**Teaching Schedule**

Session 2023-24

Department of Physics

A.B.V. Govt. College Sunni

**BSc 1st Year**

**Course 1: DSC 1A**

**MECHANICS**

**Course code: PHYS101TH**

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| **Month** | **Weeks** | **Unit** | **Topics** |
| July | 4th | 1 | **Ordinary Differential Equations:** 1st order homogeneous differential equations. 2nd order homogeneous differential equations with constant coefficients. |
| August | 1st |  | **Coordinate systems and motion of a particle:** Volume, velocity and acceleration in Cartesian and Spherical co-ordinate systems, Solid angle. |
|  | 2nd |  | **Space Time Symmetry and Conservation Laws:** Relationship of conservation laws and symmetries of space and time. |
|  | 3rd |  | **Frames of Reference:** Inertial frames of reference, Galilean transformation and Galilean invariance. Non-inertial frames, Coriolis force and its applications; Foucault’s pendulum. |
|  | 4th | 2 | **Gravitation and Inverse Square Force Law:** Newton’s Law of Gravitation, Various forces in nature (qualitative). Central and non-central forces, Inverse square force, Centre of mass. |
| September | 1st |  | Equivalent one body problem. Reduced mass, angular momentum in central force field. Equation of motion under a force law**.** |
|  | 2nd |  | Equation of orbit and turning points. relationship between eccentricity and energy, Kepler’s laws. Basic idea of global positioning system (GPS). |
| October | 4th | 3 | **Rotational Motion and Kinematics of Elastic and Inelastic Collisions:** Angular velocity, angular momentum, Torque, Conservation of angular momentum. |
| November | 1st |  | Elastic and inelastic collisions, coefficient of restitution, Elastic collisions in laboratory and C.M. systems, Velocities, angle and energies in elastic collisions in C.M. and lab. Systems. |
|  | 2nd |  | Classical Scattering: Cross- section for elastic scattering, Rutherford scattering (with derivation). |
| December | 1st |  | Revision & MTT |
|  | 2nd |  | Revision & MTT |
| February | 2nd | 4 | **Special Theory of Relativity:** Concept of stationary universal frame of reference and search for ether. Michelson- Morley experiment, postulates of special theory of relativity. Lorentz transformations. Observer in relativity. Relativity of simultaneity. |
|  | 3rd |  | **Effects of Relativity:** Length contraction. Time dilation. Relativistic addition of velocities. Relativistic Doppler effect. Variation of mass with velocity and mass energy equivalence. Increase of mass in an inelastic collision, Relativistic momentum and energies. Transformation of momentum, energy. Minkowsky space. |
| March |  |  | **Final Practicals** |

There will be a class test at the end of each unit.

**DSC 1A LAB**

**MECHANICS**

**Course Code: PHYS101PR**

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| **Month** | **Experiment** |
| August | Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope. |
| September | To determine the Height of a Building using a Sextant. |
| October | To determine the Moment of Inertia of a Flywheel. |
| November | To determine the Elastic Constants of a Wire by Searle’s method. |
| December | To determine g by Bar Pendulum. |
| February | To determine g by Kater’s Pendulum. |

There will be seminar & viva after the completion of each experiment.

