Heat Transfer and Industrial Furnaces (Code: MEP293)

1. **(a) What are heat transfer and its modes?**
   (b) What is the physical mechanism of conduction heat transfer in solids and fluids?
   (c) Why does metal feel colder than wood, if they are both at the same temperature?
   (d) What is the difference between free and forced convection heat transfer?
   (e) Where is the freezer compartment put in a fridge? Why?

2. **The inner and outer surfaces of a 5 m x 6 m brick wall of thickness 30 cm and thermal conductivity $0.69\ W/m.℃$ are maintained at temperatures of 20℃ and 5℃, respectively. Determine the rate of heat transfer through the wall, in W.**

3. **The inner and outer surfaces of a 0.5 cm thick, 2 m x 2 m window glass in winter are at 10℃ and 3℃, respectively. If the thermal conductivity of the glass is $0.78\ W/m.℃$, determine the amount of heat loss, in kJ, through the glass over a period of 5 hours. What would your answer be if the glass were 1 cm thick?**

4. **An aluminum pan whose thermal conductivity is $237\ W/m.℃$ has a flat bottom with diameter 20 cm and thickness 0.4 cm. Heat is transferred steadily to boiling water in the pan through its bottom at a rate of 800 W. If the inner surface of the bottom of the pan is at 105℃, determine the temperature of the outer surface of the bottom of the pan.**

5. **A 0.3 cm thick, 12 cm high and 18 cm long circuit board houses 80 closely spaced logic chips on one side, each dissipating 0.06 W. The board is impregnated with copper fillings and has an effective thermal conductivity of $16\ W/m.℃$. All the heat generated in the chips is conducted across the circuit board and is dissipated from the back side of the board to the ambient air. Determine the temperature difference between the two sides of the circuit board.**

6. **The roof of an electrically heated home is 6 m long, 8 m wide and 0.25 m thick, and is made of a flat layer of concrete whose thermal conductivity is $k = 0.8\ W/m.℃$. The temperatures of the inner and the outer surfaces of the roof one night are measured to be 15℃ and 4℃, respectively, for a period of 10 hours. Determine (a) the rate of heat loss through the roof that night and (b) the cost of that loss to the home owner if the cost of electricity is LE 0.05/kWh.**

7. **Hot air at 80℃ is blown over a 2 m x 4 m flat surface at 30℃. If the average convection heat transfer coefficient is $55\ W/m^2.℃$, determine the rate of heat transfer from the air to the plate, in kW.**

8. **A 1.4 m long, 0.2 cm diameter electrical wire extends across a room that is maintained at 20℃. Heat is generated in the wire as a result of resistance heating, and the surface temperature of the wire is measured to be 240℃ in steady operation. Also, the voltage drop and electric current through the wire are measured to be 110 V and 3 A, respectively. Disregarding any heat transfer by radiation, determine the convection heat transfer coefficient for heat transfer between the outer surface of the wire and the air in the room.**

9. **Consider a person standing in a room at 23℃. Determine the total rate of heat transfer from this person if the exposed surface area and the skin temperature of the person are $1.7\ m^2$**

and 32℃, respectively, and the convection heat transfer coefficient is 5 $W/m^2.℃$. Take the emissivity of the skin and the clothes to be 0.9, and assume the temperature of the inner surfaces of the room to be the same as the air temperature.

10. **Consider a flat plate solar collector placed horizontally on the flat roof of a house. The collector is 1.5 m wide and 5 m long, and the average temperature of the exposed surface of the collector is 70℃. The emissivity of the exposed surface of the collector is 0.9. Determine the rate of heat loss from the collector by convection and radiation during a calm day when the ambient air temperature is 22℃ and the effective sky temperature for radiation exchange is 15℃. Take the convection heat transfer coefficient on the exposed surface to be 10 $W/m^2.℃$.**

11. **A 5 cm diameter spherical ball whose surface is maintained at a temperature of 80℃ is suspended in the middle of a room at 20℃. If the convection heat transfer coefficient is 8 $W/m^2.℃$ and the emissivity of the surface is 0.8, determine the total rate of heat transfer from the ball.**