Enrolment No./Seat No_____

GUJARAT TECHNOLOGICAL UNIVERSITY

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

Subject Code:3151909 Date:28-11-2024

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)**	Distinguish between the conduction, convection and radiation modes of heat transfer with suitable example.	**03**
	(b)	Draw temperature variation for the condenser of the domestic refrigerator and evaporator of the thermal power plant.	**04**
	(c)	Derive equation of logarithmic mean temperature difference for parallel flow heat-exchanger.	**07**
Q.2	**(a)**	"Generally fin is provided to increase the heat transfer rate but by providing fin heat transfer may decrease" Justify the statement in context to heat transfer.	**03**
	(b)	a) Explain the situation when the addition of fins to a surface is not useful. b) Under what situations does the fin efficiency becomes 100%.	**04**
	(c)	Write the most general equation in Cartesian coordinates for heat transfer by conduction. Hence, deduce the above equation for the following cases with suitable assumptions; (i) Laplace equation, (ii) Poisson equation, and (iii) Fourier equation.	**07**
		OR	
	(c)	A steel fin (k=55W/mK) with a cross-section of an equilateral triangle, 5mm on the side is 80mm long. It is attached to a plane wall maintained at 350^0C. The ambient air temperature is 40^0C and unit surface conductance is 100W/m^2K. Calculate the heat dissipation rate by assuming the fin as a rod with the tip of the fin is insulated.	**07**
Q.3	**(a)**	What is critical radius of insulation? Explain its importance in electrical and thermal system.	**03**
	(b)	Compare the value of effectiveness for the counter and parallel flow for regenerator for NTU = 2.5.	**04**
	(c)	Explain with neat sketch, the various regimes in boiling and explain the condition for the growth of bubbles. What is the effect of bubble size on boiling?	**07**
		OR	
Q.3	**(a)**	Write three properties of shape factor.	**03**
	(b)	Write the general differential equation in Cartesian coordinates for 3D unsteady heat conduction by considering an infinitesimal volume element. Deduce there from the conduction equations for the following cases; (i) Steady-state 1-D flow with heat generation at a uniform rate within the material.	**04**

(c) State the relationship between Nusselt number, Grashoff number and Prandtl number in case of heat transfer by nature convection from a vertical plate. **07**

Q.4 **(a)** Justify the use of polished surfaces in thermal insulation systems from the perspective of radiation. **03**

(b) Define Biot number and Fourier number, and point out their physical significance. **04**

(c) Define radiation shield. Prove that if radiation shields of the emissivity same as the emissivity of two parallel plates is inserted between two parallel plates net heat transfer rate due to radiation is reduced to half as compared to without shield. **07**

OR

Q.4 **(a)** Differentiate mean film temperature and bulk mean temperature. **03**

(b) What is lumped system analysis? What are the assumption made in the lumped system analysis and when it is applicable? **04**

(c) What is heat exchanger? Classify the heat exchanger types with example. **07**

Q.5 **(a)** What is the significance of thermal conductivity in material selection for heat exchangers and insulators? Discuss its role in optimizing heat transfer. **03**

(b) Why is it important to analyze heat conduction through composite walls in industrial applications? Explain in brief, how to calculate the overall heat transfer rate in such systems. **04**

(c) An egg with mean diameter of 4 cm and initially at 20°C is placed in a boiling water pan for 4 minutes and found to be boiled to the consumer's test. For how long should a similar egg for same consumer be boiled when taken from a refrigerator at 5°C. **07**

Take following properties for egg :

$k = 10 W / m^0C$, $\rho = 1200 kg /m3$, $c = 2 kJ / kg^0C$, $h = 100 W /m^2 {}^0C$

OR

Q.5 **(a)** What is the relevance of one-dimensional heat conduction analysis in practical applications? Explain with the example of heat transfer through a plane wall or cylinder. **03**

(b) Discuss the principle behind why black surfaces absorb more radiant energy and how it enhances the efficiency of solar panels in converting sunlight to electricity. **04**

(c) A cylinder in vertical position is having dimension of 18 cm diameter and length 1.5 m is maintained at a temperature of 100^0C. It is kept in atmosphere having temperature 20^0C. **07**

Calculate the heat lost by cylinder surface to the atmosphere by free convection.

Properties of air at mean film temperature 60^0C are as follows :

$\rho = 1.06 kg/m^3$, $\upsilon = 18.97 * 10^{-6} m^2/s$, $k = 0.1042 kJ/m.hr.^0C$, $Cp = 1.004 kJ/kg^0C$.

Use the relation $Nu = 0.10 (Gr.Pr)^{1/3}$

(The symbols have their usual meanings)

****