Unit 5: Group Theory

Abstract groups: subgroups, classes, cosets, factor groups, normal subgroups, direct product of groups; Homomorphism & Isomorphism. Representations: reducible and irreducible, unitary representations, Schur's lemma and orthogonality theorems, characters of representation, direct product of representations. Introduction to continuous groups: Lie groups, rotation and unitary groups. Representation of SO(3), SU(2). **(12 Lectures)**

Expected learning outcomes: *At the end of this course the students are expected to learn the basics of linear vector spaces, group theory, tensors and their applications in various physical problems. Moreover, the students are expected to gain the knowledge of various mathematical tools like complex analysis, integral transform which will equip the students with skills to solving a given ODE, PDE.*

Reference Books:

i. Murry R Spiegel, Vector Analysis McGraw Hill.
ii. Murry R Spiegel, Complex variables McGraw Hill.
iii. A W Joshi, Elements of Group Theory for Physicists New Age International.
iv. A W Joshi, Matrices and tensors in physics New Age International.
v. I Snedden, Elements of partial differential equations McGraw Hill.
vi. G B Arfken, Mathematical Methods for Physicists Academic Press.
vii. Corte S.D. and de Boor, Elementary Numerical analysis, 3rd Ed, McGraw Hill, 1980.
viii. James B. Scarborough, Numerical Mathematical Analysis, Oxford.
ix. F.B. Hildebrand, Introduction to Numerical Analysis, McGraw Hill, 1956.
x. L.A. Pipes and L.R. Harwill, Applied Mathematics for Physicists and Engineers, McGraw Hill.

PHYDSC402T

CLASSICAL MECHANICS

Contact Hours: 60

Full Marks = 100 [ESE (70) CCA(30)]

Course objective: *The objective of this course is to build the concepts of classical mechanics with problems involving central force motion, small oscillations, rigid body dynamics and methods of formulations of Lagrangian and Hamiltonian and their applications.*

Unit 1:

Mechanics of a system of particles: Centre of mass, conservation of linear and angular momentum, energy conservation. Two-body central force problem: reduction to one body problem, equations of motion, classification of orbits, differential equation of the orbit, Kepler's laws. **(12 Lectures)**

Unit 2:

Constraints, generalized coordinates, principle of virtual work, D'Alembert's principle, Lagrange's equations. Velocity dependent potential and dissipation function. First integrals of motion and cyclic coordinates. Hamilton's principle, Lagrange's equations from Hamilton's principle, Hamilton's principle for non-holonomic systems. Symmetry principles and conservation laws. **(12 Lectures)**

Unit 3:

Hamilton's equations of motion, Hamilton's equations from variational principle. Integrals of Hamilton's equations. Principle of least action. Canonical transformation, infinitesimal canonical transformation, Poisson brackets, fundamental properties of Poisson brackets, equations of motion in Poisson bracket form. Lagrange brackets. **(12 Lectures)**

Unit 4:

Hamilton-Jacobi theory, Hamilton's characteristic function, Harmonic oscillator in Hamilton-Jacobi method, separation of variables in Hamilton-Jacobi equation. Action and angle variables, Kepler problem in action-angle variables. **(13 Lectures)**

Unit 5:

Motion of rigid bodies: Angular momentum and kinetic energy, inertia tensor, principalaxes and moments of inertia. Euler's angles, Euler's equations of motion. Coriolis force. Force- free motion of a symmetrical top.

Small oscillations: equilibrium and potential energy, frequencies of free vibration and normal coordinates. Longitudinal vibration of linear triatomic molecule. **(11 Lectures)**

Expected learning outcomes: *At the end of this course the students are expected to learn the Lagrangian and the Hamiltonian formulations of classical mechanics and their applications in appropriate physical problems. Students are also expected to have the idea of Hamilton Jacobi theory, Kepler problem in action-angle variables, Euler's angles, Euler's equations of motion and small oscillations.*

Reference Books:

i. Goldstein, Classical Mechanics Narosa Publishing, Delhi,

ii. Landau & Lifshitz, Course of theoretical Physics, Vol-10, Oxford University, Press.

iii. Joag& Rana, Classical Mechanics, Mc Graw Hill.

iv. Berger, Classical Mechanics A modern Perspective, Mc Graw Hill International.

v. Awqhmare, Classical Mechanics, Prentice Hall.

vi. Sommerfield, Lectures on theoretical Physics. Vol-I, Academic Press, NY 1952.

vii. Hestness, New foundations for classical Mechanics, Kluwer Academic Publisher.

viii. R. Resnik, Introductions of Relativity, Wiley Eastern 1967.

ix. Corben & Stehle, Classical Mechanics, Wiley NY 1974.