Subject Information Guide

Optimisation and Optimal Control (Advanced Methods in Mathematics 1 - MATH708)

Semester 1, 2018

Administration and contact details

Host Department	Department of Mathematics
Host Institution	Macquarie University
Name of lecturer	Prof Vlad Gaitsgory
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Subject details

Handbook entry URL	http://www.handbook.mq.edu.au/2016/Units/ResearchUnit/MATH708
Subject homepage URL	
Honours student hand-out URL	
Start date:	26 February 2018
End date:	1 June 2018
Contact hours per week:	2 hours per week
Lecture day and time:	TBA
Description of electronic access arrangements for students (for example, WebCT)	Materials will be made available on lecturers website.

Subject content

1. Subject content description

Optimisation and optimal control constitute a basis for decision making. They have numerous applications, many of them posing new challenges and stimulating further mathematical

research. The aim of this course is to present students with key ideas and results of the theory of optimisation and optimal control and also to equip them with mathematical tools for analysis and solution of problems arising in these important areas of applied mathematics.

2. Week-by-week topic overview

The following content will be distributed over the 12 weeks semester.

- **Elements of convex analysis:**
  Convex sets and convex functions. Separation theorems and related results.
- **Linear and nonlinear mathematical programming problems:**
  Karush–Kuhn theorem. Duality in linear and nonlinear problems. Numerical optimisation techniques. Simplex method. Sensitivity analysis.
- **Problems of optimal control of dynamical systems:**
  Optimal control problems in continuous and discrete time. Dynamic programming principle and Hamilton-Jacobi-Bellman equations. Pontryagin's Maximum principle.
- **Occupational measure approach to optimal control problems:**
  Infinite-dimensional linear programming formulations of optimal control problems. Characterization of optimal controls with the help of duality results.

3. Assumed prerequisite knowledge and capabilities

Differential Equations (as obtained through, for example, a good third year unit on differential equations, both ODEs and PDEs).

4. Learning outcomes and objectives

At the end of this subject, students will be equipped with all the tools necessary to analyse differential equations arising in a broad range of physically motivated problems.

AQF specific Program Learning Outcomes and Learning Outcome Descriptors (if available):

AQF Program Learning Outcomes addressed in this subject	Associated AQF Learning Outcome Descriptors for this subject
K1	coherent and advanced knowledge of the underlying principles and concepts in one or more disciplines
K2	knowledge of research principles and methods
S1	cognitive skills to review, analyse, consolidate and synthesise knowledge to identify and provide solutions to complex problem with intellectual independence
S3	cognitive skills to exercise critical thinking and judgement in developing new understanding
S4	technical skills to design and use in a research project

A1	with initiative and judgement in professional practice and/or scholarship
A2	to adapt knowledge and skills in diverse contexts

Learning Outcome Descriptors at AQF Level 8

Knowledge

K1: coherent and advanced knowledge of the underlying principles and concepts in one or more disciplines

K2: knowledge of research principles and methods

Skills

S1: cognitive skills to review, analyse, consolidate and synthesise knowledge to identify and provide solutions to complex problem with intellectual independence

S2: cognitive and technical skills to demonstrate a broad understanding of a body of knowledge and theoretical concepts with advanced understanding in some areas

S3: cognitive skills to exercise critical thinking and judgement in developing new understanding

S4: technical skills to design and use in a research project

S5: communication skills to present clear and coherent exposition of knowledge and ideas to a variety of audiences

Application of Knowledge and Skills

A1: with initiative and judgement in professional practice and/or scholarship

A2: to adapt knowledge and skills in diverse contexts

A3: with responsibility and accountability for own learning and practice and in collaboration with others within broad parameters

A4: to plan and execute project work and/or a piece of research and scholarship with some independence

5. Learning resources

Brief lectures notes will be available for students and will be uploaded to the unit website. The following references may prove useful.

- *Convex Analysis,* R.T. Rockafellar, Princeton University Press (1970).
- *Deterministic and Stochastic Optimal Control,* W.H. Fleming and R.W. Rishel, Springer (1975).
- *Linear and Nonlinear Programming*, D. Lunberger and Y. Ye, Springer (2008).
- *Theory of Suboptimal Decisions: Decomposition and Aggregation*, A.A. Pervozvankii and V. Gaitsgory, Kluwer (1988).

6. Assessment

Four assignments each worth 25% (the due dates for the assignments will be advertised before the start date)

Institution Honours program details

Weight of subject in total honours assessment at host department	12.5% of BPhil
Thesis/subject split at host department	BPhil has no thesis; thesis is 90% of MRes
Honours grade ranges at host department:	
H1	85%
H2a	75%
H2b	65%
H3	50