

<b>MODULE TITLE</b>	Graphs, Networks and Algorithms	<b>CREDIT VALUE</b>	15
<b>MODULE CODE</b>	MTH3022	<b>MODULE CONVENER</b>	Prof Barrie Cooper (Coordinator)
<b>DURATION: TERM</b>	1	<b>2</b>	<b>3</b>
<b>DURATION: WEEKS</b>	0	11 weeks	0
<b>Number of Students Taking Module (anticipated)</b>		76	

#### DESCRIPTION - summary of the module content

Graphs are a structure used to describe the underlying connectedness of a system and, therefore, have a vast range of applications from designing circuit boards to running a business efficiently. In this module, you will learn the theory of graphs and explore their practical application to solve a range of mathematical problems. Real life problems typically involve enormous graphs, so a key theme in this module will be solving problems efficiently. In particular, some seemingly small and simple problems are so computationally complex that, even in this era of supercomputers, it would take longer than the lifetime of the universe to find a solution. Through analysing the effectiveness and computational complexity of algorithms, you will learn how to refine your proposed solution methods to optimise their performance. You should be familiar with material from the core undergraduate Mathematics curriculum at Exeter, including the theory of sets and functions, analysis, linear algebra and mathematical proof.

Pre-requisites: (MTH2001 (Analysis) and MTH2002 (Algebra)) or (MTH2008 (Real Analysis) and MTH2011 (Linear Algebra)).

#### AIMS - intentions of the module

The aim of the module is to present the central results of modern graph theory together with the algorithms used to solve network problems. Whilst accurate computation is essential and will be the focus of the computer-marked quizzes, the lectures and exam will focus on a rigorous development of theory and its application in a range of guided and unseen problems. There will be a particular emphasis on studying the correctness of algorithms (i.e. how do you know it does what you want?) and their complexity (i.e. how quickly does it do it?) in the context of network problems. A project element will allow students to demonstrate their understanding of a subtopic through independent investigation.

#### 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 perform algorithms and routine computations in the theory of graphs and networks accurately;
- 2 state and apply key definitions and results in the theory of graphs and networks;
- 3 prove core theorems in graph theory;
- 4 translate problems into a network format for solution;
- 5 analyse the effectiveness and computational complexity of algorithms for solving network problems;
- 6 recognise problems that are computationally complex and require heuristic solution methods;

##### Discipline Specific Skills and Knowledge:

- 7 discuss and use the material from this module in the context of the wider mathematics curriculum;
- 8 develop independently and with minimal guidance material relevant to this topic;

##### Personal and Key Transferable / Employment Skills and Knowledge:

- 9 communicate effectively your knowledge of this topic;
- 10 work independently to develop your knowledge in this subject.

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

Topics will be chosen from:

- basic graph theory: definitions, subgraphs, Euler tours and Hamiltonian cycles, representation of graphs;
- shortest paths and spanning trees;
- flows and the max-flow-min-cut theorem;
- minimal-cost feasible-flow problems;
- the marriage theorem;
- graph colouring and applications;
- connectivity and search in graphs;
- matchings and weighted matchings;
- postman problems and the salesman problem;
- graphic embedding and planar decomposition;
- analytic graph theory and discrete differential geometry;
- electrical networks and rectangle tilings;
- additional topics will be considered depending on the interests of the student cohort.

#### LEARNING AND TEACHING

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

<b>Scheduled Learning &amp; Teaching Activities</b>	33.00	<b>Guided Independent Study</b>	117.00	<b>Placement / Study Abroad</b>	0.00
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##### DETAILS OF LEARNING ACTIVITIES AND TEACHING METHODS

Category	Hours of study time	Description
Scheduled Learning and Teaching Activities	11	Lectures
Scheduled Learning and Teaching Activities	11	Tutorials
Scheduled Learning and Teaching Activities	11	Practicals
Guided Independent Study	117	Guided independent study

#### 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
Exercise Sheets	4 x 10 hours	All	Generic feedback, solutions and discussions in class
Computer- Marked Quizzes	6 x 40 minutes	1, 9, 10	Computer-generated feedback
Project draft	5000 words	2-10	Written feedback

**SUMMATIVE ASSESSMENT (% of credit)**

<b>Coursework</b>	0	<b>Written Exams</b>	60	<b>Practical Exams</b>	40
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**DETAILS OF SUMMATIVE ASSESSMENT**

Form of Assessment	% of Credit	Size of Assessment (e.g. duration/length)	ILOs Assessed	Feedback Method
Written Exam – Closed Book	30	1.5 hours (Summer)	2 - 10	Mark via SRS
Project	30	5000 words	2 - 10	Written feedback
Practical – Computer-Marked Quizzes	40 (non-condonable)	6 x 40 minutes	1, 9, 10	Computer generated 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 (30%)	2, 3, 4, 5, 6, 7, 8, 9, 10	August Ref/Def period
Project	Project (30%)	2, 3, 4, 5, 6, 7, 8, 9, 10	Summer, with a deadline in August
Coursework - Computer-Marked Quizzes	Computer marked quizzes (40% non-condonable)	1, 9, 10	Summer, with a deadline in August

**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 computer marked quizzes only. As it is a referral, the mark will be capped at 40%.

**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**

ELE: <http://vle.exeter.ac.uk>

Reading list for this module:

Type	Author	Title	Edition	Publisher	Year	ISBN	Search
Set	Jungnickel, D.	Graphs, Networks and Algorithms		Springer	1999	000-3-540-63760-5	<a href="#">[Library]</a>
Set	Ahuja, R.K., Magnanti, T.L. & Orlin, J.B.	Network Flows: Theory, Algorithms, and Applications		Prentice-Hall	1993	000-0-136-17549-X	<a href="#">[Library]</a>
Set	Smith, D.K.	Networks and Graphs: Techniques and Computational Methods		Horwood Publishing	2003	000-1-898-56391-8	<a href="#">[Library]</a>

<b>CREDIT VALUE</b>	15	<b>ECTS VALUE</b>	7.5
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<b>PRE-REQUISITE MODULES</b>	MTH2001, MTH2008, MTH2011, MTH2002
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**CO-REQUISITE MODULES**

<b>NQF LEVEL (FHEQ)</b>	6	<b>AVAILABLE AS DISTANCE LEARNING</b>	No
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<b>ORIGIN DATE</b>	Tuesday 10 July 2018	<b>LAST REVISION DATE</b>	Thursday 26 January 2023
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<b>KEY WORDS SEARCH</b>	Graph; Network; Algorithm; Mathematics; Complexity
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