ST.JOSEPH'S COLLEGE FOR WOMEN (AUTONOMOUS), VISAKHAPATNAM

VII SEMESTER **PHYSICS** TIME:3Hrs/week
PH 7401(4) **CLASSICAL AND STATISTICAL MECHANICS** Max.Marks:100
w.e.f. 20AH Batch **SYLLABUS**

Course Objectives:

- *To equip students with a strong foundation of the Lagrangian and Hamiltonian formalisms for one and many particle systems, as well as the concepts of phase space, ensembles, and partition functions and their applications in Statistical Mechanics.*

Course Outcomes

- *Upon the successful completion of the course, students will be able to:*
- *CO1: Describe the principles and the mathematical techniques used in Newtonian Mechanics of one*
- *and many particle systems and their applications.*
- *CO2: Solve problems using Canonical Transformations and Hamilton - Jacobi theory*
- *CO3: Explain motion in central force fields, Kepler's laws of planetary motion and gyroscopes.*
- *CO4: Calculate the translational, rotational, and vibrational partition functions for molecules in different energy states.*
- *CO5: Summarize the concepts of Maxwell – Boltzmann, Bose – Einstein and Fermi – Dirac Statistics and Black body radiation using Planck's radiation law.*

UNIT – I: Lagrangian Mechanics and Hamiltonian Mechanics (14Hrs)

Newtonian mechanics of one and many particle systems: Conservation laws, Constraints and their classification, Degrees of freedom: Generalized coordinates: Principle of virtual work, D'Alembert's principle, Lagrange's equations of motion.

Applications: Inclined plane, Linear harmonic oscillator and simple pendulum, Hamiltonian principle, Lagrange's equation from Hamilton's principle, Hamilton's equation of motion, Applications, Simple pendulum, Compound pendulum.

UNIT – II: Canonical Transformations and Hamilton - Jacobi Theory (14Hrs)

Canonical Transformations, Generating function and their properties, Condition for transformation to be canonical, Illustration of canonical transformation, Poisson –

Brackets, Canonical equations in terms of Poisson, Bracket notation-Lagrange-Brackets and their properties.

Hamiltonian - Jacobi equation, one dimensional harmonic oscillator, Small oscillations and normal modes, Action Angle variables, Kepler problem in action angle variables.

UNIT –III: Motion in a Central Force Field (12 Hrs)

Reduction to the equivalent one body problem; Motion in a central force field: Conditions for closed orbits: Inverse square law of forces: Kepler's laws of planetary motion; Rutherford scattering. Rotations – Space and body fixed axes: Angular momentum and Torque; Eulerian angles

– Euler's equations of a rigid body: Motion of symmetrical top; Expression for slow and fast precessions; Larmour precision; Gyroscope.

UNIT- IV: Ensembles and Partition Functions (12Hrs)

Phase space – Concept of ensembles – Types of ensembles - Ensemble average - Liouville's Theorem – Micro canonical ensemble: ideal gas – Gibb's paradox Canonical partition function – Molecular partition function – Transnational partition function – Rotational partition function – Vibrational partition function

UNIT – V: Maxwell – Boltzmann, Bose – Einstein and Fermi – Dirac Statistics (12 Hrs)Maxwell - Boltzmann distribution - Equipartition energy. Bose – Einstein distribution,Bose – Einstein condensation, Black body radiation and the Planck's radiation law - Fermi - Dirac distribution – One dimensional random walk – Random walk and Brownian motion.

List of Activities:

1. Assignments
2. Student Seminars

Recommended Books

1. Classical Mechanics, N.C. Rana and P.S. Joag - Tata Mc-Graw Hill, 1991.
2. Classical Mechanics, J.C. Upadyaya - Himalaya Publishing House, 2005.
3. Classical Mechanics, Gupta, Kumar and Sharma –Pragathi Prakashan, 2012.

4. Introduction to Classical Mechanics, R.G. Takwale and P.S. Puranic -Tata McGraw-Hill, 1989.

5. Statistical Mechanics, B.K. Agarwal, Melvin Eisner, 2nd Edition, New Age International (P)Ltd.

6. Statistical Mechanics and properties of Matter by ESR Gopal, Student Edition (Ellis Horwood)

Reference Books

1. Classical Mechanics, H. Goldstein - Addison Wesley, 1980.

2. Classical Dynamics of Particles, J.B.Marion Academic Press -Saunders College Publications, 4th edition, 1995.

3. Statistical and Thermal Physics , F. Reif, 4th Edition, McGraw Hill

4. Elementary Statistical Mechanics, C. Kittel, Dover Publications

5. Foundations of Classical mechanics by P. C. Deshmukh, Cambridge University Press