**Course 2: DSC 1B**

**ELECTRICITY, MAGNETISM AND EMT**

**Course Code: PHYS102TH**

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| --- | --- | --- | --- |
| **Month** | **Weeks** | **Unit** | **Topics** |
| September | 3rd | 1 | **Vector Analysis**: Review of vector algebra (Scalar and Vector product), gradient, divergence, Curl and their significance, Vector Integration, Line, surface and volume integrals of Vector fields, Gauss-divergence theorem, Stokes’s theorem, Green’s theorem |
|  | 4th |  | **Electrostatics**: Significance of electrostatic force, Electrostatic Field, electric flux, Gauss's theorem of electrostatics. Applications of Gauss theorem- Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor, electrostatic potential, electrostatic potential energy. Electric potential due to a dipole and quadrupole, long uniformly changed wire, charged disc. Electric potential energy. |
| October | 1st |  | Electric field as a gradient of a scalar potential. Calculation of electric field due to a point charge and a dipole from potential. Method of Electrical Images. Poisson and Laplace equations.  **Electric Current and Fields of Moving charges**: Current and current density. Continuity equation; Microscopic form of Ohm’s law (J α E) and conductivity. Failure of Ohms law and its explanation. Invariance of charge. |
|  | 2nd | 2 | **Magnetism:** Ampere circuital law and its applications. Hall Effect, Expression for Hall constant and its significance. Divergence and curl of magnetic field B. Vector potential: Definition of vector potential A and derivation. Field of Moving Charges: E in different frames of reference. Field of a point charge moving with constant velocity. Field of charge that starts or stops (qualitative). |
|  | 3rd |  | Interaction between moving charge and force between parallel currents.  **Surface current density:** Definition. and its use in calculation of change in magnetic field at a current sheet. Transformation equations of E and B from one frame of reference to another. Dielectrics, parallel plate capacitor with a dielectric, dielectric constant, polarization and polarization vector, displacement vector D, molecular interpretation of Claussius - Mossotti equation, boundary conditions satisfied by E and D at the interface between two homogenous dielectrics, illustration through a simple example. |
| November | 3rd | 3 | **Electrostatic Fields in Dielectrics:** Polarization of matter. Atomic and molecular dipoles, induced. Dipole moment and atomic polarizability. Electric susceptibility and polarization vector |
|  | 4th |  | Capacity of a capacitor filled with Dielectrics. Dielectrics and Gauss’s law Displacement vector-Establishment of relation ∇.*D* = *ρ free* . Energy stored in a dielectric medium. |
| December | 1st |  | Revision & MTT |
|  | 2nd |  | Revision & MTT |
|  | 3rd | 3 | **Magnetic Fields in Matter**: Behavior of various substances in magnetic fields. Definition of M and H and their relation to free and bound currents. Magnetic permeability and susceptibility and their interrelation. Orbital motion of electrons and diamagnetism. Electron spin and paramagnetic. Ferromagnetism. Domain theory of ferromagnetism, magnetization curve, hysterics loss, ferrites. |
|  | 4th | 4 | **Maxwell`s equations and Electromagnetic wave propagation:** Displacement current, Maxwell's equations and its physical interpretation, EM waves and wave equation in a medium having finite permeability and permittivity but with conductivity δ= 0. Poynting vector, Poynting theorem, |
| February | 4th | 4 | Impedence of a dielectric to EM waves, EM waves in conducting medium and skin depth. EM waves velocity in a conductor and anomalous dispersion. Reflection and Transmission of EM waves at a boundary of two dielectric media for normal and oblique incidence of reflection of EM waves from the surface of a conductor at normal incidence |
| March |  |  | **Final Practicals** |

There will be a class test at the end of each unit.

**DSC 1B LAB**

**ELECTRICITY, MAGNETISM AND EMT**

**Course Code: PHYS 102PR**

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| **Month** | **Experiment** |
| August | To use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, and (d) checking electrical fuses. |
| September | 1. To compare capacitances using De’Sauty’s bridge. 2. To determine a Low Resistance by Carey Foster’s Bridge. |
| October | 1. To study a series LCR circuit and determine its (a) Resonant Frequency, (b) Quality Factor 2. To study a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor Q . |
| November | To verify the Thevenin and Norton theorem |
| December | To determine unknown capacitance by flashing and quenching method. |
| February | To find frequency of ac supply using an electrical viberator. |

There will be seminar & viva after the completion of each experiment.

