CO-PO attainment
in
Outcome Based Education

Department of Physics,

Government General Degree College, Kalna-I

Program Outcome (PO)

- ❖PO1: Disciplinary knowledge
- ❖PO2: Communication Skills
- ❖PO3: Critical thinking
- ❖PO4 : Problem solving
- ❖PO5: Self directed learning
- ❖PO6: Research-related skills
- ❖PO7: Scientific reasoning
- ❖PO8: Information/digital literacy
- ❖PO9: Lifelong learning

Program Specific Outcome (PSO): UG Physics

- ❖ PSO1: **Foundation for Theoretical Concepts of Physics:** To use theoretical methodologies to explain physical laws around us.

- ❖ PSO2: **Foundation for Experimental/Numerical tools of Physics :** The ability to implement/visualize the theoretical knowledge through laboratory based experimental /numerical techniques.

- ❖ PSO3: **Foundation for possible further developments** : The ability to grasp the scientific ideas behind different physical laws and connecting them to broad area of real life applications and provide new ideas and innovations towards research.

Course Content

Course code : DSE-4
Course name : Applied Dynamics

DSE- 4: APPLIED DYNAMICS
(Credits: Theory-04, Practicals-02)
F.M. = 75 (Theory - 40, Practical – 20, Internal Assessment – 15)
Internal Assessment [Class Attendance (Theory) – 05, Theory (Class Test/ Assignment/ Tutorial) – 05, Practical (Sessional Viva-voce) - 05]
Theory: 60 Lectures

Introduction to Dynamical systems: Definition of a continuous first order dynamical system. The idea of phase space, flows and trajectories. Simple mechanical systems as first order dynamical systems : the free particle, particle under uniform gravity, simple and damped harmonic oscillator. Sketching flows and trajectories in phase space; sketching variables as functions of time, relating the equations and pictures to the underlying physical intuition. Other examples of dynamical systems – In Biology: Population models e.g. exponential growth and decay, logistic growth, species competition, predator-prey dynamics, simple genetic circuitsIn Chemistry: Rate equations for chemical reactions e.g. auto catalysis, bistability In Economics: Examples from game theory. Illustrative examples from other disciplines.Fixed points, attractors, stability of fixed points, basin of attraction, notion of qualitative analysis of dynamical systems, with applications to the above examples. Computing and visualizing trajectories on the computer using software packages. Discrete dynamical systems.The logistic map as an example. (26 Lectures)

Introduction to Chaos and Fractals: Examples of 2-dimensional billiard, Projection of the trajectory on momentum space. Sinai Billiard and its variants.Computational visualization of trajectories in the Sinai Billiard. Randomization and ergodicity in the divergence of nearby phase space trajectories, and dependence of time scale of divergence on the size of obstacle. Electron motion in mesoscopic conductors as a chaotic billiard problem.Other examples of chaotic systems; visualization of their trajectories on the computer. Self similarity and fractal geometry: Fractals in nature – trees, coastlines, earthquakes, etc. Need for fractal dimension to describe self-similar structure. Deterministic fractal vs. self-similar fractal structure.Fractals in dynamics – Serpinski gasket and DLA. Chaos in nonlinear finite-difference equations- Logistic map: Dynamics from time series. Parameter dependence- steady, periodic and chaos states.Cobweb iteration.Fixed points. Defining chaos- aperiodic, bounded, deterministic and sensitive dependence on initial conditions. Period-Doubling route to chaos. Nonlinear time series analysis and chaos characterization: Detecting chaos from return map. Power spectrum, autocorrelation, Lyapunov exponent, correlation dimension. (20 Lectures)

Elementary Fluid Dynamics: Importance of fluids: Fluids in the pure sciences, fluids in technology. Study of fluids: Theoretical approach, experimental fluid dynamics, computational fluid dynamics. Basic physics of fluids: The continuum hypothesis- concept of fluid element or fluid parcel; Definition of a fluid- shear stress; Fluid properties- viscosity, thermal conductivity, mass diffusivity, other fluid properties and equation of state; Flow phenomena- flow dimensionality, steady and unsteady flows, uniform & non-uniform flows, viscous & inviscid flows, incompressible & compressible flows, laminar and turbulent flows, rotational and irrotational flows,separated& unseparated flows. Flow visualization -streamlines, pathlines, Streaklines. (14 Lectures)

