Ref. No Ex/Prod/T/211/2017(S)

B.Prod.Engg.2ND YEAR 1ST SEMESTER SUPPLEMENTARY EXAMINATION 2017

FLUID MECHANICS

THREE HOURS FULL MARKS 100

Answer any five questions

1(a) Derive the expression of resultant hydrostatic force on an inclined plate submerged in a fluid of specific weight is γ N/m^3. Hence derive the expression of centre of pressure of that resultant force. (8)

(b) Fig 1 shows the water level on both sides of a cylindrical gate that lies across the full width of an open channel . If the cylinder is 2 m in diameter and 1.5 m width , determine

(i) The magnitude and direction of the resultant hydrostatic force exerted on it.

(ii) What should be the least weight of the cylinder so that it will not float away from the floor of the channel. (8)

(c) What do you mean by non Newtonian fluid? Give two examples of non Newtonian fluid. (4)

2(a) Derive an expression for three dimensional continuity equation for incompressible unsteady fluid flow. (8)

(b) A fluid of constant density flows at a rate of 15 liters/s along a pipe AB of 100 mm diameter. This pipe branches at B into two pipes BC and BD each of 25 mm diameter and the third pipe BE of 50 mm diameter. The flow rates are such that the flow rate through BC is three times the flow rate through BE and the velocity through BD is 4 m/s. Find the flow rates in the three branches BC , BD and BE and the velocities in pipes AB,BC and BE. (8)

(c) Mathematically determine the total accelerations of a fluid particle moving along a curvilinear path. (4)

3(a) State the assumptions of Bernoulli's equations (4)

(b) 50 liters / s of water flows in a horizontal pipe line of 200 m long as shown in Fig 2. The pipe tapers from 0.3 m diameter to 0.2 m diameter. If the pressure at the large end diameter is 98.1 kN / m^2 , calculate the pressure on the other end of the pipe. Neglect any loss in the pipe. (8)

(c) Derive an equation to measure the quantity of water flowing through a horizontal pipe with the help of an orifice meter (8)

4(a) A right angled triangular v-notch weir is used to measure the flow rate of water from a channel and it is estimated that the error in measuring the head could be 1.5mm. For a discharge of $0.28 m^3/s$, determine the percentage of error of discharge which may occur due to the error of measuring head . Take co-efficient of discharge is 0.6. Derive the formula you have used to measure flow rate of water of a channel with help of right angled triangular v-notch (8)

(b) With the help of neat sketch derive the expression for the time of empting liquid from a hemi-spherical tank having an orifice at the bottom . (7)

(c) Prove that $C_d = C_v \times C_c$
Where, C_d is Co-Efficient of discharge , C_v is Co-Efficient of velocity and C_c is Co-Efficient of contraction (5)

5(a) Prove that pressure gradient in the direction of flow is equal to shear stress gradient normal to the motion in laminar flow. (4)

(b) Derive the expression of Hagen-Poiseuille's equation (8)

(c) 12 liters / s of oil is pumped through two pipes , one is 12 cm diameter and other is 10 cm diameter , both being 1000 m long as shown in Fig 3 . The kinematic viscosity of the oil is $9 cm^2 / s$. Calculate the flow rate through each pipe and the head loss in the pipe in m of oil. Assume pressure drop in each pipe is equal and flow is laminar. (8)

6(a) State and explain Buckingham's PI (π) theorem. (6)

(b) Discuss briefly the selection criteria of repeating variables for Buckingham's PI (π) theorem . (6)

(c) The efficiency η of a fan depends on the density ρ, the dynamic viscosity μ of the fluid, the angular velocity ω , diameter D of the rotor and discharge Q. Using Buckingham's Pi (π) theorem express η in terms of dimensionless parameters. (8)

7(a) Prove that head loss h_l of a fluid flowing through a pipe which is suddenly enlarged is

$$h_l = (V_1 - V_2)^2 / 2g$$

Where V_1 = Velocity of fluid at smaller section of the pipe
V_2 = Velocity at larger section of the pipe (5)

