Q. Code:351909

Reg. No. | | | | | | | | | | | | | | |

B.E / B.TECH. DEGREE EXAMINATIONS, MAY 2024

Fourth Semester

CH18402 – HEAT TRANSFER

(Chemical Engineering)

(Regulation 2018 / 2018A)

TIME: 3 HOURS **MAX. MARKS: 100**

COURSE OUTCOMES	STATEMENT	RBT LEVEL
CO 1	Impart knowledge on the various modes of heat transfer.	3
CO 2	Apply convective heat transfer concept to fluids without phase change.	3
CO 3	Develop the ability to model and analyze heat transfer processes.	3
CO 4	Augment the capability to solve heat transfer problems.	4
CO 5	Design and analyze various types of heat exchangers.	4

PART - A (10 x 2 = 20 Marks)

(Answer all Questions)

		CO	RBT LEVEL
1.	Calculate heat transfer resistance for conduction through composite wall of thickness 3cm and 4 cm with thermal conductivity of 0.5 and 3 W/m°C respectively. Given the area of both the walls to be $4m^2$	1	3
2.	Fins enhance heat transfer – Justify this statement.	1	3
3.	Calculate the value of nusselt number when heat transfer occurs only through conduction.	2	3
4.	Write the law governing convective heat transfer.	2	2
5.	Identify the methods to enhance nucleate boiling.	3	2
6.	Differentiate between sub-cooled and saturated boiling.	3	2
7.	State Stefan-Boltzmann's law of thermal radiation.	4	2
8.	Identify the suitable evaporator for concentrating highly heat sensitive materials.	4	2
9.	How will you calculate LMTD correction factor?	5	2
10.	Indicate the purpose of baffles in heat exchangers.	5	2

PART - B (5 x 14 = 70 Marks)

		Marks	CO	RBT LEVEL
11. (a)	A furnace wall is constructed of material having thermal conductivity 2.35 W/m.K. The thickness of the wall is 45 cm. The wall will be insulated on the outer side with the material having average thermal conductivity 0.3	**(14)**	**1**	**3**

W/m K so that the heat loss from the furnace will be equal to or less than 1750W/m^2. The inner surface of the wall is at 1750 K, while the outer surface is at 400 K. Calculate the thickness of insulation required and the temperature at the wall-insulation interface.

(OR)

(b)	(i) Derive the equation of heat flux for a hollow cylinder having inner radius R_1, outer radius R_2, and thermal conductivity k. Inner wall temperature (T_1) is higher than outer wall temperature (T_2) (10 marks) (ii) Give the significance of critical insulation thickness. (4 marks)	**(14)**	**1**	**3**
12. (a)	A 0.3 m long glass plate is hung vertically in the air at 285 K (27 ℃). The plate is maintained at 325 K (77 ℃). Calculate the average heat transfer coefficient for natural convection. The properties of air at the mean temperature are: kinematic viscosity = 18.41x10^{-6} m^2/s, k = 28.15x10^{-3} W/m.K, N_{Pr} = 0.7	**(14)**	**2**	**3**
	(OR)			
(b)	Derive an expression for heat transfer in the case of forced convection using dimensional analysis. Discuss few correlations for internal and external flows in pipes in both laminar and turbulent flow conditions.	**(14)**	**2**	**3**
13. (a)	Explore the process of heat transfer in boiling liquids and delve into the mechanisms underlying boiling, including nucleate boiling and film boiling.	**(14)**	**3**	**3**
	(OR)			
(b)	Elaborate on the heat transfer mechanisms implicated in vapor condensation, highlighting the differences between drop-wise and film-wise condensation. Analyze the pivotal factors affecting the condensation mode and its practical relevance in engineering contexts.	**(14)**	**3**	**3**
14. (a)	Explore the operation of multiple effect evaporators and the process of designing calculations for such systems. Also, examine the factors taken into consider when designing evaporators for viscous solutions.	**(14)**	**4**	**3**

(OR)

		Marks	CO	RBT LEVEL
(b)	(i) Find the heat transfer rate per unit area due to radiation between two infinitely long parallel planes. The first plane has an emissivity of 0.42 and is maintained at 473 K. The emissivity of the second plane is 0.22 and is maintained at 300 K. If a radiation shield having e = 0.5 is interposed between the given planes, find the percentage reduction in heat transfer rate and the steady-state temperature attained by the shield. (10 marks) (ii) Differentiate grey and black body. (4 marks)	**(14)**	**4**	**3**
15. (a)	A heat exchanger heats 25,000 kg/hr of water entering at 30 ℃ while cooling 20,000 kg/hr of water from 100 ℃ to 80 ℃. Determine the area necessary for (i) Parallel flow arrangement (ii) Counter flow arrangement. Overall heat transfer coefficient may be assumed as 1,600 W/m^2.K.	**(14)**	**5**	**3**
	(OR)			
(b)	Determine the area of the double pipe heat exchanger required to reduce the temperature of a product B from 403 K to 353 K using a solution A. The flow rates of B and A are 6000 and 4500 kg/h respectively. Solution A enters the heat exchanger at a temperature of 313 K. The specific heat capacities of the hot and cold fluids are 4000 and 5000 J/kg.K respectively. The heat exchanger is operated in counter-current fashion. The heat transfer coefficients of the two fluids are given as follows: h_o = 1075.3 W/m^2.K and h_i = 1021 W/m^2.K. Take fouling factors $R_{fo} = R_{fi}$ = 0.0002 m^2.K/W. Given Data: Diameter of outer pipe = 70 mm Diameter of inner pipe = 43 mm Thermal conductivity of the pipe material = 40 W/m.K	**(14)**	**5**	**3**

PART - C (1 x 10 = 10 Marks)

(Q.No.16 is compulsory)

		Marks	CO	RBT LEVEL
16.	Develop a flowchart for establishing design parameters of a heat exchanger based on minimum input data.	**(10)**	**5**	**5**

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