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

CLASS: B.TECH **SEMESTER : III**
BRANCH: CHEMICAL ENGG/FT **SESSION : MO/2025**

SUBJECT: CL24207 HEAT TRANSFER OPERATIONS

TIME: 02 HOURS **FULL MARKS: 25**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 5 marks and total 25 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
4. Tables/Data handbook/Graph paper etc., if applicable, will be supplied to the candidates

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			CO	BL
Q.1(a)	Define thermal conductivity and thermal diffusivity.	[2]	1	1
Q.1(b)	A hollow aluminium (204 W/m.°C) sphere having inner diameter of 5 cm and an outer diameter of 10 cm is maintained at 100 °C and 50 °C at inside and outside of the sphere. Calculate the heat flux at the outer surface.	[3]	1	3
Q.2(a)	It is required to heat oil to about 300$^\circ C$ for frying purpose. A ladle is used in the frying. The section of the handle is 5 mm×18 mm. The surroundings are at 30$^\circ C$. The conductivity of the material is 205 $W/m^\circ C$. If the temperature at a distance of 380 mm from the oil should not reach 40$^\circ C$, determine the convective heat transfer coefficient.	[5]	1	3
Q.3(a)	What is the physical significance of the Biot number?	[2]	1	2
Q.3(b)	Stainless steel ball bearings (ρ = 8085 kg/m^3, k = 15.1 W/m·°C, C_p = 0.480 kJ/kg °C, and a= 3.91×10^{-6} m^2 /s) having a diameter of 1.2 cm are to be quenched in water. The balls leave the oven at a uniform temperature of 900 °C and are exposed to air at 30 °C for a while before they are dropped into the water. If the temperature of the balls is not fall below 850 °C prior to quenching and the heat transfer coefficient in the air is 125 $W/m^2\cdot{}^\circ C$, determine how long they can stand in the air before being dropped into the water.	[3]	1	3
Q.4(a)	Define Grashof number and its physical significance.	[2]	2	2
Q.4(b)	Using the Reynolds–Colburn analogy, describe the correlation between the Fanning friction factor, Stanton number, and heat transfer in turbulent flow.	[3]	2	3
Q.5(a)	Define thermal and hydrodynamic boundary layer thickness.	[2]	2	1
Q.5(b)	Consider the flow of a fluid with density 1kg/m^3, viscosity 1.5×10^{-5} kg/m.s, specific heat 840 J/kg.K and thermal conductivity 0.017 W/m.K, in a diameter 0.01m and length one meter and assume the viscosity does not change with temperature. If the fluid flows through the pipe with an average velocity 0.1 m/s, find the heat transfer coefficient. Data given $Nu = 0.026 Re^{0.8} Pr^{0.33}$ $for\ Re > 21000\ and\ \frac{L}{D} > 10$ and $$Nu = 1.86\left(Re \times Pr \times \frac{D}{L}\right)^{1/3}\ \ for\ Re < 2100\ and\ \left(Re \times Pr \times \frac{D}{L}\right) < 10$$	[3]	2	3

:::::23/09/2025 :::::E