CBCS SCHEME

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17ME63

Sixth Semester B.E. Degree Examination, July/August 2022
Heat Transfer

Time: 3 hrs. Max. Marks: 100

Note: *1. Answer any FIVE full questions, choosing ONE full question from each module.*
2. Use of heat transfer data handbook and steam tables are permitted.

Module-1

1 a. State the laws of governing there basic modes of heat transfer. **(06 Marks)**

b. What do you mean by boundary conditions of 1st, 2nd and third kind? **(06 Marks)**

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

OR

2 a. Derive the general 3 – dimensional conduction equation in Cartesian co-ordinates and state the assumptions. **(10 Marks)**

b. A metal (K = 45W/m°C) steam pipe of 5cm ID and 6.5cm OD is lagged with 2.75cm thickness of high temperature high insulation having thermal conductivity 1.1W/m°C convective heat transfer co-efficient on inside and outside surface h_i = 4650W/m^{2}K and h_0 = 11.5W/m^{2}K respectively. If the steam temperature is 200°C and the ambient temperature is 25°C calculate :

i) Heat lost per meter length of pipe
ii) Temperature at the interface
iii) Overall heat transfer co-efficient to outside and inside surfaces. **(10 Marks)**

Module-2

3 a. Derive an expression for critical thickness of insulation for a cylinder. **(06 Marks)**

b. Derive an expression for temperature distribution and heat flow through a rectangular fin, when the end of fin is insulated. **(08 Marks)**

c. A steel rod (K = 30W/mK) 1cm diameter and 5cm long with insulation end is to be used as spine. It is exposed to surrounding temperature of 65°C and heat transfer co-efficient of 50W/m^{2}K. The temperature of base is 98°C. Determine :

i) Fin efficiency
ii) Temperature at the end of rod. **(06 Marks)**

OR

4 a. Explain the physical significance of Biot and Fourier number. **(04 Marks)**

b. What is lumped system analysis? Derive an expression for temperature distribution in a lumped system. **(08 Marks)**

c. A 15mm diameter Mild steel sphere (K = 42W/m°C) is exposed to cooling air flow at 20°C resulting in the convective co-efficient of 'h' = 120W/m°C. Determine the following :

i) Time required to cool the sphere from 550°C to 90°C
ii) Instantaneous heat transfer rate 2 minutes after start of cooling
iii) Total energy transferred from the sphere during the first 2 minutes. For mild steel take ρ = 7850 kg/m^3. C_p = 475J/kg°C and α = 0.045m^2/hr. **(08 Marks)**

Module-3

5 a. Explain the following :
i) Velocity boundary layer
ii) Thermal boundary layer. **(06 Marks)**

b. Explain the physical significance of following dimension less number
i) Reynolds number
ii) Prandtl number
iii) Nusselt number. **(06 Marks)**

c. Consider a square plate 0.5m by 0.5m with one surface insulated and other surface maintained at a uniform temperature of T_ω = 385K which is placed in quiescent air at temperature of T_∞ = 315K. Calculate the average heat transfer coefficient for following orientation of surface :
i) The plate is vertical
ii) The plate is horizontal, and the hot surface facing down. **(08 Marks)**

OR

6 a. Using dimensional analysis derive an expression relating to Nusselt number, Prandtl and Grashoff's numbers for natural convection. **(10 Marks)**

b. Water at 50°C enters 1.5cm diameter and 3m long tube with a velocity of 1.5m/s. The tube wall is maintained at 100°C. Calculate the heat transfer co-efficient and total amount of heat transferred if the exit temperature is 70°C. **(10 Marks)**

Module-4

7 a. Define :
i) Block body
ii) Planks law
iii) Wein displacement law
iv) Lamberts law. **(08 Marks)**

b. Prove that the emissive power of the block body in hemispherical enclosure is π terms of intensity of radiation. **(08 Marks)**

c. The temperature of black surface of 0.2m^2 area is 540°C. Calculate :
i) The total rate of energy emission
ii) The intensity of normal radiation
iii) The wave length of monochromatic emissive power. **(04 Marks)**

OR

8 a. Obtain an expression for Radiation shield between two parallel in finite plates (planes) separated by one radiation shield. **(10 Marks)**

b. The large parallel plates having emissivity 0.3 and 0.6 are maintained at a temperature of 900°C and 250°C. A radiation shield having an emissivity of 0.05m both sides is placed between plates calculate :
i) Heat transfer without shield
ii) Heat transfer with shield
iii) Percentage of reduction in the heat transfer due to shield
iv) Temperature of shield. **(10 Marks)**

Module-5

9 a. Derive an expression for LMTD counter flow heat exchanger and state the assumptions made. **(10 Marks)**

b. A refrigerator is designed to cool 250kg/hr of hot fluid of specific heat 3350J/kg°C at 120°C using a parallel arrangement 1000kg/hr of cooling water is available for cooling purposes at a temperature of 10°C. If overall heat transfer co-efficient is 1160W/m^2°C and the surface area of the heat exchanger is 0.25m^2. Calculate the outlet temperature of the cooling liquid and water and also the effectiveness of the heat exchanger and rate of heat transfer. **(10 Marks)**

OR

10 a. With neat sketch explain the regions of pool boiling at 1 atmospheric pressure. **(10 Marks)**

b. A 12 cm outside diameter and 2m long tube is used in a big condenser to condensate the steam at 0.4 bars. Estimate the unit surface conductance :

i) In vertical position

ii) In horizontal position. Also find the amount of condensate formed per hour in both cases. **(10 Marks)**

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