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On-line course materials

MATH20512 - Classical Mechanics

Year: 2 - **Semester:** 2 - **Credit Rating:** 10

Requisites

Prerequisites
MATH20401 or MATH20411

Aims

The course unit aims to develop an understanding of how Newton's laws of motion can be used to describe the motion of systems of particles and solid bodies, and how the Lagrangian and Hamiltonian approaches allow use of more general coordinates systems.

Brief Description

This course concerns the general description and analysis of the motion of systems particles acted on by forces. Assuming a basic familiarity with Newton's laws of motion and their application in simple situations, we shall develop the advanced techniques necessary for the study of more complicated systems. We shall also consider the beautiful extensions of Newton's equations due to Lagrange and Hamilton, which allow for simplified treatments of many interesting problems and which provide the foundation for the modern understanding of dynamics. The course is a useful primer to third and fourth level course units in physical applied mathematics.

Learning Outcomes

On completion of this unit successful students will be able to:

- model simple mechanical systems, both in inertial and rotating frames, using Lagrange's equations;
- analyze the dynamics of systems near equilibrium; find the normal modes of oscillation;
- relate the Hamiltonian and Lagrangian approaches;
- recognize and make use of conserved quantities.

Syllabus

1.**Newtonian Mechanics of Systems of Particles**. Review of Newtonâs laws; centre of mass; basic kinematic quantities: momentum, angular momentum and kinetic energy; circular motion; 2-body problem; conservation laws; reduction to centre of mass frame. [5]

2.**Lagrangian formulation of mechanics**. Lagrangeâs equations and their equivalence to Newtonâs equations, generalized coordinates; constraints; cyclic variables; examples. [5]

3.**Potential wells and oscillations**. Particle in a potential well; coupled harmonic oscillators; normal modes; wave equation on a finite string and Fourier modes. [4]

4.**Rotating Frames and the Rigid Body**. Rotating frames in 2-D; centrifugal and Coriolis forces; moments of inertia, parallel axes theorem. Rotations in 3-D; free rigid body rotation, Eulerâs equations. [4]

5.**Hamiltonian formulation**. Hamiltonâs equations, equivalence with Lagrangian formulation; canonical transformations in one degree of freedom, equilibria; stability; conserved quantities. [4]

Teaching & Learning Process (Hours Allocated To)

Lectures	Tutorials/ Example Classes	Practical Work/ Laboratory	Private Study	Total
22	11	0	67	100

Assessment and Feedback

- Coursework (worth 20%) set around the middle of the semester
- End of semester examination (worth 80%).

Further Reading

- Classical Mechanics, by R.D. Gregory, CUP.
- Classical Mechanics, by T.W.B. Kibble. F.H. Berkshire, Addison Wesley

Staff Involved

Dr James Montaldi - Lecturer

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