**BSc 2nd Year**

**Course 1: DSC 1C**

**STATISTICAL AND THERMAL PHYSICS**

**Course Code: PHYS201TH**

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| **Month** | **Weeks** | **Unit** | **Topics** |
| July | 4th | 1 | **Basic Ideas of Statistical Physics:** Scope of statistical physics, basic ideas about probability, distribution of four distinguishable particles in two compartments of equal sizes. Concept of macro-states, micro-states, thermodynamic probability, effect of constraints on the system. |
| August | 1st |  | **Distribution of Particles in Compartments:** Distribution of n particles in two compartments, Deviation from the state of maximum probability. Equilibrium state of a dynamic system, distribution of n distinguishable particles in k compartments of unequal sizes. |
| September | 2nd | 2 | **Types of Statistics in Physics:** Phase space and division into elementary cells. Three kinds of statistics. The basic approach in the three statistics. M-B. Statistics applied to an ideal gas in equilibrium, |
|  | 3rd |  | experimental verification of the Maxwell Boltzmann’s law of distribution of molecular speeds. Need for quantum statistics, h as a natural constant and its implications, indistinguishability of particles and its implications. B-E statistics, **Bose Einstein and Fermi Dirac Statistics:** Derivation of Planck’s law of radiation, |
|  | 4th |  | deduction of Wien’s distribution law and Stefan’s law from plank’s law. Fermi-Dirac statistics. Applications to liquid helium, free electrons gas (Fermi level and Fermi Energy), Comparison of M-B, B-E, F-D statistics. |
| November | 1st | 3 | **Entropy and Laws of Thermodynamics:** Application of thermodynamics to the thermoelectric effect, change of entropy along a reversible path in a p-v diagram, |
|  | 2nd |  | entropy of a perfect gas, equation of state of ideal gas from simple statistical considerations, heat death of the universe. |
|  | 3rd |  | **Statistical Interpretation of entropy:** Statistical definition of entropy, change of entropy of system, additive nature of entropy, law of increase of entropy. |
|  | 4th |  | Reversible and irreversible processes, example of reversible and irreversible processes. Work done in a reversible process, example of entropy in natural process, entropy and disorder. |
| December | 1st |  | Revision & MTT |
|  | 2nd |  | Revision & MTT |
| February | 2nd | 4 | **Maxwell’s Thermodynamic Relations and Their Applications:** Thermodynamic Potentials: Enthalpy, Gibbs, Helmholtz and Internal Energy functions, |
|  | 3rd |  | Derivation of Maxwell’s thermodynamic relations. **Applications of thermodynamics relations**. Cooling produced by adiabatic stretching, adiabatic compression, adiabatic Stretching of a wire, stretching of thin films, change of internal energy with volume. |
|  | 4th |  | Clausius-Clapeyron Equation, Thermo dynamical treatment of Joule-Thomson effect for liquification of Helium. Production of very low temperatures by adiabatic demagnetization, TdS equations. |
| March |  |  | **Final Practicals** |

There will be a class test at the end of each unit.

**DSC 1C LAB**

**STATISTICAL AND THERMAL PHYSICS**

**Course Code: PHYS 201PR**

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| **Month** | **Experiment** |
| August | To prove the law of probability by using one coin, two coins and 10 or more coins. |
| September | To study the spectral characteristics of a photo-voltaic cell. |
| October | To study the current voltage, power load, areal, azimuthal and spectral characteristics of a photo voltaic cell. |
| November | To verify inverse square law of radiation using a photoelectric cell. |
| December | To study the variation of thermo emf across two junctions of a thermocouple with temperature. |
| February | To determine the coefficient of thermal conductivity of copper by Searle’s Apparatus. |

There will be seminar & viva after the completion of each experiment.

