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

CLASS: B.TECH. **SEMESTER : V**
BRANCH: MECHANICAL **SESSION : MO/2023**

SUBJECT: ME315 HEAT & MASS TRANSFER

TIME: 3 Hours **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
***4*. Before attempting the question paper, be sure that you have got the correct question paper.**
5. Data Book of Heat and Mass Transfer to be allowed to the candidates in the examination hall.

			CO	BL
Q.1(a)	A steam pipe, 10cm ID and 11 cm OD, is covered with insulating substance having k=1W/mK and kept in ambient air. The steam and ambient temperatures are 200°C and 20°C, respectively. The convective coefficient of heat transfer made by insulating surface and air is 8W/m^{2}K. Find the critical radius of insulation. For the surface at critical radius evaluate heat loss per metre length of pipe and the surface temperature. Neglect resistance of pipe material.	[5]	1	5
Q.1(b)	An aluminium sphere weighing 5.5kg and temperature of 290°C is suddenly immersed in a fluid at 15°C. The convective heat transfer coefficient is 58W/m^{2}K. Evaluate the time required to cool aluminium to 95°C.	[5]	1	5
Q.2(a)	A long solid rod of diameter 2.5 cm is heated at one end with a constant heat source and projected to ambient air at 22°C. When steady state condition prevails, the convective heat transfer coefficient was found to be 28.4W/mK while some distance away from the heated end the temperatures at two points 10cm apart have been noted as 110°C and 85°C. Evaluate thermal conductivity of the rod material.	[5]	2	5
Q.2(b)	Two large parallel gray planes of Area A_1 and A_2 and temperatures T_1 and T_2 are kept close to each other separated by a non-absorbing medium. Derive the equation of net radiatve heat exchange in terms of equivalent emissivity.	[5]	2	1,5
Q.3(a)	Air at 20°C flows over a heated flat plate at 134°C at a velocity of 3m/s. The plate is 2m long and 1.5m wide. Evaluate local convective heat transfer coefficient at 0.4m and average convective heat transfer coefficient for 0.4m from the leading edge of the plate	[5]	3	5
Q.3(b)	A man assumed as a cylinder of diameter 30cm and 1.7m height with surface temperature of 30°C stands in 36km/hr wind at 10°C. Estimate the heat he would lose.	[5]	3	5
Q.4(a)	Explain the physical significance of the following: (i) Nusselt number (ii) Stanton number (iii) Grashoff's number	[5]	4	3
Q.4(b)	Consider a solid cubical block of size 0.1mx0.1mx0.1m and suspended in still air at 20°C. All the surfaces of the block have been maintained at 160°C. Estimate the total heat loss from the block.	[5]	4	5
Q.5(a)	Explain Fick's law of diffusion and the diffusion coefficient.	[5]	5	3
Q.5(b)	In a food processing plant water is to be cooled from 18°C to 6.5°C by using brine solution entering at inlet temperature of -1.1°Cand leaving at 2.9°C. Estimate the area required when using a shell and tube heat exchanger with water making one shell pass and brine making two tube passes. Assume average overall heat transfer coefficient of 850W/m^{2}K and a design load of 6000W.	[5]	5	5

::::::23/11/2023::::::M