PX155-10 Classical Mechanics & Special Relativity

22/23

Department
    Physics
Level
    Undergraduate Level 1
Module leader
    David Quigley
Credit value
    10
Module duration
    10 weeks
Assessment
    100% exam
Study location
    University of Warwick main campus, Coventry

Description

Introductory description

This module studies Newtonian mechanics and special relativity emphasizing the conservation laws inherent in the theory. These have a wider domain of applicability than just classical mechanics (for example they also apply in quantum mechanics). The module looks in particular at the mechanics of oscillations and of rotating bodies.

Einstein pointed out that Newton's laws were inconsistent with the theory of light waves: in mechanics objects only move relative to each other, whereas light appears to move relative to nothing at all (the vacuum). Einstein realised that Newtonian mechanics itself was the problem. He proposed that the laws of classical mechanics had to be consistent with just two postulates, namely that the speed of light is a constant and that all frames of reference are equivalent. These postulates forced Einstein to reject previous ideas of space and time and led directly to the special theory of relativity.

Module web page

Module aims

To revise A-level classical mechanics and to develop the theory using vector notation and calculus. To introduce special relativity. To cover material required for future physics modules.

Outline syllabus

This is an indicative module outline only to give an indication of the sort of topics that may be covered. Actual sessions held may differ.

Forces, interactions and Newton's Laws of Motion
Applying Newton's Laws - equilibrium, dynamics of particles, friction and dynamics of circular motion
Work and kinetic energy.
Potential energy and energy conservation.
Conservation of momentum, elastic collisions, centre of mass
Rotation of rigid bodies - angular velocity and acceleration
Dynamics of rotational motion, conservation of angular momentum
Hooke's law, equation of motion for a mass attached to a spring on a frictionless plane. Solutions for shm. Energy in shm. The pendulum, departures from shm for large amplitude. Complex notation. Damping: critical and under-/over-damping. Forced oscillations.
Motion as seen by different observers. Galilean Transformation of Velocities. Inertial frames of reference
The Michelson Morley experiment. The universality of the speed of light. The meaning of simultaneity.
Einstein's postulates: Lorentz transformation, Inverse Lorentz transformation and invariants.
Length Contraction and Time Dilation, Doppler Effect.
Einstein' energy and mass relation, energy and momentum of elementary particles.
Minkowski diagrams - graphical representation of past/present/future

Learning outcomes

By the end of the module, students should be able to:

- Solve F=dp/dt for a variety of cases
- Work with the concepts of kinetic and potential energy
- Recognise and solve the equations of forced and damped harmonic motion;
- Solve problems involving torque and angular momentum
- Explain the transformation between inertial frames of reference (Lorentz transformation) and work through illustrative problems

Indicative reading list

Reading lists can be found in Talis

Specific reading list for the module

Interdisciplinary

Mechanics is inherently interdisciplinary. It uses mathematics to understand phenomena across physics, astronomy, engineering and living systems. It is about the use of calculus to describe motion and stability. Calculus is the mathematics co-invented by Newton to describe physical systems.

Subject specific skills

Knowledge of mathematics and physics. Skills in modelling, reasoning, thinking.

Transferable skills

Analytical, communication, problem-solving, self-study

Study

Study time

Type	Required
Lectures	30 sessions of 1 hour (30%)
Private study	70 hours (70%)
Total	100 hours

Private study description

Working through lecture notes, solving problems, wider reading, discussing with others taking the module, revising for exam, practising on past exam papers

Costs

No further costs have been identified for this module.

Assessment

You must pass all assessment components to pass the module.

Assessment group B

	Weighting	Study time	Eligible for self-certification
Assessment component			
Centrally-timetabled examination (On-campus) Answer 4 questions	100%		No

- Students may use a calculator
- Answerbook Pink (12 page)

Reassessment component is the same

Feedback on assessment

Personal tutor, group feedback

[Past exam papers for PX155]

Availability

Courses

This module is Core for:

- Year 1 of UPXA-GF13 Undergraduate Mathematics and Physics (BSc)
- UPXA-FG31 Undergraduate Mathematics and Physics (MMathPhys)
    - Year 1 of GF13 Mathematics and Physics
    - Year 1 of FG31 Mathematics and Physics (MMathPhys)
- Year 1 of UPXA-F300 Undergraduate Physics (BSc)
- UPXA-F303 Undergraduate Physics (MPhys)
    - Year 1 of F300 Physics
    - Year 1 of F303 Physics (MPhys)
- Year 1 of UPXA-F3F5 Undergraduate Physics with Astrophysics (BSc)
- Year 1 of UPXA-F3FA Undergraduate Physics with Astrophysics (MPhys)
- Year 1 of UPXA-F3N2 Undergraduate Physics with Business Studies

This module is Option list B for:

- Year 1 of UMAA-G105 Undergraduate Master of Mathematics (with Intercalated Year)
- Year 1 of UMAA-G100 Undergraduate Mathematics (BSc)

- UMAA-G103 Undergraduate Mathematics (MMath)
    - Year 1 of G100 Mathematics
    - Year 1 of G103 Mathematics (MMath)
- Year 1 of UMAA-G106 Undergraduate Mathematics (MMath) with Study in Europe
- Year 1 of UMAA-G1NC Undergraduate Mathematics and Business Studies
- Year 1 of UMAA-G1N2 Undergraduate Mathematics and Business Studies (with Intercalated Year)
- Year 1 of UMAA-GL11 Undergraduate Mathematics and Economics
- Year 1 of UECA-GL12 Undergraduate Mathematics and Economics (with Intercalated Year)
- Year 1 of UMAA-G101 Undergraduate Mathematics with Intercalated Year