Subject Code: KME501

PAPER ID-310639

Roll No:

B. TECH
(SEM-V) THEORY EXAMINATION 2020-21
HEAT & MASS TRANSFER

Time: 3 Hours ***Total Marks: 100***

Note: 1. Attempt all Sections. If require any missing data; then choose suitably.

SECTION A

1. Attempt *all* questions in brief. 2 x 10 = 20

Q no.	Question	Marks	CO
a.	What are the limitations of Fourier's law?	2	1
b.	Explain the various modes of heat Transfer.	2	1
c.	Why are fins installed on electric motor?	2	3
d.	State the assumption of lumped system.	2	2
e.	Explain the Newton's law of cooling.	2	1
f.	Explain the different parameter which effect thermal boundary layer thickness.	2	4
g.	Show the physical significance of following dimensionless numbers. (i) Gasthof number (ii) Reynold number	2	4
h.	Define the Following: (i) Irradiation, (ii) Radiosity	2	5
i.	Explain the concept of black body.	2	5
j.	Define the term "Overall heat transfer coefficient".	2	6

SECTION B

2. Attempt any *three* of the following:

Q no.	Question	Marks	CO
a.	A mild steel tank of wall thickness 10 mm contains water at 90°C. The thermal conductivity of mild steel is 50 W/m°C, and the heat transfer co-efficients for the inside and outside of the tank are 2800 and 11 W/m^2°C, respectively. If the atmospheric temperature is 20°C, calculate (i) The rate of heat loss per m^2 of the tank surface area. (ii) The temperature of the outside surface of the tank.	10	1
b.	A sphere of 200 mm diameter made of cast iron initially at uniform temperature of 400°C is quenched into oil. The oil bath temperature is 40°C. If the temperature of sphere is 100°C after 5 minutes, find heat transfer coefficient on the surface of the sphere. Take: c_p (cast iron) = 0.32 kJ/kg°C; ρ (cast iron) = 7000 kg/m^3 Neglect internal thermal resistance.	10	2
c.	Air at a temperature of 30°C flows past a flat plate at a velocity of 2 m/s. The flat surface has a sharp leading edge, and its total length equals 800 mm. Calculate the following: (i) The average skin friction or, drag coefficient, (ii) The average shear stress, (iii) The ratio of the average shear stress to the shear stress at the trailing edge. Properties of air at 30°C are: ρ = 1.165 kg/m^3, μ = 6.717 x 10^{-2} kg/hm, υ = 16 x 10^{-6} m^2/s.	10	4
d.	What is shape factor? Explain the various properties of shape factor.	10	5
e.	State Fick's law of diffusion. what are the limitations of Fick's law?	10	1

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SECTION C

3. Attempt any *one* part of the following:

Q no.	Question	Marks	CO
a.	Calculate the rate of heat flow through the wall of a refrigerated van of 1.5 mm of steel sheet at outer surface, 100 mm plywood at the inner surface and 2 cm of glass-wool in between, if the temperatures of the inside and outside surfaces are -15°C and 24°C respectively. Take thermal conductivities of steel, glass-wool and plywood as 23.2 W/m°C, 0.014 W/m°C and 0.052 W/m°C respectively.	10	1
b.	What is thermal diffusivity? What will be your interpretation if its value is high or low?	10	1

4. Attempt any *one* part of the following:

Q no.	Question	Marks	CO
a.	Explain the term fin efficiency and fin effectiveness. How do we decide whether the fins are required or not for a surface?	10	3
b.	One end of a long rod, 30 mm in diameter, is inserted into the furnace with the other end projecting in the outside air. After the steady state is reached, the temperature of the rod is measured at two points 150 mm apart and found to be 140°C and 100°C. The atmospheric air temperature is 30°C. If the heat transfer coefficient is 60 $W/m^{2}°C$, determine the thermal conductivity of the rod.	10	3

5. Attempt any *one* part of the following:

Q no.	Question	Marks	CO
a.	Air at 30°C and at atmospheric pressure flows at a velocity of 2.2 m/s over a plate maintained at 90°C. The length and the width of the plate are 900 mm and 450 mm respectively. Using exact solution, calculate the heat transfer rate from, (i) first half of the plate, (ii) full plate, and (iii) next half of the plate. The properties of air at mean bulk temperature (90 + 30)/2 = 60°C are: ρ = 1.06 kg/m3, μ = 7.211 kg/hm, υ = 18.97 x 10^{-6} m2/s, Pr = 0.696, k = 0.02894 W/m°C	10	4
b	A hot plate 1 m x 0.5 m at 130°C is kept vertically in still air at 20°C. Find: (i) Heat transfer coefficient, (ii) Initial rate of cooling the plate in °C/min. (iii) Time required for cooling plate from 180°C to 80°C if the heat transfer is due to convection only Mass of the plate is 20 kg and cp = 400 J/kg K. Assume 0.5 m side is vertical and that the heat transfer coefficient calculated in (i) above remains constant and convection takes place from both sides of the plate. Take properties of air at 75°C as: c =1007 J/kg °C, ρ = 1.07 m2/s; k = 0.029 J/kg K; υ = 19.1 x 10-6 m2/s. Use correlation as NuL = 0.59(Gr.Pr)1/4 for (104<Gr.Pr<109)		4

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6. Attempt any *one* part of the following:

Q no.	Question	Marks	CO
a.	A square room 3m × 3m, has a floor heated to 270C and has a ceiling at 100C.The walls are assumed to be perfectly insulated. The height of the room is 2.5 m. The emissivity of all the surfaces is 0.8. Determine the following: (i) The net heat interchange between the floor and the ceiling (ii) The wall temperature Assume ceiling to floor shape factor as 0.25.	10	5
b.	Consider two large parallel plates one at T_1=727^{0}C with emissivity ε_1=0.8 and other at T_2=227^{0}C with emissivity ε_2=0.4. An aluminum radiation shield with an emissivity, ε_s= 0.05 on both sides is placed between the plates. Calculate the percentage reduction in heat transfer rate between the two plates as a result of the shield. Use σ =5.67 × 10^{-8} W/m^2 K^4	10	5

7. Attempt any *one* part of the following:

Q no.	Question	Marks	CO
a.	Define effectiveness of a heat exchanger. Derive an expression for the effectiveness of a double pipe parallel flow heat exchanger. State the assumptions made.	10	4
b.	Explain the following with neat sketch: (i) Film wise condensation. (ii) Define Drop wise condensation.	10	4