

MA252-10 Combinatorial Optimisation

24/25

Department

Warwick Mathematics Institute

Level

Undergraduate Level 2

Module leader

Oleg Pikhurko

Credit value

10

Module duration

10 weeks

Assessment

Multiple

Study location

University of Warwick main campus, Coventry

Description

Introductory description

The focus of combinatorial optimisation is on finding the "optimal" object (i.e. an object that maximises or minimises a particular function) from a finite set of mathematical objects. Problems of this type arise frequently in real world settings and throughout pure and applied mathematics, operations research and theoretical computer science. Typically, it is impractical to apply an exhaustive search as the number of possible solutions grows rapidly with the "size" of the input to the problem. The aim of combinatorial optimisation is to find more clever methods (i.e. efficient algorithms) for exploring the solution space.

[Module web page](#)

Module aims

To introduce students to basic concepts and techniques of combinatorial optimisation.

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.

This module provides an introduction to combinatorial optimisation. Our main focus is on several

fundamental problems arising in graph theory and algorithms developed to solve them. These include problems related to shortest paths, minimum weight spanning trees, matchings, network flows, etc. We will also discuss "intractable" (e.g. NP-hard) problems.

Learning outcomes

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

- Upon completion of the module the students should be able to apply various combinatorial structures and basic algorithmic techniques to describe and solve fundamental problems of combinatorial optimization.,
- apply covered techniques to concrete combinatorial problems,
- state and prove particular results presented in the module,
- adapt the presented methods to other combinatorial settings.

Indicative reading list

Main Reference:

D. Du, P. Pardalos, X. Hu, & W. Wu, Introduction to Combinatorial Optimization, Springer 2022.

Other Resources:

- W.J. Cook, William H. Cunningham, W. Pulleybank, & A. Schrijver, Combinatorial Optimization, Wiley-Interscience Series in Discrete Mathematics, 1998.
- B. Korte & J. Vygen, Combinatorial Optimization: Theory and Algorithms, Springer, 6th Edition, 2018.
- J Lee, A First Course in Combinatorial Optimization, Cambridge University Press, 2010.
- C.H. Papadimitriou & K. Steiglitz, Combinatorial Optimization: Algorithms and Complexity, Dover Publications, 1998.
- L.A. Wolsey & G.L Nemhauser, Integer and Combinatorial Optimization, Wiley 1999.

Subject specific skills

The module will help the students to develop an algorithmic style of thinking.

Transferable skills

Upon completion of the module the students should be able to formalise real-life optimisation problems and apply formal methods to solve them.

Study

Study time

| Type | Required |
|---------------|-----------------------------|
| Lectures | 30 sessions of 1 hour (30%) |
| Seminars | 9 sessions of 1 hour (9%) |
| Private study | 61 hours (61%) |
| Total | 100 hours |

Private study description

Review lectured material and work on set exercises.

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 B1

| | Weighting | Study time |
|---|------------------|-------------------|
| 2 hour examination (Summer) | 100% | |
| <ul style="list-style-type: none"> • Answerbook Pink (12 page) | | |

Assessment group R1

| | Weighting | Study time |
|---|------------------|-------------------|
| In-person Examination - Resit | 100% | |
| <ul style="list-style-type: none"> • Answerbook Pink (12 page) | | |

Feedback on assessment

Exam feedback.

[Past exam papers for MA252](#)

Availability

Courses

This module is Core option list A for:

- UMAA-GV17 Undergraduate Mathematics and Philosophy
 - Year 2 of GV17 Mathematics and Philosophy
 - Year 2 of GV17 Mathematics and Philosophy
 - Year 2 of GV17 Mathematics and Philosophy
- Year 2 of UMAA-GV19 Undergraduate Mathematics and Philosophy with Specialism in Logic and Foundations

This module is Core option list B for:

- Year 3 of UMAA-GV19 Undergraduate Mathematics and Philosophy with Specialism in Logic and Foundations

This module is Core option list D for:

- Year 4 of UMAA-GV19 Undergraduate Mathematics and Philosophy with Specialism in Logic and Foundations

This module is Option list A for:

- UCSA-G4G1 Undergraduate Discrete Mathematics
 - Year 2 of G4G1 Discrete Mathematics
 - Year 2 of G4G1 Discrete Mathematics
- Year 2 of UCSA-G4G3 Undergraduate Discrete Mathematics
- UMAA-G105 Undergraduate Master of Mathematics (with Intercalated Year)
 - Year 2 of G105 Mathematics (MMath) with Intercalated Year
 - Year 4 of G105 Mathematics (MMath) with Intercalated Year
- UMAA-G100 Undergraduate Mathematics (BSc)
 - Year 2 of G100 Mathematics
 - Year 2 of G100 Mathematics
 - Year 2 of G100 Mathematics
 - Year 3 of G100 Mathematics
 - Year 3 of G100 Mathematics
 - Year 3 of G100 Mathematics
- UMAA-G103 Undergraduate Mathematics (MMath)
 - Year 2 of G100 Mathematics
 - Year 2 of G103 Mathematics (MMath)
 - Year 2 of G103 Mathematics (MMath)
 - Year 3 of G100 Mathematics
 - Year 3 of G103 Mathematics (MMath)
 - Year 3 of G103 Mathematics (MMath)
- Year 2 of UMAA-G1NC Undergraduate Mathematics and Business Studies
- Year 2 of UMAA-G1N2 Undergraduate Mathematics and Business Studies (with Intercalated Year)
- Year 2 of UMAA-GL11 Undergraduate Mathematics and Economics

- Year 2 of UECA-GL12 Undergraduate Mathematics and Economics (with Intercalated Year)
- USTA-GG14 Undergraduate Mathematics and Statistics (BSc)
 - Year 2 of GG14 Mathematics and Statistics
 - Year 2 of GG14 Mathematics and Statistics
- UMAA-G101 Undergraduate Mathematics with Intercalated Year
 - Year 2 of G101 Mathematics with Intercalated Year
 - Year 4 of G101 Mathematics with Intercalated Year

This module is Option list B for:

- UPXA-GF13 Undergraduate Mathematics and Physics (BSc)
 - Year 2 of GF13 Mathematics and Physics
 - Year 2 of GF13 Mathematics and Physics
- UPXA-FG31 Undergraduate Mathematics and Physics (MMathPhys)
 - Year 2 of FG31 Mathematics and Physics (MMathPhys)
 - Year 2 of FG31 Mathematics and Physics (MMathPhys)
- USTA-Y602 Undergraduate Mathematics,Operational Research,Statistics and Economics
 - Year 2 of Y602 Mathematics,Operational Research,Stats,Economics
 - Year 2 of Y602 Mathematics,Operational Research,Stats,Economics