MAHARAJA GANGA SINGH UNIVERSITY

SCHEME OF EXAMINATION FOR

THE DEGREE OF MASTER OF SCIENCE IN PHYSICS

M.SC. (PHYSICS)

Applicable for students seeking admission to the Two year M.Sc. Course in Physics for the Academic Year 2025-2026

PROGRAMME BROCHURE

SCHEME OF EXAMINATION FOR THE DEGREE OF M.Sc. (PHYSICS)

Program Objectives:

To develop the skill of students to prepare globally competitive for research, teaching and technology with human values.

Program Outcomes (PO)

On completing Master in Faculty of Science, the students shall be able to realize the following outcomes:

PO	Description
PO1	Develop ethical, moral and social values to make good human being for society.
PO2	Understand scientific thought for all aspect in social life.
PO3	Develop the problem solving thinking with scientific knowledge.
PO4	Demonstrate highest standards of Actuarial ethical conduct and Professional Actuarial behavior, critical, interpersonal and communication skills as well as a commitment to life-long learning.
PO5	Developed various communication skills such as reading, listening, speaking, etc., which will help express ideas and views clearly and effectively.
PO6	Develop entrepreneurship skill.

Program Specific Outcomes (PSO)

On completing M.Sc. in Physics, the students shall be able to realize the following outcomes:

PSO	Description
PSO1	Be competent to success in various national exams as NET-JRF, GATE, JEST etc. for higher education.
PSO2	Understand the basics of mechanics and their applications.
PSO3	Apply their knowledge and skill in the development of Electronics circuits to enter to the needs of Electronic Industry
PSO4	Use their knowledge to start new dimension in the interdisciplinary field of research or teaching.
PSO5	Can start as a trainer in the area of electronics, optical communication, nonlinear circuits, materials characterization and lasers etc.
PSO6	Excel in the research field of theoretical and experiment field.

SYLLABUS STRUCTURE FOR SEMESTER M.Sc. COURSE IN PHYSICS

M.Sc. programme is a two-year course divided into four-semesters. To complete the course and award of degree, a student is required to obtain 104 credits.

- Each theory course is of 4 credits for lecture per week (1 credit = 15 hour). This amounts to 60 hours for each theory paper per semester.
- Each practical course is of 4 credits for each laboratory work per batch per week (1 credit = 30 hours). A batch must not exceed 10 students. This amounts to 240 hours per semester per batch for completing two laboratory works.
- Each demonstration / training laboratory work is of 2 credits per semester for which a student has to devote 40 hours in each semester.
- The maximum marks for theory / practical / project course can be 100. For theory course, 100 marks will be allocated for end-semester examination of 3 hours duration. For each laboratory/project course, 100 marks shall be allocated for end-semester examination of 5 hours to be conducted by an external examiner.
- In order to opt an elective paper during III and IV semesters, choice for the elective paper must be taken from each student and proper record to be maintained. Minimum intake of students for each paper should not be less than ten to run the said elective paper. Wherein the number of students is less than ten, only one option will be selected.

Guidelines for Award of Internal Assessment Marks

- Continuous comprehensive evaluation will be adopted to find out each course level learning outcome , i.e. assignment, test, quiz, seminars
- Individual Assignments *i.e.* Case Study, Practical Record, Dissertation.
- Seminar Presentation, Project report writing

Proper record of the Internal Assessment evaluation along with the attendance of students is required by the university for each course adopted by the institution.

Guidelines for Demonstration / Training Laboratory

Every student should be assigned work related to demonstration and development of experiments at UG and PG level as well as training of repair and maintenance of experimental laboratories in the departments. It may also include visits to national laboratories or institutions of higher learning to gain extra knowledge. A record of attendance may be kept by the institution to award credit to the student.

Guidelines for Setting Theory Question Paper

The question paper shall consist of 3 sections.

Section-A will consist of 10 questions (at least 3 questions from each unit).

Section-B will consist of 9 questions (3 questions from each unit).

Section-C will consist of 6 questions (2 questions from each unit).

The word limit of part A, B, and C are 50, 200, and 500 words respectively

Pass Marks and Promotion Criteria

A candidate must obtain 25% marks to pass in internal assessment as well as theory paper and practical individually to pass each semester. The overall percentage required to clear a semester will be 36%. The promotion criterion shall be decided by the university.

Attendance Requirement

As per University rules

M.Sc. Programme (Semester Wise)

Semester I									
Course Code	Course Title	Lecture	Tutorial	Practical	Credits	Max. Marks		Pass Marks	
						Internal	External	Internal	External
PHY6.0-CC-101	Mathematical Physics	4			4	20	80	5	20
PHY6.0-CC-102	Classical Mechanics	4			4	20	80	5	20
PHY6.0-CC-103	Quantum Mechanics I	4			4	20	80	5	20
PHY6.0-CC-104	Statistical Physics	4			4	20	80	5	20
PHY6.0-CC - 105	Laboratory I			4	4	20	80	5	20
PHY6.0-CC - 106	Laboratory II			4	4	20	80	5	20
PHy6.0-cc-107	Demonstration / Training Lab			2	2				

Semester II									
Course Code	Course Title	Lecture	Tutorial	Practical	Credits	Max. Marks		Pass Marks	
						Internal	External	Internal	External
PHY6.0-CC-201	Quantum Mechanics II	4			4	20	80	5	20
PHY6.0-CC-202	Electrodynamics and Plasma Physics	4			4	20	80	5	20
PHY6.0-CC-203	Atomic and Molecular Physics	4			4	20	80	5	20
PHY6.0-CC-204	Electronic Devices	4			4	20	80	5	20
PHY6.0-CC-205	Laboratory I			4	4	20	80	5	20
PHY6.0-CC-206	Laboratory II			4	4	20	80	5	20
PHY6.0-CC-207	Demonstration / Training Lab			2	2				

Semester III									
Course Code	Course Title	Lecture	Tutorial	Practical	Credits	Max. Marks		Pass Marks	
						Internal	External	Internal	External
PHY6.5-CC-301	Condensed Matter Physics	4			4	20	80	5	20
PHY6.5-CC-302	Nuclear and Particle Physics	4			4	20	80	5	20
PHY6.5-SE-303	(A) Advanced Condensed Matter Physics	4			4	20	80	5	20
	(B) Advanced Quantum Mechanics	4			4	20	80	5	20
PHY6.5-SE-304	(A) Physics of Electronic Devices and Integrated Circuits	4			4	20	80	5	20
	(B) Digital Electronics and Communication Electronics								
PHY6.5-CC-305	Laboratory – I			4	4	20	80	5	20
PHY6.5-CE-306	Elective Lab-I/II			4	4	20	80	5	20
PHY6.5-CC-307	Demonstration / Training Lab			2	2				

Semester IV									
Course Code	Course Title	Lecture	Tutorial	Practical	Credits	Max. Marks		Pass Marks	
						Internal	External	Internal	External
PHY6.5-CC-401	Numerical Methods and Programming	4			4	20	80	5	20
PHY6.5-CC-402	Physics of Nanomaterials and Nanostructures	4			4	20	80	5	20
PHY6.5-SE-403	(A) Physics of Lasers and Laser Applications (B) Science and Technology of Renewable Energies (C) Medical Physics	4			4	20	80	5	20
PHY6.5-SE-404	(A) Optoelectronics and Microwave Electronics (B) Physics of Semiconductor Devices (C) Solid State Physics and Disordered Systems	4			4	20	80	5	20
PHY6.5-CC-405	Laboratory – I			4	4	20	80	5	20
PHY6.5-CE-406	Elective Lab-I/II			4	4	20	80	5	20
PHY6.5-CC-407	Research Project / Dissertation			2	2	20	80	5	20

COURSE WISE CONTENT

SEMESTER I

MATHEMATICAL PHYSICS

Course Code: PHY6.0-CC-101

Max Marks 100 **60 hours**

Objectives

To train the students about the mathematical skills necessary to solve problems of advanced physics courses.

Learning Outcomes

After the completion of course, the students will

- be able to understand and apply the mathematical skills to solve quantitative problems in the study of physics.
- enable to apply integral transform to solve mathematical problems of interest in physics.
- be able to use Fourier transforms as an aid for analyzing experimental data.
- be able to formulate and express a physical law in terms of tensors, and simplify it by use of coordinate transforms.

