GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–V (NEW) EXAMINATION – WINTER 2022

Subject Code:2151909 Date:04-01-2023

Subject Name:Heat Transfer

Time:10:30 AM TO 01:00 PM Total Marks:70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

			Marks
Q.1	**(a)**	Define: Fin performance and fin efficiency	**03**
	(b)	Explain Stefan Boltzmann constant.	**04**
	(c)	Discuss velocity boundary layer and thermal boundary layer over a flat plate. Show the thickness of these layers for different Prandtl numbers.	**07**
Q.2	**(a)**	Define: 1) Intensity of Radiation 2) Irradiation 3) Radiosity	**03**
	(b)	Making use of Plank's law of distribution, establish the relation for the Wien's displacement law.	**04**
	(c)	A furnace wall is made of 20 cm of magnesite brick and 20 cm of common brick. The magnesite brick is exposed to hot gases at 1355 °C and common brick outer surface is exposed to 45 °C room air. The convection and radiation heat transfer coefficient towards air side are 12.5 and 7.5 W/m2 respectively. Thermal conductivities of magnesite and common brick are 3.8 and 0.66 W-m K respectively. Calculate a) heat loss per m2 area of furnace wall and b) maximum temperature to which common brick is subjected .	**07**
		OR	
	(c)	Saturated steam at 110 °C flows inside a copper pipe (thermal conductivity 450 W/m K) having an internal diameter of 10 cm and and external diameter of 12 cm, the surface resistance on steam side is 12000 W/m2 and that on the outside surface of pipe is 18 W /m2 K. Calculate the heat loss from the pipe if it is located in space at 25 °C.	**07**
Q.3	**(a)**	State Kirchoff's Law.	**03**
	(b)	What is the fouling factor? Explain their effect in Heat Exchanger design.	**04**
	(c)	Atmospheric air at 25 °C flows parallel to a flat plate at a velocity of 3m/s. Use the exact Blasius solution to estimate the boundary layer thickness and the local skin friction coefficient at x=1 m from leading edge of the plate. Take $\nu = 15.33 \times 10^{-6}$ m^2/s.	**07**
		OR	
Q.3	**(a)**	State Fourier number and Biot number.	**03**
	(b)	Explain fundamental dimensions. State thermal resistance, thermal diffusivity and convective heat transfer coefficient in fundamental dimensions.	**04**
	(c)	A polished metal pipe 5 cm outside diameter and 370K temperature at the outer surface is exposed at ambient conditions at 295 K temperature. The emissivity of surface is 0.2 and convection coefficient of heat transfer is 11.35 W/ m2 deg. Calculate the heat transfer by radiation and	**07**

natural convection per meter length of pipe. Take thermal radiation constant σ_b = 5.67x 10-8 W/ m^2 K

Q.4	**(a)**	Define shape factor. What is shape factor with respect to itself if the surface is concave, convex or flat?	**03**
	(b)	Describe the following dimensionless numbers for: Grashoff number 2) Nusselt number	**04**
	(c)	Derive the interchange factor for infinite parallel planes between non-black bodies	**07**

OR

Q.4	**(a)**	Compare Sub cooled and Saturated boiling.	**03**
	(b)	Explain the phenomenon of heat transfer by natural and forced convection	**04**
	(c)	Calculate the rate of heat loss from a human body which may be considered as a vertical cylinder, 30 cm in diameter and 175 cm high in still air at 15 °C. The skin temperature is 35 °C and emissivity at the skin surface is 0.4. For air: $\nu = 15.33 \times 10^{-6}$ m^2/s, k= 0.026 W/m deg. Laminar flow: $10^4 < GrPr < 10^9$, $Nu = 0.53(GrPr)^{0.25}$ Turbulent flow: $10^9 < GrPr < 10^{12}$, $Nu = 0.13(GrPr)^{0.33}$	**07**

Q.5	**(a)**	Differentiate between Recuperator and Regenerator Heat exchanger	**03**
	(b)	What is critical radius of insulation? Explain its importance in electrical and thermal system.	**04**
	(c)	Establish an expression for log mean temperature difference for parallel flow heat exchanger	**07**

OR

Q.5	**(a)**	Define: 1) Effectiveness and NTU related to Heat Exchanger	**03**
	(b)	Explain with neat sketch, the various regimes in boiling and explain the condition for the growth of bubbles.	**04**
	(c)	Hot water having specific heat 4200 J/kg K flows through a heat exchanger at the rate of 4 kg/min with an inlet temperature of 100°C. A cold fluid having a specific heat 2400 J/kg k flows in at a rate of 8 kg/min and with inlet temperature 20°C. Calculate the maximum possible effectiveness if the fluid flow conforms to a) parallel flow arrangement b)counter flow arrangement.	**07**

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