Seat No.:_____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE- SEMESTER–V (NEW) EXAMINATION – WINTER 2020

Subject Code:2151909 Date:22/01/2021

Subject Name:Heat Transfer

Time:10:30 AM TO 12:30 PM Total Marks: 56

Instructions:

1. **Attempt any FOUR questions out of EIGHT questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

			MARKS
Q.1	**(a)**	Define : 1) Fin efficiency 2) Critical radius and 3) Fourier number.	**03**
	(b)	Define time constant for the thermocouple." Diameter of thermocouple wire should be as low as possible" Justify above statement analytically	**04**
	(c)	Define Boiling and Write different modes of it. Draw boiling curve and show different regimes on that. Explain in brief 1) Film boiling 2) Critical heat flux and 3) Leidenfrost Point	**07**
Q.2	**(a)**	Write the equation of fin effectiveness for the infinitely long fin. Based on this state two conclusions for selection of fin.	**03**
	(b)	Write the differential equation for steady state heat conduction in radial direction for sphere without heat generation in it. Solve the equation and represent the solution graphically.	**04**
	(c)	A steam pipe 10cm in outer diameter is covered with two layers of insulation material each is 2.5 cm thick. Ratio of their thermal conductivity is 3. Compare the effective thermal conductivity of two layers when better insulation material is placed inside layer than when it is on the outside.	**07**
Q.3	**(a)**	Differentiate mean film temperature and bulk mean temperature.	**03**
	(b)	Write equation for hydraulic diameter. Calculate its value for 1) two parallel plates and 2) rectangular duct.	**04**
	(c)	Atmospheric air at 275K and free stream velocity of 20m/s flows over 1.5m long flat plate maintained at uniform temperature of 325K. 1) Average heat transfer co-efficient over entire length of 1.5m 2) Heat transfer rate from the plate over 1.5m and 1m wide. 3) Average heat transfer co-efficient over laminar boundary layer.. For turbulent flow : $Nu_L = 0.037(\mathrm{Re}_L^{0.8} - 871)\,\mathrm{Pr}^{1/3}$ For laminar flow : $Nu_L = 0.664\,\mathrm{Re}_L^{1/2}\,\mathrm{Pr}^{1/3}$ For calculation use : K_{air} = 0.026 W/mK, Pr = 0.708, Kinematic viscosity = $16.8 * 10^{-6}$ m^2/s, Dynamic viscosity = $1.98*10^{-5}$ kg/ms Assume transition occurs at Re = $2 * 10^5$.	**07**
Q.4	**(a)**	Define hydrodynamic and thermal boundary layer. Represent their respective thickness for the liquid metal.	**03**
	(b)	Air at temperature 300K and 1 atm flows flows over a flat plate at a speed of 2 m/s. Calculate the mass flow rate enters the boundary layer between 0.2m and 0.4 m from the leading edge. Assume unit depth in z- direction. Take : viscosity of air = $1.85 * 10^{-5}$ kg/m-s.	**04**

Density of air is 1.177 kg/m^3.

(c) Using Buckingham – π theorem show that **07**
Nu = f (Gr, Pr)

Q.5 **(a)** Do as directed : **03**
1) Write Wien's displacement law.
2) Define monochromatic emissive power.
3) Define absorptivity

(b) Calculate the shape factor of the conical hole whose semi cone angle is α. **04**

(c) Two large parallel plates at temperature 1000K and 600K have emissivity of 0.5 and 0.8 respectively. A radiation shield of emissivity 0.1 on one side and 0.05 on other side is placed between these plates. Calculate **07**
1) Heat transfer rate by radiation with and without radiation shield.
2) % reduction in heat transfer rate by radiation shield.

Q.6 **(a)** Do as directed: **03**
1) Define : Radiosity and
2) Define : Grey body
3) State Kirchoff's Law for radiation.

(b) Explain summation rule and superposition rules for shape factor in brief. **04**

(c) A spherical liquid oxygen tank 0.3m in diameter is enclosed concentrically in a spherical container of 0.4m diameter and space between them is evacuated. Tank surface is at -183^{0}C and has emissivity of 0.2. Container is exposed to 15 ^{0}C and has emissivity of 0.25. **07**
Calculate :
1) Net radiant heat transfer rate
2) Rate of evaporation of Oxygen if latent heat is 220kJ/kg.

Q.7 **(a)** Classify heat exchanger based on **03**
1) Constructional features
2) Flow arrangement.

(b) "Flow arrangement doesn't affect performance of the heat exchanger which involves phase change process" Justify the statement analytically. **04**

(c) A chemical having specific heat of 3.3kJ/kg-K at a rate of 20000kg/h enters a parallel flow heat exchanger at 120°C. Cooling water flow rate is 50000kg/h with an inlet temperature of 20°C. Heat transfer area is 10m^2 and overall heat transfer co-efficient is 1050W/m^2-K. **07**
Calculate :
1) Effectiveness of heat exchanger
2) Outlet temperature of hot and cold fluids.
Take specific heat of water is 4.2 kJ/kg-K

Q.8 **(a)** Explain in brief fouling. Write the equation for fouling factor. **03**

(b) Determine the area required for a shell and tube heat exchanger with two tube passes to cool oil at rate of 10 kg/s from 60°C to 30°C flowing in the shell using water at 20°C passing through the tubes and heated up to 26°C. The specific heat of the oil is 2200 J/kg K. **04**
The value of overall heat transfer coefficient is 300 W/m^2 K. Take correction factor F = 0.875.

(c) Define: effectiveness. Develop its equation for the counter flow heat exchanger. **07**

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