Content

Unit I

Vector Spaces and Matrices: linear independence; Bases; Dimensionality; Inner product; Linear transformations; Matrices; Inverse; Orthogonal and unitary matrices; Independent elements of a matrix; Eigenvalues and eigenvectors; Diagonalization; Complete Orthonormal sets of functions.

Complex variables Analytic functions, Cauchy-Riemann conditions, Cauchy's Integral theorem and Integral formula, Laurent expansion, Singularities, Evaluation of residues, Residue theorem. Series of complex term: Taylor's series, Laurentz series

Unit II

Differential Equations and Special Functions; Second order linear ODEs with variable coefficients; Solution by series expansion; Legendre, Bessel, Hermite and Lagaurre equations; Physical application; Generating functions; recursion relations.

Unit III

Integral Transforms: Laplace transform - First and second shifting theorems; Laplace transform of derivatives and integrals, inverse Laplace transforms, partial fraction method, series expansion method,; Fourier transforms – sine and cosine transforms; Dirac delta function- derivative of delta function, Laplace and Fourier transform of delta function; Fourier series - properties such as convergence, integration and differentiation, applications such as square wave and triangular wave

Text and Reference Books:

Mathematical Methods for Physics, by G Arfken
Matrices and Tensors for Physicists, by A W Joshi
Advanced Engineering Mathematics, by E Kreyzing
Special Functions, by E D Rainville
Special Functions, by W W Bell
Mathematical Methods for Physics and Engineerings, by K F Reily. M P Hobson and S J Bence
Mathematics for Physics, by Marry Boas
Mathematical Physics by Rajput

CLASSICAL MECHANICS

Course Code: PHY6.0-CC-102

Max Marks 100 **60 hours**

Objectives

To develop an understanding about Lagrangian and Hamiltonian formulation which allow simple treatments of many complex problems of classical mechanics alongwith the foundation of modern dynamics.

Learning Outcomes

After the completion of course, the students will

- be able to use the variational principles to real problems of physics.
- be understand the model mechanical systems, both in inertial and rotating frames, using Lagrange and Hamilton equations.

Content

Unit I

Preliminaries; Newtonian mechanics of one and many particle systems; conservation laws, work-energy theorem; open systems (with variable mass).

Constraints; their classification, D'Alembert's principle, generalized coordinates. Lagrange's equations; gyroscopic forces; dissipative system; Gauge invariance; Invariance under Galilean transformations; generalized coordinates and momenta; symmetries of space and time with conservation laws; Jacobi integral; integrals of motion.

Unit II

Principle of least action; derivation of equations of motion; Hamilton's principle and characteristic functions; Hamilton-Jacobi equation.

Canonical transformation; generating functions; Hamilton-Jacobi equation Properties; group property; examples; infinitesimal generators; Poisson bracket; Poisson theorems; angular momentum in PB; small oscillation; normal modes and coordinates.

Unit III

Rotating frames; inertial forces; terrestrial and astronomical applications of coriolis force.

Central force; definition and characteristics; Two-body problem; closure and stability of circular orbits; general analysis of orbits; Kepler's laws and equation; artificial satellites; Rutherford scattering.

Text and Reference Books:

Classical Mechanics, by NC Rana and PS Joag (Tata McGraw-Hill,1991)
Classical Mechanics, by H Goldstein (Addison Wesley, 1980)
Mechanics, by A Sommerfeld (Academic Press, 1952)
Introduction to Dynamics, by I Perceival and D Richards {Cambridge Univ. Press. 1982).
Classical Mechanics by Rutherford

QUANTUM MECHANICS I

Course Code: PHY6.0-CC-103

Max Marks 100 **60 hours**

Objectives
To provide an understanding of the formalism and language of non-relativistic quantum mechanics.

Learning Outcomes
After completion of course, the students will

- Be able to understand the importance of quantum mechanics compared to classical mechanics at microscopic level.
- Be able to formulate and solve problems in quantum mechanics using Dirac representation.
- Be able to grasp the concepts of spin and angular momentum, as well as their quantization and addition rules.

Content
Unit I

Inadequacy of classical mechanics; Schrödinger equation; continuity equation; Ehrenfest theorem; Admissible wave function; Stationary states. One-dimensional problems, wells and barriers; Solution of Harmonic oscillator by Schrodinger equation and by operator method.

Unit II

Completeness of eigenfunctions; Dirac delta function; bra and ket notation; Matrix representation of an operator; Unitary transformation.

Uncertainty relation, x and p States with minimum uncertainty product, General formalism of wave mechanics, Commutation relations, Representation of states and dynamical variables.

Angular momentum in Quantum Mechanics; Addition of angular momentum, CG coefficient, Wigner-Eckart theorem

Unit III

Central force problem; Solution of Schrödinger equation for spherically symmetric potentials; application in Hydrogen atom.

Time-independent perturbation theory; Non-degenerate and degenerate cases; Applications such as Stark effect and Zeeman effect.

Text and Reference Books

L.I. Schiff, Quantum Mechanics (McGraw-Hill)
S. Gasiorowicz, Quantum Physics (Wiley)
B Craseman and J.D. Powell, Quantum Mechanics (Addison Wesley)
A.P. Messiah, Quantum Mechanics
J.J. Sakurai, Modem Quantum Mechanics
Mathews and Venkatesan, Quantum Mechanics
Ghatak and Loknathan, Quantum Mechanics

STATISTICAL MECHANICS

Course Code: PHY6.0-CC-104

Max Marks 100 **60hours**

Objectives

To understand equilibrium and non-equilibrium physical systems at microstate level with Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics.

Learning Outcome

After completion of course, the students will

- Be able to use statistics for the understanding of physical systems to analysis.
- Be able to understand connection between statistics and thermodynamics.
- Be identify difference between classical statistics and quantum statistics.

Content

Unit I

Foundations of statistical mechanics; specification of states of a system, phase space, trajectories and density of states, Liouville'stheorem,. Microcanonical ensemble, classical ideal gas, entropy of mixing and Gibb's paradox, contact between statistics and thermodynamics canonical and grand canonical ensembles; partition function, calculation of statistical quantities, Energy fluctuations in canonical ensemble , energy and density fluctuations in grand canonical ensemble.

Unit II

Density matrix, statistics of ensembles, statistics of indistinguishable particles, Maxwell-Boltzman, Fermi-Dirac and Bose-Einstein statistics, Ideal Bose Gas - Bose-Einstein condensation, Plank radiation law; Ideal Fermi gas – Weakly and strongly degenerate gas, Free electron theory of metals.

Cluster expansion for a classical gas, Virial equation of state, Ising model, mean-field theories of the Ising model in three, two and one dimensions Exact solutions in one-dimension

Unit III

Landau theory of phase transition, critical indices, scale transformation and dimensional analysis.

Fluctuations, Correlation of space-time dependent fluctuations, fluctuations and transport phenomena, Brownian motion, Langevin theory, Fluctuation dissipation theorem, The Fokker-Planck equation.

Text and Reference Books:

Statistical and Thermal Physics, by F Reif
Statistical Mechanics, by K Huang
Statistical Mechanics, R K Pathria
Statistical Mechanics, R Kubo
Statistical Physics, Landau and Lifshitz
Statistical Physics, A.K.Sinha

PRACTICAL LAB I

Course Code: PHY6.0-CC-105

Max Marks 100 **120 hours**

Instruction for Practical Examination:

Experiment	40 Marks
Viva-voce	25 Marks
Record	15 Marks
Total	80 Marks
Internal Assessment	20 Marks

A total of eight experiments must be performed by the students to complete the laboratory course. Experiments of equal standard can be designed to satisfy the minimum condition.

1. To determine e/m by Thomson Method.
2. To determine e/m by Helical Method.
3. To determine e/m by Millikan's oil Drop method.

