Ex/FTBE/BS/B/T/215/2025

B.E. FOOD TECHNOLOGY AND BIO-CHEMICAL ENGINEERING
SECOND YEAR FIRST SEMESTER EXAM 2025
Fluid Flow

Time: 3 hrs. (50 Marks for each Part) Use separate answer scripts for each Part Full Marks : 100

Part – I(50 Marks)

[Answer Q 1 and any three from the rests (5 + 15x3 = 50)]

1. (a) What will be the unit (in SI) of each term in engineering Bernoulli's equation?
   (b) A fluid flows through a cylindrical pipe. What happens to the flow rate of the fluid if the pressure difference between the ends of the tube is doubled?
   (c) Write the relation between maximum velocity and average velocity of a flowing fluid at any cross section of the flow pipe. (2 + 2 +1)

2. What is Reynolds number and how its related to fluid flow pattern? What do you mean by 'power law' model equation? Show the profile of 'shear stresses against 'shear rate' for different types of fluids citing example for each. What do you mean by 'eddies'? What are compressible and incompressible flow ?

(3+3+5+2 +2)

3.

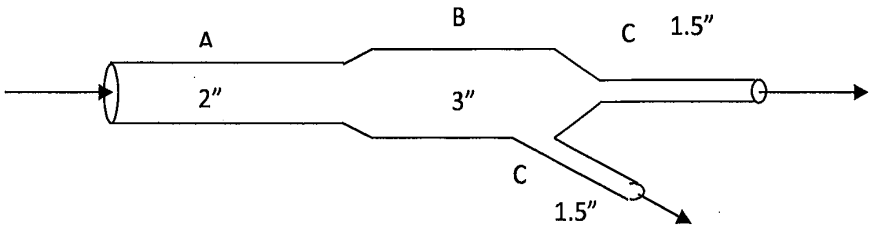

Fig. 1

Crude oil , specific gravity 0.887 at ambient condition, flows through a piping system shown in above fig. Pipe A is 2 inch , B is 3 inch and each of pipes C is 1.5 inch. Equal amount of liquid flows through each of the line C. The flow through the pipe A is 40 gal/min. Calculate (a) mass flow rate in each pipe, in pounds per hr. (b) the average linear velocity in each pipe, in feet per sec (Ref. Fig 1).
Inner cross-sectional area of 2 in. , 3 in. and 1.5 in. pipe are 0.0233 ft^2 , 0.0513 ft^2 and 0.01414 ft^2, respectively. Assume, 1 ft^3 equals to 7.48 gal. (15)

4. Prove that velocity distribution with respect to radius of the flow pipe is a parabola for laminar flow of Newtonian fluid through circular pipe. Find the position in the pipe where flow velocity is equal to average velocity. (10 + 5)

5. (a) Obtain an expression for the velocity and the volumetric and mass flow rates out of a pipe of diameter d at the bottom of a storage tank in which a liquid is maintained at a height H. The tank is open to the atmosphere, and the liquid issues out of the pipe as a free jet into the atmosphere (Ref. Fig . 2)

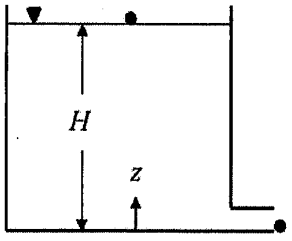

Fig. 2

(b) An aeroplane has wings each of 50m^2 surfac area. While moving horizontally through the air , air is passing at the velocity of 400miles/hr and 300 miles/hr at the top and bottom side of each wing , respectively. Find the mass of the plane. 1mile = 1609 meter . Density of air = 1.29kg/m^3. (5 + 10)

[Turn over

6. (a) Refer Fig 3, which depicts siphon action. Find an expression of the pressure at location 2 incorporating h and H . Also state how small may be the pressure at this location and why?

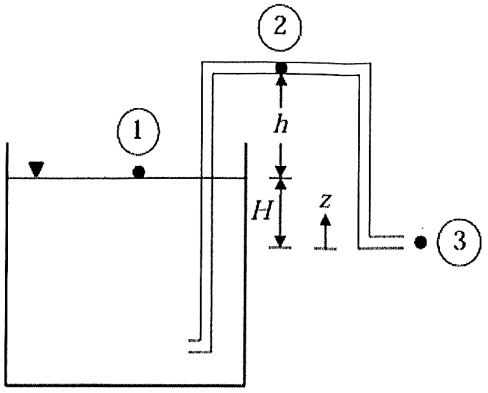

Fig. 3

(b) Aorta carries blood away from the heart at a speed of about 40cm/s and has a radius of approximately 1.1cm. The aorta branches eventually into a large number of tiny capillaries that distribute the blood to the various body organs. In a capillary, the blood speed is approximately 0.07cm/s and the radius is about 6×10^{-4}cm. Treating the blood as an incompressible fluid, find the number of capillaries in the human body. (5+3) + 7

7. Oil of viscousity 0.1 Ns/m and relative density 0.9 is flowing through a circular pipe of diameter 50mm and of length 300m. The rate of flow of fluid through the pipe is 3.5 lit/ sec. Calculate the difference of pressure at the two ends of the pipe and also find the shear stress at the pipe wall. (8 + 7)

8.

