4 Free Shear Flows I: Jets, Wakes, etc.–Solutions Based on Simple Mean–Flow Closure Schemes

4.1 Mean–flow closure schemes for free shear flows.

4.2 Spreading of a velocity discontinuity with downstream distance in steady flow. The nature of the laminar flow solution and its stability. Similarity solution for turbulent flow, based on Prandtl's second closure hypothesis. Comparison with experiment.

4.3 Plane and axisymmetric jets. The momentum flow constraint. Comments on laminar jets and their stability. Scaling laws for jet width (radius) and maximum velocity in turbulent jets. Similarity solution for the far region based on Prandtl's second closure hypothesis. Comparison with experiment. Entrainment in jets and secondary flows induced by jets. Simple integral methods for jets based on an entrainment hypothesis.

4.4 for Plane and axisymmetric wakes. The momentum defect constraint. Scaling laws width and velocity defect in turbulent wakes. Similarity and integral solutions for far wake region.Comparison with experiment.

4.5 Distribution of passive scalars (concentration or temperature) in the far region of jets and wakes, neglecting buoyancy effects.

Readings:

White. 2nd ed. 470–481 (see also pp. 253–260, 301–304 for laminar flow).
Pope. Chap. 4 & 5
Schlichting. 7th ed. Chap. 24 (see also pp. 183–185 for laminar flow).
For turbulent shear layer: Champagne, Pao, & Wygnaski, J. *Fluid Mech*., **74** (1976): 209–250.

Further reading:

Hinze. Chapter 6.
Abramovich. *The Theory of Turbulent Jets:* 103–113, 120–125.

Rajaratnam. "Turbulent Jets." Elsevier, 1976.
Rodi. In "Studies in Convection" B. E. Launder. ed. Academic Press, 1975: 79 ff.
Townsend. Chap.6 in *The Structure of Turbulent Shear Flow.* 2nd ed. Cambridge, 1976.

Handouts: Selected experimental data & summaries.