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<http://www.maths.bris.ac.uk/~marp/fluids3/fluids3.html>

Preliminaries

Course information

Recommended texts

Revision of vector operations

Formulae in cylindrical polar coordinates

Formulae in spherical polar coordinates

1 Introduction & Basic ideas

1.1 Introductory remarks

1.2 What is a fluid ?

1.3 Lagrangian and Eulerian descriptions of the flow

1.4 Particle paths, streamlines and streaklines

1.5 The Lagrangian derivative

1.6 Mass conservation

1.7 Incompressibility

1.8 Streamfunctions (for incompressible flows)

1.8.1 Two-dimensional flows

1.8.2 Three-dimensional (axisymmetric) flows

1.9 Kinematic boundary condition

1.10 The motion near a point in a fluid

2 Flow dynamics for an incompressible inviscid flow

2.1 Forces on a fluid

2.2 Equation of motion

2.3 Hydrostatics

2.3.1 Example: The milk bottle.

2.3.2 Archimedes principle (250BC)

2.3.3 Example: Lock gates

2.4 The momentum integral

2.5 Example: Jet impinging on a wall

2.6 Dynamic boundary condition

2.7 Bernoulli's equation for steady flows

2.7.1 Example: Flow out of a tank

2.7.2 Example: Flow through a slowly diverging channel

2.7.3 Example: Flow through a rapidly diverging channel

2.8 The vorticity equation

2.9 Kelvin's circulation theorem

3 Irrotational flows: potential theory

3.1 The velocity potential

3.1.1 Uniqueness of the velocity potential

3.2 Some simple flows and their potentials

3.2.1 Two dimensional flows

3.2.2 Axisymmetric flows

3.3 More complex flows: superposition of solutions

3.3.1 Steady flow past a circular cylinder, radius a

3.3.2 Steady flow past a sphere, radius a

3.4 Bernoulli's theorem for unsteady, irrotational flows

3.4.1 Example: Flow out of a bottle

3.5 Separable solutions to Laplace's equation

3.6 The collapse of a spherical bubble

3.7 Uniformly translating cylinder

3.8 Steady flow past a circular cylinder with circulation

3.9 Water waves

3.9.1 Example: Tsunamis

3.9.2 Example: Wave energy - the oscillating water column (OWC) device

3.9.3 Oscillations in a container

4 Complex potentials for two-dimensional flows

4.1 Definition of the complex potential

4.1.1 Example

4.2 Some common potentials

4.3 Example: Flow in a corner

4.4 Translations, Images and Superposition

4.5 Method of Images: Flow next to a wall

4.5.1 Example: Line source next to a wall

4.5.2 Example: Motion of a vortex next to a wall

4.6 Method of Images: Flows next to cylinders

4.6.1 Example: Flow past a cylinder (again!)

4.6.2 Example: Vortex outside a cylinder

4.7 Blasius' Theorem

4.7.1 Example

4.8 Forces on arbitrary cylinders: the lift on an aerofoil

4.9 Mappings and transformations

4.9.1 Example: A uniform stream at an angle α .

4.9.2 Example: A source in a corner

4.9.3 Example: Mapping circles to ellipses

4.10 Oblique flows past plates: An introduction to aerofoils

Appendix A: Vector calculus

A.1 Suffix notation and summation convention

A.1.2 The Kronecker delta

A.1.3 The antisymmetric symbol

A.1.4 The cross product

A.1.5 The double product

A.1.6 The vector triple product

A.2 Differential operations

A.2.1 Useful vector identities

A.3 Integral results

A.3.1 The divergence theorem

A.3.2 Stokes' theorem

Appendix B: Separable solutions of Laplace's equation

B.1: Plane polar coordinates

B.2: Cylindrical polar coordinates

B.3: Axisymmetric solutions in spherical polar coordinates