GULBARGA UNIVERSITY, KALABURAGI
M. Sc. Physics (CBCS)

(Effective from 2017-2018)

Teaching and Evaluation Scheme

Semester	Course Code	Title of the Paper	Credits	Teaching hours/week	Semester End Exam.		Internal Assessment		Total Max. marks
					Duration	Max. marks	Duration	Max. marks	
I	HCT1.1	Classical Mechanics	4	4	3 hrs	80	1 hr	20	100
	HCT1.2	Electrodynamics	4	4	3 hrs	80	1 hr	20	100
	HCT1.3	Introductory Quantum Mechanics	4	4	3 hrs	80	1 hr	20	100
	SCT1.1	Mathematical Physics - I	4	4	3 hrs	80	1 hr	20	100
	SCT1.2	Applied Physics	4	4	3 hrs	80	1 hr	20	100
	HCP1.1/1.2	Practical 1.1	4	2	4 hrs	80	4 hrs	20	100
	SCP1.1/1.2	Practical 1.2	4	2	4 hrs	80	4 hrs	20	100
		Total	**24**			**480**		**120**	**600**

In the beginning of the Semester-I, the Department will notify the actual soft core course that it wants to offer depending on the availability of staff and facility. Accordingly, the students will be allotted soft core course.

Semester	Course Code	Title of the Paper	Credits	Teaching hours/week	Semester End Exam.		Internal Assessment		Total Max. marks
					Duration	Max. marks	Duration	Max. marks	
II	HCT 2.1	Basic Nuclear Physics	4	4	3 hrs	80	1 hr	20	100
	HCT 2.2	Basic Solid State Physics	4	4	3 hrs	80	1 hr	20	100
	SCT 2.1	Atomic & Molecular Physics	4	4	3 hrs	80	1 hr	20	100
	SCT 2.2	Plasma Physics	4	4	3 hrs	80	1 hr	20	100
	OET 2.1	Elementary concepts in Physics	4	4	3 hrs	80	1 hr	20	100
	OET 2.2	Modern Physics	4	4	3 hrs	80	1 hr	20	100
	HCP 2.1/2.2	Practical 2.1	4	2	4 hrs	80	4 hrs	20	100
	SCP 2.1/2.2	Practical 2.2	4	2	4 hrs	80	4 hrs	20	100
		Total	**24**			**480**		**120**	**600**

In the beginning of the Semester-II, the Department, will notify the actual Soft core and open elective courses that it wants to offer depending on the availability of staff and facility. Accordingly, the students will be allotted soft Core and open elective courses.

Semester	Course Code	Title of the Paper	Credits	Teaching hours/week	Semester End Exam.		Internal Assessment		Total Max. marks
					Duration	Max. marks	Duration	Max. marks	
III	HCT 3.1	Electronics & Instrumentation	4	4	3 hrs	80	1 hr	20	100
	HCT 3.2	Mathematical Physics -II	4	4	3 hrs	80	1 hr	20	100
	SCT 3.1	Solid State Physics I/ Materials Physics I/ Nano Physics I	4	4	3 hrs	80	1 hr	20	100
	SCT 3.2	Nuclear Physics I/ Energy Physics I/ Biophysics I	4	4	3 hrs	80	1 hr	20	100
	OET 3.1	Mechanics	4	4	3 hrs	80	1 hr	20	100
	OET 3.2	Radiation Physics	4	4	3 hrs	80	1 hr	20	100
	HCP 3.1/3.2	Practical 3.1	4	2	4 hrs	80	4 hrs	20	100
	SCP 3.1/3.2	Practical 3.2	4	2	4 hrs	80	4 hrs	20	100
Total			**24**			**480**		**120**	**600**

In the beginning of the Semester-III, the Department will notify the actual soft core and open elective courses that it wants to offer depending on the availability of staff and facility. Accordingly, the students will be allotted soft core and open elective courses.

Semester	Course Code	Title of the Paper	Credits	Teaching hours/week	Semester End Exam.		Internal Assessment		Total Max. marks
					Duration	Max. marks	Duration	Max. marks	
IV	HCT 4.1	Statistical Mechanics	4	4	3 hrs	80	1 hr	20	100
	HCT 4.2	Quantum Mechanics-II	4	4	3 hrs	80	1 hr	20	100
	SCT 4.1	Solid State Physics II/ Materials Physics II/ Semiconductor Physics and devices	4	4	3 hrs	80	1 hr	20	100
	SCT 4.2	Nuclear Physics II/ Energy Physics II/ Biophysics II	4	4	3 hrs	80	1 hr	20	100
	HCP 4.1/4.2	Practical 4.1	4	2	4 hrs	80	4 hrs	20	100
	SCP 4.1/4.2	Practical 4.2	2	2	4 hrs	40	4 hrs	10	50
	HCMP 4.3	Project	6	6	--	120*	2 hrs	30	150
		Total	**24**			**480**		**120**	**600**

*(72 marks for project report + 48 marks for Viva-Voce)

In the beginning of the Semester-IV, the Department will notify the actual soft core courses that it wants to offer depending on the availability of staff and facility. Accordingly, the students will be allotted soft core course.

M Sc SEM-I
Paper HCT1.1: CLASSICAL MECHANICS

Preamble: Study of celestial and terrestrial motions, as pioneered by Sir Isaac Newton and Kepler is central to the understanding the concepts of "Classical Mechanics". Classical Mechanics remains an indispensable part of the physicist's education. It has a two fold role in preparing the student for the study of modern physics. It serves as the springboard for the various branches of modern physics.

Unit I [16 hours]
Newtonian Mechanics. Single and many particle system- Conservation laws of linear momentum, angular momentum and energy. Application of Newtonian mechanics: Two-body central force field motion; Kepler's laws of planetary motion. Scattering in a central force field; scattering cross-section; the Rutherford scattering problem.

Unit II [16 hours]
Lagrangian formulation. Constraints in motion. Generalized co-ordinates. Virtual work and D'Alembert's principle. Lagrangian equations of motion. Symmetry and cyclic co-ordinates. Hamilton's variational principle; Lagrangian equations of motion from variational principle, simple applications.

Unit III [16 hours]
Hamiltonian formalism. Hamilton's equations of motion - from Legendre transformations and the variational principle, simple applications. Canonical transformations. Poisson brackets-Canonical equations of motion in Poisson bracket notation. Hamilton-Jacobi equations.

Unit IV [16 hours]
Continuum Mechanics. Basic concepts, equations of continuity and motion-Navier-Stokes equations; simple applications.
Relativistic Mechanics. Relativistic mechanics: Four-dimensional formulation-four-vectors, four-velocity, four-momentum and four-acceleration. Lorentz co-variant form of equation of motion.

References
1. Classical Mechanics: H Goldstein, (Addison-Wesley, 1950)
2. Introduction to Classical Mechanics: R G Takawale and P S Puranik (TMH, 1979)
3. Classical Mechanics: N C Rana and P S Joag (Tata McGraw, 1991)
4. Mechanics: Landau L D and Lifshitz E M (Addison-Wesley,1960)

M Sc SEM-I
Paper HCT1.2: ELECTRODYNAMICS

Preamble: Classical electromagnetic theory, together with classical and quantum mechanics, forms the core of present-day theoretical training for graduate physicists. The aim is to present the basic subject matter as a coherent whole, to develop and utilize a number of topics in mathematical physics which are useful in electromagnetic theory and presentation of new material, especially on the interaction of relativistic charged particles with electromagnetic fields.

Unit I [16 hours]

Electrostatics: The static electric change, Coulomb's law, the electrostatic field and Gauss law. The static field laws in integral and differential forms. The electrostatic scalar potential, Poisson and Laplace equations. The potential energy of charges and field energy density. The electric potential and fields due to monopole, dipole and quadrupole. The dipole in an external field and the dipole interaction energy. The multipolar expansion of potential and for the energy of localized charge distribution in an external field, the physical significance of various multipoles. The electrostatic field in matter, polarization, macroscopic field equations. The electrostatic energy in dielectric media. The electrostatic boundary conditions.

Unit II [16 hours]

Magnetostatics: The steady electric current, Biot-Savart law, magnetic field and Ampere's law. The magnetostatic field laws in integral and differential forms. The magnetic scalar and vector potentials. Potential and field of a circular current element-magnetic dipole. The dipole in an external field and the dipole interaction energy. The multipoles. Expansion for the potential of localized current distribution, the physical significance of multipoles. Magnetic fields in matter, magnetization of the microscopic equations. The energy in the magnetic field. The magnetostatic boundary conditions.

Unit III [16 hours]

Electromagnetics: The nonsteady currents and charges, Lorentz force law and Faraday's laws of induction. The displacement current. Maxwell's electromagnetic field laws in integral and differential forms. The macroscopic equations and boundary conditions. The electromagnetic potential, Coulomb, and Lorentz gauges. Energy in the electromagnetic field. Poynting's theorem and energy momentum conservation.

Unit IV [16 hours]

Electromagnetic waves: The wave equation, light and its electromagnetic character. Plane waves in free space, waves in non-conducting media and polarization. Electromagnetic waves in conducing media, skin depth. Electromagnetic waves in bounded media; Reflection and refraction of waves. Energy flux in a plane wave. The retarded potentials, Lienard-Wiechart potentials and fields for a moving point change.

Relativistic Electrodynamics: The principle of invariance-Lorentz transformations. Four-vectors in electrodynamics and the covariant formulation of the laws of electrodynamics.

References

1. Introduction to Electrodynamics: D J Griffith (Prentice-Hall, 1981)
2. Classical Electromagnetic Radiation: J B Marion (Academic, 1968)
3. Classical Electrodynamics: C D Jackson (Wiley Eastern, 1978)
4. Electromagnetics: B B Laud (Wiley Eastern, 1987)
5. The Feynman Lectures on Physics-II: R P Feynman (Addison Wesley, 1964)
6. Classical Electricity and Magnetism: W Panofsky & M Philips (Addison Wesley, 1962)

M Sc SEM-I
Paper HCT1.3: INTRODUCTORY QUANTUM MECHANICS

Preamble: The purpose of this course is to introduce to the graduate student, the concepts of quantum mechanics, to describe the mathematical formalism, and to present illustrative examples of both the quantum mechanical ideas and the methods. At the present stage of human knowledge, quantum mechanics can be regarded as the fundamental theory of atomic phenomena.

UNIT I [16 hours]

Physical basis of quantum mechanics: Experimental background, inadequacy of classical Physics, Planck's quantum hypothesis, Bohr Hydrogen model, Correspondence principle, experimental observations of quantized orbits, inadequacy of quantum theory.

Wave Mechanics : Basic postulates of quantum mechanics. Wave function, Uncertainty principle, Complimentarity, principle of superposition, wave–particle duality. Ehrenfest's theorem.

General formalism: Hilbert space, observables, quantum mechanical operators – definition and properties, eigen values and eigen vectors of an operator; Hermitian operator, unitary and projection operators. Commuting operators and complete set of commuting operators. Bra and ket notation for vectors.

UNIT II [16 hours]

Development of wave equation: One-dimensional and three dimensional cases for a free particle subject to forces. Separation of wave equation, boundary and continuity conditions. Some exactly solvable eigen value problems: Eigen value problem – degeneracy, eigen values and eigen functions- physical interpretation.

One dimensional eigen value problems: square well, rectangular step potentials, rectangular barrier and simple harmonic oscillator.

