MODULE TITLE	**Linear Algebra**	**CREDIT VALUE**	**15**
MODULE CODE	**MTH2011**	**MODULE CONVENER**	**Prof Jan Sieber (Coordinator)**

DURATION: TERM	**1**	**2**	**3**
DURATION: WEEKS	**0**	**11**	**0**

Number of Students Taking Module (anticipated)	**230**

DESCRIPTION - summary of the module content

Abstract vector spaces are important objects in linear algebra, which has its origins in solving linear equations over a field such as the rational, real or complex numbers. The elements of a vector space can be somewhat abstract: for example, they can be functions. However, it is precisely this abstraction that makes the theory of vector spaces such a powerful tool. They arise in almost every area of (pure and applied) mathematics and statistics. For example, PDEs (partial differential equations) of some types are just ODEs (ordinary differential equations) in vector spaces of functions, and numerical and data analysis methods consider vector spaces of increasing dimension to approximate function spaces.

The material in this module underpins the study of many topics in pure and applied mathematics modules at levels 3 and M.

Prerequisite module: MTH1001 (or equivalent).

AIMS - intentions of the module

This module aims to develop the theories and techniques of modern algebra, particularly in relation to vector spaces and inner product spaces.

INTENDED LEARNING OUTCOMES (ILOs) (see assessment section below for how ILOs will be assessed)

On successful completion of this module, **you should be able to**:

Module Specific Skills and Knowledge:
1 understand the relationship between linear maps and matrices, and how the properties of each influence the solvability of systems of linear equations;
2 comprehend algorithms for solving linear equations and finding eigenvalues and eigenvectors in rigorous and formal terms.

Discipline Specific Skills and Knowledge:
3 tackle problems in many branches of mathematics that are linearisable, using the core skills of solving linear systems;
4 understand fundamental concepts in linear algebra for subsequent studies in pure mathematics.

Personal and Key Transferable / Employment Skills and Knowledge:
5 appreciate that concrete problems often require abstract theories for their solution;
6 show the ability to monitor your own progress, to manage time, and to formulate and solve complex problems.

SYLLABUS PLAN - summary of the structure and academic content of the module

- vector spaces and subspaces
- linear independence, spanning sets;
- linear maps, matrices of linear maps, change of basis;
- kernel and image of linear maps;
- dimension of vector spaces;
- rank and nullity theorem;
- generalization of concepts and key results over arbitrary fields;
- characteristic and minimal polynomials; Cayley-Hamilton theorem; Jordan Canonical Form;
- normed and inner product spaces: bilinear forms and inner products; norms; Cauchy-Schwartz inequality; Gram-Schmidt;
- unitary matrices; self-adjoint operators, including the spectral theorem; diagonalisability; dual spaces and examples; adjoint maps.

LEARNING AND TEACHING

LEARNING ACTIVITIES AND TEACHING METHODS (given in hours of study time)

Scheduled Learning & Teaching Activities	38.00	**Guided Independent Study**	112.00	**Placement / Study Abroad**	0.00

DETAILS OF LEARNING ACTIVITIES AND TEACHING METHODS

Category	Hours of study time	Description
Scheduled learning and teaching activities	33	Lectures including example classes
Scheduled learning and teaching activities	5	Tutorials
Guided independent study	112	Lecture and assessment preparation; wider reading

ASSESSMENT

FORMATIVE ASSESSMENT - for feedback and development purposes; does not count towards module grade

Form of Assessment	Size of Assessment (e.g. duration/length)	ILOs Assessed	Feedback Method
None			

SUMMATIVE ASSESSMENT (% of credit)

Coursework	20	**Written Exams**	80	**Practical Exams**	0

DETAILS OF SUMMATIVE ASSESSMENT

Form of Assessment	% of Credit	Size of Assessment (e.g. duration/length)	ILOs Assessed	Feedback Method
Written Exam – closed book	80%	2 hours (summer)	All	Written/verbal on request, SRS
Coursework Exercises 1	4%	10 hours	All	Annotated script and written/verbal feedback

Coursework Exercises 2	4%	10 hours	All	Annotated script and written/verbal feedback
Coursework Exercises 3	4%	10 hours	All	Annotated script and written/verbal feedback
Coursework Exercises 4	4%	10 hours	All	Annotated script and written/verbal feedback
Coursework Exercises 5	4%	10 hours	All	Annotated script and written/verbal feedback

DETAILS OF RE-ASSESSMENT (where required by referral or deferral)

Original Form of Assessment	Form of Re-assessment	ILOs Re-assessed	Time Scale for Re-assessment
Written exam*	Written Exam (2 hours) (80%)	All	August Ref/Def period
Coursework Exercises 1*	Coursework Exercises 1 (4%)	All	August Ref/Def period
Coursework Exercises 2*	Coursework Exercises 2 (4%)	All	August Ref/Def period
Coursework Exercises 3*	Coursework Exercises 3 (4%)	All	August Ref/Def period
Coursework Exercises 4*	Coursework Exercises 4 (4%)	All	August Ref/Def period
CourseworkExercises 5*	Coursework Exercises 5 (4%)	All	August Ref/Def period

*Please refer to reassessment notes for details on deferral vs. Referral reassessment

RE-ASSESSMENT NOTES

Deferrals: Reassessment will be by coursework and/or written exam in the deferred element only. For deferred candidates, the module mark will be uncapped.

Referrals: Reassessment will be by a single written exam worth 100% of the module only. As it is a referral, the mark will be capped at 50%.

RESOURCES

INDICATIVE LEARNING RESOURCES - The following list is offered as an indication of the type & level of information that you are expected to consult. Further guidance will be provided by the Module Convener

Web based and Electronic Resources:
ELE: http://vle.exeter.ac.uk

Reading list for this module:

Type	Author	Title	Edition	Publisher	Year	ISBN	Search
Set	Axler, S.	Linear Algebra Done Right	2nd	Springer	1997	978-0387982588	[Library]
Set	Cohn P.M.	Elements of Linear Algebra	1st	Chapman & Hall/CRC	1994	978-0412552809	[Library]
Set	Griffel, D.H.	Linear Algebra and Its Applications. Vol.1, A First Course		Ellis Horwood Limited	1989	000-0-745-80571-X	[Library]
Set	Griffel D.H.	Linear Algebra and Its Applications. Vol.2, More Advanced		Ellis Horwood Limited	1989	000-0-470-21354-X	[Library]
Set	Cameron, P.J.	Fields Introduction to Algebra	Second	Oxford Science Publications	2008	978-0-19-852793-0	[Library]

CREDIT VALUE	15	**ECTS VALUE**	7.5
PRE-REQUISITE MODULES	MTH1001		
CO-REQUISITE MODULES			
NQF LEVEL (FHEQ)	5	**AVAILABLE AS DISTANCE LEARNING**	No
ORIGIN DATE	Wednesday 26 February 2020	**LAST REVISION DATE**	Thursday 26 January 2023
KEY WORDS SEARCH	Vector spaces; linear maps; scalar products; orthogonal vectors; linear independence; spanning sets; subspaces; Jordan form; adjoint; dual; rings; groups; fields; isomorphism; irreducibility; characteristic polynomial.		