Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

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

Subject Code:3140503 Date:14-12-2022

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)**	Distinguish between the conduction, convection and radiation modes of heat transfer.	**03**
	(b)	Write some examples to illustrate the importance of heat transfer in various field of engineering.	**04**
	(c)	List some of the factors that affect the boiling heat transfer. Explain pool boiling. How does it differ from forced convection boiling? In the design of condenser, which of the two types of condensation is usually selected and why?	**07**
Q.2	**(a)**	State the effect of impurities on the thermal conductivity of a metal.	**03**
	(b)	What is meant by critical thickness of insulation? How do you decide the thickness of insulation for electric wires and steam pipe.	**04**
	(c)	A furnace wall is made up of three layers of thicknesses 250 mm, 100 mm and 150 mm with thermal conductivities of 1.65, k and 9.2 W/ m ^{0}C respectively. The inside is exposed to gases at 1250 ^{0}C with a convection coefficient of 25 W/m^2 ^{0}C and the inside surface is at 1100 ^{0}C, the outside surface is exposed to air at 25 ^{0}C with convective coefficient of 12 W/m^2 ^{0}C. Determine (i) The unknown thermal conductivity k (ii) The overall heat transfer coefficient.	**07**
		OR	
	(c)	Saturated steam at 110 ^{0}C flows inside a copper pipe (thermal conductivity 450 W/m K) having an internal diameter of 10 cm and an external diameter of 12 cm. The heat transfer coefficient on the steam side is 12000 W/m^2 K and that on the outside surface of pipe is 18 W/m^2 K. Determine the heat loss from the pipe if it is located in space at 25 ^{0}C. How this heat loss would be affected if the pipe is lagged with 5 cm thick insulation of thermal conductivity 0.22 W/m K.	**07**
Q.3	**(a)**	Discuss the physical significance of (i) Prandtl Number (ii) Peclet number.	**03**
	(b)	Set up the relationship between local heat transfer coefficient and average heat transfer coefficient for flow past a stationary flat plate.	**04**

(c) Estimate the heat transfer from a 40 W incandescent bulb at 125 ^{0}C to 25 ^{0}C in quiescent air. Approximate the bulb as a 50 mm diameter sphere. What percentage of the power is lost by free convection? **07**

The appropriate correlation for the convection coefficient is

$Nu = 0.60\ (Gr \times Pr)^{0.25}$

Where the different parameters are evaluated at the mean film temperature and the characteristics length is the diameter of the sphere.

The thermo physical properties of air are at 75 ^{0}C:

$\gamma = 20.55 \times 10^{-6}$ m^2/s

k = 0.03 W/m-deg

Pr = 0.693

OR

Q.3 **(a)** What is Rayleigh number? Give its value that sets the criterion of laminar or turbulent character of flow. **03**

(b) What is meant by thermal boundary layer? State the relationship between thermal and hydrodynamic boundary layer thickness. **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 while standing in a 30 km/hr wind at 15 ^{0}C. The surface of the human is 35 ^{0}C. The thermo-physical properties of air at 25 ^{0}C are: **07**

$\gamma = 15.53 \times 10^{-6}$ m^2/s; k = 0.0263 W/m-deg; Pr = 0.7

Use the following correlation

$$Nu = 0.664(\mathrm{Re})^{0.5} \times (\mathrm{Pr})^{0.33}$$

Q.4 **(a)** Enumerate some salient features of thermal radiation. What position does thermal radiation occupy in the electromagnetic spectrum? **03**

(b) Point out the different criterion that forms the basis for the classification of heat exchanger. **04**

(c) The flow rate of hot and cold water streams running through a parallel flow heat exchanger are 0.2 kg/s and 0.5 kg/s respectively. The inlet temperatures on the hot and cold sides are 75 ^{0}C and 20 ^{0}C respectively. The exit temperature of hot water is 45 ^{0}C. If the individual heat transfer coefficients on both sides are 650 W/m^2 ^{0}C, calculate the area of the heat exchanger. **07**

OR

Q.4 **(a)** Define monochromatic and total emissive power. How is the latter related to the absolute temperature? **03**

(b) Set up expression for logarithmic mean temperature difference in case of a counter flow heat exchanger. **04**

(c) A chemical (C_p = 3.3 kJ/kg K) flowing at the rate of 20,000 kg/hr enters a parallel flow heat exchanger at 120 ^{0}C. The flow rate of the cooling water (C_p = 4.186 kJ/kg K) is 50,000 kg/hr with an inlet temperature of 20 ^{0}C. The heat transfer area is 10 m^2 and the overall heat transfer coefficient is 1050 W/m^{2}K. Find the outlet temperatures of water and the chemicals. **07**

Q.5	**(a)**	State and explain the following laws relating to thermal radiation and temperature of a radiating body: Planck's law	**03**
	(b)	Draw schematic temperature profile of evaporator. How does evaporation differ from distillation?	**04**
	(c)	Draw neat sketch of forced circulation evaporator and explain briefly its construction and working. Also, mention any four characteristics of solutions to be considered before selecting the evaporator.	**07**

OR

Q.5	**(a)**	State and explain the following laws relating to thermal radiation and temperature of a radiating body: Wien's displacement law	**03**
	(b)	When concentration of solution in evaporator varies with operation, what would be the behavior of boiling point of solution? Explain in detail with due example.	**04**
	(c)	State the method of feeding multiple effect evaporation system. Compare mixed feed arrangement with parallel feed arrangement in case of multiple effect evaporation system. State why the economy of single effect evaporator is less than one and also mention the method of increasing the economy of an evaporator.	**07**

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