Syllabus template

Semester: 6	
Programme : Mathematics	
Course : Mechanics-1	
Paper code: C3MT230641T	**Credits:4**
Hours/week : 4	
Category: Core/MDC/SEC/VAC : Core	
Theory / Practical / Composite : Theory	
No of Modules : Nil	

Course Overview: Mechanics-1

This problem-focused course covers particle motion in one dimension (variable acceleration, gravity in resisting media, terminal velocity, simple harmonic motion with damping/forced oscillations, elastic strings/springs), two dimensions (Cartesian/polar/tangent-normal coordinates, projectiles, central forces/orbits, conical orbits, constrained motion on curves), and forces in 2D/3D (coplanar equilibrium, Poinsot's central axis, wrench/pitch/invariants). Emphasis is on analytical problem-solving using vector methods and coordinate transformations**.**

Course Outcome: On successful completion of the course a student will be able to do the following:

1. **Describe** the kinematic equations for motion under variable acceleration, gravity in resisting media, and simple harmonic motion including damped/forced oscillations
2. **Derive and apply** expressions for velocity and acceleration in Cartesian, polar, tangent-normal, and rotating coordinate systems for 2D motion.
3. **Solve** problems involving projectile motion, central orbits, terminal velocity, and constrained motion on curves (cycloid, parabola, circle).
4. **Analyze** the stability of central orbits using apses, apsidal angles, and inverse-square force laws to classify conical orbits
5. **Calculate** force systems in 2D/3D, including coplanar equilibrium, Poinsot's central axis, wrench characteristics (pitch, intensity), and invariants.
6. **Evaluate** the appropriateness of coordinate systems and solution methods for different symmetry classes of motion problems
7. **Develop** complete analytical solutions to complex mechanics problems by selecting appropriate coordinate systems, force decompositions, and boundary conditions.

Prerequisites:

SYLLABUS

UNIT/Module	**CONTENT**	**NUMBER OF CLASSES**	**CO Mapping**	**COGNITIVE LEVEL**
I. Motion in One dimension (main stress will be laid on problems)	Motion in a straight line under variable acceleration, Motion of a particle under gravity in a resisting medium-concept of terminal velocity, Simple Harmonic motion- definition, properties, damped oscillation,	**13**	**CO1**	**K2**

		damped forced oscillation, motion of a particle tied to an elastic string or elastic spring.			
II.	Motion in Two dimensions (main stress will be laid on problems) :	Introduction to different coordinate systems—Cartesian, Polar, and Tangent–Normal—chosen according to the symmetry of the problem under consideration, each interpreted as a different choice of basis of $\mathbb{R}2$, Deduction of expressions of velocity & acceleration of a moving particle in Cartesian, Polar, Tangent-normal and rotating coordinate systems, Inertial Cartesian co-ordinate system in 2D and motion of a projectile under gravity in a resisting medium-concept of terminal velocity, Motion of a particle described by plane polar co-ordinate system in 2D, Central force & central orbits, Central orbit is a plane orbit, Stability of central orbit-Apses & Apsidal angle, Central orbit in a resisting medium, Constrained motion in 2D-motion of a particle on a rough or smooth plane curve, specially cycloid and parabola and circle, Motion under Inverse square law and classification of conical orbits.	**25**	**CO2, CO3, CO4**	**K3, K4**
III.	Forces in 2D and 3D	Coplanar forces and astatic equilibrium, forces in 3D: Poinsot's central axis and its	**14**	**CO5, CO6, CO7**	**K3, K5, K6**

	uniqueness, wrench, pitch, intensity, and invariant of a given system of forces, simple problems			
Text Books				
1. Classical Mechanics: N. C. Rana & P. S. Joag.				
2. Analytical Dynamics: Saha & Ganguly.				
3. Analytical Statics: Sinha & Pradhan.				
Suggested readings				
1. An Elementary Treatise on the Dynamics of a Particle and of Rigid Bodies: S. L. Loney.				
Web Resources				
Evaluation: Theory CIA: 20+5+5=**30** Semester Exam: **70**				
Paper Structure for Theory Semester Exam Module: 7 questions each of 10 marks out of a set of **12/13** questions.				

Course outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive levels
CO1	**Describe** the kinematic equations for motion under variable acceleration, gravity in resisting media, and simple harmonic motion including damped/forced oscillations	**K2**
CO2	**Derive and apply** expressions for velocity and acceleration in Cartesian, polar, tangent-normal, and rotating coordinate systems for 2D motion.	**K3**
CO3	**Solve** problems involving projectile motion, central orbits, terminal velocity, and constrained motion on curves (cycloid, parabola, circle).	**K3**
CO4	**Analyze** the stability of central orbits using apses, apsidal angles, and inverse-square force laws to classify conical orbits	**K4**
CO5	**Calculate** force systems in 2D/3D, including coplanar equilibrium, Poinsot's central axis, wrench characteristics (pitch, intensity), and invariants.	**K3**
CO6	**Evaluate** the appropriateness of coordinate systems and solution methods for different symmetry classes of motion problems	**K5**
CO7	**Develop** complete analytical solutions to complex mechanics problems by selecting appropriate coordinate systems, force decompositions, and boundary conditions.	**K6**