Three dimensional eigen value problems: Particle in a box, particle in a spherically symmetric potential. Eigen values and eigen functions of hydrogen and hydrogen like atoms.

UNIT III [16 hours]

Representation theory: Matrix representation of an operator, co-ordinate and momentum representations. Expectation values, matrix method solution of linear harmonic oscillator.

Quantum dynamics: Equations of motion. Schrodinger, Heisenberg and Interaction pictures.

Approximation methods for stationary states: Time independent perturbation theory– Variation method, eigen values in the first approximation, perturbed harmonic oscillator. Application to anharmonic oscillator and to the ground state of Helium atom. WKB method: Application to barrier penetration, Bohr-Sommerfield quantum condition.

UNIT IV [16 hours]

Theory of scattering: Scattering cross section, scattering amplitude and wavelength scattering by central field potentials: Partial wave analysis. Briet-Wigner formula, scattering by square well potentials, Born approximation, Optical theorem. Exactly solvable problems: scattering by square well potential and screened Coulomb potential.

References

1. Quantum Mechanics: L I Schiff [McGraw-Hill, NY, 1968]
2. A Text book of Quantum Mechanics: P M Mathews and K Venkateshan [TMH, 1994]
3. Quantum Mechanics: V K Thankappan [Wiley Eastern, 1980]
4. Quantum Mechanics: Theory and Applications: A K Ghatak &S Loknathan (5^{th} Edn.) [MacMillan India Ltd., 2010]
5. Modern Quantum Mechanics: Sakurai J J and Tuan S F [Addison Wesley 1999]
6. Introduction to Quantum Mechanics: L Pauling and E B Wilson [McGraw Hill 1935]
7. Quantum Mechanics : G Aruldas, PHI Learning Private Ltd.,(2^{nd} Edn.), 2013.

M Sc SEM-I
Paper SCT1.1: MATHEMATICAL PHYSICS -I

Preamble: Mathematical physics refers to development of mathematical methods for application to problems in physics. It can be defined as "the application of mathematics to problems in physics and the development of mathematical methods suitable for such applications and for the formulation of physical theories".

Unit I [16 hours]

Differential equations & special functions: Ordinary differential equations: first & second order homogeneous and non-homogeneous equations with constant and variable coefficients. Partial differential equations: classifications, methods of solutions.

Special functions Power series method for ordinary differential equations, Legender's equation, Legendre polynomials and their properties, Bessel's equation, Bessel function and their properties, Laguerre's equation, its solution and properties. Hermite equation, its solution and properties.

Unit II [16 hours]

Vector spaces and Matrices: Vector spaces, inner product space. Cauchy sequence. Hilbert space of n-dimension, function space, dual space. Direct sum of function space. Operators: Linear operator, Hermitian operator, unitary operator and orthogonal operator. Matrices: definition, sum, product and inverse of matrices. Symmetric orthogonal, Hermitian and unitary matrices. Eigen value and eigen vectors. Diagonalization of a real symmetric matrix. Matrix representation of linear operators, eigen values and eigen vectors of operators.

Unit III [16 hours]

Tensors: Curvilinear co-ordinates: definition, line, surface and volume elements, contrvariant, covariant and physical components of a vector. Definition of tensors, tensors in Physics, notation and conventions, tensors of higher rank. Algebra of tensors: addition, subtraction, outer product, inner product; contraction of tensor; symmetric and antisymmetric tensors; Quotient law, fundamental tensor: length of a vector, covariant metric tensor, associate tensor, raising and lowering of indices. Tensor Calculus: differentiation of a tensor, Christoffel symbols, covariant differentiation.

Unit IV [16 hours]

Groups: Basic concept of a group, examples of finite group. Groups, subgroups, classes. Homomorphism and isomorphism, group representation, reducible and irreducible representations. Character of a representation, character tables, construction of representations, representation of groups. Lie groups, unitary groups and their irreducible representations. The three dimensional rotation group and its representation; Applications of group theory in Physics.

References

1. Mathematical Methods for Physicists: G Arfken
2. Mathematical Physics by P K Chattopadhyay, Wiley Eastern
3. Matrices and Tensors in Physics : A W Joshi
4. Methods of Mathematical Physics : R K Bose and M C Joshi
5. Introduction to Mathematical Physics by C Harper, PHI
6. Elements of Group Theory for Physicists: A. W. Joshi

M Sc SEM-I
Paper SCT1.2: APPLIED PHYSICS

Preamble: The purpose of introducing this course to a graduate student is to highlight the significance of the study of LASER and its applications in Physics, to study the Physics of biological systems, to understand the tenuous plasma and the astrophysical concepts.

Unit I [16 hours]
Lasers physics: Principle and characteristics of lasers, population inversion techniques, lasing action criteria and threshold condition, spatial and temporal coherence. Types of lasers: Nd: YAG laser, Nitrogen laser, Dye laser, Semiconductor laser. Applications of lasers: principle of holography, recording and reconstruction of holograms, applications of holography. Fibre optic communication.

Unit II [16 hours]
Biophysics: Living versus nonliving; molecular basis of life, biological complementarity principle. Plant and animal cells, types of cells, typical cell structure, composition and function, the structure and function of cell constituents. Biological molecules- their structure and function; Intermolecular interactions and molecular recognition.

Unit III [16 hours]
Plasma Physics: Nature and occurrence of plasma. Plasma properties and parameters. The kinetic and fluid descriptions of plasma, motion of charged particles in electric and magnetic fields- motion in uniform and time varying fields. Ponderomotive force. Plasma diagnostic techniques.

Unit IV [16 hours]
Astrophysics: Observational information on stars, stellar spectra and H R diagram. The stellar energy and stellar structure models, the evolution of stars and Chandrasekhar's limit. The structure and composition of main sequence stars, red giants, white dwarfs and neutron stars; pulsars and quasars, supernova and black holes.

References

1. Lasers- Theory and Applications: K Thyagarajan & A K Ghatak (Mcmillan, 1984)
2. Principles of lasers: O. Svelto, (Plenum,1956)
3. Lasers and nonlinear optics: B B Laud (New-Age, 1996)
4. Molecular Biophysics: R B Setlow and E C Polland (Addition Wesley, 1962)
5. An introduction to Biophysics: C Sybesma (Academic, 1977)
6. Biophysics and human approach: I W Sherman and V G Sherman (Oxford, 1979)
7. Plasma Physics: R A Cairns (Blackie, 1985)
8. Introduction to plasma physics and controlled fusion: F F Chen (Plenum, 1984)
9. Introduction to plasma theory: D R Nicholson (John Wiley, 1983)
10. Astrophysics-stars and galaxies: K D Abhyankar (Tata McGraw Hill, 1990)
11. Structure and Evolution of stars: M Schwarachild (Dover, 1958)
12. Astrophysics vol I & II: R Bowers and T Deeming (Jones & Bartlett, 1984)

M Sc SEM-I: PRACTICAL COURSES

[4 hours/Practicals/Week]

HCP 1.1/1.2: Optics and Electronics	
Optics: 1.Calibration of spectrometer using Talbot's band. 2. Diffraction haloes: Size of Lycopodium particles. 3. Wavelength of laser by using grating element. 4. Determination of h/e using photocell. 5. Excitation and ionization potentials. 6. e/m by Millikan's oil drop method. Assignments/Computations	Electronics: 7. Determination of resonance frequency of LCR series and parallel circuits. 8. Cathode Ray Oscilloscope and measurement of AC and DC voltages. 9. Basic and their derived Logic gates with verification of their Truth-Tables. 10. Inverting and Non- inverting Op-Amp by IC-741. 11. Voltage Comparator using Op-Amp by IC-741. 12. Schmitt Trigger using Op-Amp by IC-741. Assignments/Computations
SCP 1.1/1.2: Nuclear Physics and Solid State Physics	
Nuclear Physics: 1. G M Counter characteristics. 2. Dead time of G M Counter. 3.Inverse square law for nuclear radiation. 4. Attenuation of beta rays. 5. Analysis of stopping power and energy Loss. 6. Alpha scattering cross-section analysis. Assignments/Computations	Solid State Physics: 7. Determination of interplanar spacing using X-ray powder pattern. 8. Measurement of resistivity of a semiconductor by four probe method. 9. Specific heat of metals. 10 Determination of Debye's temperature of Lead or Tin. 11. Activation energy of point defects in metals. Assignments/Computations

Note: Experiments shall be added as and when developed.

M Sc SEM-II
Paper HCT 2.1: BASIC NUCLEAR PHYSICS

Preamble: Pure and applied nuclear physics is a gigantic area of research and engineering. Numerous subtopics have grown rapidly into large and separate fields of professional competence, but each of these derives its strength and nourishment from fundamental experimental and theoretical principles. It is this fundamental core material which is introduced here in this course.

Unit I [16 hours]

Basic properties of Nucleus: Nuclear constitution. The notion of nuclear radius and its estimation from Rutherford's scattering experiment; the Coulomb potential inside the nucleus and the mirror nuclei. Nuclear size by electron scattering experiment. The nomenclature of nuclei, and nucleon quantum numbers. Nuclear spin and magnetic dipole moment. Nuclear electric moments and shape of the nucleus. Nuclear forces**:** General features of nuclear forces. Bound state of deuteron with square well potential, binding energy and size of deuteron. Deuteron electric and magnetic moments- evidence for non-central nature of nuclear forces. Yukawa's meson theory of nuclear forces.

Unit II [16 hours]

Nuclear Reactions: Reaction scheme, types of reaction and conservation laws. Reaction kinematics, threshold energy and Q-value of nuclear reaction. Energetics of exoergic and endoergic reactions. Reaction probability and cross section. Bohr's compound nucleus theory of nuclear reaction. Nuclear Models: The shell model; evidence for magic numbers, energy level scheme for nuclei with Infinite square well potential and the ground state spins. The extreme single particle prediction of nuclear spin and magnetic dipole moments- Schmidt limits. The liquid drop model: Nuclear binding energy, Bethe-Weizsacker's semi empirical mass formula; stability limits against spontaneous fission and nuclear decay.

Unit III [16 hours]

Nuclear Decays: Alpha decay: Quantum mechanical barrier penetration, Gamow's theory of alpha decay and alpha half-life systematics. Beta decay: Continuous beta spectrum, neutrino hypothesis, and Fermi's theory of beta decay, beta comparative half-life systematics. Gamma decay: Qualitative consideration of multipole character of gamma radiation and systematics of mean lives for gamma multipole transitions. Interaction of radiation with matter: interactions of charged particles with matter; ionization energy loss, stopping power and range energy relations for charged particles. interaction of gamma rays; photoelectric, Compton and pair production processes. Nuclear radiation detectors- G M counter and Scintillation detector

Unit IV [16 hours]

Elementary Particle Physics: Fundamental interactions in nature and their general features. Elementary particles and their classification; Conservation laws in elementary particle interactions. Quark model of elementary particles. Nuclear energy: Fission process, fission chain reaction, four factor formula and controlled fission chain reactions, energetics of fission reactions, fission reactor. Fusion process, energetics of fusion reactions: Controlled thermonuclear reactions; Fusion reactor stellar nucleo synthesis.