**Course 2:** **DSC 1D**

**WAVES AND OPTICS**

**Course code: PHYS202TH**

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| **Month** | **Weeks** | **Unit** | **Topics** |
| August | 2nd | 1 | **Simple harmonic motion**: characteristics, graphical representation of SHM, phase relation between displacement, velocity and acceleration of a particle, executing SHM, SHM oscillator (mass attached to a spring placed on horizontal frictionless surface). |
|  | 3rd |  | Energy of a simple harmonic oscillator. solution of the differential equation of SHM. Average kinetic energy, average potential energy and total energy. **Damped SHM:** Damped oscillations. differential equation of motion of one dimensional damped harmonic mechanical oscillator. Types of damping. damped harmonic electric oscillator (differential equation and its solutions). |
|  | 4th |  | Determination of the damping constants. Logarithmic decrement. Relaxation time. The quality factor, power dissipation in a damped harmonic oscillator when damping is weak. Relation between power dissipation energy and relaxation time of damped harmonic oscillator. |
| October | 1st | 2 | **The Forced Oscillator:** Transient and steady behaviour of forced oscillator. Displacement and velocity variation with driving force frequency. Variation of phase with frequency. Power supplied to an oscillator and its variation with frequency. Q- value and band width. Q-value as an amplification factor (Phasor treatment to be followed).  **Coupled Oscillators:** Stiffness coupled pendulums. Normal co-ordinates and normal modes of vibration. |
|  | 2nd |  | Inductance coupling of electrical oscillators.  **Wave Motion:** The type of waves. The wave equation and its solution. Characteristic impedance of a string. Impedance matching. Reflection and transmission of energy. Reflected and transmitted energy coefficients. Standing waves on a string of fixed length. Energy of a vibrating string. Wave velocity and group velocity. |
|  | 3rd | 3 | **Wave Optics:** Electromagnetic nature of light. Definition and Properties of wave front. Huygens Principle.  **Interference:** Division of wavefront and division of amplitude. Young’s Double Slit experiment. Lloyd’s Mirror and Fresnel’s Biprism. Phase change on reflection: Stokes‟ treatment. |
|  | 4th |  | Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton’s Rings: measurement of wavelength and refractive index. Michelson’s Interferometer. |
| December | 1st |  | Revision & MTT |
|  | 2nd |  | Revision & MTT |
|  | 3rd | 4 | **Diffraction:** Fraunhofer diffraction: Single slit; Double Slit. Multiple slits & Diffraction grating, Dispersive power of diffraction grating, Fresnel Diffraction: Half-period zones. Zone plate. Fresnel Diffraction pattern of a straight edge, a slit and a wire using half-period zone analysis. |
|  | 4th |  | **Polarization:** Transverse nature of light waves. Unpolarized and plane polarized light, production of polarized light, Wire grid polarizer, Polaroid, Effect of intensity of light passing through Polaroid, Malus‟ law, double refraction; ordinary ray and extraordinary ray, positive and negative crystals, birefringence, Nicol Prism, quarter wave plate and half wave plate, Polarization by reflection (Brewster law), polarization by scattering, Circular and elliptical polarization, production of elliptically polarized and circularly polarized light. |
| March |  |  | **Final Practicals** |

There will be a class test at the end of each unit.

**DSC 1D LAB**

**WAVES AND OPTICS**

**Course Code: PHYS 202PR**

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| **Month** | **Experiment** |
| August | To find the refractive index of glass slab using travelling microscope |
| September | To find the refractive index of water using travelling microscope |
| October | To determine wavelength of (1) Sodium & (2) spectrum of Mercury light using plane diffraction Grating. |
| November | To determine wavelength of sodium light using Newton’s Rings. |
| December | 1. Familiarization with Schuster`s focussing; determination of angle of prism. 2. To determine the Refractive Index of the Material of a given Prism using Sodium Light. |
| February | To investigate the motion of coupled oscillators . |

There will be seminar & viva after the completion of each experiment.

**SEC-1**

**PHYSICS WORKSHOP SKILL**

**Course Code: PHYS203TH**

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| **Month** | **Weeks** | **Topics** |
| October | 1st | **Introduction:** Measuring units. conversion to SI and CGS. Familiarization with meter scale, Vernier calliper, Screw gauge and their utility. |
|  | 2nd | Measure the dimension of a solid block, volume of cylindrical beaker/glass, diameter of a thin wire, thickness of metal sheet, etc.. |
|  | 3rd | Use of Sextant to measure height of buildings, mountains, etc |
|  | 4th | **Mechanical Skill**: Concept of workshop practice. Overview of manufacturing methods: casting, foundry, machining, forming and welding. |
| November | 1st | Types of welding joints and welding defects. Common materials used for manufacturing like steel, copper, iron, metal sheets, composites and alloy, wood. |
|  | 2nd | Concept of machine processing, introduction to common machine tools like lathe, shaper, drilling, milling and surface machines. Use of bench vice and tools for fitting. Make funnel using metal sheet.  **Electrical and Electronic Skill**: Use of Multimeter |
|  | 3rd | Cutting tools, lubricating oils. Cutting of a metal sheet using blade. Smoothening of cutting edge of sheet using file. Drilling of holes of different diameter in metal sheet and wooden block. |
|  | 4th | Use of bench vice and tools for fitting. Make funnel using metal sheet.  **Electrical and Electronic Skill**: Use of Multimeter |
| December | 1st | Revision & MTT |
|  | 2nd | Revision & MTT |
|  | 3rd | Soldering of electrical circuits having discrete components (R, L, C, diode) and ICs on PCB. Operation of oscilloscope. |
|  | 4th | Making regulated power supply. Timer circuit, Electronic switch using transistor and relay. |
| February | 2nd | **Introduction to prime movers**: Mechanism, gear system, wheel, Fixing of gears with motor axel. |
|  | 3rd | Lever mechanism, Lifting of heavy weight using lever. braking systems, pulleys, working principle of power generation systems. Demonstration of pulley experiment. |

