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Question Paper Code	11569

B.E./B.Tech. - DEGREE EXAMINATIONS, NOV/DEC 2022

Sixth Semester

Mechanical Engineering

ME8693 - HEAT AND MASS TRANSFER

(Regulations 2017)

(Use of standard HMT data book permitted)

Duration: 3 Hours Max. Marks: 100

PART - A (10 × 2 = 20 Marks)

Answer ALL Questions

		Marks, K-Level,CO
1.	State Fourier's Law of conduction.	*2,K1,CO1*
2.	Define Fin effectiveness.	*2,K1,CO1*
3.	What is meant by Newtonian and non-Newtonian fluids?	*2,K1,CO2*
4.	Define boundary layer thickness.	*2,K1,CO2*
5.	What is meant by Recuperater?	*2,K1,CO3*
6.	What is meant by compact heat exchangers?	*2,K1,CO3*
7.	State Wien's displacement law.	*2,K1,CO4*
8.	State Kirchoff's law of radiation.	*2,K1,CO4*
9.	Give the examples of mass transfer.	*2,K1,CO5*
10.	Define forced convective mass transfer.	*2,K1,CO5*

PART - B (5 × 13 = 65 Marks)

Answer ALL Questions

11. a) Two slabs, each 120 mm thick, have thermal conductivities of 14.5 W/m°C and 210 W/m°C. These are placed in contact, but due to roughness, only 30 percent of area is in contact and the gap in the remaining area is 0.025 mm thick and is filled with air. If the temperature of the face of the hot surface is at 220°C and the outside side surface of other slab is at 30°C, determine: *13,K2,CO1*

(i) Heat flow through the composite system.

(ii) The contact resistance and temperature drop in contact.

Assume that the conductivity of air is 0.032 W/m°C and that half of the contact (of the contact area) is due to either metal.

OR

b) A very long 25 mm diameter copper rod (k = 380 W/m°C) extends horizontally from a plane heated wall at 120°C. The temperature of the surrounding air is 25°C and the convective heat transfer coefficient is 9.0W/m²°C. *13,K2,CO1*

(i) Determine the heat loss.

(ii) How long the rod in order to be considered infinite?

12. a) A plate of length 750 mm and width 250 mm has been placed longitudinally in a stream of crude oil which flows with a velocity of 5 m/s. If the oil has a specific gravity of 0.8 and kinematic viscosity of 1 stoke, calculate: *13,K2,CO2*

(i) Boundary layer thickness at the middle of plate,

(ii) Shear stress at the middle of plate, and

(iii) Friction drag on one side of the plate.

OR

b) A hot plate 1.2 m wide, 0.35 m high and at 115°C is exposed to the ambient still air at 25°C. Calculate the following: *13,K2,CO 2*

(i) Maximum velocity at 180 mm from the leading edge of the plate.

(ii) The boundary layer thickness at 180 mm from the leading edge of the plate.

(iii) Local heat transfer coefficient at 180 mm from the leading edge of the plate.

(iv) Average heat transfer coefficient over the surface of the plate.

(v) Total mass flow through the boundary.

13. a) Water at atmospheric pressure is to be boiled in polished copper pan. The diameter of the pan is 350 mm and is kept at 115°C. Calculate the following: *13,K2,CO3*

(i) Power of the burner.

(ii) Rate of evaporation in kg/hr .

(iii) Critical heat flux for these conditions.

OR

b) A hot fluid at 200°C enters a heat exchanger at a mass flow rate of 10^4 kg/hr. Its specific heat is 2000 J/kg K. It is to be cooled by another fluid entering at 25°C with a mass flow rate 2500 kg/hr and specific heat 400 J/kg K. The overall heat transfer coefficient based on outside area of 20 m² is 250 W/m²K. Find the exit temperature of the hot fluid when the fluids are in parallel flow. *13,K2,CO3*

14. a) Calculate the following for an industrial furnace in the form of a black body and emitting radiation at 2500°C: *13,K2,CO4*

(i) Monochromatic emissive power at 1.2 μm length,

(ii) Wavelength at which the emission is maximum

(iii) Maximum emissive power,

(iv) Total emissive power, and
(v) Total emissive power of the furnace if it is assumed as a real surface with emissivity equal to 0.9.

OR

b) Determine heat lost by radiation per metre length of 80 mm diameter pipe at 300° C. if, (i) located in a large room with red brick walls at a temperature of 27° C. (ii) enclosed in a 160 mm diameter red brick conduit at a temperature of 27° C. *13,K2,CO4*
Take $\varepsilon_{(pipe)}$=0.79 and $\varepsilon_{(brick\ conduit)}$ = 0.93.

15. a) Ammonia and air are in equimolar diffusion in a cylindrical tube of 3.5 mm diameter and 25 m length. The total pressure is 1 atmosphere and the temperature is 27°C. One end of the tube is connected to a large reservoir of ammonia and the other end of the tube is open to the atmosphere. If the mass diffusivity for the mixture is 0.3 x 10^{-4} m^2/s, calculate the mass transfer rates of ammonia and air through the tube. *13,K2,CO5*

OR

b) Air at 20°C (ρ = 1.205 kg/m^3; ν = 15.06 x 10^{-6} m^2/s; D = 4.166 x 10^{-5} m^2/s) flows over a tray (length 320 mm, width= 420 mm) full of water with a velocity of 2.8 m/s. The total pressure of moving air is 1 atm and the partial pressure of water present in the air is 0.0068 bar. If the temperature on the water surface is 15°C, calculate the evaporation rate of water. *13,K2,CO5*

PART - C (1 × 15 = 15 Marks)

16. a) A 12 mm outside diameter pipe carries a cryogenic fluid at 90 K. Another pipe of 15 mm outside diameter and at 290 K surrounds it coaxially and the space between the pipes is completely evacuated. *15,K3,CO6*
(i) Determine the radiant heat flow for 3.5 m length of pipe if the surface emissivity for both surfaces is 0.25. (ii) Calculate the percentage reduction in heat flow if a shield of 13.5 mm diameter and 0.06 surface emissivity is placed between the pipes.

OR

b) The flow of heat occurs along the axis of the solid which has the shape of a truncated cone with circumferential surface insulated. The base is at 360°C and the area of the section at distance x measured from the base of the cone is given by: *15,K3,CO6*
$A = 1.2\ (1\text{-}1.5x)\ m^2$ where x is in meters. If the plane at x= 0.2 m is maintained at 120°C and the thermal conductivity of the solid material is 3W/m°C, determine:(i) Heat flow, (ii) Temperature at x 0.1 m, and (iii) Temperature gradient at the two faces and at x= 0.1 m.