/ Output, structures, cells

Unit-IV

MATLAB – II: Linear Algebra; solving a linear system, Gaussian elimination, finding eigenvalues and Eigen vectors, matrix factorization, Curve fitting and Interpolation; polynomial curve fitting, least square curve fitting, interpolation, Data analysis and statistics, Numerical integration; double integration, Ordinary differential equation; first order linear ODE, second order nonlinear ODE, tolerance, ODE suite

Note: The syllabus is divided into four units. Nine questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit. A student has to attempt five questions in all.

Text & Reference Books:

[1] Introduction to Numerical Analysis by F B Hildebrand (Tata McGraw Hill)
[2] Fortran Programming and Numerical methods by R C Desai (Tata McGraw Hill).
[3] Computer Applications in Physics by Suresh Chandra (Narosa Publishing House)
[4] Numerical Recipes in Fortran 77 By William H. Press, Saul A Teukolsky, William T Vellerling and Brain P. Flannery (Cambridge University Press)
[5] Introduction to Computation Physics by M L De Jong (Addison-Wesley).
[6] Computational Physics an Introduction by R C Verma, P K Ahluwalia and K C Sharma (New Age International).
[7] Computer Oriented Numerical Method by V Rajaraman (PHI).
[8] An introduction to numerical analysis by K E Atkinson (John Wiley and Sons).
[9] Getting Started with MATLAB by RudraPratap (Oxford University Press).
[10] A concise introduction to MATLAB by William J Palm III (McGraw Hill).

M.Sc. Physics Semester IV Paper XXXI
Radiation Physics – II23PHY24DB2

Theory Marks:80
Internal Assessment Marks:20
Time: 3 Hours

COURSE OUTCOMES

After taking the course, students should be able to handle and resolve problems related to
CO1 radiation detectors.
CO2 Biological effects of radiation.
CO3 radiation hazard.

Unit I

Principles of radiation detection; Gas filled radiation detectors: ionization chambers, proportion counters, GM counters, and Spark counter. Scintillation (organic/inorganic) counter; Solid State Detector: Crystal detector, Semiconductor Detectors (Junction type detector, Lithium drift Germanium detector, and HPGe), Thermo – Luminescent Dosimeters (TLD), Chemical detectors (Photographic Emulsions Films), Radiation Monitoring Instruments and Calibration check of radiation monitoring equipment.

Unit II

Biological Effects of Ionizing Radiation:Introduction, Cell Biology: Structure and function of living cell, cell division-mitosis, meiosis and differentiation, central dogma of molecular biology, genetic codes-DNA, RNA and Proteins; Effect of Radiation on Cell: inhibition of cell division, chromosome aberrations, genes mutation, and cell death; Biological effects of Radiation on Human: Somatic Effects (Early effect) and Stochastic effect (Late effect).

Unit III

Principles of Radiological Protection: Justification of Practice, Optimization of Practice, and Dose Limitations; Internal Exposure, Dose Limit for (i) Radiation Workers (ii) Public, Occupational Exposure of Women, Apprentices and Students .

Production of Radioisotopes and Labeled Compounds: Introduction, Separation of Isotopes, Production of labeled compounds, Specific Activity of labeled compounds, Storage, Quality, and Purity of Radio-labeled compounds.

Unit IV

Radiation Hazard: Internal Hazards and External Hazards; Evaluation and Control of Radiation Hazard, Radiation Shield, Monitoring of External Radiation, Control of Internal Hazard: (i) Containment of Source (ii) Control of Environment (iii) Contamination (iv) Air Contamination Monitoring (v) Personal Contamination Monitoring (vi) Decontamination Procedures; Radiation Emergency and Preparedness.

Note: The syllabus is divided into four units. Nine questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit. A student has to attempt five questions in all.

Text & Reference Books:

[1] Radiation Oncology Physics: a handbook for teachers and students; International Atomic Energy Agency Vienna, 2005
[2] Practical knowledge for Handling Radioactive Sources by Claus Grupen
[3] Introduction to Radiological Physics and Radiation Dosimetry by Frank Herbert Attlx
[4] Radiation Biology: a handbook for teachers and students; International Atomic Energy Agency Vienna, 2010

M.Sc Physics Semester- III Paper XXII
Experimental Physics– II 23PHY24DB3

Theory Marks: 80
Internal Assessment Marks: 20
Time: 3 Hrs.

