Imperial College London

Module Specification (Curricu...

Basic details

UID [ ]

Earliest cohort
Cohorts covered [2025-26]

Long title [Mathematical Methods for Physicists]

New code [PHYS70051]

New short title [ ]

Brief description of module
(approx. 600 chars.)

[The module covers several mathematical techniques fundamental for performing across physics and necessary for a proper formulation of its foundations. This in spaces and tensors, Green's functions, Hilbert spaces, integral transforms, conto the calculus of variations. The module will enable students to appreciate the univ mathematical concepts employed and gain a sound basis for more advanced ma techniques encountered in research.]

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	30	
Group teaching	8	*Incl. seminars, tutorials, problem classes.*
Lab/ practical		
Other scheduled		*Incl. project supervision, fieldwork, external visits.*
Independent study	149.5	*Incl. wider reading/ practice, follow-up work, completion of assess*
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	[ ]

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		Fay	Dowker

Learning and teaching
Module description

Learning outcomes

On completion of the module you will be able to:
- Define the nomenclature of vector spaces and apply vector and tensor techniques to pro
interest
- Solve boundary value problems using the techniques of Green's functions
- Apply and evaluate integral transforms to ordinary differential equations and other proble
interest
- Define poles and residues and be able to solve problems of complex functions using the
- Apply variational calculus to physical problems

Module content	Definition of a vector space; dimensionality, orthogonality, linear dependence.
	Reminder of eigenvectors, eigenvalues and normal modes.
	Tensor algebra, suffix notation, rank. Transformation law. Tensor fields. Representation of
	Principal axes and diagonalisation. Representation quadric. Stationary property of eigenva
	principle.
	Dirac delta function. Variation of parameters method for inhomogeneous ODEs. Green's fu
	value and boundary value problems.
	Definition of a Hilbert space; dimensionality, orthogonality, linear dependence, Wronskian.
	Sturm-Liouville Theory; self-adjoint operators, eigenfunctions, eigenvalues, weight functior
	expansions, completeness. Examples of orthogonal functions to include Bessel functions
	and Legendre polynomials, including solution of Laplace's equation in spherical polar coorc
	of variables and series solution of Legendre's equation.
	Continuous Fourier transforms: Parseval's theorem and convolution theorem; bandwidth th
	connection to quantum mechanics; application to Fraunhofer diffraction and heat diffusion
	Laplace transforms: convolution theorem; application to ordinary differential equations.
	Functions of a complex variable. Cauchy-Riemann relations, analytic functions, Cauchy's
	theorem. Order of poles. Residue theorem. Principal values and the Kramers-Kronig relatic
	Contour integration. Inverse integral transforms, Bromwich integral.
	Lagrange multipliers. Functionals and their differentiation. Local, non-local, and semi-local
	Lagrange equations. Application to classical mechanics. Euler-Lagrange equations for mul
	dependent/independent variables. Variational principles. Rayleigh-Ritz methods; connectic
	problems and constrained minimisation. Application to solving the Schroedinger equation.
	Noether's theorem.
Learning and Teaching Approach	Students will be taught over a term using a combination of lectures, office hours and direc
	theoretical work.
Assessment Strategy	Assessment is based on continuously assessed problem sheets (20%) and a final 2 hour
	(80%) that will evaluate competences in the following four topics:
	• Vector and Hilbert spaces
	• Variational Calculus
	• Green's functions
	• Integral transforms
	• Contour Integration
	Questions may mix the various topics.
Feedback	Problem sheets are provided weekly (8 in total) with questions and examples students car
	Questions are then reviewed during a problem class / feedback session with a teaching a:
Reading list	Mathematical Methods for Physics and Engineering: A Comprehensive Guide, K.F. Riley, I
	S.J. Bence, Cambridge University Press, 3rd edition, 2006
	Mathematical Methods for Physicists: A Comprehensive Guide, George B. Arfken, Acader
	2012
	Mathematical Methods in the Physical Sciences}, Mary L. Boas, Wiley, 3rd edition, 2005

Quality assurance

Date of first approval	
Date of last revision	
Date of this approval	

Module leader	Fay Dowker

Notes/ comments

Office use only

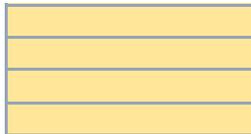|	
QA Lead	
Department staff	
Date of collection	

Date exported	
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Latest cohort

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