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 2023-2024

PROGRAMME BROCHURE

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

Program Objective:

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 I-IV 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 complete 100 credits for the completion of course.

- Each theory course is of 4 credits for which there will be 4 hours of lecture/tutorial per week.
- Each practical course is of 4 credits for which there will be 18 hours of laboratory work per batch per week. A minimum of 240 hours are required as per UGC norms for the completion of laboratory work and conduct practical examination.

The maximum marks for each course will be 50. For theory course, 50 marks will be allocated for end-semester examination of 3 hours duration. For laboratory course, 50 marks shall be allocated for end-semester examination of 5 hours to be conducted by an external examiner.

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 Setting Theory Question Paper

The question paper shall consist of 3 sections.

Section-A will consists 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 words limit of parts A, B, and C are 50, 200, and 500 words respectively

Pass Marks and Promotion Criteria

A candidate has to pass in internal assessment as well as theory paper and practical individually to pass each semester. 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
PHY-CC-101	Mathematical Physics	3	1		4	10	40	03	10
PHY-CC-102	Classical Mechanics	3	1		4	10	40	03	10
PHY-CC-103	Quantum Mechanics I	3	1		4	10	40	03	10
PHY-CC-104	Statistical Mechanics	3	1		4	10	40	03	10
PHY-PR - 105	Practical Lab I			4	4	10	40	04	16
PHY-PR-106	Practical Lab II			4	4	10	40	04	16

Semester II								
Course Code	Course Title	Lecture	Tutorial	Practical	Credits	Max. Marks		Min. Marks
						Internal	External	
PHY-CC-201	Quantum Mechanics II	3	1		4	10	40	13(25%)
PHY-CC-202	Electrodynamics and Plasma Physics	3	1		4	10	40	13(25%)
PHY-CC-203	Atomic and Molecular Physics	3	1		4	10	40	13(25%)
PHY-CC-204	Semiconductor Devices	3	1		4	10	40	13(25%)
PHY-PR-205	Practical Lab III			4	4	10	40	18(36%)
PHY-PR-206	Practical Lab IV			4	4	10	40	18(36%)

Semester III								
Course Code	Course Title	Lecture	Tutorial	Practical	Credits	Max. Mark		Min. Marks
						Internal	External	
PHY-CC-301	Condensed Matter Physics	3	1		4	10	40	13(25%)
PHY-CC-302	Nuclear and Particle Physics	3	1		4	10	40	13(25%)
PHY-CE-303	(A) Advanced Condensed Matter Physics	3	1		4	10	40	13(25%)
	(B) Nuclear Radiation Detection, Measurement and Dosimetry							
PHY-CE-304	(A) Digital Electronics and Communication Electronics	3	1		4	10	40	13(25%)
	(B) Microwave Electronics							
PHY-PR-305	Practical Lab V			4	4	10	40	18(36%)
PHY-PR-306	Practical Lab VI			4	4	10	40	18(36%)

Semester IV								
Course Code	Course Title	Lecture	Tutorial	Practical	Credits	Max. Marks		Min. Marks
						Internal	External	
PHY-CC-401	Computational Methods and Programming	3	1		4	10	40	13(25%)
PHY-CC-402	Physics of Nanomaterials and Nanostructures	3	1		4	10	40	13(25%)

PHY-CE-403	**(A) Physics of Lasers and Laser Applications** **(B) Solid State Physics and Disordered System** **(C) Advanced Quantum Mechanics**	**3**	**1**		**4**	**10**	**40**	**13(25%)**
PHY-CE-404	**(A) Physics of Semiconductor Devices** **(B) Science and Technology of Renewable Energies** **(C) Medical Physics**	**3**	**1**		**4**	**10**	**40**	**13(25%)**
PHY-PR-405	**Practical Lab VII**			**4**	**4**	**10**	**40**	**15(36%)**
PHY-PR-406	**Practical lab VIII**			**4**	**4**	**10**	**40**	**15(36%)**
PHY-PROJ-407	**Research Project**				**4**	**10**	**40**	**15(36%)**

COURSE WISE CONTENT

MATHEMATICAL PHYSICS

Course Code: PHY-CC-101

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; inverse LT by partial fractions; LT; derivative and integral of a function; Fourier series; FS or arbitrary period; Half-wave expansions; Partial sums; Fourier integral and transforms; F T of delta function.