COURSE OUTCOMES

CO1 Student would be able to understand working and application of absorption and emission spectroscopy for material characterization

CO2 Student would be acquaintance with IR and Raman spectroscopy

CO3 Student would be appreciate the electrical and dielectric properties of material and their data interpretation

CO4 Student would be get familiarity with different tools for measurement of thermal properties

Unit-I

Basic principle and instrumentation of UV-Vis. spectroscopy, Optical absorption data, Optical absorption edge, Determination of optical band gap energy and type of optical transition from absorption data, Estimation of size of semiconducting nanoparticles using Brus equation, Basic principle and instrumentation of PL spectroscopy and its application in characterization of luminescent materials, Ellipsometry: Basic principle and instrumentation, determination of n, k and thickness of films

Unit-II

Electromagnetic Radiation and origin of molecular vibrations, Normal mode of molecular vibrations and number of normal vibration modes, Fouriertransforms infrared spectroscopy: Infrared absorption and activity, Workingprinciple and instrumentation, Examination techniques, transmittance, identifying characteristic bands, Raman Scattering: Basic principle, Raman activity and instrumentation, Analysis of Raman spectra

Unit-III

Differential scanning calorimetry and Differential thermal analysis: Thermal events, working principle, instrumentation and calibration of temperature, Determination of various characteristic temperatures from thermogram, Measurement of enthalpy change, Determination of specific heat, Thermogravimetry: Basic working principle and instrumentation, types and interpretation of thermogravimetric curves, study of stability of polymeric materials and determination of percentage crystallinity of polymer

Unit-IV

Measurement of resistivity using two, four probe and Vander paw methods: Solids samples and thin films, Hall Effect experiment, dielectric characterization using impedance analyzer, Connection between different dielectric parameters, Review of magnetic materials, basic principle and brief idea about set-up of vibrating sample magnetometer (VSM) and SQUID magnetometer, magnetization vs. temperature profiling for zero field cooling (ZFC) and field cooling (FC), M-H hysteresis loops, AC magnetic susceptibility

Note: The syllabus is divided into four units. Nine questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit. A student has to attempt five questions in all.

Text and References Books

[1] Effect of replacement of Bi_2O_3 by Li_2O on structural, thermal, optical and other physical properties of zinc borate glasses, Manju Bala, Sunil Agrohiya, Sajjan Dahiya, Anil Ohlan, R Punia, AS Maan, Journal of Molecular Structure 1219 (2020) 128589.
[2] Evans, C., Brundle, R., & Wilson. S. (1992). Encyclopedia of Materials Characterization: Surfaces, Interfaces, Thin Films. Butterworth-Heinemann.
[3] Leng, Y. (2013). Materials Characterization: Introduction to Microscopic and Spectroscopic Methods. Wiley-VCH.
[4] Hummel, R.E. (2011). Electronic Properties of Materials. Springer.
[5] Goldstein, J., Newbury, D.E., Joy, D.C., Lyman, C.E., Echlin, P., Lifshin, E., Sawyer, L., Michael, J.R. (2003). Scanning Electron Microscopy and X-Ray Microanalysis. Springer.
[6] Cullity, B.D., & Stock, S.R. (2013). Elements of X-Ray Diffraction. Pearson.
[7] Kaufmann, E.N. (2003). Characterization of Materials (Vol 1 & 2). John Wiley and Sons.

M.Sc. Physics Semester IV Paper XXXIV
Practical –Condensed Matter Physics 23PHY24DL2

Max Marks: 100
Time: 3 Hrs.

COURSE OUTCOMES

At the end of this laboratory course in Condensed Mater Physics, students would beable to:

CO1 Characterize the semiconductor materialsby determining resistivity, band gap, mobility, and carrier type.
CO2 Understand phase transitions in ferroelectric materials and find the ferroelectric Curie temperature (Tc)
CO3 Analyze the experimental data of powder diffraction in terms of indexing of peaks coming from different crystal planes and lattice parameters.
CO4 Find the magnetic susceptibility and energy loss/volume/cycle in ferromagnetic materials.

