CBCS SCHEME

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21AE/AS71

Seventh Semester B.E./B.Tech. Degree Examination, June/July 2025
Conjugate Heat Transfer

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Explain the heat transfer by solid and fluids with any application **(15 Marks)**

b. Write the applications of conjugate heat transfer **(05 Marks)**

OR

2 a. A surface wall is made up of 3 layers one of fire brick, one of insulating brick and one of red brick. The inner and outer surface temperatures are 900°C and 30°C respectively. The respective co.efficient of thermal conductivity of the layers are 1.2, 0.14 and 0.9 W/mk and the thickness of 20 cm, 8 cm and 11 cm. Assuming close bonding of the layers at the interfaces. Find the heat loss per square meter and interface temperatures. **(08Marks)**

b. A steel pipe of 120 mm inner diameter, 140 mm outer diameter with thermal conductivity 55 w/mk is covered with two layers of insulation each having a thickness of 55 mm. The thermal conductivity of the first insulation material is 0.05 W/mk and that of the second is 0.11 W/mk. The temperature of the inside tube surface is 240°C and that of the outside surface of the insulation is 60°C. Calculate the loss of heat per meter length of pipe and interface temperature between the two layers of insulation. **(08 Marks)**

c. A hollow sphere K = 65W/mk of 120mm inner diameter and 350 mm outer diameter is covered 10 mm layer of insulation K = 10 W/mk. The inside and outside temperatures are 500°C and 50°C respectively. Calculate the rate of heat flow through this sphere. **(04 Marks)**

Module-2

3 a. What is the purpose of fins? List the types of fins with their applications. **(06 Marks)**

b. Find the heat loss from a rod of 3mm in diameter and infinitely long when its base is maintained at 140°C. The conductivity of the material is 150 W/mk and the heat transfer co. efficient on the surface of the rod is 300 w/m^{2}K. The temperature of the air surrounding the rod is 15°C. **(06 Marks)**

c. A long rod 5 cm diameter, its base is connected to a furnace wall at 150°C, while the end is projecting into the room at 20°C. The temperature of the rod at distance of 20 cm apart from its base is 60° C. The conductivity of the material is 200 W/mk. Determine connective heat transfer co. efficient. **(08 Marks)**

OR

4 a. A 50 × 50 cm^2 aluminium slab of 6mm thick is at 400°C initially and it is suddenly immersed in water. So its surface temperature is lowered to 50°C. Determine the time required for the slab to reach 120°C. Take heat transfer co. efficient h= 100 W/m^2k. **(08 Marks)**

b. A solid copper cylinder of 7 cm diameter is initially t a temperature of 25°C and it is suddenly dropped into ice water. After 3 minutes the temperature of the cylinder is again measured as 1°C. Determine unit surface conductance by using humped heat analysis method. **(06 Marks)**

c. An aluminium cube 6 cm on a side is originally at a temperature of 500°C. It is suddenly immersed in a liquid at 10°C for which h is 120 W/m^2k. Estimate the time required for the cube to reach a temperature of 250°C. For aluminium ρ = 2700 kg/m^3, C_p = 900J/kgk, k = 204 W/mk. **(06 Marks)**

Module-3

5 a. A vertical plate of 0.75 m height is at 170°C and is exposed to air at a temperature of 105°C and one atmosphere, Calculate :
i) mean heat transfer co. efficient
ii) Rate of heat transfer per unit width of the plate. **(10 Marks)**

b. A vertical pipe of 12 cm outer diameter, 2.5 m long at a surface temperature of 120°C is in a room where the air is in at 20°c. Calculate the heat loss per meter length of the pipe. **(10 Marks)**

OR

6 a. Air at 20°c, at a pressure of 1 bar is following over a flat plate at a velocity of 3m/s. If the plate is maintained at 60°c, Calculate the heat transfer per unit width of the plate. Assuming the length of the plate along the flow of air is 2 m. **(10 Marks)**

b. Air at 15°c, 30km/hr flows over a cylinder of 400mm diameter and 1500mm height with surface temperature of 45°c. Calculate the heat loss. **(10Marks)**

Module-4

7 a. A block body at 3000 Kemits radiation. Calculate the following :
1. Monochromatic emissive power at 1 μm wave length.
2. Wavelength at which emission is maximum.
3. Maximum emissive power.
4.Total emissive power
5. Calculate the total emissive of the furnace it is assumed as a real surface having emissivity equal to 0.85. **(10 Marks)**

b. Emissivities of two large parallel plates maintained at 800°c are 0.3 and 0.5 respectively. Find the net radiant heat exchange per square meter for these plates. Find the percentage reduction in heat transfer when a polished aluminium radiation shield of emissivity 0.06 is placed between them. Also find the temperature of the shield. **(10 Marks)**

OR

8 a. Two large parallel plates are maintained at 600k and 900k and emissivities are 0.4 and 0.7 respectively. Determine the heat transfer by radiation and also calculate percentage reduction in heat transfer and shield temperature when another plate of emissivity 0.05 introduced in between them. **(10 Marks)**

b. Expand the basic concepts of heat exchangers with a neat sketch for a different types with the applications. **(10 Marks)**

Module-5

9 a. Explain the factor of conjugation for limiting variants. (10 Marks)
b. Discuss the harmonic law of Oscillations (10Marks)

OR

10 a. Explicate Nucleate boiling. (10 Marks)
b. Interpret drop wise condensation (10 Marks)

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