Course: Discipline Specific Elective [Semester-6]

Semester	**6**
Paper Number/ Code	**Paper number: 3 Paper code: HMTDS6031T**
Paper Title	**Motion in two dimension and Rigid Dynamics**
No. of Credits	**6**
Theory/ Composite	**Theory**
No of periods assigned	**Th:6**
Name of Faculty Member(s)	**Prof. Anindya Dey** **Prof. Diptiman Saha**
Course Description/ Objective	• Two dimensional motion is studied looking into Cartesian system, polar coordinate syatem and tangent-normal system as manifestation of different choices of basis of R^2. • Problem specific basis choice realization is the primary goal. Motion in a resisting medium is a direct use of Cartesian system. The study of central orbit through polar coordinates and its stability through manifestation of effective potential is another objective. Constrained motion is studied as an application of tangent-normal system. • Solving variety of simple problems to explore physical insight of the problem • Translation and rotational motion of a rigid body is seen as evolving from Isometry in R^3. • Vectorial treatment done in developing the subject as it helps treat motion in 2D and in 3D on the same footing and tools of linear algebra used in the treatment of inertia matrix and its physical findings. • Equations of motion of a rigid body derived from D'Alembert's principle. Motion about a fixed axis, compound pendulum and motion in 2D studied as its particular applications. • Principles of conservation of linear momentum, angular momentum and energy under finite forces

	studied.
Syllabus	**Motion in two dimensions (39 classes)** Introducing different co-ordinate systems (Cartesian, Polar, Tangent-Normal), depending on the symmetry of the problems under discussion, all being viewed as different choices of basis of R^2.Deduction of expressions of velocity & acceleration of a moving particle in Cartesian, Polar, Tangent-normal and rotating co-ordinate system by either vector or matrix method.[6] Inertial Cartesian co-ordinate system in R^2.Motion of a projectile under gravity in a resisting medium --concept of terminal velocity. [6] Motion of a particle described by plane polar co-ordinate system in R^2 [6] Central force & central orbits.Why central orbit is a planar orbit.Characteristics of a central orbit-Apses & Apsidal angle. Idea of effective potential .Stability of Central Orbits. [10] Motion under Inverse square law and classification orbits. [4] Constrained motion on a rough or smooth plane curves (cycloid, parabola & circles only) [7] **Rigid Dynamics (39 classes)** Two possible motion of a rigid body—translation and rotation, emerging from the idea of isometry in R^3 (3). Kinetic energy of a rigid body and Inertia Matrix(3). Determination of moments of inertia of various rigid bodies —Theorems of parallel axes and perpendicular axes (2) Diagonalisability of the Inertia Matrix and emergence of the ideas of principal moments and principal axes(2). Momental ellipsoids (1). Equimomental bodies and related results (4) Determination of whether a straight line is a principal axis at some point on the line (2)). D'Alembert's Principle and general equations of motion of a rigid body. Independence of motion of centre of inertia and motion relative to the centre of inertia: Non collinearity of angular velocity and angular momentum: Theory and problems (6). Motion of a rigid body about a fixed axis. (4) Compound Pendulum: theory and problems (4). Motion of a rigid body in two dimensions: theory and

	elementary problems. [5] Principles of conservation of linear momentum, angular momentum and energy under finite forces: theory only (3).
Texts	1. Classical Mechanics—N. C. Rana, P. S. Joag 2. Rigid Dynamics—Motiur Rahaman.
Reading/Reference Lists	1. Dynamics of a Particle and of Rigid Bodies—S. L. Loney 2. Rigid Dynamics—Motiur Rahaman. 3. Analytical Dynamics— Saha & Ganguly 4. Advanced Analytical Dynamics—Utpal Chatterjee 5. Classical Mechanics-- J.C. Upadhyaya
Evaluation	**CIA: 20** **End-Sem: 80[40 +40]**