

Tutorial on “Advanced Fluid Dynamics”

Deadline: 14th January 2010

Exercise 10 Reconsider the singular perturbed boundary value problem due to J.D. Cole from the lecture:

$$\varepsilon y'' + yy' - y = 0 \quad \text{in } (0, 1),$$

but now using the boundary conditions

$$y(0) = -\frac{3}{4}, \quad y(1) = \frac{5}{4}$$

The boundary layer has moved to an intermediate position which is determined by the property for the inner that y jumps within the boundary layer from $-M$ to M , for some value M . Find the leading order matched asymptotic expansions.

Exercise 11 Prandtl's boundary layer equations for a uniform, two-dimensional flow over a flat plate read

$$\begin{aligned} u_\xi + w_\eta &= 0 \\ -u_{\eta\eta} + uu_\xi + wu_\eta &= 0 \end{aligned}$$

Reformulate the equations in terms of the streamfunction $\Psi(\xi, \eta)$ and use the concept of similarity solutions to reduce the boundary layer equations to a single ordinary differential equation.