Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE – SEMESTER- VII EXAMINATION-SUMMER 2023

Subject Code: 3171911 Date: 19/06/2023

Subject Name: Advanced 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.**
5. **Use of Steam table and Molliar diagram is permitted.**
6. **Use of Heisler chart is permitted.**

			MARKS
Q.1	**(a)**	Define transient, Non periodic and periodic heat conduction with examples?	**03**
	(b)	What are Biot and Fourier numbers? Explain their physical significance?	**04**
	(c)	Derive a general heat conduction equation in spherical coordinates.	**07**
Q.2	**(a)**	What are the initial and boundary condition in conduction heat transfer problem?	**03**
	(b)	Define thermal contact resistance? Upon what parameters does this resistance depend ?	**04**
	(c)	The inside dimensions of a small cubical furnace constructed of fire clay bricks (k = 1.05 W/m ^{0}C) are 0.6 m x 0.6 m x 0.6 m; the walls being of 0.12 m thick. The temperatures at the inside and outside surfaces are 600 ^{0}C and 70 ^{0}C respectively. Determine the heat lost through the walls.	**07**
		OR	
	(c)	Explain radial fins of rectangular and hyperbolic profiles- longitudinal fin of rectangular profile radiating to free space.	**07**
Q.3	**(a)**	Explain effectiveness of fin.	**03**
	(b)	What is lumped parameter analysis? How it is differ from Heisler's chart analysis?	**04**
	(c)	An egg with mean diameter of 40 mm and initially at 20 ^{0}C is placed in a boiling water pan for 4 minutes and found to be boiled to the consumer's taste. For how long should a similar egg for same consumer be boiled when taken from a refrigerator at 5 ^{0}C. Take the following properties for egg: K = 10 W/m^{0}C, ρ = 1200 kg/m^3, c = 2 kJ/kg ^{0}C and h (heat transfer coefficient) = 100 W/m^2 ^{0}C. Use lump theory.	**07**
		OR	
Q.3	**(a)**	Define a semi-infinite body. What is error function?	**03**
	(b)	What is the criterion for transition from laminar to turbulent boundary layer in free convection on a vertical plate?	**04**
	(c)	How do numerical solution methods differ from analytical ones? Explain finite difference method for solving multi-dimensional steady state heat conduction problems.	**07**
Q.4	**(a)**	What are the factors affecting Nucleate boiling?	**03**
	(b)	Derive the Nusselt theory of laminar flow film condensation on a vertical plate?	**04**

(c) Derive expressions for boundary layer thickness and local skin friction coefficient following the Blasius method of solving laminar boundary layer equations for flat plate. **07**

OR

Q.4 **(a)** Explain with neat sketch why is the flow separation in flow over cylinders delayed in turbulent flow? **03**

(b) Discuss the significance of bulk temperature in case of fully developed laminar flow in a tube. **04**

(c) A vertical plate 500 mm high and maintained at 30 ^{0}C is exposed to saturated steam at atmospheric pressure. Calculate the following: **07**

(i) The rate of heat transfer, and

(ii) The condensate rate per hour per metre of the plate width for film condensation.

The properties of water film at the mean temperature are:
$\rho = 980.3$ kg/m^3, $k = 66.4 \times 10^{-2}$ W/m^{0}C, $\mu = 434 \times 10^{-6}$ kg/ms and h_{fg} =2257 kJ/kg.
Assume vapour density is small compared to that of the condensate.

Q.5 **(a)** Explain briefly the physical mechanism of boiling and condensation. **03**

(b) What do you mean by thermal capacity and thermal diffusivity of material? Explain with example. **04**

(c) Derive expressions for the radiation heat exchange for two gray surfaces connected by single refractory surface. **07**

OR

Q.5 **(a)** Define intensity of the radiation. How the solid angle is measured? **03**

(b) Write a short note on radiation from gases vapours and flames. **04**

(c) For a hemispherical furnace, the flat floor is at 700 K and has an emissivity of 0.5. The hemispherical roof is at 1000 K and has emissivity of 0.25. Find the net radiative heat transfer from root to floor. **07**

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