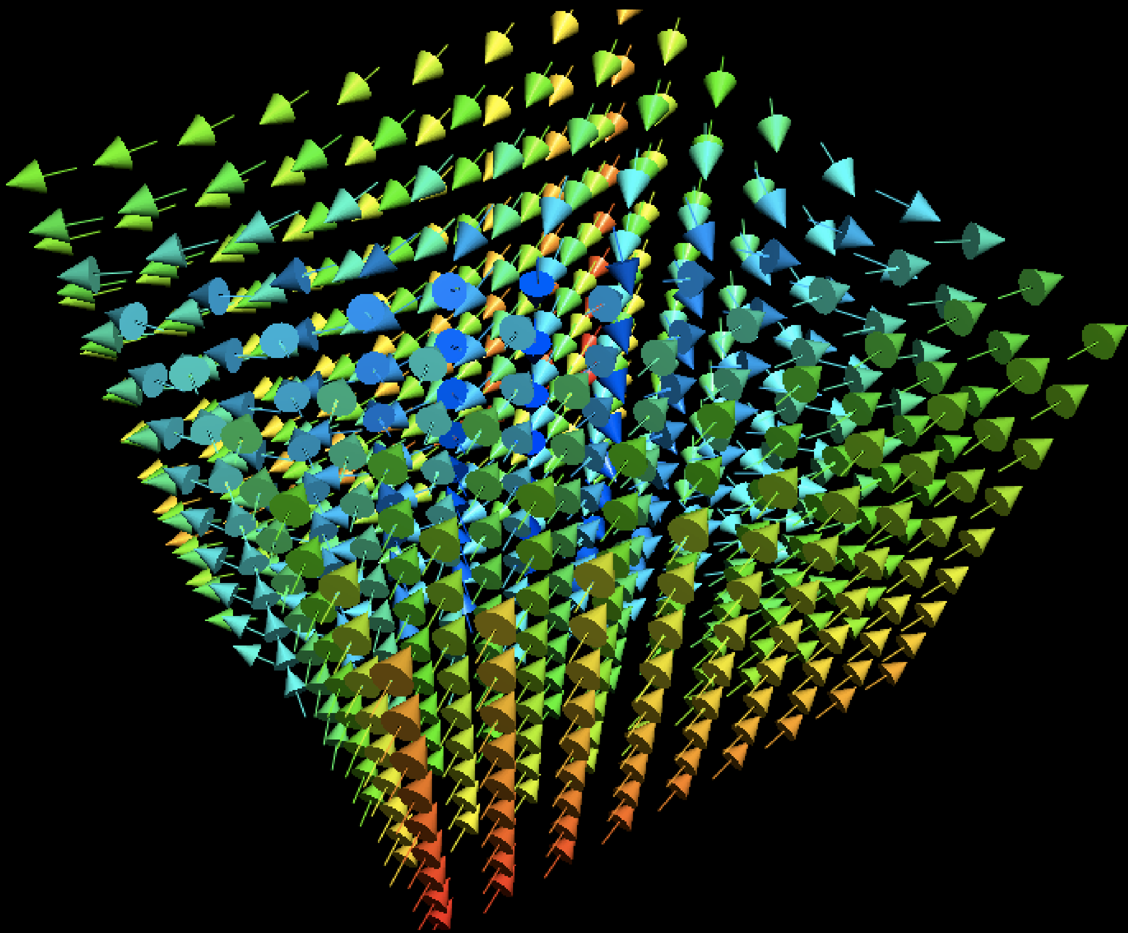
University of Glasgow | School of Physics & Astronomy



PHYS4055Mathematical Methods 1 (Dec. Exam)

Course Information Guide 2023-2024

1 Course Details

PHYS 4055 is identical to PHYS 4011. It is only available to Exchange students who are unable to attend the May exam diet.

