Imperial College London

Module Specification (Curriculum Review)

Basic details

UID		Cohorts covered	Earliest cohort: 2023-24	Latest cohort:

Long title: Advanced Classical Physics

New code: PHYS60005

New short title: Advanced Classical Physics

Brief description of module *(approx. 600 chars.)*:

This course covers advanced concepts in classical physics. It explores rotating systems and provides the foundations for Lagrangian and Hamiltonian mechanics. This allows the student to understand the transition from classical to quantised systems. The course also prepares the student for progression onto general relativity by introducing the classical theory of fields in covariant notation and onto field theory by introducing the Lagrangian for a vector field and the resulting Maxwell's equations. Finally, the course provides the student with an appreciation for the role played by symmetries in fundamental physics.

623 characters

Available as a standalone module/ short course? N

Statutory details

	ECTS	CATS	Non-credit
Credit value	7.5	15	N

HECOS codes:

FHEQ level: Level 6

Allocation of study hours

	Hours	
Lectures	26	
Group teaching	10	*Incl. seminars, tutorials, problem classes.*
Lab/ practical		
Other scheduled	12	*Incl. project supervision, fieldwork, external visits.*
Independent study	139.5	*Incl. wider reading/ practice, follow-up work, completion of assessments, revisions.*
Placement		*Incl. work-based learning and study that occurs overseas.*
Total hours	187.5	
ECTS ratio	25.00	

Project/placement activity

Is placement activity allowed? No

Module delivery

Delivery mode	Taught/ Campus	Other	
Delivery term	Term 1	Other	Term 1, exam in term 3

Ownership

Primary department: Physics

Additional teaching departments	None

Delivery campus	South Kensington

Collaborative delivery

Collaborative delivery?	N

External institution	N/A
External department	N/A
External campus	N/A

Associated staff

Role	CID	Given name	Surname
Module Leader		Andrew	Tolley

Learning and teaching

Module description

Learning outcomes	On completion of this module you will be able to: - Transform from a rotating frame to a static frame - Describe the rotation of Rigid bodies - Demonstrate familiarity with Lagrangian mechanics - Demonstrate familiarity with Hamiltonian mechanics - Establish the stability of a solution - Demonstrate familiarity with electromagnetism in relativistic notations.
Module content	• Rotating Rigid bodies: Inertia tensor, Principal moments and principal axes of inertia, Euler angles. • Lagrangian Mechanics: Calculus of variations, Action integral, Principle of least action, Euler-Lagrange equation, Generalised co-ordinates and momenta, Degrees of Freedom, Constraints and Lagrange Multipliers, Conserved Quantities, Normal modes, Stability analysis. • Hamiltonian Mechanics: Hamilton's equations, Poisson brackets, Canonical transformations, Noether's theorem, dynamical systems and stability analysis. • Relativistic Electromagnetism: Four-vectors, Lorentz transformation in tensor formulation, Minkowski Metric, Contravariant and covariant vectors, Lorentz tensors, relativistic formulation of Lorentz law, Field Strength tensor, Lorentz transformations for electromagnetic fields, Maxwell's equations in four-vector form, Four-vector potential, Maxwell Lagrangian.
Learning and Teaching Approach	Students will be taught over a term using a combination of lectures, office hours and directed exercises on theoretical work.
Assessment Strategy	Assessment based on final exam: 2 hour written exam that will evaluate competences in the following 4 topics: •Rotating Bodies and Tensors of Inertia •Lagrangian Mechanics •Hamiltonian Mechanics •Relativistic Electromagnetism Questions may mix the various topics (e.g., a question may involve the moments of inertia in Lagrangian formulation).

Feedback	Problem Sheets are provided weekly (9 in total) with questions and examples students can get practice with. Out of those questions, one or two are marked as Rapid Feedback questions. Students can hand in their answers to those questions which will be reviewed and annotated (no formal mark). Rapid Feedback questions are then reviewed during a Rapid Feedback session with teaching assistant.
Reading list	Lecture notes are provided to students. The notes are designed to be self-contained, and there is no designated textbook required for this course. There are however also some excellent textbooks that are suggested as supplementary or complementary reading for those of you wishing to explore further some aspects of the course. All those textbooks are fully optional. The course mainly follows the following two core textbooks: •Classical Mechanics (5th Edition), Kibble & Berkshire (Imperial College Press 2004), •Classical Mechanics (3rd Edition), Goldstein, Poole & Safko (Addison-Wesley 2002). Other useful textbooks: •A student's guide to Lagrangians and Hamiltonians, Patrick Hamill (Cambridge University Press 2014), •Lagrangian and Hamiltonian Dynamics, Peter Mann, (Oxford University Press 2018), •Classical Mechanics (2nd Edition), McCall (Wiley 2011), •Classical Mechanics, Gregory (Cambridge University Press 2006), •Mechanics (3rd Edition), Landau & Lifshitz (Elsevier 1976), •Classical Electrodynamics (3rd Edition), Jackson (Wiley 1999), •The Classical Theory of Fields, Landau & Lifshitz (Elsevier 1975).

Quality assurance

Date of first approval	
Date of last revision	
Date of this approval	
Module leader	Andrew Tolley
Notes/ comments	

Office use only

QA Lead	
Department staff	
Date of collection	
Date exported	
Date imported	

Programme structure
Associated modules

UID	Legacy code	Module title	Requisite type

UID	Legacy code	Module title	Requisite type

Assessment details

			Pass mark
Grading method	Numeric		40%

Assessments

Assessment type	Assessment description	Weighting	Pass mark	Must pass?
Examination	2h final examination	100%	40%	N
		100%		