

# KYA315 Fluid Mechanics 3

## Lectures

This subject will be taught by Prof Larry Forbes in 2012. There are 3 lectures per week as follows:

Monday 12 noon	Physics Lecture Theatre 2
Thursday 1 pm	Physics Lecture Theatre 1 (!)
Friday 1 pm	Physics Lecture Theatre 2

There is one tutorial per week, on

Friday 3 pm Computer PC Lab 329. – note the change of time / venue

We will do some occasional computer work, using the package *MATLAB* to view fluid flows. This is informative, and great fun, and we can do this during the tute times.

## Content of the Subject

This subject will aim to cover the following topics:

1. **Basic Equations of Fluid Mechanics.** The continuum hypothesis. Vector, scalar and tensor fields. Kinematics of fluid motion; Lagrangian and Eulerian description. Streamlines. Derivative following the motion. Reynolds' transport theorem. Dynamics of fluid motion; conservation of mass and linear momentum, the stress tensor.
2. **Inviscid, Incompressible Fluid Flow.** Euler's equation (for conservation of momentum in a non-viscous fluid). The "slip" boundary condition. Kelvin's circulation theorem. Potential flows. Elementary sources and sinks. Integrating the momentum equation – Bernoulli's equation. The Rayleigh bubble.
3. **Two-dimensional "ideal" Fluid Flow.** Cauchy-Riemann equations. Elementary sources and sinks, and the line vortex. The use of complex variables in two-dimensional flow. Conformal mapping to solve flow problems. Blasius' theorem. Airflow about cylindrical wings. Joukowski theory and the Kutta-Joukowski condition.
4. **Viscous Fluid Flow.** The Navier-Stokes momentum equation. Vorticity. Simple exact solutions; Poiseuille flow, Couette flows. Boundary layers. Instability and the transition to turbulent flow. Properties of turbulence.

## Assessment

The assessment for this subject is as follows:

3 hour examination	80%
assignments	20%

The assignments will be (approximately) fortnightly, and there will be about 5 of them during the semester.

## Reference Texts

There are many books on fluid mechanics, and some classical texts are:

G.K. Batchelor, *An introduction to Fluid Dynamics*, Cambridge University Press, Cambridge 1977.

L.M. Milne-Thomson, *Theoretical Hydrodynamics*, 5<sup>th</sup> edition, MacMillan Press, London 1968.

There are also books on vectors, continuum mechanics and even several books in the *Schaum outline* series that will be helpful. An important (but rather theoretical) book on the foundations of fluid mechanics is:

R. Aris, *Vectors, Tensors, and the Basic Equations of Fluid Mechanics*, Dover, New York 1962.

An impressive book on the foundations of continuum mechanics is

G.E. Mase, *Continuum Mechanics*, Schaum Outline Series in Engineering, McGraw-Hill, New York 1970.

Some other possible books are::

F.M. White, *Fluid Mechanics*, 7<sup>th</sup> edition, McGraw-Hill, New York 2011.

Y.A. Çengel and J.M. Cimbala, *Fluid Mechanics Fundamentals and Applications*, 2<sup>nd</sup> edition, McGraw-Hill, New York 2010.

This will be on my web page, at

<http://www.maths.utas.edu.au/People/Forbes/KYA315.html>