Total number of printed pages: **B.Tech. (UG)/5thSemester//UFET504**

2022

FUNDAMENTALS OF HEAT AND MASS TRANSFER

Full Marks: 100

Time: Three hours

The figures in the margin indicate full marks for the questions.

*Answer **any five** questions.*

1.	a)	Differentiate between heat and thermodynamics.	2
	b)	What are the different modes of heat transfer? Explain.	3+3 = 6
	c)	What are assumptions made during the analysis of Fourier's law of heat conduction?	4
	d)	Define and derive Fourier's law of heat conduction	2+6=8
2.	a)	Define thermal resistance. Why it is analogous to electric resistance? State your opinion.	2+3=5
	b)	Derive an equation of Steady State Conduction of Heat Transfer through a composite wall. **Or** Derive an equation of heat conduction through a hollow cylinder.	6
	c)	The wall of a cold storage consists of 3-layerers-an outer layer of ordinary bricks, 30 cm thick, a middle layer of cork, 15 cm thick, and an inner layer of cement, 11 cm thick. The thermal conductivities of the materials are-brick-0.7, cork-0.043, and cement-0.72 W/m^{0}C. The temperature of the outer surface of the wall is 30^{0}C and that of the inner is -10^{0}C. Calculate (a) the steady state rate of heat gain per unit area of the wall, (b) the temperature at the interface of the composite wall and (c) the % of the total heat transfer resistance offered by the individual layers. What additional thickness of the cork should be provided to make the rate of heat transfer 25% less than the present value?	3×3=9
3.	a)	Define Thermal conductivity. What are parameters which affect the thermal conductivity? Discuss.	2+8 =10
	b)	A thick walled tube of stainless steel with 25 mm inner diameter and 45 mm outer diameter is covered with a 30 mm layer of asbestos insulation(k=0.2 W/m^{0}C). If the inside wall temperature of the pipe is maintained at 600^{0}C and the outside insulation at 1000^{0}C, calculate the heat loss per meter of	5

		length.	
	c)	A mild steel tank of wall thickness 15 mm contains water at 95^0C. The thermal conductivity of mild steel is 50W/m^{0}C, and heat transfer coefficients for the inside and outside the tank are 2850 and 10W/m^2 ^{0}C respectively. If the atmospheric temperature is 15^0C, calculate (a) the rate of heat loss per m^2 of the tank surface area, (b) the temperature of the outside surface of the tank.	2.5+2.5=5
4.	a)	Define convection. Differentiate between free convection and forced convection.	2+3=5
	b)	State and derive Newtown's law of cooling.	3
	c)	Define Momentum thickness and derive the mathematical expression.	6
	d)	The velocity distribution in the boundary layer is given by: $u/U=y/\delta$, where u is the velocity at a distance y from the plate and $u=U$ at $y=\delta$, δ being boundary layer thickness. Find (i) the displacement thickness, (ii) the momentum thickness.	3+3 = 6
5.	a)	Define Nusselt number and Prandtl number.	3+3 = 6
	b)	State and derive Reynold's analogy.	6
	c)	Air at 30^0C flows with a velocity of 3 m/s over a flat plate 1000mm×600mm×25mm. The top surface of is maintained at 90^0C. If the thermal conductivity of the plate material is 25W/m^{0}C, calculate (i) heat loss by the plate, (ii) bottom temperature of the plate for steady state condition. The thermo physical properties of air at mean film temperature 60^0C are, ρ=1.06 kg/m^3, C_p=1.005 kJ/kgK, k=0.02894W/m^{0}C, $\nu=18.97\times10^{-6}$ m^2/s, Pr=0.696	4×2=8
6	a)	Define mass transfer. State some industrial and day to day life example of mass transfer.	2+2=4
	b)	Differentiate between mass transfer by diffusion and mass transfer by convection.	2+2=4
	c)	State and discuss about Fick's law.	2+4=6
	d)	The molecular weights of the two components A and B of a gas mixture are 24 and 28 respectively. The molecular weight of gas mixture is found to be 30. If the mass concentration of the mixture is 1.2 kg/m^3, determine (i) Molar fractions, (ii) Mass fraction and (iii) Total pressure if the temperature of the mixture is 290K.	2×3=6
7.	Write short note		4×5=20
	a)	Heat transfer by radiation	
	b)	Emissivity	

	c)	Absorptivity	
	d)	Black body	

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