Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–V (NEW) EXAMINATION – WINTER 2021

Subject Code:3151909 Date:01/01/2022

Subject Name:Heat Transfer

Time:02:30 PM TO 05:00 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)**	What are three modes of heat transfer? Explain their differences briefly with example.	**03**
	(b)	Draw the sketch of variation of temperature along the length for parallel and counter flow heat exchangers and write their comparisons.	**04**
	(c)	A roof of the electrically heated home is 6 m long, 8 m wide and 0.25 m thick and is made of a concrete layer whose thermal conductivity is 1.0 W/m-k. The temperature of the inner and the outer surfaces of the roof are measured to be 30 °C and 15 °C respectively for a period of 12 hours. Assume steady state condition for the mentioned period of 12 hours. Determine: 1. The rate of heat loss through the roof and 2. The cost of heat loss to the home owner if the cost of electricity is Rs 0.5/kWh.	**07**
Q.2	**(a)**	Explain and differentiate natural and forced convection.	**03**
	(b)	With neat sketch explain the heat conduction through a plan wall with and without heat generation.	**04**
	(c)	Determine the amount of heat transferred through a pin fin made of aluminum, length 50 mm, width 100 mm and thickness of 5 mm. The temperature at the base of the fin is 80 °C. Take thermal conductivity k = 210 W/m°C and heat transfer coefficient h=42 W/m^{2}K. Also determine the temperature at tip of the fin, if the atmospheric temperature is 30 °C.	**07**
		OR	
	(c)	What is the limitation of Rayleigh's method of dimensional analysis? Which method is preferred in such case and how repeating variables are selected?	**07**
Q.3	**(a)**	What do you understand by absorptivity? How can it be improved for an opaque body?	**03**
	(b)	Prove with the usual notations that the Reynolds number for flow in a circular tube of diameter (d) can be expressed as Re=4m/πdμ.	**04**
	(c)	Define Boit number. What is the physical significance of it? The Biot number during a heat transfer process between sphere and it surrounding is 0.02. Would you use lumped system analysis for determining the centre temperature of the sphere? Why?	**07**
		OR	
Q.3	**(a)**	What is a compact heat exchanger? Write their key areas of applications.	**03**
	(b)	State the regimes of pool boiling and define process of condensation.	**04**
	(c)	In a thermal power plant heat loss is to be minimized in a 240 mm steam main which is 210 meter long and is covered with two insulation materials. First 50	**07**

mm of high temperature insulation (k=0.092 W/m°C) and 40 mm of low temperature insulation (k=0.062 W/m°C). The inner and outer surface temperatures as measured are 390 °C and 40 °C respectively. Neglecting heat conduction through pipe material Determine:

1. The total heat loss per hour.
2. The temperature between two layers of insulation.

Q.4 **(a)** What do you understand by fouling factor in case of heat exchanger? List the causes of fouling. **03**

(b) Derive the Stefan-Boltzmann law from the Plank's law of thermal radiation. What is the value of Stefan-Boltzmann constant? **04**

(c) A potato having mean diameter of 50 mm and initially at 25 °C is placed in boiling water for 4 minutes and found to be boiled to the desired level. For how long should a similar potato should be boiled in the same environment and for the same level when taken from the cold storage at 10 °C. Take the following properties for potato **07**

K=10 W/m °C, ρ = 1200 kg/m^3, c = 2000 J/kg °C, h = 100 W/m^2 °C and Use Lump Theory.

OR

Q.4 **(a)** What do you understand by TEMA charts? How are they useful in the design of multi-pass heat exchangers. **03**

(b) How is the thermal performance of a fin measured? Explain fin efficiency and effectiveness. **04**

(c) Explain geometric similarity, kinematic similarity and dynamic similarity with example. **07**

Q.5 **(a)** List the good characteristics of thermal insulating material? **03**

(b) Define radiation heat transfer coefficient? On what factor does it depend? **04**

(c) In a certain mechanical industry a counter flow heat exchanger is to be used to cool the air from 540 °C to 145 °C. The flow rate of air is 12.5 kg/s and heat exchanger contains 4200 tubes each having a diameter of 30 mm. The sea water is to be used to cool the air and water enters the heat exchanger at 25 °C and leaves at 75 °C. If the water side resistance to flow is negligible, calculate the tube length required for this heat duty. For turbulent flow inside tubes use Nu = 0.023 Re$^{0.8}$ Pr$^{0.4}$ and mass flow m = NAρV where N= number of tubes **07**

The properties of the air at the average temperature are as follows:

K=0.003 W/m °C, ρ = 1.09 kg/m^3, c_p = 1.008 kJ/kg °C, μ = 2.075 × 10^{-5} kg/ms (Ns/m^2)

OR

Q.5 **(a)** Explain Displacement thickness, Momentum thickness and Energy thickness. **03**

(b) Write a short note of critical radius of insulation. **04**

(c) What do you understand by NTU method in case of heat transfer? Derive its expression following the usual notations for parallel flow heat exchanger. **07**

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