Seat No.: ________ Enrolment No.___________

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–V (NEW) EXAMINATION – SUMMER 2021

Subject Code:3151909 Date:09/09/2021

Subject Name: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. **Simple and non-programmable scientific calculators are allowed.**

			MARKS
Q.1	**(a)**	Write any three assumptions of Nusselt theory for film condensation.	**03**
	(b)	Draw boiling curve for water at 1 atm. Pressure and Represent different regimes on that.	**04**
	(c)	Steam enters a counter flow heat exchanger dry saturated at 10 bar and leaves at 350 ^{0}C. The mass flow of steam is 800 kg/min. the gas enters the heat exchanger at 650 ^{0}C and mass flow rate is 1350 kg/min. if the tubes are 30mm diameter and 3m long. Determine the number of tubes required. Neglect the resistance offered by metallic tubes. Use following data : Tsat = 180 ^{0}C (At 10 bar) Cps =2.71 kJ/kg-K Cpg =1 kJ/kg-K Heat transfer co-efficient steam side = 600 W/m^2-K Heat transfer co-efficient gas side = 250 W/m^2-K	**07**
Q.2	**(a)**	Define : 1) Critical thickness of insulation for cylinder 2) Thermal diffusivity 3) Thermal resistance	**03**
	(b)	Determine the overall heat transfer coefficient U_0 based on the outer surface of a 2.54 cm O.D 2.286 cm I.D. heat exchanger tube (K= 102 W/mK).If the heat transfer co-efficient at the inside and outside of the tube are hi = 5500 W/m^{2}K and ho = 3800 W/ m^{2}K respectively and the fouling factors are R_{fi} = R_{fo} = 0.0002 m^2-K/W	**04**
	(c)	Superheated steam at 330^{0}C is flowing at 20m/s velocity (h = 110 W/m^{2}K) through a pipe 120 mm in diameter. The temperature of steam is to be measured by putting a pocket in the pipe of 15mm ID and 1mm thickness. Pocket material thermal conductivity is 50W/m^{2}K. 1) Determine length of insertion so that error in the thermometer is 0.5%. 2) If pipe wall is maintained at temperature of 40^{0}C ,find temperature measured by thermometer.	**07**
		OR	
	(c)	A cylindrical hot ingot of 50mm diameter and 200mm long is	**07**

taken out from the furnace at 800^0C and dipped into the water till its temperature becomes 500^0C. After that it is exposed to air till its temperature becomes 100^0C. Find the total time required to reduce its temperature from 800^0C to 100^0C.
Use following data:
k for ingot = 60 W/m-K.
specific heat for ingot = 200 J/m-K
h_{air} =20 W/m^2-K ,h_{water} = 200 W/m^2-K
Density of ingot material = 800kg/m^3
Temperature of water and air both = 30^0C

Q.3 **(a)** Differentiate fin efficiency and fin effectiveness. **03**

(b) Prove that logarithmic mean area of hollow sphere is geometric mean of its inner and outer surface area. **04**

(c) A standard cast iron pipe ID = 50mm and OD =55mm is insulated with 85% Magnesium insulation (k = 0.02W/m-K). Temperature at the interface between the pipe and insulation is 300^oC. The allowable heat loss through the pipe is 600 W per meter length of pipe and the safety, The temperature of the outside surface of insulation must not exceed 100^0C. **07**
Determine :
1) Minimum thickness of insulation required
2) The temperature of inside surface of the pipe assuming its thermal conductivity 20 W/m-K.

OR

Q.3 **(a)** Define time constant of thermocouple and state parameters which affect time constant of thermocouple. **03**

(b) "Generally fin is provided to increase the heat transfer rate but by providing fin heat transfer may decrease" Justify the statement analytically. **04**

(c) A 240mm steam main 210 m long is covered with 50mm high temperature insulation (k = 0.092 W/m-K) and 40 mm of low temperature insulation (k = 0.062 W/m-K). The inner and outer surface temperatures are measured 390^0C and 40^0C respectively. Calculate **07**
1) Total heat loss per hour
2) The temperate at two insulation interface
3) The heat loss per unit outer surface area.

Q.4 **(a)** Define thermal boundary layer and hydrodynamic boundary layer. Draw them for very low Prandtl number fluid. **03**

(b) Air at 27^OC and 1 atm. flow over a flat plate at a speed of 2m/s. Calculate boundary layer thickness at a distance 40 cm from leading edge of plate. At 27^OC viscosity (air) = 1.85 *10^{-5} kg/m-s. **04**

(c) Ait at 1 bar and a temperature 30^0C, dynamic viscosity = 0.06717 kg-ms flows at a speed of 1.2m/s over a flat plate. Determine the boundary layer thickness at of 250mm and 500mm from the leading edge of the plate. Also calculate the mass entrapment between these two sections. Assume the parabolic velocity distribution as: **07**

$$\frac{u}{U}=\frac{3}{2}\left(\frac{y}{\delta}\right)-\frac{1}{2}\left(\frac{y}{\delta}\right)^3$$

OR

Q.4 **(a)** Write the value of critical Reynolds Number for flow over a flat plate. Differentiate viscous sub layer and buffer layer. **03**

(b) Velocity distribution in the boundary layer is given by **04**

$\frac{u}{U} = \frac{y}{\delta}$, where u is velocity at distance y from the plate and at y = δ, u =U. Calculate energy thickness.

(c) Using Buckingham – π theorem show that Nusselt number for free convection is a function of Grashof Number and Prandtl number **07**

Q.5 (a) State Wien's displacement law and write its significance. **03**

(b) With respect to shape factor explain : **04**

1) Superposition rule
2) Summation rule

(c) Consider two large parallel plates one at 727^0C with the emissivity 0.8 and other 227^0C with the emissivity 0.4. A plate of emissivity 0.05 on the both the sides is placed between the plates. Calculate percentage reduction in the heat transfer rate between the two plates as a result of the shield. **07**

OR

Q.5 (a) Define gray body. Differentiate between surface resistance and space resistance w.r.to radiation heat transfer between two grey bodies. **03**

(b) Calculate the shape factor of cylinder cavity w.r.to itself. Take depth of cavity h and diameter of cylinder is d. it is enclosed with flat surface. **04**

(c) Define radiation shield. Prove that if radiation shield of the emissivity same as the emissivity of two parallel plate is inserted between two parallel plates net heat transfer rate due to radiation is reduced to half as compared to without shield. **07**

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