[1] To study the B-H curve of a ferrite with temperature and hence find the ferromagnetic transition temperature of the material
[2] Determination of dielectric constant of PZT material with temperature variation and hence find the Curie temperature(T_C)
[3] To study the magneto-resistance of bismuth crystal
[4] Measurement of magnetic susceptibility of paramagnetic materials using Gouy's method
[5] To study thermo-luminescence of F-centers in alkali halide crystals
[6] To simulate X-Ray Diffraction Experiment
[7] Determination of particle size and lattice strain using Williamson's Halls Plot from x-ray diffraction data of a Nanomaterials
[8] Indexing and determination of lattice parameter of a simple cubic crystal for a given x-ray diffraction data
[9] To study hysteresis in the electrical polarization of a TGS crystal/PZT/$BaTiO_3$with temperature and hence to find the Curie temperature(T_C)
[10] Study of lead tin phase diagram

[11] Verification of Lambert Beer's law and determination of concentration of unknown solution byUV-Vis spectrophotometer
[12] To measure the resistivity of an insulating material as function of temperature and hence to find the activation energy for conduction

Note: Out of the list as above, a student has to perform atleast 08 (eight) Practicals in the semester

M.Sc. Physics Semester III Paper XXIV
Practical: Electronics 23PHY23DL2

Max Marks:100
Time: 3 Hrs.

COURSE OUTCOMES

CO1 Students would be able to demonstrate relation between the input and the corresponding digital output of various digital systems
CO2 Designing basic building blocks for the ICs for different electronics functions like addition, subtraction, code generation, data register, counting etc. would help in realizing complex circuits.
CO3 Students would be able to appreciate the effect of different types of modulation on the modulating signal.
CO4 Students would be enable for measurement of various digital circuits parameters and comparison of experimental outcomes with theoretical results

[1] Pulse position/Pulse width Modulation/Demodulation
[2] FSK Modulation Demodulation using Timer/PLL
[3] PLL circuits and applications
[4] BCD to Seven Segment display
[5] To study digital to analog and analog to digital conversion (DAC to ADC) circuit.
[6] Addition, subtraction, multiplication & division using 8085/8086.
[7] To study various applications of op-amp
[8] To study the digital comparator, 3 to 8 line Decoder and tri-state digital O/P circuits.
[9] To study the binary module-6 and 8 decade counter and shift register.
[10] Exp. Board on Timer (555) Applications
[11] Study of frequency Multiplication using PLL
[12] Study of Frequency Modulation and Demodulation
[13] Study of Pulse Amplitude Modulations & Demodulation
[14] Transfer characteristics of TTL inverter and TTL trigger inverter with two digital volt meter
[15] Study of Module-N Counter using Programmable Counter IC 74190 with input Logics with LED display

Note: Out of the list as above, a student has to perform atleast 08 (eight) practical's in the semester

M.Sc. Physics Semester IV Paper XXXIII
Practical; Advanced Spectroscopy 23PHY24DL1

Max Marks: 100
Time: 3 Hrs.

COURSE OUTCOMES

CO1 Student would be able to realize the different types of transitions in molecules and liquids

CO2 Student would understand dispersion relation and interferometers

CO3 Student would be able to analyzes the spectra of alkali and transition metals

[1] Jamin's interferometer – refractive index of air.
[2] Measurement and analyses of electronic spectra of molecules and liquids.
[3] Measurement and analyses of vibrational spectra of molecules and liquids.
[4] Measurement and analyses of rotational spectra of molecules and liquids.
[5] Measurement and analyses of absorption/transmission spectra of solids.
[6] Study of line spectra on photographed plates/films and calculation of platefactor.
[7] Verification of Hartman's dispersionformula.
[8] Study of sharp and diffuse series of potassium atom and calculation of spin orbit interactionconstant.
[9] Michelsoninterferometer.
[10] Analysis of ESR Spectra of transitionmetals.
[11] Analysis of H-atom spectra inminerals.
[12] LED & Laser Diode CharacteristicsApparatus
  a) To Study I-V characteristics of LED and DiodeLaser.
  b) To Study P-I characteristics of LED and DiodeLaser.
[13] To measure the numerical aperture (NA) of opticalfiber
[14] To determine the wavelength of He-Ne Laser light using an engraved scale as a diffractiongrating.
[15] Measurement of thickness of thin wire withlaser
[16] Determination of Lande's factor of DPPH using Electron - Spin resonance (E.S.R.) Spectrometer.

Note: Out of the list as above, a student has to perform atleast 08 (eight) Practicals in the semester

M.Sc. Physics Semester IV Paper XXXIII
Practical Computational Physics 23PHY24DL1

Max Marks:100
Time:3 Hrs.

