School of Mathematics

Module MA22S4 — Mechanics 2009-10
(SF Science)

Lecturer: Dr. B. Redmond

Requirements/prerequisites: prerequisite: MA22S1

Duration: Hilary term, 11 weeks

Number of lectures per week: 3 lectures and 1 tutorial per week

Assessment: 10% for assignments.

End-of-year Examination: 2 hour examination in Trinity term.

Description:
This is a provisional syllabus.

- *Introduction*

  Scalar and vector products, differentiation and integration of vectors, velocity and acceleration, Newtons Laws.

- *Motion in Plane Polar Coordinates*

  Derivation of velocity and acceleration in polar coordinates and applications to circular and elliptical motion of a particle.

- *Central Force Motion*

  Equations of motion for a particle in a central force field, derivation of the orbit equation, conservation of angular momentum, potential energy, conservation of energy, solution of the orbit equation for different force fields, apsides and apsidal angles, calculation of maximum and minimum distance of a particle from the origin of a force, inverse square law of attraction and conic sections, properties of the ellipse. Planetary motion, Newtons Universal Law of Gravitation, proof of Keplers Laws, examples involving calculating eccentricity, periodic time, velocity at aphelion and perihelion of planets and related problems.

- *Work and Energy*

  Evaluation of work done by a force on a particle using line integrals, work as related to kinetic and potential energy, conservative forces, path independence, conservation of energy. Energy diagrams use of energy diagrams to analyse the motion of a particle qualitatively, positions of stable and unstable equilibrium, small oscillations in a bound system.

- *Rotating Frames*

  Non-inertial coordinate systems, velocity and acceleration in rotating systems, centrifugal and coriolis forces, derivation of the equation of motion for a particle moving in the vicinity of the rotating earth and related examples.

- *Lagrangian Mechanics*

  Generalised coordinates, derivation of Lagrange's Equations and some simple applications.

Textbooks

1. An Introduction to Mechanics, Daniel Kleppner, Robert J. Kolenkow, McGraw-Hill (1973)
2. Classical Mechanics, Tom W.B. Kibble, Frank H. Berkshire, Imperial College Press, 2004
3. Theory and Problems of Theoretical Mechanics, Murray R. Spiegel, McGraw-Hill 1987
4. Principles of Mechanics, John L. Synge, Byron A. Griffith, McGraw-Hill

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