

# IB352-15 Applied Optimization Methods

**23/24**

**Department**

Warwick Business School

**Level**

Undergraduate Level 3

**Module leader**

Juergen Branke

**Credit value**

15

**Module duration**

10 weeks

**Assessment**

Multiple

**Study location**

University of Warwick main campus, Coventry

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## Description

### Introductory description

This is a module for MORSE students in particular.

To introduce general algorithms for convex and non-convex optimization problems arising in various application areas such as financial portfolio optimization, energy system planning, and engineering design optimization, and their computational aspects using a numerical software tool such as Matlab.

[Module web page](#)

### Module aims

To introduce general algorithms for convex and non-convex optimization problems arising in various application areas such as financial portfolio optimization, energy system planning, and engineering design optimization, and their computational aspects using a numerical software tool such as Matlab.

### 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.

Module introduction with examples of several optimization problems in various application areas such as financial portfolio optimization, energy system planning, and engineering design optimization, and review of mathematical background materials (linear algebra, calculus-derivatives, etc.).

Introduction to a software for modelling and solving optimization problems.

Optimality conditions.

Unconstrained optimization.

Quadratic programming.

Constrained optimization.

Discrete optimization and exact methods.

Heuristics.

Global optimization.

Multi-objective optimization.

We plan to cover various applications such as financial portfolio optimization, energy system planning, and engineering design optimization, and several solution algorithms.

## **Learning outcomes**

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

- Derive general optimality conditions for convex optimization problems.
- Apply numerical algorithms for unconstrained and constrained convex optimization problems.
- Apply exact methods for discrete optimization problems with general non-linear convex objective as well heuristics methods.
- Understand global optimization methods.

## **Indicative reading list**

- G. Calafiore and L. El Ghaoui, Optimization Models, Cambridge Publications, 2014
- P. Venkataraman, Applied Optimization with Matlab Programming, Wiley, 2nd Edition, 2009
- J. Nocedal and S. Wright, Numerical Optimization, Springer, 2nd Edition, 2000
- C. Papadimitriou and K. Steiglitz, Combinatorial Optimization: Algorithms and Complexity, Dover Publications, 1998
- A. E. Eiben and J. E. Smith, Introduction to Evolutionary Computing, Springer 2015

## **Subject specific skills**

Use Matlab or similar numerical software to solve optimization problems using numerical algorithms and builtin/add-on optimization solver.

## **Transferable skills**

Distinguish between convex and non-convex optimization problems and different solution

techniques.

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## Study

### Study time

Type	Required
Lectures	10 sessions of 1 hour (7%)
Tutorials	10 sessions of 1 hour (7%)
Online learning (independent)	10 sessions of 1 hour (7%)
Private study	48 hours (33%)
Assessment	69 hours (47%)
Total	147 hours

### Private study description

Private Study.

## Costs

No further costs have been identified for this module.

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## Assessment

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

### Assessment group D5

	Weighting	Study time
Group Work	20%	15 hours
Numerical problem solving.		
Weekly Online Multiple Choice Questions	5%	4 hours
In-person Examination	75%	50 hours
Exam		

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

## Assessment group R1

	Weighting	Study time
Individual Assignment	25%	
In-person Examination - Resit	75%	

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

## Feedback on assessment

For the assignment, students will receive individual feedback. For the exam, general feedback will be provided about typical errors made.

[Past exam papers for IB352](#)

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## Availability

### Pre-requisites

To take this module, you must have passed:

- Any of
  - [IB104-12 Mathematical Programming I](#)
  - [IB207-12 Mathematical Programming II](#)

## Courses

This module is Core for:

- USTA-G300 Undergraduate Master of Mathematics, Operational Research, Statistics and Economics
  - Year 3 of G30C Master of Maths, Op.Res, Stats & Economics (Operational Research and Statistics Stream)
  - Year 3 of G30C Master of Maths, Op.Res, Stats & Economics (Operational Research and Statistics Stream)
- USTA-G301 Undergraduate Master of Mathematics, Operational Research, Statistics and Economics (with Intercalated)
  - Year 3 of G30G Master of Maths, Op.Res, Stats & Economics (Operational Research and Statistics Stream) Int
  - Year 4 of G30G Master of Maths, Op.Res, Stats & Economics (Operational Research and Statistics Stream) Int

This module is Optional for:

