Register Number:……..

KUMARAGURU
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B.E. DEGREE EXAMINATIONS: APRIL / MAY 2023

(Regulation 2018)

Sixth Semester

MECHANICAL ENGINEERING

U18MEI6201: Heat and Mass Transfer

Use of Heat and Mass Transfer Data Book is permitted

COURSE OUTCOMES

CO1: Apply steady state heat conduction problems for composite systems and fins.
CO2: Solve transient heat conduction problems.
CO3: Solve problems in natural and forced convection for internal and external flows.
CO4: Calculate the effectiveness of heat exchanger using LMTD and NTU methods.
CO5: Illustrate radiation shape factors for various geometries.
CO6: Explain the phenomenon of diffusion and convective mass transfer.

Time: Three Hours **Maximum Marks: 100**

Answer all the Questions:-
PART A (10 x 2 = 20 Marks)
(Answer not more than 40 words)

1.	Define Fourier law of conduction and write the equation involved in it	CO1	[K_1]
2.	What is meant by fin efficiency and fin effectiveness	CO1	[K_1]
3.	Compare the infinite and semi-infinite solid	CO2	[K_1]
4.	Define time constant and sensitivity of thermocouple	CO2	[K_2]
5.	What is the significance of boundary layer?	CO3	[K_2]
6.	Define burnout point in boiling. Also mention its importance	CO4	[K_2]
7.	Write the reciprocity relation used in radiation and mention its applications.	CO5	[K_2]
8.	What is meant by mean beam length in gas radiation	CO5	[K_2]
9.	Compare mass fraction and mole fraction of species	CO6	[K_2]
10.	Define convective mass transfer with examples.	CO6	[K_2]

Answer any FIVE Questions:-
PART B (5 x 16 = 80 Marks)
(Answer not more than 400 words)

11.	a)	Derive heat transfer equation of long fin	6	CO1	[K_2]
	b)	A steel pipe line (k= 55 W/m K) of I.D 120 mm and O.D 130 mm is to be covered with two layers of insulation each having a thickness of 50 mm. The thermal conductivity of the first insulation material is 0.05 W/m K and that of the	10	CO1	[K_4]

second is 0.12 W/mK. Calculate the loss of heat per meter length of pipe and interface temperature between the two layers of insulation when the temperature of inside tube surface is 250^0C and that of the outside surface of the insulation is 30^0C

12.	a)	Derive an expression temperature distribution in lumped mass system with unsteady state heat transfer.	6	CO2	[K_3]
	b)	A large slab of aluminum at a uniform temperature of 150^0C suddenly has its surface temperature lowered to 50^0C. Calculate the time required for the temperature to reach 110^0C at a depth of 4cm. Also find the total heat removed from the slab per unit surface area during this time. Take $\alpha = 7.2x10^{-5}$ m^2/s and k=210 W/m ^{0}C	10	CO2	[K_4]
13.	a)	Draw the velocity profile and temperature profile for a flow through a tube	6	CO3	[K_3]
	b)	One surface of a panel 0.35m x0.25m is insulated and the other surface is kept at a uniform temperature of 72^0C. Calculate the average heat transfer coefficient due to free convection between the heated surface of the panel and the atmospheric air at 28^0C when. i) plate is horizontal with hot surface facing up and 0.25m side is along the flow ii) plate is horizontal with hot surface facing down and 0.25m side is along the flow	10	CO3	[K_4]
14.	a)	Derive an LMTD expression for the counterflow heat exchanger .State all assumptions made.	6	CO4	[K_3]
	b)	In a shell and tube heat exchanger with 4 tube passes through the shell, hot engine oil available at 130°C flows through the shell and water through the tubes. Water at the rate of 1.5 kg/s is heated from 25°C to 65°C and there are ten tubes per pass. The diameter of each tube is 1.5 cm and the average convection coefficient h_o = 300 W/m^2K.Determine the flow rate of oil if its exit temperature is to be 80°C.Also compute the length of the tubes. Assume specific heat of oil as 2000 J/kg K	10	CO4	[K_4]
15.	a)	Obtain an expression for net heat transfer between two gray surface.	6	CO5	[K_3]
	b)	A thin aluminum sheet with an emissivity of 0.25 on both sides is placed between two very large parallel plates, which are maintained at uniform temperatures T1 = 400 K and T2 = 320 K and have emissivity of 0.3 and 0.6, respectively. Determine the net rate of radiation heat transfer between the two plates per unit surface area of the plates and compare the result with that without the shield.	10	CO5	[K_4]
16.	a)	Describe the equimolar counter diffusion of gases through stationary medium	6	CO6	[K_2]
	b)	A mixture of O_2 and N_2 with their partial pressures in the ratio 0.21 to 0.79 is in a container at 35°C. Calculate the mass density, the mole fraction , mass fraction of each species for a total pressure of 1 bar. What would be the average molecular weight of the mixture ?	10	CO6	[K4]

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