Imperial College London

Module Specification (Curriculum Review)

Basic details

UID		Cohorts covered	Earliest cohort: 2025-26; Latest cohort:
Long title	Mathematical Methods		
New code	PHYS50007	New short title	Mathematical Methods

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

The module covers several mathematical techniques fundamental for performing computations across physics and necessary for a proper formulation of its foundations. This includes analytic continuation, residues, integral transforms, calculus of variations, linear algebra including suffix notation. The module will enable students to appreciate the universality of mathematical concepts employed and gain a sound basis for more advanced mathematical techniques encountered in later studies.

489 characters

Available as a standalone module/ short course? N

Statutory details

	ECTS	CATS	Non-credit
Credit value	5	10	N

HECOS codes:

FHEQ level: 5

Allocation of study hours

	Hours	
Lectures	22	
Group teaching	0	*Incl. seminars, tutorials, problem classes.*
Lab/ practical	0	
Other scheduled	22	*Incl. project supervision, fieldwork, external visits.*
Independent study	81	*Incl. wider reading/ practice, follow-up work, completion of assessments, revisions.*
Placement	0	*Incl. work-based learning and study that occurs overseas.*
Total hours	125	
ECTS ratio	25.00	

Project/placement activity

Is placement activity allowed? No

Module delivery

Delivery mode	Taught/ Campus	Other	
Delivery term	Term 2	Other	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		Claudia	De Rham

Learning and teaching

Module description

Learning outcomes	On completion of this module you will be able to: LO1. Select and use appropriate mathematical methods in physics LO2. Perform analytic continuation and use the residue method for evaluating integrals LO3. Perform and make use of integral transforms. LO4. Demonstrate basic variational calculus LO5. Apply suffix notation in linear algebra and tensor calculus LO6. Manipulate matrices and analyse problems using linear algebra.

Module content	The module is split into five parts: 1. Calculus of Variations: Euler-Lagrange equation as a stationarity condition; Lagrange multipliers; isoperimetric problems. Variational derivatives. 2. Complex Variables: Complex differentiation, analytic functions, Cauchy-Riemann equations, entire functions; Complex integration, Cauchy's integral formula and applications, Taylor's theorem; poles and branching points; Residue theorem and application to computing real integrals. 3. Integral Transforms: Review of Fourier transforms, Heaviside and sign function, delta function. Introduction to Laplace Transforms, computation of Fourier and (inverse) Laplace transforms using contour integration. 4. Cartesian tensors and suffix/index notation: Definition of vectors via their transformation properties, cartesian tensors, tensor algebra, suffix/index notation for vectors and tensors, contraction of tensor indices. Vectors and pseudo-vectors (or polar and axial vectors), cartesian tensors, LeviCivita symbol, cross product, grad, div, curl and Laplacian. Physical examples of Cartesian tensors. 6. Linear algebra: Eigenvectors/Eigenvalues, Inner products, Linear transformations and change of basis, Linear dependence, Orthogonalization by Gram-Schmidt, Kernel/null space, LU decomposition, Singular value decomposition, Schmidt decomposition, Trace, Determinant and properties, (anti-)symmetric matrices, unitary, anti-unitary and Hermitian matrices.
Learning support	
Pattern of learning and teaching activities	
Learning and Teaching Approach	Students will be taught using a combination of lectures, office hours, study groups and directed exercises.
Assessment Strategy	An exam in term 3 covering all learning outcomes will comprise the summative assessment and will contribute 100% of the module mark.
Feedback	Formative feedback will be provided throughout the module in classwork sessions. General feedback on written examinations for each module is provided in the form of written reports from the examiners for the students.
Reading list	The module is self-contained and no additional books are required to be purchased by the students. Further discussion of material covered by the module, along with relevant problems can be found in: •Churchill. Complex variables and applications. •Churchill. Fourier series and boundary value problems. •KF Riley, MP Hobson and SJ Bence, Mathematical Methods for Physics and Engineering.

Quality assurance

Date of first approval	
Date of last revision	
Date of this approval	
Module leader	Claudia De Rham

Office use only

QA Lead	
Department staff	
Date of collection	
Date exported	
Date imported	

Notes/ comments	

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?
			40%	
Examination	2-hour exam	100%	40%	Y
		100%		