THE OPEN UNIVERSITY OF SRI LANKA
Department of Civil Engineering

Bachelor of Technology (Civil) - Level 3
CEX 3232 - Hydraulics & Hydrology

Final Examination - 2014/2015

Time Allowed **3 Hours**

Date: 7th September 2015 Time 13:30 - 16:30

This paper consists *Six* Questions. Answer *Five* Questions **Only**.

All questions carry ***equal*** marks.

Please write answers clearly showing any derivations required and stating necessary assumptions.

Density of water = 1000 kgm^{-3} Acceleration of gravity = 9.81 ms^{-2}

1. Theoretical discharge over a V-notch is given by $\frac{8}{15}\sqrt{2g}\tan\frac{\theta}{2}H^{5/2}$ where notations have their usual meanings.

(a) A tank 15 m long and 3 m wide is provided with a 60^0 V-notch. The time taken to lower the water level in the tank from 1 m to 0.5 m is 67 s. Determine the coefficient of discharge for the V-notch.

(b) Above V-notch is used to measure flow in a proposed micro hydro scheme to supply power to a rural area. Flow measurements carried out at the site gave a head of 0.6 m over the V-notch. If the head available at the site is 20 m, determine the power that could be generated assuming an overall efficiency of 70%.

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2. Consider a cylindrical gate of diameter 2.5 m retaining two liquids with different relative densities on either side of it as shown in Figure 1.

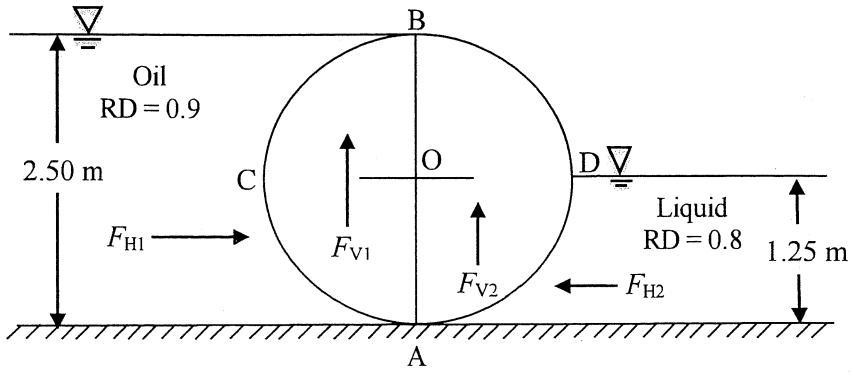

Figure 1

(a) Find the horizontal force components F_{H1} and F_{H2} acting on either sides of the gate considering unit length of the gate.

(b) Find the vertical force components F_{V1} and F_{V2} acting on either sides of the gate considering unit length of the gate.

(c) Estimate the resultant fluid force acting on unit length of the gate.

3. In a hydropower scheme, water flows from a reservoir through a pipe of length 300 m and diameter 300 mm and discharges through a nozzle 30 m below the surface of the reservoir.

The friction factor λ for the pipe may be taken as 0.025. The head loss at the entry to the pipe may be taken as 0.5 times the velocity head in the pipe and the head loss at the nozzle may be taken as 0.05 times the velocity head of the jet of water.

(a) Determine the nozzle diameter required for **maximum** power transmission.

(b) Determine the transmission efficiency at **maximum** power transmission.

(c) Sketch the Energy Grade Line and the Hydraulic Grade Line, indicating important values, at maximum power transmission.

(Note: For maximum power transmission, power available at the outlet (nozzle) should be considered.)

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4. Water flows through a pipe junction where pipes of different diameters are connected as shown in Figure 2. Fluid pressure at section 1 is 25 kPa. Flow rate at section 1 is 12 liters per second (12 l/s) while flow rate at section 3 is 4 liters per second (4 l/s). Flow directions and pipe diameters are shown in the figure.

