Subject Information Guide

Introduction to Vortex Dynamics (MATH705)

Semester 2, 2018

Administration and contact details

Host department	Department of Mathematics
Host institution	Macquarie University
Name of lecturer	Dr Christopher Green
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Subject details

Handbook entry URL	http://www.handbook.mq.edu.au/2018/Units/ResearchUnit/MATH705
Honours student hand-out URL	TBC
Start date:	30 July 2018
End date:	2 November 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 the unit website.

Subject content

1. **Subject content description**

   This is an advanced course which will provide an introduction to the mathematics associated with vorticity. Vortices are ubiquitous throughout nature and many fluid dynamical processes arising in physics and engineering make use of different vortex models to facilitate the modelling, and to encapsulate the key features, of their associated flow fields. Three important types of vortex which will be explored in this course are the point vortex, the vortex patch, and the hollow vortex.

2. **Week-by-week topic overview**

   Weeks 1-3: Vorticity and circulation

   - Euler and vorticity equations
   - Biot-Savart law
   - Kelvin's circulation theorem
   - Helmholtz laws

   Weeks 4-8: Point vortex dynamics

   - Equilibria, stability and dynamics
   - Point vortex motion in different domains
   - Kirchhoff-Routh theory
   - Point vortex motion on a sphere

   Weeks 9-12: Distributed vorticity models

   - Vortex patches
   - Hollow vortices

3. **Assumed prerequisite knowledge and capabilities**

   A basic knowledge of fluid dynamics and complex variable theory is desirable but not essential.

4. **Learning outcomes and objectives**

   At the end of the course, students will have an understanding of the introductory concepts in vortex dynamics and will be equipped with the mathematical tools to solve problems involving three types of vortex in different domains.

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 problems 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.
A1	With initiative and judgement in professional practice and/or scholarship.
A2	To adapt knowledge and skills in diverse contexts.

5. Learning resources

Written lecture notes will be available for students and will be uploaded to the unit website.

The following three texts may prove useful:

- D. J. Acheson, Elementary Fluid Dynamics, Oxford University Press
- G. K. Batchelor, An Introduction to Fluid Dynamics, Cambridge University Press
- P. G. Saffman, Vortex Dynamics, Cambridge University Press

6. Assessment

Exam/assignment/classwork breakdown					
Exam	60%	**Assignments**	40%	**Class work**	0%
Assignment due dates				TBC	
Approximate exam date				TBC	

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%