References

1. The Atomic Nucleus: R D Evans (TMH)
2. Nuclear and Particle Physics: W E Burcham and M Jobes (Addison Wesley, 1998)
3. Subatomic Physics-Nuclei and Particles: L Valentin
4. Nuclei and Particles: E Segre (Benjamin)
5. Nuclear Physics: D C Tayal (Himalaya)
6. Nuclear Physics: R C Sharma (Khanna)
7. Introduction to Nuclear Physics: S B Patel (Wiley eastern)
8. Introductory Nuclear Physics: Kenneth S Krane (Wiley)
9. Atomic and Nuclear Physics: S N Ghoshal (Chand)

M Sc SEM-II
Paper HCT 2.2: BASIC SOLID STATE PHYSICS

Preamble: Solid state physics is largely concerned with crystals and electrons in crystals. The study began in the early years of 20^{th} century following the discovery of x-ray diffraction by crystals and the publication of a series of simple calculations and successful predictions of the properties of crystals.

Unit I [16 hours]

Crystal structure: Crystal systems, concept of point and space groups, crystal classes, Bravais lattice. Unit cell: Wigner-Seitz cell. Notations of planes and directions, Miller indices, concept of reciprocal lattice, Ewald's construction. NaCl, ZnS and Diamond crystal structures. X-ray diffraction, Bragg condition, atomic scattering factor and structure factor with some examples.

Unit II [16 hours]

Crystal binding: Types of binding – van der Waals-London interaction, repulsive interaction. Madelung energy, Madelung constant, ideas of metallic bonding, Hydrogen bonded crystals.

Lattice vibrations: Vibrations of monatomic and diatomic lattice. Brillion zone. Quantization of lattice vibration - concept of phonon.

Unit III [16 hours]

Energy bands in solids: Formation of energy bands. Free electron model: free electron in one and three dimensional potential wells, paramagnetism. Kronig-Penny model. Fermi-Dirac distribution, concept of Fermi energy.

Defects in solids: Point defects: Schottky and Frenkel defects and their equilibrium concentrations. Line defects: Dislocations, multiplication of dislocations. Frank-Read mechanism. Plane defects: grain boundary and stacking faults, color centres.

Unit IV [16 hours]

Semiconductors: intrinsic and extrinsic semiconductors, concept of majority and minority carriers, statistics of electrons and holes, electrical conductivity, Hall effect.

Superconductors: Superconductivity, zero resistance, Meissner effect, persistent currents, critical fields, Type I and Type II superconductors, thermodynamics of superconducting transition, simple applications of superconductors.

References

1. Elementary Solid State Physics: Principles and Applications, MA Omar, Addison
2. Introduction to Solid State Physics, C. Kittel, Wiley Eastern
3. Solid State Physics: A J Dekkar, Prentice Hall Inc.
4. Semiconductor Physics, P. S Kireev, MIR Publishers

M Sc SEM-II
Paper SCT 2.1: ATOMIC & MOLECULAR PHYSICS

Preamble: It is the study of matter-matter and light-matter interactions; at the scale of one or a few atoms. The theory and applications of emission, absorption, scattering of electromagnetic radiation (light) from excited atoms and molecules, analysis of spectroscopy, generation of lasers, and the optical properties of matter in general, is dealt with in this course.

Unit I [16 hours]

One and Two-electron system: Einstein's A and B coefficients, transition probabilities, electric dipole approximation and selection rules. Hydrogen atom: electron spin interaction terms, vector model and lamb shift, electrostatic interaction and exchange degeneracy, ground state and excited states of helium, electron spin functions and Pauli exclusion principle. Central-field approximation: Central field, Thomas-Fermi potential, gross structure of the alkalis. Angular problems in many electron atoms: LS coupling-approx., allowed terms, fine structure and relative intensities; JJ coupling approximation and other types of coupling.

Unit II [16 hours]

Interaction with static external fields: Zeeman effect in LS coupling, relative intensities in Zeeman effect, quadratic and linear Stark effect. Hyperfine structure and isotope shift: magnetic dipole interaction, hyperfine structure nuclear spin, and nuclear magnetic moment; hyperfine structure in two-electron spectra, electric quadrupole interaction, Zeeman effect of hyperfine structure and isotope shift.

Unit III [16 hours]

Microwave, IR and UV-Visible spectra: Types of molecules- linear, symmetric top, asymmetric top and spherical top molecules. Theory of rotational spectra for rigid and non-rigid rotator diatomic molecules, energy levels, intensity of rotational lines. Microwave spectrometer. Vibrational energy of diatomic molecule as simple harmonic and anharmonic oscillators, energy levels and vibrational spectra, diatomic molecule as a vibrating-rotator, vibration-rotation spectra. IR- spectrometer. electronic spectra of diatomic molecules, Born-Oppenheimer approximation, vibrational coarse structure- band progressions and sequences, Frank-Condon principle-intensity of vibrational-electronic spectra, classification of electronic states and multiplet structure, selection rules for electronic transitions and simple electronic transitions. UV-Visible spectrometer.

Unit IV [16 hours]

Lasers: Principles of lasers, population inversion techniques, criteria for lasing and threshold condition. Laser beam characteristics- spatial and temporal coherence. Types of lasers: Neodymium laser, Nitrogen laser, Dye laser and Semiconductor laser; applications of lasers: Principle of holography, recording and reconstruction of holograms and applications.

References

1. Elementary Atomic Structure : G K Woodgate (Oxford,)
2. Introduction to Atomic Spectra : H B White (McGraw Hill)
3. Fundamentals of Molecular Spectroscopy : C N Banwell (TMH)
4. Molecular Spectra and Molecular Structure Vol.1: Spectra of diatomic molecules: G. Herzberg (Von Nostrand)
5. Spectroscopy-1, 2 & 3: B P Straughan and Walker (Chapman and Hall)

M Sc SEM-II
Paper SCT 2.2: PLASMA PHYSICS

Preamble: The understanding and use of plasmas is entering a Golden Age. Profound new insights into the behavior of solar and stellar phenomenon, exciting advances in fusion energy research and development, and the technological applications of plasmas will play an increasing role in 21st century science and research.

Unit I [16 hours]

Plasma properties: Occurrence of plasma in nature, definition of Plasma, Debye shielding, plasma parameters, criteria for plasma.

Single particle motions: uniform E and B fields, non uniform B field, non uniform E field, time-varying E field time-varying B field, guiding centre drifts, adiabatic invariants.

Unit II [16 hours]

Plasma as fluids: Relation between Plasma Physics and Electromagnetics, the fluid equation of motion, fluid drift perpendicular to B, fluid drifts parallel to B, plasma approximation.

Unit III [16 hours]

Kinetic approach to Plasma: Equations of kinetic theory, derivation of the fluid equations, Plasma oscillations and Landau damping (physical derivation), ion Landau damping, kinetic effects in a magnetic field.

Unit IV [16 hours]

Waves in Plasma: Representation of waves, plasma oscillations, electron plasma waves, sound waves, ion waves, plasma approximation and its validity, comparison of ion and electron waves, electromagnetic waves in magnetized plasma. Hydromagnetic waves, magneto sonic waves.

References

1. Introduction to Plasma Physics and controlled fusion: F F Chen (Plenum, 1984)
2. Principles of Plasma Physics: N A Krall and A W trivelpiece (McGraw Hill, 1973)
3. Plasma Physics: R A Cairns (Blackie, 1985)
4. Introduction to Plasma theory: D R Nicholson (John Wiley, 1983)
5. The Theory of Plasma Waves: T H Stix(McGraw Hill, 1962)
6. Magneto hydrodynamics: T G Cowling(Interscience, 1957)
7. Foundations of Plasma Dynamics: E H Holt and R E Huskell (McGraw Hill, 1965)
8. Plasma diagnostic techniques:RH Huddlestone&LSLeonard (Eds, Academic, 1965)
9. Methods in Non-linear Plasma Physics: R C Davidson (Academic, 1972)
10. MHD Instabilities: G. Bateman (MIT, 1978)

M Sc SEM-II
Paper OET 2.1: ELEMENTARY CONCEPTS IN PHYSICS

Preamble: This course is an open elective one and is designed to suit the graduate students, other than physics, to get a glimpse of the advancements in the field of physics.

Unit I [16 hours]

Laws of Motion: Newton's laws of motion; laws of conservation of linear and angular momentum and energy. Kepler's laws of planetary motion. Work, energy and power, work-energy theorem, conservative and non- conservative forces; elastic and inelastic collisions.

Gravitation: The law of universal gravitation, inertial and gravitational mass, acceleration due to gravity and its variation, Gravitational field and potential. Satellites: Basic concepts of satellite launching, types of satellites.

Unit II [16 hours]

Oscillations and Waves: Periodic motion – simple harmonic motion and its equation; Wave motion – longitudinal and transverse waves, principle of superposition, interference of waves, standing waves, resonance. The interference of light waves – coherence, Young's double slit experiment; diffraction due to single and double slits. Resolving power of microscopes and astronomical telescopes. Polarization of light waves.

Unit III [16 hours]

Electromagnetism and Electric Currents: Electric charges, Coulomb's law-force between two point charges; superposition, Electric field and potential, Gauss law. Electric Currents: Biot- Savart law –force between two current carrying elements. Amperes law. Faraday's laws of induction, Maxwell's equations.

Direct and Alternating Currents. Ohm's law, resistance and capacitances. Peak and RMS values; reactance and impedance; Electric Generator.

Unit IV [16 hours]

Thermodynamics and Properties of Matter: Concept of work, heat, internal energy. Fundamentals of thermodynamics: system and surroundings, extensive and intensive properties, state functions, types of thermodynamic processes. Carnot's heat engine. Laws of thermodynamics- enthalpy and entropy, spontaneity- reversible and irreversible processes.

Properties of Matter: Elastic behaviour, Stress- Strain relationship, Hooke's law and modulii of elasticity, surface tension and surface energy, viscosity, Stokes' law and Reynolds number.

References:

1. Physics- I & II by Robert Resnick and David Halliday, Wiley Eastern, 1966.
2. Concepts of Physics –I & II by Verma, Bharathi Bhavan, 2006.
3. Feynmann Lectures on Physics –I & II by Richard Feynman, Robert Leighton and Mathew Sands, Addison Wesley 1965.

M Sc SEM-II
Paper OET 2.2: MODERN PHYSICS

Preamble: This course is an open elective one and is designed to suit the graduate students, other than physics, to get a glimpse of the advancements in the field of modern physics.

Unit I : Elements of Nuclear Physics [16 hours]
Basic properties of nucleus: composition, charge, mass, size. Radioactivity: natural and artificial. Laws of radioactivity, Types of radiations and their properties, alpha, beta and gamma decay (qualitative), radioactive equilibrium, Construction and working of G M Counter, Scintillation Counter. Medical, Industrial and Agricultural applications of nuclear radiations, radioactive dating (age of earth). Nuclear fission and fusion processes (Qualitative).

Unit II : Elements of Solid State Physics [16 hours]
Crystal structures: lattice, base, unit cell, Miller indices, crystal systems. NaCl & ZnS structures. Electron theory of metals: Free electron model, expression for conductivity. Energy bands formation in solids, features of nearly free electron model. Semiconductors: p type and n type, carrier concentrations in intrinsic semiconductors. Superconductors: zero resistivity, Meissner effect, types of superconductors, applications of superconductors.

Unit III: Laser Physics [16 hours]
Principles of lasers, population inversion techniques, building up of laser action, criteria for lasing and threshold condition. Laser beam characteristics, spatial and temporal coherence. Types of lasers: Nd:YAG laser, Nitrogen laser, Dye laser, Semiconductor laser. Applications of lasers. Principle of holography, recording and reconstruction of holograms, applications of holography. Non-linear optics, harmonic generation, fibre optic communication.

