BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: BE **SEMESTER : IV**
BRANCH: BIOTECHNOLOGY **SESSION : SP/19**

SUBJECT: BT4021 CHEMICAL ENGINEERING II

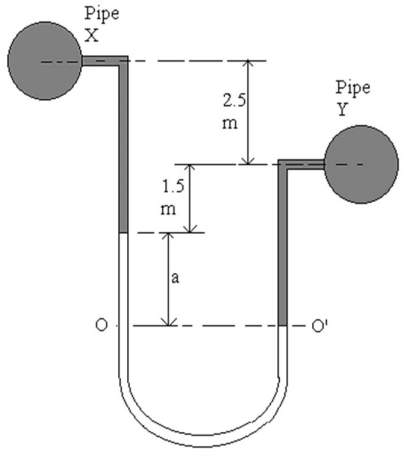
TIME: 3.00 Hrs. **FULL MARKS: 60**

INSTRUCTIONS:
1. The question paper contains 7 questions each of 12 marks and total 84 marks.
2. Candidates may attempt any 5 questions maximum of 60 marks.
3. The missing data, if any, may be assumed suitably.
***4*. Before attempting the question paper, be sure that you have got the correct question paper.**
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

Q.1(a) Explain dynamic viscosity and Kinematic viscosity. [2]

Q.1(b) A U-tube manometer filled with mercury is connected between two points in a pipeline. If the manometer reading is 26 mm of Hg, calculate the pressure difference between the points when (a) water is flowing through the pipe (b) air at atmospheric pressure and 20°C is flowing in the pipe. Density of mercury = 13.6 gm/cc Density of water = 1 gm/cc Molecular weight of air = 28.8 [4]

Q.1(c) A U - tube differential mercury manometer is connected between two pipes X and Y. Pipe X contains carbon tetra chloride (Sp.gr. 1.59) under a pressure of 103 kN/m^2 and pipe Y contains oil (Sp.gr. 0.8) under a pressure of 172 kN/m^2. Pipe X is 2.5 m above pipe Y. Mercury level in the limb connected to pipe X is 1.5 m below the centerline of pipe Y. Find the manometer reading as shown by a centimeter scale attached to it. [6]



Q.2(a) What is Reynolds's Number? Write about transition from laminar to turbulent flow? [2]

Q.2(b) The pressures at two sections of a horizontal pipe are 0.3 kgf/cm^2 and 0.6 kgf/cm^2 and the diameters are 7.5 cm, and 15 cm respectively. Determine the direction of flow if water flows at a rate of 8.5 kg/sec. State your assumptions. [4]

Q.2(c) A capillary tube 0.2 cm in diameter and 10 cm long discharge one liter of a liquid in ten minutes under a pressure difference of 5 cm mercury. Find the viscosity of the liquid using the following data: Density of oil = 850 kg/m^3, Density of mercury = 13600 kg/m^3 [6]

Q.3(a) Write about lift and drag force? [2]

Q.3(b) A flat plate 2m x 2m moves at 40 km/hr in a stationary air of density 1.2 kg/m^3. If the co efficient of drag and lift are 0.1 and 0.5 respectively, Calculate i. The lift force ii. The drag force iii. The resultant force iv. The power required to keep the plate in motion [4]

Q.3(c) A gas is flowing through a horizontal pipe at a temperature of 4 C. The diameter of the pipe is 8 cm and the pressure is 40.3x10^4 N/m^2. The diameter of the pipe changes from 8cm to 4 cm at the another end of the pipe where the pressure is 30.3x10^4 N/m^2 . Find the velocities of the gas at these two different sections assuming as isothermal process. R = 287.14 Nm/ kg K [6]

Q.4(a) What is meant by isothermal compressible flow? [2]

Q.4(b) A horizontal venturi meter having a throat diameter of 4 cm is set in a 10 cm I.D. pipeline. Water flows through the system and the pressure differential across the venturi meter is measured by means of a simple U-tube manometer filled with mercury. Estimate the flow rate when the manometer reading is 30 cm. Assume C_v = 0.98. If 10% of the pressure differential is permanently lost, calculate the power consumption of the meter. [4]