**SEC-2**

**ELECTRICAL CIRCUITS AND NETWORK SKILLS**

**Course Code: PHYS205TH**

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| **Month** | **Weeks** | **Topics** |
| July | 4th | **Basic Electricity Principles**: Voltage, Current, Resistance, and Power. Ohm's law. Series, parallel, and series-parallel combinations. AC Electricity and DC Electricity. Familiarization with multimeter, voltmeter and ammeter. |
| August | 1st | **Understanding Electrical Circuits**: Main electric circuit elements and their combination. Rules to analyze DC sourced electrical circuits. Current and voltage drop across the DC circuit elements. |
|  | 2nd | Single-phase and three-phase alternating current sources. Rules to analyze AC sourced electrical circuits. Real, imaginary and complex power components of AC source. Power factor. Saving energy and money. |
|  | 3rd | **Electrical Drawing and Symbols**: Drawing symbols. Blueprints. Reading Schematics. Ladder diagrams. Electrical Schematics. Power circuits. Control circuits. Reading of circuit schematics. Tracking the connections of elements and identify current flow and voltage drop. |
|  | 4th | **Electric Motors**: Single-phase, three-phase & DC motors. Basic design. Interfacing DC or AC sources to control heaters & motors. Speed & power of ac motor. |
| September | 1st | **Solid-State Devices**: Resistors, inductors and capacitors. Diode and rectifiers. Components in Series or in shunt. Response of inductors and capacitors with DC or AC sources |
|  | 2nd | **Electrical Protection**: Relays. Fuses and disconnect switches. Circuit breakers. Overload devices. Ground-fault protection. Grounding and isolating. Phase reversal. Surge protection. Interfacing DC or AC sources to control elements (relay protection device) |
|  | 3rd | **Electrical Wiring**: Different types of conductors and cables. Basics of wiring-Star and delta connection. Voltage drop and losses across cables and conductors. Instruments to measure current, voltage, power in DC and AC circuits. |
|  | 4th | Insulation. Solid and stranded cable. Conduit. Cable trays. Splices: wire nuts, crimps, terminal blocks, split bolts, and solder. Preparation of extension board. |
| December | 1st | Revision & MTT |
|  | 2nd | Revision & MTT |
| February | 4th | **Generators and Transformers**: DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Operation of transformers. |

**BSc 3rd Year**

**Course 1: DSE 1A**

**ELEMENTS OF MODERN PHYSICS**

**Course Code: PHYS301TH**

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| **Month** | **Weeks** | **Unit** | **Topics** |
| August | 4th | 1 | Planck’s quantum, Planck’s constant and light as a collection of photons; Photo-electric effect and Compton scattering. |
| September | 1st |  | De Broglie wavelength and matter waves; Davisson-Germer experiment.  Problems with Rutherford model- instability of atoms and observation of discrete atomic spectra; |
|  | 2nd |  | Bohr's quantization rule and atomic stability; calculation of energy levels for hydrogen like atoms and their spectra. |
| October | 1st | 2 | Heisenberg uncertainty principle- impossibility trajectory; estimating minimum energy of a confined principle; Energy-time uncertainty principle. Wave-particle duality. |
|  | 2nd |  | Matter waves and wave amplitude; Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; |
| November | 2nd |  | physical interpretation of wave function, probabilities and normalization; Probability and probability current densities in one dimension. |
|  | 3rd | 3 | One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions, normalization; Quantum dot as an example; Quantum mechanical scattering and tunnelling in one dimension - across a step potential and across a rectangular potential barrier. |
| December | 1st |  | Revision & MTT |
|  | 2nd |  | Revision & MTT |
|  | 3rd |  | Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. Nature of  nuclear force, NZ graph, semi-empirical mass formula and binding energy. |
|  | 4th | 4 | Radioactivity: stability of nucleus; Law of radioactive decay; Mean life & half-life; α decay; β decay - energy released, spectrum and Pauli's prediction of neutrino; γ-ray emission. |
| February | 4th |  | Fission and fusion - mass deficit, relativity and generation of energy; Fission - nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and thermonuclear reactions. |
| March |  |  | Final Practicals |

There will be a class test at the end of each unit.