Unit IV : Plasma Physics [16 hours]
Introduction to plasma- nature and occurrence of plasma. Plasma properties and parameters. The kinetic and fluid descriptions of plasma. Motion of charged particles in electric and magnetic fields- motion in uniform and time-varying fields. Particle drifts. Ponderomotive force. Plasma diagnostic techniques. Magneto hydro dynamic equations.

Solid State Devices: PN junction as a diode, Zener diode as a voltage regulator, LED, use of LED in display. Liquid crystals and their use in display, Tunnel diode. Transistors: transistor characteristics for common emitter configuration.

References

1. Nuclear Physics: D C Tayal (Himalaya)
2. Introduction to Nuclear Physics: S B Patel (Wiley Eastern)
3. Atomic and Nuclear Physics: S N Ghoshal (S. Chand)
4. Elementary Solid State Physics: Principles and Applications, MA Omar, Addison
5. Introduction to Solid State Physics, C. Kittel, Wiley Eastern
6. Solid State Physics: A J Dekkar, Prentice Hall Inc.
7. Lasers-theory and applications: K Thyagarajan and A K Ghatak (Mcmillan,1984)
8. Lasers and nonlinear optics: B B Laud (New Age, 1996)
9. Principles of lasers: O. Svelto, (Plenum,1986)
10. Optics: Ajay Ghatak (Tata McGraw Hill,1994)
11..Plasma Physics: R A Cairns (Blackie,1985)
12.Introduction to Plasma theory: D R Nicholson (John Wiley,1983)
13.Introduction to plasma Physics and controlled fusion: F F Chen (Plenum,1984)

M Sc SEM-II
PRACTICAL COURSES

HCP 2.1/2.2: Optics and Electronics	
Optics: 1. Analysis of line spectra using Hartman's formula. 2. Determination of wavelength of sodium light using Michelson's interferometer. 3. Determine the wavelength of He-Ne laser light by single slit diffraction method. Assignments/ Computations	Electronics: 4. Study of summing and difference amplifier, differentiator integrator using Op-Amp 5. Timer circuit using IC 555 6. Study of Flip-Flops. Assignments/ Computations
SCP 2.1/2.2: Nuclear Physics and Solid State Physics	
Nuclear Physics: 1. Attenuation of gamma rays. 2. Determination of half- life of Potassium 3. Study of scintillation detector 4. Gamma ray spectrum using Scintillation Detector 5. Study of beta ray spectrum. 6. Spectral response analysis of solid state Detector Assignments/ Computations	Solid State Physics: 7. Ultrasonic velocity in solids 8. Thermoelectric power of a metal 9.Thermoelectric power of a semiconductor 10. Thermister characteristics 11. Curie temperature of a ferromagnetic material 12. Magnetic susceptibility of liquid by Quinke's method 13. Energy gap of a semiconductor diode Assignments/ Computations

Note: New experiments shall be added to the list as and when developed.

M Sc SEM-III
Paper HCT 3.1: ELECTRONICS AND INSTRUMENTATION

Preamble: This course introduces the graduate student, the significance of the study of digital electronics, analog and digital circuit analysis, various forms of transducers. The study of physics would be incomplete without measurement of various physical parameters. Instruments do provide the platform for the thorough understanding and verification of the physical concepts through experimentation.

Unit I [16 hours]
Analog IC s and applications: Basic characteristics of operational amplifier: offset error voltage and currents, inverting and non inverting amplification using closed loop concept, input and output impedance. Adder and subtractor circuits, voltage to current converter, current to voltage converter, analog integration and differentiation, analog computation, logarithmic and exponential amplifiers, comparators and voltage regulators. Waveform generators: RC-oscillator, Wein bridge oscillator, multi vibrators, square and triangle wave generator, Schmitt trigger. Digital to Analog converter, Analog to Digital converter.

Unit II [16 hours]
Digital ICs and applications: Combinational digital system: Binary adders, arithmetic functions, decoder-demultiplexer data selector, multiplexer, encoder, read only memory (ROM), PROMs and EROMs. Sequential circuits and systems: 1bit memory, clocked flip-flops, S-R, J-K,T and D-type flip-flops, shift registers, asynchronous and synchronous counters and their application(qualitative). Micro processor: architecture and operation, memory, input/output, timing instructions.

Unit III [16 hours]
Transducers: Electrical transducer types and their selection. Resistive transducer: strain gauges-resistance wire gauge and semiconductor gauge. Thermometer-platinum resistance and thermister. Inductive transducer: principle, variable reluctance type, differential output transducer, linear variable differential transducer(LVDT). Piezoelectric transducer. Photoelectric transducers: photomultiplier tube, photoconductive cell, photovoltaic cell, semiconductor photodiode, phototransistor. Thermoelectric transducers: Resistance temperature detector (RTD), Thermocouples. Signal conditioning: Need, methods, instrumentations amplifier.

Unit IV [16 hours]
Physical methods of analysis: Thermal methods: Differential thermal analysis (DTA): Differential Scanning Calorimetry (DSC);Thermo gravimetric analysis (TGA). Electron microscopy: Scanning electron microscopy (SEM), Transmission electron microscopy (TEM). Scanning tunneling electron microscopy (STEM). Magnetic Resonance Spectroscopy: Principle, spectrometer, applications of NMR and ESR. Vacuum Technique: production by rotary and diffusion pumps, measurement by Pirani and Penning gauges.

References

1. Microelectronics: J Milman and Arvin Grabel.
2. Electronics Fundamentals and Application: J D Ryder.
3. Digital Principle and Applications: Malvino and Leach.
4. Microcomputers/ Microprocessor: John L hiburn and M Julich.
5. Microprocessor Architecture, Programming and Applications: Ramesh S Gaonker.
6. Electronics Instrumentation, H S Kalsi, TMH, 1995.
7. Handbook of Analytical Instruments, R S Khandpur, Tata McGraw-Hill Publishing Company Ltd., New Delhi.
8. Instrumental Methods of Analysis, Willard, Merritt, Dean and settle, 6th edition, CBS Publishers & Distributors, New Delhi.
9. Instrumental methods of Chemical Analysis, Chatawal and Anand, Himalaya Publishing House.

M Sc SEM-III
Paper HCT 3.2: MATHEMATICAL PHYSICS -II

Preamble: Mathematical physics refers to development of mathematical methods for application to problems in physics. It can be defined as "the application of mathematics to problems in physics and the development of mathematical methods suitable for such applications and for the formulation of physical theories". This course is included, in addition to the earlier course on mathematical physics, so as to provide the in depth knowledge of mathematical computation.

Unit I [16 hours]

Fourier series and integral transforms: Fourier's theorem. Change of interval. Complex form of Fourier series. Fourier integral.

Fourier transform: Transform of some simple functions, properties, transforms of cosine and sine transforms, transforms of derivatives, Transform of impulse function. Constant unit step function and periodic function, Convolution theorem some physical applications.

Laplace transforms: Transforms of some simple functions, transforms of periodic function and derivatives. Transforms of integral, inverse transform, some physical applications.

Unit II [16 hours]

Linear integral equations: Examples of linear integral equations of first and second kind, Fredholm and Voltaire integral, integral equations and their solutions, relationship between integral and differential equations, some applications.

Greens functions: Greens function method of solving boundary value problems, Greens functions for one dimensional problems, eigen function expansion of Green's function, Green's function in higher dimensions, some applications.

Unit III [16 hours]

Numerical techniques: Numerical methods. Solutions of algebraic and transcendental questions: Bisection, iterative and Newton-Raphson methods. Interpolation: Newton's and Lagrange's methods. Curve fitting: method of least squares. Differentiation: Newton's formula, Integration: Trapezoidal rule, Simpson's 1/3 and 3/8 rules, solutions of ordinary differential equations: Euler's modified method and Runge-Kutta method.

Unit IV [16 hours]

C-Language and Programming: Constants and variables, arithmetic expressions, data types, input and output statements, control statements, switch statements, the loop statements, format specifications, functions.

Examples for programming in C; solutions of algebraic equations-quadratic and higher order equations, linear least square fit, Newton's forward and backward interpolation formulae, numerical integration - Trapezoidal rule, Simpson's1/3 and 3/8 rules, numerical differentiation- Euler's modified method, Runge Kutta 2nd and 4th order methods, Eigen values and eigen vectors of a matrix, Solutions of ordinary differential equations.

References

1. Introduction to Mathematical Physics by C Harper, PHI.
2. Mathematical Physics by P K Chattopadhaya, Willey Eastern Ltd, Mumbai.
3. Mathematical Physics by Satya Prakash, S Chand and Sons, New Dehli.
4. Mathematical Physics by Arfkin
5. Mathematical Physics by R.K.Bose and M.C.Joshi
6. Introductory Methods of Numerical Analysis; S S Sastry PHI,1995.
7. Programming in Basic by Galaguuswamy TMH.
8. Programming in C by Venugopal and Prasad,TMH.

M Sc SEM-III
Paper SCT 3.1: SOLID STATE PHYSICS -I

Preamble: This course is introduced to study the periodic structures, influence of lattice vibrations on the properties of materials, elastic properties of materials. Fermi surface study is important in revealing the electron dynamics.

Unit I [16 hours]

Periodic structures: Translational symmetry, reciprocal lattice and its properties. Periodic potential and Bloch theorem. Wannier functions.

Electron states: Nearly free electron model, discontinuity at zone boundary, energy gap and Bragg reflection. Tight binding model, band width and effective mass in linear lattice and cubic lattices. APW and OPW methods of band structure calculations.

Unit II [16 hours]

Lattice vibrations: Lattice waves: Lattice dynamics, properties of lattice waves using mono and diatomic lattices, lattice spectrum and Van Hove singularity, diffraction by a crystal with and without lattice vibrations. Phonons, N- and U- electron scattering processes and Debye-Waller factor. Anharmonicity and thermal expansion, phonon-phonon interaction.

Unit III [16 hours]

Thermal properties: Phonon heat capacity, Density of states in one- and three-dimensions. Thermal energy of a harmonic oscillator. Lattice heat capacity: Dulong-Petit's classical theory, Einstein and Debye's theories, comparison of theory with experimental results.

Elastic properties of solids: Stress and strain tensors, elastic constants and Hooke's law, strain energy, reduction of elastic constants from symmetry, isotropy for cubic crystals, technical moduli and elastic constants. Propagation of long wavelength vibrations. Experimental determination of elastic constants by ultrasonic interference method.

Unit IV [16 hours]

Fermi surface studies

Construction of Fermi surface in a square lattice, Harrison construction, slope of band at zone boundary, electron orbits, hole orbits and open orbits. Experimental methods: Electron dynamics in a magnetic field, cyclotron frequency and mass, cyclotron resonance. Quantization of orbits in a magnetic field, Landau quantization, degeneracy of Landau levels, quantization of area of orbits in k-space, de Has-van Alphen effect, extremal orbits.

