Ref. No Ex/Prod/T/211/2019

B.E. PRODUCTION ENGG SECOND YEAR FIRST SEMESTER 2019

FLUID MECHANICS **THREE HOURS** **FULL MARKS 100**

Answer any five questions

1(a) State and explain Newton's law of viscosity. Define dynamic viscosity. Prove that 1 poise = 0.1 N-s /m^2 (7)

(b) A tank with partitions containing water , air and Kerosene oil of specific gravity 0.9 as shown in Fig1.Find the gauge pressure and absolute pressure at points P , Q , R and S. (6)

(c) State and prove Pascal's law (7)

2(a) A curved surface is immersed in a liquid whose specific weight is γ N/m^3 . Derive the expression for the resultant force exerted by the liquid on the curved surface as well as the direction of resultant force. (7)

(b) A cylindrical gate (3 m long) has water on its both sides as shown in fig 2 . Determine the magnitude , location and direction of the resultant hydrostatic force exerted on the gate. Also calculate the minimum weight of the gate so that it will not float away from the floor. (7)

(c) With the help of neat sketches explain the conditions of stability of a submerged body and floated body (6)

3(a) Mathematically prove that the stream function along a stream line is constant (6)

(b) Mathematically determine the different types of accelerations when a fluid particle is moving along a curvilinear one dimensional stream lime . (7)

(c) The velocity along the centre line of a nozzle of length L is given by

$$u = 2t\,(1-0.5x/L)^2$$

Where u is the velocity in m/s , t is the time in sec from the commencement of the flow , x is the distance at a section from the inlet of the nozzle . Find the total tangential acceleration when t = 3 sec , x=L/2 and L =0.8 (7)

4(a) Prove that dynamic force exerted by the fluid on the pipe bend when fluid flows through a pipe is given by $\rho Q\,(V_1 \sim V_2)$ Where
ρ: Density of Fluid , Q : discharge , V_1 : Initial Velocity and V_2 : Final Velocity . (6)

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(b) A pipe junction as shown in Fig 3 . Water enters in section 1-1 and 2-2 at the rate of 0.20 m^3 /s and 0.14 m^3 / s respectively. If the pressure at section 3-3 is 245.156 kN / m^2 determine the resultant force required to hold the junction in position when water flows through it. Neglect the elevation and head loss. (8)

(c) Prove that (Mathematically) the jet of water comes out from a nozzle and travels in the atmosphere follows a parabolic path (6)

5(a) Define co-efficient of velocity (c_v) and explain with neat sketch how do you experimentally evaluate it. (6)

(b) Prove that time 'T' required for emptying a cylindrical tank through an orifice at the bottom of the tank is given by

$$T = (2A [(H_1)^{1/2}]) / (c_d . a. (2g)^{1/2})$$

Where , H_1 : height of the liquid in the tank ; A : Area of the tank : a: area of the orifice : g Acceleration due to gravity and c_d : co-efficient of discharge (7)

(c) A crude oil of viscosity 0.95 poise and specific gravity 0.8 is flowing through a horizontal pipe of diameter 150 mm and length 10 m. Calculate the difference of pressure at two ends of the pipe in m of oil , if 100 kg of oil is collected in a tank in 30 sec. (7)

6(a) Prove that for a convergent-divergent mouth piece fitted in a cylindrical vessel , the ratio of areas at outlet and at vena-contracta is

$$a_1 / a_c = [1 +(H_a - H_c) /H]^{1/2}$$

Where a_1 : Area of mouth piece at outlet : a_c : Area of mouth piece at vena-contracta : H_a : Atmospheric Pressure Head : H_c : Absolute pressure head at vena contracta: H : Height of liquid level above the centre line of mouth piece in the cylindrical vessel.Neglect the loss. (7)

(b) Distinguish with neat sketches between Weir and Notch in connection with measurement of flow rate for open channel. (6)

(c) A rectangular weir 50 cm wide has been used to measure the discharge estimated to be 30 lit /s . Find the percentage error in computing the discharge that would be introduced by an error of 2 mm in observing the head over the weir. Assume c_d : 0.63. (7)
Deduce the formula you have used.

