

# MA263-10 Multivariable Analysis

23/24

**Department**

Warwick Mathematics Institute

**Level**

Undergraduate Level 2

**Module leader**

Felix Schulze

**Credit value**

10

**Module duration**

10 weeks

**Assessment**

Multiple

**Study location**

University of Warwick main campus, Coventry

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## Description

### Introductory description

Mathematical Analysis is the heart of modern Mathematics. This module is the final in a series of modules where the subject of Analysis is rigorously developed in many dimensional setting.

### Module aims

extend the analysis of one variable from the first year to the multivariable context.

### 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.

- Different notions of continuity of functions of several variables
- Quantitative Linear Algebra in terms of norms
- Different notions of differentiability of functions of several variables
- Chain rule, (generalised) mean value inequality and other properties of differentiable functions
- Inverse Function Theorem and Implicit Function Theorem, with applications to regular curves and hypersurfaces
- Vector Fields and the theorems of Green, Gauss and Stokes, with some applications to

PDEs.

- Maxima, minima and saddles and constrained critical points.

## Learning outcomes

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

- learn the basic concepts, theorems and calculations of multivariable analysis
- understand the Implicit and Inverse Function Theorems and their applications
- acquire a working knowledge of vector fields and the Integral Theorems of Vector Calculus
- learn how to analyse and classify critical points using Taylor expansions

## Indicative reading list

J. E. Marsden and A. Tromba. Vector Calculus. Macmillan Higher Education, sixth edition, 2011.

J. J. Duistermaat, J. A. C. Kolk. Multidimensional Real Analysis I : Differentiation, CUP, 2004

[available online via Warwick's library]

R. Coleman. Calculus on normed vector spaces, Springer 2012. [available online via Warwick's library]

W. Rudin. Principles of Mathematical Analysis. International Series in Pure and Applied Mathematics. McGraw-Hill Book Co., New York-Auckland-Düsseldorf, third edition, 1976.

T. M. Apostol. Mathematical Analysis. Addison-Wesley Publishing Co., Reading, Mass.-London-Don Mills, Ont., second edition, 1974.

T. W. Körner. A Companion to Analysis: A Second First and First Second Course in Analysis, volume 62 of Graduate Studies in Mathematics. American Mathematical Society, Providence, RI, 2004.

## Subject specific skills

Multivariable Analysis gives students tools to do rigorous Analysis in higher dimensional spaces. Students will learn definitions, theorems and calculations with vector-valued functions of many variables, for instance, Inverse and Implicit Function Theorems, vector fields, maxima, minima and saddles.

## Transferable skills

Students will acquire key reasoning and problem solving skills, empower them to address new problems with confidence.

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## Study

## Study time

<b>Type</b>	<b>Required</b>
Lectures	20 sessions of 1 hour (20%)
Online learning (independent)	9 sessions of 1 hour (9%)
Private study	13 hours (13%)
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**

	<b>Weighting</b>	<b>Study time</b>
Assignments	15%	20 hours
Examination	85%	38 hours

- Answerbook Pink (12 page)

#### **Assessment group R**

	<b>Weighting</b>	<b>Study time</b>
In-person Examination - Resit	100%	

### **Feedback on assessment**

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

[Past exam papers for MA263](#)

### **Availability**

## Courses

This module is Core for:

- Year 2 of UMAA-G105 Undergraduate Master of Mathematics (with Intercalated Year)
- UMAA-G103 Undergraduate Mathematics (MMath)
  - Year 2 of G103 Mathematics (MMath)
  - Year 2 of G103 Mathematics (MMath)

This module is Core optional for:

- UMAA-G100 Undergraduate Mathematics (BSc)
  - Year 2 of G100 Mathematics
  - Year 2 of G100 Mathematics
  - Year 2 of G100 Mathematics
- Year 2 of UMAA-G103 Undergraduate Mathematics (MMath)
- Year 2 of UMAA-G1NC Undergraduate Mathematics and Business Studies
- Year 2 of UMAA-G1N2 Undergraduate Mathematics and Business Studies (with Intercalated Year)
- Year 2 of UMAA-G101 Undergraduate Mathematics with Intercalated Year

This module is Option list A for:

- Year 2 of UMAA-GL11 Undergraduate Mathematics and Economics
- Year 2 of UECA-GL12 Undergraduate Mathematics and Economics (with Intercalated Year)
- UPXA-GF13 Undergraduate Mathematics and Physics (BSc)
  - Year 2 of GF13 Mathematics and Physics
  - Year 2 of GF13 Mathematics and Physics
- UPXA-FG31 Undergraduate Mathematics and Physics (MMathPhys)
  - Year 2 of FG31 Mathematics and Physics (MMathPhys)
  - Year 2 of FG31 Mathematics and Physics (MMathPhys)
- USTA-GG14 Undergraduate Mathematics and Statistics (BSc)
  - Year 2 of GG14 Mathematics and Statistics
  - Year 2 of GG14 Mathematics and Statistics

This module is Option list B for:

- UCSA-G4G1 Undergraduate Discrete Mathematics
  - Year 2 of G4G1 Discrete Mathematics
  - Year 2 of G4G1 Discrete Mathematics
- Year 2 of UCSA-G4G3 Undergraduate Discrete Mathematics
- USTA-Y602 Undergraduate Mathematics, Operational Research, Statistics and Economics
  - Year 2 of Y602 Mathematics, Operational Research, Stats, Economics
  - Year 2 of Y602 Mathematics, Operational Research, Stats, Economics