Enrolment No./Seat No_____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VII EXAMINATION – SUMMER 2025

Subject Code:3170102 Date:27-05-2025

Subject Name:Theory of 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)**	What are three modes of heat transfer? Explain their differences briefly with example.	**03**
	(b)	Write Fourier rate equation of heat transfer by conduction. Give units of each parameter appearing in this equation.	**04**
	(c)	Using dimensional analysis, obtain a general form of equation for force convective heat transfer.	**07**
Q.2	**(a)**	Compare free convection and force convection.	**03**
	(b)	Derive an expression of critical radius of insulation for the cylinders.	**04**
	(c)	Derive equations of temperature distribution and heat dissipation for infinite fin.	**07**
		OR	
	(c)	A steel pipe 3 cm in diameter has its outer surface at 210°C, is placed in air at 35°C with heat transfer coefficient of 8.5 W/m^2K. It is proposed to add insulation (k = 0.07 W/mK) on its outer surface to reduce the heat loss by 40%. Estimate the thickness of insulation required, if pipe temperature and heat transfer coefficient remain unchanged.	**07**
Q.3	**(a)**	Define: Biot number and Fourier number.	**03**
	(b)	Enlist assumptions need to be considered for the analysis of heat flow through the fin.	**04**
	(c)	A large vertical flat plate 3 m high and 2 m wide is maintained at 75°C and is exposed to atmosphere at 25°C. Calculate the rate of heat transfer. The thermophysical properties of air are evaluated at the mean temperature and are as follow: $\rho = 1.088$ kg/m^3, Cp = 1.00 kJ/kg.K, $\mu = 1.96 \times 10^{-5}$ Pa-s, k = 0.028 W/mK, Pr = 0.7. Use the following correlation for convective heat transfer coefficient $Nu = 0.1\ (Gr.Pr)^{1/3}$.	**07**
		OR	
Q.3	**(a)**	Explain the following terms: (a) Thermal diffusivity (b) Thermal Conductivity (c) Thermal contact resistance	**03**
	(b)	Explain mean film temperature and bulk mean temperature.	**04**
	(c)	A solid copper sphere of 10 cm diameter [ρ = 8954 kg/m3, c_p = 383 J/kg K, k = 386 W/mK] initially at a uniform temperature t_i = 250 °C, is suddenly immersed in a well-stirred fluid which is maintained at a uniform temperature t_a = 50 °C. The heat transfer coefficient between the sphere and the fluid is h = 200 W/m^2K. Determined the temperature of the copper block at τ = 5 min after immersion.	**07**
Q.4	**(a)**	Define: Thermal boundary layer, Hydrodynamic boundary layer, Laminar sub layer.	**03**
	(b)	Differentiate parallel flow and counter flow heat exchanger.	**04**
	(c)	Discuss the concept of thermal boundary layer in case of flow over the plates. How it differ from velocity boundary?	**07**

OR

Q.4	**(a)**	State & explain Lambert's cosine law.	**03**
	(b)	Explain the following terms in heat exchanger: (1) Effectiveness (2) NTU	**04**
	(c)	Derive the Stefan-Boltzmann law from the Plank's law of thermal radiation. What is the value of Stefan-Boltzmann constant?	**07**
Q.5	**(a)**	Justify that a good absorber is also a good emitter for radiation heat transfer.	**03**
	(b)	List the factors on which the rate of emission of radiation by a body depends.	**04**
	(c)	With a neat sketch explain filmwise and dropwise condensation.	**07**

OR

Q.5	**(a)**	What do you understand by fouling factor in case of heat exchanger? List the causes of fouling.	**03**
	(b)	Differentiate between boiling and condensation.	**04**
	(c)	Derive equation of effectiveness of parallel flow heat exchanger.	**07**

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