CBCS SCHEME

USN | | | | | | | | | | 18ME63

Sixth Semester B.E. Degree Examination, Jan./Feb. 2023
Heat Transfer

Time: 3 hrs. Max. Marks: 100

Note: *1. Answer any FIVE full questions, choosing ONE full question from each module.*
2. Heat transfer data hand book permitted.

Module-1

1 a. Derive the general three dimensional heat conduction equation in Cartesian co-ordinate system. **(10 Marks)**

b. A wall of a furnace is made up of inside layer of silica brick 120mm thick (1.7w/m°k) covered with a layer of magnetite brick 240mm thick (5.8w/m°k). Temperature at the inside surface of silica and outside surface of magnetite brick wall are 725°C and 110°C respectively. The thermal contact resistance between two walls is 0.0035°k/w per unit area. Calculate : i) Heat flux ii) Temperature drop at interface. **(10 Marks)**

OR

2 a. What do you mean by boundary condition of 1^{st}, 2^{nd} and 3^{rd} kind? **(06 Marks)**

b. Derive critical thickness and insulation of cylinder. **(06 Marks)**

c. A composite wall consists of 10cm layer of building brick (0.7 w/m°C) and 3 cm plaster (0.5 w/m°k). An insulating material of K = 0.08 w/m°C is to be added to reduce the heat transfer through the wall by 70%. Determine the thickness of insulating layer. **(08 Marks)**

Module-2

3 a. Derive an expression for the temperature distribution for a long fin of uniform cross section with insulated trip. **(10 Marks)**

b. A rod (K = 200w/m°k) 10mm in diameter and 5cm long has its one end maintained at 100°C. The surface of the rod is exposed to ambient air at 30°C with convective HTC of $100 w/m^2K$. Assuming other end insulated, determine :

i) Temperature of rod at 25mm distance from the end at 100°C
ii) Heat dissipation rate
iii) Effectiveness. **(10 Marks)**

OR

4 a. Obtain an expression for temperature distribution of solid in lumped heat transfer analysis in dimensional numbers. **(10 Marks)**

b. A 15 mm diameter mild steel sphere K = 42 w/m°C is exposed to cooling air flow at 20°C with h = 120 w/m^{2}°C. Determine the following :

i) Time required to cool from 550°C to 90°C
ii) Instantaneous heat transfer rate 2 minutes after start of cooling. **(10 Marks)**

Module-3

5 a. Explain the energy balance procedure to obtain the finite difference formulation of one dimensional conduction problem in Cartesian coordinates. **(08 Marks)**

b. One face of a slab of thickness 1 cm (K = 20w/mk) is maintained at 40°C and the other surface is subjected to a convection heat transfer with fluid at 100°C and h = $4000 w/m^{2}$°k. There is uniform internal heat generation of $8 \times 10^7 w/m^3$. Dividing slab into 5 equally spaced subregions.

i) Find temperature at different nodes. Assume one dimensional steady state conduction.
ii) If the left surface is insulated. What is the temperatures at surface in steady state. **(12 Marks)**

OR

6 a. State and explain :
i) Kirchoff's law
ii) Plank's law
iii) Wein's Displacement law
iv) Stefan – Boltzamann law. **(08 Marks)**

b. Explain the concept of Black body. **(04 Marks)**

c. Calculate the net radiant heat exchange per unit area for two large parallel plates at temperature of 427°C and 27°C respectively. $E_{hot} = 0.9$, $E_{cold} = 0.6$. If a polished aluminium shield is placed between them. Find the percentage reduction in heat transfer $\epsilon_{shield} = 0.4$. **(08 Marks)**

Module-4

7 a. With reference to fluid flow over a flat plate, discuss the concepts of velocity boundary layer and thermal boundary layer, with necessary sketches. **(08 Marks)**

b. Air at 0°C and 20 m/sec flows over a flat plate of length 1.5m, that is maintained at 50°C. Calculate the average heat transfer coefficient over the region where flow is laminar. Find the average heat transfer coefficient and the heat loss for the entire plates per unit width. **(12 Marks)**

OR

8 a. Explain the significance of :
i) Nusselt number
ii) Reynolds's number
iii) Prandtl number
iv) Groshoff number. **(08 Marks)**

b. Consider a square plate size of 0.6m in a room with stagnant air at 20°C. One side of plate is maintained at 100°C, while the other side is adiabatic. Determine the heat loss if the plate is:
i) Vertical ii) Horizontal with hot surface facing NP. **(12 Marks)**

Module-5

9 a. Derive an expression for LMTD for a parallel flow heat exchanges. **(10 Marks)**

b. Oil at 100°C (C_p = 3.6kJ/kg°K) flows at rate of 30,000kg/hr and enters a parallel flow heat exchanges. Cooling water (C_P = 4.2kJ/kg°K) enters heat exchanges at 10°C at the rate of 50,000kg/hr. The heat transfer area is 10m^2 and u = 1000w/m^{2}k calculate outlet temperature of oil and water. Also find maximum possible temperature of oil and water at exit. **(10 Marks)**

OR

10 a. Clearly explain the regions of pool boiling with neat sketch. **(08 Marks)**

b. A vertical tube of 60mm outside diameter and 1.2m long is exposed at atmospheric pressure. The outer surface of the tube is maintained at a temperature of 30°C. Calculate the following:
i) Rate of heat transfer
ii) Rate of steam condensation per second. **(12 Marks)**

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