### **School of Mathematics**

## Course 2S5 — Mechanics for Physics students

(Mathematics course for SF Natural Science Physics SF Physics & Chemistry of Advanced Materials )

Lecturer: Dr. B. Redmond

#### **Requirements**/prerequisites:

Duration: 23 weeks

Number of lectures per week: 2 lectures per week, tutorial every second week

Assessment: Assignments count 10% towards final result.

End-of-year Examination: 3-hour exam in May/June

#### **Description:**

1. Introduction

Scalar and vector products, differentiation and integration of vectors, velocity and acceleration, Newton's Laws.

2. Motion in Plane Polar Coordinates

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

3. 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, Newton's Universal Law of Gravitation, proof of Kepler's Laws, examples involving calculating eccentricity, periodic time, velocity at aphelion and perihelion of planets and related problems.

4. 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.

5. Rotating Frames

2006-07

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.

6. Systems of Particles

Centre of mass, conservation of momentum, conservation of angular momentum, kinetic energy of a system of particles, conservation of energy, motion relative to the centre of mass.

7. Plane Motion of Rigid Bodies

Rotation about a fixed axis, moments of inertia, parallel and perpendicular axis theorems, general planar motion of a rigid body, action at axes of rotation and related problems, energy methods.

8. Lagrangian Mechanics

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

# Textbooks:

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

February 26, 2007