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: PHY-CC-102

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: PHY-CC-103

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 Eigen functions; 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.

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: PHY-CC-104

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, contact between statistics and thermodynamics, classical ideal gas, entropy of mixing and Gibb's paradox. Micro canonical ensemble, phase space, trajectories and density of states, Liouville's theorem, canonical and grand canonical ensembles; partition function, calculation of statistical quantities, Energy and density fluctuation.

Unit II

Density matrix, statistics of ensembles, statistics of indistinguishable particles, Maxwell-Boltzman, Fermi-Dirac and Bose-Einstein statistics, properties of ideal Bose and Fermi gases, Applications such as Bose-Einstein condensation, Free electron theory of metal.

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 tranport 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: PHY-PR-105

1. To determine e/m by Thomson Method.
2. To determine e/m by Helical Method.
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 determine e/m by Millikan's oil Drop method.
7. To determine Resolving Power of a Telescope.
8. To plot B-H Hysteresis curve using a solenoid on CRO and study it.
9. To determine velocity of Sound in Air by Standing Wave Method.
10. To determine the Magnetic Susceptibility of a Paramagnetic salt using Quinke'smethod .
11. To study Energy Transfer between Coupled Oscillators.
12. To use a Michelson Interferometer to determine :
    a. The wave length of Sodium yellow light
    b. The difference between the wave length of the two sodium D-lines. (iii) the thickness of a mica sheet.

PRACTICAL LAB II

Course Code: PHY-PR-106

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.

QUANTUM MECHANICS II

Course Code: PHY-CC-201

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, WKB approximation; Alpha decay Identical particles; Symmetric and antisymmetric wave functions; collision of identical particles; Spin angular momentum; Spin functions for a many-electron. Klein-Gordan and Dirac’s equation.

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: PHY-CC-202

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

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, Cut- offs, Resonance for Electromagnetic Wave propagating Parallel and Perendicular to the Magnetic Field, Propagation at Finite Angle and CMA Diagram, Appleton-Hartee Formula and Propagation through Ionosphere and Magnetosphere: Helicon, Whistler, Faraday Rotation.

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: PHY-CC-203

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

SEMICONDUCTOR DEVICES

Course Code: PHY-CC-204

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 for lasing, 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, Piezoelectries resonators and filters. High frequency piezoelectric 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 Ajoy Ghatak and K. Thyaearajan. (Cambridge Univ. Press)

PRACTICAL LAB I

Course Code: PHY-PR-205

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

PRACTICAL LAB II

Course Code: PHY-PR-206

1. Design of a Regulated Power supply.
2. Design of a Common Emitter Transistor Amplifier.
3. Experiment on Bias Stability
4. Characteristics and applications of Silicon Controlled Rectifier.
5. Experiment on FET and MOSFET characterization and application as an amplifier.
6. Experiment on Uni-junction Transistor and its application,
7. Digital I : Basic Logic Gates, TTL, NAND and NOR.
8. Digital II: Combinational logic.
9. Flip-Flops.
10. Operational Amplifier (741)
11. Solution of nonlinear equation using Scilab
12. Numerical Integration (Simpson’s 1/3 rule, Simpson’s 3/8 rule etc.) using Scilab
13. Numerical Differentiation (Runga-Kutta method) using Scilab

CONDENSED MATTER PHYSICS

Course Code: PHY-CC-301

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: PHY-CC-302

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.

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

Unit II

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.

