5E6201

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B. Tech. (Sem. V) (Main / Back) Examination, November - 2018
Mech. Engineering
5ME1A Heat Transfer

Time : 3 Hours] **[Maximum Marks : 80**
[Min. Passing Marks : 26

*Attempt any **five questions**, selecting **one question** from **each unit**. All Questions carry **equal** marks. Schematic diagrams must be shown wherever necessary. Any data you feel missing suitably be assumed and stated clearly. Units of quantities used / calculated must be stated clearly.*

Use of following supporting material is permitted during examination. (Mentioned in form No. 205)

1. Heat Transfer Data Book 2. NIL

UNIT - I

1 (a) Write the Fourier rate equation for heat transfer by conduction. Also explain parameters which influence the value of heat transfer coefficient. **8**

(b) A container with outside surface area 0.36 m^2 and outside temperature of 0°C contains ice at 0°C. The container is placed in ambient air at 24°C and the surface coefficient of heat transfer between the container surface and the surrounding air is estimated to be 6.25 W/m^2 deg. Calculate the rate of which ice would be changed into liquid water. Take latent heat of fusion of ice as 340 J/g. **8**

OR

1 (a) Derive the general conduction equation for cylindrical coordinates system being with uniform heat generation and unsteady state.

6

(b) A steam main 75 mm inside diameter and 90 mm outside diameter is lagged with two successive layers of insulation. The layer in contact with the pipe is 38 mm asbestos and the asbestos layer is covered with 25 mm thick magnesia insulation. The surface coefficients for inside and outside surface are 227 W/m^2k and 6.8 W/m^2k respectively. If the steam temperature 375°C and the ambient temperature is 35°C, calculate the steady loss of heat from steam for 60 m length of pipe.

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UNIT - II

2 (a) Derive the heat dissipation from an infinitely long fin and fin efficiency.

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(v) A long cylindrical bar of radius 7.5 cm comes out of an oven at 815°C through out and is cooled by quenching it in a large bath of 38°C coolant. If the surface coefficient of heat transfer between the bar surface and the coolant is 175 W/m^2-deg. Calculate the time it takes for the shaft centre to reach 116°C. Assume that k = 17.5 W/m-deg. and α = 0.0185 m^2/hr.

8

OR

2 (a) What do you understand by hydrodynamic and thermal boundary layers ? Illustrate with reference to flow over a flat heated plate.

8

(b) Define the Nusselt number. How it is related to temperature gradient in the fluid immediately in contact with the solid surface ? Mention the various approaches which have suggested for estimating the value of Nusselt number.

8

UNIT - III

3 (a) Explain Reyleigh method and the Buckingham's π theorem for dimensional analysis. What are repeating variables and how are they selected for dimensional analysis ?

8

(b) A steam pipe 6 cm in diameter is covered with 2 cm thick layer of insulation which has a surface emissivity of 0.92. The insulation surface temperature is 75°C and the pipe is placed in atmospheric air a 25°C. Considering heat loss both by radiation and natural convection, estimate the heat loss from 5 m length of pipe. Also calculate overall heat transfer coefficient.

8

OR

3 (a) Explain the different regimes of foiling heat transfer with the help of boiling curve coordinates.

6

(b) A copper pan of 35 cm diameter contains water and its bottom surface is maintained at 115°C by an electric heater. Calculate the power required to boil water in this pan and the rate at which water evaporates from the pan due to the boiling process. Also make calculations for the heat flun for these conditions.

10

UNIT - IV

4 (a) Working in terms of inlet and outlet temperature of the fluids and overall heat transfer coefficient, develop an expression for the heat transfer from one fluid to another in 9 conventional (i) Parallel flow (ii) Counter flow heat exchanger.

8

(b) A heat exchanger with 2 shell passes and 4 tube passes is used to cool oil (C_p = 3.55 kj/kg K) from 125°C to 50°C flowing at the rate of 2.5 kg/s. The cooling water (C_p = 4.18 kJ/kg k) enters the shell at 20°C with a flow rate of 3 kg/s and the overall heat transfer coefficient for the exchanger has been estimated at 115 W/m^{2}k. Calculate heat transfer through heat exchanger and area to accomplish the specified energy transfer.

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OR

4 (a) Derive the relationship between the effectiveness and the number of transfer units for a counter flow heat exchanger. **6**

(b) The engine oil at 150°C is cooled to 80°C in a parallel flow heat exchanger by water entering at 25°C and leaving at 60°C. Estimate the exchanger effectiveness and the number of transfer units. If the fluid flow rates and the inlet conditions remain unchanged, work out the lowest temperature to which the oil may be cooled by increasing length of exchanger. **10**

UNIT - V

5 (a) Derive a general relation for the radiation shape factor in case of radiation between two surface. **6**

(b) A domestic hot water tank 0.5 m diameter and 1m high is located in a large space effectively forming block surrounding. The surface emissivity and temperature are 0.8 and 350 k, and the temperature of surroundings is 295 k. Estimate the heat loss by radiation from the tank and suggest a possibility to reduce this heat loss. **10**

OR

5 (a) Explain the salient features and characteristics of radiation. **8**

(b) A stainless steel plate (E=0.6) at 100°C faces a brick wall (E = 0.75) 500°C. Estimate the heat flux and radiant heat transfer coefficient. **8**
