Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE- SEMESTER–IV (NEW) EXAMINATION – WINTER 2020

Subject Code:3140503 Date:11/02/2021

Subject Name:Heat Transfer

Time:02:30 PM TO 04:30 PM Total Marks:56

Instructions:

1. **Attempt any FOUR questions out of EIGHT questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

			Marks
Q.1	**(a)**	Distinguish between the conduction, convection and radiation modes of heat transfer.	**03**
	(b)	A furnace wall is made up of steel plate 10 mm thick (k= 62.8 kJ/m-hr-deg) lined on inside with silica bricks 150 mm thick (k= 7.32 kJ/m-hr-deg) and on the outside with magnesia bricks 200 mm thick (k= 18.84 kJ/m-hr-deg). The inside and outside surfaces of the wall are at temperature 650 ^{0}C and 125 ^{0}C respectively. Make calculations for the heat loss from unit area of the wall.	**04**
	(c)	Derive equation for heat transfer by conduction through hollow cylinder. Also mention assumptions made for it.	**07**
Q.2	**(a)**	Discuss the physical significance of (i) Reynolds Number (ii) Prandtl number.	**03**
	(b)	Set up the relationship between local heat transfer coefficient and average heat transfer coefficient for flow past a stationary flat plate.	**04**
	(c)	Calculate the rate of heat loss from a human body which may be considered as a vertical cylinder 30 cm in diameter and 175 cm high in still air at 15 ^{0}C. The skin temperature is 35 ^{0}C and emissivity at the skin surface is 0.4. Neglect sweating and effect of clothing. The thermo-physical properties of air at 25 ^{0}C are: $\gamma = 15.53 \times 10^{-6}$ m^2/s; k = 0.0263 W/m-deg; Pr = 0.7 Use the following correlation $Nu = 0.13(Gr \times \Pr)^{0.33}$	**07**
Q.3	**(a)**	Explain the concepts of critical insulation. How do you decide the thickness of insulation for electric wires?	**03**
	(b)	Explain the terms absorptivity, reflectivity and transmissivity of radiant energy. How are they related to each other for a black body and opaque body?	**04**
	(c)	What is boiling and when does occurs? Explain pool boiling. How does it differ from forced convection boiling?	**07**
Q.4	**(a)**	How the thermal conductivity of metals varies with temperature and pressure?	**03**
	(b)	State and prove Stefan Boltzman law relating to thermal radiation and temperature of a radiating body.	**04**

	(c)	What is condensation and when does occurs? How does film-wise condensation differ from drop-wise condensation? Which type has a higher heat transfer film coefficient and point out the reason thereof?	**07**
Q.5	**(a)**	When can we consider heat exchanger as compact heat exchanger?	**03**
	(b)	Explain the concept of NTU for heat exchangers.	**04**
	(c)	Derive equation for LMTD for parallel flow heat exchanger. Also state necessary assumptions made for it.	**07**
Q.6	**(a)**	List at least eight important parts of shell & tube heat exchanger.	**03**
	(b)	What do you mean by "fouling" in heat exchangers? What is the effect of it on performance of heat exchangers?	**04**
	(c)	Calculate the surface area required for a heat exchanger which has to cool 55,000 kg/hr of alcohol from 66 ^{0}C to 40 ^{0}C using 40,000 kg/hr of water entering at 5 ^{0}C. Assume that U based on the outer area is 580 W/m^2 K. Specific heat of alcohol is 3.76 kJ/kg K and that of water is 4.18 kJ/kg K. Consider counter flow tube and shell arrangement.	**07**
Q.7	**(a)**	How does evaporation differ from distillation?	**03**
	(b)	Mention any four characteristics of solutions to be considered before selecting the evaporator?	**04**
	(c)	What are the various types of evaporators? Draw neat sketch of Calandria type evaporator and briefly explain its construction and working.	**07**
Q.8	**(a)**	Why evaporators generally operate under vacuum?	**03**
	(b)	When will you select plate type evaporators? Explain construction & working of it.	**04**
	(c)	Discuss various methods of feeding in multiple effect evaporators with their relative merits and demerits.	**07**

