TECHING PLAN ACCADEMIC YEAR 2025- 26 (ODD Semesters)

Name: Monoranjan Kakoti **Department: Physics**

Year	Paper/Unit	Course Content
Semester-I **Course Title: Mechanics** **Course Code:PHYMJ-011** **UG Major** **(NEP)**	**Unit 6** **Marks : 8** **Lectures: 6** **Unit 7** **Marks : 10** **Lectures: 8**	**Gravitation and Central Force Motion:** Law of gravitation. Gravitational potential energy. Inertial and gravitational mass. Potential and field due to spherical shell and solid sphere. **Motion of a particle under a central force field**. Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram. Kepler's Laws. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness.
Semester-III **Course Title: MATHEMATICAL PHYSICS-I** **Course Code: PHYMJ-031** **UG Major** **(NEP)**	**Unit 5** **Marks : 25** **Lectures: 20** **Unit 6** **Marks : 5** **Lectures: 4**	**Frobenius Method and Special Functions:** Singular Points of Second Order Linear Differential Equations and their importance. Frobenius method and its applications to differential equations. **Legendre's Differential Equation**: The Power series Solution of Legendre Functions of the first and second kind, Generating Function, Rodrigues Formula, Orthogonal Properties and Recurrence Relations. **Bessel's Differential Equation:** Power series Solution of Bessel Functions of First and Second kind, Generating Function,Orthogonal Properties and Recurrence Relations. **Hermite Differential Equation:** Power series Solution of Hermite polynomials - Generating Function, orthogonality –Recurrence relations - Rodrigues formula. Partial differential equations: Solutions for Laplace, wave and Helmholtz equations by method of separation of variables and Green's function method (Dirac-Delta functions) in Cartesian, Spherical and Cylindrical coordinates, other PDE in physics. **Some Special Integrals**: Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions.
Multidisciplinary Course **Semester-III** **Course Title: Physics in Everyday Life**	**Unit 4** **Marks : 12** **Lectures: 6**	**Physics in Sports:** The sweet spot, Dynamics of rotating objects, Running, Jumping and pole vaulting, Motion of a spinning ball, Continuity and Bernoulli equations, Banana shot: Magnus force, Physics of water sports.

Course Code:PHY MU-1	**Unit 5 Marks : 12 Lectures: 6**	**Physics in home appliances:** Microwave ovens, induction coil/pan, refrigeration system, optical detectors, Lasers, Displays, memory devices, Electric motors and dynamo, rechargeable battery, hybrid car.
Semester-V Course Title: ATOMIC AND MOLECULAR PHYSICS Course Code: PHYMJ-052 UG Major (NEP)	**Unit 4 Marks : 12 Lectures: 12** **Unit 5 Marks : 10 Lectures: 9**	**Molecular Physics:** Molecular symmetry, irreducible representation Rotational Spectra of diatomic molecule, intensity of spectral lines, Effect of isotope substitutions, non-rigid rotator, Vibrational spectra of diatomic molecules, harmonic and anharmonic Vibrator-rotational spectra Pure rotational Raman spectra, linear and symmetric top molecules, vibrational Raman spectra, rotational fine structure, selection rule, overtone spectra. **Electronic properties of molecules:** Electronic spectra of diatomic molecules: Born-Oppenheimer approximation, Franck-Condon principle, Dissociation energy and dissociation products, rotational fine structures, pre dissociation of molecules.
Semester-V Course Title: THERMAL PHYSICS Course Code: PHYMJ-054 UG Minor (NEP)	**Unit 8 Marks: 12 Lectures: 10**	. **Real Gases:** Behavior of Real Gases: Deviations from the Ideal Gas Equation. The Virial Equation. Andrew's Experiments on CO_2 Gas. Critical Constants. Continuity of Liquid and Gaseous State. Vapour and Gas. Boyle Temperature. Van der Waal's Equation of State for Real Gases. Values of Critical Constants. Law of Corresponding States. Comparison with Experimental Curves. P-V Diagrams. Joule's Experiment. Free Adiabatic Expansion of a Perfect Gas. Joule-Thomson Porous Plug Experiment. Joule-Thomson Effect for Real and Van der Waal Gases. Temperature of Inversion. Joule-Thomson Cooling.
PG Semester-I **COURSE TITLE: Mathematical Methods in Physics** **Course Code: PHYC-101**	**Unit 4 Marks: 10 Lectures: 10** **Unit 5 Marks: 10 Lectures: 10**	**Integral transformations**: Laplace transforms: solution of linear differential equations with constant Coefficients – Fourier integral. Fourier transforms: Fourier sine and cosine transforms – Convolution theorems. Applications. Fourier Transform : Infinite Fourier Sine and Cosine transforms –Properties of Fourier transforms-Derivative of Fourier transform –Fourier transform of a derivative-Fourier Sine and Cosine transform of derivatives-Finite Fourier Transforms. **Matrices**: Different kind of matrices, orthogonal matrices, Hermitian matrices, unitary matrices, diagonalisation of matrices, eigenvectors and eigen values. **Tensors**: Tensors, inner and outer products, contraction, symmetric and antisymmetric tensors, metric tensor, covariant and contra variant derivatives.

