University of Glasgow | School of Physics & Astronomy

PHYS 5004 Dynamics, Electrodynamics and Relativity

Course Information Guide

1 Course Details

PHYS 5004 Dynamics, Electrodynamics and Relativity is a level 5 Physics Masters course. It is compulsory for Theoretical Physics students and elective for many other physics degree options. It is composed of 18 lectures and 2 full class tutorials, all given in Semester 1.

Lecturer:

Dr David Miller
Room 535, Kelvin Building
David.J.Miller@glasgow.ac.uk

Time and place: Normally Mondays and Wednesday 10:00 - 11:00 am, but see current Physics M-Level course timetable for alterations and locations.

Course notes and Question Sheets will be made available on Moodle.

2 Assessment

The course will be assessed via an examination in the April/May diet. It provides 10 M-level credits.

3 Required Knowledge

This course will build on material studied at level 2 (dynamics) and levels 3/4 (electromagnetism), which are core courses in all physics-based degree programmes. Revision of key mathematical concepts will be given in the lectures, but some familiarity with the calculus of variations, and the solution of differential equations will be helpful.

4 Intended Learning Outcomes

By the end of the course, students should be able to demonstrate a knowledge and broad understanding of classical physics. They should understand that equations of motion for mechanical systems can be derived via a number of different methods, and should be able to apply analytical mechanics to a range of systems. They should also appreciate how

classical mechanics affects and relates to the topics of their other honours level physics courses.

5 Course Outline

[The following is a list of topic titles only.]

Non-Newtonian Dynamics

Lagrangian recipe for deriving equations of motion; basic examples; central potential, Atwood's machine; Hamilton's approach - projectiles

The Lagrangian Formalism

Functionals and extremals; Deriv ation of Euler-Lagrange (Lagrange) Equations; Generalised coordinates; Action; Principle of Least Action (Hamilton's Principle); Symmetries and conservation laws;

Analytical Mechanics

Further applications of the Lagrangian method; Rôle of generalised co-ordinates and constraints; holonomic and non-holonomic constraints; constraint forces; generalised forces; generalised forces for conservative systems; generalised momenta; the energy function;

Motion of a system of particles

Linear and angular momentum; separation of motion into that with respect to the centre of mass of a system and that of the centre of mass.

Small Oscillations

Lagrange method for systems with small number of degrees of freedom; small co-ordinate approximation; normal frequencies and normal co-ordinates.

Rotating reference frames

Inertial and non-inertial reference frames; Coriolis and centrifugal forces; particle motion near the Earth's surface.

Special Relativity

Contravariant and covariant vectors; Summation convention; Revision of Special Relativity in four vector notation; invariants, light-cone; 4-vectors, scalar products, 4-velocity, 4-momentum

Electrodynamics

Vector potential A. Maxwell's equations rewritten in terms of A and f. Choice of gauge, charged particle in EM field in Lagrangian form.

Combining Electrodynamics and special relativity

Transformation of E and B, invariance of Maxwell's Equations; Electromagnetism in tensor notation Magnetism as a relativistic effect.