

END SEMESTER EXAMINATION, JULY. – 2021-22

Course Name: Heat Transfer Operations,

Course Code: 201CHL214

Day and Date:day, .../.../2022

Seat No:

Time: ----- to -----

Max. Marks- 100

Instructions:

- i. Question No. 1 is compulsory.
- ii. Figure to the right indicate full marks.
- iii. Use of calculator is allowed

BT	CO		Marks
		Q 1 Answer the following	
BT3	1	a) i) State Fourier's law of heat conduction. Why negative sign is present in the equation	4
BT3	1	ii) What are various modes of heat transfer? Explain with examples	6
BT4	1	b) i) Differentiate between steady state and unsteady conduction	3
BT2	1,2	ii) Draw temperature length curves for parallel and counter flow.	3
BT3	1	iii) How LMTD is calculated?	4
BT3	1	c) i) Toluene is being condensed at 110°C on the outside of 19-mm BWG 16 copper condenser tubes through which cooling water is flowing at an average temperature of 26.7°C. Individual heat-transfer coefficients are $h_i = 400 \text{ W/m}^2 \cdot ^\circ\text{C}$ and $h_o = 500 \text{ W/m}^2 \cdot ^\circ\text{C}$. Neglecting the resistance of the tube wall, what is the tube-wall temperature? Data: $D_o = 0.62 \text{ m}$; $D_i = 0.75 \text{ m}$	5
BT3	2	ii) Air at 20°C. blows over a hot plate 50 by 75 cm maintained at 250°C. The convection heat-transfer coefficient is $25 \text{ W/m}^2 \cdot ^\circ\text{C}$. Calculate the heat transfer rate	5
BT3	2	d) i) A thick-walled tube of stainless steel [18% Cr, 8% Ni, $k = 19 \text{ W/m} \cdot ^\circ\text{C}$] with 2-cm inner diameter (ID) and 4-cm outer diameter (OD) is covered with a 3-cm layer of asbestos insulation [$k = 0.2 \text{ W/m} \cdot ^\circ\text{C}$]. If the inside wall temperature of the pipe is maintained at 600°C, calculate the heat loss per	5

meter of length

- ii) Water flows at 50 °C, inside a 2.5-cm-inside-diameter tube such that $h_i = 3500 \text{ W/m}^2 \text{ }^\circ\text{C}$. The tube has a wall thickness of 0.8 mm with a thermal conductivity of $16 \text{ W/m }^\circ\text{C}$. The outside of the tube loses heat by free convection with $h_o = 7.6 \text{ W/m}^2 \text{ }^\circ\text{C}$. Calculate the overall resistance to surrounding air at 20 °C.

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Q.2 Attempt the following.

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|-----|-----|----|---|---|
| BT4 | 3 | a) | Differentiate between drop wise and film wise condensation | 6 |
| BT2 | 2,3 | b) | What is Leiden frost point ? Explain critical heat flux with boiling curve | 7 |
| BT3 | 2 | c) | How film coefficient is calculated using Nusselt Equation for horizontal and vertical tubes | 7 |

Q.3 Write short notes on the following (Any-4)

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|-----|-----|----|--|
| BT3 | 3 | a) | Types of heat exchangers |
| BT3 | 4 | b) | Plate Type heat exchanger |
| BT3 | 3,4 | c) | Temperature-length curves for 1-2 exchanger and 2-4 exchanger. |
| BT3 | 3 | d) | Kettle-type reboiler. |
| BT2 | 3 | e) | Heat Transfer in agitated vessel |

Q.4 Attempt the following (Any-4)

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|-----|---|----|---|
| BT2 | 4 | a) | What is BPE? State Duhring's rule. |
| BT3 | 4 | b) | Derive an expression for enthalpy balance over single effect evaporation |
| BT2 | 4 | c) | Explain in brief : Types of evaporators based on methods of feeding |
| BT3 | 4 | d) | In a textile mill, a double-effect evaporator system concentrates, weak liquor containing 4% (by mass) caustic soda to produce a lye containing 25% solids (y mass). Calculate the evaporation of water per 100 kg feed in the evaporator. |
| BT3 | 4 | e) | A single effect evaporator is fed with 10000 kg/h of weak liquor containing 15% caustic by weight and is concentrated to get thick liquor containing 40% by weight caustic (NaOH). Calculate: (a) kg/h of water evaporated and if kg/h of thick liquor obtained is 3750 |