Total No. of Questions : 4]

SEAT No. :

PC70

[Total No. of Pages : 2

[6360]-72

T.E. (Mechanical)/(Mechanical Sandwich) (Insem)
HEAT AND MASS TRANSFER
(2019 Pattern) (Semester - I) (302042)

Time : 1 Hour] *[Max. Marks : 30*

Instructions to the candidates:

1) ***Answer Q.1 or Q. 2, Q. 3 or Q. 4.***
2) ***Neat diagrams must be drawn wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Assume suitable data wherever necessary.***

Q1) a) Derive the three dimensional general heat conduction equations in Cartesian co-ordinates from first principles. Write simplified form of it i.e. **[9]**

i) Laplace Equation

ii) Fourier Equation and

iii) Poisson's Equation

b) The temperature at the inner and outer surfaces of a boiler wall made of 20mm thick steel and covered with an insulating material of 5 mm thickness are 300°C and 50°C respectively. If the thermal conductivities of steel and insulating material are 58W/m°C and 0.116 W/m°C respectively, determine the rate of flow through the boiler wall. **[6]**

OR

Q2) a) Explain the following laws which governs the modes of Heat Transfer : **[6]**

i) Fourier's Law of Conduction

ii) Newton's Law of Cooling

iii) Stefan Boltzmann's Law

b) In a furnace, temp of hot gases is 2100°C. Ambient temp is 40°C. Heat flow by radiation from hot gases to inner surface of the wall is 23kW/m^2. Convective heat transfer coefficient between hot gases and the inner surface of the wall is 12W/m^2K. Thermal conductance of the wall is 58W/m^2K. Heat flow by radiation from external surface of the wall to surroundings is 10kW/m^2. Temp of inside surface of the wall is 900°C. For the external surface of the wall, find surface temp and convective heat transfer coefficient. **[9]**

P.T.O.

Q3) a) Write the equation for finding critical radius of cylindrical and spherical object. Why critical thickness is not significance in case of slab. **[8]**

b) A straight rectangular fin (k = 55 W/mK), 1.4 mm thick and 35mm long is exposed to air at 20°C with h=50W/m^{2}K, when its base temperature is 150°C. Assume insulated fin tip.

i) Calculate the maximum possible heat loss rate.

ii) What is actual heat loss for this base temperature?

[7]

OR

Q4) a) Explain the Following Terms : **[6]**

i) Effectiveness of Fins

ii) Efficiency of Fins

b) A pipe with inner diameter = 12 cm and outer diameter = 12.5 cm carries steam is covered with an insulating substance (k = 1 w/mK). The steam temperature and the ambient temperatures respectively are 200°C and 30°C. If the convective heat transfer coefficient between the insulation surface and air is 8 W/m^{2}K, find the critical radius of insulation. For this value of outer radius, calculate the heat loss if the length of pipe is 100m and also find outer surface temperature. Neglect resistance of pipe material. **[9]**