References

1. Principle of the theory of solids: J.M. Ziman (Cambridge University Press)
2. Introduction to Solid State Physics: C. Kittel (Wiley Eastern)
3. Solid State Physics: A.J. Dekkar (Prentice Hall Inc)
4. Solid State Physics: N.W. Ashcroft & N.D. Mermin (Saunders College Publishing)
5. Elementary Solid State Physics: Principles & applications, M.A. Omar (Addison-Wesley)
6. Physics of Solids: F.C. Brown (Benjamin Inc. Amsterdam)
7. Introduction to Theory of Solid State Physics: J.D. Patterson (Addison-Wesley)

M Sc SEM-III
Paper SCT 3.1: MATERIALS PHYSICS -I

Preamble: The breadth of the field is a real challenge for a course on Materials. Much innovation has occurred in engineering materials and in the way they are used. This course intends to show the significance of engineering materials, crystal growth techniques, importance of phase diagrams in interpretation of the physical phenomena.

Unit I [16 hours]

Engineering Materials: Materials Science and Engineering, classification, levels of structure, structure-property relationship in materials.

Structure of Solids: Covalent solids: bond formation and properties, ionic solids: bond formation and properties, metallic solids: bond formation and properties. The crystalline and non-crystalline states, advantages and disadvantages of crystalline and non crystalline states, Covalent solids, Metals and Alloys, Ionic Solids, the structure of Silica and Silicates.

Unit II [16 hours]

Crystal growth: Crystal growth from melt: Bridgeman technique, crystal pulling by Czochralski's method, Growth from solutions, Hydrothermal method, Gel method, Zone refining method of purification.

Crystal imperfections: Point imperfections, Dislocation- Edge and Screw Dislocation, concept of Burger vector and Burger Circuit, surface imperfections, color centers in ionic solids.

Unit III [16 hours]

Solid Phases and Phase diagrams: Single and multiphase solids, Solid solutions and Hume-Rothery rules, intermediate phase, the intermetallic and interstitial compounds, properties of alloys: solid solutions and two component alloy systems; phase diagram, Gibbs phase rule, Lever rule; first, second and third order phase transitions with examples; some typical phase diagrams: Pb-Sn and Fe-Fe_3C ; Eutectic, eutectoid, peritectic and peritectoid systems.

Unit IV [16 hours]

Phase transformations: Time scale for phase changes; nucleation and growth, nucleation kinetics; the growth and overall transformation kinetics, applications: transformation in steel; Precipitation processes, Solidification and crystallization; glass transition, recovery, recrystallization and grain growth.

Diffusion in Solids: theory of diffusion (qualitative), self-diffusion, Fick's law of diffusion (derivation), Kirkindal effect, Activation energy for diffusion (derivation), Applications of diffusion.

References

1. Elements of Materials Science and Engineering, L. H. Vanvleck, Addison Wesley (1989, 6th edition)
2. Materials Science and Engineering, V. Raghavan, Prentice Hall of India, 3rd edn.
3. Materials Science and Processes, S. K. Hazra Chaudari, Indian Distr Co. (1977)
4. Introduction to Solids, L. V. Azaroff, Tata McGraw Hill.
5. Crystal Growth, B. R. Pamplin, Pergamon Press.

M Sc SEM-III
Paper SCT3.1: NANOPHYSICS

Preamble: Prof. Feynman remarked " There's plenty of room at the bottom". He consciously explored the possibility of direct manipulation of the individual atoms to be effective as a more powerful form of synthetic chemistry. This course introduces the essence of nano materials, their synthesis, and characterization.

Unit I [16 hours]

Nano materials –Background, Nano (Quantum) perspective, quantum confinement, One and two-dimensional quantum systems, concept of quantum dots, classification of nano materials.

Unit II [16 hours]

Synthesis of nanoparticles – bottom up and top down approaches–Various chemical methods of synthesis - sol gel, hydrothermal, solvo thermal, combustion and chemical vapor deposition.

Unit III [16 hours]

Semiconductor nanoparticles- synthesis, characterization and applications of quantum dots. Magnetic nanoparticles- assembly and nanostructures.

Unit IV [16 hours]

Characterization of nanoparticles and nanostructures– Optical spectroscopy– UV-Vis, FTIR, thermal techniques – TGA, DSC, Electron Microscopy, AFM, SEM, STM scanning probe techniques, spectroscopic techniques – PL, XPS with depth profiling. X-Ray diffraction of nanoscale materials and particle size determination.

References

1. Introduction to Nanoscience –G L Hornyak, J Dutta, H F Tibbbals & A K Rao- CRC Press
2. Nanomaterials: Synthesis, Properties and Application, A.S Edelstein, R C Cammarada (IOP Pub.)
3. Optical Properties of Metal Clusters, Uwe Kribig and Michael Vollmer, Springer.
4. Nanostructured Materials: Processing, Properties and Applications, Carl C Koch, Noyes Pub
5. Nano: The Essentials, T. Pradeep. Tata McGraw Hill, New Delhi (2007)
6. Introduction to Nanotechnology, C P Poole Jr and FJ Ownes, John Wiley Sons,Inc.
7. Nanocomposite Science and Technology, P M. Ajayan, LS.Schadler, PV.Braun, Wiley –VCH Verlag, Weiheim (2003)
8. Nanotechnology: Basic Science and Emerging Technologies, Mick Wilson, K Kannangara, G Smith, M Simmons, B Raguse, Overseas Press (2005).
9. Semiconductor Quantum Dots, L.Banyai and S.W.Koch (World Scientific) 1993
10. An introduction to Physics of Low Dimensional Semiconductors, J.H. Davies, Cambridge Press,1998.

M Sc SEM-III
Paper SCT3.2: NUCLEAR PHYSICS -I

Preamble: This course is an advanced course in nuclear physics after its study in the previous semester on the basic concepts of nuclear physics.

Unit I: Two Nucleon systems and Nuclear forces [16 hours]
Deuteron: The deuteron ground state and its radius. Excited state of deuteron. Magnetic dipole and electric quadrupole moments-deuteron as admixture of S and D states. Tensor nature of nuclear force and its range. Nucleon-nucleon scattering: The partial wave analysis of neutron-proton scattering at low energy, Scattering length and effective range formalism. Scattering from ortho-and para-hydrogen and spin dependence of nuclear force. Proton-proton scattering at low energy, coulomb effects, scattering length and effective range theory: Neutron-neutron system at low energy and the scattering parameters. Qualitative features of nucleon-nucleon scattering at high energies.

Unit II: Nuclear Structure Models [16 hours]
Shell model: Single particle model: energy level scheme for infinite harmonic oscillator and intermediate potentials, spin orbit interaction. Shell model predictions, nuclear spin and moments, Nordheim's rules. Nuclear isomerism and isobaric levels. Independent particle model and coupling schemes. Collective model: Nuclear deformations and collective motions of nucleons. Nuclear rotational motion and rotational energy spectra for even-even nuclei. Vibrational excitation and vibrational energy levels for even-even nuclei. Nuclear moments. Fermi model: Fermi gas model, Fermi energy of nucleons, Fermi momentum and level density; nuclear matter.

Unit III: Particle Physics [16 hours]
Fundamental interaction and their basic features. Elementary particles and their classification based on fundamental interactions. Conservation laws in elementary particle decays; Strangeness and Gellmann- Nishijima relation; Isospin conservation in strong interactions. The conservation laws, invariance, and symmetry principles; space-time symmetries, internal and gauge symmetries; the parity and its non-conservation in weak interaction; Tau theta puzzle. Change conjugation invariance; isotopic parity; C P invariance; C P violation and its analysis. Time reversal symmetry; C P T invariance and its consequences.

Unit IV: Unification of basic interactions [16 hours]
Quark model of hadrons. The eight fold way; meson and baryon multiplets; Gellmann-Okubo mass formula. Broken symmetry. Qualitative discussion on unification of basic interaction; Standard model, GUTs and proton decay; Super symmetry.

References
1. Physics of Nuclei and Particles: P Marmier and V Sheldon (Academic)
2. Nuclear Physics: R R Roy and B P Nigam (Wiley Eastern)
3. The Structure of Nucleus: M A Preston and R K Bahaduri
4. Nuclei and Particles: E Segre (Benjamin)
5. Nuclear and Particles Physics: W E Burcham and M. Jobes (Addison Wesley, 1998, ISE)
6. Nuclear Physics: D C Tayal (Himalaya)
7. Atomic and Nuclear Physics: S N Ghoshal (S. Chand)
8. Fundamentals of Elementary Physics: M J Longo
9. Elementary Particle Physics: D C Cheng and G K O Neill
10. Introduction to High Energy Physics: Houghs
11. Introduction to High Energy Physics: D H Perkins.

M Sc SEM-III
Paper SCT3.2: ENERGY PHYSICS -I

Preamble: The present era is passing through acute shortage of energy and its supply for human endeavors. Man has to develop renewable sources of alternate forms of energy as there is rapid depletion of the existing conventional sources of energy. This course is intended to introduce the various forms of energy, their production, their utilization.

Unit I [16 hours]

Sources of Energy: A brief survey of various energy sources, present and future needs, energy conservation, replenishable and non replenishable energy sources of the world. Estimated reserves of on replenishable energy sources. Problems and viable solutions of energy utilization in ecological and sociological perspectives.

Solar Radiation: Sun as source of radiation, spectral composition, solar constant, the basic earth-sun angles, solar time and equation of time. Effect of earth's atmosphere on solar radiation, terrestrial insolation and its measurement.

Unit II [16 hours]

Thermodynamics of Energy Conversion: Principles of energy conversion, conversion between different forms of energy. Thermodynamics of various conversion processes and their comparison in terms of efficiency. Thermodynamic engine cycles: Carnot, Rankine Otto, Sterling, Diesel cycles and their efficiency. Comparison of Carnot and other cycles. Generation of electric power from heat. Brief sketch of machines: turbines, compressors and pumps. Heat transport processes: conduction, forced convection, radiation, boiling and condensation.

Unit III [16 hours]

Direct Electrical Conversion of Solar Energy: Photo voltaic effect, solar photo emissive and photo voltaic cells. Solar cell characteristics, efficiency and spectral response of solar cells. Description and comparison of different types of solar cells, homojunction and heterojunction cells. Factors off action efficiency of solar cells, solar panels and their performance.

Unit IV [16 hours]

Solar Radiation Collectors: Conversion of solar radiation into heat. Liquid flat plate collectors, thermal losses, energy balance equation and thermal analysis. Flat plate air collectors, types of solar air heaters, performance and applications. Focusing type collectors, need for focusing, solar disc and theoretical solar image. Solar concentrators and receiver geometries, characterisation of focusing collectors, optical loss, energy balance equation and thermal analysis.

References

1. Renewable Energy : Sorenson.
2. Principles of Energy Conversion : A Culp.
3. Treatise on Solar Energy : H P Garg.
4. Solar Energy Utilization : G D Rai.
5. An Introduction to Solar Energy for Scientist and Engineers : Sol Wieder.
6. Fundamentals of Solar Cells : Fahrenbruch and Bube.
7. Solar Cell device Physics : Fonasn.
8. Physics of Semiconductor Devices : S M Sze.
9. An Introduction to Energy Conversion : V Kadambi.

M Sc SEM-III
Paper SCT3.2: BIOPHYSICS -I

Preamble: The course covers study of cell biophysics, membrane biophysics & physiological biophysics.

Unit I [16 hours]

Cell Biophysics: Cell doctrine; General organization and compositions of the cells.
Bioenergetics: The biological energy cycle and the energy currency, thermodynamic concepts; free energy of a system-Gibb's free energy function, chemical potential and redox potentials. Energy conversion path ways-Kreb's cycle; respiratory chain, oxidative phosporylation. Photosynthesis-Photosynthetic apparatus; mechanism of energy trapping and transfer; photo phosporylation.

