2.25

12 Basic Concepts in Turbulence Modeling

12.1 Comments on laminar flow, its stability, and the transition to turbulent flow.

12.2 Features of turbulent flows (high Reynolds number, "randomness", three-dimensionality of fluctuations, intermittency near free boundaries, role of viscous dissipation, etc.).

12.3 The range of scales in turbulent motion; the Kolmogorov microscale. Limitations imposed by computer memory and speed on attempts to obtain *exact* numerical solutions (fluctuations and all!) of the Navier-Stokes equations for turbulent, high Reynolds number flows.

12.4 Statistical averages of random quantities in turbulent flow. Reynolds' equation for the mean flow; the Reynolds stress and the closure problem.

12.5 Prandtl's mixing length hypothesis: a simple "mean flow" (or "zero-equation") closure model.

12.6 Prandtl's closure hypothesis for free turbulent flows (jets, wakes). A rough back-of-the-envelope "solution" for a round turbulent jet.

12.7 The nature of wall-bounded turbulent flows: the outer and inner layers, the "universal law of the wall" for the inner layer; the logarithmic sublayer and the viscous sublayer. Derivation of the logarithmic mean-velocity profile from Prandtl's mixing length model.

<u>Some General References</u>

Monin, A. S., & Yaglom, A. M., Statistical Fluid Mechanics, Vol. 1, MIT (see Chapter 3 in particular)

Schlichting, H., Boundary Layer Theory (7th edition), McGraw-Hill

Tritton, D. J., Physical Fluid Dynamics (2nd edition), Oxford

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