Registration No : | | | | | | | | | | |

Total number of pages : 02 **B.Tech**

PCE3I101

3rd Semester Regular/Back Examination 2018-19

FLUID FLOW AND FLOW MEASUREMENT

BRANCH : CHEM, PT

Time : 3 Hours

Max Marks : 100

Q.CODE : E785

Answer Question No.1 (Part-I) which is compulsory, any EIGHT from Part-II, and any TWO from Part-III.

The figures in the right-hand margin indicate marks.

Assume suitable notations and any missing data wherever necessary.

Answer all parts of a question at a place.

Part – I

Short Answer Type Questions (Answer All TEN)

Q1 **Answer the following questions :** **(2 x 10)**

a) Classify non-Newtonian fluids and give the corresponding mathematical expressions used for describing non-Newtonian fluid behavior.

b) Write the barometric equation for an ideal gas stating the assumptions made.

c) Determine the specific gravity of a fluid having viscosity 0.07 poise and kinematic viscosity 0.042 stokes.

d) Estimate the transition length at the entrance to a 15mm tube through which 100 percent glycerol at 60^0C is flowing at a velocity of 0.3m/s. The density and dynamic viscosity of glycerol are 1240 kg/m^3 and 98 cP respectively.

e) State Hagen-Poiseuille equation and give its application.

f) Distinguish between major and minor losses of flow through pipes.

g) Write and explain Kozney-Carman equation and state the Darcy's Law.

h) Define the concept of asterisk condition and stagnation temperature of compressible fluid flow.

i) Differentiate between fans, blower, and compressor.

j) Why priming is required for centrifugal pumps?

Part – II

Focused-Short Answer Type Questions(Answer Any Eight out of Twelve)

Q2 **Answer the following questions :** **(6 x 8)**

a) For a static fluid, prove that the pressure at any point is independent of direction.

b) Explain the development of boundary layer within a pipe with a schematic diagram and also discuss how boundary layer separation takes place.

c) A U-tube differential manometer connects two pressure pipes Aand B. Pipe Acontains carbon tetrachloride having a specific gravity 1.594 under a pressure of 11.772 N/cm^2while pipe B contains oil of specific gravity 0.8 under a pressure of 11.772 N/cm^2.The pipe A lies 2.5 m above pipe B. Find the difference of pressure measured by mercury as fluid filling this U-tube.

d) Derive the continuity equation for three dimensional flow of an incompressible fluid using Cartesian co-ordinates.

e) A conical tube of length 3m is fixed vertically with its smaller end upwards. The velocity of flow at the smaller end is 4 m/s while at the lower end it is 2 m/s. The pressure head at the smaller end is 2m of liquid. The loss of head in the tube is $0.95(v_1-v_2)^2/2g$, where v_1 is the velocity at the smaller end and v_2 at the lower end respectively. Determine the pressure head at the lower end. Flow takes place in the downward direction.

f) Explain the construction of orifice meter with a neat sketch and derive a mathematical expression for determining the theoretical discharge through an orifice meter.

g) Prove that the kinetic energy correction factor for laminar flow of Newtonian fluids in pipes is 2.0.

h) Discuss in detail the process and types of fluidization.

i) A metallic ball of 0.002 m drops in a fluid of specific gravity 0.9 and viscosity 1.5 Ns/m^2. If the weight density of the ball is $120kN/m^3$, find the drag force exerted by fluid on metallic ball, the form drag, the skin drag, and the terminal velocity of ball in fluid.

j) In a process for removing SO_2 from flue gas, gas at 410^0C and 1.2 atm is passed upward through a fluidized bed containing 1.5mm spherical particles of Al_2O_3 impregnated with copper. The particle density is 2300 kg/m^3. The gas density and viscosity are almost same as for air. Predict the minimum fluidization velocity.

k) Explain in detail the construction and working of a reciprocating pump with a neat diagram.

l) Water at 20^0C is pumped at a constant rate of 9 m^3/hr from a large reservoir resting on the floor to the open top of an experimental absorption tower. The point of discharge is 5m above the floor and friction losses in the 50mm pipe from the reservoir to the tower amount to 2.5 J/kg. At what height in the reservoir must the water level be kept if the pump can deliver only 0.1 kW?

Part – III

Long Answer Type Questions (Answer Any Two out of Four)

Q3 The pressure difference Δp in a pipe of diameter D and length L due to turbulent flow depends on velocity V, viscosity μ, density ρ, and roughness k. Using Buckingham's π-theorem, obtain an expression for Δp. **(16)**

Q4 Starting from the fundamental, derive the Navier-Stokes equation and mention its application. **(16)**

Q5 A 20×10 cm venturimeter is provided in a vertical pipeline carrying oil of specific gravity 0.8, the flow being upwards. The difference in elevation of the throat section and entrance section of the venturimeter is 50 cm. The differential U-tube mercury manometer shows a gauge deflection of 40 cm. Calculate : **(16)**

a) the discharge of oil, and

b) the pressure difference between the entrance section and the throat section.

Take C_d =0.98 and specific gravity of mercury as 13.6.

Q6 It is proposed to pump 10,000kg/h of toluene at 114 and 1.1 atm absolute pressure from the reboiler of a distillation tower to a second distillation unit without cooling the toluene before it enters the pump. If the friction loss in the line between reboiler and pump is 7 $kN/m^2$and density of toluene is $866kg/m^3$. **(16)**

a) How far above the pump must the liquid level in the reboiler be maintained to give a net positive suction head of 2.5m?

b) Calculate the power required to drive the pump if the pump is to elevate the toluene 10m, the pressure in the second unit is atmospheric and friction loss in the discharge line is $35kN/m^2$. The velocity in the pump discharge line is 2m/s.