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

CLASS: B.TECH. **SEMESTER: III**
BRANCH: CHEMICAL ENGINEERING **SESSION: MO/2022**

SUBJECT: CL219 HEAT TRANSFER OPERATION

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

INSTRUCTIONS:
1. The total marks of the questions are 25.
2. Candidates 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 handbook/Graph paper etc. to be supplied to the candidates in the examination hall.

			CO	BL
Q1 (a)	What is critical thickness of insulation? What is the difference between Biot number and Nusselt number?	[2]	1	2
Q1 (b)	A steam pipe of 10 cm ID and 11 cm OD is covered with an insulating substance k = 1 W/mK. The steam temperature is 200 ^oC and ambient temperature is 20 ^oC. If the convective heat transfer coefficient between insulating surface and air is 8 W/m^2K, find the critical radius of insulation for this value of r_c. Calculate the heat loss per m of pipe and the outer surface temperature. Neglect the resistance of the pipe material.	[3]	2	4
Q2 (a)	Discuss Grashof number and Rayleigh's number in natural convection process.	[2]	1	1
Q2 (b)	A mild steel tank of wall thickness 10 mm contains water at 90 ^oC. The thermal conductivity of mild steel is 50 W/m ^oC, and the heat transfer coefficient for inside and outside of the tank area are 2800 and 11 W/m^2 ^oC, respectively. If the atmospheric temperature is 20 ^oC, calculate (Assumption – no heat loss from the top water surface) (i) The rate of heat loss per m^2 of the tank surface area. (ii) The temperature of the outside surface tank.	[3]	2	4
Q3 (a)	What is the difference between the black body, grey body and non-grey body in terms of emissivity?	[2]	1	2
Q3 (b)	An aluminum sphere mass of 5.5 kg and initially at a temperature of 290 ^oC is suddenly immersed in a fluid at 15 ^oC with heat transfer co-efficient 58 W/m^2 K. Estimate the time required to cool the aluminum to 95 ^oC for aluminum take ρ = 2700 kg/m^3, c = 900 J /kg K, k = 205 W/m.k.	[3]	2	5
Q4 (a)	In forced convection, Nusselt number is a function of which dimensionless groups and give the significance of those dimensionless groups.	[2]	1	2
Q4 (b)	When 0.6 kg of water per minute is passed through a tube of 2 cm diameter, it is found to be heated from 20 ^oC to 60 ^oC. the heating is achieved by condensing steam on the surface of the tube and subsequently the surface temperature of the tube is maintained at 90 ^oC. Determine the length of the tube required for fully developed flow. Given: At bulk mean temperature properties of water, ρ = 995 kg/m^3, v = 0.657 x10-6 m^2/s, Pr = 4.340, K = 0.628 W/m. K, Cp = 4178J/kg. K, for laminar flow Nu = 3.66 & for turbulent flow Nu = 120	[3]	2	5
Q5 (a)	Suppose there is a grey surface at a temperature "T" K. It receives a total radiative flux of "G" W/m^2. If its emissivity, reflectivity, and transmissivity are ε, ρ, and τ respectively, what will be the total radiative flux leaving the surface.	[2]	3	3
Q5 (b)	Consider the flow of a gas with density 1 kg/m^3, viscosity 1.5 x 10^{-5} kg/(m.s), specific heat C_p = 846 J/kg. K and K = 0.01665 W/m. K, in a pipe of diameter D = 0.01 m and length L =1 m and assume the viscosity does not change with temperature. The Nusselt number for a pipe with (L/D) ratio greater than 10 and Reynolds number greater than 20000 is given by Nu = 0.026 $Re^{0.8}$ $Pr^{1/3}$. While the Nusselt number for a laminar flow for Reynolds number less than 2100 and (Re Pr D/L) < 10 is Nu = 1.86 $[Re\ Pr\ (D/L)]^{1/3}$. If the gas flows through the pipe with an average velocity of 0.1 m/s, find the value of heat transfer coefficient?	[3]	2	4

::::::30/09/2022::::::M