4. To determine Resolving Power of a Telescope.
5. To determine velocity of Sound in Air by Standing Wave Method.
6. To study Energy Transfer between Coupled Oscillators.
7. Using laser light :
   a. Measure of wavelength with the help of ruler.
   b. Measure of thickness of the wire.
8. Testing goodness of fit of Poisson distribution to cosmic ray busts by Chi-square test.
9. To study Faraday effect using a laser.
10. To Study frequency versus energy curve using magnet-magnet interaction using air track.
11. To study potential energy curve of magnet-magnet interaction using air track.
12. To study parametric amplifier for different initial length and variation of damping with mass of bob.
13. To determine velocity of Sound in Air by Standing Wave Method.
14. To study modulus of rigidity with temperature using tortional pendulum.
15. Plot the Poisson and Gaussian distribution for a radioactive source.
16. To determine velocity of waves in water using ultrasonic interferometer

PRACTICAL LAB II

Course Code: PHY-CC-106

Max Marks 100 **120 hours**

Instruction for Practical Examination:

Experiment	40 Marks
Viva-voce	25 Marks
Record	15 Marks
Total	80 Marks
Internal Assessment	20 Marks

A total of eight experiments must be performed by the students to complete the laboratory course. Experiments of equal standard can be designed to satisfy the minimum condition.

1. To Study Mathematical Operations using OPAMP.
2. To study OPAMP as Comparator using Inverting and Non-inverting configuration
3. To study Clipping and Clamping circuits.
4. To study Differentiating and Integrating circuits using diode.
5. To study Miller Sweep Generator.
6. To study Bootstrap Sweep Generator.
7. To study the Recovery Time of Diode.

8. To study Free-running Multivibrator.
9. To study Mono- and Bi-stable Multivibrator circuits.
10. To study RC coupled Two-Stage Amplifier.
11. Differential Amplifier.
12. Design of a Regulated Power supply.
13. Design of a Common Emitter Transistor Amplifier.
14. Experiment on Bias Stability
15. Operational Amplifier (741)
16. To study Fourier Analysis.

SEMESTER II

QUANTUM MECHANICS II

Course Code: PHY6.0-CC-201

Max Marks 100 **60 hours**

Objectives

To understand the concepts of time-independent perturbation theory and their applications to physical situations.

Learning Outcomes

After completion of course, the students will

- Be familiar with various approximation methods applied to atomic, nuclear and solid-state physics.
- Be use the approximation methods and scattering theories.

Content

Unit I

Time-dependent perturbation theory; Harmonic perturbation; Fermi's golden rule; Adiabatic and sudden approximations. Semi classical theory of radiation; Transition probability for absorption and induced emission; Electric dipole and forbidden transitions; Selection rules.

Unit II

Variational method- Helium and its excited states, Hydrogen molecule; WKB approximation - Alpha decay, Bohr Sommerfield quantization condition

Identical particles; Symmetric and antisymmetric wave functions; collision of identical particles; Spin angular momentum; Spin functions for a many-electron.

Unit III

Collision in 3-D and scattering; Laboratory and reference frames; Scattering amplitude; differential scattering cross section and total scattering cross section; Scattering by spherically symmetric potentials; Partial wave analysis and phase shifts; Scattering by a perfectly rigid sphere and by square well potential; complex potential and absorption. Born approximation

Text and Reference Books

L.I. Schiff, Quantum Mechanics (McGraw-Hill)
S. Gasiorowicz, Quantum Physics (Wiley)
B Craseman and J.D. Powell, Quantum Mechanics (Addison Wesley)
A.P. Messiah, Quantum Mechanics
J.J. Sakurai, Modem Quantum Mechanics
Mathews and Venkatesan Quantum Mechanics

ELECTRODYNAMICS AND PLASMA PHYSICS

Course Code: PHY6.0-CC-202

Max Marks 100 **60 hours**

Objectives

To provide concept of electrodynamics and fourth state of matter Plasma and their applications in real life problems.

Learning Outcomes

After completion of course, the students will

- Explain and solve advanced problems based on classical electrodynamics using Maxwell's equation.
- Be able to analyze's radiation systems in which the electric dipole, magnetic dipole or electric quadruple dominate.
- Have an understanding of the covariant formulation of electrodynamics and the concept of retarded time for charges undergoing acceleration.

Content

Unit I

Review of Four-Vector and Lorentz Transformation in Four-Dimensional Space, Electromagnetic Field Tensor in Four Dimension and Maxwell's Equations, Dual Field Tensor, Wave Equation for Vector and Scalar Potential and their Solutions.

Unit II

Retarded Potential and Lienard-Wiechart Potential, Electric and Magnetic fields due to a Uniformly moving Charge and an accelerated Charge, Linear and Circular Acceleration and Angular Distribution of power Radiated, Bramsstrahlung, Synchrotron radiation and Cerenkoy Radiation, reaction Force of Radiation.

Motion of charged Particles in Electromagnetic Field: Uniform E and B Fields, Non-uniform Fields, Diffusion Across Magnetic Fields, Time varying E and B Fields, Adiabatic Invariants: First, Second Third Adiabatic Invariants.

Unit III

Plasma Physics : Elementary Concepts; Derivation of moment equations from Boltzmann equation, Plasma oscillations, Debye Shielding, Plasma Parameters, Magnetoplasma, Plasma Confinement. Hydrodynamical description of Plasma Fundamental. Hydromagnetic Waves: Magnetosonic and Alfven Waves.

Wave phenomena in Magneto plasma: Polarization, Phase velocity, Group velocity, Resonance for Electromagnetic Wave propagating Parallel and Perpendicular to the Magnetic Field, Propagation through

Ionosphere and Magnetosphere

Text and Reference Books:

Panofsky and Phillips : Classical Electricity and Magnetism.
Bittencourt : Plasma Physics.
Chen : Plasma Physics.
Jackson : Classical Electrodynamics.

ATOMIC AND MOLECULAR PHYSICS

Course Code: PHY6.0-CC-203

Max Marks 100 **60 hours**

Objectives

To understand the physics at atomic and molecular level.

Learning Outcome

After completion of course, the Students will

- Be able to understand energy level of hydrogen and hydrogen spectra.
- Be able to understand zeeman and strak effect or splitting of emission spectra.
- Be able to understand basics of rotational and vibrational spectra for molecular level study of matter.

Content

Unit I

Quantum states of one electron atoms-Atomic orbitals-Hydrogen spectrum-Pauli's principle, Spectra of alkali elements-Spin orbit interaction and fine structure in alkali Spectra-Equivalent and non-equivalent electrons-Normal and anomalous Zeeman effect- Paschen Back effect• Stark effect-Two electron systems-interaction energy in LS and JJ Coupling-Hyperfine structure (qualitative)-Line broadening mechanisms (general ideas)

Unit II

Types of molecules-Diatomic linear symmetric top, asymmetric top and spherical top molecules• Rotational spectra of diatomic molecules as a rigid rotor-Energy levels and spectra of non rigid rotor-intensity of rotational lines-Stark modulated microwave spectrometer (qualitative)

Unit III

Vibrational energy of diatomic molecule-Diatomic molecule as a simple harmonic oscillator• Energy levels and spectrum-Morse potential energy curve-Molecules as vibrating rotator• Vibration spectrum of diatomic molecule-PQR branches IA spectrometer (qualitative)

Text and Reference Books

Introduction to Atomic spectra-H.E.White(T)

Fundamentals of molecular spectroscopy-C.B.Banwell (T) Spectroscopy Vol I, II & Ill-Walker &Straughen

Introduction to Molecular spectroscopy-G.M.Barrow

Spectra of diatomic molecules-Herzberg Molecular spectroscopy-Jeanne L McHale Molecular spectroscopy-J.M.Brown

Spectra of atoms and molecules-P.F.Bemath

Modem spectroscopy-J.M.Holias

ELECTRONIC DEVICES

Course Code: PHY6.0-CC-204

Max Marks 100 **60 hours**

Objectives

To develop an understanding of fundamentals of electronics in order to deepen the understanding of electronic devices that are part of the technologies around us.

Learning Outcome

After completion of course, the Students will

- Be able to use techniques for analyzing analogue and electronic devices.
- Be able to understand the concepts of Photonic devices.
- Be able to understand electronic devices based on electro-optic, acousto-optic and ferro-electric principle.

Content

Unit I

Transistors : JFET, BJT, MOSFET, and MESFET : Structure, Working, Derivations of the equations for I-V characteristics under different conditions. High frequency limits.