- UECA-4 Undergraduate Economics 4 Year Variants
  - Year 4 of LV16 Economics & Economic History with Study Abroad
  - Year 4 of L114 Industrial Economics with Study in Europe
- USTA-G300 Undergraduate Master of Mathematics, Operational Research, Statistics and Economics
  - Year 3 of G300 Mathematics, Operational Research, Statistics and Economics
  - Year 4 of G300 Mathematics, Operational Research, Statistics and Economics
- Year 3 of UMAA-G1NC Undergraduate Mathematics and Business Studies
- Year 4 of UECA-GL12 Undergraduate Mathematics and Economics (with Intercalated Year)
- USTA-G1G3 Undergraduate Mathematics and Statistics (BSc MMathStat)
  - Year 3 of G1G3 Mathematics and Statistics (BSc MMathStat)
  - Year 4 of G1G3 Mathematics and Statistics (BSc MMathStat)
- USTA-G1G4 Undergraduate Mathematics and Statistics (BSc MMathStat) (with Intercalated Year)
  - Year 4 of G1G4 Mathematics and Statistics (BSc MMathStat) (with Intercalated Year)
  - Year 5 of G1G4 Mathematics and Statistics (BSc MMathStat) (with Intercalated Year)

This module is Unusual option for:

- UPHA-L1CA Undergraduate Economics, Psychology and Philosophy
  - Year 2 of L1CA Economics, Psychology and Philosophy
  - Year 3 of L1CA Economics, Psychology and Philosophy
- UPHA-V7ML Undergraduate Philosophy, Politics and Economics
  - Year 3 of V7ML Philosophy, Politics and Economics (Tripartite)
  - Year 3 of V7ML Philosophy, Politics and Economics (Tripartite)
  - Year 3 of V7ML Philosophy, Politics and Economics (Tripartite)

This module is Option list A for:

- Year 3 of USTA-G300 Undergraduate Master of Mathematics, Operational Research, Statistics and Economics
- USTA-G301 Undergraduate Master of Mathematics, Operational Research, Statistics and Economics (with Intercalated)
  - Year 3 of G30E Master of Maths, Op.Res, Stats & Economics (Actuarial and Financial Mathematics Stream) Int
  - Year 4 of G30E Master of Maths, Op.Res, Stats & Economics (Actuarial and Financial Mathematics Stream) Int
- USTA-Y602 Undergraduate Mathematics, Operational Research, Statistics and Economics
  - Year 3 of Y602 Mathematics, Operational Research, Stats, Economics
  - Year 3 of Y602 Mathematics, Operational Research, Stats, Economics
- Year 4 of USTA-Y603 Undergraduate Mathematics, Operational Research, Statistics, Economics (with Intercalated Year)

This module is Option list B for:

- Year 4 of UCSA-G504 MEng Computer Science (with intercalated year)
- UCSA-G500 Undergraduate Computer Science

- Year 3 of G500 Computer Science
- Year 3 of G500 Computer Science
- UCSA-G502 Undergraduate Computer Science (with Intercalated Year)
  - Year 4 of G502 Computer Science with Intercalated Year
  - Year 4 of G502 Computer Science with Intercalated Year
- UCSA-G503 Undergraduate Computer Science MEng
  - Year 3 of G500 Computer Science
  - Year 3 of G503 Computer Science MEng
  - Year 3 of G503 Computer Science MEng
- USTA-GG14 Undergraduate Mathematics and Statistics (BSc)
  - Year 3 of GG14 Mathematics and Statistics
  - Year 3 of GG14 Mathematics and Statistics
- Year 4 of USTA-GG17 Undergraduate Mathematics and Statistics (with Intercalated Year)

This module is Option list C for:

- Year 4 of UCSA-G504 MEng Computer Science (with intercalated year)
- UCSA-G500 Undergraduate Computer Science
  - Year 3 of G500 Computer Science
  - Year 3 of G500 Computer Science
- UCSA-G502 Undergraduate Computer Science (with Intercalated Year)
  - Year 4 of G502 Computer Science with Intercalated Year
  - Year 4 of G502 Computer Science with Intercalated Year
- UCSA-G503 Undergraduate Computer Science MEng
  - Year 3 of G500 Computer Science
  - Year 3 of G503 Computer Science MEng
  - Year 3 of G503 Computer Science MEng

This module is Option list G for:

- UPHA-V7ML Undergraduate Philosophy, Politics and Economics
  - Year 2 of V7ML Philosophy, Politics and Economics (Tripartite)
  - Year 2 of V7ML Philosophy, Politics and Economics (Tripartite)
  - Year 2 of V7ML Philosophy, Politics and Economics (Tripartite)