Total No. of Questions :10]

SEAT No. :

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[Total No. of Pages : 4

[5560]-512

T.E. (Mech.)

HEAT TRANSFER

(2015 Course) (Semester-I) (302042)

Time : 2½ Hours] *[Max. Marks : 70*

Instructions to the candidates:

1) *Answers to one questions either or option.*
2) *Neat diagrams must be drawn wherever necessary.*
3) *Figures to the right side indicate full marks.*
4) *Use of scientific non programmable calcultor is allowed.*
5) *Assume suitable data, if necessary.*

Q1) a) Explain its variation of thermal conductivity with increase in temperature for metals and non-metals. **[4]**

b) An exterior wall of a house consists of a 10.16 cm layer of common brick having thermal conductivity 0.7 W/m.k. It is followed by a 3.8 cm layer of gypsum plaster with thermal conductivity of 0.48 W/m.k. What thickness of loosely packed rock-wool insulation (k = 0.065 W/m.k.) Should be added to reduce the heat loss through the wall by 80%? **[6]**

OR

Q2) a) If temperature distribution for a thin and long fin, insulated at its tip is given by $\frac{T(x)-T_\infty}{T_0-T_\infty}=\frac{\cosh m(L-x)}{\cosh mL}$ Then show that the heat transfer from the fin is given by $Q_{fin}=\sqrt{hpkA_c}\,(T_0-T_\infty)$ tanh mL. **[6]**

b) Define with their physical significance **[4]**

i) Biot Number

ii) Fourier Number

Q3) a) Explain the concept of critical thickness of insulation on cylinder with the help of material and surface resistances. **[6]**

b) An aluminium sphere having radius 0.0809 m and initially at temperature of 350°C is suddenly immersed in a fluid at 30°C with convection coefficient of 60 W/m^2.K. Estimate the time required to cool the sphere to 100°C. Take thermo - physical properties as C= 900J/kg.K, ρ = 2700kg/m^3, k=205 W/m.K. **[4]**

OR

Q4) a) Deduce an expression for centerline temperature distribution in a plane wall under steady state heat conduction with uniform heat generation. The wall is insulated on left surface and maintained at temperature T_s on right surface You may use differential heat conduction equation in x- direction as $\frac{d}{dx}\left(\frac{dT}{dx}\right)+\frac{9_0}{k}=0$ **[8]**

b) A spherical electronic device (1.4 W/m.k) of 10 mm diameter generates 4W. It is exposed to air at 20° C with a convection coefficient of 20 W/m^2.K. Find the surface temperature. **[2]**

Q5) a) Prepare formulation for Rayliegh number, Stanton number and Peclet number and interpret them. **[6]**

b) A pipe carrying steam runs in a large room and is exposed to air at a temperature of 30°C. The pipe surface temperature is 200°C. The pipe diameter is 20 cm. If total heat loss rate from the pipe per metre length is 1.9193 kW/m, determine the pipe surface emissivity. Use correlation.

Nu = 0.53 $(Gr\ Pr)^{1/4}$ and properties of air at 115°C kf = 0.03306 W/m.K, v = 24.93 × 10^{-6} m^2/s Pr = 0.687. **[10]**

OR

Q6) a) What do you understand by dimensional analysis? Develop the dimensional analysis for one dimensionless term of forced convection. **[8]**

b) A metallic bar of 25 mm diameter is cooled by air at 30°C and with velocity of 2.5 m/s. If the surface temperature of the bar is not to exceed 85°C. The resistivity of the metal is 0.015 × 10^{-6} Ohm per metre. Calculate

i) The heat transfer coefficient from the surface to air, and

ii) The permissible current intensity for the bus bar.

The properties of air v = 18.65 ×10^{-6} m^2/s, k_f = 0.0288 W/m. K and Pr_1 = 0.696 Use correlation Nu = 0.683 $Re^{0.466}$ $pr^{1/3}$. **[8]**

Q7) a) Define blackbody? What are its properties? Why does a cavity with a small hole behave as blackbody? **[6]**

b) Two parallel infinite gray surfaces are maintained at temperature of 127° C and 227°C respectively. If the temperature of the hot surface is increased to 327°C. By what factor is the net radiation exchange per unit area increased? Assume the emissivity of colder and hotter surfaces to be 0.9 and 0.7, respectively. **[10]**

OR

Q8) a) Write a short note on gray body approximation. **[6]**

b) A hot water radiator of overall dimensions 2×1×0.2 m is used to heat the room at 18°C. The surface temperature of radiator is 60°C and its surface is black. The actual surface of the radiator is 2.5 times the area of its envelope for convection for which the convection coefficient is given by $h_c = 1.3\ (\Delta T)^{1/3}$ W/m^2.K. Calculate the rate of heat loss from the radiator. **[6]**

c) Define irradiation and radiosity establish the relationship between them. **[4]**

Q9) a) Why drop-wise condensation is better than film-wise condensation. What are practical difficulties to obtain drop-wise condensation? **[4]**

b) A condenser is employed in a steam power plant to handle 35,000 kg/h of dry and saturated steam at 50°C. The cooling water enters the condenser at 15°C and leaves at 25°C. the tubes are 22.5 mm inside diameter and 25 mm outside diameter. The water flows through the tubes at an average velocity of 2m/s. The heat transfer coefficients are 7020 W/m.^{2}.K on water side is and 5000 W/m^2.K on steam side. Ignore thermal resistance of wall material

Calculate:

i) The mass flow rate of water.

ii) Heat transfer surface area.

iii) Number of tubes required for water flow.

iv) Number of tube passes in condenser if the length of each tube per pass should not be more than 2.5 m.

Assume that the condensate coming out the condenser is saturated water i.e., steam loose only its latent heat of 2374kJ/kg.

Use properties of water as: ρ = 998.8 kg/m^3, C_p = 4180J/kg. k,**[14]**

OR

Q10) a) Classify heat exchangers in brief. **[2]**

b) Define effectiveness of heat exchanger. How maximum heat transfer rate is obtained? **[6]**

c) Consider the following parallel flow heat exchanger specification **[10]**

cold flow enters at 40°C : C_c = 20,000 W/K

hot flow enters at 150°C : C_h = 10,000 W/K

A = 30 m^2, U = 500 W/m^2. K.

Determine the heat transfer rate and the exit temperatures.

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