Unit II

Photonic Devices ; Radiative and non-radiative transitions. Optical Absorption, Bulk and Thin film Photoconductive devices (LDR), diode photodetectors, solar cell (open circuit voltage and short circuit current, fill factor). LED (high frequency limit, effect of surface and indirect recombination current, operation of LED), diode lasers (conditions for population inversion, in active region, light confinement factor. Optical gain and threshold current forlasing, Fabry-Perrot Cavity Length for lasing and the separation.

Unit III

Other Electronic Devices: Electro-Optic, Magneto-Optic and Acousto-Optic Effects. Material Properties related to get these effects. Important Ferro electric, Liquid Crystal and Polymeric materials for these devices. Piezoelectric, Electrostrictive and magneto strictive effects, Important materials exhibiting these properties, and their applications in sensors and actuator devices. Acoustic Delay lines, Piezoelectric resonators and filters. High frequency piezo electric devices- Surface Acoustic Wave Devices.

Text and Reference Books

Semiconductor Devices-Physics Technology, by SM Sze (Wiley 1985)

Introduction to semiconductor devices, by M.S. Tyagi, John Wiley & Sons

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

Optical electronics by AjoyGhatak and K. Thyaearajan. (Cambridge Univ. Press)

PRACTICAL LAB I

Course Code: PHY6.0-CC-205

Max Marks 100 **120 hours**

Instruction for Practical Examination:

Experiment	40 Marks
Viva-voce	25 Marks
Record	15 Marks
Total	80 Marks
Internal Assessment	20 Marks

A total of eight experiments must be performed by the students to complete the laboratory course. Experiments of equal standard can be designed to satisfy the minimum condition.

1. To use a Michelson Interferometer to determine :
   a. The wave length of Sodium yellow light
   b. The difference between the wavelength of the two sodium D-lines.
   c. The thickness of a mica sheet.
2. To test the validity of the Hartmann's prism dispersion formula using the visible region of mercury spectrum.
3. To analyze Elliptically Polarized light by Babinet’s Compensator.
4. To verify Fresnel’s Relations using prism and spectrometer.
5. To determine the Young’s Modulus of rod using Cornu’s Optical Method
6. To plot B-H Hysteresis curve using a solenoid on CRO and study it.
7. To determine the Magnetic Susceptibility of a Paramagnetic salt using Quinke’smethod .
8. To find the refractive index of air by means of a Fabry-Perot Etalon, the thickness between the plates being given.
9. Determination of wave length of Neon light taking Hg source as a standard source applying Hartmann

formula.

10. Determine Stefan's constant.
11. Determination of ionization potential of Lithium.
12. Determination of e/m of electron by Normal Zeeman Effect.
13. Determinations of dissociation energy of Iodine (I) molecules by photography, the absorptions band of Iodine in the visible region.
14. To determine Resolving Power of a Telescope.
15. To determine Dielectric constant of liquid using Lechar wire method.

PRACTICAL LAB II

Course Code: PHY6.0-CC-206

Max Marks 100 **120 hours**

Instruction for Practical Examination:

Experiment	40 Marks
Viva-voce	25 Marks
Record	15 Marks
Total	80 Marks
Internal Assessment	20 Marks

A total of eight experiments must be performed by the students to complete the laboratory course. Experiments of equal standard can be designed to satisfy the minimum condition.

1. Characteristics and applications of Silicon Controlled Rectifier.
2. Experiment on FET and MOSFET characterization and application as an amplifier.
3. Experiment on Uni-junction Transistor and its application,
4. Digital I : Basic Logic Gates, TTL, NAND and NOR.
5. Digital II: Combinational logic.
6. Flip-Flops.
7. To Study Wide Band Amplifier.
8. To study RF oscillator using Hartley and Colpitts Method.
9. To study Wein bridge Oscillator.
10. To study Phase Shift Oscillator.
11. To study the SCR circuit Solution of nonlinear equation using Scilab
12. To study dark and illumination characteristic of p-n junction solar cell and to determine (i) Its internal series resistance (ii) Diode ideality factor
13. To study the characteristics of following semiconductor devices (i) VDR (ii) photo transistor (iii)

Thermistor (iv) IED

14. To study dark and illumination characteristics of p-n junction solar cell and to determine its (i) Maximum power available (ii) Fill factor.

SEMESTER III

CONDENSED MATTER PHYSICS

Course Code: PHY6.5-CC-301

Max Marks 100 **60 hours**

Objectives

To provide extended knowledge of structure, thermal and electrical properties of solids.

Learning Outcome

After completion of course, the Students will

- Be able to formulate basic models for electrons and lattice vibrations for describing the physics of crystalline materials.
- Develop an understanding of relation between band structure and the electrical/optical properties of a material.

Content

Unit I

Crystalline solids, unit cells and direct lattice, two and three dimensional Bravais lattices, closed packed structures.

Interaction of X-rays with matter, absorption of X-rays. Elastic scattering from a perfect lattice. The reciprocal lattice and its applications to diffraction techniques. The Laue, powder and rotating crystal methods, crystal structure factor and intensity of diffraction maxima.

Unit II

Point defects, line defects and planer (stacking) faults. The role of dislocations in plastic deformation and crystal growth. The observation of imperfections in crystals, X-ray and electron microscopic techniques.

Electrons in a periodic lattice: Bloch theorem, band theory, classification of solids, effective mass. Tight-binding, pseudo potential methods.

Unit III

Fermi surface, de Hass von Alfen effect, cyclotron resonance, magneto resistance, quantum Hall effect,

Superconductivity: critical temperature, persistent current, Meissner Effect.

Weiss theory of ferromagnetism. Heisenberg model and molecular field theory. Spin waves and magnons. Curie-Weiss law for susceptibility, Ferri- and antiferro-magnetic order. Domains and Bloch-wall energy.

Text and Reference Books

Verma and Srivastava: Crystallography for Solid State Physics
Azaroff: Introduction to Solids
Omar: Elementary Solid State Physics
Aschroft&Mermin: Solid State Physics
Kittel: Solid State Physics
Chaikin and Lubensky: Principles of Condensed Matter Physics
Madelung: Introduction to Solid State Theory
Callaway: Quantum Theory of Solid State
Huang: Theoretical Solid State Physics
Kittet: Quantum Theory of Solids

NUCLEAR AND PARTICLE PHYSICS

Course Code: PHY6.5-CC-302

Max Marks 100 **60 hours**

Objectives

To provide an understanding of basic properties of nuclei, nuclear decay modes, nuclear force and nuclear models.

Learning Outcome

After completion of course, the Students will

- Have an understanding of the structure of the nucleus, radioactive decay, nuclear reactions and the interaction of nuclear radiation with matter.
- Develop an insight into the building block of matter along with the fundamental interactions of nature.

Content

Unit I

Nucleon - nucleon interaction - Exchange forces and tensor forces - Meson theory of nuclear forces - Nucleon - nucleon scattering - Effective range theory - Spin dependence of nuclear forces - Charge independence and charge symmetry of nuclear forces - Isospin formalism -Yukawa interaction.

Direct and compound nuclear reaction mechanisms - Cross sections in terms of partial wave amplitudes - Compound nucleus - Scattering matrix - Reciprocity theorem - Breit - Wigner one -level formula - Resonance scattering.

Unit II

Liquid drop model - Bohr - Wheeler theory of fission - Shell model - Spin - Orbit coupling - Magic numbers - Angular momentum and parities of nuclear ground states - Qualitative discussion and estimates of transition rates - Magnetic moments and Schmidt lines - Collective model of Bohr and Mottelson

Beta decay - Fermi theory of beta decay - Shape of the beta spectrum - Total decay rate-Angular momentum and parity selection rules - Comparative half - lives - Allowed and forbidden transitions - Selection rules - Parity violation - Two-component theory of neutrino decay -Detection and properties of neutrino

Gamma decay - Multipole transitions in nuclei - Angular momentum and parity selection rules - Internal conversion - Nuclear isomerism.

Unit III

Types of interaction between elementary particles - Hadrons and leptons - Classification of hadrons
Invariance, Symmetry and conservation laws , CP and CPT invariance
Lie algebra, SU(2) - SU(3) – multiplet building –
Quark model - Gell - Mann - Okubo mass formula for octet and decuplet hadrons , Quarks
Interaction of radiation with matter – Ionizing radiations, Ionization and transport phenomena in gases - Range Energy relationship, Avalanche multiplication.
Gas Counters : Ionization chambers, proportional counters, Geiger-Muller counters, neutron detector
Solid State Detectors : Semiconductor based detectors - Surface barrier detectors, Germanium Lithium Detectors ; Scintillation counters : Organic and inorganic scintillators - Theory, characteristics and detection efficiency; High Energy Particle Detectors : Nuclear emulsions - Cloud chambers - Bubble chambers - Cerenkov counter.

