THE OPEN UNIVERSITY OF SRI LANKA
FACULTY OF ENGINEERING TECHNOLOGY
DIPLOMA IN TECHNOLOGY – LEVEL 03
FINAL EXAMINATION 2005
MED1204 – FLUID MECHANICS –PART B

Density of water $\rho = 1000 kg/m^3$

1. A rectangular, uniform sluice gate AB of width 3m and length 4m is hinged at A as shown in Figure Q1. The mass of the gate is 1000kg. The gate is kept closed by a horizontal force P applied at B. Calculate the minimum value of force P required to keep the gate closed when the water level in the tank is 8m.
In addition to this force a weight of 400kN too is placed at the center of gravity of the gate to maintain a higher water level in the tank. Calculate the height to which water can be filled before the gate just opens under the new arrangement.

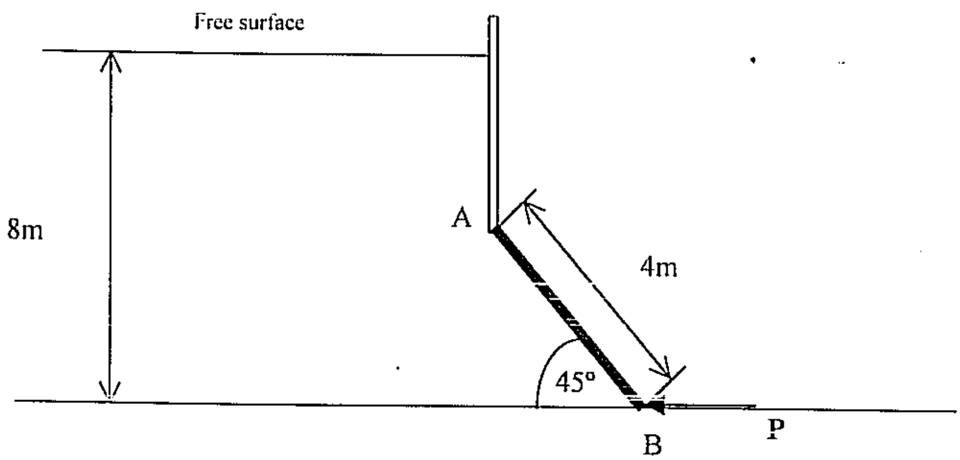

Figure Q1

Hint: In usual notation, the depth of center of pressure , H, of a plane surface fully immersed in a liquid with its plane inclined at an angle θ to the horizontal is $H = (I_G \sin^2 \theta)/Ah + h$

2. (a) Starting from first principles show that the distance of center of gravity from the base of the trapezium shown in Figure Q2 is $\left[\frac{2a+b}{a+b}\right]\frac{h}{3}$

Also show that the moment of inertia of the trapezium, about an axis passing through the center of gravity and parallel to the base is given by

$$\left[\frac{a^2+4ab+b^2}{36(a+b)}\right]h^3$$

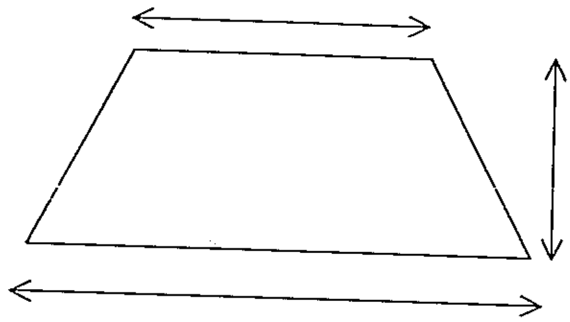

Figure Q2

(b) A gate for closing the entrance to a dry dock is of trapezoidal form 160m wide at the top and 100m wide at the bottom and 6m deep. Find the total pressure and center of pressure on the gate if the water on the out side is just level with the top and dock is empty.

3. A centrifugal pump has an impeller of outer radius r_2 and inner radius r_1 and the corresponding peripheral velocities are U_2 and U_1. If the flow enters the impeller radially, obtain an expression for the work done/unit weight on the fluid by the impeller in terms of U_2 and the velocity of whirl at outlet w_2

The diameter of the impeller of a pump is 1.2m and its peripheral speed is 9m/s. water enters radially and is discharged from the impeller with a velocity whose radial component is 1.5m/s. The vanes are curved backwards at exit and make an angle of 30° with the periphery. If the pump discharges 3.4m³/min. What will be the turning moment on the shaft.

4. A single acting reciprocating pump has a bore diameter of 200mm and a stroke length 400mm. The center of the pump is 4m above the water surface in the sump and 22m below the delivery water level. The diameters and lengths of suction and delivery pipes are 100mm,5m and 100mm,30m respectively. If the pump is working at 30rev/min, determine the pressure heads on the piston at the beginning, middle and at the end of both suction and delivery strokes.

5. Starting from first principles show that the flow per unit width past fixed cross section for laminar flow between two parallel plates moving in opposite directions is given in with usual notation as

$$Q = \frac{h}{2}(U - V) + \frac{h^3}{12\mu}\left[\frac{-dp}{dx}\right]$$

Water flows between two parallel plates separated by a distance of 40mm under a pressure drop of 0.25mm/m. The coefficient of viscosity of water is 1.12×10^{-3} Ns/m². Assuming that the flow is laminar, determine the maximum shear stress and discharge, if the upper plate is moving at a velocity of 0.2m/s of flow while the lower plate is stationary.