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 - Elementary ideas of CP and CPT invariance

Lie algebra, SU(2) - SU(3) – multiplet building –

Quark model - Gell - Mann - Okubo mass formula for octet and decuplet hadrons

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

ADVANCED CONDENSED MATTER PHYSICS

Course Code: PHY-CE-303 (A)

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 type II 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

NUCLEAR RADIATION DETECTION, MEASUREMENT AND DOSIMETRY

Course Code: PHY-CE-303 (B)

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

Interaction of radiation with matter – Range Energy relationship, Ionizing radiations: Ionization and transport phenomena in gases - Avalanche multiplication.

Detector Properties: Energy measurement - Position measurement , Time measurement.

Gas based Counters : Ionization chambers, - Proportional counters - Geiger - Muller counters - Neutron detectors.

Solid State Detectors : Semiconductor based detectors - Integrating solid state devices - Surface barrier detectors, Germanium Lithium Detectors

Unit II

Scintillation counters : Organic and inorganic scintillators - Theory, characteristics and detection efficiency.

High Energy Particle Detectors : General principles - Nuclear emulsions - Cloud chambers - Bubble chambers - Cerenkov counter.

Nuclear Electronics : Analog and digital pulses - Signal pulses - Transient effects in an R-C circuit - Pulse shaping - Linear amplifiers - Pulse height discriminators - Single channel analyzer - Multichannel analyzer

Unit III

Radiation quantities and units : particle flux and fluence energy flux, mass absorption coefficient, stopping power. Bragg-Gray principle and air wall chamber, Kerma rate constant, relative biological effectiveness, radiation weighing factors, absorbed dose, equivalent dose, tissue weiging factors, effective dose and directional equivalent dose, ambient and directional equivalent dose and their relevance to dosimetry, tissue equivalence, dose commitment and collective dose.

Internal exposure : Effective half-life, selectivity of organs, beta particles, dosimetry, commited dose and dose coefficients

Dosimeters : primary dosimeters, secondary dosimeters, direct reading dosimeters, chemical and calorimetric devices.

Text and Reference Books

G. E. Brown and A. D. Jackson, Nucleon - Nucleon Interaction,

North - Holland, Amsterdam, 1976.

S. de Benedetti, Nuclear Interaction, John Wiley and Sons, New York, 1964.

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.

F.H. Attix et.al. – Radiation Dosimetry

F.M. Khan – The physics of radiation therapy

DIGITAL AND COMMUNICATION ELECTRONICS

Course Code: PHY-CE-304 (A)

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 AM waves - 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 NANO 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)

MICROWAVE AND COMMUNICATION ELECTRONICS

Course Code: PHY-CE-304 (B)

Objectives

To provide the basic understanding about analog systems and their working.

Learning Outcome

After completion of course, the Students will

- Be able to understand the working of various analog computation using electronic devices.
- Get the idea about digital to analog and analog to digital conversion device.
- Be able to understand and use the working of photo detector and photo emitter devices.

Content

Unit I

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.

Unit II

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.

PRACTICAL LAB V

Course Code: PHY-PR-305

1. To Study frequency versus energy curve using magnet-magnet interaction using air track.
2. To study potential energy curve of magnet-magnet interaction using air track.
3. To study parametric amplifier for different initial length and variation of damping with mass of bob.
4. To draw the characteristic curve of GM counter.
5. To determine the end point energy of a beta ray source.
6. To write and run program using microprocessor 8085A.
7. To determine Resolving Power of a Telescope.
8. To write numerical analysis program and solving them using BASIC.
9. To determine velocity of Sound in Air by Standing Wave Method.
10. To study modulus of rigidity with temperature using tortional pendulum.
11. To determine Dielectric constant of liquid using Lechar wire method.
12. To determine wavelength of laser beam and study beam divergence.

PRACTICAL LAB VI

Course Code: PHY-PR-306

1. To Study LC Transmission Line
2. To Study Wide Band Amplifier.
3. To study RF oscillator using Hartley and Colpitts Method.
4. To study Wein bridge Oscillator.
5. To study Phase Shift Oscillator.
6. To study RS & JK Flip Flop Circuits and to verify the Truth Tables.
7. To study the SCR circuit.
8. To study Absorption Coefficient of a Liquid using Photovoltaic cell.
9. To study Fourier Analysis.
10. To study Decade and Binary Counters.
11. To study Two-input Multiplexer and to verify its Truth Table.

