Introduction to Applied Analysis (ACM 30020)

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1 Overview

In this document, I explain the format of ACM 30020 in the Spring Trimester 2024, starting in Week 1, Monday January 19th, 2026.

Version history:

- First version, 5th January 2026

2 Mode of Delivery

The instruction in this module is planned to be primarily face-to-face.

VLE

My website will be the main point-of-reference for this module:

`https://maths.ucd.ie/~onaraigh/acm30020.html`

Already, there is a complete set of **typed notes** available there. The lectures will follow the typed notes closely. Brightspace won't be used that much in this module.

Format of module

- Three lecture-hours per week (Mondays at 13:00, Wednesdays at 12:00, Fridays at 15:00).
- One of these weekly lecture-hours will be devoted to exercises ('problem-solving classes').
- Office hours can be arranged on request.

3 Assessment

Assessment as follows:

- One final exam, worth 80%.
- One long take-home assignment, due just after the midterm break (Monday 23rd March).

4 How to succeed in the module

Problem Classes: One of the weekly lecture-hours will be devoted to 'problems'. These will be in the form of a weekly set of exercises, not for credit. Students will be given these exercises in advance, they should work on them (and discuss them together). Subsequently, the lecturer will go through a selection of model answers in class.

The exercises are a bit like training, if you can do all of the problems you will basically know the whole content of the module. It is no harm to be bamboozled by the problems at the start, the main thing is to understand them after going through them with the lecturer.

Final exam: The questions in the weekly exercises have been designed to showcase techniques and tricks necessary for tackling a wide class of problems in differential equations and integral equations if you learn these techniques you will have fulfilled the learning outcomes of the module. With this in mind, a significant portion of the questions in the final exam will be drawn from the problem sheets. The following structure will be used:

- 3 questions directly from the problem classes
- 1 unseen problem
- 1 theorem, from a short list of theorems from the lecture notes, to be given to the students before the exam.

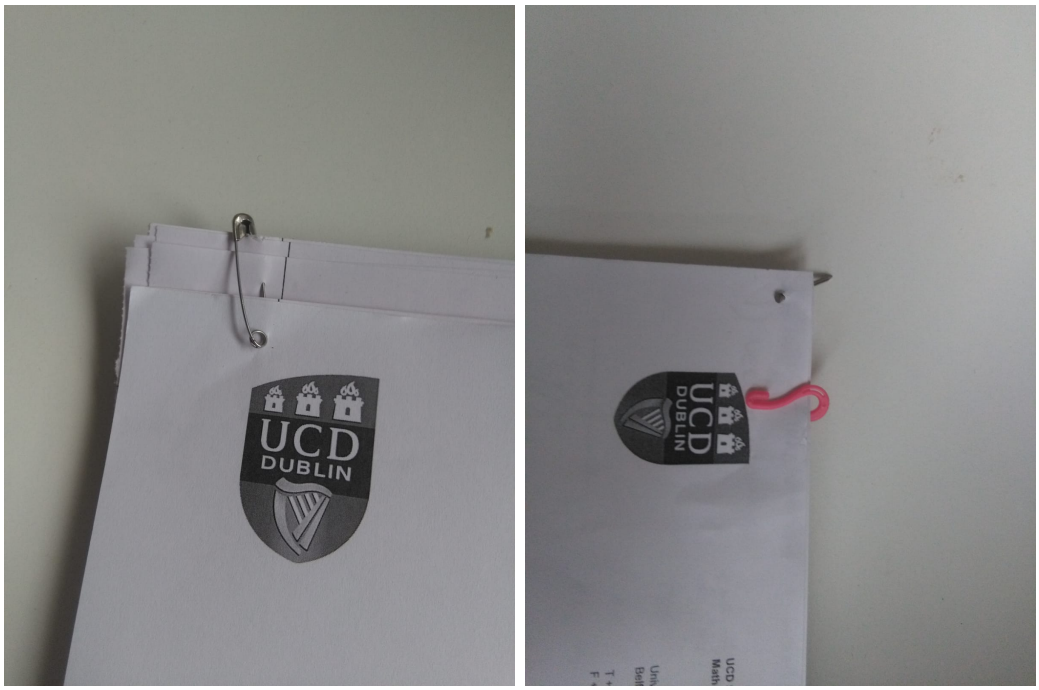
Graded Assignment: There will also be one graded assignment, due just after the midterm break. This will assess all of the materials covered up to and including Week 7. This take-home assignment will be handed out at the start of the module, students can work on it at their leisure, they won't understand it all at once but they will fill in the details as the module progresses. Submission will be by hardcopy. The idea of this assessment is that completion of the take-home assignment is like climbing a tall mountain, the summit is far in the distance, but bit by bit, you will get there. Please use a stapler to stable the pages of the assignment together (Figure 1). The assessment structure has been designed based on feedback from previous years, to minimize stress on the students, while maximizing opportunities for learning and reflection.

5 Use of AI

This module uses the AI Assessment Scale of the College of Science. AI assistance up to and including level 3 on that scale are acceptable.

6 Feedback

Detailed feedback on the graded assignment will also be made available to students.



