MATH0077 Real Fluids

Year:	2024–2025
Code:	MATH0077
Level:	7 (UG)
Normal student group(s):	UG Year 3 and 4 Mathematics degrees
Value:	15 credits (= 7.5 ECTS credits)
Term:	1
Assessment:	90% examination, 10% coursework
Normal Pre-requisites:	MATH0015, MATH0016, and MATH0056
Lecturer:	Dr B Walker

Course Description and Objectives

This is a course on the flow of incompressible viscous (ie real) fluids. Unlike an ideal fluid, a viscous fluid exerts tangential stresses which are analogous to friction forces in mechanics. Once the governing partial differential equations are derived, we move on to obtaining and interpreting special solutions, eg for flow between rotating cylinders, over an oscillating plate, between converging walls, or through pipes of various cross-sections. Domestic and industrial applications are mentioned. Motion of a very viscous fluid and slow flows as in lubrication are then considered in more detail.

Recommended Texts

The recommended book is: G K Batchelor, *An Introduction to Fluid Dynamics*, Cambridge University Press.

Detailed Syllabus

- Deriving the Navier-Stokes equations of motion of the fluid, using the concepts of pressure and motion of a fluid element, and the stress tensor.
- Obtaining and interpreting special exact solutions, eg if the flow is steady and/or one- or two-dimensional, as in flow between rotating cylinders, over an oscillating flat plate, between converging walls, or through pipes.
- Showing the importance of the Reynolds number (a nondimensional parameter R which enables flows of different scales to be related), and obtaining, when possible, the exact solution in the boundary-layer limit where $R \gg 1$.
- Considering in detail the slow flow limit, where $R \ll 1$.
- Solving problems in lubrication theory.