BACHELOR OF TECHNOLOGY (C.B.C.S.) (2020 COURSE)
B.Tech.Sem - V MECHANICAL : WINTER- 2022
SUBJECT : HEAT TRANSFER - PRINCIPLES & APPLICATIONS

Day : Tuesday | Time : 02:30 PM-05:30 PM

Date : 06-12-2022 | **W-24505-2022** | Max. Marks : 60

N. B. :

1) All questions are **COMPULSORY.**
2) Figures to the right indicate **FULL** marks.
3) Draw neat and labelled diagrams **WHEREVER** necessary.
4) Use of non-programmable calculator is **ALLOWED.**
5) Assume suitable data, if necessary.

Q. 1 Explain the concept of critical radius of insulation. How do you decide the thickness for electric wire and steam pipes? **(10)**

OR

Explain Fourier's Law of heat conduction. **(10)**
A 2 mm diameter wire with 0.8 mm thick layer of insulation (k = 0.15 W/ m^0c) is used in certain electric heating application. The insulated surface is exposed to atmosphere with convective heat transfer coefficient 40 W/ m^0c. What percentage change in heat transfer rate would occur if critical thickness of insulation is used? It may be assumed that temperature difference between surface of the wire and surrounding air remains unchanged.

Q. 2 Saturated steam at 110^0C flows inside a copper pipe (k = 450 W/ mK)having on internal diameter of 10 cm and an external diameter of 12 cm the surface resistance on the steam side is 12000 W/ m^2K and that on the outside surface of the pipe is 18 W/ m^2K. Determine the heat loss from the pipe if it is located in space at 25^0C. How this loss would be affected if the pipe is lagged with 5 cm thick insulation of thermal conductivity 0.22 W/mK. **(10)**

OR

A 8 mm thick plane wall generates heat at the rate of $1.2 \times 10^5 W/m^3$. One side of the wall is exposed to environment at 90^0C whilst the outer side is insulated. The convective heat coefficient is 560 W/m^{20} C. Proceed from the basic principles to determine the maximum temperature to which the wall will be subjected. The thermal conductivity of the wall material may be taken as 0.15 W/ m^0c. **(10)**

Q. 3 Give the classification of fins. The handle of a saucepan, 30 cm long and 2 cm in diameter is subjected to 100^0 C temperature during a certain cooking operation. The average heat transfer coefficient of 7.35 W/ m^2 ^{0}c at 24^0 C of air temperature. The cook is likely to grasp the last 10 cm of the handle and hence the temperature in this region should not exceed 38^0c. What should be the thermal conductivity of the handle material to accomplish it? The handle may be treated as insulated tip fin. **(10)**

OR

Give significance of Biot number and Time constant. Derive the expression for temperature distribution in convective off end fin. **(10)**

Q. 4 Explain thermal boundary layer concept. Discuss dimensional analysis for forced convection heat transfer. **(10)**

OR

Air moving at 0.3 m/s blows over a top of chest type freezer. The top of the freeze measures 0.9 m by 1.5 m and is poorly insulated so that the surface remains at 10^0 C. If the temperature of air is 30^0 C make calculations for the maximum heat transfer by forced convection. From the top of the freezer. Properties of air 20^0 C are as **(10)**

$\upsilon = 15.06 \times 10^{-6} m^2 / s$, $k = 0.0259\ w / m''c$, Pr = 0.7.3.

Q. 5 Explain Planck's Distribution Law. Derive expression for Stefan – Boltzmann Law of Radiation. **(10)**

OR

Derive the expression for heat exchange between block bodies. Explain intensity of radiation and Lambert's Cosine Law. **(10)**

Q. 6 Explain fooling factor. Derive expression for LMTD for counter flow heat exchanger. **(10)**

OR

Explain drop wise condensation. In a food processing plant a brine solution is heated from 12^0 C to 6.5^0 C in a double pipe parallel flow heat exchanger by water entering at 20.5^0 C at the rate of 9kg/min. Determine the heat exchanger area for an overall heat transfer coefficient of 860W/ m^2k for water Cp = 4.8 KJ/kgk. **(10)**

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