Unit II [16 hours]

Membrane Biophysics: Cell membranes- Structure, function and models; transport across membranes- passive and active processes; chemiosmotic energy transduction- van't Hoff equations; ionic equilibrium- electrochemical potential; Nernst's equation; Flow across membranes- membrane permeability.
Neurophysics: The nervous system. Synaptic transmission; information processing in neural systems. Physical basis of biopotentials; Action potential; Nernst- Planck equation. Nerve excitation and conduction; Hodgkin-Huxley model.

Unit III

[16 hours]

Physiological Biophysics: Physics of sensory organs- the transmission of information; Generator potentials. Visual receptor- mechanism of image formation; Auditory receptor- mechanism of sound perception; mechanisms of chemical, somatic and visceral receptors. Mechanism of muscle contractility and motility. Temporal organization- basis of biorhythms.

Unit IV [16 hours]

Biophysics of the immune system: the immune system; cellular basis of immunal responses; antibodies and antigens; immunological memory.
Genetic engineering: Gene- structure, expression and regulation; Genetic code and genome organization; recombinant technology, transgenic systems. Cybernetics.

References

1. An introduction to Biophysics, C Sybesma, Academic, 1977.
2. Biophysics, V Pattabhi and N Gautham, Narosa 2002.
3. Essentials of Biophysics, P Narayanan, New Age 2001.
4. Molecular Biophysics: R B Setlow and E C Polland (Addition Wesley, 1962).
5. Biophysics, W Hoppe, W Lohmann, H Markl, H Ziegler (Springer Verlag, 1983)
6. Biophysics and Human Approach, I W Sherman and V G Sherman (Oxford, 1979)
7. Molecular Biology of the Cell, B. Alterts, D. Bray, J. Lewis, M. Raft, K. Roberts and J.D. Watson (Garland, 1984).
8. Molecular Cell Biology, H Lodish, A Berk, S L Zipursky, P Matsudaira, D Baltomore and J Darnel (Freeman, 2000).

M Sc SEM-III
Paper OET3.1: MECHANICS

Preamble: This course is designed for open elective students. The student is introduced to the concepts of classical, quantum and statistical mechanics.

Unit I: **Classical Mechanics** [16 hours]

Newtonian Mechanics: Single and many particle systems-Conservation laws of linear momentum, angular momentum and energy. Kepler's laws of planetary motion.

Lagrangian formalism: Constrains in motion, generalized co-ordinates, virtual work and D'Alembert's principle. Lagrangian equation of motion form D'Alembert's principle. Symmetry and cyclic co-ordinates. Hamiltonian formalism: Hamilton's equations of motion-from Legendre transformations and the variational Principle. Simple applications.

Unit II: **Relativity** [16 hours]

Galilean transformations, Covariance of physical laws, Michelson-Morley experiment, Ether hypothesis, Postulates of special theory of relativity, Lorentz transformations and their consequences; length contraction, simultaneity, time dilation, relativistic Doppler's effect.

Unit III: Quantum Mechanics [16 hours]

Inadequacy of classical physics, postulates of quantum mechanics. Wave function, Uncertainty Principle, Complimentarity, interpretation of wave function, normalization, Schrodinger wave equation in one and three dimensions. Energy eigen values and eigen functions. Exactly solvable one dimensional problems: Square well and rectangular step potentials, Harmonic oscillator.

Unit IV: **Statistical Mechanics** [16 hours]

Laws of thermodynamics, concept of entropy, Statistical ideas in physics, phase space, ensemble, ensemble average, probable and most probable distributions, Gibb's paradox, Boltzmann equipartition theorem (derivation). Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac distribution laws and their comparison, Blackbody radiation and photons.

References

1. Introduction to Classical Mechanics: R G Takwale and P.S .Puranik (TMH, 1979)
2. Classical Mechanics by J.C.Upadhyaya, Himalaya Publishing House
3. Classical Mechanics: N C Rana and P S Joag (Tata McGraw, 1991)
4. Classical Mechanics: H Goldstein, (Addision-Wesley, 1950)
5. A Text Book of Quantum Mechanics by P.M. Mathews and K Venkateshan
6. Advanced Quantum Mechanics by Satyaprakash, Meerut Publication.
7. Statistical Mechanics: K Huang (Wiley Eastern)
8. Statistical Mechanics and Properties of matter: E S R Gopal (Macmillan)

M Sc SEM-III
Paper OET3.2: RADIATION PHYSICS

Preamble: This course is designed for open elective students. As 'physics' is a study of matter and its interaction with radiation, this course introduces the student to the field of radioactivity.

Unit I [16 hours]

Radiation and Radioactivity: the atom, electromagnetic spectra, non-ionizing radiations, ionizing radiations, radiation and radioactivity: Alpha, Beta and Gamma radiations, properties and their characteristics. Radiation detection and measurement: Principles of measurements of radiation and radioactivity. Gas filled Ionization chamber, proportional counters, GM counters, Scintillation detectors, semiconductor detectors, BF3 counters for neutron detection.

Unit II [16 hours]

Interaction of radiation with matter: Mechanism of interaction of ionizing radiation: ionization and absorption of energy – photon beam attenuation – attenuation coefficient and mass energy attenuation coefficients – half value layer-narrow and broad beams-mass, electronic and atomic attenuation coefficients-energy transfer and energy absorption-Interactions of photons with matter – coherent scattering – Photoelectric absorption – Compton effect- – Pair Production – total attenuation coefficient-– relative importance of various types of interaction. Heavy ion interactions ; energy loss per ion pair primary and secondary ionizations, interaction of neutron with matter, neutron activation, radio isotope production.

Unit III [16 hours]

Dosimeters and survey meters Dosimeters: primary standard dosimeters, secondary standard dosimeters, Victoreen R meter, dosimeter based on current measurements, radio isotope calibrator, multipurpose dosimeters -water phantom dosimetry systems, Brach therapy dosimeters, calibration and maintenance of dosimeters.

Instruments for personal monitoring, digital pocket dosimeters using solid state devices, and GM counters, tele-detectors, portable survey meters, gamma area (zone) alaram

TLD dosimetry: process and properties, glow curves and dose response, photon energy dependence, fading, physical form of TLD materials, residual TL and annealing for reuse, repeated read out of TLD's. TL instrumentation, ultrathin TLD's, graphite /boron carbide mixed TLD'S glow curve analysis.

Unit IV [16 hours]

Radiation quantities and Units: particle flux and fluence- photon flux and fluence-cross section- linear and mass absorption coefficient-stopping power and LET. activity – Curie – Becquerel, exposure and its measurements – Roentgen, radiation absorbed dose – Gray – Kerma- Kerma rate constant- electronic equilibrium-relationship between kerma, exposure and absorbed dose–relative biological effectiveness- radiation weighting factors.

Equivalent dose-effective dose- tissue weighting factors-ambient and directional equivalent dose and their relevance in dosimetry, tissue equivalence, dose commitment and collective dose.

References

1. John Lilley, Nuclear Physics, Principles & Applications, John-Wiley, NY (2001)
2. Ghoshal, Nuclear Physics : S Chand and Compnay Ltd., New Delhi (2004)
3. B. L. Cohen, Concepts of Nuclear Physics, Tata McGraw Hill, New Delhi (2000)
4. H. S. Hans, Nuclear Physics: Experimental and Theoretical, New Age International Publishers, New Delhi (2001)

M Sc SEM-III
PRACTICAL COURSES

HCP 3.1/3.2: Optics and Electronics	
Optics: 1. Sodium doublet separation, RI and thickness of the film using Michelson interferometer. 2. Determination of Lycopodium powder particle size by hollow method. 3.Wavelength of laser beam using double slit interference pattern. Assignments/ Computations	Electronics: 4. RC coupled transistor Amplifier 5. Half adder and full adder 6. A/D converter Assignments/ Computations
SCP 3.1/3.2: Nuclear Physics and Solid State Physics	
Nuclear Physics: 1.Spectral response analysis of scintillation detector. 2. Analysis of electron scattering and estimation of nuclear size. 3. Determination of rest mass energy of electron from gamma ray spectrum. 4. Multi channel analysis of gamma ray spectrum. 5. Beta spectrum using scintillation detector. 6. Study of solar cell 7. Solar spectrum and determination of solar constant. Assignments/ Computations	Solid State Physics: 8. Specific heat of graphite. 9. Study of creep behavior in Lead. 10. Magnetic susceptibility by Gouy's method. 11. Magnetoresistance of a semiconductor. Assignments/ Computations

Note: New experiments shall be added to the list as and when developed.

M Sc SEM-IV
Paper HCT4.1: STATISTICAL MECHANICS

Preamble: This paper pertains to the study of thermodynamics and statistical concepts, distinguishing features of classical and quantum statistics, irreversible phenomena and fluctuation theory.

Unit I [16 hours]
Basic Thermodynamical and Statistical Concepts: The laws of thermodynamics and their implications, thermodynamic potentials, Maxwell's relations and their applications, phase space, ensembles, Ergodic hypothesis and Liouville's theorem. Probability, probability distribution and the most probable distribution, partition functions, microcanonical, canonical and grand canonical ensembles, thermodynamic potentials and the partition functions.

Unit II [16 hours]
Classical Statistics: Partition function of a system of particles, the translational partition function, Gibbs paradox and Boltzmann equipartition theorem, rotational and vibrational partition functions, Einstein relation and electronic partition function. The various partition functions and the corresponding thermodynamic potentials. Maxwell-Boltzmann distribution and its physical applications.

Unit III [16 hours]
Quantum statistics: the symmetry and anti symmetry of the wave functions, Bosons and Fermions, Bose- Einstein and Fermi-Dirac distributions, ideal Bose and Fermi gases- their properties at high and temperatures and densities. Bose –Einstein condensation, blackbody radiation and photons, phonons and specific heat of solids.

Unit IV [16 hours]
Fluctuations: Fluctuations in canonical, grand canonical and microcanonical ensembles, Brownian motion and Langevin equation, random walk, diffusion and the Einstein relation for mobility. Fockker-Plank equation. Johnson noise and shot noise.

Irreversible Thermodynamics: Onsager reciprocity relations, thermoelectric phenomena, non-equilibrium phenomena in liquid helium-fountain effect. Gibbs entropy for non-equilibrium states, the entropy and information.

References

1. Statistical Mechanics: K Huang. (Wiley Eastern.)
2. Statistical Mechanics and Properties of Matter: E S R Gopal. (Macmillan.)
3. Elementary Statistical Physics: C Kittel. (John Wiley.)
4. Fundamentals of Statistical and Thermal Physics: F Reif (Mc Graw Hall.)
5. An Introduction to Statistical Physics: W G V Roser. (John Wiley.)
6. Thermodynamics of Irreversible Processes: S R de Groot.
7. Statistical Physics: L D Landau and E M Lifshitz (Pergamon)

M Sc SEM-IV

Paper HCT4.2: QUANTUM MECHANICS -II

Preamble: This course is an advanced course. The student, after getting the exposure of introductory quantum mechanics in the earlier semester will be taught the advanced topics in quantum mechanics.

Unit I [16 hours]

Time-dependent phenomena: perturbation theory for time evolution, first and second order transition amplitudes and their physical significance, application of first order theory: constant perturbation, wide and closely spaced levels-Fermi's golden rule, scattering by a potential, harmonic perturbation: interactions of an atom with electromagnetic radiation, dipole transitions and selection rules; spontaneous and induced emission, Einstein A and B coefficients, Sudden approximation.