(a) (b)

Figure 1: For health and safety reasons, please refrain from using these solutions to join together the pages of your long assignment. **Use a stapler instead.**

7 Integrity in assessment

The usual rules around academic integrity to all elements of assessment in the module. There is a university plagiarism policy which is posted on the Brightspace page, along with the School of Mathematics and Statistics academic integrity protocol.

In addition, for the take-home assignment, you will be asked to submit a coversheet on which you assert that the submitted work is your own and was completed under the rules and proper format for continuous assessment. The School of Mathematics and Statistics / University will take action if it transpires that this cover sheet is not completed truthfully and in good faith.

8 Please don't fail the module!

If you do, there will be a resit exam in the Autumn Trimester.

9 Grading

The Standard Conversion Scale is used in this module.

10 Textbooks

The typed lecture notes are self-contained. However, there are two key texts, on which the notes are based:

- Hildebrand, F.B. Methods of Applied Mathematics. Dover Publications Inc, New edition (2003)
- Riley, K.F., Hobson, M.P. and Bence, S.J. Mathematical methods for physics and engineering. Cambridge University Pressm 2006 (Third Edition)

The first book is quite nice as it's a Dover publication and as such is available on online bookstores for under 20 pounds.

11 Higher-Level Aim of Module

Often, in Applied Mathematics, there is the temptation to view a module such as this one as "just another maths methods module". The blame for this misconception lies with the Lecturer and not the students. There is the risk that such a misconception could arise in this module, because of the smorgasbord of techniques and methods covered. However, there is real substance in this module, as it is an introduction into a branch of Mathematics called Applied Analysis. Here, the aim is to take an equation inspired by applications, and to submit it to rigorous analysis. To ask questions like, "does a solution to this equation even exist?" Or,"how smooth is the solution?" Or, "if this model is a mathematical model for a population (say), is there a way *a priori* to say that the solution remains positive?" This module will equip students with the tools to answer such questions. Indeed, by the end of this module, students will be familiar with some of the issues involved in determining whether or not the Navier–Stokes equations in Fluid Dynamics have a unique globally defined solution in three dimensions. This is the main question tackled in the book below (Figure 2) by the end of this module, students will have the background to read and appreciate this book. **To emphasize this higher purpose of the module, the module (since 2025) is called Applied Analysis**.

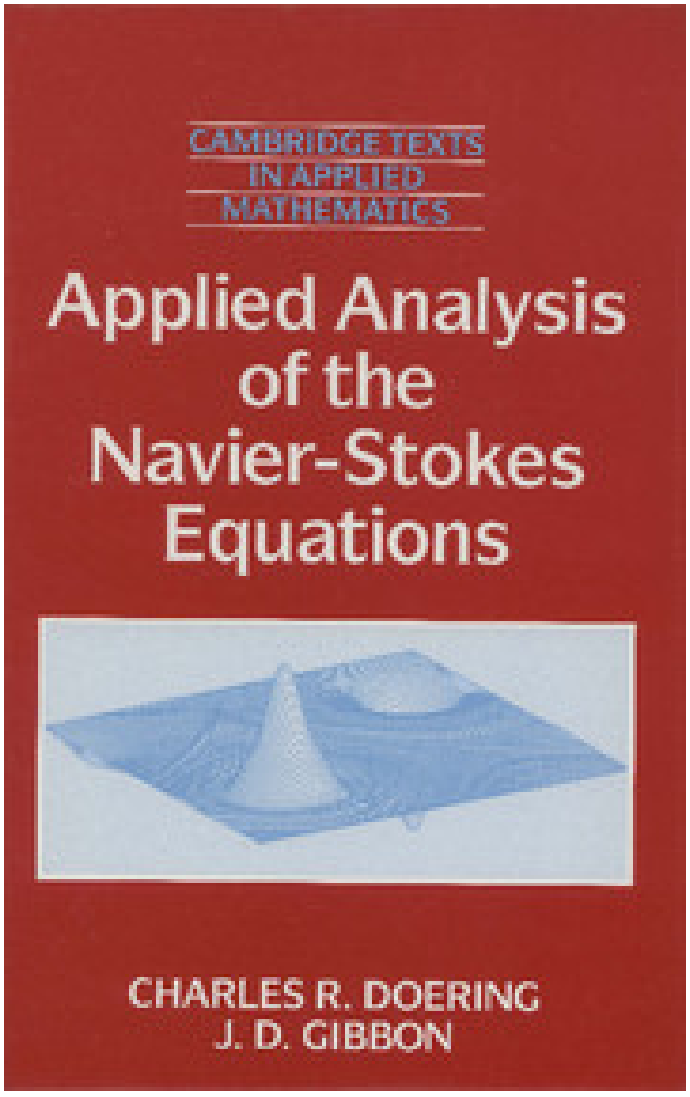


Figure 2: Textbook by Doering and Gibbon on the Applied Analysis of the Navier–Stokes equations. These are the key equations of Fluid Dynamics. Showing that a unique globally definied solution exists in 3D is one of the key questions of contemporary Applied Mathematics.