1. 10%

Discuss the similarities and differences of the governing equations for rigid body motion and fluid motion.

2. 30%

Explain the following terms:

(a) Laminar Flow. (b) Transition Flow. (c) Turbulent Flow. (d) Streamline. (e) Path line. (f) Streak line. (g) Circulation. (h) Vortex. (i) Vorticity. (j) Potential Flow.

3. 30%

The incompressible Navier-Stokes equation can be written as:

$$\nabla \bullet \vec{V} = 0$$

$$\rho \frac{D\vec{V}}{Dt} = -\nabla P + \mu \nabla^2 \vec{V}$$

where $\vec{V}$ is velocity vector, ρ is fluid density, P is pressure and μ is viscosity.

(a) Explain the physical meaning for every term appearing in the equations, and non-dimensionalize the equations. (10%)

(b) Write down the governing equation corresponding to the Cartesian scalar component (u, v, w) in the (x, y, z) coordinate system. (5%)

(c) How to simply the above equations to be Boundary Layer equations? (10%)

(d) What is the major difference between the Boundary layer equations and the Navier-Stokes equations in mathematical sense. (5%)

4. 20%

A uniform flow is injected into a 2-D channel as shown in the following figure.

(a) Estimate the entrance length. (10%)

(b) What is the mathematical expression for the velocity distribution in the fully developed region? (10%)
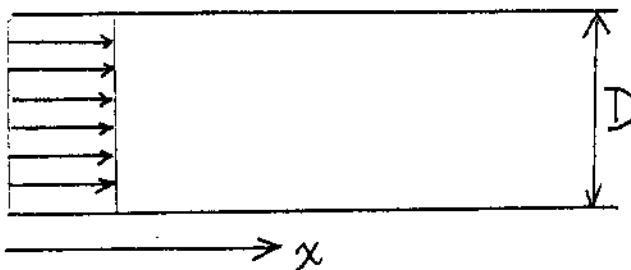
5. 10%

Mixing is important in bio-fluid handling. describe at least two methods that can be used to enhance the mixing phenomena.