Applied Mathematics

MP365: Fluid Mechanics (5 ECTS)

(This course will be run every other year.) This course consists of an introduction to the theory of fluid mechanics. Topics covered include: a review of vector calculus, ideal fluids, irrotational flow, Laplace's equation and some potential theory, elementary viscous flow with examples, the stress tensor, Cauchy's equation of motion, the Navier-Stokes equations, very viscous flow, including thin film and lubrication theory.

Taught in Semester(s) II. **Examined** in Semester(s) II.

Workload: 36 hours (24 Lecture hours, 12 Tutorial hours).

Module Learning Outcomes. On successful completion of this module the learner should be able to:

1. Mathematically model the behaviour of ideal fluids.
2. Solve some simple fluid problems for incompressible, irrotational flows using potential theory.
3. See how the method of images can be used to construct flow solutions.
4. Understand the assumptions made in deriving the Navier-Stokes equations for fluid motion.
5. Construct some analytical solutions for some elementary viscous fluid flows.
6. Ability to use Phyton Jupyter notebooks to numerically simulate the potential flows using streamlines.

Indicative Content

1. A review of vector calculus.
2. Ideal fluids and Bernooulli's theorem.
3. Irrotational flows, steady flows, Laplace's equation and potential theory.
4. Elementary viscous flow with examples.
5. 2D flows, stream functions and complex potentials.
6. The Navier-Stokes equations and some classicaly solutions; very viscous flows.
7. Python-based simulations to develop intuition.

Module Resources

1. Elementary Fluid Dynamics, D.J . Acheson, Oxford University Press
2. An Introduction to Fluid Dynamics, G.K. Batchelor, Cambridge University Press

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