Course Outcome (CO) — Paper: DSE-4

Sl. No.	Course Outcome (CO)	Knowledge Level (Bloom's Level)	POs	PSOs
1	Define the dynamical systems with examples form different physical phenomena.	L1: Remembering	1,2,6,7,8,9	1,2,3
2	Outline the solution of 1D continuous time dynamical system by both graphical and analytical methodologies.	L4: Analyzing	1,2,3,4,7,8,9	1,2,3
3	Analyze two dimensional phase-space by breaking down different possibilities based on domains of trace-determinant space of Jacobian matrix.	L4: Analyzing	1,2,3,4,5,7,8,9	1,2,3
4	Explain different types of motion for discrete dynamical systems.	L2: Understanding	1,2,3,4,5,8,9	1,2,3
5	Formulate qualitative behavior of continuous time dynamical systems in light of different techniques like Poincare map, Numerical simulation, Lyapunov exponents etc.	L6: Creating	1,2,3,4,5,6,7,8,9	1,2,3
6	Demonstrate basic ideas of Fluid dynamics via Navier-Stokes's equation.	L3: Applying	1,2,5,7,9	1,2,3
7	Outline different types of flows in light of dynamical systems.	L4: Analyzing	1,2,3,4,6,7,8,9	1,2,3

Programme Articulation Matrix (CO-PO Matrix)

CO	Program Outcome (PO)								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
1	3	3	-	-	-	1	2	1	2
2	3	3	2	2	-	-	3	2	3
3	2	2	3	3	3	-	3	3	3
4	2	3	3	3	3	-	2	3	3
5	3	3	3	3	3	3	3	3	3
6	2	2	-	-	2	-	2	-	2
7	2	2	3	3	-	2	2	2	2
Average	2.4	2.6	2.8	2.8	2.8	2.0	2.4	2.3	2.9

Course Content

Course code : DSE-3
Course name : Nuclear and Particle Physics

DSE- 3: Nuclear and Particle Physics (Credits 06)
F.M. = 75 (Theory - 60, Internal Assessment – 15)
Internal Assessment [Class Attendance – 05, Class Test/ Assignment/ Tutorial – 10]

Theory: 75 Lectures
General Properties of Nuclei: Constituents of nucleus and their Intrinsic properties, quantitative facts about mass, radii, harge density (matter density), binding energy, average binding energy and its variation with mass number, main features of inding energy versus mass number curve, N/A plot, angular momentum, parity, magnetic moment, electric moments, nuclear xcites states. (10 Lectures)

Nuclear Models: Liquid drop model approach, semi empirical mass formula and significance of its various terms, condition of nuclear stability, two nucleon separation energies, Fermi gas model (degenerate fermion gas, nuclear symmetry potential in Fermi gas), evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model, concept of mean field, residual interaction, concept of nuclear force. (12 Lectures)

Radioactivity decay: (a) Alpha decay: basics of α-decay processes, theory of α- emission, Gamow factor, Geiger Nuttall law, α-decay spectroscopy. (b) β-decay: energy kinematics for β-decay, positron emission, electron capture, neutrino hypothesis. (c) Gamma decay: Gamma rays emission & kinematics, internal conversion. (10 Lectures)

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). (8 Lectures)
Interaction of Nuclear Radiation with matter: Energy loss due to ionization (Bethe- Block formula), energy loss of electrons, Cerenkov radiation. Gamma ray interaction through matter, photoelectric effect, Compton scattering, pair production, neutron interaction with matter. (8 Lectures)

Detector for Nuclear Radiations: Gas detectors: estimation of electric field, mobility of particle, for ionization chamber and GM Counter. Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT).Semiconductor Detectors (Si and Ge) for charge particle and photon detection (concept of charge carrier and mobility), neutron detector. (8 Lectures)
Particle Accelerators: Accelerator facility available in India: Van-de Graaff generator (Tandem accelerator), Linear accelerator, Cyclotron, Synchrotrons. (5 Lectures)

Particle physics: Particle interactions; basic features, types of particles and its families. Symmetries and Conservation Laws: energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness and charm, concept of quark model, color quantum number and gluons. (14 Lectures)

Course Outcome (CO) Paper: DSE-3

Sl. No.	Course Outcome (CO)	Knowledge Level (Bloom's Level)	POs	PSOs
1	Identification of constituents of the nucleus and their intrinsic properties.	L1: Remembering	1, 2, 3, 6, 7, 9	1, 2, 3
2	Developing diverse nuclear models and structures, and the study of the significance of their various terms.	L6: Creating	1, 2, 3, 4, 5, 6, 7, 8, 9	1, 2, 3
3	Illustration of the three types of radioactive decay and their processes- alpha-decay, beta-decay, and gamma-decay	L4: Analyzing	1, 2, 3, 4, 5, 7, 9	1, 2, 3
4	Summarizing different kinds of nuclear reactions and assessment of the interaction of charged particles and neutral particles with the matter.	L5: Evaluating	1, 2, 3, 4, 5, 6, 7, 8, 9	1, 2, 3
5	Demonstration of the basic principles of detectors for nuclear radiations, and construction of particle accelerators to produce highly energetic particles.	L3: Applying	1, 3, 4, 5, 6, 9	1, 2, 3
6	Explaining the basic constituents of particles and their interactions. Observing the symmetries and conservation laws of particle physics.	L2: Understanding	1, 2, 3, 6, 8, 9	1, 2, 3