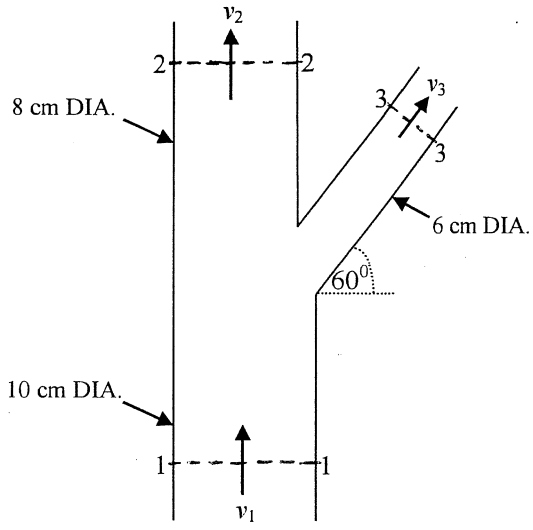

Figure 2

(a) Find the flow velocities v_1, v_2, and v_3 at sections 1, 2, and 3 respectively.

(b) Find the fluid pressures P_2 and P_3 at sections 2 and 3 respectively.

(c) Find the resultant force acting on the pipe junction due to the fluid flow.

5.

(a) State the principle of Archimedes.

(b) Describe metacentric height of a rectangular floating vessel with a neat sketch.

(c) A solid cylinder of diameter D and height H having a relative density of s floats in water with its axis vertical. Obtain an expression for the maximum value of H/D for which the cylinder will float in stable equilibrium with its axis vertical.

(Note: Second moment of area about the axis passing through the center of a circle is given by $\pi D^4/64$ where D is the diameter of circle.)

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6. A flow of kerosene (ρ = 800 kgm^{-3}) goes through a ***horizontal*** pipe as shown in Figure 3. The outflow is to the atmosphere.

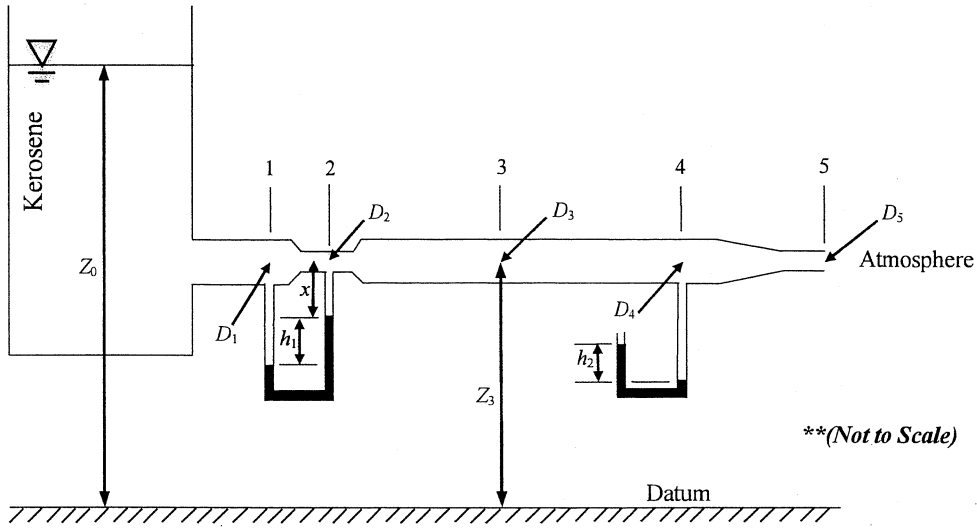

Figure 3

Z and h values represents heights while D values represents pipe diameters.

The fluid in the manometers is Mercury (RD = 13.6).
Losses due to friction can be neglected.

Also;
Z_0 = 20 m D_1 = 10 cm h_1 = 4 cm D_2 = 7 cm $D_3 = D_4$ = 10 cm
D_5 = 5 cm

Using the above information, calculate;

(a) Discharge Q through the pipe
(b) Velocity at section 5 (v_5)
(c) Height Z_3
(d) Height h_2