# MA259-12 Multivariable Calculus

## 23/24

Department Warwick Mathematics Institute Level Undergraduate Level 2 Module leader Mario Micallef Credit value 12 Assessment Multiple Study location University of Warwick main campus, Coventry

# Description

#### Introductory description

N/A

Module web page

#### Module aims

To 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.

- Continuous Vector-Valued Functions
- Some Linear Algebra
- Differentiable Functions
- Inverse Function Theorem and Implicit Function Theorem
- Vector Fields, Green's Theorem in the Plane and the Divergence Theorem in R3
- Maxima, minima and saddles

#### Learning outcomes

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

- Demonstrate understanding of the basic concepts, theorems and calculations of multivariate analysis.
- Demonstrate understanding of the Implicit and Inverse Function Theorems and their applications.
- Demonstrate understanding of vector fields and Green's Theorem and the Divergence Theorem.
- Demonstrate the ability to analyse and classify critical points using Taylor expansions.

#### Indicative reading list

- 1. R. Abraham, J. E. Marsden, T. Ratiu. Manifolds, Tensor Analysis, and Applications. Springer, second edition, 1988.
- 2. T. M. Apostol. Mathematical Analysis. Addison-Wesley Publishing Co., Reading, Mass.-London-Don Mills, Ont., second edition, 1974.
- 3. R. Coleman. Calculus on normed vector spaces, Springer 2012. [available online via Warwick's library]
- 4. J. J. Duistermaat, J. A. C. Kolk. Multidimensional Real Analysis I : Differentiation, CUP, 2004 [available online via Warwick's library]
- 5. 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.
- 6. J. E. Marsden and A. Tromba. Vector Calculus. Macmillan Higher Education, sixth edition, 2011.
- 7. J. R. Munkres. Analysis on Manifolds. Addison-Wesley Publishing Company, Advanced Book Program, Redwood City, CA, 1991.
- 8. W. Rudin. Principles of Mathematical Analysis. International Series in Pure and Applied Mathematics. McGraw-Hill Book Co., New York-Auckland-Düsseldorf, third edition, 1976.
- 9. M. Spivak. Calculus on Manifolds. A Modern Approach to Classical Theorems of Advanced Calculus. W. A. Benjamin, Inc., New York-Amsterdam, 1965.

#### Subject specific skills

Students will gain knowledge of definitions, theorems and calculations in

- -Continuous vector-valued functions
- -Differentiable functions
- -Inverse and Implicit Function Theorems
- -Vector fields
- -Maxima, minima and saddles

#### Transferable skills

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

# Study

# Study time

Туре	Required
Lectures	30 sessions of 1 hour (67%)
Seminars	5 sessions of 1 hour (11%)
Other activity	10 hours (22%)
Total	45 hours

#### Private study description

85 self-working: reviewing lectured material and accompanying supplementary materials; working on both summative and formative coursework; revising for exams.

#### Other activity description

Collaborative project

## 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 D2

	Weighting	Study time
Assignments	15%	
Project	10%	
Examination	75%	

• Answerbook Pink (12 page)

#### Assessment group R

	Weighting	Study time
In-person Examination - Resit	100%	

Weighting Study time

• Answerbook Pink (12 page)

#### Assessment group S

	Weighting	Study time
Assignments	15%	
In-person Examination	85%	

• 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 MA259

## Availability

#### Courses

This module is Core for:

• Year 2 of UMAA-G106 Undergraduate Mathematics (MMath) with Study in Europe

This module is Optional for:

• Year 3 of USTA-G300 Undergraduate Master of Mathematics, Operational Research, Statistics and Economics

This module is Option list A for:

• Year 2 of USTA-G300 Undergraduate Master of Mathematics, Operational Research, Statistics and Economics

This module is Option list B for:

- Year 4 of USTA-G1G4 Undergraduate Mathematics and Statistics (BSc MMathStat) (with Intercalated Year)
- USTA-GG14 Undergraduate Mathematics and Statistics (BSc)
  - Year 3 of GG14 Mathematics and Statistics
  - Year 3 of GG14 Mathematics and Statistics
- Year 4 of USTA-GG17 Undergraduate Mathematics and Statistics (with Intercalated Year)

- USTA-Y602 Undergraduate Mathematics, Operational Research, Statistics and Economics
  - Year 3 of Y602 Mathematics, Operational Research, Stats, Economics
  - Year 3 of Y602 Mathematics, Operational Research, Stats, Economics

This module is Option list E for:

- Year 3 of USTA-G300 Undergraduate Master of Mathematics, Operational Research, Statistics and Economics
- USTA-G301 Undergraduate Master of Mathematics, Operational Research, Statistics and Economics (with Intercalated
  - Year 3 of G30H Master of Maths, Op.Res, Stats & Economics (Statistics with Mathematics Stream)
  - Year 4 of G30H Master of Maths, Op.Res, Stats & Economics (Statistics with Mathematics Stream)