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.

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.