# CBCS SCHEME

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17ME63

## Sixth Semester B.E. Degree Examination, June/July 2023

## 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 hand book is permitted, steam table is permitted.***





### Module-1

1 a. Explain the different modes of heat transfer with laws governing them. **(09 Marks)**

b. What are the three thermal boundary conditions? Explain. **(06 Marks)**

c. Derive an expression for rate of heat transfer and variation of temperature with radius for a hollow cylinder. **(05 Marks)**

**OR**

2 a. Derive the generalized three dimensional conduction equation in Cartesian Co-ordinates under unsteady state with heat generation. State the assumptions made. **(10 Marks)**

b. A thin metal sphere of diameter 300 mm is used to store a liquefied gas at -200°C. To reduce heat leakage from atmosphere at 30°C, it is insulated by two layers of insulation each 30 mm thick. The first layer of insulating material has a thermal conductivity of 0.06 W/m-K and second layer has a thermal conductivity of 0.6 W/m-K.
Determine the heat leakage,
(i) When the better insulator is next to sphere
(ii) When the better conductor is next to sphere. **(10 Marks)**

### Module-2

3 a. Derive an expression for critical thickness of insulation for a cylinder and explain its significance. **(08 Marks)**

b. An casing of electric motor is an approximate cylinder of 250 mm diameter and 500 mm long. There are 30 equispaced longitudinal fins of thickness 5 mm, height 25 mm on the pheripherry of casing. If the temperature of casing is 56°C and ambient temperature is 26°C. Determine heat dissipation from casing body. Take $h = 25$ W/m$^2$K and K(fin) = 30 W/m-K. Assume that fins are insulated at the tip. **(12 Marks)**

**OR**

4 a. Derive an expression for the temperature distribution and rate of heat transfer for a pin fin, when the tip of the fin is insulated. **(12 Marks)**

b. A 12 cm diameter long bar initially at a uniform temperature of 40°C is placed in a medium at 650°C with a convective co-efficient of 22 W/m$^2$K. Calculate time required for a bar to reach 255°C. Take K = 20 W/m-K, $\rho = 580$ kg/m$^3$, C = 1050 J/kg-K for material of bar. **(08 Marks)**

### Module-3

5 a. Explain the physical significance of,
(i) Prandtl number (ii) Reynold's number
(iii) Nusselt number (iv) Grashoff number. **(08 Marks)**

b. A square plate $(0.5m \times 0.5m)$ with one surface insulated and the other surface maintained at temperature of 385 K is placed in ambient air at a temperature of 315 K. Calculate the average heat transfer co-efficient for free convection for the following orientations of the hot surface :
   (i) The plate is horizontal and hot surface faces up.
   (ii) The plate is horizontal and hot surface faces down. **(12 Marks)**

**OR**

6 a. Using dimensional analysis, obtain the dimensionless parameters in-forced convection heat transfer. **(10 Marks)**

b. Air at 25°C and atmospheric pressure flows across a heated cylinder of diameter 7.5 cm. If the velocity of air flow is 1.2 m/s and the cylinder surface is maintained at 95°C, compute the rate of heat transfer. **(10 Marks)**

## Module-4

7 a. State and explain the following laws of radiation:
   (i) Kirchoff's law.
   (ii) Plank's law.
   (iii) Weins displacement law
   (iv) Lambert cosine law **(08 Marks)**

b. Two large parallel plates of equal area are at temperature 150°C and 40°C while their emmisivities are 0.6 and 0.7. If the radiation shield of emissivity 0.04 is inserted between the plates. Estimate the percentage reduction in heat transfer and equilibrium temperature of radiation shield. **(12 Marks)**

**OR**

8 a. Explain briefly the concept of black body. **(05 Marks)**

b. For a black body enclosed in a hemispherical space, prove that emissive power of the black body is $\pi$ times the intensity of radiation. **(07 Marks)**

c. Define : (i) Emissive power (ii) Radiation shield (iii) Radiation shape factor (iv) Radiosity **(08 Marks)**

## Module-5

9 a. Define LMTD and obtain an expression for LMTD for parallel flow heat exchanger. **(10 Marks)**

b. A counter flow concentric tube heat exchanger is used to cool the engine oil [$C_P$ = 2130 J/kgK] from 160°C to 60°C with water available at 25°C as the cooling medium. The flow rate of cooling water through inner tube of 0.5 m diameter is 2 kg/s. While flow rate of oil through outer annulus of diameter 0.7 m is also 2 kg/s. If the value of overall heat transfer co-efficient is 300 W/m$^2$K. How much length the heat exchanger should be to meet its cooling requirement. **(10 Marks)**

**OR**

10 a. With neat sketch, explain different regims of pool boiling. **(08 Marks)**

b. Explain filmwise and dropwise condensation. **(06 Marks)**

c. Air free saturated steam at a temperature of 65°C condenses on a vertical outer surface of a 3 m long vertical tube maintained at a uniform temperature of 35°C. Assuming film condensation, calculate the average heat transfer co-efficient over the entire length of the surface. **(06 Marks)**

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