(b) What is equivalent pipe ?
Prove that $L_1 / d_1^5 + L_2 / d_2^5 + L_3 / d_3^5 + \ldots\ldots\ldots = L / d^5$
Where , L_1 , L_2 , L_3 .... Length of pipes connected in series ,
d_1^5 , d_2^5 , d_3^5 ...... corresponding diameter of pipes , $L = L_1 + L_2 + L_3 \ldots\ldots$
and d is the equivalent size of the pipe. (7)

(c) Three reservoirs A , B , C are connected by pipe systems 1,2 and 3 as shown in Fig 4 . The lengths of pipes 1 , 2 and 3 are 800 m , 1000 m and 800 m and diameters of pipes 1 , 2 and 3 are 300 mm , 200 mm and 150 mm respectively. Determine the piezometric head at the junction D. Assume friction factor f = 0.005 (8)

8(a) Prove that the conditions of a most economical rectangular open channel are

$b = 2d$ and $m= d/2$

where b : width of channel , d : depth of cannel and m: hydraulic mean depth . (6)

(b) Find the diameter of a circular sewer pipe which is laid at a slope of 1 in 8000 and carries a discharge of 800 liters / s , when flowing half full. Take value of Manning's constant is 0.020. (7)

(c) Define displacement thickness in connection with boundary layer concept. Hence prove that

$$\delta^* = \int_0^\delta [\, 1-u/U] \, dy$$

Where

δ^* : displacement thickness
u : Velocity in boundary layer at a distance y
U : Free stream velocity
δ : Boundary layer thickness

(7)