COURSE OUTCOMES

CO1 Students would develop understanding for programming concepts.

CO2 Students would learn the practical implementation of programming languages for carrying numerical calculations.

CO3 Students would be benefited from their enhanced computational skills in context of higher studiesin physics or business purposes as well.

List of programs using FORTRAN/MATLAB

[1] Numerical Integration
[2] Least square fitting
[3] Numerical solutions of equations (single variable)
[4] Solution of H-atom problem

[5] Solution of RL circuits
[6] Numerical solution of simultaneous linear algebraic equations
[7] Numerical solution of ordinary differential equation
[8] Simulation of chaotic pendulum
[9] Motion of Projectile thrown at an angle
[10] Simulation of Planetary Motion
[11] Charging and discharging of Capacitor
[12] Solution of LCR circuit

Note: Out of the list as above, a student has to perform atleast 08 (eight) practicals in the semester

M.Sc. Physics Semester IV Paper XXXIV
Practical - Radiation Physics 23PHY24DL2

Max Marks: 100
Time: 3 Hrs.

COURSE OUTCOMES

CO1 Students will get hand on experience on GM counter, Spark Counter, Scintillation counter
CO2 Student will be able measure range of alpha, beta particles, attenuation coefficient
CO3 Students will be aquatinted with different techniques of detection of nuclear radiations
CO4 Students will be appreciate the interaction of nuclear radiation with mater

[1] Investigation of the plateau and optimal operating voltage of a Geiger-Muller counter
[2] Investigation of statistical nature of counting rate
[3] To determine the resolving time of a GM counter
[4] To investigate the relationship between absorber materials (atomic number), absorption thickness and backscattering.
[5] To verify the inverse square relationship between the distance and intensity of radiation.
[6] To investigate the attenuation of radiation via the absorption of beta particles.
[7] To determine the maximum energy of decay of a beta particle.
[8] Measurement of range of α particle range in air using a spark counter
[9] Study of the attenuation coefficients of the γ rays for Al, Fe and Pb using NaIscintillation counter
[10] Measurement of γ ray energy of Cs-137 source using a NaIScintillation detector

Note: Out of the list as above, a student has to perform at least 08 (eight) practicals in the semester

M.Sc. Physics Semester IV Paper XXXIII
Practical; Experimental Physics 23PHY24DL1

Max Marks: 100
Time: 3 Hrs.

At the end of this laboratory course in Experimental Techniques

CO1 Student would be able to record and interpret the optical absorption data

CO2 Student would be able to understand the working of x-ray diffractometer and analysis of x-ray diffraction data
CO3 Student would be able to measure dielectric parameters and their interpretation
CO4 Student would be able to analyze AFM, SEM and TEM Images

1. To record the optical absorption data of a solid transparent sample such as glass and to
   - (i) find the optical band gap(E_g) energy from cut-off wavelength
   - (ii) find the optical band gap energy(E_g) using Tauc's relation
   - (iii) type of optical transitions
   - (iv) Urbach's energy
2. To record the optical absorption spectrum of semiconducting nanoparticles and hence to estimate the size of nanoparticles using Brus equation
3. To record x-ray diffraction data of a simple cubic crystalline material and to find the lattice parameters using manual indexing method
4. Recording of x-ray diffraction data of nanomaterials and hence to find the crystallite size and using Scherer equation
5. Measurement of capacitance and dielectric loss of a ferroelectric material using Impedance analyzer/ LCR meter
   - (i) at a fixed frequency to find the ferroelectric transition temperature
   - (ii) at different temperature as function of frequency to find different dielectric parameters from measured values of C and D
6. To obtain DSC thermogram of a glass sample find the glass transition, crystallization, melting temperature
7. To obtain FTIR data of sample and assignment of different functional group present
8. Analysis of Scanning electron micrograph of a material using ImageJ software
9. Analysis of Transmission electron micrograph (Bright and Dark Field images) of a material using ImageJ software
10. Indexing of selected area electron diffraction (SAED) pattern of a simple cubic crystalline material
11. Measurement of PL spectra of luminescent materials and to find photoluminescence quantum efficiency (PLQE)
12. To study the transient photoresponse of a UV detector in plane and sandwich geometry and also draw I-V characteristics of photodetector in absence and presence of UV light

Note: Out of the list as above, a student has to perform atleast 08 (eight) practical's in the semester