Ref. No. : Ex/FTBE/T/211/2019

B.E. FOOD TECHNOLOGY AND BIO-CHEMICAL ENGINEERING
SECOND YEAR, FIRST SEMESTER-2019

Subject: FLUID FLOW

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

Use separate answer scripts for each group

Part-I **50 marks**

GROUP-A

Answer any one question **10×1 = 10**

1. Derive the expression for temperature at any point in compressible fluid. What is lapse rate? derive its expression.

2. How fluid velocity is measured by Pitot tube? A submarine moves horizontally in sea and its axis 15m below the surface of water. A pitot tube properly placed just in front of the sub-marine and along its axis is connected to the two limbs of a U tube containing mercury. the difference of mercury level is found to be 170mm. Find the speed of the sub-marine knowing that sp.gr. of mercury is 13.6 and that of sea water is 1.026 with respect of fresh water.

4+6 = 10

GROUP-B

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

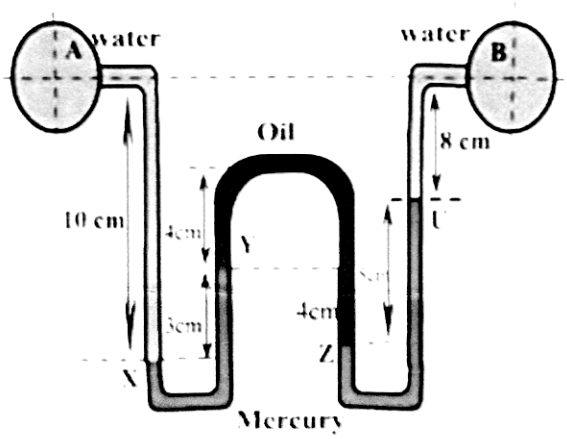
3. (a) Convert a pressure head of 10 m of water column to kerosene of specific gravity 0.8 and carbon-tetra-chloride of specific gravity of 1.62.

(b) Derive the basic equation of static pressure in a fluid. 8+12 = 20

4. (a) Briefly describe about different pressure measuring devices.

(b) As shown in figure water flows through pipe A and B. The pressure difference of these two points is to be measured by multiple tube manometers. Oil with specific gravity 0.88 is in the upper portion of inverted U-tube and mercury in the bottom of both bends. Determine the pressure difference. 8+12 = 20

[Turn over



5. (a) A horizontal venturimeter with inlet diameter 20cm and throat diameter 10cm is used to measure the flow of water. The pressure at inlet is 17.658 N/cm^2 and the vacuum pressure at the throat is 30cm of mercury. Find the discharge of water through venturimeter.

Take $C_d = 0.98$.

(b) Derive an expression for flow rate of a fluid through a orifice meter. 12+8 = 20

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B.E. FOOD TECHNOLOGY AND BIO-CHEMICAL ENGINEERING
SECOND YEAR FIRST SEMESTER EXAM 2019

Fluid Flow

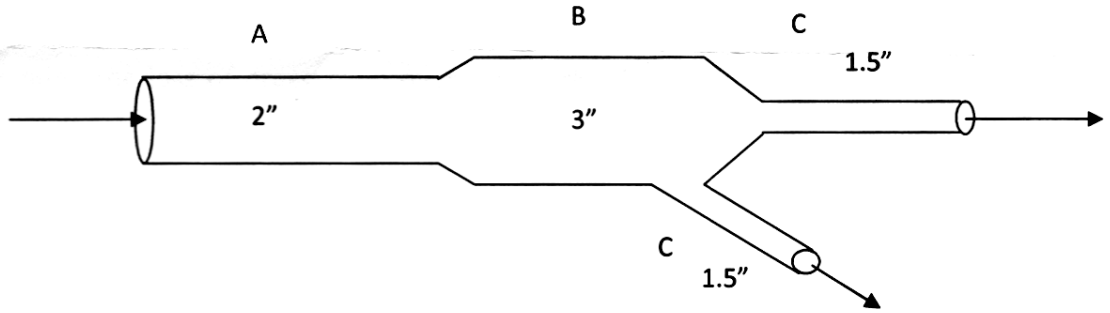
Time: 3 hrs. Full Marks : 100

Part – II

[Answer any five questions, 10 x 5 = 50)]