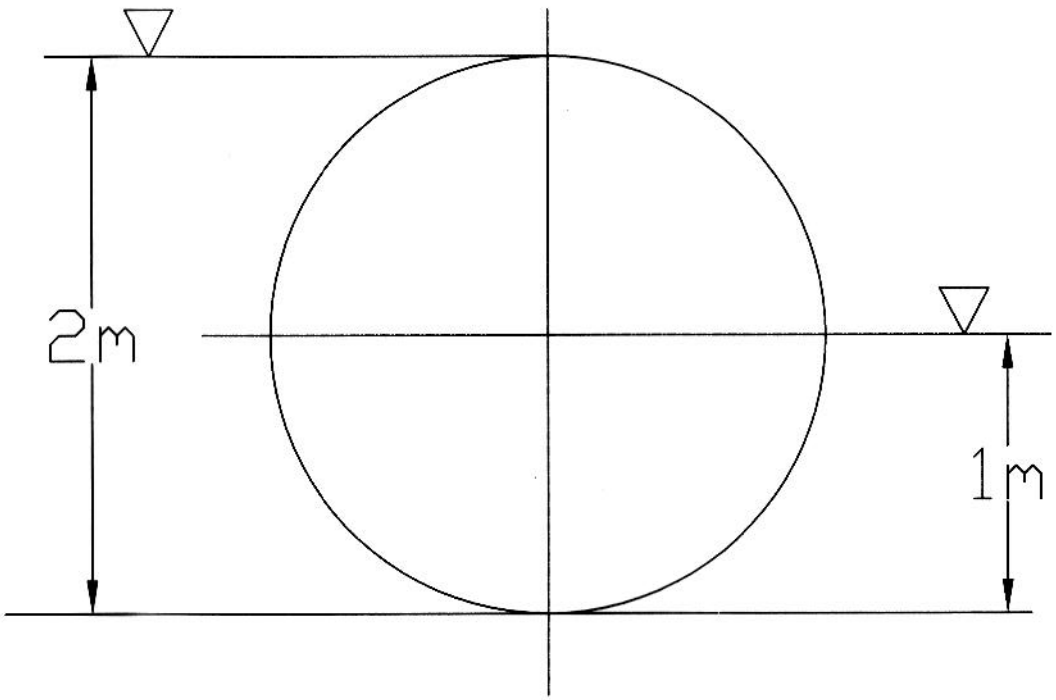

Fig 1

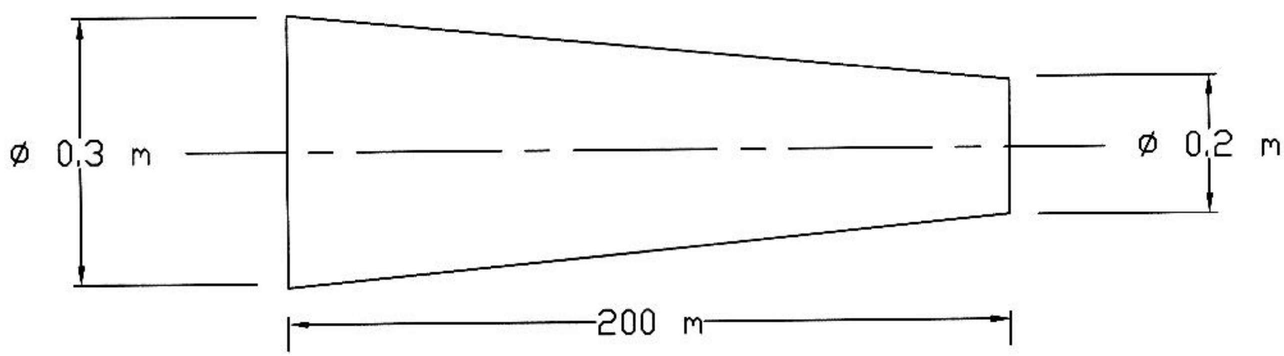

Fig 2

