Reg. No. | | | | | | | | | | | | |

B.E./ B. TECH.DEGREE EXAMINATIONS, MAY 2023

Fifth Semester

ME18504 – Heat and Mass transfer

(Mechanical Engineering)

(Regulation 2018 / 2018A)

(Use of Heat and Mass transfer data book is permitted)

TIME: 3 HOURS **MAX. MARKS: 100**

COURSE OUTCOMES	STATEMENT	RBT LEVEL
CO 1	Student will illustrate the concepts of heat transfer in steady, transient and infinite solids	**3**
CO 2	Students will examine the heat transfer coefficients for Natural and Forced convection	**3**
CO 3	Students will apply the concepts of heat transfer in heat exchanger, Boiling and condensation phenomenon.	**3**
CO 4	Students can determine the radiation in black body, grey body and gases.	**3**
CO 5	Students will analyze the mass transfer occurring in both diffusion and convection mode.	**3**

PART- A(10x2=20Marks)

(Answer all Questions)

		CO	RBT LEVEL
1.	Differentiate fin effectiveness and fin efficiency	**1**	**1**
2.	What is meant by transient heat conduction?	**1**	**2**
3.	Differentiate Natural and forced convection.	**2**	**1**
4.	State the significance of Grashof number.	**2**	**2**
5.	Why counter flow heat exchanger is more effective than parallel flow heat exchanger?	**3**	**1**
6.	What is meant by dropwise condensation?	**3**	**1**
7.	Find the temperature of the sun which is assumed to be a Black Body, if the intensity of radiation is maximum at the wavelength of 0.5μ.	**4**	**3**
8.	What is the purpose of radiation shield?.	**4**	**2**
9.	Define the following.(i) Mass Concentration (ii) Molar Concentration	**5**	**1**
10.	What is convective mass transfer? Give two examples.	**5**	**1**

PART- B (5x 14=70Marks)

			Marks	CO	RBT LEVEL
11. (a)	**(i)**	Consider a 0.8 m high and 1.5 m wide double plane window consisting of two 4mm thick layers of glass (k = 0.78 W/mK) separated by a 10	**(7)**	**1**	**3**

mm wide stagnant air space (k = 0.026 W/mK). Determine the heat transfer through this double plane window and temperature of the inner surface, which the room is maintained at 20°C while the temperature of the outdoors is -10°C. Take the convective heat transfer coefficient inner and outer surfaces of the window to be h_1 =10 W/m^{2}K and h_2 = 40 W/m^{2}K

	(ii)	The body of electric motor is 360 mm in diameter and 240 mm long, it dissipates 360 W of heat and its surface temperature should not exceed 55°C, longitudinal fins of 15 mm thickness and 40 mm height are proposed. If the convective heat transfer coefficient is 40 W/m^{2}K, ambient temperature is 30°C. Find number of fins required. Take k = 40 W/m K.	**(7)**	**1**	**3**

(OR)

(b)		A slab of aluminum 10 cm thick is originally in a temperature at 500°C. It is suddenly immersed in a liquid at 100°C resulting in a heat transfer coefficient of 1200 W/m^2 K. Determine the temperature at the centerline and the surface 1 minute after immersion. Also calculate the total thermal energy removed per unit area of the slab during this period.	**(14)**	**1**	**3**
12. (a)	**(i)**	A long 10-cm diameter steam pipe whose external surface temperature is 110°C passes through some open area that is not protected against the winds. Determine the rate of heat loss from the pipe per unit of its length when the air is at 1 atmospheric pressure and 10°C and the wind is blowing across the pipe at a velocity of 8 m/s.	**(7)**	**2**	**3**
	(ii)	The local atmospheric pressure is 83.4 kpa. Air at this pressure and 20°C flows with a velocity of 8 m/s over a 1.5 m x 6 m flat plate whose temperature is 140°C. Determine the rate of heat transfer from the plate if the air flows parallel to the 6 m long side.	**(7)**	**2**	**3**

(OR)

(b)		Consider a 0.6 m x 0.6 m thin square plate in a room at 30°C. One side of the plate is maintained at a temperature of 90°C, while the other side is insulated. Determine the rate of heat transfer from the plate by natural convection if the	**(14)**	**2**	**3**

plate is (a) horizontal with the hot surfaces facing up.(b) horizontal with the hot surfaces facing down.

