ME527 **Sample Final Exam Problems**

1. Find the similarity transformation for a laminar axisymmetric jet flow. Also state the functional relation of u_z and u_r with distance from the jet, z.

2. For a boundary layer over a flat plate, assume a trial velocity field given as

$$\frac{u}{U_o} = \frac{4y}{3\delta} - \frac{1}{3}\left(\frac{y}{\delta}\right)^4, \quad 0 < y < \delta; \qquad \frac{u}{U_o} = 1 \quad y > \delta.$$

(a) Check the boundary conditions for this velocity field.
(b) Use the momentum integral and evaluate the boundary layer thickness δ.
(c) Also evaluate the momentum thickness θ, and the skin friction coefficient.

3. Given that

$$\varepsilon y'' + y' + \varepsilon y^2 = 2x. \qquad y(0) = 0 \qquad y(1) = 2$$

(a) Evaluate the single term outer solution.
(b) Determine the single term inner solution.
(c) Evaluate the composite solution.

4. Consider a velocity field given as

$$u=-x+1, \qquad v=-x+t, \qquad w=-1+t$$

(a) Find the streamline that paths through point (0,0,0) at different times.
(b) Determine the path line of a particle, which is at (0,0,0) at time t = 0.
(c) Find the streak line of point (1,1,1) at time 1.
(d) Evaluate the deformation rate tensor and vorticity vector for this flow field.

5. Consider a flow between two parallel plates with upper plate moving as shown. Flow starts from rest. (a) Assuming a fully developed laminar flow, state the governing equation of motions for u(y, t) and the corresponding boundary and initial conditions.
(b) Neglect the gravity and pressure drop and evaluate the steady velocity field.
(c) Evaluate the unsteady velocity field when the upper plate begins to move with speed U_o and the fluid is initially at rest.