Q.4(c) Brine of specific gravity 1.2 is flowing through a 10 cm I.D. pipeline at a maximum flow rate of 1200 liters/min. A sharp edged orifice connected to a simple U-tube mercury manometer is to be installed for the purpose of measurements. The maximum reading of the manometer is limited to 40 cm. Assuming the orifice coefficient to be 0.62, calculate the size of the orifice required. [6]

Q.5(a) Compare centrifugal and reciprocating pumps? [2]

Q.5(b) A plane brick wall, 25 cm thick, is faced with 5 cm thick concrete layer. If the temperature of the exposed brick face is 70°C and that of the concrete is 25°C, find out the heat lost per hour through a wall of 15 m x10 m. Also, determine the interface temperature. Thermal conductivity of the brick and concrete are 0.7 W/m.K and 0.95 W/m.K respectively. [4]

Q.5(c) A steel sphere is of inner diameter 40 cm and outer diameter 45 cm is used to store liquid oxygen (B.P is minus 183°C). The sphere is covered with one layer of insulation, of thickness 50 mm whose K is 0.35 W/m.K and another insulation, of thickness 50 mm whose K is 0.098 W/m.K. The sphere is exposed to atmosphere of 25°C. Find out the rate of oxygen becoming vapor every minute. Latent heat of oxygen is 370 kJ/kg. Thermal conductivity of steel = 20 W/m.K. Heat transfer coefficient of ambient air = 80 $W/m^2.K$ [6]

Figure 5 (b)

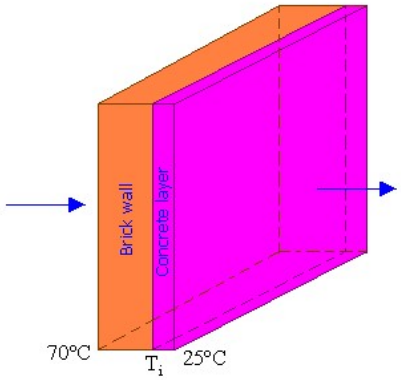
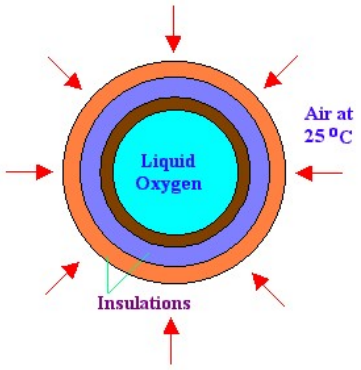


Figure 5 (c)



Q.6(a) Compare Natural and forced convection? [2]

Q.6(b) Determine the rate of heat loss from a 100 mm diameter steam pipe placed horizontally in ambient air at 30°C. The length of the pipe is 4 m and wall temperature, T_w = 170°C. Use the following empirical expression: $Nu=0.53(Gr \times Pr)^{1/4}$ Properties of air at 100°C are as following b =1/373 K^{-1}; g = 23.13 x 10^{-6} m^2 /sec, k= 0.0325 W/m.K, Pr = 0.7 [4]

Q.6(c) A horizontal cylinder, 3.0 cm in diameter and 0.8 m length, is suspended in water at 20°C. Calculate the rate of heat transfer if the cylinder surface is at 55°C. Given Nu = 0.53 (Gr x Pr)$^{1/4}$ .The properties of water at average temperature are as follows: Density, =990kg/m^3 Viscosity, = 2.47 kg/hr.m , Thermal conductivity, k = 0.534 kcal/hr.m.°C, C_p = 1 kcal/kg.°C. [6]

Q.7(a) Explain black body and grey body? [2]

Q.7(b) In a completely opaque medium, if 50% of the incident monochromatic radiation is absorbed, then which of the following statements are CORRECT? Justify your answer? [4]
(P) 50% of the incident radiation is reflected (Q) 25% of the incident radiation is reflected (R) 25% of the incident radiation is transmitted (S) No incident radiation is transmitted
(A) P and S only (B) Q and R only (C) P and Q only (D) R and S only

Q.7(c) Two parallel black plates 0.5 by 1.0 m are spaced 0.5 m apart. One plate is maintained at 1000 °C and the other is at 500 °C. What is the net radiant heat exchange between the two plates? The shape factor F_{12} = 0.285. [6]

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