Imperial College London

Module Specification (Curriculum Review)

Basic details

			Earliest cohort	Latest cohort
UID		Cohorts covered	2024-25	

Long title: Group Theory

New code	PHYS60015	New short title	Group Theory

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

Abstract group theory is developed rigorously for finite groups, then finite group representation theory is constructed, again rigorously, followed by non-relativistyic quantum-mechanical applications. The second part of the course is devoted to the theory of Lie groups. The rotation groups SO(2) ans SO(3) are used to illustrate the basic concepts of Lie groups, including the analyticity of the composition law and irreducible representations. The course concludes with the development of Lie algebras, again using SO(2) and SO(3) as example for infinitesimal generators and the exponential representation of their elements.

628 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	Exam in term 3

Ownership

Primary department: Physics

Additional teaching 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
Lecturer	6123	Dimitri	Vvedensky

Learning and teaching

Module description

Learning outcomes	On completion of this module you will: • understand of the fundamentals of the abstract group theory and representation theory of finite groups; • be able to apply the tools of group theory to problems in non-relativistic quantum mechanics, including prediction of degeneracies and selection rules, classification of normal modes, application of projection operator technique, • an understanding of the basics of the theory of Lie groups and Lie algebras, incl. irreducible representations of SO(2) and SO(3), their infinitesimal generators and exponentiation to obtain group elements
Module content	1. Abstract group theory. Groups and subgroups, cosets, conjugacy classes, direct products 2. Representations of groups. Reducible and irreducible representations, Schur's lemmas and the Great Orthogonality Theorem, character tables, decomposition of direct products. 3. Applications of finite group in physics. The group of the Hamiltonian, eigenfunctions and irreducible representations, Bloch's theorem, selection rules. 4. Continuous groups and Lie groups. Linear tranformation groups, analytic composition rules, topology of SO(n), compact Lie groups. 5. Irreducible representations of SO(3). Axis-angle representation of an orthogonal matrix, parameter space of SO(3), irreducible representations and.characters. 6. Lie algebras. Infinitesimal generators of SO(2) and SO(3), exponentiation, formal theory of Lie algebras
Learning and Teaching Approach	Students are taught over one term using a combination of lectures and rapid feedback sessions. Detailed lecture notes are made available over Blackboard before each lecture. Office hours are available for two hours every week and by appointment.

Assessment Strategy	Summative assessment is by a 2h written exam.
Feedback	Problem sheets are provided every week (10 in total) with questions and examples students can practise with. Students will have the opportunity to solve problems real time in interactive Rapid Feedback sessions with assistance and advice provided by several teaching assistants. Solutions will be provided after the rapid feedbacks.
Reading list	Core reading: • Group theory: Applications to the physics of condensed matter by M S Dresselhaus, G Dresselhaus, and A Jorio • Group theory and its application to physical problems by Hamermesh, Morton • Group theory and quantum mechanics by M Tinkham • Group Theory in Physics by W-K Tung Supplementary reading: • Contemporary abstract algebra by J A Gallian • Lie algebras in particle physics by H Georgi • Group theory and its application to the quantum mechanics of atomic spectra by E Wigner • Group theory in a nutshell for physicists by Zee.

Quality assurance

Date of first approval	
Date of last revision	
Date of this approval	
Module leader	Dimitri Vvedensky

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

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Assessment details

		Pass mark
Grading method	Numeric	40%

Assessments

Assessment type	Assessment description	Weighting	Pass mark	Must pass?
Examination	2h final examination in term 3.	100%	40.00	N
		100%		