Seat No.: _____ Enrolment No.

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–V (NEW) EXAMINATION – SUMMER 2019

Subject Code: 2151909 **Date: 06/06/2019**

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.**
4. **Use of air, water properties chart is allowed.**

Q.1	**(a)**	Distinguish between the conduction, convection and radiation modes of heat transfer with suitable example.	**03**
	(b)	Define Biot and Fourier numbers, and point out their physical significance.	**04**
	(c)	Derive general heat conduction equation in cylindrical coordinate system $\left(\frac{\partial^2 t}{\partial r^2}+\frac{1}{r}\frac{\partial t}{\partial r}+\frac{1}{r^2}\frac{\partial^2 t}{\partial \phi^2}+\frac{\partial^2 t}{\partial z^2}\right)+\frac{q_g}{k}=\frac{1}{\alpha}\frac{\partial t}{\partial \tau}$	**07**
Q.2	**(a)**	What is critical radius of insulation? Explain its importance in electrical and thermal system.	**03**
	(b)	State the difference between the fin effectiveness and fin efficiency, and setup the relation between their performance parameters.	**04**
	(c)	Steam at 350 ^oC flowing in a pipe (k=80 W/mK) 5 cm i.d., 5.6 cm o.d. is covered with 3 cm thick insulation (k=0.05 W/mK). Heat is lost to the surroundings at 5 ^oC by natural convection and radiation with combined h=20 W/m^{2}K and h_i=60 W/m^{2}K. Find: (i) the rate of heat loss from the pipe per unit length (ii) the temperature drops across the pipe and the insulation.	**07**
		OR	
	(c)	Explain with neat sketch, the various regimes in boiling and explain the condition for the growth of bubbles. What is the effect of bubble size on boiling?	**07**
Q.3	**(a)**	Explain the phenomenon of heat transfer by forced convection. What forces control the fluid motion? Cite suitable examples to illustrate your answer.	**03**
	(b)	How does film-wise condensation differ from drop-wise condensation? Which type has a higher film coefficient and point out the reason thereof.	**04**
	(c)	The temperature of a gas stream is to be measured by a thermocouple whose junction can be approximated as 1 mm diameter sphere. The properties of a junction are k=35 W/mK, density = 8500 kg/m^3, Cp=320 J/kg K and h=210 W/m^{2}k. Determine how long it will take for thermocouple to read 99% (θ/θ_i=0.01) of the initial temperature difference.	**07**
		OR	
Q.3	**(a)**	What are the fundamental dimensions? Explore thermal resistance, thermal diffusivity and convective heat transfer coefficient in fundamental dimensions.	**03**
	(b)	What is meant by thermal boundary layer? State the relation between thermal and hydrodynamic boundary layer thickness.	**04**

	(c)	Which of the following arrangement of pin fins will give higher heat transfer rate from a hot surface? (i) 6 fins of 10 cm length (ii) 12 fins of 5 cm length. The base temperature of the fin is maintained at 200 ^oC and the fin is exposed to a convection environment at 15 ^oC with h=25 W/m^2C. Each fin has cross sectional area 2.5 cm^2, perimeter 5 cm and is made of a material having thermal conductivity 250 W/mC. Neglect the heat loss from the tip of fin.	**07**
Q.4	**(a)**	Define a black body. Give examples of some surfaces which don't appear black but have high value of absorptivity.	**03**
	(b)	What do you mean by thermal capacity and thermal diffusivity of material? Explain with example.	**04**
	(c)	A thermo flask has a double walled bottle and the space between the walls is evacuated so as to reduce the heat flow. The bottle surfaces are silver plated, and the emissivity of each surface is 0.025. If the contents of the bottle are at 375 K, find the rate of heat loss from the thermos bottle to ambient air at 300 K. What thickness of cork (k=0.03 W/mK) would be requited if the same insulating effect is to be achieved by the use of cork?	**07**

OR

Q.4	**(a)**	Explain the meaning of the terms radiosity and irradiation.	**03**
	(b)	Making use of Plank's law of distribution, establish the relation for the Wien's displacement law.	**04**
	(c)	A square room 4 m x 4 m and height 3 m has all its walls perfectly insulated. The floor and ceiling are maintained at 300 K and 280 K respectively. Assuming an emissivity value 0.75 for all the surfaces, make calculation for the wall temperature and net heat interchange between the floor and ceiling. Take floor to ceiling shape factor as 0.28.	**07**
Q.5	**(a)**	Explain the operation of a heat pipe. Why is it called a superconductor?	**03**
	(b)	Write the energy equation for a fluid element. What is dissipation function? When is its effect significance and when can it be neglected?	**04**
	(c)	Water (C_p=4.187 kJ/kg K) is heated at the rate of 1.4 kg/s from 40 ^oC to 70 ^oC by an oil (C_p=1.9 kJ/kg K) entering at 110 ^oC and leaving at 60 ^oC in a counter flow heat exchanger. If U_o=350 W/m^2K, calculate the surface area required. Using the same entering fluid temperature and the same oil flow rate, calculate the exit temperature of oil and water and the rate of heat transfer, when the water flow rate is halved.	**07**

OR

Q.5	**(a)**	Draw the simple electrical circuit which is analogous to transient heat transfer from a body at uniform temperature.	**03**
	(b)	Show that for parallel flow heat exchanger $\varepsilon = \frac{1-\exp\left[-NTU\left(1+R\right)\right]}{1+R}$	**04**
	(c)	What is heat exchanger? Classify the heat exchanger types with example.	**07**

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