

**END SEMESTER EXAMINATION, JULY. – 2021-22**

**Course Name:** Heat Transfer Operations,

**Course Code:** 201CHL214

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

Seat No:
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**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
<b>Q 1 Answer the following</b>			
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.**

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