Subject Code: XXXXX

Roll No:

BTECH

(SEM-3) HEAT AND MASS TRANSFER 2021-22

TIME:3 HOUR ***Total Marks: 100***

Instruction: Attempt the questions as per the given instructions. Assume missing data suitably.

SECTION - A

Attempt *All Parts* in Brief **2*10 = 20**

Q1	Questions	Marks
(a)	What is the difference between thermodynamics and heat transfer ?	2
(b)	How the thermal conductivity of material is defined? What are its units ?	2
(c)	What is meant by transient heat conduction ?	2
(d)	Explain effectiveness and efficiency of fin.	2
(e)	What is turbulent flow ? Define it.	2
(f)	Define Reynolds's number. Also write the significance of Reynolds's number.	2
(g)	Define Stefan-Boltzmann's law.	2
(h)	Explain black body, opaque body, white body and grey body also.	2
(i)	How heat exchangers are classified ?	2
(j)	What are the various modes of mass transfer ?	2

SECTION - B

Attempt ***Any Three*** of the following		3*10 = 30
Q2	**Questions**	**Marks**
(a)	Drive an expression for heat conduction through a composite wall.	10
(b)	It is required to heat oil to about 300 C for frying purpose. A ladle is used in the frying. The section of the handle is 5 mm x 18 mm the surroundings are at 30 °C. The conductivity of the material is 205 W/m °C. If the temperature at a distance of 380 mm from the oil should not reach 40 °C. Determine the convective heat transfer coefficient.	10
(c)	Differentiate between: i. Natural and forced convection. ii. Hydrodynamic and thermal boundary layer thickness.	10
(d)	A 70 mm long circular surface of a circular hole of 35 mm diameter maintained at uniform temperature of 250 C. Find the loss of energy to the surroundings at 27 °C, assuming the two ends of the hole to be as parallel discs and the metallic surfaces and surroundings have a black body characteristics.	10
(e)	Derive an expression for effectiveness by NTU method for parallel flow.	10

SECTION - C

Attempt ***Any One*** of the following		5*10 = 50
Q3	**Questions**	**Marks**
(a)	Derive a general heat conduction equation for cartesian co-ordinate. And also draw the temperature-thickness profile for it.	10
(b)	A mild steel tank of thickness 12 mm contains water at 95 °C. The thermal conductivity of mild steel is 50 W/m °C, and the heat transfer coefficients for the inside and outside the tank are 2850 and 10 W/m^2 °C, respectively. If the atmospheric temperature is 15 °C, calculate: i. The rate of heat loss per square meter of the tank surface area ii. The temperature of the outside surface of the tank.	10
Q4	**Questions**	**Marks**
(a)	An aluminium alloy plate of 400 mm x 400 mm x 4 mm size at 200 °C is suddenly quenched into liquid oxygen at 183 °C. Starting from fundamentals or deriving the necessary expression to determine the time required for the plate to reach a temperature of - 70°C. Assume h = 20000 kJ/m^2h °C, C_p =0.8 kJ/Kg °C and density = 3000 kg/m^3,	10
(b)	Prove that for a body whose thermal resistance is zero, the temperature required for cooling or heating can be obtained from the relation $(t - t_a)\ (t_i - t_a) = \exp[-B_i F_a]$ Where the symbols have their usual meanings.	10

Q5	Questions	Marks
(a)	A nuclear reactor with its core constructed of parallel vertical plates of 2.2 m high and 1.4 m wide has been designed on free convection heating of liquid bismuth. The maximum temperature of the plate surface is limited to 960 °C while the lowest allowable temperature of the bismuth is 340 °C. Calculate the maximum possible heat dissipation from the both sides of each plate. For the convection coefficient for the plate is $Nu = 0.13 (GrPr)^{0.333}$ Where different parameter are evaluated at the mean film temperature.	10
(b)	Air at 20 °C flowing over a flat plate which is 200 mm wide and 500 mm long. The plate is maintained at 100 C. Find the heat loss per hour from the plate if the air is flowing parallel to 500 mm side with 2 m/s velocity. What will be the effect on heat transfer if the flow is parallel to 200 mm ? The properties of air at (100 + 20)/2 = 60 °C are v = 18.97 x 10^{-6} m^2/s, k 0.02 Wlm °C and Pr = 0.7.	10
Q6	**Questions**	**Marks**
(a)	Determine the radiant heat exchange in W/m2 between two large parallel steel plates of emissivity's 0.8 and 0.5 held at temperature of 1000K and 500 K respectively, if a thin copper plate of emissivity 0.1 is introduced as a radiation shield between the two plates. Use $\sigma = 5.67* 10^{-8}$ W/ m^2K^4.	10
(b)	Derive the expression for net heat exchange between black bodies for infinite parallel planes.	10
Q7	**Questions**	**Marks**
(a)	The flow rates of hot and cold water streams running through a parallel flow heat exchangers are 0.2 kg/s and 0.5 kg/s respectively the inlet temperatures 75 °C and 20°C respectively. The exit temperature of hot water is 45 °C. If the individual heat transfer coefficient on both sides are 650 W/m^2°C. Calculate: i. The area of heat exchanger. ii. The rate of heat transfer.	10
(b)	Differentiate between the mechanisms of filmwise and dropwise condensation.	10