University of Glasgow | School of Physics & Astronomy

PHYS 4012
Mathematical Methods II

Course Information Guide 2023-24

1 Course Details

PHYS 4012 Mathematical methods is a level 4 Physics Honours course. It is composed of 20 lectures all given in Semester 1.

Lecturer:

Dr Mark Owen
Rm 452
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Time: Normally Thursdays and Fridays 11:00 - 12:00 am but check the timetable.

Recommended Text: Boas – Mathematical Methods in the Physical Sciences *or*
Riley, Hobson and Bence – Mathematical Methods for Physics and Engineering

Lecture slides and Question Sheets will be made available on Moodle.

2 Assessment

The course will be assessed via an examination in the April/May diet. It provides 10 H-level credits.

3 Required Knowledge

Students are expected to be have completed Mathematical Methods I.

4 Intended Learning Outcomes

By the end of the course students will be able to demonstrate a knowledge and broad understanding of Mathematical Methods relevant to physics. They should be able to describe and analyse quantitatively processes, relationships and techniques relevant to the topics included in the course outline, applying these ideas to solve general classes of problems in physics, which may include straightforward unseen elements. They should be able to write down and, where appropriate, explain the underlying basis of the mathematical principles relevant to the course topics, discussing their applications and appreciating their relation to the topics of other courses taken in physics.

5 Course Outline

a. Curvilinear Coordinate Systems

We will introduce (3-D) curvilinear coordinate systems in a general way and describe how partial differential equations can be translated between these systems of coordinates and Cartesian coordinates.

b. Partial Differential Equations and Systems of Polynomials

We will discuss the properties of sets of polynomials and functions that are relevant to the solution of partial differential equations in a variety of coordinate systems in Quantum Mechanical and Classical problems in physics. These are Legendre Polynomials, Bessel Functions, Hermite and Laguerre Polynomials. Various strategies to construct and manipulate these polynomials will be worked out. General solutions for Laplace's equation, the wave equation, the diffusion equation and Schrödinger's equation will be discussed as well as techniques for finding specific solutions that match given boundary conditions.

c. Matrices

We will solve for the eigenvalues and eigenvectors of 3x3 matrices and discuss the similarity transformations that can be used to diagonalize them. We will apply these techniques to physical problems such as finding the principal axes of the moment of inertia tensor for a solid body and finding the normal modes of coupled oscillators.

d. Complex analysis

We will discuss analytic functions in the complex plane and the application of the Cauchy-Riemann equations. We will develop contour integration techniques using the residue theorem and show how and when these can be applied to real integrals, angular integrals and to solving for inverse Laplace transforms. Simple conformal transformations will be introduced and their application to solving Laplace's equation in 2-D.