Reg. No. :

Question Paper Code : 91844

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2019

Fifth Semester

Mechanical Engineering

ME 6502 – HEAT AND MASS TRANSFER

(Common to Mechanical Engineering (Sandwich) Mechanical and Automation Engineering)

(Regulations 2013)

(Also common to PTME 6502 – Heat and Mass Transfer B.E. Part-Time Mechanical Engineering – Fourth Semester – Regulations 2014)

Time : Three Hours Maximum : 100 Marks

Use of HMT data book is Allowed

Answer ALL questions.

PART – A (10×2=20 Marks)

1. Write the expression to determine the thermal conductivity as the function of temperature and unit of thermal conductivity.
2. Illustrate the Fourier's law of heat conduction.
3. State the Newton's law of cooling.
4. Define the Grashof Number.
5. How do you define the effectiveness of heat exchanger ?
6. Distinguish between the two basic types of condensation.
7. How do you define the black body and emissivity of a surface ?
8. Define the terms absorptivity, transmissivity and reflectivity.
9. State the Fick's law of diffusion.
10. Write the expression for determining the rate of mass convection.

PART – B (5×13=65 Marks)

11. a) Derive the three dimensional heat conduction governing equation in Cartesian Co-ordinates with neat sketch.

(OR)

b) An iron fin (end insulated type) having the length of 50 mm, width 100 mm and thickness 5 mm. Assume, K = 210 kJ/(mh°c) and h = 42 kJ/(m^2h°C) for the material of the fin and the temperature at fin base is 80°C. Find the amount of heat transferred through a fin. Also find the temperature at tip of the fin, if the atmosphere temperature is 20°C.

12. a) Air at 25°C flows over a flat plate at a speed of 5 m/s and heated to 135°C. The plate is 3 m long and 1.5 m wide. Calculate the local heat transfer coefficient at x = 0.5 m and the heat transferred from the first 0.5 m of the plate.

(OR)

b) A thin 80 cm long and 8 cm wide horizontal plate is maintained at a temperature of 130°C in large tank full of water at 70°C. Estimate the rate of heat input into the plate necessary to maintain the temperature of 130°C.

13. a) Explain in detail about the different regimes of pool boiling and boiling curve with neat sketch.

(OR)

b) i) Hot air at the rate of 8000 kg/h and at 100°C is cooled by passing it through a single-pass cross flow heat exchanger. To what temperature is the air cooled if water entering at 15°C flows through the tubes unmixed at the rate of 7500kg/h. Treat both fluids are unmixed.

Assume : U = 500 kJ/(h-m^2°C)
A = 20 m^2
Cp, air = 1.0 kJ/(kg°C)
Cp, water = 4.2 kJ/(kg°C). **(8)**

ii) Discuss the effects of non condensable gases in condenser. **(5)**

14. a) Derive the general expression for the determination of view factor between two differential surfaces with neat sketch.

(OR)

b) Consider the 5 m × 5 m × 5 m cubical furnace, whose surfaces closely black surfaces. The base, top and side surfaces of the furnace are maintained at uniform temperatures of 800 K, 1500 K and 500 K, respectively. Determine (a) the net rate of radiation heat transfer between the base and the side surfaces, (b) the net rate of radiation heat transfer between the base and the top surface, and (c) the net radiation heat transfer from the base surface.

15. a) Derive the steady state one dimensional expression for the rate of mass diffusion of species A through a plane wall with neat sketch.

(OR)

b) Explain in detail about the analogy between heat and mass transfer with neat sketches.

PART – C (1×15=15 Marks)

16. a) Derive an expression to determine the overall heat transfer coefficient from individual heat transfer coefficients in a double pipe shell and tube heat exchanger with heat sketch.

(OR)

b) Consider a staggered tube arrangement for which the tube OD is 16.4 mm and the longitudinal and transverse pitches are 34.3 mm and 31.3 mm respectively. There are seven rows of tubes in the air flow direction and eight tubes per row. Under typical operating conditions the tube surface temperature is at 70°C, while the air upstream temperature and velocity are 15°C and 6 m/s respectively. Determine the

i) air-side convection coefficient and **(10)**

ii) air-side pressure drop. **(5)**
