MT421 Aerodynamics and geophysical fluid dynamics (Term 2: Dr C M Davies)

Prerequisite: MT322
Teaching: 33hr lectures
Assessment: 2hr written examination

Aims

This course aims to show how the mathematical models of MT222 and MT322 are successful in describing how aircraft are able to fly, and how the motions of the atmosphere and the oceans are caused. It also gives insight into the effect that individual terms in the mathematical model may have on the behaviour of the whole system.

Learning outcomes

At the end of the course the students should be able to

- derive the freezing-in of vortex lines for incompressible fluids;
- use complex variable theory to derive the formula for lift on an infinite cylinder;
- explain in broad terms how an aircraft is able to fly;
- understand the role of Coriolis and centrifugal forces in a rotating fluid;
- describe how rotation causes various phenomena in fluids;
- solve the simple equations for motion in an Ekman layer.

Content

Vortex dynamics: freezing-in of vortex lines, why vorticity can be treated as a pollutant. Examples.
Flow past wing sections: two-dimensional flow, flow at sharp corners, generation of lift. Blasius' formula. Three-dimensional flows, trailing vortices, induced drag. Supersonic flow past wing sections.
Rotating fluid systems: equation of motion of a rotating fluid. Geostrophic flow and simple properties. Secondary flow and examples (e.g. meanders, tea leaves in a cup). Inertial waves.
Viscosity-rotation interactions: Ekman layers and boundary fluxes.
The atmosphere and oceans: large-scale motions and the role of Coriolis forces. Tornado generation. Effects of the earth's curvature and induced waves.

Indicative text

Fluid Mechanics – P K Kundu and I M Cohen (Academic Press 2002) *Library ref. 532 KUN*