

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 $k = 210 \text{ W/m}^\circ\text{C}$ and heat transfer coefficient $h=42 \text{ W/m}^2\text{K}$. 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 $Re=4m/\pi d\mu$.	04
	(c) Define Biot 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 ($k=0.092 \text{ W/m}^\circ\text{C}$) and 40 mm of low temperature insulation ($k=0.062 \text{ W/m}^\circ\text{C}$). 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**
 $K=10 \text{ W/m}^\circ\text{C}$, $\rho = 1200 \text{ kg/m}^3$, $c = 2000 \text{ J/kg}^\circ\text{C}$, $h = 100 \text{ W/m}^2^\circ\text{C}$ 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 $m = N\rho V$ where N = number of tubes **07**
 The properties of the air at the average temperature are as follows:
 $K=0.003 \text{ W/m}^\circ\text{C}$, $\rho = 1.09 \text{ kg/m}^3$, $c_p = 1.008 \text{ kJ/kg}^\circ\text{C}$, $\mu = 2.075 \times 10^{-5} \text{ kg/ms}$ (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**