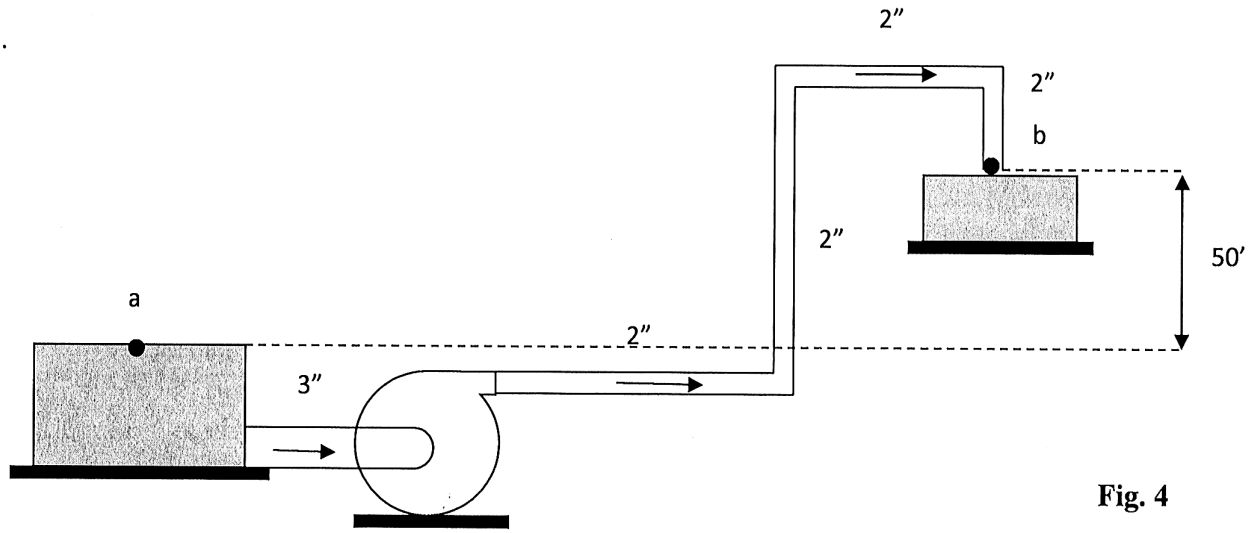

Fig. 4

In the above figure (Fig 4) , shown above, a pump draws a solution , sp. Gravity 1.84, from a storage tank through 3 inch steel pipe. The efficiency of the pump is 60%. The velocity of the flow in the suction line is 3 ft/sec. The pump discharges thorough a 2 inch steel pipe to an overhead tank. The end of the discharge pipe is 50 ft above the level of the solution in the feed tank. What is the horse power of the pump ? You can assume the losses in the 2" ID pipe to be 4 velocity heads, and the losses in the 3" ID pipe to be 5 velocity heads. Inner cross-sectional area of 2 in. and 3 in. pipe are 0.0233 ft^2 , 0.0513 ft^2, respectively.

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FLUID FLOW

Part – II (50 Marks)

Full Marks: 100 **Time: 3 hrs**

Group-A

Answer any one question **1×10 = 10**

1. How pressure change with incompressible fluid height? Derive the equation. Define gauge pressure and absolute pressure and find their correlation.
2. Write short note on rotameter. Calculate the pressure on a circular area of 100 cm^2 in a water of 100m deep.

Group-B

Answer any two questions **2×20 = 40**

3. (i) Define discharge coefficient of flow meter. Why discharge coefficient of venturiment is higher that orifice meter? Write short note on pitot tube.
   (ii) An Orifice Meter with orifice diameter 0.15 m is inserted in a pipe of 30 cm diameter. The pressure difference measured by mercury oil differential manometer on the two sided of orifice meter gives a reading of 40 cm of Mercury. Find the rate of flow of oil of specific gravity = 0.8, when C_d = 0.62. 10+10 = 20
4. (i) How pressure changes with height in atmosphere (considering troposphere)?
   (ii) Atmospheric pressure at sea level is 76 cm of mercury. Calculate the vertical height of air column exerting the above pressure. Assume the density of air 1.29kgm^{-3} and that of mercury is 13600kgm^{-3}. 10+10 = 20
5. What are the different types of pumps? What are the different major sections of a centrifugal pumps? Define static head and manomatric head of a centrifugal pump. Find their relationship. Define cavitation and write its cause, effect and process to overcome this problem. 5+3+4+4+4 = 20