1. Given the velocity components $u = x(1+t)$, $v = y$, $w = 0$ (20%, each 5%)
   (a) Find the instantaneous streamlines which passed through the point $(x, y) = (1,1)$.
   (b) Find the pathline of the particles which passed through the point $(x, y) = (1,1)$.
   (c) Find the streakline of the particles which passes through the point $(x, y) = (1,1)$ before $t = 0$.
   (d) In addition, please give the streamline which passed $(x, y) = (1,1)$ at $t = 0$. Please explain why the above three flowlines are all different.

2. The continuity equation for a two dimensional incompressible flow in Cartesian coordinates (x, y) is given by $\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0$. Please derive the equation in cylindrical coordinates (r, θ) by using the identities $x = r\cos\theta$, $y = r\sin\theta$, $u = u_r\cos\theta - u_\theta\sin\theta$ and $v = u_r\sin\theta + u_\theta\cos\theta$, where (u, v) and (u_r, u_θ) are the velocity vectors in Cartesian and cylindrical coordinates, respectively. (20%)

3. The velocity distribution for a certain flow between parallel plates is given by $V(r) = V_{max}(1 - y^2/h^2)$, where $2h$ is the spacing between the plates, y is measured from the centerline, V_{max} is the maximum velocity at the centerline. Determine (a) the momentum correction factor β and (b) kinetic energy correction factor α. (20%, each 10%)

4. A velocity field in a particular flow is given by $\mathbf{V} = y^2\mathbf{i} - xy\mathbf{j}$. Calculate the following quantities at the point (1,-1,2)
   (a) the acceleration vector (a_x, a_y, a_z), (6%)
   (b) angular velocity vector $(\Omega_x, \Omega_y, \Omega_z)$, (6%)
   (c) any nonzero rate-of-strain components. (6%)
   (d) Is the flow irrotational? Why? (2%)

5. Explain the following terms in Chinese. Possible you should draw a simple diagram or write some equations to reinforce your answers. (20%, each 5%)
   (a) Reynolds number
   (b) Bernoulli equation
   (c) Hydraulic jump
   (d) Newtonian fluid