

10 Potential Flow, Lift, and Drag

- 10.1 The occurrence of irrotational (potential) flows. The definition of the velocity potential ϕ .
- 10.2 Incompressible potential flows as solutions of Laplace's equation for the velocity potential with $\partial\phi/\partial n$ specified at the boundaries (the "Neumann problem").
- 10.3 The equation for the pressure distribution (Bernoulli's integral in terms of ϕ).
- 10.4 An example: The solution for 2D potential flow over a cylinder. Comparison with experimental data at high Reynolds number, where the flow might be expected to be reasonably "inviscid." Discussion of the pitfalls of potential flow theory.
- 10.5 [Two-dimensional potential flows. Analytical solutions for simple 2D flows: parallel uniform flow, line source or sink, line vortex. Superposition of simple elemental flows as representations of flows over 2D bodies.]
- 10.6 Three properties of ideal potential flows around 2D bodies in an infinite stream: (a) The nonexistence of drag (D'Alembert's paradox), (b) the relation between lift and circulation around the body (Kutta-Joukowski theorem), and (c) the indeterminacy of the circulation in 2D potential flow theory.
- 10.7 The Kutta condition: an ad hoc criterion, derived from experimental observation, that allows potential flow analysis to be used to establish the circulation (i.e. lift) for a 2D shape *with a sharp trailing edge*.
- 10.8 Comments on the fact that viscosity, no matter how "small" it may be in a high Reynolds number flow, is responsible—by causing separation!—for the existence of both lift and drag.
- 10.9 Qualitative picture of the 3D flow field over a finite lifting surface (wing). Wing-tip vortices, downwash, etc. Induced drag.
- 10.10 Overview of lift and drag forces on lifting surfaces.

Read: Fay, Chapter 11,
or, for example, Potter & Foss, pp. 360-390, 454-468