Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

PDDC SEMESTER– VI • EXAMINATION – SUMMER- 2015

Subject Code :X61903 **Date:14 /05/2015**

Subject Name: Heat & Mass Transfer.

Time:10:30 am - 01:00 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)** With usual notations derive general heat conduction equation in Cartesian coordinates. Also obtain the same for no heat sources case. **07**

(b) Distinguish between the Conduction, Convection, & radiation mode of heat transfer. **07**

Q.2 **(a)** Derive equation of temperature distribution & heat dissipation for infinite long fin. **07**

(b) A wall of a furnace is made up of inside layer of silica brick 120 mm thick covered with a layer of magnesite brick 240 mm thick. The temperature at the inside surface of silica brick wall & outside surface of magnesite brick wall are 725^0 C & 110^0 C respectively. The contact thermal resistance between the two walls at interface is 0.0035^0 C/W per unit wall area. If the thermal conductivities of silica & magnesite bricks are 1.7 W / mK & 5.8 W / mK, **07**

Calculate :

(1) Rate of heat loss per unit area of walls & (2) Temperature drop at the interface.

OR

(b) A furnace wall, 32 cm thick, is made up of an inner layer of brick (k = 0.84 W/mk) covered with a layer of insulation (k = 0.16 W/m^0 K). The furnace operates at a temperature of 1325^0 C & the ambient temperature is 25^0 C. **07**

(i) Determine the thickness of brick & insulation which gives minimum heat loss,

(ii) Calculate the heat loss presuming that the insulating material has a maximum temperature of 1200^0 C. If the calculated heat loss is not accepted than state whether addition of another layer of insulation would provide a satisfactory solution.

Q.3 **(a)** Derive expression for the logarithmic Mean Temperature Difference for the flow in a counter flow heat exchanger. **07**

(b) How does dropwise condensation differ from film condensation ? Which mode of condensation is characterized by lrger heat transfer rates ? **07**

OR

Q.3 **(a)** Describe the phenomenon of radiation from real surface. **07**

(b) What is the StephenBoltzmann Law ? Explain the concept of total emissive power of a surface. **07**

Q.4 **(a)** Distinguish (1) Subcooled & Saturated boiling. (2) Nucleate & film boiling. **07**

(b) Derive an expression for LMTD for counter flow heat exchanger. **07**

OR

Q.4 **(a)** By dimensional analysis show that for forced convection heat transfer the Nusselt number can be expressed as a function of Prandlt number & Reynolds number. **07**

(b) A copper pipe carrying referigent at -20^0 C is 10 mm in outer diameter & is exposed to convection at 50 W/m^2 K to air at 25^0C. It is proposed tp apply insulation of conductivity 0.5 W/m K. Determine the thickness beyond which the heat gain will be reduced. Calculated the heat gains for 2.5mm, 5mm, 7.5mm & 20mm thickness for 1 m length. The convection coefficient remains same. **07**

Q.5 **(a)** Drive the expression for radiant heat exchange between two finite black surfaces by radiation. **07**

(b) Turbine blade of alloy steel (K = 29 W/mK, 6 cm long, Acs = 500mm^2 & p = 12cm) is exposed to hot gases of 820^0 C. The root temperature is 480^0 C. Determine the temperature in the middle of the blade & heat loss from the blade. Take h=320 W/m^2K. **07**

OR

Q.5 **(a)** Define & disuss velocity boundry layer & thermal boundry layer over a flat plate. Show the thickness of these layers for different Prandtl numbers. **07**

(b) The air at atmospheric pressure & temperature of 30^0C flows over one side of the plate with a velocity of 90 m/min. The plate is heated & maintained at 100^0 C over its entire length, Find out the following at 0.3 m & 0.6 m from its leading edge. **07**

(i) Thickness of velocity boundry layer & thermal boundry layer.

(ii) Mass flow rate which enters the boundry layer between 0.3 m & 0.6 m per metre depth of plate. Assume unit width of plate. Properties of air at 30^0 C are as follows :

P = 1.165 kg/m3, v = $16x10^{-6}$ m^2/s, Pr = 0.701,
Cp = 1.005 kj/kg-K, k = 0.02675 W/m-K.

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