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Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–IV (NEW) EXAMINATION – WINTER 2021

Subject Code:3140503 Date:01/01/2022

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 the Fourier equation for heat transfer by conduction. Give the units and physical significance of each term appearing in this equation.	**03**
	(b)	The walls of house in cold region comprise three layers 15 cm outer brick work (k = 0.75 W/m-deg) 1.25 cm inner wooden paneling (k = 0.2 W/m-deg) 7.5 cm intermediate layer of insulating material The insulation layer is stated to offer resistance twice the thermal resistance of brick work. If the inside and outside temperatures of the composite wall are 20 ^{0}C and -15 ^{0}C respectively. Determine the rate of heat loss per unit arear of the wall and thermal conductivity of the insulating material.	**04**
	(c)	Derive an expression for heat flow through a composite sphere taking into account the film heat transfer coefficients on the inside and outside surface of the sphere.	**07**
Q.2	**(a)**	Discuss the physical significance of (i) Prandtl Number (ii) Grashoff number.	**03**
	(b)	Set up the relationship between local heat transfer coefficient and average heat transfer coefficient for flow past a stationary flat plate.	**04**
	(c)	A nuclear reactor with its core constructed of parallel vertical plates 2.25 m high and 1.5 m wide has been designed on free convection heating of liquid bismuth. Metallurgical consideration limits the maximum surfaces temperature of the plate to 975 ^{0}C and the lowest allowable temperature of bismuth is 325 ^{0}C. Estimate the maximum possible heat dissipation from both sides of each plate. The appropriate correlation for the convection coefficient is $Nu = 0.13 (Gr \times Pr)^{1/3}$ The thermo physical properties of bismuth are at 650 ^{0}C: $\mu = 3.12$ kg/m-hr $\rho = 10^4$ kg/m^3 $C_p = 150.7$ J/kg-deg k = 13.2 W/m-deg	**07**
		OR	
	(c)	Liquid mercury flows through a copper tube of 2 cm inner diameter at the rate of 1.25 kg/s. The mercury enters at 15 °C and is heated to 25 °C as it passes through the tube. Determine the tube length which would satisfy the condition of a constant heat flux at the wall which is at an average temperature of 40	**07**

°C. For liquid metals, the following correlation is presumed to agree well with experimental results:

$Nu = 7 + 0.025 (Pe)^{0.8}$

where Pe is the Peclet number: Pe = Pr × Re

Thermo-physical properties of the liquid mercury are at 20 °C

$\rho = 13580$ kg/m^3

k = 8.685 W/m K

$C_p = 139.35$ J/kg K

$\gamma = 1.145 \times 10^{-7}$ m^2/s

Pr = 0.0249

Q.3 **(a)** What is critical insulation thickness? Can you give a physical explanation of its existence? Does a critical thickness exist for every insulated cylindrical surface? **03**

(b) Enumerates some salient features of thermal radiation. Based upon the reradiating properties of absorptivity, reflectivity and transmissivity, how would you distinguish between the following: black body, white body, transparent body and opaque body **04**

(c) Draw the boiling curve and identify the different boiling regimes. Also explain the characteristics of each regime. **07**

OR

Q.3 **(a)** Point out and explain the various factors which affect the thermal conductivity of a material. **03**

(b) Describe how the monochromatic emissive power varies with the wavelength for emissions from a black body? At what wavelength the black body monochromatic emissive power is maximum? **04**

(c) What is condensation and when does occurs? How does film-wise condensation differ from drop-wise condensation? Which type has a higher heat transfer film coefficient and point out the reason thereof? In design of condensers, which type of condensation is usually selected and why? **07**

Q.4 **(a)** Where do we use direct contact heat exchangers in day to day life? **03**

(b) Explain the concept of NTU for heat exchangers. **04**

(c) Derive equation for LMTD for counter flow heat exchanger. Also state necessary assumptions made for it. **07**

OR

Q.4 **(a)** List at least eight important parts of shell & tube heat exchanger. **03**

(b) What do you mean by “fouling” in heat exchangers? What is the effect of it on performance of heat exchangers? **04**

