Enrolment No./Seat No_____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE- SEMESTER–IV EXAMINATION – WINTER 2025

Subject Code:3140503 Date:15-11-2025

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)**	Discuss the fourier's law of conduction.	**03**
	(b)	Define thermal conductivity and discuss the effect of temperature on thermal conductivity of gas and liquid.	**04**
	(c)	Explain conduction and flow of heat through a composite wall when resistances are in series.	**07**
Q.2	**(a)**	Enlist different types of fins with neat sketch.	**03**
	(b)	Explain concept of critical thickness of insulation and derive equation for the critical thickness of insulation.	**04**
	(c)	Using Dimension analysis derive expression for forced convection for the fluid flowing inside tube in a turbulent flow.	**07**
		OR	
	(c)	A pin fin 2.5 mm diameter is made of copper (k=396 w/m K). It protrudes from a wall maintained at 95 ^{o}C and placed in 25 oC air. The convective heat transfer coefficient over the fin is 10 W/m^2 K. Calculate the heat loss for the two cases. (1) Fin length 25 mm, (2) Fin length infinite	**07**
Q.3	**(a)**	Give the physical significance of (i) Nusselt Number (ii) Prandtl Number	**03**
	(b)	Differentiate between free and forced convection? Mention the factors on which the heat transfer coefficient depends.	**04**
	(c)	Differentiate between film wise and drop wise condensation.	**07**
		OR	
Q.3	**(a)**	Explain the significance of Biot, Graetz and Peclet numbers	**03**
	(b)	Discuss Condensation of vapor on Vertical and horizontal surface.	**04**
	(c)	Calculate the heat transfer coefficient for water at 60 ^{o}C flowing through a 0.625 cm diameter tube with a velocity of 0.9 m/sec. The tube wall temperature is 40 ^{o}C. Viscosity of water = 2.167 kg/m hr, thermal conductivity = 2.27 kJ/m hr K, heat capacity=4.187 kJ/Kg K.	**07**
Q.4	**(a)**	Define: Transmitivity, Absorptivity, and Reflectivity with example	**03**
	(b)	State and derive Kirchhoff's Law for radiation	**04**

	(c)	Two large parallel plates with temp 400 ^{o}C & 900 ^{o}C & emissivity 0.4 and 0.75 are engaged in radiative heat transfer. Calculate the rate of heat transfer. $\{\sigma = 56.7 \text{ X } 10^{-9} \text{ W/m}^2 \text{ K}^4\}$	**07**

OR

Q.4	**(a)**	Define: White body and Grey body	**03**
	(b)	List out various laws of radiation and discuss any one in details.	**04**
	(c)	Discuss the various regimes of pool boiling with neat sketches.	**07**
Q.5	**(a)**	Discuss the classification of heat exchanger briefly.	**03**
	(b)	Derive the equation for L.M.T.D. in parallel flow heat exchanger. State all the assumption made in derivation.	**04**
	(c)	Hot oil (sp. Heat = 0.5 kcal/kg C) with a capacity of 5000 kg/hr flows through double pipe heat exchanger. It enters at 360 ^{o}C and leaves at 300 ^{o}C and cold fluid enters at 30 ^{o}C and leaves at 200 ^{o}C. if the overall coefficient is 800 kcal/hr m^2 C, determine the heat transfer area required for parallel flow.	**07**

OR

Q.5	**(a)**	Define Capacity and Economy of evaporators.	**03**
	(b)	Explain Boiling Point Elevation (BPE).	**04**
	(c)	Discuss about feed forward and feed backward arrangement is multiple effect evaporators.	**07**

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Enrolment No./Seat No_____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE- SEMESTER–IV (NEW) EXAMINATION – WINTER 2024

Subject Code:3140503 Date:21-11-2024

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)**	Define: Thermal Resistance, Thermal diffusivity, Angle of vision	**03**
	(b)	Give Significance of thermal conductivity and discuss the effect of temperature on thermal conductivity of solid and liquid.	**04**
	(c)	Derive equation for heat transfer through a composite wall made up of three different materials in close thermal contact with each other, with no heat loss to surrounding when temperatures of hot and cold ends are T_h and Tc.	**07**
Q.2	**(a)**	Define : Intensity of Radiation, Monochromatic emissive power, Planck's distribution law	**03**
	(b)	Differentiate Viscous sub layer and Buffer layer.	**04**
	(c)	A pipe carrying steam having an outside diameter of 30 cm runs in a large room and is exposed to air at a temperature of 35°C. The pipe surface temperature is 405°C. Calculate the loss of heat to surrounding per meter length of pipe due to thermal radiation. The emissivity of the pipe surface is 0.8. What would be the loss of heat by thermal radiation if the pipe is enclosed in a 50 cm diameter brick conduit of emissivity 0.91? Value of Stefan Boltzmann constant is 5.67×10^{-8} W/(m^2K^4)	**07**
		OR	
	(c)	Draw the temperature profiles of cold and hot fluids for true co-current and counter current flow in double pipe heat exchanger, Derive expression relating Rate of heat transfer and Log mean temperature difference.	**07**
Q.3	**(a)**	Define Radiation shield. How Radiation from gases differ from solids?	**03**
	(b)	Discuss the effect of non-condensable gases on condensation.	**04**
	(c)	Derive and equation for Critical Thickness of Insulation for Composite cylinder.	**07**
		OR	
Q.3	**(a)**	Write Dittus- Boeltier equation and Sieder-Tate equation explaining each term and highlight the difference.	**03**
	(b)	Prove that the temperature of a body at any time τ during Newtonian heating and cooling is given by the relation $t - t_a / t_i - t_a = \exp[-Bi\,F_o]$	**04**
	(c)	Define fin effectiveness and derive an expression for Temperature profile for Insulated Fin at the tip.	**07**
Q.4	**(a)**	Draw the neat diagram of Box type furnace and mention its working principle.	**03**
	(b)	Explain Natural Convection from vertical tube with empirical equation.	**04**
	(c)	Explain in details with neat sketch: Shell & Tube heat exchanger.	**07**