13. (a)	Water in a tank is to be boiled at sea level by a 1 cm diameter nickel plated steel heating element equipped with electrical resistance wires. Determine the maximum heat flux that can be attained in the nucleate boiling regime and surface temperature of the heater in the case.	**(14)**	**3**	**3**
	(OR)			
(b)	**(i)** A chemical having specific heat of 3.3 kJ/kg K flowing at the rate of 20,000kg/hr. enters a parallel flow heat exchanger at 120°C. The flow rate of cooling water is 50,000 kg/hr with an inlet temperature of 20°C. The heat transfer area is10 m^2 and the overall heat transfer coefficient is 1050 W/m^2 K, Find (i) the effectiveness of the heat exchanger,(ii) the outlet temperature of water and chemical, Take for water, C_p = 4.186 kJ/kg K.	**(7)**	**3**	**3**
	(ii) A counter flow heat exchanger is to heat air entering at 400°C with a flow rate of 6 kg/s by the exhaust gas entering at 800°C with a flow rate of 4 kg/s. The overall heat transfer coefficient is 100 W/m^2K and the outlet temperature of air is 551.5°C and the Specific heat of both air and exhaust gas can be taken as 1100 J/Kg K. Calculate the heat transfer area needed and number of transfer units.	**(7)**	**3**	**3**
14. (a)	Determine the shape factor between the surfaces 1-4 and 4-1 as shown in Figure 1.	**(14)**	**4**	**3**

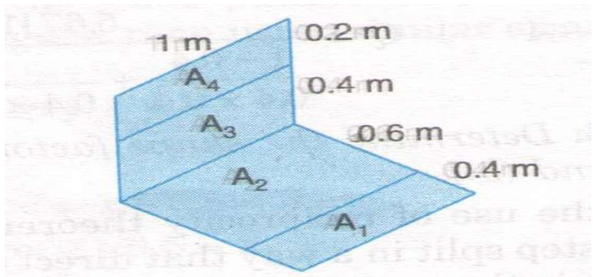

Figure 1

(OR)

(b)	Two large parallel plates of emissivities 0.3 and 0.5 are maintained at a temperature 800°C and 200°C respectively. Find the net radiant heat transfer per square metre between these plates. If a radiation shield of emissivity 0.05 is placed between them. Find the percentage reduction in heat transfer.	**(14)**	**4**	**3**
15. (a)	**(i)** Explain the different modes of mass transfer.	**(7)**	**5**	**2**
	(ii) CO_2 and air experience equimolar counter diffusion in a circular tube whose length and diameter are 1 m and 50 mm respectively. The system is at a total pressure of 1 atmosphere and a temperature of 25°C. The ends of the tube are connected to large chambers in which the species concentrations are maintained at fixed values. The partial pressure of CO_2 at one end is 190 mm of Hg while at the other end is 95 mm of Hg. Estimate the mass transfer rate of CO_2 and air through the tube. Take R= 8.205x10-2 m^3 atm/k mol K.	**(7)**	**5**	**3**
	(OR)			
(b)	**(i)** Describe the analogy between heat and mass transfer.	**(7)**	**5**	**2**
	(ii) Dry air at 27°C and 1 atm flows over a wet flat plate 50 cm long at a velocity of 50 m/s. Determine the convective mass transfer coefficient of water vapour in air at the end of the plate.	**(7)**	**5**	**3**

PART- C (1x 10=10Marks)
(Q.No.16 is compulsory)

		Marks	CO	RBT LEVEL
16.	Water at 50°C enters a 1.5 cm diameter and 3 m long tube with a velocity of 1 m/s. The tube wall is maintained at a constant temperature of 90°C. Calculate the heat transfer coefficient and total amount of heat transfer if the exit water temperature is 64°C.	**(10)**	**2**	**3**