Lecturer:	Dr Robert Bennett	Schedule:	18 lectures, Mon. 10am; Wed. 10am
SCQF Credits:	10	ECTS Credits:	5
Assessment:	Examination (100%)	Co-requisites:	PHYS4025, PHYS4030, PHYS4031
Level:	Honours		
Typically Offered:	Semester 1	Prerequisites:	Physics 2

2 Course Aims

This course is compulsory for all third year BSc (Honours) and MSci students and is an elective for designated degree students in the School of Physics & Astronomy. It aims to provide an understanding of the basic mathematical techniques required for studying physics at undergraduate level. In particular, it will provide a working knowledge of:

- Matrix manipulation (revision);
- Fourier series representation and applications to physical problems;
- Integral transforms used in physics;
- Vector calculus, the Divergence Theorem and Stokes' Theorem;
- Solving partial differential equations and their applications in physics.

3 Intended Learning Outcomes

By the end of the course students will be able to:

- Demonstrate knowledge and a broad understanding of various mathematical methods used in physics;
- Describe qualitatively and quantitatively the processes, relationships and techniques relevant to the topics included in the course outline and apply these techniques to solve general classes of problems;
- Where appropriate, prove or explain the underlying basis of physical laws by applying the developed mathematical methods, and appreciate their relation to the topics of other courses taken.

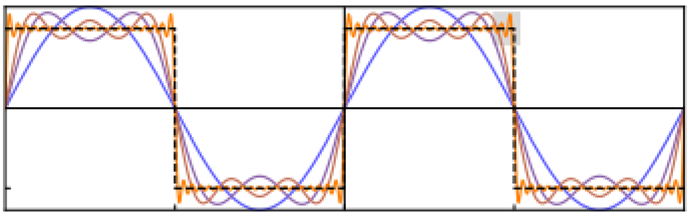


Figure 1: Fourier series representation of a square wave.

4 Course Outline

- ***Matrix revision***: Inversion and the solution of linear simultaneous equations. Reduction of a set of linear equations to one involving matrices. Eigenvalues and eigenvectors. Special matrices. Eigenvalues of a Hermitian matrix.
- ***Fourier Series***: Role of Fourier series in the solution of wave problems. Orthogonality properties of the sine and cosine functions. Fourier series representation of a periodic function. Complex form of a Fourier series. Convergence of Fourier series. Representation of odd and even functions by Fourier sine and cosine series, respectively. Parseval's theorem. Applications of Fourier series to the solution of forced vibration problems.
- ***Integral Transforms***: Fourier transforms. Fourier sine and cosine transforms and their application to time-series analysis. Convolution integrals and their role in finding inverse transforms. Dirac delta function. Applications of integral transforms to impulse response systems. Laplace transforms and their use in ordinary and coupled ordinary linear differential equations. Inverse transforms and their application to circuit and system analysis.
- ***Vector Calculus***: Definitions and physical interpretations of div, grad, curl and Laplacian in Cartesian coordinates. Derivations of useful vector relations. Revision of line, surface and volume integrals. The Divergence Theorem and its applications. Stokes' Theorem and its application to electromagnetism. Conservative force fields and the mathematical concept of vector potentials.
- ***Partial Differential Equations***: Laplace's equation, Poisson's equation, the Diffusion equation, the Wave equation, the Helmholtz equation and brief treatment of Schrödinger equation in Cartesian coordinates. Solutions using separation of variables. The role of boundary conditions in finding the form of the solutions. Solution for simple one or two dimensional physical systems by combining separation of variables with Fourier series.

5 Further Information

Further information can be found on the course Moodle page and also using the links below:

- Course specification
- Reading list

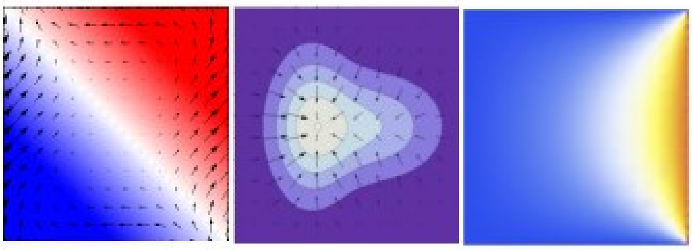


Figure 2: Divergence and rotation of vector fields.