OR

Q.4	**(a)**	When LMTD correction factor is used in heat exchanger calculation?	**03**
	(b)	What are the advantages of square pitch arrangement over the triangular pitch in case of heat exchanger tubes?	**04**
	(c)	Derive an equation for heat transfer coefficient for condensation on vertical plate.	**07**
Q.5	**(a)**	Hot oil at a rate of 1.3 kg/s having Cp of 2083 J/(kg.K) flows through a double pipe heat exchanger. It enters at 643 K and leaves at 583 K. cold fluid enters at 313 K and leaves at 410 k. If the overall heat transfer co-efficient is 500 W/(m2.K), calculate the heat transfer area for parallel flow.	**03**
	(b)	Explain Boiling Point Elevation (BPE).	**04**
	(c)	An evaporator is operating at atmospheric pressure. It is desired to concentrate a feed from 5% solute to 20% solute by weight at a rate of 5000 kg/hr. Dry saturated steam at a pressure corresponding to the saturation temperature 399 K is used. The feed is at 298 K and the boiling point rise is 5 K. The overall heat transfer coefficient is 2350 w/m^2 K. Calculate the economy of the evaporator and the area of the heat transfer to be provided. Data: Treating solution as a pure water and neglecting the B.P.R, the latent heat of condensation of steam at 399 K is 2185 KJ/kg., Latent heat of vaporization of water at 101.325 KPa and 373 K= 2257 KJ/kg and specific heat of feed is 4.187 KJ/Kg. K	**07**

OR

Q.5	**(a)**	What is the reason for increasing the number of passes in a shell & tube heat exchanger?	**03**
	(b)	Explain Vapor recompression in evaporators.	**04**
	(c)	Discuss various boiling regimes and factors affecting on nucleating boiling.	**07**

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Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–IV (NEW) EXAMINATION – WINTER 2023

Subject Code:3140503 Date:17-01-2024

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)**	Explain how thermal conductivity of gases, liquid and solids depends upon temperature?	**03**
	(b)	Discuss the Concept of Internal temperature gradient for unsteady state heat transfer. Also mention its correlation with Biot Number.	**04**
	(c)	List out various laws of radiation and discuss any one in details.	**07**
Q.2	**(a)**	Enlist different types of fins with neat sketch.	**03**
	(b)	Derive an expression for heat flow through a Sphere.	**04**
	(c)	A furnace is constructed with a 23 cm thick layer of fire brick, 75 cm thick layer of insulating brick and followed by a 89 cm thick layer of building brick. The inside temperature of the furnace is 800 °C and the outside temperature is 60 °C. The thermal conductivities of fire brick, insulating brick and building brick are 1.22, 0.121 and 0.865 W/(m.K). Find the heat loss per unit area and the temperature at the interfaces.	**07**
		OR	
	(c)	Derive the equation for critical radius of insulation.	**07**
Q.3	**(a)**	Write down difference between free and forced convection.	**03**
	(b)	Give the physical significance of Prandlt No., Nusselt No. and Grashoff No. and Stanton No.	**04**
	(c)	Discuss with the help of diagram various regimes of pool boiling. What is the use of finding critical flux and critical temperature drop?	**07**
		OR	
Q.3	**(a)**	State and explain Stefan-Boltzmann Law of radiation.	**03**
	(b)	Define the black body and Give applications where this concept is used in heat transfer.	**04**
	(c)	Using Dimension analysis derive expression for forced convection for the fluid flowing inside tube in a turbulent flow.	**07**
Q.4	**(a)**	Draw the temperature profiles of cold and hot fluids for true co-current and counter –current flow in double pipe heat exchanger.	**03**
	(b)	Discuss the Concept of Effectiveness.	**04**
	(c)	Discuss construction and working of Plate type heat exchanger.	**07**
		OR	
Q.4	**(a)**	Give the advantages of square pitch arrangement over the triangular pitch in case of heat exchanger tubes?	**03**
	(b)	Derive an equation for Overall heat transfer coefficient in double pipe heat exchanger.	**04**

	(c)	Explain in details with neat sketch: Shell & Tube heat exchangers.	**07**
Q.5	**(a)**	Draw the sketch of various methods of feeding the multiple effect evaporators	**03**
	(b)	Explain Boiling Point Elevation (BPE)	**04**
	(c)	Derive the material and energy balances for multi effect evaporator.	**07**

OR

Q.5	**(a)**	Define capacity and economy of evaporator.	**03**
	(b)	Differentiate between forward feed and backward feed in a multiple effect evaporator with a neat sketch	**04**
	(c)	Write a short note on Multiple Effect Evaporator	**07**

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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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