PX153-20 Mathematics for Physicists

23/24

Department
Physics
Level
Undergraduate Level 1
Module leader
Neil Wilson
Credit value
20
Module duration
20 weeks
Assessment
15% coursework, 85% exam
Study location
University of Warwick main campus, Coventry

Description

Introductory description

All scientists use mathematics to state the basic laws and to analyze quantitatively and rigorously their consequences. The module introduces the concepts and techniques, which will be assumed by future modules. These include: complex numbers, functions of a continuous real variable, integration, functions of more than one variable and multiple integration.

Module web page

Module aims

To revise relevant parts of the A-level syllabus, to cover the mathematical knowledge to undertake first year physics modules, and to prepare for mathematics and physics modules in subsequent years.

Outline syllabus

This is an indicative module outline only to give an indication of the sort of topics that may be covered. Actual sessions held may differ.

Term 1

Vector algebra, scalar and vector product

Complex numbers: Algebra, Argand diagram, exp (iθ), De Moivre's theorem, roots

Introduction to differential equations: Ordinary with constant coefficients), complete solutions and boundary or initial conditions; how such equations arise; second order homogeneous linear differential equations with constant coefficients; use of complex numbers; first order differential equations: separation of variables; first order inhomogeneous equations with non-constant coefficients; integrating factor method; inhomogeneous second order constant coefficient equations; particular integral and complementary function; applications within physics

Power Series: Convergence, ratio test and interval of convergence, Taylor Series and applications

Functions of two or more variables: Contours and cross-sections; partial differentiation, Taylor series, maxima, minima and saddle points; introduction to partial differential equations; change of co-ordinates ((x,y)-> (r,θ)); the gradient vector of functions of 2 and 3 variables

Term 2

Riemann Integral: Standard Integrals, use of change of variables; multiple Integrals, double integrals and volume under a surface; change of variable and change of order of integration; introduction to line, surface and volume integrals in physics

Fourier series: Conditions for convergence, orthogonality relations, computation of Fourier coefficients, examples. Periodic extensions; symmetric and antisymmetric functions; sine and cosine series; arbitrary periods. Parseval's theorem, Gibbs phenomenon

Linear algebra: Matrices, matrix addition and multiplication. Simultaneous linear equations and their solution by Gaussian elimination, row-reduced echelon form; idea of a linear map and relation to matrices. Determinants: Definition using co-factors and properties; inverse of a square matrix, conditions for its existence, adjugate matrix, relation to solution of simultaneous equations; efficiency of algorithms, LU decomposition; orthogonal, Hermitian and unitary matrices

Eigenvalues and characteristic equation; eigenvectors, their orthogonality for Hermitian matrices; similarity transformations, corresponding invariance of determinant and trace, use to diagonalise matrices

Learning outcomes

By the end of the module, students should be able to:

- Discuss mathematical modelling and how this leads to descriptions using differential equations
- Explain the concept of a vector and carry out vector algebraic manipulations
- Explain the notion of a complex number and manipulate expressions involving complex numbers
- Solve some types of first and second order Ordinary Differential Equations.
- Explain the notion of convergence and obtain the interval of convergence of a series.
- Work with functions of more than one variable and with partial differentiation.
- Determine the gradient vector of a function of 2 and 3 variables.
- Deal with multiple integrals and know how to evaluate the volume of a three dimensional object

- Describe and evaluate line and surface integrals
- Discuss Fourier series and compute the Fourier coefficients of a function
- Work with elements of linear algebra including: matrices, determinants, eigenvalues and eigenvectors and the diagonalisation of matrices.

Indicative reading list

KF Riley, MP Hobson and SJ Bence, Mathematical Methods for Physics and Engineering: a Comprehensive Guide, CUP

View reading list on Talis Aspire

Subject specific skills

Mathematical methods including: Vectors, complex numbers, integration, Fourier methods and linear algebra

Transferable skills

Analytical, communication, problem-solving, self-study

Study

Study time

Type	Required
Lectures	60 sessions of 1 hour (30%)
Seminars	18 sessions of 1 hour (9%)
Private study	122 hours (61%)
Total	200 hours

Private study description

Working through lecture notes, solving problems, wider reading, discussing with others taking the module, revising for exams, practising on past exam papers

Costs

No further costs have been identified for this module.

Assessment

You do not need to pass all assessment components to pass the module.

Assessment group D

	Weighting	Study time
Coursework Problems	15%	
Written solutions to weekly problems and computer tests		
In-person Examination 1	42%	
Written examination		

- Students may use a calculator
- Answerbook Pink (12 page)

In-person Examination	43%	
Written examination		

- Answerbook Pink (12 page)
- Students may use a calculator

Feedback on assessment

Supervisors at weekly examples, tutors for written examinations

Past exam papers for PX153

Availability

Courses

This module is Core for:

- UPXA-F300 Undergraduate Physics (BSc)
  - Year 1 of F300 Physics
  - Year 1 of F300 Physics
  - Year 1 of F300 Physics
- UPXA-F303 Undergraduate Physics (MPhys)
  - Year 1 of F300 Physics
  - Year 1 of F303 Physics (MPhys)
- UPXA-F3F5 Undergraduate Physics with Astrophysics (BSc)
  - Year 1 of F3F5 Physics with Astrophysics

    - Year 1 of F3F5 Physics with Astrophysics
- Year 1 of UPXA-F3FA Undergraduate Physics with Astrophysics (MPhys)
- Year 1 of UPXA-F3N2 Undergraduate Physics with Business Studies