Course Title: Classical Mechanics

Course Code: MATH-302

Course Type: Major Math

Prerequisites: Fundamentals of Mechanics

Credit Hours: 3 (3 + 0)

Course Objectives: Classical mechanics will provide a comprehensive understanding of classical mechanics, essential for advanced studies in mechanics and engineering. After completion of this course, the students will be able to:

- Understand inertial and non-inertial reference systems, and analyze the dynamics of particles in rotating frames.
- Examine the center of mass and gravity for both discrete and continuous systems.
- Study the planar motion and general motion of rigid bodies in space.
- Apply Euler's equations to explore the rotational dynamics of rigid bodies, including gyroscopic motion and precession.

Course Contents:

Non Inertial Reference Systems: Inertial and non-inertial frames, Accelerated coordinate systems and inertial forces, Rotating coordinate systems, Velocity and acceleration in moving system, Coriolis, centripetal and transverse acceleration, Dynamics of a particle in a rotating coordinate system.

Centre of Mass and Gravity: Discrete and continuous systems, Density of rigid and elastic bodies, Centroid. Solid regions: region bounded by planes, semi-circular region, sphere, hemisphere, cylinder and cone.

Planar Motion of Rigid Bodies: Introduction to rigid and elastic bodies, degrees of freedom, translations, rotations, instantaneous axis and center of rotation. Motion of the center of mass, Eulers theorem and Chasles theorem, rotation of a rigid body about a fixed axis, moments and products of inertia. Hoop or cylindrical shell, circular cylinder, spherical shell, Parallel and Perpendicular axis theorem. Radius of gyration of various objects.

Motion of Rigid Bodies in Three Dimensions: General motion of rigid bodies in space, moments and products of inertia, inertia matrix, the momental ellipsoid and equimomental systems. Angular momentum vector and rotational kinetic energy. Determining principal axes and principal moments of inertia by diagonalizing the inertia matrix.

Euler's Rigid Body Dynamics: Eulers equations of motion, force free motion, free rotation of a rigid body with an axis of symmetry, free rotation of a rigid body with three different principal moments, the Euler angles, angular velocity and kinetic energy in terms of Euler angles, body and space cones, motion of a spinning top and gyroscopes, steady precession and sleeping top.

Recommended Books:

1. Aruldhas, G., *Classical Mechanics*, PHI Learning Private Limited, 2009.

2. Fowles, G. R., and Cassiday, G. L., *Analytical Mechanics*, Thomson Brooks/Coley, 7th edition, 2005.

3. Goldstein, H., *Classical Mechanics*, Addison-Wesley Publishing Co., 1980.

4. Greiner, W., *Classical Mechanics- Systems of Particles and Hamiltonian Dynamics*, Springer-Verlag, 2004.

5. Spiegel, M. R., *Theoretical Mechanics*, McGraw Hill Book Company, Singapore, 1980.

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