Text and Reference Books

A. Bohr and B.R. Mottelson, Nuclear Structure, Vol. 1 (1969) and Vol.2, Benjamin, Reading, A, 1975.
Kenneth S.Kiane, Introductory Nuclear Physics.Wiley, New York,1988.
Ghoshal, Atomic and Nuclear Physics Vol. 2,
P. H. Perkins, Introduction to High Energy Physics, Addison-Wesley, London, 1982.
ShirokovYudin, Nuclear Physics Vol. I & 2, Mir Publishers, Moscow, 1982.
D. Griffiths, Introduction to Elementary Particles, Harper and Row, New York, 1987.
H. A. Enge, Introduction to Nuclear Physics, Addison- Wesley, 1975.
G. E. Brown and A. D. Jackson, Nucleon - Nucleon Interaction, North - Holland, Amsterdam, 1976.
S. de Benedetti, Nuclear Interaction, John Wiley & Sons, New York, 1964.
M. K. Pal, Theory of Nuclear Structure, Affiliated East - West, Madras, 1982.
Y.R. Waghmare, Introductory Nuclear Physics, Oxford - IBH, Bombay, 1981.
J.M. Longo, Elementary Particles, Me Graw - Hill, New York, 1971.
RD.Evans, Atomic Nucleus, Me Graw Hill, New York,1955.
I. Kaplan, Nuclear Physics, 2nd Ed., Narosa, Madras, 1989.
B. L. Cohen, Concepts of Nuclear Physics, TMGH, Bombay, 1971.
R. R. Roy and B. P. Nigam, Nuclear Physics, Wiley - Eastern Ltd., 1983
G. E. Brown and A. D. Jackson, Nucleon - Nucleon Interaction,
North - Holland, Amsterdam, 1976.
P. Marmier and E.Sheldon, Physics of Nuclei and Particles, Vol. t &II, Academic Press, New York, 1970.
H. A. Enge, Introduction to Nuclear Physics, Addison - Wesley, 1975.

S.S. Kapoor and V. S. Ramamurthy, Nuclear Radiation Detectors, Wiley - Eastern, New Delhi, 1986.
W. H. Tait, Radiation Detection, Butterworths, London, 1980.
W. J. Price, Nuclear Radiation Detection, Mc Graw Hill, New York, 1964

ADVANCED CONDENSED MATTER PHYSICS

Course Code: PHY6.5-SE-303 (A)

Max Marks 100 **60 hours**

Objectives

To provide extended knowledge of optical properties of solids and superconductor.

Learning Outcome

After completion of course, the Students will

- Be able to formulate basic models for electrons and lattice vibrations for describing the physics of crystalline materials.
- Develop an understanding of relation between band structure and optical properties of a material.

Content

Unit I

Interaction of electrons and phonons with photons. Direct and indirect transitions. Absorption in insulators, one-phonon absorption, Interaction of electrons with acoustic and optical phonons, Polaron theory, electronic transport and optical properties of polarons

Unit II

Plasmonics – Electromagnetic properties of metals, skin effect and anomalous skin effect. Surface Plasmons - Polaritons, Localized surface Plasmon Resonances, Bulk Plasmon-Polaritons , applications of Plasmonics

UNIT III

Superconductivity: manifestations of energy gap. Cooper pairing due to phonons, BCS theory of superconductivity, Ginzsburg-Landau theory and application to Josephson effect: d-c Josephson effect, a-c Josephson effect, macroscopic quantum interference. Vortices and typeII superconductors, high temperature superconductivity (qualitative).

Text and Reference Books

Madelung: Introduction to Solid State Theory
Callaway: Quantum Theory of Solid State
Huang: Theoretical Solid State Physics
Kittel: Quantum Theory of Solids

ADVANCED QUANTUM MECHANICS

Course Code: PHY6.5-SE-303 (B)

Max Marks 100 **60 hours**

Objectives

To provide deepen knowledge of physics to work with interdisciplinary field of quantum electrodynamics

Learning Outcome

After completion of course, the Students will

- Be able to understand about Dirac field and KG field
- Be able to understand the Feynmann diagrams.
- Understand about application to high energy and subatomic physics

Content

Unit I

Dirac equation, properties of Dirac matrices. Projection operators, Traces and trace theorems, bilinear covariants. Feynman's theory of positron.

Klein-Gordon field, Second quantization of Klein-Gordon Field

Unit II

Creation and Annihilation operators, Commutation relations, Quantization of electromagnetic field - creation and Annihilation operators, Commutation relations.

Fock space representation, interacting fields, Dirac (interaction) picture, S-Matrix and its expansion.

Unit III

Ordering theorems, Feynman graph and Feynman rules. Application to problems - Rutherford scattering, Compton scattering, pair production, pair annihilation. calculation of cross-sections using Feynman graphs.

Text and Reference Books

Bjorken& Drell: Relativistic Quantum Fields

Muirhead: The Physics of Elementary Particles

Schweber, Bethe and Hoffmann: Mesons and Fields

Sakurai: Advanced Quantum Mechanics

Mandal: Introduction to Field Theory

Lee: Particle Physics and Introduction to Field Theory

PHYSICS OF ELECTRONIC DEVICES AND INTEGRATED CIRCUITS

Course Code : PHY6.5-SE-304(A)

Max Marks 100 **60 hours**

Content

Unit I

Energy bands, direct and indirect band semiconductors, degenerate and compensated semiconductors, Elemental Si and GaAs compound semiconductors. Ternary and quaternary alloys such as Al-Ga-As, Ga-P-As etc. Important properties of ternary and quaternary such as band gap and refractive index changes with concentration of elements. Doping of elements of group III, V, II and VI in compounds. Diffusion of impurities-thermal diffusion, surface concentration, total dopant diffusion, ion implantation

Unit II

Static and dynamic random access memories, SRAM and DRAM, CMOS and NMOS, non-volatile memory, magnetic and ferromagnetic memories, charge coupled CCD and solid stateSSD devices

Electro-optic, magneto-optic and acousto-optic effects, Ferromagnetic, liquid crystals and polymeric materials for these devices.

Piezoelectric, electrostrictive and magnetostrictive effects and their applications in sensors and actuator devices. High frequency piezoelectric devices – surface acoustic wave devices, pyroelectric effect, inorganic oxide and polymer pyroelectric materials and their applications

Unit III

Thin film deposition techniques : vacuum evaporation – vacuum gauge and pump-pumping speed-effective conductance control; chemical vapour deposition (CVD), MOCVD, PEMOCVD (plasma enhanced CVD); physical vapourdeposition , thermal evaporation,; Molecular beam epitaxy (MBE),

Lithography – etching and micromachining of Si, fabrication of integrated circuits and integrated micro-electro-mechanical systems (MEMS), principle of nanolithography technique

DIGITAL ELECTRONICS AND COMMUNICATION ELECTRONICS

Course Code: PHY6.5-SE-304 (B)

Max Marks 100 **60 hours**

Objectives

To provide the basic understanding about digital electronics and communication.

Learning Outcome

After completion of course, the Students will

- Be able to understand the amplitude and frequency modulation.
- Get the idea about combinational and sequential logic circuits and applications

- Be able to understand and use the working microprocessors

Content

Unit I

Communication

Amplitude modulation - Generation of AM waves - Demodulation of AMwaves - DSBSC modulation. Generation of DSBSC waves, Coherent detection of DSBSC waves, SSB modulation, Generation and detection of SSB waves. Vestigial sideband modulation. Frequency Division multiplexing (FDM).

Unit II

Digital Electronics

Combinational Logic - The transistor as a switch, OR, AND and NOT gates - NOR and NAND gates Boolean algebra - Demorgan's theorems - Exclusive OR gate, Decoder/Demultiplexer Data selector/multiplexer - Encoder.