(c) A tabular heat exchanger is to be designed for cooling oil from a temperature of 80 ^{0}C to 30 ^{0}C by a large of stagnant water which may be assumed to remain constant at a temperature of 20 ^{0}C. The heat transfer surface consists of 30 m long straight tube of 20 mm inside diameter. The oil (specific heat = 2.5 kJ/kg K and specific gravity = 0.8) flows through the cylindrical tube with an average velocity of 50 cm/s. Calculate the overall heat transfer coefficient for the oil cooler. **07**

Q.5 **(a)** Differentiate evaporation and drying. **03**

(b) When can we use agitated thin film evaporators? How it works? **04**

(c) Classify different types of evaporators. Explain the term ‘forced circulation’ and ‘natural circulation’ in the context of evaporators. Draw neat sketch of short tube vertical evaporator and explain briefly its construction and working **07**

OR

Q.5 **(a)** Why evaporators generally operate under vacuum? **03**

(b) As a chemical engineer how will you select evaporator? **04**

(c) State the method of feeding multiple effect evaporation system. Compare forward feed arrangement with backward feed arrangement in case of multiple effect evaporation system. **07**

Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

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

Subject Code:3140503 Date:04/09/2021

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. **Simple and non-programmable scientific calculators are allowed.**

Q.1		Answer the followings.	
	(a)	State Fourier's Law of Conduction and its limitations.	**[3]**
	(b)	Discuss general characteristic and application of insulating materials.	**[4]**
	(c)	Calculate the rate of heat loss through the vertical walls of a boiler furnace of size 4m by 3 m by 3 m high. The walls are constructed from an inner fire brick wall 25 cm thick of thermal conductivity 0.4 W/m K, a layer of ceramic blanket insulation of thermal conductivity 0.2 W/m K and 8 cm thick, and a steel protective layer of thermal conductivity 55 W/m K and 2 mm thick. The inside temperature of the fire brick layer was measured at 600 ^{o}C and the temperature of the outside of the insulation 60 ^{0}C. Also find the interface temperature of layers.	**[7]**
Q.2	**(a)**	Differentiate between film wise and dropwise condensation.	**[3]**
	(b)	Write physical significance of the following terms: Biot number, Thermal time constant, Fourier's number and Nusselt number	**[4]**
	(c)	Derive an expression for the critical thickness of insulation of cylindrical pipe.	**[7]**
		OR	
	(c)	A 12 cm diameter long bar initially at a uniform temperature of 40 ^{o}C is placed in a medium at 650 ^{o}C with a convective co efficient of 22 W/m^{2}K calculate the time required for the bar to reach255^{0}C. Take k = 20W/m K, ρ = 580 kg/m^3 and c = 1050 J/kg K.	**[7]**
Q.3	**(a)**	Define black body and grey body emphasizing on the differences and similarity.	**[3]**
	(b)	Classify the heat exchangers based on the Flow arrangement with neat diagrams.	**[4]**
	(c)	Discuss Reynolds analogy between heat and momentum transfer.	**[7]**
		OR	
Q.3	**(a)**	What is Wein's law?	**[3]**
	(b)	What is the physical meaning of LMTD? Why correction factors for LMTD is required?	**[4]**
	(c)	Define fin effectiveness and derive equation for the fin efficiency.	**[7]**
Q.4	**(a)**	Explain Leidenfrost phenomenon in film boiling.	**[3]**
	(b)	What do you understand by the hydrodynamic and thermal boundary layers? Illustrate with reference to flow over a flat plate.	**[4]**
	(c)	Derive the equation for the Logarithmic Mean Temperature Difference (LMTD)for the Parallel Flow.	**[7]**
		OR	
Q.4	**(a)**	Explain how the presence of non-condensable gases affect the condensation rate of vapor?	**[3]**
	(b)	A furnace inside temperature of 2250 K has a glass circular viewing of 6 cm diameter. If the transmissivity of glass is 0.08, make calculations for the heat loss from the glass window due to radiation.	**[4]**
	(c)	Discuss various Boiling regimes for pool boiling.	**[7]**