Unit II [16 hours]

Identical particles and spin: Indistinguishability of identical particles, symmetry of wave function and spin, Bosons and Fermions. Pauli exclusion principle, singlet and triplet states of He atom and exchange integral, spin angular momentum, Pauli matrices.

Angular momentum: Angular momentum operators, commutation relations, eigen values and eigenvectors, matrix representation, orbital angular momentum. Addition of angular momenta, Clebsch-Gordon coefficients for simple cases.

Unit III [16 hours]

Symmetry Principles: symmetry and conservation laws, symmetry and degeneracy. space-time symmetries, displacement in space- conservation of linear momentum, displacement in time – conservation of energy, rotation in space–conservation of angular momentum, space inversion–parity, time reversal invariance.

Relativistic Wave equations: Schrodinger's relativistic equation: free particle, electromagnetic potentials, separation of equations, energy level in a Coulomb field, Dirac's relativistic equation: free particle equation, Dirac matrices, free particle solutions, charge and current densities, electromagnetic potentials. Dirac's equation for central field: spin angular momentum, approximate reduction, spin orbit energy. separation of the equation, the Hydrogen atom, classification of energy levels and negative energy states.

Unit IV [16 hours]

Quantization of wave fields: classical and quantum field equations; co –ordinates of the field, classical Lagrangian equation, functional derivative; Hamilton's equations, quantum equations for the field; quantization of non-relativistic Schrodinger wave equation: classical Lagrangian and Hamiltonian equations, second quantization.

References

1. Quantum Mechanics: L I Schiff (McGraw-Hill, 1968)
2. Quantum Mechanics: F. Schwab1 (Narosa, 1992).
3. A Text book of Quantum Mechanics: P M Mathews & K Venkateshan (TMH, 1994)
4. Quantum Mechanics: V. K. Thankappan (Wiley Eastern, 1980)
5. Quantum Mechanics: B K Agarwal and Hariprakash (Prentice-Hall, 1997)
6. Quantum Mechanics: Theory and Applications: A K Ghatak &S Loknathan [MacMillan India Ltd., 1984]
7. Quantum Mechanics : G Arulkhas, PHI Learning Private Lte.,(2^{nd} Edn.), 2013.

M Sc SEM-IV
Paper SCT4.1: SOLID STATE PHYSICS -II

Preamble: This is an advanced course in solid state physics. Charge and heat transport phenomena in metals, semiconductors is crucial to understand the nature of materials and their response to electrical, magnetic etc. stimulus. Ferroelectric materials are materials of choice for high energy storage. Arriving at the room temperature superconductivity is a challenge.

Unit I [16 hours]

Transport properties

Metals: Boltzmann equation, electrical conductivity, calculation of relaxation time, impurity scattering, ideal resistance, general transport coefficients, thermal conductivity, thermoelectric effects, lattice conduction, phonon drag.

Semiconductors: Thermal conductivity, thermoelectric and magnetic effects, hot electron and energy relaxation times. High frequency conductivity. Acoustic and optical (polar and non polar) scattering by electrons.

Unit II [16 hours]

Dielectric and ferroelectric properties

Dielectric: Macroscopic description of static dielectric constant, electronic, ionic and orientational polarization, Lorentz field and its derivation, dielectric constant of solids, complex dielectric constant and dielectric losses. Debye's equations, theory of electronic polarization and optical absorption.

Ferroelectricity: General properties and classification of ferroelectrics, dipole theory and its drawbacks, thermodynamics of ferroelectric transitions (qualitative), ferroelectric domains.

Unit III [16 hours]

Magnetic properties

Classification of magnetic materials, diamagnetism: origin of diamagnetism, Langevin classical theory. Paramagnetism: origin of paramagnetism, review of classical theory, quantum theory (quantitative).

Ferromagnetism: concept of domains, thickness of Bloch wall, molecular field concept, Weiss theory, Heisenberg exchange interaction, Ising model, spin waves dispersion relation (one dimensional case), quantization of spin waves, concept of magnons and thermal excitation of magnons, Bloch $T^{3/2}$ law for magnetization.

Antiferromagnetism: Two sub-lattice model (quantitative description). Ferrimagnetism: ferrimagnetism in iron garnets.

Unit IV [16 hours]

Superconductivity: Review of basic properties, classification into type I and type II. Energy gap and its temperature dependence. Super current and critical currents.

London's equations (derivation), penetration depth. Cooper pairs, coherence length. Instability of Fermi surface and cooper pairs. BCS theory and comparison with experimental results. Ground state energy of superconductor. Quantization of magnetic flux. Josephson effects (AC and DC) and applications

High T_c materials: Structure and properties, some applications.

References

1. Principle of the theory of solids: J.M. Ziman (Cambridge University Press)
2. Introduction to Solid State Physics: C. Kittel (Wiley Eastern)
3. Solid State Physics: A.J. Dekkar (Prentice Hall Inc)
4. The physical principles of Solids: A.H. Morish
5. Introduction to Superconductivity: M. Tinkham (McGraw-Hill, Int. Edition)
6. Semiconductor Physics: P.S. Kireev (MIR Publishers)
7. Solid State Science: K. Seeger (Springer Verlag)

M Sc SEM-IV
Paper SCT4.1: MATERIALS PHYSICS -II

Preamble: This is an advanced course in materials physics. It covers materials like glasses, ceramics, polymers which are integral to mankind. Dielectric, ferroelectric and magnetic properties are studied. Special materials such as ferrites, liquid crystals and nano materials are also studied.

Unit I [16 hours]

Elastic properties: Atomic model of elastic behavior, Modulus as a parameter in design, Spring-Dashpot model for viscoelastic behavior. Plastic deformation: tensile stress-strain curve, plastic deformation by slip, shear strength of perfect and real crystals, mechanism of creep, creep resistant materials. Fracture of materials: ductile and brittle fracture, fatigue fracture, fracture toughness, ductile-brittle transition, methods of protection against fracture.

Unit II [16 hours]

Glasses, Ceramics and Polymers

Glasses: Glass forming constituents, structure of glasses, glass transition, types of glasses. Optical, electrical properties of glasses.

Ceramics: Classification and their structures, polymorphism; mechanical and thermal properties; Application of ceramics.

Polymers: Polymers, basic concepts, mechanisms of polymerization, structure and properties of polymers. Molecular weight of polymers. Electrical and optical properties.

Unit III [16 hours]

Dielectric, ferroelectric and magnetic properties: Ideas of static dielectric constant, loss, polarization, types of polarization; lorentz field, dielectric break down. Complex dielectric constant, applications of dielectrics.

Ferroelectrics and their properties. Types of ferroelectrics. Dipole theory of ferroelectricity, their objections. Ferroelectric domains. Relaxor ferroelectrics.

Magnetic materials; dia, para, ferro, antiferro and ferrimagnetism. Weiss theory of ferromagnetism, domains.

Unit IV [16 Hours]

Special materials:

Ferrites: Classification, soft and hard ferrites, Structure of ferrites, cation distribution, Mossbauer spectroscopic technique to determine cation distribution. B-H hysteresis loop, retentivity, coercieve field, saturation magnetization. Application of ferrites.

Liquid crystals: Classification, structure, optical and dielectric properties. Ferroelectric, anti ferroelectric and polymeric liquid crystals. Liquid crystal display.

Nano materials: Classification, structure, properties. Carbon nano tubes, Quantum dots, quantum wires. Synthesis of nano materials; Sol-Gel.

References

1. Elements of Materials Science and Engg, L.H. van Vleck, Addison-Wesley, 6th edition.
2. Materials Science and Engineering, V. Raghvan, Printice Hall of India, 3rd edition.
3. Materials Science and Processes: S. K Hazra Chaudary,Indian Distr Co., 1977.
4. Introduction to Ceramics, W.D. Kingery John Wiley
5. Polymer Science, V. R Gowarikar, N. V Vishwanathan, Wiley Eastern (1986).
6. Solid State Physics, A J Dekkar, Prentice-Hall, Inc.
7. Advances in Ferrites, V.R. K. Murthy and B, Vishwanath, Narosa Pub.
8. Liquid crystals, S. Chandrasekhar, Cambridge Univ Press, 2nd edition.
9. Principles of Polymer Science, P. Bahadur & N V Sastry, Narosa, 2002.

M Sc SEM-IV

Paper SCT4.1: SEMICONDUCTOR PHYSICS AND DEVICES

Preamble: This course is on semiconductors, semiconductor devices and amorphous semiconductors.

Unit I [16 hours]

Introduction to semiconductors: Crystal structure and bonding in typical semi conductors, band structures of some semi-conductors; electron and hole statistics; density-of-states, extrinsic and intrinsic semi-conductors; non- degenerate and degenerate semi-conductors.

Transport in Semiconductors:

Electrical conductivity, magneto-resistance and Hall effect, thermoelectric properties, experimental determination, types of scattering mechanisms (qualitative).

Unit II [16 hours]

Charge carrier recombination: continuity equation, life time, recombination mechanism, diffusion and drift of non- equilibrium carriers; Schokley- Hayney experiment.

Contact phenomena: Debye length, work function, contact potential, metal-metal, metal-semiconductor and metal-semiconductor-insulator contacts, two-dimensional solids and Stark effect.

Unit III [16 hours]

Devices: P-N Junction. Theory of rectification, junction transistor and amplification, breakdown in junctions; Tunnel & Zener diodes and their breakdown mechanisms; F.E.T; Semi-conductor diode laser; Microwave devices; Radiation detectors, (Photo-determinations, I.R. detectors, Photovoltaic device); The semi-conductor lamp (L.E.D.);

Solar cells: Fabrication and application to energy conversion

Unit IV [16 hours]

Amorphous Semiconductors: Types of amorphous semiconductors, preparation methods, band structure, electrical properties, optical properties and thermal properties, Applications: Switching and Xerography.

References

1. The principles of Magnetism : A. H. Morrish.
2. Introduction to magnetic resonance : A Carrington and A.D. Mclachlan.
3. Introduction to Ligand field theory : B. N. Figgis.
4. Solid State Physics by Ashcroft and Mermin.
5. Elementary Solid state Physics : M. Ali Omar.
6. Semi-conductor Physics : P. S. Kireev.

M Sc SEM-IV

Paper SCT4.2: NUCLEAR PHYSICS -II

Preamble: This course is an advanced course in nuclear physics. Heavy ion physics, special features of heavy ion reactions, nuclear reactions are introduced, Different types of particle detectors and radiation safety aspects are introduced.

Unit I [16 hours]

Formal theory of nuclear reactions: Nuclear reactions, general formalism and cross sections. Principle of detailed balance. Resonance reactions, Breit-Wigner formula for 1=0, level widths and strength functions.

Statistical model: Statistical theory of nuclear reactions, evaporation probability and cross sections for specific reaction. Experimental results.

Optical model: Optical potentials and optical model parameters. Optical model at low energy, Kapur-pierls dispersion formula for potential scattering&experimental results.

Unit II [16 hours]

Direct reactions: Transfer reactions. Theory of stripping and pickup reaction. Plane wave Born approximation and qualitative consideration of distorted wave Born approximation.

Heavy ion Physics: Special features of heavy ion reactions. Qualitative treatment of remote electromagnetic interaction- Coulomb excitations; close encounters, grazing collisions and particle transfer. Direct and head on collision, compound nucleus and quasi molecule formation.