Programme Articulation Matrix (CO-PO Matrix)

	Programme Outcomes (POs)								
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
1	3	3	3	-	-	1	2	-	3
2	3	3	3	3	3	3	3	3	3
3	3	2	2	2	3	-	2	-	2
4	2	3	3	3	3	3	3	3	3
5	2	-	2	2	2	3	-	-	3
6	3	3	2	-	-	3	-	2	3
Average	2.67	2.8	2.5	2.5	2.75	2.6	2.5	2.67	2.83

Course Content

Course code : CC-XIV
Course name: Statistical Mechanics

CC - XIV: STATISTICAL MECHANICS
(Credits: Theory-04, Practicals-02)
F.M. = 75 (Theory - 40, Practical – 20, Internal Assessment – 15)
Internal Assessment [Class Attendance (Theory) – 05, Theory (Class Test/ Assignment/ Tutorial) – 05, Practical (Sessional Viva-voce) - 05]
Theory: 60 Lectures

Classical Statistics: Macrostate & Microstate, Elementary Concept of Ensemble, Phase Space, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function, Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, Gibbs Paradox, Sackur Tetrode equation, Law of Equipartition of Energy (with proof) – Applications to Specific Heat and its Limitations, Thermodynamic Functions of a Two-Energy Levels System, Negative Temperature.(18 Lectures)

Classical Theory of Radiation: Properties of Thermal Radiation. Blackbody Radiation.Pure temperature dependence. Kirchhoff‟s law. Stefan-Boltzmann law: Thermodynamic proof. Radiation Pressure.Wien's Displacement law. Wien's Distribution Law. Saha's Ionization Formula. Rayleigh-Jean's Law.Ultraviolet Catastrophe. (9 Lectures)

Quantum Theory of Radiation: Spectral Distribution of Black Body Radiation. Planck's Quantum Postulates. Planck‟s Law of Blackbody Radiation: Experimental Verification. Deduction of (1) Wien‟s Distribution Law, (2) Rayleigh-Jeans Law, (3) Stefan-Boltzmann Law, (4) Wien‟s Displacement law from Planck's law. (5 Lectures)

Bose-Einstein Statistics: B-E distribution law, Thermodynamic functions of a strongly Degenerate Bose Gas, Bose Einstein condensation, properties of liquid He (qualitative description), Radiation as a photon
gas and Thermodynamic functions of photon gas. Bose derivation of Planck's law. (13 Lectures)

Fermi-Dirac Statistics: Fermi-Dirac Distribution Law, Thermodynamic functions of a Completely and strongly Degenerate Fermi Gas, Fermi Energy, Electron gas in a Metal, Specific Heat of Metals, Relativistic Fermi gas, White Dwarf Stars, Chandrasekhar Mass Limit. (15 Lectures)

Course Outcome (CO) — Paper: CC-14

Sl. No.	Course Outcome (CO)	Knowledge Level (Bloom's Level)	POs	PSOs
1	Outline the importance of Statistical ideas for describing systems with large number of constituents.	L1: Remembering	1,2,3,7,9	1,2,3
2	Distinguish different kind of ensembles in Statistical mechanics and identify essential results from Microcanonical ensemble.	L4: Analyzing	1,2,3,4,5,7,9	1,2,3
3	Demonstrate the ideas behind Classical formulation of theory of radiation and compute macroscopic results starting from microscopic descriptions.	L3: Applying	1,2,3,4,5,7,8,9	1,2,3
4	Discriminate Quantum theory of radiation from Classical theory and illustrate their experimental justifications.	L4: Analyzing	1,2,3,4,5,7,8,9	1,2,3
5	Formulate the B-E statistics and construct the ideas of B-E condensate.	L6: Creating	1,2,3,4,5,6,7,8,9	1,2,3
6	Illustrate the F-D statistics and relate them with the experimental values from semiconductor physics.	L4: Analyzing	1,2,3,4,6,7,8,9	1,2,3

Programme Articulation Matrix (CO-PO Matrix)

CO	Program Outcome (PO)								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
1	3	3	2	-	-	-	2	-	2
2	3	3	2	2	2	-	2	-	3
3	2	2	3	3	3	-	3	3	3
4	2	3	3	3	3	-	2	3	3
5	3	3	3	3	3	3	3	2	3
6	3	3	2	2	-	2	2	2	2
Average	2.7	2.8	2.5	2.6	2.8	2.5	2.3	2.5	2.7

