Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VI • EXAMINATION – WINTER • 2014

Subject Code: 163503 Date: 01-12-2014

Subject Name: Fluid Flow and Heat Transfer

Time: 02:30 pm - 05:00 pm Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** i) The shear stress at a point in a oil is 0.30 Pa and the velocity gradient at that point is 0.25 per second. Find the viscosity of the oil, if the density of the oil is 970 kg/m^3. Find also the kinematic viscosity of the oil. **04**

ii) Explain the different kind of boundary conditions used in conduction heat transfer studies. **03**

(b) i) Write the principle of floatation with the condition of equilibrium of submerged bodies. **03**

ii) Pressurized water at 50 °C flows inside a 5 cm diameter, 1 m long tube with the surface temperature maintained at 130 °C. If the heat transfer coefficient between water and tube is h = 2000 W/m^2 °C, determine the heat transfer rate from tube to the water. **04**

Q.2 **(a)** i) Discuss the boundary layer separation with the formation of boundary layer when a fluid flows over a flat plate **07**

ii) Water flows through a pipe of 5 mm diameter with a velocity of 1.6m/s. This pipe expands to a diameter of 12 mm. Calculate the volumetric flow rate of water flowing through expanded section.

(b) Find the density of a metallic body which floats at the interface of mercury of specific gravity 13.6 and water such that 40% of its volume is submerged in mercury and remaining 60% is submerged in water. **07**

OR

(b) A pipe of 250mm diameter carries an oil of specific gravity 0.8 at the rate of 140 liters/sec and under a pressure of 3 kPa. Find the total energy per unit weight at a point which is 3m above the datum line. Also find the total energy per unit mass and per unit volume. **07**

Q .3 **(a)** With a neat sketch explain the main parts, construction and working principle of orifice meter? Derive the equation of discharge for an orifice meter. **07**

(b) The maximum flow through a 300 mm diameter horizontal pipe line is 300 liters/sec. A venturimeter is introduced at a point of the pipe where the pressure head is 5 m of water. Find the diameter of throat so that pressure at the throat is never negative. Take value of C_d of venturimeter as 0.98. **07**

OR

Q.3 **(a)** Brine is to be pumped through a 35 m long smooth copper tube having inside diameter of 2.5-cm. The flow rate is 94.7×10^{-3} m^3 /min. Calculate the head loss due to friction. Data given: Specific gravity of brine = 1.18. Viscosity of brine = 2.5 cp. Use the below mentioned relation of 'f' and 'Re' **07**

$$f = 0.0014 + \frac{0.125}{Re^{0.32}}$$

(b) Detail the various kinds of impellers used in process industries with kind of flow patterns produced in them during agitation. **07**

Q.4 **(a)** Explain the significance of following dimensionless numbers i) Reynolds Number ii) Power number iii) Froude Number iv) Prandtl Number v) Nusselt Number vi) Biot Number vii) Grashoff Number **07**

(b) An aluminum plate of k= 160W/m°C, density = 2790 kg/m^3 C_p = 0.88 kJ/kg °C of thickness L = 3 cm and at a uniform temperature of T_0 = 225 °C is suddenly immersed at time t = 0 in a well stirred fluid maintained at a constant temperature T = 25 °C. The heat transfer coefficient between the plate and the fluid is 320 W/m^2 °C. Determine the time required for the plate to reach 50°C. **07**

OR

Q.4 **(a)** Explain the concept of "Fluidization" with various types involved and its application in industry. **07**

(b) A six-bladed turbine impeller is used to agitate an aqueous solution in a tank of diameter 0.5m. Impeller diameter is one-third tank diameter. The solution to be agitated has a viscosity of 1.01cp and density of 980 kg/m^3. The turbine impeller turns at 300rpm. What will be the power required for agitation? (Take value of K_T = 6.3) **07**

Q.5 **(a)** i) Explain the significance of critical thickness of Insulation and Optimum thickness of Insulation? **03**

ii) Consider a hollow sphere of inner and outer radii r_i and r_o. Both the inner and outer surfaces are isothermal and maintained at T_i and T_o. Develop an expression for steady state temperature distribution and heat transferred through the sphere. **04**

(b) A shell and tube heat exchanger is used to cool 6 kg/sec of oil having a specific heat of 2000 J/kg °C from 65 °C to 35 °C with 10 kg/sec of cooling water entering at 20 °C. The overall heat transfer coefficient is 600 W/(m^2 °C). Calculate the heat transfer area required in (i) parallel flow heat exchanger (ii) counter flow heat exchanger. **07**

OR

Q.5 **(a)** Differentiate pool boiling and forced convection boiling? With a neat sketch explain the various boiling regimes in forced convection boiling. **07**

(b) A single effect evaporator is to be designed to concentrate 9000 kg/hr of a solution from 12% to 20% solids. Feed enters at 25 °C. Saturated steam at 110°C (latent heat = 540 kcal/kg) is available. The condensate leaves at the condensing temperature. Saturation temperature of vapor to the condenser is 400 °C (λ= 580 kcal/kg). Specific heat of all solutions may be taken as 1 kcal/kg °C. Boiling point rise is 5°C. The evaporator has an overall heat transfer coefficient of 1900 kcal/hr.m^2 °C. **07**

Calculate: i) evaporator capacity ii) evaporator economy, iii) the area of heating surface required. Use 1 kcal = 4186 J.

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