Unit III [16 hours]

Particle detectors and accelerators: Gas filled ionization detectors: Current mode and pulse mode operation; proportional counter, position sensitive ionization chamber and multi-wire proportional counter. Semiconductor detectors: Semiconductor P-N junction as a detector. Type of semiconductor detectors; surface barrier, Si(Li), Ge(Li) and high purity germanium detectors. Pelletron accelerator.

Radiation protection: Dose units, estimation and measurement of dose from beta, gamma and neutron sources. Dosimeters. Biological effects of ionizing radiation. Radiation protection, tolerance limits of exposure to radiation and late effects of radiation. Radiation shielding.

Unit IV [16 hours]

Neutron diffraction: classification of neutrons in terms of energy, bound and free atom cross section, coherent and incoherent cross sections, neutron diffraction from single crystals and powders, advantages of neutron diffraction over X-ray diffraction. Refractive index of neutrons and mirror reflection of cold neutrons. Neutron interferometer and its application.

Nuclear techniques: Basic principles, instrumentation and application of positron annihilation spectroscopy, x-ray fluorescence, proton induced x-ray emission, Rutherford back scattering.

References

1. Nuclear Radiation Detectors: Kapoor and Ramamurthy.
2. Radiation Detection and Measurement : G F Knoll.
3. Measurement and detection of radiation : Nicholas Tsonlfanidis.
4. Physics of Nuclei and Particles : Marmier and Sheldon (Academic Press)
5. Introduction to Experimental Nuclear Physics : Singru.
6. Nuclear Physics : R R Roy and B P Nigam (Wiley Eastern)
7. Nuclear Physics : D C Tayal (Himalaya)
8. Atomic and Nuclear Physics : S N Ghoshal (S. Chand)
9. Neutron Diffraction: G F Bacon.

M Sc SEM-IV
Paper SCT4.2: ENERGY PHYSICS -II

Preamble: This course is an advanced course in energy physics. Nuclear fusion and fission energies are dealt with.

Unit I [16 hours]

Nuclear Fission Energy: Fission chain reaction, neutrons and their classification in terms of energy, energetics of neutron induced fission and four factor formula. Diffusion of neutrons (Qualitative discussions): Diffusion coefficient, diffusion equation and diffusion length. Slowing down of neutrons: Energy loss of neutrons in elastic scattering, mean energy loss and average logarithmic energy decrement. Slowing down power, slowing down density and lethargy. Continuous slowing model and Fermi age theory.

Unit II [16 hours]

Nuclear reactors: Fission reactors condition for criticality, bare homogenous reactor, geometrical and material buckling. Critical size for bare homogenous cylindrical and rectangular assemblies. Power reactors: Gas cooled and graphite moderated reactors, pressurised water reactor, heavy water moderated reactor and fast breeder reactors.

Unit III [16 hours]

Nuclear Fusion Energy: Controlled fusion reaction cycle in hydrogen plasma, reaction cross sections and reaction rates. Ignition temperature, Lawson's criterion, radiation loss and kinetics of fusion reaction. Transport coefficient in plasma. Confinement of plasma: Pinch effect, dynamics of pinched plasma, instabilities of plasma and plasma stabilization, linear and toroidal pinched plasma. Tokomak and stellarator fusion reactors. Laser derived fusion reactor and power generation.

Unit IV [16 hours]

Wind, geothermal and Electrochemical Energy: Energy in the wind. Horizontal and vertical axis wind mills. Sources of geothermal energy and its utilisation working and efficiency of photochemical cells.

Bioenergy: Bio conversion and mechanism of photosynthesis, microbial and plant photosynthesis. Bio-mass systems, assessment, conversion, utilisation and conversion. Types of conversion of Bio-mass, anaerobic conversion and Bio-gas generation, enzymatic conversion and liquid fuel production.

References

1. Renewable Energy : B Sorenson.
2. Principles of Energy Conversion : A W Culp.
3. Introduction to Nuclear Reactor Theory : J K Lamarsh.
4. Introduction to Nuclear Reactor Theory : Isbin.
5. Elementary Nuclear Reactor Theory : Gladstone and Edlund.
6. Nuclear Energy and Energy Policies : S S Penner.
7. Nuclear Power Engineering : D K Singhai.
8. Plasma Physics : R A Cairns.
9. Non-conventional Energy Sources : G D Rai.

M Sc SEM-IV
Paper SCT4.2: BIOPHYSICS -II

Preamble: This is an advanced course in biophysics. Biophysical methods are discussed. Radiation and medical biophysics and bioinformatics are dealt with.

Unit I [16 hours]
Molecular biophysics: Molecular interactions and bonds. Biophysical organization; Molecular recognition processes; structure and function of biomolecules-Carbohydrates, and Lipids; Structure of nucleic acids; conformational polymorphism in nucleic acids. Structure of proteins; polyptides and protein conformation.

Unit II [16 hours]
Biophysical methods: Principle, working and applications of ultracenterifugation, electrophoretic and chromatographic techniques. Optical electron and Atomic Force Microscopy. Principles of absorption and fluorescence spectroscopy, optical rotary dispersion and circular dichroism. X-ray spectrometer and structure analysis. Nuclear Magnetic Resonance and Electron Spin Resonance spectrometers. Radiotracer techniques.

Unit III [16 hours]
Radiation biophysics: Interaction of radiation with matter; radiation detection, measurement and dose estimation; Biological effects of ionizing radiations- effects at the molecular, cellular and tissue levels; genetic effects. Biological effects of nonionizing radiations. Radiation hazards and safety standards for radiation protection.

Unit IV [16 Hours]
Medical biophysics: Diagnostic and therapeutic uses of ionizing radiations- Nuclear medicine. Medical uses of nonionizing radiation- Photomedicine; physiological and therapeutic uses of heat radiation. Biosensors: Medical expert systems-principle, working, and applications; Endoscopic, Ultrasonic, Fluoroscopic and Tomographic techniques.

Bioinformatics: Information Computers-Data bases-Bimolecular, sequence and structure databases. Sequence analysis of proteins and nucleic acids. Genome project.

References

1. An introduction to Biophysics: C Sybesma (Academic,1977).
2. Biophysics: V Pattabhi and N Gautham, (Narosa,2002).
3. Essentials of Biophysics: P Narayan, (New Age,2001).
4. Molecular Biophysics: R B Setlow and E C Polland, (Addition Wesey, 1962).
5. Biophysics: W Hoppe, W Lohmann, H. Markl, H Ziegler, (Springer Verlag, 1983).
6. Biophysical Principle of Structure and Function: F M Snell, Shulman, R P Spensor and Moos, (Addison Wesley, 1965).
7. Principles of Protein Structure: G E Schultz and R H Shirmer, (Springer.1969).
8. Principles of nucleic acid structures: W. Saenger, (Springer Verlag, 1984).
9. Radiation Biophysics: E L Alpen, (Prentice-Hall, N J, 1990).
10. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Eds A D Baxevanis & B F Francis (John Wiley, 1998).

M Sc SEM-IV
Paper HCMP4.3: PROJECT

Compulsorily each student has to carry out a project work under the supervision of a staff member. The topic for project work can be of theoretical or experimental or computational in nature. A group of students under a staff member can work on a single topic for project. However, each student has to submit his/her own independently written original project report and face examination independently. Maximum of six credits are given for the project work. On completion of the project work and at the end of the Semester IV, a project report (certified by both supervisor and Chairman/Head of the Department) based on the project work carried out must be submitted to the Department. Project work will be valued for maximum of 150 marks (project report 72 marks,Viva-Voce 48 marks and Internal Assessment 30 marks).

M Sc SEM-IV
PRACTICAL COURSES

HCP 4.1/4.2 : Optics and Electronics	
Optics: 1. Wavelength of laser beam by single slit diffraction method. 2. Wavelength of laser beam by diffraction due to engraving on vernier calipers. 3. Velocity of light by Kerr cell method. 4. Determination of numerical aperture by an optical fibre. Assignments/ Computations	Electronics: 5. RC coupled transistor CE amplifier. 6. Fixed voltage regulation using IC 7812 or 7912 7. Variable voltage regulation using IC 723 or 8085 8. Study of counters and shift registers 9. D/A converter. Assignments/ Computations
SCP 4.1/4.2 : Nuclear Physics and Solid State Physics	
Nuclear Physics: 1. Spectral response analysis of solid state detector. 2. Study of coincidence circuits. 3. Study of Bremsstrahlung radiation 4. Analysis of n-p and p-p scattering parameters. 5. Nuclear structure analysis. 6. Analysis of beta spectrum by multi channel analyzer. 7. Study of solar panels. 8. Positron annihilation and angular correlation of annihilation photons. 9. Analysis of nuclear reaction cross section. Assignments/ Computations	Solid State Physics: 10. Dielectric constant of PZT. 11. Hall effect in semiconductors. 12. Electron Spin Resosnance. 13.Four probe method to study resistivity variation with temperature of a semiconductor. 14. Study of lattice dynamics. 15. B-H hysteresis loop tracer. Assignments/Computations.

Note: New experiments shall be added to the list as and when developed.

QUESTION PAPER PATTERN FOR INTERNAL ASSESSMENT TESTS AND SEMESTER END EXAMINATIONS

IA Test 1 for theory courses (Hard core, Soft core & Open electives)

There shall be three questions of 10 marks each. Students will have to answer any two questions.

Example: Question 1 has to be drawn from Unit 1. Question 2 has to be drawn from Unit 2. Question 3 consisting of two parts (a) and (b) has to be drawn from both the Units 1 & 2.

Duration of the test is one hour. Maximum marks 20.

IA Test 2 for theory courses (Hard core, Soft core & Open electives)

There shall be three questions of 10 marks each. Students will have to answer any two questions.

Example: Question 1 has to be drawn from Unit 3. Question 2 has to be drawn from Unit 4. Question 3 consisting of two parts (a) and (b) has to be drawn from both the Units 3 & 4.

Duration of the test is one hour. Maximum marks 20.

Average of the marks secured in two internal assessment tests will be taken as the final awarded marks in the internal assessment test of the respective subject.

Practical Internal Assessment Test

1. There shall be one Internal Assessment test in each of the practical courses for 20 marks. In the practical test, the students may be asked to perform the experiment or analyse the data or work out a computation or answer few questions orally etc. The methodology to be followed in the given practical test will be decided by the Department and that would be uniformly applied to all the students in that semester.

Duration of the practical test is 1 or 1½ hour. Maximum marks 20

Semester End Examinations

Question paper Pattern for theory courses (Hard core, Soft core and Open Electives)

There shall be 8 questions of 15 marks each (two questions from each unit). Students will have to answer four questions. There shall be internal choice in each unit.

Example:

Questions 1 & 2 must be from Unit 1. Students will answer either Question 1 or Question 2.

Questions 3 & 4 must be from Unit 2. Students will answer either Question 3 or Question 4.

Questions 5 & 6 must be from Unit 3. Students will answer either Question 5 or Question 6.

Questions 7 & 8 must be from Unit 3. Students will answer either Question 7 or Question 8.

Further, there shall be four questions of 10 marks each. One question from each unit must be drawn. Students will have to answer two questions.

Example:

Question 9 must be drawn from Unit 1.

Question 10 must be drawn from Unit 2.

Question 11 must be drawn from Unit 3.

Question 12 must be drawn from Unit 4.

Duration: 3 hours Max. marks : 80 [=(15x4) + (10x2)]