Sequential Logic - Flip - Flops: A I - bit memory - The RS Flip - Flop, JK Flip - Flop - JK master slave Flip - Flops - T Flip - Flop - D Flip - Flop - Shift registers - synchronous and asynchronous counters - cascade counters.

Unit III

Microprocessors

Introduction to microcomputers - memory - input/output - Interfacing devices 8085 CPU - Architecture - BUS timings - Demultiplexing the address bus generating control signals - Instruction set - addressing modes - Illustrative programmes - writing assembly language programmes looping, counting and indexing - counters and timing delays - stack and subroutine.

Text and Reference Books

"Electronic Devices and circuit theory" by Robert Boylested and Louis Nashdsky PHI, New Delhi -110001,1991

"OP-Amps & Linear integrated circuits," by Ramakanth A. Gayakwad PHI, Second Edition, 1991

"Digital principles and Applications" by A.P. Malvino and Donald P. Laach, Tata Megraw - Hill company. New Delhi, 1993.

"Microprocessor Architecture, programming and Applications with 8085/8086 by Ramesh S. Gaonkar, Wiley - Eastern Ltd., 1987 (for unit v)

PRACTICAL LAB I

Course Code: PHY6.5-CC-305

Max Marks 100 **120 hours**

Instruction for Practical Examination:

Experiment	40 Marks
Viva-voce	25 Marks
Record	15 Marks
Total	80 Marks
Internal Assessment	20 Marks

A total of eight experiments must be performed by the students to complete the laboratory course. Experiments of equal standard can be designed to satisfy the minimum condition.

1. To draw the characteristic curve of GM counter.
2. Determine dead time of GM counter using two source method
3. Determine the end point energy of a given beta ray source.
4. Determine mass attenuation coefficient of beta rays in a given medium using GM counter .
5. Find out the percentage resolution of given scintillation spectrometer using Cs-137
6. Find out the energy of a given X-ray source with the help of a scintillation spectrometer.
7. To study Absorption Coefficient of a Liquid using Photovoltaic cell.
8. X-ray diffraction by Telexometer
9. Find out the percentage resolution of given scintillation spectrometer using Cs_{137}
10. Find out the energy of a given X-ray source with the help of scintillation spectrometer.
11. Measurmentof Hall coefficient, mobility and carrier concentration of a given semiconductor and identification of type of semiconductor.
12. Determine the dielectric constant of given oil with the Leacher wire system.
13. Determine of Lande's 'g' factor for IRRH crystal using electron spin resonance spectrometer
1. To determine e/m of an electron by magnetron valve method.
2. To determine e/k using transistor characteristics.
14. Study magnetism by heating and cooling bar magnets
15. Determine fine structure constant using sodium doublet.

ELECTIVE LAB I / II

Course Code: PHY6.5-CE-306

Max Marks 100 **120 hours**

The experiments in this course are to be designed to cover topics in elective papers opted in course PHY6.5-CE-303 or PHY6.5-CE-304 as fas as possible. A total of eight (08) experiments must be performed by the students. Experiments of equivalent standards can be set to satisfy minimum requirements.

Instruction for Practical Examination:

Experiment	40 Marks
Viva-voce	25 Marks
Record	15 Marks
Total	80 Marks
Internal Assessment	20 Marks

SEMESTER IV

NUMERICAL METHODS AND PROGRAMMING

Course Code: PHY6.5-CC-401

Max Marks 100 **60 hours**

Objectives

To introduce numerical methods and Computational techniques for solving problems in various areas of Physics using Programming.

Learning Outcome

After completion of course, the Students will

- Be able to understand basics of error analysis and its use in theory and experiments.
- Be able to use numerical methods to solve linear and nonlinear equation, differentiation and integration.
- Be able to understand basics of computer programming and its use to solve physics problems.

Content

Unit I

Methods for determination of zeroes of linear and nonlinear algebraic equations and transcendental equations, convergence of solutions.

Solution of simultaneous linear equations, Gaussian elimination, pivoting, iterative Method, matrix inversion.

Eigenvalues and eigenvectors of matrices, Power and Jacobi Method.

Finite differences, interpolation with equally spaced and unevenly spaced points. Curve fitting, Polynomial least squares and cubic Spline fitting.

Unit II

Numerical differentiation and integration, Newton-Cotes formulae, errorestimates, Gauss method.

Random variate, Monte Carlo evaluation of Integrals, Methods of importance sampling, Random walk and Metropolis method.

Numerical solution of ordinary differential equations, Euler and Runge Kutta methods, Predictor and corrector method. Elementary ideas of solutions of partial differential equations.

Unit III

Introduction to Scilab, Scilab environment, workspace and working directory, Basic syntax and Built in Functions, Creating matrices and some matrix operation, Programming: Functions, Loops, Conditional statement and Plotting, Script file and Function file.

Text and Reference Books

Shastry : Introductory Methods of Numerical Analysis

Rajaraman : Numerical Analysis,

Vetterming, Teukolsky, Press and Flannery : Numerical Recipes

Sandeep Nagar: Introduction to Scilab: For Engineers and Scientists

PHYSICS OF NANOMATERIALS AND NANOSTRUCTURES

Course Code: PHY6.5-CC-402

Max Marks 100 **60 hours**

Objectives

To provide deepen understanding the properties of nanomaterials and nanostructures

Learning Outcome

After completion of course, the Students will

- Be able to understand the properties of nanomaterial and use in modern technology.
- Use the fabrication and characterization techniques of nanomaterials.

Content

Unit I

Free electron theory and its features, Idea of band structure, Metals, insulators and semiconductors, Density of state in bands, Variation of density of states with energy, Variation of density of state and band gap with size of crystal. (only qualitative)

Atomic structure: Electron orbits, The Bohr atom; Quantum Structure: 2D (Quantum well), 1D (Quantum Wires), 0D (Quantum Dots); Electron confinement in infinitely deep square well, confinement in two and one dimensional well, Idea of quantum well structure - Quantum dots, Quantum wires etc.

Unit II

Metal nanoclusters, geometric structures, electronic structure, bulk to nanotransition, magnetic clusters, semiconducting nanoparticles, Carbon nanoparticles: Carbon nanotubes (CNT), unit cell for CNTs. Phonons in carbon nanotubes , Bulk nanostructured materials: Solid disordered crystals, Metamaterials, Photonic crystals

Unit III

Novel Properties of Nanomaterials

Size and shape dependent optical emission, electronic transport, photonic, refractive index, dielectric, mechanical, magnetic, non-linear optical properties;

Determination of particle size :Increase in width of XRD peaks of nanoparticles, Shift in photoluminescence peaks, Variations in Raman spectra of nanomaterials

Different methods of preparation of nanomaterials, Bottom up: wet chemical method like sol-gel method, micro emulsion technique, decomposition of organometallic precursors and chemical vapor deposition, Ion beam deposition, Chemical bath deposition with capping techniques and Top down : Ball Milling, laser ablation, microwave and ultrasound assisted synthesis sputtering and microwave plasma

Text and Reference Books

Nanotechnology Molecularly designed materials by Gan-Moog Chow, Kenneth E. Gonsalves, American Chemical Society

Quantum dot heterostructures by D. Bimerg, M. Grundmann and N.N. Ledentsov, John Wiley & Sons, 1998.

Nano technology : Molecular speculations on global abundance by B.C. Crandall, MIT Press 1996.

Physics of low dimensional semiconductors by John H. Davies, Cambridge Univ. Press 1997. Physics of semiconductor nano structures by K.P. Jain, Narosa 1997.

Nano fabrication and bio system : Integrating materials science engineering science and biology by Harvey C. Hoch, Harold G. Craighead and Lynn Jelinski, Cambridge Univ. Press 1996.

Nano particles and nano structured films; Preparation characterization and applications Ed. J.H Fendler, John Wiley &Sons 1998.

Schmid, G. (Ed.), "Nanoparticles", Wiley-VCH Verlag GmbH & Co. KgaA.2004

G.L. Hornyak, J. Dutta, H. F. Tibbals and A. K. Rao, Introduction to Nanoscience, CRC Press (2008)

Nanostructures and Nanomaterials, synthesis, properties and applications by Guozhong Cao, Imperial College Press, 2004.

PHYSICS OF LASERS AND LASER APPLICATIONS

Course Code: PHY6.5-SE-403 (A)

Max Marks 100 **60 hours**

Objectives

To provide an understanding of LASER, its technological application.