**DSE 1A LAB**

**ELEMENTS OF MODERN PHYSICS**

**Course Code: PHYS301PR**

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| **Month** | **Experiment** |
| August | Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light |
| September | To verify the inverse square law by using photovoltaic cell. |
| October | To measure the DC voltage by using CRO |
| November | To display the action of junction Diode as (a) Half wave rectifier and (b) Full wave rectifier using CRO |
| December | To determine value of Boltzmann constant using V-I characteristic of PN diode. |
| February | To determine the ionization potential of mercury. |

There will be seminar & viva after the completion of each experiment.

**Course 2: DSE 1B**

**NUCLEAR AND PARTICLE PHYSICS**

**Course Code: PHYS304TH**

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| **Month** | **Weeks** | **Unit** | **Topics** |
| July | 4th | 1 | **General Properties of Nuclei**: Constituents of nucleus and their Intrinsic properties, quantitative facts about size, mass, charge density (matter energy), |
| August | 1st |  | binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/A plot, angular momentum, parity, magnetic moment, electric moments, nuclear excites states. |
|  | 2nd |  | **Nuclear Models**: Liquid drop model approach, semi empirical mass formula and significance of various terms, condition of nuclear stability. Two nucleon separation energies, Fermi gas model (degenerate fermion gas, nuclear symmetry potential in Fermi gas), |
|  | 3rd |  | evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model, concept of mean field, residual interaction, concept of nuclear force. |
| September | 3rd | 2 | **Radioactivity decay**:(a) Alphaα decay: basics of -decay processes, theory of α-emission, Gamowα factor, Geiger Nuttall law, -decay spectroscopy. |
|  | 4th |  | (b) β-decay: energy kinematics for β-decay, positron emission, electron capture, neutrino hypothesis. (c) Gamma decay: Gamma rays emission & kinematics, internal conversion. |
| October | 3rd |  | **Nuclear Reactions:** Types of Reactions, Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section, Concept of compound and direct reaction, resonance reaction, Coulomb scattering (Rutherford scattering). |
|  | 4th | 3 | **Nuclear Detectors and Accelerators:** Interaction of nuclear radiation with matter: Energy loss due to ionization (Bethe-Block formula), energy loss of electrons, Cerenkov radiation, Detector for Nuclear Radiations: Gas detectors, estimation of electric field, mobility of particle, for ionization chamber and GM Counter |
| November | 1st |  | Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT). Semiconductor Detectors (Si & Ge) for charge particle and photon detection (concept of charge carrier and mobility). |
|  | 4th |  | Accelerator facility available in India: Van-de Graaff generator (Tandem accelerator), Linear accelerator, Cyclotron, Synchrotrons. |
| December | 1st |  | Revision & MTT |
|  | 2nd |  | Revision & MTT |
| February | 2nd | 4 | **Particle Physics:** Particle interactions; basic features. Classification of elementary particles and its families. Conservation Laws: energy and momentum, angular momentum, parity, Baryon number, Lepton number, Isospin, Strangeness, Gell-Mann-Nishijima Scheme, CPT theorem, parity violation in weak interactions. Particle Symmetries. Quarks Model, quantum number of quarks and gluons. |
|  | 3rd |  | Quark Model of Hadrons: Quark structure of non strange and strange hadrons, Mesons and baryons containing charm and bottom quarks, explanation of their quantum numbers in terms of their constituents quarks, Quark wave function of Mesons and nucleons, need of color quantum number.  Cosmic Rays; origin of cosmic rays. primary and secondary cosmic rays, hard component and soft component, the altitude effect, the latitude effect, East–west asymmetry, cosmic rays showers. |

There will be a class test at the end of each unit.