Q.5	**(a)**	Explain Dühring rule.	**[3]**
	(b)	When and why do we prefer to use backward-feed evaporator?	**[4]**
	(c)	Discuss with neat sketch Construction and working of agitated thin film evaporators.	**[7]**

OR

Q.5	**(a)**	Define Grashof number and its physical significance. What is the analogous in forced convection?	**[3]**
	(b)	Define/explain the following terms in detail: Effectiveness, Capacity Ratio , NTU and fouling factor	**[4]**
	(c)	Water flows at the rate of 65 kg/min through a double pipe counter flow heat exchanger. Water is heated from 50 ^{o}C to75 ^{o}C by an oil flowing through the tube. The specific heat of the oil is 1.780 kJ/kg.K. The oil enters at 115^{o}C and leaves at 70 ^{0}C.the overall heat transfer co-efficient is 340 W/m^{2}K.calcualte the following 1. Heat exchanger area 2. Rate of heat transfer	**[7]**

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Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–IV (NEW) EXAMINATION – SUMMER 2022

Subject Code:3140503 Date:27-06-2022

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)**	Define: Heat & Temperature. How it can be differ from each other.	**03**
	(b)	The temperature at the inner and outer surfaces of a boiler wall made of 20 mm thick steel and covered with an insulating material of 5 mm thickness are 3000^0C and 500^0C respectively. If the thermal conductivities of steel and insulating material are 58W/m^{0}C and 0.116 W/m^{0}C respectively, determine the rate of flow through the boiler wall.	**04**
	(c)	Derive equation for heat transfer by conduction through composite wall. Also mention assumptions made for it.	**07**
Q.2	**(a)**	Discuss the Physical significance of (i) Nusselt Number (ii) Grashoff Number (iii) Biot Number.	**03**
	(b)	Explain Velocity boundary layer & Thermal boundary layer. Which dimensionless number is related to it? How?	**04**
	(c)	A vertical pipe 80 mm diameter and 2 m height is maintained at a constant temperature of 120^{o}C.The pipe is surrounded by still atmospheric air at 30^{o}C.Find heat loss by natural convection.	**07**
		OR	
	(c)	Derive the equation of overall heat transfer co-efficient(U) from the individual heat transfer co-efficient(h) with neat sketch.	**07**
Q.3	**(a)**	Define: Thermal Conductivity. Enlist the factors on which thermal conductivity of a substance would be dependent.	**03**
	(b)	How would you distinguish between the following: black body, white body, transparent body and opaque body.	**04**
	(c)	What is boiling and when does it occurs? Explain Nucleate boiling.	**07**
		OR	
Q.3	**(a)**	Explain basic law for heat conduction.	**03**
	(b)	State and prove Stefan Boltzmann law relating to thermal radiation and temperature of a radiating body.	**04**
	(c)	Define Condensation. Explain filmwise condensation & Dropwise condensation.	**07**
Q.4	**(a)**	Define: Tube Pitch, Baffle Spacing & Range.	**03**
	(b)	What do you mean by “fouling” in heat exchangers? What is the effect of it on performance of heat exchangers?	**04**
	(c)	Explain design steps for Shell &Tube heat exchanger in detail. Draw neat sketch of 2-4 pass shell & tube heat exchanger.	**07**
		OR	
Q.4	**(a)**	Define Fin. Enlist different types of it. Differ Transverse fin with longitudinal fin.	**03**

	(b)	Explain Heat transfer effectiveness and number of transfer units (NTU).	**04**
	(c)	What is LMTD? List out its assumptions. Derive the equation for LMTD for counter current flow.	**07**
Q.5	**(a)**	How can you measure performance of evaporators?	**03**
	(b)	What is Evaporation? Distinguish Natural circulation & forced circulation evaporators.	**04**
	(c)	Discuss various methods of feeding in multiple effect evaporators with their relative merits and demerits.	**07**

OR

Q.5	**(a)**	Explain Duhring rule & Boiling point Elevation.	**03**
	(b)	What are the Properties of evaporating liquids that influence the process of evaporation?	**04**
	(c)	What are the various types of evaporators? Draw neat sketch of falling film evaporator and briefly explain its construction and working.	**07**

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