Imperial College London

Module Specification (Curriculum Review)

Basic details

UID		Cohorts covered	Earliest cohort: 2022-23; Latest cohort:
Long title	General Relativity		
New code	PHYS70006	New short title	

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

This course is an introductory course in General Relativity (GR), Einstein's theory of gravity. It introduces the mathematical concept of a dynamical, curved, Lorentzian spacetime and the physics of gravity is revealed to be a manifestation of the structure of this spacetime. Newtonian gravity is derived from GR in an approximate limit. The physics of black holes, cosmology and gravitational waves are all studied using GR.

427 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 7				

Allocation of study hours

	Hours	
Lectures	26	
Group teaching	10	*Incl. seminars, tutorials, problem classes.*
Lab/ practical	0	
Other scheduled	10	*Incl. project supervision, fieldwork, external visits.*
Independent study	141.5	*Incl. wider reading/ practice, follow-up work, completion of assessments, revisions.*
Placement	0	*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		Other	Term 1, exam in term 3

Ownership

Primary department	Physics
Additional teaching	None

departments	
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		Jerome	Gauntlett

Learning and teaching

Module description

Learning outcomes	On completing the General Relativity course, students will understand: -how four-dimensional Lorentzian spacetime replaces the Newtonian view of space and universal time -that gravity is the manifestation of the geometry of spacetime -how geometry is encoded in a metric tensor -how Newtonian gravity can be obtained from GR in a limit. -how a black hole is described by the Schwarzschild metric- -how the expanding universe is modelled by the Friedman metric -how the linearised approximation to Einstein equations admits gravitational wave solutions
Module content	-Basic geometry: Coordinates, vectors, tensors, the metric, geodesics and Euler-Lagrange equations, covariant derivatives, curvature. -Geometry of Minkowski spacetime as the physics of Special Relativity. -Physics in curved spacetime: the equivalence principle, local inertial frames, light bending, gravitational redshift, deriving Newtonian gravity in an approximate limit. -General Relativity: the Einstein field equations, the energy momentum tensor, perfect fluids, spacetime is dynamical, the Einstein's equations. -The Schwarzschild solution: the spacetime outside a spherical star, collapse to form a black hole, causal structure, event horizon and singularity. -Cosmology and the FRW spacetime: Friedman equation, the Big Bang -Gravitational waves: linearised equations, transverse traceless gauge, measuring and making gravitational waves.AssessmentStrategy
Learning and Teaching Approach	Students will be taught over one term using a combination of lectures, office hours and directed exercises on theoretical work via problem sheets.

Assessment Strategy	100% of summative assessment is based on a final written exam of 2 hours.
Feedback	Problem sheets are provided weekly (9 in total) with questions and examples students can practise 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) for formative feedback. Rapid Feedback questions are then reviewed during a Rapid Feedback session with a teaching assistant. Answers for all questions will also be provided.
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 module. There are however also some excellent textbooks, that are suggested as supplementary or complementary reading for those of wishing to explore further some aspects of the module. -Bernard Schutz, "A First Course in General Relativity" (Cambridge) -James Hartle, "Gravity: An introduction to Einstein's General Relativity" (Pearson, Addison Wesley) -Ray D'Inverno, "Introducing Einstein's Relativity" (Oxford University Press) -Sean Carroll, "Spacetime and Geometry" (Pearson, Addison Wesley) - more advanced. -Robert Wald, "General Relativity" (Univ. Chicago Press) - more advanced.

Quality assurance

Date of first approval	
Date of last revision	
Date of this approval	
Module leader	Jerome Gauntlett

Office use only

QA Lead	
Department staff	
Date of collection	
Date exported	
Date imported	

Notes/ comments	

Template version 16/06/2017

Programme structure
Associated modules

UID	Legacy code	Module title	Requisite type

Assessment details

		Pass mark
Grading method	Numeric	50%

Assessments

Assessment type	Assessment description	Weighting	Pass mark	Must pass?
			50%	
Examination	2 hour written examination.	100%	50%	N
		100%		