Learning Outcome

After completion of course, the Students will

- Understand the deepen knowledge of LASER principle and working.
- Be able to understand and use of various kind of LASER and its application for light matter interaction.

Content

Unit I

Gaussian beam and its properties. Stable Two-Minor Optical Resonators, Longitudinal and Transverse Modes of Laser Cavity. Mode Selection, Gain in a Regenerative Laser Cavity. Threshold for 3 and 4 level Laser Systems. Mode Locking Pulse Shortening - Picosecond & femtosecond operation, Spectral Narrowing and Stabilization.

Unit II

Ruby Laser, Nd-YAG Laser, Semi Conductor Lasers, Diode-Pumped Solid State Lasers, Nitrogen Laser, Carbon-dioxide Laser, Excimer Laser, Dye Laser, High Power Laser Systems.

Laser Fluorescence and Raman Scattering and their use in pollution studies,

Unit III

Non-Linear interaction of Light with matter, Laser induced multiphoton processes and their applications, Ultrahigh resolution Spectroscopy with lasers and its applications, Propagation of light in a medium with variable refractive index. Optical Fibers. Light wave communication. Qualitative treatment of Medical and Engineering applications of Lasers.

Text and Reference Book

Svelto: Lasers

Yariv: Optical Electronics

Demtroder: Laser Spectroscopy

Letekhov: Non-Linear Laser Spectroscopy

SCIENCE AND TECHNOLOGY OF RENEWABLE ENERGIES

Couse Code: PHY-SE-403 (B)

Max Marks 100 **60 hours**

Objectives

To provide an understanding solar energy and Hydrogen energy for better technological application.

Learning Outcome

After completion of course, the Students will

- Understand knowledge of solar and hydrogen energy.
- Be able to get idea of solar cell and hydrogen energy for application in advanced technology.

Content

Unit I

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

Types of Solar Celts, p n junction solar cell, Transport Equation, Current Density, Open circuit voltage and short circuit current, Brief descriptions of single crystal silicon and amorphous silicon solar cells, elementary ideas of advanced solar cells e.g. Tandem Solar Cells. Solid Liquid Junction Solar Cell.

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Unit II

Elements of Solar Thermal Energy, Wind Energy and Ocean Thermal Energy Conversion.

Principles of Photoelectrochemical solar cells, Relevance in relation to depletion of fossil fuels and environmental considerations. Solar Hydrogen through Photoelectrolysis and Photocatalytic process

Unit III

Physics of material characteristics for production of Solar Hydrogen. Brief discussion of various storage processes, special features of solid state hydrogen storage materials, structural and electronic characteristics of storage materials. New Storage Modes.

Various factors relevant to safety, use of Hydrogen as Fuel, Use in Vehicular transport, Hydrogen for Electricity Generation, Fuel Cells, Elementary concepts of other Hydrogen Based devices such as Air Conditioners and Hydride Batteries.

Text and Reference Book

Svelto: Lasers

Yariv: Optical Electronics

Demtroder: Laser Spectroscopy

Letekhov: Non-Linear Laser Spectroscopy

Fonash : Solar Cell Devices – Physics

Fahrenbruch&Bube : Fundamentals of Solar Cells Photovoltaic Solar Energy

Chandra :Photoelectrochemical Solar Gells

Winter &Nitch (Eds.) : Hydrogen as an Energy Carrier Technologies Systems Economy

MEDICAL PHYSICS

Course Code: PHY-SE-403 (C)

Max Marks 100 **60 hours**

Objectives

To provide deepen knowledge of physics to work with interdisciplinary field as medical.

Learning Outcome

After completion of course, the Students will

- Be able to understand about basics of medical diagnosis techniques
- Be able to understand the working of clinical and operational equipment.
- Understand about radiation protection and shielding for use in the medical field.

Content

Unit I

Biosignal acquisition, Bioelectric signal recording and Physiological assist devices

Physiological signal amplifiers-isolation amplifiers-differential amplifiers-bridge amplifiers-chopper amplifiers-noises and CMRR –medical preamplifier design, Bioelectric potentials-resting and action potentials-half cell potential-surface,needle and micro electrodes, electrical equivalent circuits-ECG,EMG,EEG recording circuits.

Cardiac pace makers-natural and artificial pace makers-pace maker batteries -defibrillator- AC/DC. Synchronised defibrillator-stimulators-bladder stimulators - heart lung machine.

Clinical equipments, Operation theatre equipments, Biotelemetry and safety instrumentation

Unit II

Various types of oxygenators - kidney machine-hemodialying units-peritonial dialysis. Flame photometer-spectro-flurophotometer - pH meters. Audiometers-endoscopes-electromagnetic and laser blood flow meters-ventilators –diathermy units-ultrasonic,micro wave diathermy techniques.

Design of a biotelemetry system, radiotelemetry with subcarrier-multiple channel telemetry systems-problems in implant telemetry-uses of biotelemetry-physiological effects of 50 HZ current –microshock and macro shock-electrical accidents in hospitals-devices to protect against electrical hazards.

Unit III

Radiation Protection and Shielding

Need for protection, philosophy of radiation protection, basic radiation protection criteria, External and internal exposure, additive risk model and multiplicative risk model. Risk coefficients. Dose to the foetus. Dose limits for occupational exposure, for public and special exposure situations. ICRP and AERB recommendations. Basic safety standards. Source, practices, types of exposures, interventions. Atomic energy act, Radiation protection Rules, Notifications, Transport regulations, Waste disposal rules, Food irradiation rules, licensing, approval of devices, installations, sites and packages containing radioactive material.

Radiation Shielding

Shielding calculation for gamma radiation, choice of material, Primary and secondary radiation, source geometry, discrete sources, point, kemel method, introduction to Monte Carlo method, Beta shielding, Bremsstrahlung. Neutron shielding, scattering and absorption, activation of the shielding material, heat effects. Optimization of shielding, gamma, electron, neutron irradiation facilities. Transport and storage of containers for high activity sources. Shielding requirements for medical and research facilities including accelerator installations.

Books for Study and Reference

Jacobson and Webster; Medicine and clinical engineering,Prentice Hall of India,New Delhi,1979

R.S.Khandpur,Hand book of biomedical instrumentation,Tata McGraw Hill,New Delhi,1990

M.Arumugam, Biomedical instrumendation, Anuradha publishing Co, Kumbakonam, Tamilnadu 1992.

RichadAston,Principles of biomedical instrumendation and measurements,Merrill publishing Co,London,1990.

R.F.Mould, Radiation Protection in Hospital, Adam Hilger Ltd., Bristol, 1985.

The essential Physics of Medical Imaging; Jerrold. T. Bushberg et.al, Lipcontt Williams & Wilkins 2002.

Faiz. M. Khan, The Physics of Radiationtherapy, Lippincott Williams & Wilkins, Philadelphia, 3rd edtion 2003.

A.Martin and S.A.Harbison, An introduction to Radiation Protection, John Wiley &'Sons Inc., New York, 1981.

ICRP Publications (ALL) ; AERB Safety codes(ALL) ; NCRP Publications(ALL)

OPTOELECTRONICS AND MICROWAVE ELECTRONICS

Course Code : PHY-SE-404(A)

Max Marks 100 **60 hours**

Objectives

To gain knowledge in the field of optoelectronic devices and microwave communication

Learning outcome

After the completion of course, the student will

- Understand the working principles and applications of photo detectors, light emitting diodes and application of phototransistor etc
- Gain knowledge in the field of microwave devices such as klystron, gunn diodes microwave transmission and reception

Content

UNIT I

Optoelectronics

Photodetectors : Photodetectors with external photo effect, photodetectors with internal photo effect, photoconductors and photo resistors, junction photo detectors

Circuits with light emitting diodes, diode tester, polarity and voltage tester

LED numeric and alphanumeric display units, semiconductor switches. The phototransistor as a switch in optocouplers, steady state performance, dynamic performance, use of optocouplers

UNIT II

Microwave Devices

Klystrons, Magnetrons and Travelling Wave Tubes, Velocity modulation, Basic principles of two cavity Klystrons and Reflex Klystrons, principles of operation of magnetrons. Helix Travelling Wave Tubes, Wave Modes.

