

Seat No.: _____

Enrolment No. _____

GUJARAT TECHNOLOGICAL UNIVERSITY**BE - SEMESTER-VII (NEW) - EXAMINATION – SUMMER 2018****Subject Code:2170102****Date:01/05/2018****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.

		MARKS
Q.1	(a) Explain the electrical analogy for solving heat transfer problems.	03
	(b) Derive an expression of critical radius of insulation for the cylinders.	04
	(c) Derive general heat conduction equation in Cartesian coordinates.	07
Q.2	(a) Enumerate the basic laws which govern the heat transfer.	03
	(b) Derive expression for temperature distribution under 1D steady state heat conduction for composite cylinder. [Hint: Start from general 1D steady state heat conduction equation of cylinder.]	04
	(c) A steam pipe is covered with two layers of insulation, first layer being 3 cm thick and second 5 cm. The pipe is made from steel ($k = 58 \text{ W/m-K}$) having ID of 160 mm and OD of 170 mm. The inside and outside film coefficients are $30 \text{ W/m}^2\text{-K}$ and $5.8 \text{ W/m}^2\text{-K}$, resp. Draw electrical analogy for system and calculate the heat lost per meter of pipe, if the steam temperature is 300°C and air temperature is 50°C . The thermal conductivity of two materials is 0.17 W/m-K and 0.093 W/m-K respectively.	07
OR		
	(c) A steel fin ($k = 55 \text{ W/mK}$) with a c/s of an equilateral triangle, 5 mm in side is 80 mm long. It is attached to a plane wall maintained at 350°C . The ambient air temperature is 40°C & unit surface conductance is $100 \text{ W/m}^2\text{K}$. Calculate the heat dissipation rate by assuming the fin is a rod with insulated tip.	07
Q.3	(a) Why extended surfaces are most commonly used?	03
	(b) Explain significance of fin effectiveness & fin efficiency	04
	(c) What is meant by transient heat conduction? What are the assumptions made in unsteady state heat conduction? Explain significance of Biot No and Fourier No.	07
OR		
Q.3	(a) Define: Thermal Boundary layer, Hydrodynamic Boundary layer, Laminar Sub Layer	03
	(b) For flow of air over a flat plate calculate the boundary layer thickness and local skin friction coefficient at distance of 1.2 m from the leading edge of the plate using Blasius method. The free stream velocity of air is 2.8 m/s. Take kinematic viscosity of air as $15.4 \times 10^{-6} \text{ m}^2/\text{s}$.	04
	(c) Derive an expression for temperature distribution and heat dissipation for in a straight fin of rectangular profile for infinitely long fin.	07
Q.4	(a) Distinguish between natural and forced convection heat transfer.	03
	(b) State & explain Kirchoff's identity.	04

- (c) Assuming that a man can be represented by a cylinder 400 mm in diameter & 1.72 m high with a surface temperature of 37 °C. Calculate the heat he would lose while standing in a 20 km/hour wind at 17 °C. **07**

The properties of air at 27°C are:

$K=0.0263 \text{ W/m-K}$, $Pr=0.707$, $\mu= 184.6 \times 10^{-7} \text{ Ns/m}^2$, $\rho=1.1614 \text{ kg/m}^3$

Take $Nu_{avg} = 0.027 (Re)^{0.805} (Pr)^{1/3}$

OR

- Q.4** (a) Define Grashoff (Gr) number. Explain its significance in natural convection heat transfer. **03**
- (b) Define : Total Emissive Power, Emissivity, Black body, White body **04**
- (c) Using dimensional analysis, obtain a general form of equation for forced Convective heat transfer. **07**
- Q.5** (a) State and explain the Wien displacement law. **03**
- (b) Draw temperature distribution profile along the length of the following heat exchangers: **04**
(a) Parallel Flow (b) Counter flow (c) Condenser (d) Evaporator
- (c) An oil of 0.27 kg/s ($C_p = 2.09 \text{ kJ/kg-K}$) has to cool from 80 °C to 40 °C using a coolant flow of 0.27 kg/s ($C_p = 4.187 \text{ kJ/kg-K}$) at 30 °C. Give your choice for selection of heat exchanger with reasons. Also calculate the area of heat exchanger. Take $U = 24 \text{ W/m}^2\text{-K}$ **07**

OR

- Q.5** (a) State limitations of LMTD method. **03**
- (b) Write down expression of effectiveness of following heat exchangers: **04**
(a) Parallel Flow (b) Counter flow (c) Condenser (d) Evaporator
- (c) Draw and Explain boiling curve for water. Explain Nucleate boiling. **07**
