BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(MID SEMESTER EXAMINATION)

CLASS: B.TECH **SEMESTER: IV**
BRANCH: CHEMICAL/CHEMICAL (P&P) **SESSION: SP/2020**

SUBJECT: CL208 HEAT TRANSFER OPERATIONS

TIME: 2 HOURS **FULL MARKS: 25**

INSTRUCTIONS:
1. The total marks of the questions are 25.
2. Candidates may attempt for all 25 marks.
3. Before attempting the question paper, be sure that you have got the correct question paper.
4. The missing data, if any, may be assumed suitably.
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

				CO	**BL**
Q1	(a)	Define heat transfer and describe the Fourier's law of heat conduction with their assumptions.	[2]	CO1	L1,L2
Q1	(b)	A 5cm diameter steel pipe is covered with a 1cm layer of insulating material having k = 0.22 W/m.^{O}C followed by a 3cm-thick layer of another insulating material having k = 0.06 W/m.^{O}C. The entire assembly is exposed to a convection surrounding condition of h = 60 W/m2.^{O}C and T_∞ =15 ^{O}C. The outside surface temperature of the steel pipe is 400 ^{O}C. Calculate the heat lost by the pipe-insulation assembly for a pipe length of 20 m. Express in Watts.	[3]	CO3	L3,L5
Q2	(a)	Derive the expression of heat conduction through composite wall.	[2]	CO1	L3,L4
Q2	(b)	A circumferential fin of rectangular profile has a thickness of 0.7mm and is installed on a tube having a diameter of 3cm that is maintained at a temperature of 200^{0}C. The length of the fin is 2cm and the fin material is copper. Calculate the heat lost by the fin to a surrounding convection environment at 100◦C with a convection heat-transfer coefficient of 524 W/m^2.^{0}C.	[3]	CO3	L3, L5
Q3	(a)	Give the significance of these dimensionless numbers: Nusselt number, Prandtl number, Grashof number and Stanton number.	[2]	CO1	L2
Q3	(b)	Air flows at 120 ^{O}C in a thin-wall stainless-steel tube with h=65 W/m2.^{O}C. The inside diameter of the tube is 2.5 cm and the wall thickness is 0.4 mm. k =18 W/m.^{O}C for the steel. The tube is exposed to an environment with h=6.5 W/m2.^{O}C and T_∞ =15^{o}C. Calculate the overall heat-transfer coefficient and the heat loss per meter of length. What thickness of an insulation having k =40W/m.0C should be added to reduce the heat loss by 90 percent?	[3]	CO3	L3,L5
Q4	(a)	Derive the expression for Reynolds analogy.	[2]	CO1	L3, L4
Q4	(b)	Derive the expression for local and average heat transfer coefficient, Nusselt number for flat plate.	[3]	CO1	L2,L3
Q5	(a)	Describe the newton's law of cooling and thermal boundary layer.	[2]	CO1	L2
Q5	(b)	Derive an expression for the temperature distribution and total heat transfer for the case of infinite thermal conductivity.	[3]	CO1	L2,L3

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