MA144-10 Methods of Mathematical Modelling 2

22/23

Department
: Warwick Mathematics Institute

Level
: Undergraduate Level 1

Module leader
: Siri Chongchitnan

Credit value
: 10

Module duration
: 10 weeks

Assessment
: Multiple

Study location
: University of Warwick main campus, Coventry

Description

Introductory description

This module is centred on intuitive geometric and physical concepts such as length, area, volume, curvature, mass, circulation and flux and their translation into mathematical formulas. The focus is on the practical calculation of these formulas and their application to various problems.

Module aims

To introduce and apply methods and techniques from vector calculus.

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.

1. Basic geometry of R^n with focus on R^3: vectors, dot-products, angles, components in given direction (in an orthonormal basis), equations of planes.
2. Differential geometry of curves: parametrisation, tangents, integration, arc-length, Gradshteyn-Ryzhik. [No Frenet frames or crossed products]

3. Differential calculus of scalar functions of several variables: partial derivative, chain rule, change of coordinates, gradient, directional derivative, tangent planes, level sets. [No higher order derivatives or critical points]
4. Integral calculus of scalar functions of several variables: multiple integration, rectangles, boxes, 2D integrals as Riemann sums, determinants, change of variables, Jacobian, integration in other coordinates (polar, cylindrical, spherical).
5. Differential calculus of vector functions of several variables: crossed product, vector fields, divergence, curl, nabla, algebraic identities, Laplace, expression in other coordinates (polar, cylindrical, spherical), parametrisation of surfaces, tangent planes, normal.
6. Integral calculus of vector functions of several variables: surface area, surface integral, flux, divergence theorem, line integrals, work and potential energy, circulation, Green's Theorem, Stokes' theorem.

Learning outcomes

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

- working knowledge of scalar-valued and vector-valued functions of one or more variables
- understand parametric representations of curves and surfaces
- perform coordinate transformations
- demonstrate understanding of integral theorems relating line, surface and volume integrals and evaluate such integrals
- understand concepts and techniques related to the differentiation for functions from R^n to R^m, such as partial derivatives, gradient, Jacobian, directional derivative, divergence and curl
- get familiar with the Riemann integral of a multivariable function and its geometric interpretation
- be able to integrate functions over simple domains and justify the change of area and volume elements when converting coordinates

Indicative reading list

Stewart, J., Multivariable Calculus, Cengage Learning, 2011.
Marsden, J., Tromba, A. J. and Weinstein, A., Basic Multivariable Calculus, Springer 1993.
Strang, G., Calculus, Wellesley-Cambridge Press, 1991.
G.B. Thomas et al., Calculus and Analytic Geometry, Addison-Wesley, 1969.
F.J. Flannigan and J.L. Kazdan, Calculus Two, Springer-Verlag, 1990

View reading list on Talis Aspire

Subject specific skills

This module will introduce students to connections between geometry, calculus and physical modelling, providing them with the skills to convert between reasoning physically and geometrically. Further, the understanding of and ability to manipulate concepts from multivariable calculus first developed here is crucial to understand many of the mathematical models used to describe the world around us.

Transferable skills

Along with developing problem solving skills and logical reasoning, a key aim of this module is building confidence in visualising and sketching geometric objects, enabling the development of spatial awareness and visual communication skills.

Study

Study time

Type	Required
Lectures	20 sessions of 1 hour (20%)
Online learning (independent)	10 sessions of 1 hour (10%)
Private study	12 hours (12%)
Assessment	58 hours (58%)
Total	100 hours

Private study description

Working on assignments, going over lecture notes, text books, exam revision.

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
Assignments Homeworks	15%	20 hours
In-person Examination written exam	85%	38 hours

	Weighting	Study time

- Answerbook Pink (12 page)

Assessment group R

	Weighting	Study time
In-person Examination - Resit resit exam	100%	

- Answerbook Pink (12 page)

Feedback on assessment

Marked homework (both assessed and formative) is returned and discussed in smaller classes. Exam feedback is given.

Past exam papers for MA144

Availability

Courses

This module is Core for:

- Year 1 of UMAA-G105 Undergraduate Master of Mathematics (with Intercalated Year)
- UMAA-G100 Undergraduate Mathematics (BSc)
  - Year 1 of G100 Mathematics
  - Year 1 of G100 Mathematics
  - Year 1 of G100 Mathematics
- UMAA-G103 Undergraduate Mathematics (MMath)
  - Year 1 of G100 Mathematics
  - Year 1 of G103 Mathematics (MMath)
  - Year 1 of G103 Mathematics (MMath)
- Year 1 of UMAA-G106 Undergraduate Mathematics (MMath) with Study in Europe
- Year 1 of UMAA-G1NC Undergraduate Mathematics and Business Studies
- Year 1 of UMAA-G1N2 Undergraduate Mathematics and Business Studies (with Intercalated Year)
- Year 1 of UMAA-GL11 Undergraduate Mathematics and Economics
- Year 1 of UECA-GL12 Undergraduate Mathematics and Economics (with Intercalated Year)
- Year 1 of UMAA-G101 Undergraduate Mathematics with Intercalated Year