| Semester | Course Code | Title of the Paper | Credits | Teaching hours/week | Semester End Exam. Duration | Semester End Exam. Max. marks | Internal Assessment Duration | Internal Assessment Max. marks | Total 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.

## 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 $2^{nd}$ and $4^{th}$ 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 $Fe\text{-}Fe_3C$ ; 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, 6$^{th}$ edition)
2. Materials Science and Engineering, V. Raghavan, Prentice Hall of India, 3$^{rd}$ 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**

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

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