1. (A) In Stokes region (Re < 0.1), the drag coefficient C_D is equal to Re/24. Derive an expression which can be used to determine the terminal settling velocity of a spherical particle settling in air in this region. Define all the terms you use. (15%)

(B) Use the expression you derived in Part (A) to calculate the terminal settling velocity of a spherical particle with a diameter of 6.0 μm settling in air at 1 atm and 300 K. The particle's density is 2.5 g/cm^3. The density and viscosity of air are 1.18 kg/m^3 and 0.0666 kg/m hr; respectively. Please check the validity of your result. (15%)

2. Consider the two dimensional incompressible flow which can be specified by
$u = ky, \quad v = kx, \quad w = 0$, where k is a constant.
(A) Show that this flow field satisfies the continuity equation. (5%)
(B) Sketch the streamlines for the flow field. (10%)

3. Oil is to be pumped at a rate of at least 6 liters/min through a horizontal pipe of length 300 m. The pump has a discharge pressure of 200 kN/m^2 absolute. The pipe discharges into an open tank containing oil to a depth of 8 m above the inlet. If the oil has density of 800 kg/m^3 and a viscosity of 0.004 N s/m^2. What diameter pipe would you recommend? If any assumption regarding laminar or turbulent flow is made, prove your assumption is valid. (15%)

4. Explain the following terms: (20%)
(a) Navier-Stokes Equation
(b) characteristic curves for a pump
(c) Manning formula
(d) Froude number
(e) ideal fluid

5. A vertical Venturi meter is used to measure the flowrate of a petroleum product. The product is flowing in a 150 mm diameter pipeline and the Venturi meter has a throat diameter 110 mm. Pressure tappings are placed at the throat and a height of 400 mm above the throat. A mercury filled U tube manometer is connected to the pressure tappings. What is the difference in the mercury levels on the manometer if the flowrate of the petroleum products is 0.05 m^3/s? (20%)

Relevant Data: Density of the petroleum product = 830 kg/m^3
Density of mercury = 13600 kg/m^3
The venturi discharge coefficient = 0.98