PVP 19

Code: 19ME3601

III B.Tech - II Semester – Regular Examinations – JUNE 2022

HEAT TRANSFER
(MECHANICAL ENGINEERING)

Duration: 3 hours   Max. Marks: 70

Note: 1. This question paper contains two Parts A and B.
2. Part-A contains 5 short answer questions. Each Question carries 2 Marks.
3. Part-B contains 5 essay questions with an internal choice from each unit. Each question carries 12 marks.
4. All parts of Question paper must be answered in one place.

PART – A

1. a) Define Heat transfer? Mention its applications.
   b) What is meant by steady state and unsteady state heat transfer?
   c) Differentiate between Mean film temperature and bulk mean temperature.
   d) How film wise differ from drop wise condensation.
   e) What are the assumptions made to calculate radiation exchange between the surfaces?

PART – B

UNIT – I

2. a) Explain the mechanism of thermal conduction in gases, liquids and solids. 6 M
   b) Explain in brief about Conduction, Convection and Radiation with its physical governing laws for heat transfer. 6 M

OR

3. a) Explain the following terms 6 M

(i) Thermal Conductivity and,

(ii) Thermal Diffusivity.

b) Derive the general heat conduction equation in cylindrical coordinates. 6 M

UNIT – II

4. a) Derive equation of heat transfer by conduction through composite wall. 6 M

b) A hollow cylinder of 5cm ID and 10 cm OD, has an inner surface temperature of 200 ^{0}C and an outer surface temperature of 100 ^{0}C. If the thermal conductivity of the cylinder material is 70 W/m K. Determine the heat flow through the cylinder per unit length. 6 M

OR

5. a) State and explain 6 M

(i) Critical thickness of insulation,

(ii) Efficiency of fins, and

(iii) Effectiveness of fins.

b) A steel rod (k = 30 W/m ^{0}C) 1 cm in diameter and 5 cm long protrudes from a wall which is maintained at 100 ^{0}C. The rod is insulated at its tip and is exposed to an environment with h = 50 W/m^2 ^{0}C and t_a = 30 ^{0}C. Determine the fin efficiency, temperature at the tip of fin and the rate of heat dissipation. 6 M

UNIT-III

6. a) For natural convection heat transfer, show that Nu = f(Gr, Pr). 6 M

b) A horizontal fluorescent tube which is 3.8 cm in diameter and 120 cm long stands in still air at 1 bar and 20 ^{0}C. If the surface temperature is 40 ^{0}C and radiation is neglected, what is heat transfer rate by convection? Use Nu = 0.53 $(Gr.Pr)^{0.25}$. 6 M

OR

7. a) Derive momentum equation for hydrodynamic boundary layer over a flat plate. 6 M

b) Engine oil at 60 ^{0}C flows with a velocity of 2 m/s over a 5 m long flat plate whose temperature is 20 ^{0}C. Determine the drag force exerted by oil on the plate and the rate of heat transfer for a plate width of 1 m. 6 M

<u>UNIT – IV</u>

8. a) Derive an expression for Logarithmic Mean Temperature Difference (LMTD) for counter flow heat exchanger stating the assumption made. 6 M

b) In a food processing plant, a brine solution is heated from -12 ^{0}C to -6.5 ^{0}C in a double pipe parallel flow heat exchanger by water entering at 35 ^{0}C and leaving at 20.5 ^{0}C at the rate of 9 kg/min. Determine the heat exchanger area for overall heat transfer coefficient of 860 W/m^2 K. Take specific heat of water 4186 J/kg K. 6 M

OR

9. a) Discuss various regimes of pool boiling. 6 M

b) A vertical tube of 50 mm outside diameter and 2 m long is exposed to steam at atmospheric pressure. The outer surface of the tube is maintained at the temperature of 84 ^{0}C by circulating cold water through the tube. 6 M

Determine the rate of heat transfer and also the condenser mass flow rate.

UNIT – V

10. a) Explain the following as applied to radiation heat transfer. 6 M

    (i) Wien's displacement law

    (ii) Lambert's cosine law

    (iii) Shape factor

    b) A pipe carrying steam having an outside diameter of 20 cm runs in a large room, and is exposed to air at a temperature of 30 ^{0}C. The pipe surface temperature is 200 ^{0}C. Find the heat loss per meter length of the pipe by convection and radiation taking the emissivity of the pipe surface as 0.8. 6 M

OR

11. a) Derive the expression for radiant heat exchange between two finite black surfaces by radiation. 6 M

    b) Emissivities of two large parallel plates maintained at 800 ^{0}C and 300 ^{0}C are 0.3 and 0.5 respectively. Find the net radiation heat exchange per square meter for this plate. Find the percentage reduction in heat transfer when a polished aluminum radiation shield ($\varepsilon = 0.05$) is placed between them. Also find the temperature of shield. 6 M