6. A horizontal pipe of length 50m is connected to a water tank at one end and discharges freely into atmosphere at the other end. The diameter of the pipe is 200mm for the first 30m of its length and then the diameter is suddenly enlarged to 400mm. The height of the level of water in the tank is 10m above the center line of the pipe. Taking all the losses that may occur in the pipe line into account calculate the rate of flow of water through the pipe. Take the friction factor, f, is equal to 0.01 for both sections of the pipe.

7. Two reservoirs having a difference in surface level of 100m are connected by a series pipe system as shown in Figure Q7. The pipe system consists of two pipes AB and BC and their geometrical parameters are given below.

Pipe	Length(m)	Diameter(mm)
AB	600	400
BC	200	200

Assuming a constant pipe friction factor of 0.01 for both the pipes, determine the rate of flow of water from the upper reservoir. Neglect all losses other than those due to pipe friction.

Also determine the percentage change in the rate of flow of water from the upper reservoir, if one quarter of the quantity of water entering pipe BC is withdrawn uniformly at the point D of pipe BC.

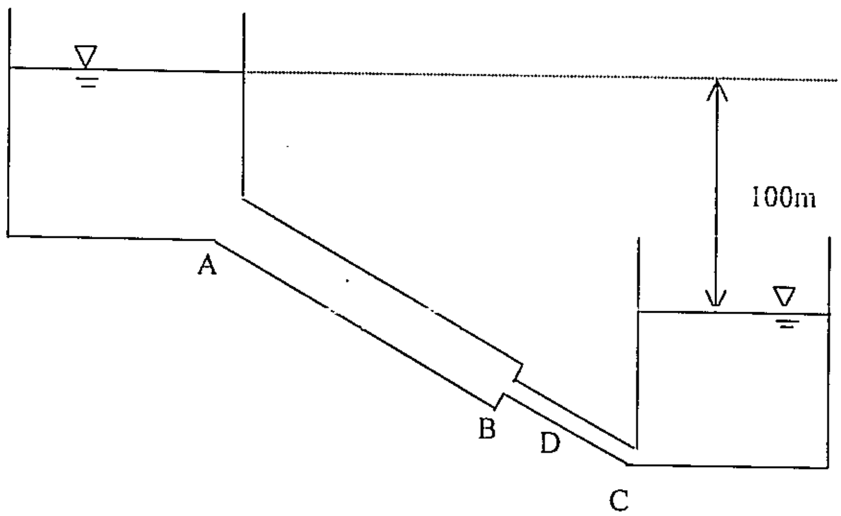

Figure Q7

8. The diameter of a pipe bend is 400mm at inlet and 250mm at outlet and the flow is turned through 120° in a horizontal plane. Neglecting friction, calculate the magnitude and direction of the net force exerted on the bend by water flowing through it at $0.45 m^3/s$ when the inlet pressure is 160kPa.

9. (a) A jet of water is being issued from a nozzle placed on the ground. The nozzle makes an angle $\theta°$ to the horizontal. Obtain an expression for the maximum height of the water trajectory from the ground level.

(b)

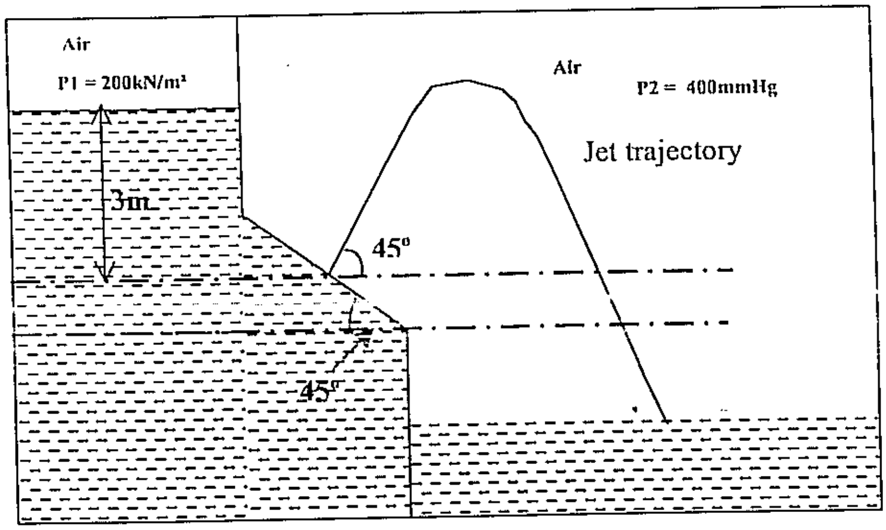

Figure Q9

The nozzle shown in Figure Q9 has a jet diameter of 30mm. The pressures on the water surfaces on the two sides of the arrangement shown in the figure are P_1= 200kN/m²(gauge) and P_2 =200mmHg.

Determine (1) The discharge through the nozzle.

(2) The maximum height of the free jet above the nozzle.

Density of Hg is 13600kg/m³

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