1. What is the dimensional representation of the quantities (18%)
   (a) power (b) pressure (c) Modulus of elasticity (d) angular velocity (e) energy (f) momentum (g) shear stress (h) specific heat (i) thermal expansion coefficient. Assume basic dimensions of M, L, t, and T

2. Define the following terms with physical meaning (45%)
   (a) Newtonian Fluid (b) inviscid flow (c) incompressible (d) non-slip condition (e) point of separation (f) streamline (g) Eulerian and Lagrangian methods (h) Reynolds number (i) geometrical similarity (j) irrotational flow (k)laminar/turbulent flow (l) laminar/turbulent shear stress (m) adverse pressure gradient (n) Couette flow

3. Derive Prandtl's law of wall (1930) using dimensional analysis (5%)
   $u+=F(y+)$, $u+=u/u^*$, $y+=yu^*/\nu$, $u^*=(\tau/\rho)^{1/2}$, $u=f(\mu,\tau_w,\rho,y)$

4. Plot the laminar/turbulent velocity profiles inside a circular pipe and assume the volume flow rates are the same. (5%)

5. (a) Define Darcy's friction factor f (b) please suggest a relation between f and Reynolds number for a laminar pipe flow (5%)

6. Derive the differential equation of mass conservation using cylindrical coordinates (10%)
   $$\frac{1}{r}\frac{\partial}{\partial r}(r\rho v_r) + \frac{1}{r}\frac{\partial}{\partial\theta}(rv_\theta) + \frac{\partial}{\partial z}(rv_z)=0$$

7. Show that the two-dimensional laminar flow pattern with dp/dx=0 $u=U_o(1-e^{Cy})$, $v=v_o<0$ is an exact solution to the boundary layer equations. Find the value of the constant C in terms of the flow parameters. Are the boundary conditions satisfied? What might this flow represent?
   Hint: $\partial u/\partial x + \partial v/\partial y=0$
   $u\,\partial u/\partial x + v\,\partial u/\partial y = U\,dU/dx + 1/\rho\,\partial\tau/\partial y$
   (12%)