Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VII EXAMINATION – SUMMER 2016

Subject Code:170102 Date:07/05/2016

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.**

Q.1	**(a)**	Derive general heat conduction equation in Cartesian coordinates.	**07**
	(b)	A refrigerator stands in a room, where air temperature is 21 ^{o}C. The surface temperature on the outside of the refrigerator is 16 ^{o}C. The sides are 30 mm thick and has a thermal conductivity of 0.1 W/m-K. The heat transfer coefficient on the outside is 10 W/m^2-K. Assume one dimensional conduction through sides; calculate the net heat flow rate and the inside surface temperature of the refrigerator.	**07**
Q.2	**(a)**	A fin 30 cm long and 10 cm diameter throughout is made of steel alloy of thermal conductivity 43 W/m-K. The fin attached to a plane heated wall at 200°C temp. extends into surroundings at 25°C and heat transfer coefficient of 120 W/m^2-K. Find fin efficiency and fin effectiveness. Assume that the tip of the fin is insulated and thermal radiation effect is negligible.	**07**
	(b)	Define and Explain significance of fin effectiveness & fin efficiency.	**07**
		OR	
	(b)	What is the critical thickness of insulation on a small diameter wire and a steam pipe. Explain its physical significance in both the cases & derive an expression for the same.	**07**
Q.3	**(a)**	Explain the term NTU. Discuss various considerations essential for design of Heat Exchanger. Discuss advantages of NTU method over LMTD method of Heat Exchanger design.	**07**
	(b)	In a shell and tube heat exchanger, 6 kg/s of oil flows through the shell side. The oil enters at 105 ^{o}C and leaves at 40 ^{o}C. Water flows in the tubes, entering at 32 ^{o}C and leaving at 50 ^{o}C. In addition, $C_p$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 0.85	**07**
		OR	
Q.3	**(a)**	Using dimensional analysis, obtain a general form of equation for natural Convective heat transfer.	**07**
	(b)	Explain unsteady state heat transfer when Bi < 0.1	**07**
Q.4	**(a)**	Explain dropwise and filmwise condensation.	**07**
	(b)	Derive Von-karman integral momentum equation	**07**
		OR	
Q.4	**(a)**	Define Grashoff number, Reynold Number & Nusselt Number. Explain its significance in convection heat transfer.	**07**

(b) A long horizontal pipe of 15 cm outside diameter passes through a large room. The surface temp of the pipe is 95 °C and the surrounding air is at 25°C. Work out the convective coefficient for free convection. Use the correlation: **07**

$$Nu = 0.53 (Gr . Pr)^{0.25}$$

Take the air properties at mean film temp. of 60 °C as :

$Cp = 1046$ J/kg-K $\quad k = 2.9 \times 10^{-2}$ W/m-K

$\nu = 18.97 \times 10^{-6}$ m^2/s $\quad \mu = 1.929 \times 10^{-5}$ kg/m.s

Q.5 **(a)** State & Explain the Wien Displacement Law. Show that $E_{b\lambda}$ will be maximum when $\lambda_{max} .T = 2900\ \mu K$ **07**

(b) 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**

OR

Q.5 **(a)** Distinguish between: **07**

(i) A black body & grey body

(ii) Specular & diffuse surfaces

(iii) Absorptivity & Emissivity of a surface

(iv) Total Emissivity & Equilibrium emissivity

(b) Define and explain Radiation shield and Radiation shape factor **07**

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