MODULE TITLE	**Vectors and Matrices**	**CREDIT VALUE**	**15**
MODULE CODE	**ECM1902**	**MODULE CONVENER**	**Dr Markus Mueller (Coordinator)**

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

Number of Students Taking Module (anticipated)	**40**

DESCRIPTION - summary of the module content

Mathematics is all about numbers and structures. Vectors are one of the most fundamental structures in Mathematics and, more generally, across science, engineering and business. They underlie all areas of mathematics, computer science and engineering. They are the fundamental to describing multi-dimensional objects and the natural language of information retrieval systems, computer aided design, 3D graphics, and pattern recognition. Matrices are the operators that transport vectors.
This introduction to vectors and matrices gives you an excellent foundation in and understanding of how vectors and matrices interact; aiming to familiarise you with, and build confidence in, using them in numerous applications across science, engineering and business. This foundation in the concepts of vectors and matrices, together with applications of geometry and the solution of systems of linear equations aims to prepare you for everything you are likely to encounter over the course of your chosen programme and discipline. On completing this module you will be equipped with the skills to apply vectors and matrices to all areas of maths and computing with the ability to tackle a range of problems, as well as demonstrating a sound understanding of the basic concepts of Linear Algebra.
Parallel to the lectures and tutorials you will work on weekly exercise sheets with problems in the field of Linear Algebra. You will be asked to form study groups with fellow students to solve these problems. Starting from week two, you will be asked to prepare the solution for one of the problems from the previous week's exercise sheet during one of the tutorial sessions and submit to the module convener (if you miss a session, you will have the chance to submit a solution in the following week). Each individual solution will be marked and you will receive feedback from the module convener. The problem mark counts 1/8 towards the overall Coursework mark. This should encourage you to work out solutions for all problems from the weekly exercise sheets (this can happen in small groups, however you have to be able to reproduce the solution individually).

AIMS - intentions of the module

The aims are to provide a basic introduction to complex numbers and a foundation in the concepts of vectors and matrices, together with applications both to geometry and to the solution of systems of linear equations. No previous knowledge of vectors and matrices is assumed. There is an emphasis on algorithmic aspects rather than a rigorous theoretical development, but proofs will be included where appropriate.

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 demonstrate a sound understanding of the basic concepts of Linear Algebra;

2 apply those concepts in tackling an appropriate range of problems;

Discipline Specific Skills and Knowledge

3 demonstrate a sufficient knowledge of those fundamental mathematical concepts, manipulations and results in Linear Algebra which are necessary to be able to progress to, and succeed in, further studies in all branches of the mathematical sciences;
4 understand how to read mathematical definitions, theorems and proofs; understand the logic behind different methods of proof, the mechanics of using them and gain experience in applying them; develop an appreciation of the role of rigorous proof in mathematics;

Personal and Key Transferable / Employment Skills and Knowledge

5 reason using abstract ideas, formulate and solve problems and communicate reasoning and solutions effectively in writing and oral presentation;
6 work in groups to solve in-depth problems effectively; and learn to analyse/assess other solutions for problems;
7 acquire ability for self-criticism of your work;
8 demonstrate appropriate use of learning resources;
9 demonstrate self management and time management skills.

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

- **"Calculus and Geometry" and "Vectors and matrices" fundamentals (see also ECM1901): numbers: The standard number systems N, Z, Q, R and C. Introduction to mathematical proofs [4 hours (+4 hours in "Calculus and Geometry")];**
- Systems of linear equations: Matrix representation; Examples, e.g. Population Projection Matrices and graphs; Elementary Row Operations. Gaussian elimination/Row reduction algorithm (including parameterisation of general solution), reduced echelon form and finding the inverse of a matrix by Gaussian elimination. Criteria for invertibility of a matrix [8 hours];
- Matrix Algebra: Addition/subtraction and multiplication of matrices; Matrices as linear functions on sets of vectors; e.g. rotation and reflection matrices in 2 dimensions; Transpose. Symmetric matrices [8 hours];

