Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VII(OLD) • EXAMINATION – WINTER 2016

Subject Code: 170102 **Date: 21/11/2016**

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. **Tables for properties of air and water are permitted.**

Q.1	**(a)**	Derive general heat conduction equation in Cartesian coordinates	**07**
	(b)	A steam pipe pipe is covered with two layers of insulation, first layer being 3 cm thick and second 5 cm. the pipe is made from steel (k = 58 W/m-K) having ID of 160 mm and OD of 170 mm. The inside and outside film coefficients are 30 and 5.8 W/m^2-K , resp. Draw electrical analogy for system and calculate the heat lost per meter of pipe, if the steam temperature is 300 ^{o}C and air temperature is 50 ^{o}C. The thermal conductivity of two materials are 0.17 and 0.093 W/m-K, resp.	**07**
Q.2	**(a)**	Derive equations of temperature distribution and heat dissipation for infinite long fin.	**07**
	(b)	Derive and expression for "Critical thickness of insulation" for a pipe.	**07**
		OR	
	(b)	An aluminium alloy fin (k = 200 W/m-K), 3.50 mm thick and 2.5 cm long protrudes from a wall. The base is at 420 °C and ambient air temperature is 30 °C. The heat transfer coefficient of 11 W/m^2-K. Find the heat loss and fin efficiency, if the heat loss from fin tip is negligible.	**07**
Q.3	**(a)**	Define Re, Nu, Pr. Explain their importance in convection heat transfer.	**07**
	(b)	A horizontal fluorescent tube which is 4 cm in diameter and 125 cm long stands in still air at 1 bar and 20 ^{o}C. If the surface temperature is 60 ^{o}C and radiation is neglected, what is heat transfer rate by convection? Use $\overline{N}_u = 0.53\,(Gr.Pr)^{0.25}$	**07**
		OR	
Q.3	**(a)**	Explain lumped heat capacity method and state its assumptions.	**07**
	(b)	A titanium alloy blade of an axial compressor for which k = 25 W/m-K, ρ = 4500 kg/m^3 and Cp = 520 J/kg-K is initially at 60 °C. The effective thickness of the blade is 10 mm and it is exposed to gas stream at 600 °C, the blade experiences a heat transfer coefficient of 500 W/m^2-K. Estimate the temperature of blade after 1, 5, 20 and 100 seconds.	**07**
Q.4	**(a)**	Define Heat Exchanger Effectiveness & explain its significance.	**07**
	(b)	Draw and Explain boiling curve for water. Explain Nucleate boiling	**07**
		OR	
Q.4	**(a)**	How are the heat exchangers classified ?	**07**
	(b)	In a shell and tube heat exchanger, 5.795 kg/s of oil flows through the shell side. The oil enters at 101 ^{o}C and leaves at 38 ^{o}C. Water flows in the tubes, entering at 32 ^{o}C and leaving at 49 ^{o}C. In addition, Cp_{oil} = 2282 J/kg.K and U = 416 W/m^2-K . Determine number of tubes, if outer diameter of tubes is 100 mm, length of each tube is 1.9 m and take correction factor as 0.88.	**07**

Q.5	**(a)**	Two very large parallel plates with errissivities 0.3 and 0.8 exchange radiative energy. Polished aluminum shield ($\in$ = 0.04) is placed between two plates. Determine the percentage reduction in radiation heat transfer.	**07**
	(b)	Using dimensional analysis, obtain a general form of equation for forced Convective heat transfer.	**07**

OR

Q.5	**(a)**	Define and explain Radiation shield and Radiation shape factor	**07**
	(b)	State & explain Kirchoff's identity. What are conditions under which it is Applicable	**07**

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