

ST208-12 Mathematical Methods

23/24

Department

Statistics

Level

Undergraduate Level 2

Module leader

Jeremie Houssineau

Credit value

12

Assessment

Multiple

Study location

University of Warwick main campus, Coventry

Description

Introductory description

This module runs in Term 1 and is core for students with their home department in Statistics and optional for students studying discrete mathematics. It may be possible for non-finalists from other courses to take this module as an unusual option subject to permission from the module leader and the home department.

This module has pre-requisites: MA106 Linear Algebra and MA137 Mathematical Analysis or equivalent.

[Module web page](#)

Module aims

This is a course of techniques which are in everyday use in probability and statistics, and which are essential to a proper understanding of any second or third year course in these subjects. It will provide the mathematical background for optimization, convergence, regression and best approximation, and develop mathematical thinking.

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. Preliminaries: subsets of \mathbb{R}^2 , inverse images; partial derivatives; determinants.
2. Multiple integration: calculation of areas and volumes; Fubini's theorem; change of variable; limits of integration; links with probability.
3. Real Symmetric matrices, quadratic forms, positive definiteness; orthonormal basis of eigenvectors; diagonalisation; covariance matrices.
4. Differentiation in \mathbb{R}^n : classification of critical points; types of extrema; constrained optimisation.
5. Linear algebra: vector spaces; inner products; orthogonal and orthonormal bases; Gram-Schmidt orthogonalisation; isometries; projections; spectral decomposition.
6. Metric spaces: open and closed sets; convergence; continuity; compactness.

Learning outcomes

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

- Compute areas and volumes in two and three dimensions; manipulate and solve multiple integrals using Fubini's theorem; compute expectations of functions of random variables.
- Determine whether a real matrix is positive/negative definite / semi-definite; use spectral theory to diagonalise a matrix, apply spectral ideas to recognise the structure of a covariance matrix.
- Find and classify the critical points of a multivariate function; solve constrained optimisation problems by using Lagrange multipliers.
- Describe the key properties of an inner product space; orthogonalise a set of vectors; determine when a mapping represents a projection and compute the projection onto a given subspace.
- Explain the key concepts associated with metric spaces: convergence, continuity, compactness; determine whether a set is open or closed.

Indicative reading list

[View reading list on Talis Aspire](#)

Subject specific skills

TBC

Transferable skills

TBC

Study

Study time

Type	Required	Optional
Lectures	30 sessions of 1 hour (88%)	2 sessions of 1 hour
Tutorials	4 sessions of 1 hour (12%)	
Total	34 hours	

Private study description

Weekly revision of lecture notes and materials, wider reading, practice exercises and preparing for examination.

Costs

No further costs have been identified for this module.

Assessment

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

Students can register for this module without taking any assessment.

Assessment group D4

	Weighting	Study time
Multiple Choice Quiz 1	3%	4 hours
A multiple choice quiz which will take place during the term that the module is delivered.		
Multiple Choice Quiz 2	3%	4 hours
A multiple choice quiz which will take place during the term that the module is delivered.		
Multiple Choice Quiz 3	4%	4 hours
A multiple choice quiz which will take place during the term that the module is delivered.		
Written assignment	10%	12 hours
The assignment will contain a number of questions for which solutions and / or written responses will be required. The preparation and completion time noted below refers to the amount of time in hours that a well-prepared student who has attended lectures and carried out an appropriate amount of independent study on the material could expect to spend on this assignment.		
In-person Examination	80%	2 hours
The examination paper will contain four questions, of which the best marks of THREE questions will be used to calculate your grade.		

Weighting

Study time

- Answerbook Pink (12 page)

Assessment group R2

Weighting

Study time

In-person Examination - Resit

100%

The examination paper will contain four questions, of which the best marks of THREE questions will be used to calculate your grade.

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

Feedback on assessment

Answers to problems sets will be marked and returned to you in a tutorial or seminar taking place the following week when you will have the opportunity to discuss it.

Solutions and cohort level feedback will be provided for the examination.

[Past exam papers for ST208](#)

Availability

Courses

This module is Core for:

- Year 2 of USTA-G305 Undergraduate Data Science (MSci) (with Intercalated Year)
- Year 2 of USTA-G300 Undergraduate Master of Mathematics, Operational Research, Statistics and Economics