Course ID   020705

Classical Mechanics

MATH 20512

Credit rating 10
ECTS credits 5

Unit coordinator: Gareth Jones

Semester 2

School of Mathematics
Undergraduate

Level 2

FHEQ level ' Middle part of Bachelors'

Marketing course unit overview
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.

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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.

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 Newton's 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**

Lagrange's equations and their equivalence to Newton's 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 **Hamiltonian formulation**

Hamilton's equations, equivalence with Lagrangian formulation; equilibria, stability; conserved quantities. [4]

5 **Rotating Frames and the Rigid Body**

Rotating frames in 2-D and 3-D; centrifugal and Coriolis forces; moments of inertia, parallel axes theorem; free rigid body rotation, Euler's equations. [4]

Assessment methods

Other	20%
Written exam	80%

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

Feedback methods
Tutorials will provide an opportunity for students' work to be discussed and to provide feedback on their understanding.

Requisites
NONE

Available as free choice? N

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

Scheduled activity hours

Lectures	22
Tutorials	11

Independent study hours 67 hours

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