1.For the open tank, with piezometers attached on the side, containing two different immiscible liquids, as shown in Fig.1, find the(a) elevation of the liquid surface in piezometer A ,(b) elevation of the liquid surface in piezometer B, and (c) total pressure at the bottom of the tank. (10%)

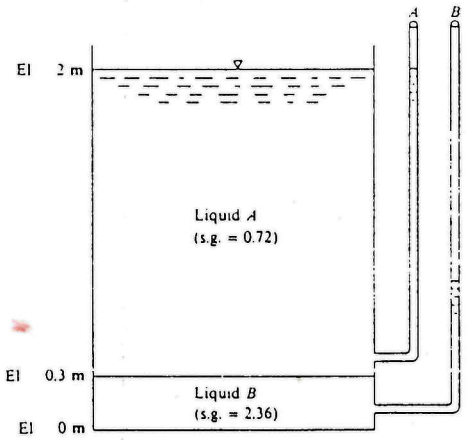

Fig 1

2.An inclined, circular gate with water on one side is shown in Fig.2. Determine the total resultant force acting on the gate and the location of the center of pressure. (10%)

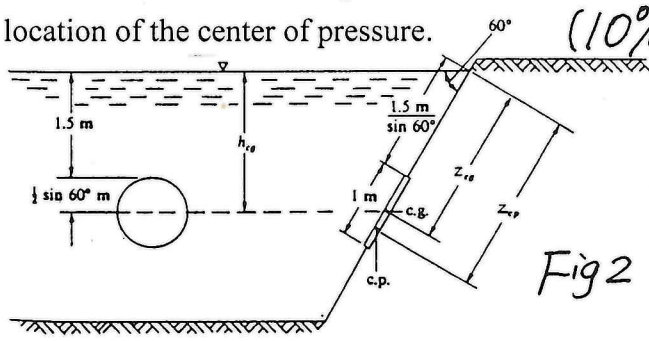

Fig 2

3. A flow nozzle is a device inserted into a pipe as shown in Fig. 3. If A is the exit area of the flow nozzle, show that for incompressible flow we get for Q

$$Q = C_d\left[\frac{A_2}{\sqrt{1-(A_2/A_1)^2}}\sqrt{2g(\frac{p_1-p_2}{r})}\right]$$

where C_d is the coefficient of discharge, which takes into account frictional effects and is determined experimentally.

(10%)

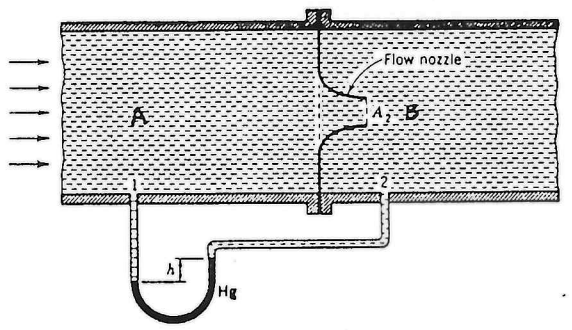

Fig 3

4.An Inward flow radial turbine (Fig. 4) involves a nozzle angle, α_1, of 60^0 and an inlet rotor tip speed, U1, of 6m/s. The ratio of rotor inlet to outlet diameter is 1.8. The absolute velocity leaving the rotor at section (2) is with a magnitude of 12 m/s. Determine the energy transfer per until mass of fluid flowing through this turbine if the fluid is (a)air,(b)water. (20%)

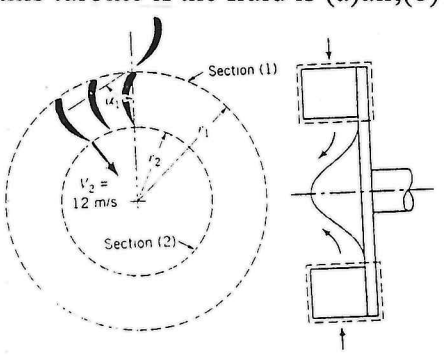

Fig 4

723002A

5. (15%) An insect can stand and move on water surface.
(1) When it stands on the water surface, its weight is supported by surface tension. Assume that its mass is m, surface tension is σ, its legs' surrounded length is l, and the gravity acceleration is g. Use dimension analysis to determine a dimensionless number related to the balance of its weight and surface tension. Use m as non-repeating variable.
(2) When this insect moves on the water surface, its speed is V, and the water density is ρ. This moving problem involves V, σ, l, and ρ. Use ρ as non-repeating variable to determine another dimensionless number. What is the name of this dimensionless number?
(3) Both dimensionless numbers represent different force ratios. What are these forces? If σ=0.0734N/m, l=1.5mm, g=9.81m/s^2, what is the maximum mass this insect can have to be supported by surface tension?

6. (15%) If we are going to do a ship model test, the dynamic similarity requires which two dimensionless numbers to be the same for the real ship and the model? If the real ship is 100m long, sailing at 10m/s in fresh water (density ρ=1,000kg/m^3, kinematic viscosity ν_w=1.12x10^{-6}m^2/s), and the model is 5m long with speed of 5m/s, calculate required kinematic viscosity and gravity acceleration according to the dynamic similarity principle. Is it possible to find such fluid and gravity field on the Earth for the model test?

7. (15%) Suppose an airplane has wings with lift coefficient C_L=0.11α+0.1 (attack angle α in degree). The wings' stall angle is 11°. The airplane usually flies at 0 degree of attack angle at speed of 810kmh. If the airplane is required to land at speed no more than 180 kmh, what is the required lift coefficient when landing this airplane? Is it possible to land this airplane without using flaps or changing wing section?

8. (5%) Please explain the following terms: "boundary layer thickness", "boundary layer displacement thickness", and "boundary layer momentum thickness".