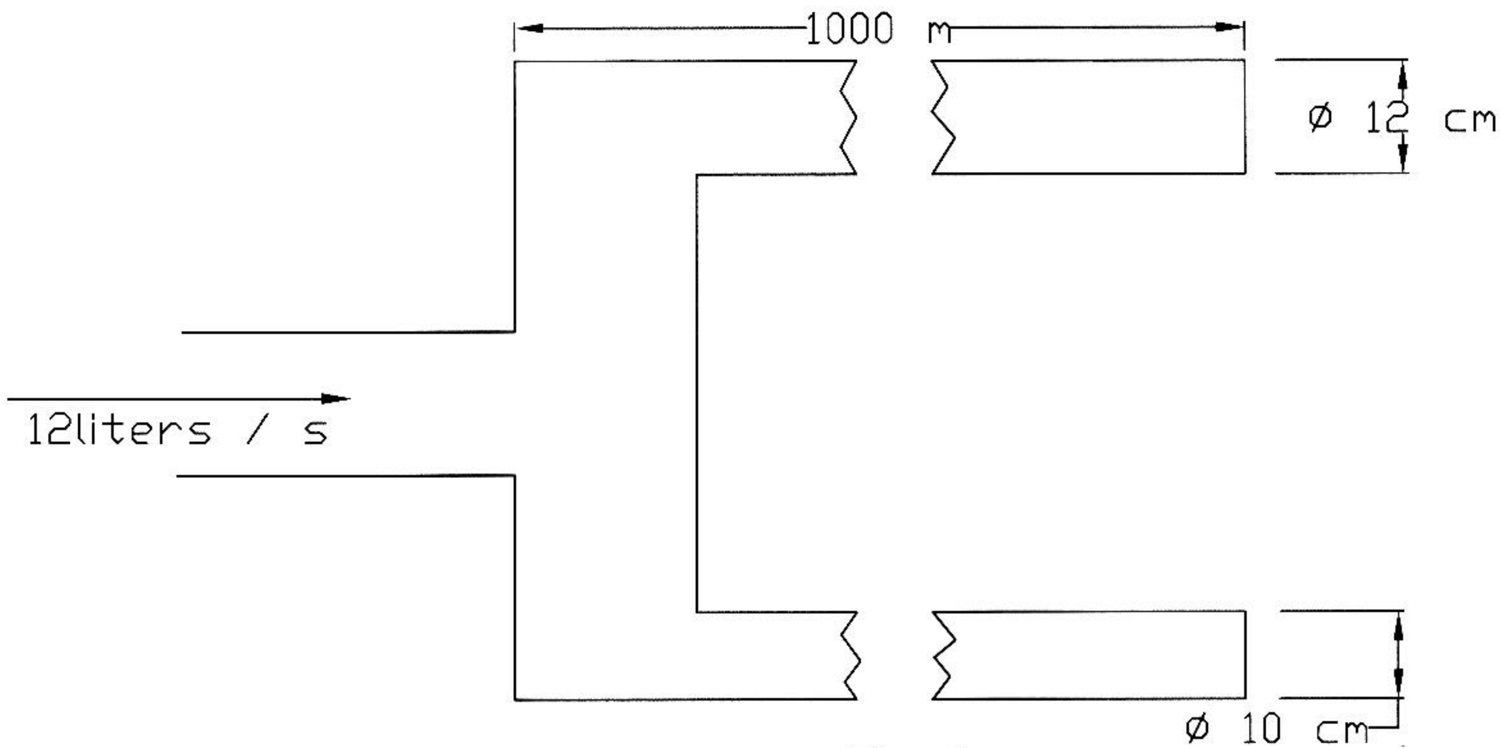

Fig 3

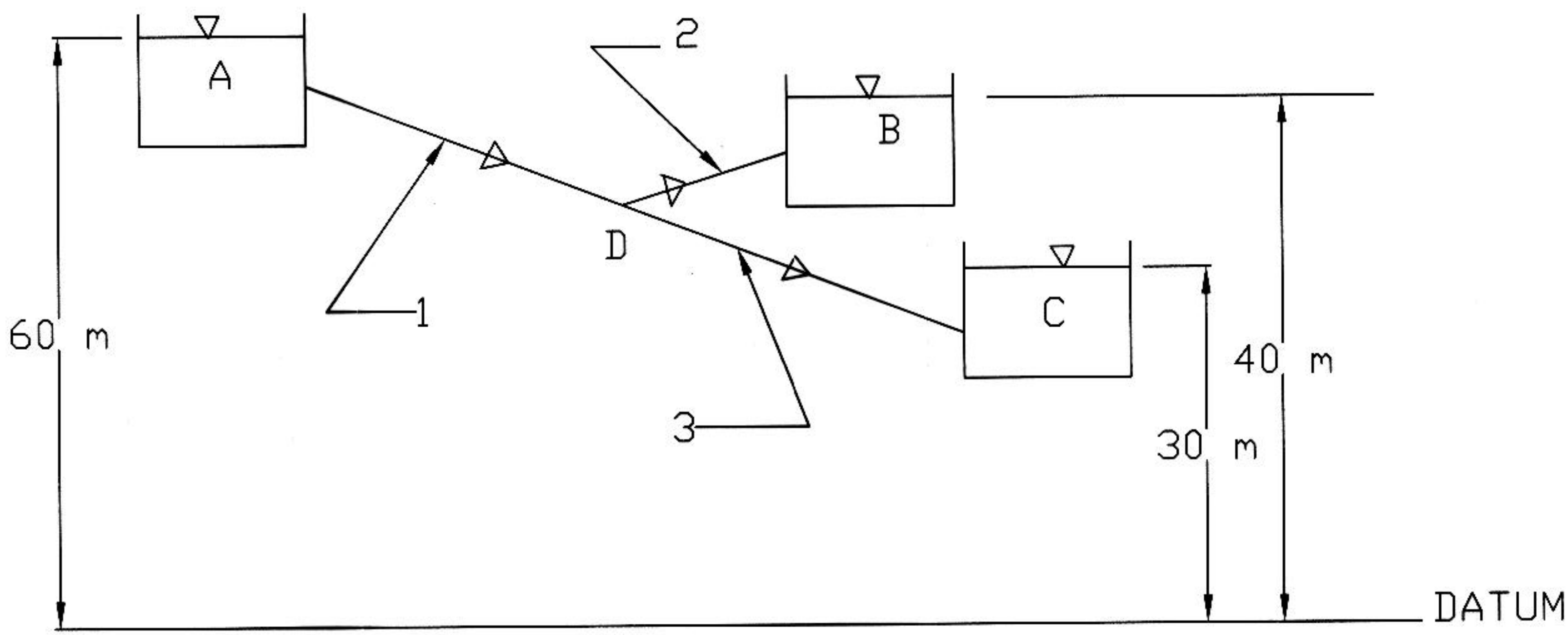

Fig 4