

MATH0065 Advanced Modelling Mathematical Techniques

<i>Year:</i>	2021–2022
<i>Code:</i>	MATH0065
<i>Level:</i>	7(UG)/7(PG)
<i>Normal student group(s):</i>	UG Year 4 Mathematics degrees PG MSc Mathematical Modelling
<i>Value:</i>	15 credits (= 7.5 ECTS credits)
<i>Term:</i>	1
<i>Assessment:</i>	100% examination
<i>Normal UG Pre-requisites:</i>	MATH0010, MATH0011, and MATH0013 Some knowledge of 2D fluid mechanics useful, but not essential.
<i>Lecturers:</i>	Dr S Timoshin and Prof G Esler

Course Description and Objectives

This module aims to ensure that students possess knowledge of the analytical techniques used in mathematical modelling.

Recommended Texts

- (i) Hinch, *Perturbation methods*, Cambridge Texts in Applied Mathematics.
- (ii) Kevorkian & Cole, *Perturbation methods in applied mathematics*, Applied Mathematical Sciences, Springer.
- (iii) Bender & Orszag, *Advanced mathematical methods for scientists and engineers*, Asymptotic Methods and Perturbation Theory: v.1, Springer.
- (iv) Churchill and Brown, *Complex variables and applications*, McGraw-Hill.
- (v) Nehari, *Introduction to complex analysis*, Allyn and Bacon.
- (vi) G. Pavliotis, *Stochastic Processes and Applications: Diffusion Processes, the Fokker-Planck and Langevin Equations*. Springer, 2014.

Detailed Syllabus

- Partial differential equations (PDEs): Revision of main solution techniques for elliptic and parabolic PDEs (separation of variables, Fourier transforms, similarity variables, Green's functions).
- Introduction to applied stochastic methods: Brownian motion and stochastic differential equations. Connection to PDEs: Fokker-Planck and backward Kolmogorov equation. Exit time problems.
- Perturbation Methods. Introduction to modelling concepts, dimensional analysis, perturbation techniques, matched asymptotics.
- Application of Complex Variables. Conformal mapping and applications. A selection from:

- (a) Hodograph and potential-plane techniques
- (b) Schwartz functions and vortex equilibria
- (c) Hele-Shaw free boundary problems
- (d) Two-dimensional freezing/melting problems

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