Seat No.: _____ **Enrolment No._____**

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–V (NEW) - EXAMINATION – SUMMER 2016

Subject Code:2151909 Date:23/05/2016

Subject Name: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) The walls of a refrigerated truck consist of 1.2 mm thick steel sheet (k=18 W/m-K) at the outer surface, 22 mm thick cork (k=0.04 W/m-K) on the inner surface. Consider Heat transfer coefficient of 5 W/m^2-K (between inside air and inside surface) and Heat transfer coefficient of 30 W/m^2-K (between outside air and outside surface). The temperatures at the inside and outside air are 0°C & 35°respectively. **07**

Calculate (1) heat transfer rate

(2) steel-cork interface temp.

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) 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**

OR

(b) Derive equations of temperature distribution and heat dissipation for Fin insulated at tip. **07**

Q.3 **(a)** Distinguish between natural and forced convection heat transfer. Also Define velocity & thermal boundary layer thickness. **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**

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

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

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

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

OR

Q.3 **(a)** Explain lumped heat capacity method and state its assumptions. **07**

	(b)	Estimate the time required to cook a carrot in boiling water at atmospheric pressure. The carrot is initially at room temp 32 °C and the cooking requirement stipulates that a minimum temp. of 97 °C is reached at the center of carrot. Treat the carrot as a long cylinder of 18 mm diameter and having the following properties: ρ=1025 kg/m3, Cp = 4000 J/kgK, k= 3.45 W/m-K, convective heat transfer coefficient h = 60 W/m^2-K.	**07**
Q.4	**(a)**	How are the heat exchangers classified ? Sketch the temp variations in (i) parallel flow heat exchanger (ii) counter-flow heat exchangers (iii) Boiler (iv) Condensor	**07**
	(b)	In a shell and tube heat exchanger, 6 kg/s of oil flows through the shell side. The oil enters at 105 ^oC and leaves at 40 ^oC. Water flows in the tubes, entering at 32 ^oC and leaving at 50 ^oC. 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.4	**(a)**	What are the fouling factors? Explain their effect in Heat Exchanger design.	**07**
	(b)	Explain dropwise and filmwise condensation	**07**
Q.5	**(a)**	Write Von-karman integral momentum equation, for the hydrodynamic laminar boundary layer of fluid flowing over stationary plate. Using this equation, derive the expression for hydrodynamic boundary layer thickness considering the cubic velocity profile	**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)	Two large parallel plates with Є = 0.5 each are maintained at different temperatures and are exchanging heat only by radiation. Two equally large radiation shields with surface emissivity 0.05 are introduced in parallel to the plates. Find the percentage reduction in net radiation heat transfer.	**07**

****