Overview
Most physical systems possess some symmetry. In some cases these are geometrically obvious. For example atoms have spherical symmetry and crystals have both translational and rotational symmetry. However, in other situations, such as in the theory of fundamental particles (quarks, gluons, etc), symmetry concepts are still very vital even though they may not be intuitively obvious geometrically. Group Theory provides a systematic way of dealing with all the types of symmetry that appear in physics, and extracting the maximum amount of information that results from the symmetry.

Aims & Objectives
To present all the necessary ideas on group theory and show how they can be applied to the quantum mechanical study of physical problems that possess symmetry.

Learning Outcomes
By the end of the module, the students should have a good knowledge of the topics covered in the lectures, and should:

- be able to appreciate the predictive power that group theory provides,
- be able to interpret and use the published tables of characters that appear in the literature
- be conversant with abstract algebraic concepts and their application to physics.

Synopsis
An introductory survey, involving: the definition of a group, with physically important examples, a detailed treatment of rotations and translations, the connection with quantum mechanics, the basic concepts of 'abstract' group theory (subgroups, classes, cosets, factor groups, homomorphic and isomorphic mappings, direct product groups, etc), for which no previous knowledge is assumed, basic ideas of the theory of Lie groups, starting with a definition, and including the concepts of connectedness, compactness, and invariant integration, theory of matrix representations of groups, including the ideas of equivalent representations, reducible and irreducible representations, unitary representations, characters, projection operators for determining basis functions, direct-product representations, irreducible tensor operators, and the Wigner-Eckart theorem, applications to quantum mechanics, including solving the Schrodinger equation, determining selection rules and transition probabilities. Pre-requisites - some previous knowledge of quantum mechanics, including perturbation theory; some knowledge of matrices; no previous knowledge of group theory is assumed.

Pre-requisites
PH2011, PH2012, MT2001 or (MT2501 and MT2503), (PH3081 or PH3082 or [MT2003 or (MT2506 and MT2507)]), PH3061 and PH3062

Anti-requisites
None

Assessment
2 Hour Examination = 100%

Recommended Books
Please view University online record:
http://resourcelists.st-andrews.ac.uk/modules/ph5003.html

General Information
Please also read the general information in the School's honours handbook.