ACE Network Subject Information Guide

MATH4411: Applied Computational Mathematics

Semester 1, 2022

Administration and contact details

Host department	School of Mathematics and Statistics
Host institution	University of Sydney
Name of lecturer	Georg Gottwald
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Subject details

Handbook entry URL	https://www.sydney.edu.au/units/MATH4411
Subject homepage URL	https://www.maths.usyd.edu.au/u/UG/HM/
Honours student hand-out URL	https://www.maths.usyd.edu.au/u/UG/HM/
Start date:	21/02/2020
End date:	15/06/2022
Contact hours per week:	4
Census date:	11/03/2022
Lecture day(s) and time(s):	Monday 2-4pm; Wednesday 11-12; Wednesday 1-2pm (computer lab/tutorial)
Description of electronic access arrangements for students (for example, WebCT)	Ed will be used to post questions, reference material, tutorial sheets etc.

Subject content

1. Subject content description

Computational mathematics fulfils two distinct purposes within Mathematics. On the one hand the computer is a mathematician's laboratory in which to model problems too hard for analytical treatment and to test existing theories; on the other hand, computational needs both require and inspire the development of new mathematics. Computational methods are an essential part of the toolbox of any mathematician. This unit will introduce you to a suite of computational methods and highlight the fruitful interplay between analytical understanding and computational practice. In particular, you will learn both the theory and use of numerical methods to simulate partial differential equations, how numerical schemes determine the stability of your method and how to assure stability when simulating Hamiltonian systems, how to simulate stochastic differential equations, as well as modern approaches to distilling relevant information from data using machine learning. By doing this unit you will develop a broad knowledge of advanced methods and techniques in computational applied mathematics and know how to use these in practice. This will provide a strong foundation for research or further study.

2. Week-by-week topic overview

Weeks 1-3: Topic 1: Numerical integration of partial differential equations

Weeks 4-7: Topic 2: Symplectic Integrators for Hamiltonian Systems and Topic 3: Numerical Solution of Stochastic Differential Equations

Weeks 8-13: Topic 4: Applications of Singular Value Decomposition Topic 5: Dynamic patterns and the Koopman operator Topic 6: Machine learning

3. Assumed prerequisite knowledge and capabilities

Advanced background in linear algebra, calculus as well as in Fourier analysis and PDEs will be required. Students also will need to be fluent in a programming language such as Python, Matlab, C, Fortran, Julia.

4. Learning outcomes and objectives

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
Knowledge	K1, K2
Skills	S1, S2, S3, S4, S5
Application of Knowledge and Skills	A1, A2, A3, A4
Insert Program Learning Outcome here	Choose from list below
Insert Program Learning Outcome here	Choose from list below
Insert Program Learning Outcome here	Choose from list below
Insert Program Learning Outcome here	Choose from list below

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

A list of reference material will be posted during the semester for the particular topics.

6. Assessment

Exam/assignment/classwork breakdown					
Exam	40% (with a 50% passing requirement)	**Assignment**	3 x 20%	**Class work**	0%
Assignment due dates		April 4 (may change)	May 4 (may change)	May 23 (may change)	Click here to enter a date.
Approximate exam date				Will be discussed with students to find suitable day.	

Institution honours program details

Weight of subject in total honours assessment at host department	12.5%
Thesis/subject split at host department	50% coursework, 50% thesis
Honours grade ranges at host department	**0-100**
H1	80-100
H2a	75-79
H2b	70-74
H3	65-69

Institution masters program details

Weight of subject in total masters assessment at host department	6.25%
Thesis/subject split at host department	75% coursework, 25% thesis
Masters grade ranges at host department	**0-100**
H1	
H2a	
H2b	
H3	