Aims

The goal of the course is to explain the basic principles of Newtonian mechanics and to show how this theory describes a range of physical phenomena. Basic mathematical concepts of the special theory of relativity are also introduced.

Syllabus

One-dimensional dynamics: Newton’s second law in one dimension: free fall in constant gravitational field, simple harmonic motion, conservation of energy  (5 lectures)

Oscillations: Revision of second order differential equations with constant coefficients: method of undetermined coefficients for inhomogeneous equations, application to equation of oscillating spring with damping and driving term, resonance  (6 lectures)

Three-dimensional kinematics and Newtonian mechanics: Motion of a particle in three dimensions, relative motion, Newton’s first and second law of motion, circular motion, projectile motion  (6 lectures)

Conservation laws: Linear momentum and energy, Newton’s third law and momentum conservation, collisions  (5 lectures)

Planetary motion: Motion under a central force, conservation of angular momentum and energy, Kepler’s laws  (4 lectures)

Introduction to relativity: Galilean principle of relativity; constancy of the speed of light and Einstein’s special theory of relativity; Lorentz transformations; time dilation and Lorentz contraction  (4 lectures)

Teaching and Assessment

Contact Hours: 3 lectures and 1 tutorial per week
Assessment: up to 20% by class tests or other continuous assessment
at least 80% by end of course 2-hour exam
Resit Type: exam
By the end of the course, students should be able to:

- Understand fundamental concepts of kinematics such as velocity, acceleration and kinetic energy
- Understand Newton's laws
- Sketch simple trajectories
- Derive and solve the equation of motion for a projectile near the earth's surface
- Derive and solve the equation of motion of an object oscillating on a spring, including damping and periodic driving force.
- Understand the terms damping constant, characteristic frequency, transient and steady solution, resonance.
- Understand elastic and inelastic collisions
- Derive and apply conservation laws for energy and angular momentum
- Understand the principles of planetary orbits
- Understand the basic mathematical concepts in special relativity