Course Content

Course code : CC-XIII
Course name: Electromagnetic Theory

CC - XIII: ELECTROMAGNETIC THEORY
(Credits: Theory-04, Practicals-02)
F.M. = 75 (Theory - 40, Practical – 20, Internal Assessment – 15)
Internal Assessment [Class Attendance (Theory) – 05, Theory (Class Test/ Assignment/ Tutorial) – 05, Practical (Sessional Viva-voce) - 05]
Theory: 60 Lectures

Maxwell Equations: Review of Maxwell‟s equations. Displacement Current.Vector and Scalar Potentials. Gauge Transformations: Lorentz and Coulomb Gauge. Boundary Conditions at Interface between Different Media.Wave Equations.Plane Waves in Dielectric Media.Poynting Theorem and Poynting Vector.Electromagnetic (EM) Energy Density.Physical Concept of Electromagnetic Field Energy Density, Momentum Density and Angular Momentum Density. (12 Lectures)

EM Wave Propagation in Unbounded Media: Plane EM waves through vacuum and isotropic dielectric medium, transverse nature of plane EM waves, refractive index and dielectric constant, wave impedance. Propagation through conducting media, relaxation time, skin depth.Wave propagation through dilute plasma, electrical conductivity of ionized gases, plasma frequency, refractive index, skin depth, application to propagation through ionosphere. (10 Lectures)

EM Wave in Bounded Media: Boundary conditions at a plane interface between two media. Reflection & Refraction of plane waves at plane interface between two dielectric media-Laws of Reflection & Refraction. Fresnel's Formulae for perpendicular & parallel polarization cases, Brewster's law.Reflection & Transmission coefficients.Total internal reflection, evanescent waves. Metallic reflection (normal Incidence) (10 Lectures)

Polarization of Electromagnetic Waves: Description of Linear, Circular and Elliptical Polarization. Propagation of E.M. Waves in Anisotropic Media.Symmetric Nature of Dielectric Tensor.Fresnel‟s Formula.Uniaxial and Biaxial Crystals. Light Propagation in Uniaxial Crystal. Double Refraction.Polarization by Double Refraction.Nicol Prism.Ordinary & extraordinary refractive indices. Production & detection of Plane, Circularly and Elliptically Polarized Light. Phase Retardation Plates: Quarter-Wave and Half-Wave Plates. Babinet Compensator and its Uses. Analysis of Polarized Light (12 Lectures)

Rotatory Polarization: Optical Rotation. Biot’s Laws for Rotatory Polarization.Fresnel‟s Theory of optical rotation.Calculation of angle of rotation.Experimental verification of Fresnel‟s theory.Specific rotation. Laurent’s half-shade polarimeter. (5 Lectures)

Wave Guides: Planar optical wave guides. Planar dielectric wave guide.Condition of continuity at interface. Phase shift on total reflection. Eigenvalue equations.Phase and group velocity of guided waves.Field energy and Power transmission. (8 Lectures)

Optical Fibres:- Numerical Aperture. Step and Graded Indices (Definitions Only). Single and Multiple Mode Fibres (Concept and Definition Only). (3 Lectures)

Course Outcome (CO) — Paper: CC-14

Sl. No.	Course Outcome (CO)	Knowledge Level (Bloom's Level)	POs	PSOs
1	Review of Maxwell's equations. Explaining the same which represents the state of electromagnetic theory.	L2: Understanding	1, 3, 5,8, 9	1, 2, 3
2	Employing and demonstrating electromagnetic wave propagation in unbounded medium – isotropic, dielectric medium, dilute plasma, and ionosphere.	L3: Applying	1, 2, 3, 5, 4, 6, 9	1, 2, 3
3	Illustrating electromagnetic waves in bounded media and relating the laws of reflection and refraction.	L4: Analyzing	1, 2, 3, 4, 6, 7, 9	1, 2, 3
4	Assessing the different kinds of polarization electromagnetic waves and evaluation of the characteristic of the electromagnetic wave through different media.	L5: Evaluating	1, 3, 4, 6, 7, 8, 9	1, 2, 3
5	Differentiating transverse electric waves and transverse magnetic waves and illustrating the rectangular waveguides for the two types of modes.	L4: Analyzing	1, 3, 4, 5, 6, 9	1, 2, 3

Programme Articulation Matrix (CO-PO Matrix)

CO	Program Outcome (PO)								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
1	3	-	3	-	3	-	-	3	3
2	3	2	3	2	2	3	-	-	2
3	2	2	3	3	-	3	3	-	2
4	3	-	3	3	-	3	2	2	3
5	2	-	2	2	2	2	-	-	3
Average	2.6	2	2.8	2.5	2.33	2.75	2.5	2.5	2.6