- **"Calculus and Geometry" and "Vectors and matrices" revision and mastery (see also ECM1901): focus on rigorous analysis, mathematical proofs and in-depth problems [4 hours (+4 hours in "Calculus and Geometry")];**
- Determinants: Recursive definition of determinant; Behaviour of determinants under Elementary Row/Column Operations [4 hours];
- Vectors and Vector Spaces: The notion of vector quantities; Addition and scalar multiplication of vectors; Simple geometric proofs; Representation of points in 2 or 3 dimensions as column vectors; Length of a vector; Unit vectors; Standard basis vectors; Linear independence; informal discussion of bases and dimension; Scalar product and vector/cross product [8 hours];
- Eigenvalues and eigenvectors: Definitions; Characteristic polynomial; Diagonalisation of matrices; Examples in 2 and 3 dimensions [4 hours];
- Revision and mastery [4 hours].

LEARNING AND TEACHING

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

Scheduled Learning & Teaching Activities	44.00	**Guided Independent Study**	106.00	**Placement / Study Abroad**	0.00

DETAILS OF LEARNING ACTIVITIES AND TEACHING METHODS

Category	Hours of study time	Description
Scheduled Learning & Teaching activities	11	Formal lectures of new material
Scheduled Learning & Teaching activities	33	Tutorials, with worked examples, support for working individually and in groups
Guided Independent Study	106	Lecture & 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
Weekly exercise	9 x 3 hours	1-9	Presentation of prepared scripts in class. Annotated scripts with oral feedback from tutor.
Mid-term revision and mastery	6 hours	1-9	Peer-to-peer marked, tutor/module leader feedback

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
Weekly in-depth problems	20	Eight problems randomly sampled from the weekly exercise sheets or questions similar to the exercises – solutions should be prepared in advance and prepared during one of the tutorial session in the next week	1-9	Annotated scripts with feedback from peers, tutor and/or module leader
Written exam - Closed book	80	2 hours - January Exam	1- 5, 7-9	Written/verbal on request

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
All Above	Written Exam (100%)	All	August Ref/Def period

RE-ASSESSMENT NOTES

If a module is normally assessed entirely by coursework, all referred/deferred assessments will normally be by assignment.
If a module is normally assessed by examination or examination plus coursework, referred and deferred assessment will normally be by examination. For referrals, only the examination will count, a mark of 40% being awarded if the examination is passed. For deferrals, candidates will be awarded the higher of the deferred examination mark or the deferred examination mark combined with the original coursework mark.

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

Basic reading:
ELE: http://vle.exeter.ac.uk

Other Resources:

Reading list for this module:

Type	Author	Title	Edition	Publisher	Year	ISBN	Search
Set	Finney R.L, Maurice D., Weir M. and Giordano F.R.	Thomas' Calculus Based on the Original Work by George B. Thomas, Jr.	10th or later	Addison-Wesley	2003	000-0-321-11636-4	[Library]
Set	Stewart, J.	Calculus	5th	Brooks/Cole	2003	000-0-534-27408-0	[Library]
Set	McGregor, C., Nimmo, J. & Stothers, W.	Fundamentals of University Mathematics	2nd	Horwood, Chichester	2000	000-1-898-56310-1	[Library]
Set	Allenby R.B.	Linear Algebra, Modular Mathematics		Arnold	1995	000-0-340-61044-1	[Library]
Set	Hamilton A.G.	Linear Algebra: An Introduction with Concurrent Examples		Cambridge University Press	1989	000-0-521-32517-X	[Library]
Set	Thomas, G., Weir, M., Hass, J.	Thomas' Calculus	12th	Pearson	2010	978-0321643636	[Library]
Set	Lipschutz, S., Lipson, M.	Schaum's Outlines: Linear Algebra	4th	McGraw-Hill	2008	978-0071543521	[Library]

CREDIT VALUE	15	ECTS VALUE	7.5
PRE-REQUISITE MODULES	None		
CO-REQUISITE MODULES	None		
NQF LEVEL (FHEQ)	4	AVAILABLE AS DISTANCE LEARNING	No
ORIGIN DATE	Thursday 06 July 2017	LAST REVISION DATE	Friday 30 November 2018
KEY WORDS SEARCH	Numbers; Vectors; Matrices; Matrix algebra; Determinants; Eigenvalues and Eigenvectors.		