**SEC-3**

**RADIATION SAFETY**

**Course Code: PHYS307TH**

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| **Month** | **Weeks** | **Topics** |
| July | 4th | **Basics of Atomic and Nuclear Physics:** Basic concept of atomic structure; X rays characteristic and production; concept of bremsstrahlung and auger electron, |
| August | 1st | The composition of nucleus and its properties, mass number, isotopes of element, spin, binding energy, stable and unstable isotopes, law of radioactive decay, Mean life and half life, |
|  | 2nd | basic concept of alpha, beta and gamma decay, concept of cross section and kinematics of nuclear reactions, types of nuclear reaction, Fusion, fission. **Interaction of Radiation with matter: Types of Radiation:** Alpha, Beta, Gamma and Neutron and their sources, sealed and unsealed sources, |
|  | 3rd | **Interaction of Photons** - Photo- electric effect, Compton Scattering, Pair Production, Linear and Mass Attenuation Coefficients, |
| October | 2nd | **Interaction of Charged Particles:** Heavy charged particles - Beth-Bloch Formula, Scaling laws, Mass Stopping Power, Range, Straggling, Channeling and Cherenkov radiation. Beta Particles- Collision and Radiation loss (Bremsstrahlung), |
|  | 3rd | **Interaction of Neutrons**- Collision, slowing down and Moderation. **(7 Lectures) Radiation detection and monitoring devices: Radiation Quantities and Units:** Basic idea of different units of activity, KERMA, exposure, absorbed dose, equivalent dose, effective dose, collective equivalent dose, Annual Limit of Intake (ALI) and derived Air Concentration (DAC). |
| November | 3rd | **Radiation detection:** Basic concept and working principle of gas detectors (Ionization Chambers, Proportional Counter, Multi-Wire Proportional Counters (MWPC) and Gieger Muller Counter), |
|  | 4th | Scintillation Detectors **(**Inorganic and Organic Scintillators), Solid States Detectors and Neutron Detectors, Thermo luminescent Dosimetry. |
| December | 1st | Revision & MTT |
|  | 2nd | Revision & MTT |
|  | 3rd | **Application of nuclear techniques:** Application in medical science (e.g., MRI, PET, Projection Imaging Gamma Camera, radiation therapy), Archaeology, Art, Crime detection, Mining and oil. Industrial Uses*:* Tracing, Gauging, Material Modification, Sterization, Food preservation. |
| February | 2nd | **Radiation safety management:** Biological effects of ionizing radiation, Operational limits and basics of radiation hazards evaluation and control: radiation protection standards, International Commission on Radiological Protection (ICRP) principles, justification, optimization, limitation, introduction of safety and risk management of radiation. |
|  | 3rd | Nuclear waste and disposal management. Brief idea about Accelerator driven Sub-critical system (ADS) for waste management. |

**SEC-4**

**RENEWABLE ENERGY AND ENERGY HARVESTING**

**Course Code: PHYS310TH**

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| **Month** | **Weeks** | **Topics** |
| August | 4th | **Fossil fuels and Alternate Sources of energy:** Fossil fuels and Nuclear Energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity. |
| September | 1st | **Solar energy**: Solar energy, its importance, storage of solar energy, solar pond, non convective solar pond, applications of solar pond and solar energy, solar water heater, |
|  | 2nd | flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems. |
|  | 3rd | **Wind Energy harvesting**: Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies. |
|  | 4th | **Ocean Energy**: Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices. Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass. |
| October | 1st | **Geothermal Energy**: Geothermal Resources, Geothermal Technologies |
|  | 4th | **Hydro Energy**: Hydropower resources, hydropower technologies, environmental impact of hydro power sources. |
| November | 1st | **Piezoelectric Energy harvesting**: Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, |
|  | 2nd | Piezoelectric parameters and modeling piezoelectric generators, Piezoelectric energy harvesting applications, Human power |
| December | 1st | Revision & MTT |
|  | 2nd | Revision & MTT |
|  | 4th | **Electromagnetic Energy Harvesting**: Linear generators, physics mathematical models, recent applications, Carbon captured technologies, cell, batteries, power consumption, |
| February | 4th | Environmental issues and Renewable sources of energy, sustainability. |