

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 Seam tables are permitted.

Module-1

- 1 a. Explain different modes of Heat transfer citing one example for each mode. (05 Marks)
b. A steam pipe of 4cm outer radius is covered with a layer of asbestos insulation of 1cm thickness, thermal conductivity, $0.15 \text{ W/m}^\circ\text{C}$ that is in turn covered by 3cm thick glass fibre insulation ($K = 0.05 \text{ W/m}^\circ\text{C}$). The surface of steam pipe is at 330°C and the outer surface of glass fibre layer is at 30°C . Determine interface temperature and the heat loss per meter length of pipe. (07 Marks)
c. Obtain the 3-D heat conduction equation in Cartesian co-ordinates stating the assumptions made. (08 Marks)

OR

- 2 a. What are Boundary Conditions? Explain BC 3rd kind for cylindrical geometry. (05 Marks)
b. A wire of 2mm diameter is heated electrically while it dissipates heat to the ambient with $h = 125 \text{ W/m}^\circ\text{C}$. If the wire is covered with 0.2mm thick insulation with $K = 0.175 \text{ W/m}^\circ\text{C}$. What are your interpretations on increase or decrease in heat loss from the wire? (07 Marks)
c. Explain the following terms with illustrations : i) Variable thermal conductivity
ii) Series and parallel arrangement of thermal resistances.
iii) Thermal diffusivity.
iv) Thermal contact resistance. (08 Marks)

Module-2

- 3 a. Explain the significance of fin efficiency and fin effectiveness. (05 Marks)
b. A cylinder 1m long and 50mm in diameter is placed in an ambience at 45°C with $h = 17 \text{ W/m}^2 \text{ }^\circ\text{C}$. It has 12 numbers of longitudinal straight fins ($K = 120 \text{ W/m}^\circ\text{C}$, height = 12.7mm, thickness = 0.76mm). Evaluate the total heat transfer rate if these fins behave as end-insulated fins when the cylinder surface temperature is held constant at 150°C . (07 Marks)
c. A spherical thermocouple junction of 0.706mm diameter measures gas temperature. The convective heat transfer coefficient on the bead surface is $400 \text{ W/m}^2 \text{ }^\circ\text{C}$. If the properties of junction material are given to be $K = 20 \text{ W/m}^\circ\text{C}$; $C_p = 400 \text{ J/kg K}$; $\delta = 8500 \text{ kg/m}^3$. Estimate the time taken by bead of reach 298°C , when placed into a hot stream of gas at 300°C . The temperature of the bead is initially at 30°C . (08 Marks)

OR

- 4 a. Explain the significance of Biot number and Fourier number in transient heat conduction. (05 Marks)
b. An ordinary egg can be approximated as a sphere of 5cm diameter. The initial temperature of the egg is 5°C before it is dropped into 95°C water with convective heat transfer coefficient of $1200 \text{ W/m}^2 \text{ }^\circ\text{C}$. Assume the egg properties to be same as that of water and evaluate the time required for the centre of egg to attain a temperature of 70°C . (07 Marks)

- c. A hot surface at 100°C is to be cooled by attaching 100 numbers of pin fins 3cm long, 0.25cm diameter made of aluminum (end insulated). ($K = 237 \text{ W/m}^{\circ}\text{C}$) while surrounding medium is at $35 \text{ W/m}^2 \text{ C}$ and 30°C . the $1 \text{ m} \times 1 \text{ m}$ system has heat dissipation through these fins of equal size. Determine the rate of heat transfer from the fin mounted surface.

(08 Marks)

Module-3

- 5 a. Explain Explicit scheme of solution to the One – dimensional transient heat conduction problem without heat generation. (10 Marks)
- b. Briefly illustrate the applications connected with Stefan Boltzmann law. A surface is maintained at a temperature of 800K and radiates heat to another surface at 500K with a unity view factor. If the emissivity of the surfaces are 0.85 evaluate the net exchange of heat between these two surfaces by radiation process. (10 Marks)

OR

- 6 a. Briefly explain the use of numerical techniques to solve the heat transfer problems. Explain the process of discretize based on finite difference methodology. (10 Marks)
- b. Explain the following laws with reference to thermal radiation heat transfer :
i) Stefan – Boltzmann law ii) Wein – Displacement law iii) Kirchoff's law
iv) Lamberts Cosine rule. (10 Marks)

Module-4

- 7 a. Explain the formation of boundary layers (thermal and hydrodynamic) for flow over a flat plate. (05 Marks)
- b. Engine oil at 60°C flows over the upper surface of a 5m long flat plate whose temperature is 20°C with a velocity of 2m/s. Determine the total drag force and the rate of heat transfer per unit width of plate. (07 Marks)
- c. Distinguish between Free convection and Forced convection on basis of the associated dimensional numbers. (08 Marks)

OR

- 8 a. Explain the concept of developed and developing flow with respect to internal flow through circular pipe. (05 Marks)
- b. A long 10cm diameter steam pipe whose external surface is at 110°C passes through some open area that is not protected against winds. Determine the rate of heat loss from the pipe when air is at 1 atmp and 10°C moving at 8m/s. (07 Marks)
- c. A 6m long section of an 8cm diameter horizontal pipe passes through a large room whose temperature is 20°C . If the outer surface temperature of the pipe is 70°C , evaluate the rate of heat loss from the pipe by natural convection. (08 Marks)

Module-5

- 9 a. Discuss the different regimes of pool boiling curve. (10 Marks)
- b. Steam condenses at 60°C on shell side of a steam condenser , while cooling water flows inside tubes at 3kg/S. The inlet and outlet temperature of water are 20°C and 50°C respectively. Considering $U_m = 2000 \text{ W/m}^2 \text{ }^{\circ}\text{C}$. Calculate the surface area required. (10 Marks)

OR

- 10 a. Distinguish between Drop wise and Film wise condensation. (08 Marks)
- b. A 2 – shell pass , 4 tube pass heat exchanger is used to cool processed water from 75°C to 25°C on the tube side at a rate of 5kg/S with cold water entering shell side at 10°C with flow rate of 6kg/S. If $U_m = 750 \text{ W/m}^2 \text{ }^{\circ}\text{C}$, find heat exchange area. (12 Marks)
