Total no. of Pages 02 Roll No…………..

First Semester **M.Tech. [THE]**

Supplementary Examination **Feb-2019**

ME-561 Advanced Heat & Mass Transfer

Time 3 Hrs. **Maximum Marks = 100**

Q-1(a): Why LMTD is used in the heat exchanger. Explain the methods for finding effectiveness in heat exchanger in counter flow heat exchanger (ii) Parallel flow heat exchanger. (8+6)

(b)A shell and tube type of heat exchanger is designed as an ammonia condenser with ammonia vapour entering the shell at 60°C as a saturated vapour. Water enters the single pass tube arrangement at 25°C and gets heated to 50oC and the total heat transfer rate is 250 kW. Calculate the area of the heat exchanger to achieve 60% effectiveness with overall heat transfer coefficient 1000 w/$m^{2o}C$. How would the heat transfer be affected if the water flow rate is reduced to half. It may be presumed that the heat exchanger area and heat transfer coefficient remain the same. (6)

Q-2(a) Based on the Nusselt theory of laminar film condensation, derive the expression for thickness of condensate film at a distance X below the top edge of the plate in the steam condensing on a vertical plate. (9)

(b) Explain the physical significance of following numbers.

(i) Nusselt Number (ii) Prandtl Number (iii) Stanton Number (iv) Reynold Number (v) Fourier Number (vi) Biot Number (vii) Grashof Number. (7)

(c) Explain the concept of overall heat transfer coefficient for the analysis of heat exchanger when scale formations are taking place. Also explain the utility of Number of transfer units , along with applications, when it was used. (4)

Q-3 (a) Why Over all heat transfer coefficient is different in composite cylinder or composite sphere. Explain the reason with full justification and also derive the expression of (i) three layered composite sphere and (ii) three layered composite cylinder. (4+4)

(b) Using dimensional analysis , that(i) shear wood number is a function of Reynold's number and Schmidt number in a force d convection mass transfer mode and Nusselt number is a function of Grashof 's number and Prandtl number in a force d convection heat transfer transfer mode (6+6)

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Q-4(a) Determine the geometrical factor of a bead shaped thermocouple to the inside wall of a circular duct. (7)

(b) A small thermocouple having a spherical shape 2 mm diameter is placed at the centre of circular duct 0.25 m long and 10 cm in diameter. The thermocouple reads a 185°C when the duct wall is at 140°C and gas at 200°C flows along the duct. Determine the convective coefficient of heat transfer between the gas and the thermocouple bead may be assumed to have characteristics of black radiating surfaces. (6)

(c) Two diffuse surfaces a small disk of area A_1 and a large disk of area A_2 , are parallel to each other and directly opposed, i.e. a line joining their centers is normal to both the surfaces. The large disk has a radius R and is located at a height L from the smaller disk. Obtain an expression for the configuration factor of small disk with respect to the large disk. (7)

Q-5(a) two horizontal surfaces separated by a distance of 5 cm having air between them at atmospheric pressure. Calculate for the heat flux if the upper surface is at 50°C and the lower surface is at 26°C. Assume Kinematic viscosity of fluid = 1.68X 10^{-5} (m^2/sec). Conductivity of fluid at average temperature is 0.028 (W/mK). (6)

(b)A cylinder 5 cm inside diameter and 1 m long is provided with 10 longitudinal straight fins at material having thermal conductivity of 120 (W/mK) . The fins are 0.75mm thick and protrude 12.5 mm from cylinder surface. The system is placed in an atmosphere at 40°C and the heat transfer coefficient from the cylinder and fins to the ambient is 20 ($W/m^{2o}C$) . If the surface temperature is 150°C, calculate the rate of heat transfer and temperature at the end of fins. Assume the fin is to be of finite length. (6)

(c) Derive the expression for critical thickness of insulation for (i)sphere and(ii) cylinder Assume inner convection is also taking place . (4+4)

Q-7(a) Derive the expression for temperature distribution and rate of heat transfer in (i) hollow sphere and (ii) Hollow cylinder , when heat generation is varies with radius and thermal conductivity is also varying with following expression $K(T)= K(1+aT+bT^2)$ and $Q_{\_gen}= Q \exp(- (1-(r^2/R_o^2)$) (7+7)

(b) Discuss the various regimes of boiling heat transfer process. (6)