Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE – SEMESTER- VII EXAMINATION-SUMMER 2023

Subject Code: 3170102 Date: 19/06/2023

Subject Name: Theory of 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)**	Differentiate natural convection and forced convection.	**03**
	(b)	Explain the following: (i) Transmissivity (ii) Emissivity (iii) Opaque body (iv) Total Emissive Power	**04**
	(c)	With a neat figure, derive the expression of overall heat transfer coefficient for a sphere.	**07**
Q.2	**(a)**	Why extended surfaces are needed in heat transfer? What are the characteristics of material of extended surfaces?	**03**
	(b)	Define the following dimensionless number and write their significance in heat transfer. Prandtl number, Grashoff number, Biot number and Nusselt number.	**04**
	(c)	Derive the expression of heat transfer rate in a transient heat transfer following lumped capacitance method.	**07**
		OR	
	(c)	A cylindrical plastic pipe (k = 0.5 W/mK) of i.d. 3 cm and o.d. 4 cm carries a fluid of average temperature 100°C and h = 300 W/m^2K. The rate of heat transfer per unit length is 500 W/m. To find: (i) The outside surface temperature of pipe, (ii) the overall heat transfer coefficient based on outside area.	**07**
Q.3	**(a)**	What is shape factor and what is its purpose in radiation heat transfer?	**03**
	(b)	State Stefan- Boltzmann law and derive the expression of the total radiant heat power emitted from a surface.	**04**
	(c)	A solid copper ball of 100 mm diameter and density = 8954 kg /m^3, Cp = 383 J/kgK, k = 386 W/m K is at a uniform temperature of 250°C. It is suddenly immersed in a well-stirred fluid which is maintained at a uniform temperature of 50°C. The heat transfer coefficient between the ball and the fluid is h = 200 W/m^2 K. Estimate the temperature of the copper ball after a lapse of 5 minutes of immersion	**07**
		OR	
Q.3	**(a)**	Define thermal conductivity and convective heat transfer coefficient.	**03**
	(b)	Discuss the Kirchhoff's law of thermal radiation.	**04**
	(c)	A tube 5 m long is maintained at 100°C by steam jacketing. A fluid flows through the tube at the rate of 2940 kg/h at 30°C. The diameter of the tube is 2 cm. find out average heat transfer coefficient. Take the properties at mean film temperature.	**07**
Q.4	**(a)**	Explain the fourier's law of conduction for solid bodies.	**03**
	(b)	What is critical thickness of insulation on a small diameter wire? Explain its physical significance and derive an expression for the same for cylinder.	**04**
	(c)	Derive the expression of heat exchanger effectiveness for counter flow arrangement.	**07**
		OR	
Q.4	**(a)**	What is heat exchanger? Why it is used in heat transfer applications?	**03**
	(b)	What are regenerators and recuperators? Give their field applications.	**04**
	(c)	State and discuss Lamberts Cosine law of radiation.	**07**

Q.5	**(a)**	What is a radiation shield? What are its applications?	**03**
	(b)	Define following: 1) Radiosity 2) Irradiation 3) Black Body 4) Monochromotic Emissive Power	**04**
	(c)	Derive the expression of temperature distribution in parallel flow heat exchangers.	**07**

OR

Q.5	**(a)**	Explain the Wien Displacement Law?	**03**
	(b)	Define fin efficiency and fin effectiveness.	**04**
	(c)	Derive the expressions for Nusselt number for forced convection.	**07**

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