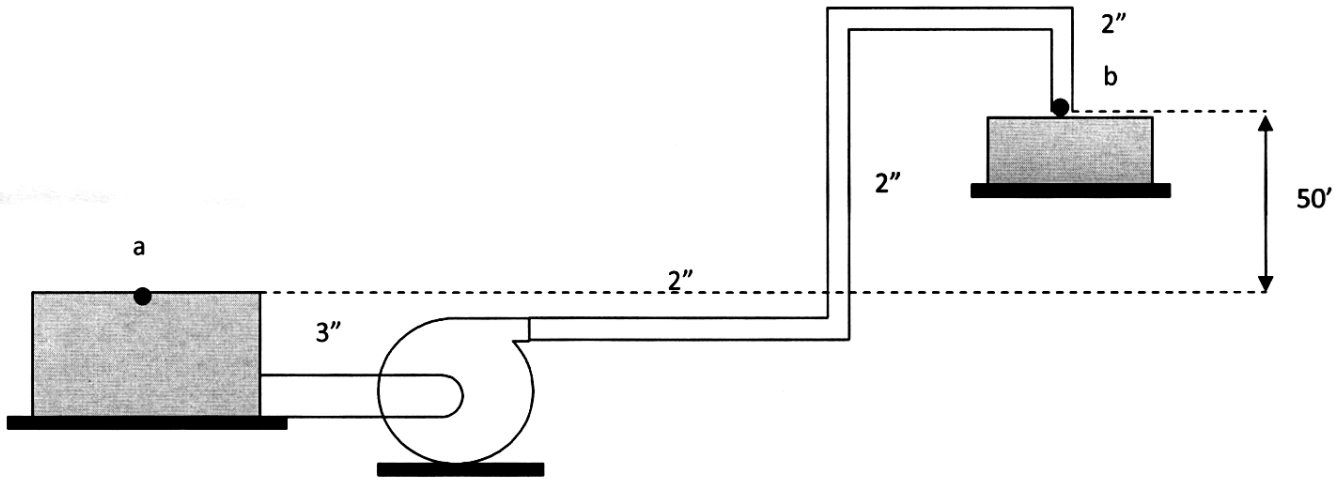
1. What is Reynolds number and how its related to fluid flow pattern? What do you mean by 'power law' model equation? Show the profile of 'shear stresses against 'shear rate' for different types of fluids citing example for each. What do you mean by 'eddies'? Develop relation between 'Fanning friction factor' and 'Reynolds No.' (2+2+3+1+2)

2.



Crude oil , specific gravity 0.887 at ambient condition, flow through the piping 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 30 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.
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. 2" (6 + 4)

3.



In the above figure , 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. Friction loss in the entire piping system is 10 ft-lb_f/ lb_m. What is the horse power of the pump ? (10)

4. Prove that velocity distribution with respect to radius of the flow pipe is a parabola for laminar flow of Newtonian flow through circular pipe. What is the basic objective of using pipe fittings. What is 'equivalent resistance' of a pipe fitting? (7+2+1)

5. (a) Benzene at 20^0C (density = 894 kg/m^3 and viscosity = 6.2 x 10^{-4}Pa-s) is being pumped through 50 m of a straight pipe of 25 mm diameter with a velocity of 3 m/s. The line discharges into a tank 20 m above the pump. Calculate the pressure gauge reading at the discharge side of the pump.

   (b) In an air pipe line , the flow has the following conditions at section 1: temperature 25^0C, pressure 1.7 bar, velocity of flow 15 m/s, inside pipe diameter 50mm and at section 2: 25^0C, pressure 1.2 bar, inside pipe diameter 75mm. Calculate the mass flow rate of air and the velocity at section 2. At 25^0C and 1.7 bar pressure, air has density of 2.1 kg/m^3.
   (6+4)

6. Determine the loss of pressure in overcoming the friction in a coil through which water flows with a velocity of 1.2 m/s. The coil is made of steel pipe with an internal diameter of 30mm. The diameter of a turn of the coil is 1 m. the number of turns is 10. The average temperature of the water in the coil is 30^0C. Assume here, density and viscosity of water as 998 kg/m^3 and 0.8 mPa-s.
   (10)

7. What do you mean by 'porosity' in a packed bed? What are 'interstitial velocity' and 'superficial velocity' and what is the relation between them ? Develop a relation between pressure drop and length of packing material for flow with very low Reynolds no. (less than 10). (2+3+5)

8. A water softener consists of a vertical tube of 50 mm diameter and packed to a height of 0.5 m with ion-exchange resin particles. May be considered spherical with a diameter of 1.20 mm. water flows over the bed , because of gravity as well as pressure difference , at a rate of 250 ml/s. The bed has a porosity of 0.3. Calculate the frictional pressure drop. (10)