Subject Information Guide

Advanced Methods in Mathematics 1 - MATH708

Semester 2, 2016

Administration and contact details

Host Department	Department of Mathematics
Host Institution	Macquarie University
Name of lecturer	Professor Jim Denier
Phone number	N/A
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Subject details

Handbook entry URL	http://www.handbook.mq.edu.au/2016/Units/ResearchUnit/MATH707
Subject homepage URL	http://web.science.mq.edu.au/~jdenier/Jim/MATH707.html
Honours student hand-out URL	http://web.science.mq.edu.au/~jdenier/Jim/MATH707.html
Start date:	1 August 2016
End date:	4 November 2016
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

Perturbation techniques underpin almost all physical applications of applied mathematics. Examples range from boundary-layer theory in viscous fluid flow, the description of shock waves in compressible fluids, acoustics, optics, describing the orbits of planets in celestial

mechanics, nonlinear oscillations and chaotic dynamics. The aim of this course is to present students with a systematic account of modern perturbation methods and demonstrate by example how they can be applied to the solution of differential equations.

2. Week-by-week topic overview

The following content will distributed over the 12 week semester.

- **Introduction:**
  Asymptotic expansions, algebraic equations.
- **Asymptotic evaluation of integrals:**
  Laplace's method. The method of stationary phase. The method of steepest descent. Stokes phenomena.
- **Boundary value problems:**
  Boundary-layer theory: transition layers. Method of strained coordinates. Boundary layer theory for partial differential equations. WKB method.
- **Evolution equations:**
  Regular perturbation methods. Poincare-Lindstedt method. The method of multiple scales. Averaging (if time permits).

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). The section on asymptotic expansions of integrals will require some background knowledge of *Complex Analysis*. Handouts providing this background will be distributed.

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

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

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

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

References:

- *Asymptotic Analysis*, J.D. Murray, Springer-Verlag (1984).
- *Perturbation Methods*, E.J. Hinch, C.U.P. (1991).
- *Advanced mathematical methods for scientists and engineers*, C.M. Bender and S.A. Orszag, McGraw-Hill, (1978).
- *Perturbation methods in applied mathematics*, J. Kevorkian and J.D. Cole, Springer-Verlag (1981).

- *Perturbation methods*, A. Nayfeh, J. Wiley (1973).
- *Multiple scale and perturbation methods*, J. Kevorkian and J.D. Cole, Springer-Verlag (1996).

6. Assessment

Exam/assignment/classwork breakdown					
Exam	60%	**Assignment**	40%	**Class work**	N/A
Assignment due dates		31 August 2016 (to be confirmed)	14 October 2016 (to be confirmed)	N/A	N/A
Approximate exam date				Not available at this time	

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