Seat No.: _____ *Enrolment No._____*

GUJARAT TECHNOLOGICAL UNIVERSITY

B E Sem-VI Examination May 2011

Subject code: 160202

Subject Name: Automobile Heat Transfer

Date:17/05/2011 **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)** The composite wall of an oven consists of three materials, two of which are of known thermal conductivity, K_a = 20 W/m.K and K_c = 50 W/m.K, and known thickness, L_a = 0.3 m and L_c = 0.15 m. The third material B, which is sandwiched between materials A and C, is of known thickness, L_b = 0.15 m, but unknown thermal conductivity K_b. Under steady-state operating conditions, measurement reveal an outer wall temperature of 20 °C, an inner wall temperature of 600 °C and an oven air temperature of 800 °C. The inside convection coefficient h is known to be 25 W/m^2.K What is the value of K_b? **07**

(b) A wire of 6.5 mm diameter at a temperature of 60 °C is to be insulated by a material having k= 0.174 W/m °C. Convection heat transfer coefficient =8.722 W/m^2 °C. The ambient temperature 20 °C. For maximum heat loss, what is the minimum thickness of insulation and the heat loss per metre length? Also find the percentage increase in the heat dissipation. **07**

Q.2 **(a)** A long cylindrical nickel-steel (k=19 W/m K) rod of 4mm diameter is used as a heating element. By passing current through the rod heat is uniformly generated at the rate of 2×10^9 W/m^3. If the outer surface of the rod is maintained at 110 °C, calculate the maximum temperature at the centre of the rod. **07**

(b) Aluminum square fins (0.5 mm× 0.5 mm) of 1 cm length are provided on the surface of an electronic semiconductor device to carry 46 mW of energy generated by the electronic device and the temperature at the surface of the device should not exceed 80 °C. The temperature of the surrounding medium is 40 °C. Thermal conductivity of aluminium 190W/m.K. and heat transfer coefficient h =12.5 W/m^2.K. Find the number of fins required to carry out the above duty. Neglect the heat loss from the end of fin. **07**

OR

(b) During a heat treatment process, alloy steel spherical balls of 12 mm diameter are initially heated to 800 °C in a furnace. Subsequently these are cooled to 100 °C by keeping them immersed in an oil bath at 35 °C with convection coefficient 20W/m^2deg. Determine the time required for the cooling process. Given properties of steel balls: density 7750kg/m^3, specific heat 520 J/kg-K, conductivity 50W/m-deg. **07**

Q.3 **(a)** Air at temperature 527 °C and 1 bar pressure flows with a velocity of 10 m/s over a flat plate 0.5m long. Estimate the cooling rate per unit width of the plate needed to maintain it at a surface temperature of 27 °C assuming that contribution of radiation is negligible. **07**

(b) A printed circuit board dissipates 100 W from one side over an area 0.3 m by 0.2 m. A fan is used to cool this board with a flow speed of 12 m/s parallel to the longest dimension of the board. Calculate the surface temperature of board for an air temperature of 30 C. **07**

Given $Nu_{avg} = [0.05 (Re_L^{0.8} - 310] (Pr)^{1/3.}$

OR

Q.3 **(a)** A furnace door, 1.5 m high and 1 m wide, is insulated from inside and has an outer surface temperature of 70 °C. If the surrounding ambient air is at 30 °C. Calculate the natural convective heat loss from the door. **07**

(b) A vertical pipe 15 cm outer diameter, 1 m long, has a surface temperature of 90 °C. If the surrounding air is at 30 °C, what is the rate of heat loss by free convection per metre length of the pipe? **07**

Q.4 **(a)** A black body emits radiation at 2000K. Calculate (a) the monochromatic emissive power at 1μm wavelength (b) wavelength at which the emission is maximum, and (c) the maximum emissive power. **07**

(b) Determine the rate of heat loss by radiation from a steel tube of outside diameter 70 mm and 3 m long at a temperature of 227 °C if the tube is located within a square brick medium of 0.3 m side and at 27 °C. Take **07**

ε (steel) =0.79 and ε (brick) =0.93.

OR

Q.4 **(a)** Two very large parallel planes with emissivities 0.3 and 0.8 exchange radiative energy. Determine the percentage reduction in radiative energy transfer when a polished aluminium radiation shield with emissivity 0.04 is placed between them. **07**

(b) Two parallel rectangular surfaces 1 m × 2 m are opposite to each other at a distance of 4 m. the surfaces are black and at 100 °C and 200 °C respectively. Calculate the heat exchange between the two surfaces. **07**

Q.5 **(a)** Saturated steam at 1.43 bar and 110 °C condenses on a 1.9cm outer diameter vertical tube which is 20 cm long. The tube wall is at a temperature of 109 °C. Calculate the average heat transfer coefficient and the thickness of the condensate film at the base of the tube. **07**

(b) Explain the types of condensation. Mention some applications and unique features of boiling and condensation. **07**

OR

Q.5 **(a)** An oil cooler for a lubrication system has to cool 1000 kg/hr of oil (Cp=2.09 KJ/kg °C) from 80 °C to 40 °C by using a cooling water flow of 1000 kg/hr at 30 °C. Give your choice for a parallel flow or counter flow with reasons. Calculate the surface area of the heat exchanger, if the overall heat transfer coefficient is 24 W/m^2 °C. [C_p water =4.18 kJ/kg °C] **07**

(b) A heat exchanger for cooling oil which enters at 180 °C and cooling water enters at 25 °C. Mass flow rates of oil and water are 2.5 and 1.2 kg/s respectively. Area for heat transfer is 16 m^2. C_p for oil and water are 1900 J/kg K and 4184 J/kg K. over all heat transfer coefficient is 285W/m^2 K. calculate the outlet temperatures of oil and water for parallel and counter flow arrangements. **07**

****