Register No : _____

THE KAVERY ENGINEERING COLLEGE

(An Autonomous Institution)

B.E./B.TECH DEGREE END SEMESTER THEORY EXAMINATIONS, APRIL-MAY 2025

Sixth Semester

Mechanical Engineering

ME3691 - Heat and Mass Transfer

(Use of Approved HMT data book is permitted)

Regulations - 2021

Duration : 3 Hrs ***Maximum : 100 Marks***

PART – A (ANSWER ALL QUESTIONS) (Marks 10*2=20)

Q.No	*Questions*	*BLT*	*CO*	*Marks*
1.	State Fourier's Law of heat conduction.	L1	1	2
2.	Why are fins used in heat transfer systems?	L2	1	2
3.	State the significance of Reynolds number in forced convection.	L1	2	2
4.	Why is the Nusselt number important in convection heat transfer analysis?	L2	2	2
5.	What are the different regimes of boiling?	L1	3	2
6.	Describe the use of LMTD in heat exchanger calculations.	L2	3	2
7.	Define emissive power [E] and monochromatic emissive power [Eb].	L1	4	2
8.	State Emissivity.	L2	4	2
9.	State Fick's first law of diffusion.	L1	5	2
10.	Distinguish between molecular diffusion and eddy diffusion.	L2	5	2

PART – B (ANSWER ALL QUESTIONS) (Marks 5*16 = 80)

Q.No			*Questions*	*BLT*	*CO*	*Marks*
11.	a	i	Derive the General Differential Equation of Heat Conduction in Rectangular Cartesian coordinates.	L2	1	10
		ii	A 3 mm wire of thermal conductivity 19 W/mK at a steady heat generation of 500 MW/m3. Determine the centre temperature if the outside temperature is maintained at 250^0C.	L2	1	6
			Or			
	b	i	A circumferential rectangular fins of 140 mm wide and 5mm thick are fitted on a 200 mm diameter tube. The fin base temperature is 170^0C and the ambient temperature is 25^0C. Estimate fin Efficiency and heat loss per fin. Take Thermal conductivity K = 220 W/mk Heat transfer coefficient h= 140W/m^2k.	L2	1	10
		ii	What are Heisler's charts? List the parameters needed for their usage.	L2	1	6
12.	a		Air at 290^0C flows over a flat plate at a velocity of 6 m/s. The plate is 1m long and 0.5 m wide. The pressure of the air is 6 KN/m^2. If the	L2	2	16

		plate is maintained at a temperature of 70^0C, estimate the rate of heat removed from the plate.			
		Or			
	b	Air flows over a vertical plate at a velocity of 2 m/s. The surface of the plate is maintained at 85°C, and air is at 25°C. Determine whether forced, free, or mixed convection dominates and calculate the heat transfer rate per unit width of the plate.	L2	2	16
13.	a	Sketch and explain the boiling curve for pool boiling. Identify the different regimes and apply it to describe how a heated surface temperature changes during the boiling of water at atmospheric pressure.	L3	3	16
		Or			
	b	In a parallel flow heat exchanger, hot liquid enters at 400°C and leaves at 250°C. Cold fluid enters at 50°C and leaves at 110°C, the inside and outside heat transfer coefficients are 120W/m^2K and 190 w/m^2K respectively. The inside and outside diameters of the tube are 0.06m and 0.08m respectively. If the heat transferred per heat is 1.6 x 10^5 KJ. Find the length of the tube required.	L3	3	16
14.	a	Two large parallel planes at 800K and 600K have emissivity's of 0.5 and 0.8 respectively. A radiation shield having an emissivity of 0.1 on one side and an emissivity of 0.05 on the other side is placed between the plates. Calculate the heat transfer rate by radiation per square meter with and without radiation shield. Comments on the results.	L3	4	16
		Or			
	b	Two large parallel plates with emissivity of 0.5 each are maintained at difference temperatures and are exchanging heat only by radiation. Two equally large radiation shields with surface emissivity 0.05 are introduced in parallel to the plates. Find the percentage of reduction in net radiative heat transfer?	L3	4	16
15.	a i	A vessel contains a binary mixture of O_2 and N_2 with partial pressure in the ratio 0.21 and 0.79 at 20°C. If the total pressure of the mixture is 11bar, calculate the following (i) Molar concentrations (ii) Mass densities (iii) Mass fractions (iv) Molar fractions of each species.	L5	5	10
	i i	Evaluate the similarities and differences between heat, mass, and momentum transfer using analogies. Support your answer with examples.	L5	5	6
		Or			
	b i	Ammonia and air in equimolar counter diffusion in a cylindrical tube of 2.5 mm diameter and 15m length. The total pressure is atmosphere and the temperature is 25°C. One end of the tube is connected to a large reservoir of ammonia and the other end of the tube is open to atmosphere. If the mass diffusivity for the mixture is 0.28 x 10^{-4} m^2/s. calculate the following (a) Mass rate of ammonia in Kg/h. (b) Mass rate of air in Kg/h.	L5	5	10

i	Justify the application of convective mass transfer principles in designing a drying system for food or pharmaceutical products.	L5	5	6