Transferred electron devices, Gunn Effect, Principles of operation. Modes of operation, Read diode, IMPATT diode, TRAPATT Diode.

Microwave Communications

Advantages and disadvantages of microwave transmission, loss in free space, propagation of microwaves, atmospheric effects on propagation, Fresnel zone problem, ground reflection, fading sources, detectors, components, antennas used in MW communication systems

Unit III

Radar Systems

Radar block diagram an operation, radar frequencies, pulse considerations. Radar range equation, derivation of radar range equation, minimum detectable signal, receiver noise, signal to noise ratio, Integration of radar pulses.

Radar cross section. Pulse repetition frequency. Antenna parameters, system Losses and Propagation losses. Radar transmitters, receivers. Antennas, Displays.

Satellite Communications

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

Text and Reference Books

"Microelectronics" by Jacob Millman, Megraw-hill International Book Co.. New Delhi,1990

"Optoelectronics: Theory and Practice", Edited by Alien chappal. Me GrawHill Book Co., New York.

"Microwaves" by K.L. Gupta, Wiley Eastern Ltd., New Delhi, 1983

"Advanced Electronics Communications Systems" by Wayne Tornasi., Phi.Edn.

Microwave Theory , by Atwater

PHYSICS OF SEMICONDUCTOR DEVICES

Course Code: PHY-SE-404(B)

Max Marks 100 **60 hours**

Objectives

To provide an understanding of electronic devices.

Learning Outcome

After completion of course, the Students will

- Understand the deepen knowledge of laser materials and semiconductor device materials and working.
- Be able to understand and use of various kind of semiconductor materials and carrier transport

Content

Unit I

Semiconductor Materials

Energy Bands, Intrinsic carrier concentration. Donors and Acceptors, Direct and Indirect band semiconductors. Degenerate and compensated semiconductors. Elemental (Si) and compound semiconductors (GaAs). Replacement of group Ill element and Group V elements to get tertiary alloys such as AlGaAs or GaPAs and quaternary such as lnGaPAs alloys and their important properties such as band gap and refractive index changes with elemental concentration changes. Doping of Si (Group Ill (n) and Group V (p) compounds) and GaAs (group II (p), IV (n.p) and VI (n compounds). Diffusion of Impurities- Thermal Diffusion, Constant Surface Concentration, Constant Total Dopant Diffusion, Ion Implantation.

Unit II

Carrier Transport in Semiconductors:

Carrier Drift under low and high fields in (Si and GaAs), saturation of drift velocity. High field effects in two valley semiconductors. Carrier Diffusion, Carrier Injection, Generation Recombination Processes- Direct, Indirect bandgap semiconductors. Minority Carrier Life Time, Drift and Diffusion of Minority Carriers (Haynes-Shockley Experiment) Hall Coefficient, Minority Carrier Life Time..

Unit III

Junction Devices: (i) p-n junction- Energy Band diagrams forhomo andhetro junctions. Current flow mechanism in p-n junction, effect of indirect and surface recombination currents on the forward biased diffusion current, p-n junction diodes- rectifiers (high frequency limit), (ii) Metal-semiconductor (Schottky Junction): Energy band diagram, current flow mechanisms in forward and reverse bias, effect of interface states. Applications of Schottky diodes, (iii) Metal-Oxide-Semiconductor (MOS) diodes. Energy band diagram, depletion and inversion layer. High and low frequency Capacitance Voltage (C-V) characteristics. Smearing of C-V curve, flat band shift. Applications of MOS diode.

Text and Reference Book

The Physics of Semiconductor Devices by D.A, Eraser, Oxford Physics Series (1986)

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

Introduction to semiconductor devices, M. S. Tyagi, John Wiley & Sons

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

Thin film phenomena by K.L.Chopra

The material science of thin films, Milton S. Ohring

Optical electronics by Ajay ghatak and K. Thyagarajan. Cambridge Univ. Press

Material Science for Engineers, by James F. Shackelford, Prentice Hall

Deposition techniques for films and coatings, R.F Bunshah (Noyes publications)

Solid state electronics, Ben G. Streetman

SOLID STATE PHYSICS AND DISORDERED SYSTEMS

Course Code: PHY-SE-404 (C)

Max Marks 100 **60 hours**

Objectives

To provide extended knowledge of structure, thermal and electrical properties of solids.

Learning Outcome

After completion of course, the Students will

- Be able to formulate basic models for electrons and lattice vibrations for describing the physics of crystalline materials.

- Develop an understanding of relation between band structure and the electrical/optical properties of a material.

Content

Unit I

Electrons in Solids and Surface States

Interacting electron gas: Hartree and Hartree-Fock approximations, correlation energy. Screening, plasma oscillations. Dielectric function of an electron gas in random phase approximation. Limiting cases and Friedel oscillation, strongly-interacting Fermi system. Elementary introduction to Landau's quasi-particle theory of a Fermi liquid

Unit II

Strongly correlated electron gas. Elementary ideas regarding surface states, metallic surfaces and surface reconstruction.

Disordered Systems

Point-defects: Shallow impurity states in semiconductors. Localized lattice vibrational states in solids. Vacancies, interstitials and colourcentresin ionic crystals.

Unit III

Disorder in condensed matter, substitutional, positional and topographical disorder, Short and long range order. Atomic correlation function and structural descriptions of glasses and liquids.

Anderson model for random systems and electron localization, mobility edge, qualitative application of the idea to amorphous semiconductors and hopping conduction.

Text and Reference Books

Madelung: Introduction to Solid State Theory
Callaway: Quantum Theory of Solid State
Huang: Theoretical Solid State Physics

PRACTICAL LAB I

Course Code: PHY-CC-405

Max Marks 100 **120 hours**

Instruction for Practical Examination:

Experiment	40 Marks
Viva-voce	25 Marks
Record	15 Marks
Total	80 Marks
Internal Assessment	20 Marks

A total of eight experiments must be performed by the students to complete the laboratory course. Experiments of equal standard can be designed to satisfy the minimum condition.

1. Numerical Integration (Simpson's 1/3 rule, Simpson's 3/8 rule etc.) using Scilab
2. Numerical Differentiation (Runga-Kutta method) using Scilab
3. For a given primitive basis vectors **a, b , c ,** write a computer program to find bravis lattice
4. Write a computer program to draw band structure of Si/Ge using Kronig Penny model
5. Least square fitting method to to find slope ofstraight line in Scilab
6. Prepare thin films using chemical bath deposition method
7. Write a programme to solve non-linear equations using Newton Raphson iterative method
8. Analyze Raman Spectrum of a sample using a simulation software
9. Analyze Fluorescence spectrum of a sample using simulator
10. Study X-ray diffraction analysis of variation of particle size in nanomaterials
11. To determine dielectric constant of the ceramic specimen using given experimental setup based on parallel plate capacitor configuration.
12. To study dispersion curves for mono and diatomic lattices using lattice dynamic kit.
13. To perform a polynomial fit for a given set of data
14. Fourier Analysis of a square wave
15. To find determinant of a matrix, its eigenvalues and eigen vectors
16. To simulate phenomenon of nuclear radioactivity using Monte Carlo technique.

ELECTIVE LAB I/II

Course Code: PHY-CE-406

Max Marks 100 **120 hours**

The experiments in this course are to be designed to cover topics in elective papers opted in course PHY6.5-CE-403 or PHY6.5-CE-404 as far as possible. A total of eight (08) experiments must be performed by the students. Experiments of equivalent standards can be set to satisfy minimum requirements.

Instruction for Practical Examination:

Experiment	40 Marks
Viva-voce	25 Marks
Record	15 Marks
Total	80 Marks
Internal Assessment	20 Marks

Research Project / Dissertation

Course Code: PHY6.5-CC-407

Max Marks 100 **60 hours**

This course will be based on **preliminary research oriented topics either from theory or experiment preferably from elective papers**. The faculty members who will act as supervisors for the projects will float projects and any one of them will be allocated to the student. After the allotment, the student shall present synopsis in the department regarding aim, objective and method(s) to carry out the research work. The department shall keep a record of the progress of the work undertaken by the students. At the completion of the research work by the semester end, the student will submit a Project Report/ Dissertation which will be examined by an external examiner. The examination shall consist of (a) Presentation and (b) Comprehensive viva-voce.