7(a) With the help of neat sketches distinguish between series and parallel configuration of compound pipe. (6)

(b) A Siphon of diameter 200 mm and 2000 m long connects two reservoirs whose free water surface level differs by 30 m . The siphon crosses a ridge whose summit is 8 m above the level of the upper reservoir. Determine the maximum depth of the pipe below the summit of the ridge and discharge , if pressure head of the summit of the siphon should not fall below 2.8 m of water absolute. Assume friction factor of the pipe f = 0.008 and atmospheric pressure head is 10 m of water absolute. The length of the siphon from the upper reservoir to its summit is 300 m .Neglect all minor losses . (8)

(c) Prove that the head loss (h_l) due to obstruction in a pipe of cross sectional area ' A ', is given by

$$h_l = (V^2/2g) [\{A / c_c (A - a) \} - 1]^2$$

Where a : Maximum area of obstruction ; V : Velocity of flow ; g Acceleration due to gravity and c_c : co-efficient of contraction. (6)

8(a) Prove that If a semi-circle is drawn with a centre at the mid-point of the top width of a most economical trapezoidal section of a channel, with a radius equal to the depth of flow , it will touch the three sides of the section . (6)

(b) Using Buckingham's Π theorem express drag force F on a partially submerged body depends upon relative velocity V between body and fluid, linear dimension L , fluid density ρ, height of surface roughness h, dynamic viscosity μ and acceleration due to gravity g. (8)

(c) Define energy thickness in connection with boundary layer theory. Hence derive an formal expression for this thickness. (6)

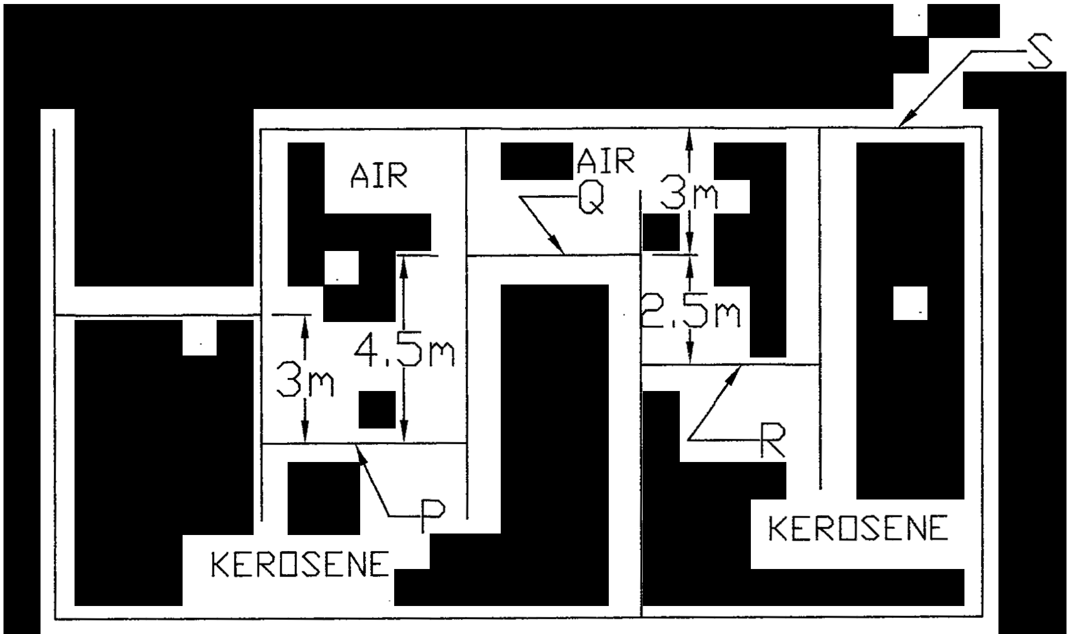

Fig 1