Master of Science in Physics
M. Sc. (Physics) Semester I

Course Code	**PS01CPHY52**	Title of the Course	**Classical and Statistical Mechanics**
Total Credits of the Course	04	Hours per Week	04

Course Objectives:	To impart the knowledge and understanding of: 1. the advanced concepts and applications in classical mechanics as well as the classical and quantum-statistical mechanics. 2. advanced theoretical framework dealing with the problems of physics in classical mechanics 3. the physics of phase transitions in materials in the framework of statistical mechanics. 4. the phenomenological treatment of non-equilibrium dynamic processes in fluids such as diffusion and the theory of Brownian motion in liquids.

Course Content		
Unit	Description	Weightage* (%)
1.	A brief review of Lagrange's & Hamilton's formalism-conservation theorem, Noether's theorem and symmetry properties, Lagrangian and Hamiltonian formulation of relativistic mechanics, Canonical transformations, Equations of Canonical transformations, Canonical transformations for the Harmonic Oscillator, Poisson brackets and canonical invariants, equations of motion, Infinitesimal CT and conservation theorems in the Poisson bracket formulation.	25%
2.	Hamilton Jacobi theory, Application to harmonic oscillator problem, Transition to quantum mechanics. Transition from a Discrete to a continuous system, Lagrangian formulation for continuous system. Types of equilibrium, Theory of Small Oscillations, Secular equation, eigenvectors and eigen frequencies, Orthogonality of eigenvectors; Normal coordinates, coupled oscillation, Linear triatomic molecule. Small oscillations of particles on string. Introduction to nonlinear oscillation.	25%
3.	*Classical Statistical Mechanics*: Canonical ensemble: Physical significance of various statistical quantities, energy fluctuations, the equipartition and the virial theorems, a system of harmonic oscillators Grand-canonical ensemble: Physical significance of various statistical quantities, density and energy fluctuations, classical ideal gas, a system of independent, localized particles *Quantum Statistical Mechanics:*	25%

	Formulation: Quantum microstate and microstate, density matrix and its properties, density matrices and partition functions for microcanonical, canonical and grand-canonical ensembles. Ideal quantum gases: Hilbert space of identical particles, canonical formulation, degenerate Fermi gas, degenerate Bose gas	
4.	System of interacting particles: Cluster expansion for a classical gas, Virial expansion of the equation of state, Evaluation of the virial coefficients Phase transitions: Phase equilibrium and Clausius-Clapeyron equation, General remarks on the problem of condensation, A dynamical model of phase transitions and statistical mechanics of the Ising model Non-equilibrium processes: Langevin theory of Brownian motion, Diffusion equation.	25%

Teaching-Learning Methodology	Lectures using traditional blackboard teaching as well as the ICT tools for effective delivery of the content.

Evaluation Pattern

Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to

1.	Take up advanced studies in theoretical and computational physics.
2.	Apply the knowledge the classical and statistical mechanics for problem-solving in various branches of physics as well as other natural sciences.

Suggested References:

Sr. No.	References
1.	Classical Mechanics – System of particles and Hamiltonian Dynamics Walter Greiner, Springer, Second Edition, 2010.

2.	Classical Mechanics H. Goldstein, C. P. Poole and J. Safko, Pearson Education, Third Edition, 2011.
3.	Classical Mechanics V. B. Bhatia, Narosa Publishing House, 1997.
4.	Introduction to Classical Mechanics R. G. Takwale and P.S.Puranik, Tata-McGraw-Hill, 2006
5.	Statistical Mechanics R K Pathria and P. D. Beale, Third Edition, Butterworth-Heinemann (Elsevier), 2011.
6.	Statistical Physics of Particles Mehran Kardar, Cambridge University Press, 2007
7.	Thermodynamics and Statistical Mechanics Walter Griener, I Ludwig Neise and H. Stoecker, Springer, 1997.
8.	Statistical Mechanics R K Srivastava and J Ashok, Prentice Hall of India, 2005

Online resources:
https://www.physicsforums.com/threads/best-online-resource-for-classical-mechanics.549044/ www.nrce.niepa.ac.in *ocw.mit.edu* www.freebookcentre.net www.mooc-list.com home.iitk.ac.in *libguides.uakron.edu*