K. K. Wagh Institute of Engineering Education & Research, Nashik

(An Autonomous Institute From A.Y. 2022-23)

WINTER- 2025	
Exam Seat No.:	
Academic Year: 2025-2026	Semester: III
Class: SY	Program: B.Tech
Branch Code: CHE	Pattern: 2023
Name of Course: Heat Transfer Processes	Course Code: 2307206
Max. Marks: 60	Duration: 2.30 Hrs.

Instructions: Candidates should read carefully the instructions printed on the Question Paper and on the cover page of the Answer Book, which is provided for their use.

1. This question paper contains two pages.
2. Answer to each new question is to be started on a new page.
3. Assume suitable data wherever required, but justify it.
4. Draw the neat labelled diagrams, wherever necessary.
5. The last columns indicates the Course Outcome.

		Marks	CO
Question No. 1			
1a)	A plane wall of thickness x has one surface at T1 and the other surface at T2. If the thermal conductivity of the wall varies with temperature as per the following equation : $k = k_o (1 + \alpha T)$, derive an expression for the heat flow rate, Q.	(6)	CO1
Question No. 2			
2a)	Give significance of following dimensionless numbers in Heat Transfer, i) Nusselt No. ii) Prandtl No. iii) Grashof No. iv) Reynolds No. v) Peclet No. vi) Rayleigh No.	(6)	CO1
Question No. 3			
3a)	Explain the concept of thermal radiation. Discuss its characteristics and the factors affecting radiation heat transfer.	(8)	CO3
	OR		
3b)	Discuss any two important laws of thermal radiation. Explain their significance in engineering applications.	(8)	CO3
3c)	Derive the expression for net radiation heat exchange between two large, infinite, parallel plates at different temperatures. State all assumptions clearly and show the effect of emissivity on heat transfer.	(8)	CO3
	OR		
3d)	Liquid oxygen at atmospheric pressure (boiling point = 90 K is stored in a spherical vessel of 300 mm outside diameter). The system is insulated by enclosing the container inside another concentric sphere of 500 mm inside diameter and the space between them is evacuated. Both the sphere surfaces are made of aluminium for which emissivity may be taken as 0.3. The temperature of the outer sphere is 313 K. Calculate the rate of heat flow due to radiation. What will be the reduction in heat flow if the polished aluminium with an emissivity of 0.05 is used for the container walls.	(8)	CO3
Question No. 4			
4a)	Explain the Log Mean Temperature Difference (LMTD) method. Derive the LMTD formula for counter-flow and parallel-flow heat exchangers.	(8)	CO4

OR

4b) Explain the working of a plate heat exchanger with a neat diagram. Mention its advantages and limitations. (8) CO4

4c) Explain the construction, working, advantages, and limitations of a fixed tube sheet heat exchanger with a neat diagram. Why is it suitable only for clean fluids. (8) CO4

OR

4d) Design a counterflow heat exchanger to achieve effectiveness $\varepsilon = 0.90$. (8) CO4

Given $C_r = 0.40$ and $C_{min} = 600$ W/K.

(a) Find the required NTU,

(b) Compute the required UA,

(c) If U = 500 W/m²·K, determine the heat transfer area A.

Question No. 5

5a) An evaporator is operating at atmospheric pressure. It is desired to concentrate a feed from 5 % solute to 20 % solute (by weight) at a rate of 5000 kg/h. Dry saturated steam at a pressure corresponding to the saturation temperature of 399 K (126^{o}C)is used. The feed is at 298 K (25^{o}C) and the boiling point rise (elevation), i.e., B.P.E. (B.P.R.) is 5 K. The overall heat transfer coefficient is 2350 W/(m^2·K). Calculate the economy of the evaporator and the area of heat transfer to be provided. (8) CO5

Data: Treating the solution as a pure water and neglecting the B.P.R., the latent heat of condensation of steam at 399 K is 2185 kJ/kg. Latent heat of vaporisation of/evaporation of water at 101.325 kPa and 373 K = 2257 kJ/kg. Specific heat of feed = 4.187 kJ/(kg·K)

OR

5b) Write the material and energy balance for Single effect evaporator with neat sketch. (8) CO5

5c) Discuss on the vapour recompression in evaporator to improve the Steam Economy of evaporators with diagram. (8) CO5

OR

5d)
- Describe the different factors affecting the evaporation operation (04 marks)
- Differentiate between the single effect and multiple effect evaporators (04 Marks).

(8) CO5

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