COMPUTATIONAL METHODS AND PROGRAMMING

Course Code: PHY-CC-401

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

Computational Method

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, error estimates, 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 RungeKutta methods, Predictor and corrector method. Elementary ideas of solutions of partial differential equations.

Unit III

Programming

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: PHY-CC-402

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 APPLICATION

Course Code: PHY-CE-403 (A)

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

SOLID STATE AND DISORDERED SYSTEMS

Course Code: PHY-CE-403 (B)

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 colour centres in 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

ADVANCED QUANTUM MECHANICS

Course Code: PHY-CE-403 (C)

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. Feynman's theory of positron.

Second quantization of Klein-Gordon Field

Unit II

Creation and Annihilation operators, Commutation relations.Quantisation 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 some problems like Rutherford scattering and compton scattering, 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 SEMICONDUCTOR DEVICES

Course Code: PHY-CE-404(A)

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 Al,Ga(i-xiAs or GaPYAsC) and quaternary ln,Ga(,·•)PyAs,,_y)alloys and their important properties such as band gap and refractive index changes with x and y. 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 Transporting 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) Determination of: Conductivity (a) four probe and (b) Van der Paw techniques.

Unit III

Hall Coefficient, Minority Carrier Life Time. Junction Devices: (i) p-n junction- Energy Band diagrams for homo and hetro junctions. Current flow mechanism in p-n junction, effect of indirect and surface recombination currents on the forward biased diffusion current, 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

SCIENCE AND TECHNOLOGY OF RENEWABLE ENERGIES

Couse Code: PHY-CE-404 (B)

Objectives

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

Learning Outcome

After completion of course, the Students will

- Understand the deepen 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.

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-CE-404 (C)

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.

Richad Aston, 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)

PRACTICAL LAB VII

Course Code: PHY-PR-405

1. Determine fine structure constant using sodium doublet.
2. Verify Cauchy's relation & determination of constants.
3. To determine e/m for an electron by Zeeman effect.
4. Determine the dissociation energy of Iodine molecute.
5. Determine of energy of a given ray from Re-De source.
6. Find out the percentage resolution of given scintillation spectrometer using Cs_{137}
7. Find out the energy of a given X-ray source with the help of scintillation spectrometer.
8. Plot the Gaussian distribution for a radioactive source.
9. Determine the dielectric constant of turpentine oil with the Leacher wire system.
10. To determine velocity of waves in water using ultrasonic interferometer.
11. To determine the magnetic susceptibility of two given samples by Gouy's method.
12. Determine of Lande's 'g' factor for IRRH crystal using electron spin resonance spectrometer.

PRACTICAL LAB VIII

Course Code: PHY-PR-406

1. Create a Pspice model of square wave generator/ Wein bridge oscillator using 741 Op-amp.
2. To determine e/m of an electron by magnetron valve method.
3. To determine e/k using transistor characteristics.
4. To study dark and illumination characteristic of p-n junction solar cell and to determine (i) Its internal series resistance (ii) Diode ideality factor
5. To study the characteristics of following semiconductor devices (i) VDR (ii) photo transistor (iii) Thermistor (iv) IED
6. To study the characteristics of MOSTET and MSSFET amplifier.
7. To study dark and illumination characteristics of p-n junction solar cell and to determine its (i) Maximum power available (ii) Fill factor.

Research Project

Course Code: PHY-PROJ-407

This course will be based on **preliminary research oriented topics either in theory or experiment**. 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 project. The department shall keep a record of the progress of the project undertaken by the students. At the completion of the project by the semester end, the student will submit Project Report which will be examined by an external examiner. The examination shall consist of (a) Presentation and (b) Comprehensive viva-voce.