PG Semester-III **COURSE TITLE: Numerical Methods and Computational Physics** **Course Code:** **PHYC-302**	**Unit 1** **Marks: 12** **Lectures: 10** **Unit 2** **Marks: 12** **Lectures: 10**	**Solution of Linear Algebraic Equations:** Gaussian Elimination (forward elimination & back substitution method), Gauss-Jordan Elimination method, Iterative methods: Jacobi methods & Gauss- Seidel methods, Comparison of direct and iterative methods. **Root-finding Methods:** Bisection method, successive bisection method, Regula falsi method, Newton-Raphson method, Secant method, method of Successive approximations.
PG Semester-III **COURSE TITLE: Project – I** **Course Code: PHYP-301**	**Credits: 4** **Marks: 100**	**Preamble:** This course is aimed at giving research exposure to students by giving small projects to them in physics related areas. **Course outline**: Each student will be given a project which they have to complete during their 3rd semester. Review of literature, theoretical principles/equations, outline of the problem, data collection and analysis. Finally brief project report submission. To be continued …

TECHING PLAN ACCADEMIC YEAR 2025- 26 (Even Semesters)

Name: Monoranjan Kakoti **Department: Physics**

Year	Paper/Unit	Course Content
Semester-IV **Course Title:** **CLASSICAL MECHANICS – I** **(Elements of Classical Mechanics)** **Course Code:** **PHYMJ-041** **UG Major** **(NEP)**	**Unit 5** **Marks : 8** **Lectures: 5** **Unit 6** **Marks : 12** **Lectures: 10**	**Rigid body motion**: Kinetic energy, momentum of inertia tensor, angular momentum, Euler angles, heavy symmetric top, and Euler's equations. **Mechanics of small oscillation:** stable and unstable equilibrium, potential energy about a point of stable equilibrium and applications to find out potential in some simple cases, e.g. elastic potential. Lagrange's equations of motion for small oscillations, deduction of the secular equation $\|V - \omega^2 T\| = 0$, normal frequencies and normal coordinates, normal frequencies of linear triatomic molecules, parallel pendulum and double pendulum.
Semester-IV **Course Title:** **QUANTUM MECHANICS -I** **Course Code:** **PHYMJ-043** **UG Major** **(NEP)**	**Unit 4** **Marks : 15** **Lectures:13**	Schrodinger's equations in one-dimension- time dependent and time independent, equation of continuity - probability density and probability current density. Applications of Schrodinger's equations to one dimensional box of infinite height- energy Eigenvalue and Eigen function, step potential barrier and rectangular potential barrier for E>V and E<V. Quantum Mechanical Tunneling.
Semester-VI **Course Title:** **COMPUTATIONAL PHYSICS** **Course Code:** **PHYMJ-064** **UG Major** **(NEP)**	**Unit 1** **Marks : 25** **Lectures:15**	**Numerical Analysis**: Solution of non-linear equations - Newton's method, method of false position (regular falsi), solution of a system of linear equations - Gaussian elimination, iterative methods (Jacobi and GaussSeidel methods), Interpolation - Newton's interpolation formula, numerical differentiation and integration - Simpson's rule, trapezoidal rule, quadrature formula, numerical solution of ordinary differential equations - Euler's method, Runge-Kutta method, fitting of curves - principle of least squares.
PG Semester-II **COURSE TITLE:** **Electromagnetic Theory and Electrodynamics** **Course Code:** **PHYC-201** **PG (NEP)**	**Unit 4** **Marks : 14** **Lectures:14**	**Relativistic Electrodynamics and Plasma Physics:** Review of Special Theory of Relativity (STR) and its application to electromagnetic theory: Conceptual basis of STR. Four-vectors, tensors. Lorentz transformation as 4-vector Transformations. Transformation properties of electric and magnetic fields. E.M. field tensor. Covariance of Maxwell's equations in four tensor form.

PG Semester-IV **COURSE TITLE: Statistical Physics** **Course Code: PHYC-401** **PG (NEP)**	**Unit 4** **Marks : 10** **Lectures:10** **Unit 5** **Marks : 15** **Lectures:15**	**Ideal Bose System**: Thermodynamic behavior of ideal Bose gas, Bose-Einstein condensation (Experimental evidences), Liquid Helium: two fluid hydrodynamics, Second sound, Theories of Landau and Feynman (qualitative only). Thermodynamics of Black body radiation – Stephan Boltzmann law, Wein's Displacement Law. Ideal Fermi System: Thermodynamic behavior of an ideal Fermi Gas, Degenerate Fermi Gas, Pauli Para magnetism. Fluctuations, Gaussian distribution, Brownian Motion (Langevin's Theorem). Approach to equilibrium: Fokker -Planck Equation. Fluctuation- dissipation theorem. **Phase Transitions**: Phenomenology —First and Second order phase transitions, elementary idea of critical phenomena, Universality of critical exponents, scaling of thermodynamic functions.
PG Semester-IV **COURSE TITLE: Project – II** **Course Code: PHYP-401**	**Credits:4** **Marks: 100**	**Preamble:** This course is aimed at giving research exposure to students by giving small projects to them in physics related areas **Course outline**: Each student will be given a project which they have to complete during their 4^{th} semester. **Modules**: This course will be based on preliminary research topics both in theory and experiment. The project supervisor will float projects and any one of them will be allocated to the student. At the semester end, the student must submit a Project Report in the form of Dissertation which will be examined by the examiners. The examination shall consist of (a) presentation and (comprehensive viva-voce).