BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION MO/2023)

CLASS: IMSC. **SEMESTER: V**
BRANCH: FOOD TECHNOLOGY **SESSION: MO/2023**

SUBJECT: FT302 HEAT TRANSFER IN FOOD PROCESSING

TIME: 03 HOURS **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions, each of 10 marks and a total 50 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**

			CO	BL
Q.1(a)	Describe the principle modes of heat transfer with examples	[5]	1	1,2
Q.1(b)	i) What is meant by one-dimension steady state heat transfer ii)What is the difference between Biot Number and Nusselt number? ii) Describe the difference between distributed and lumped analysis of unsteady state heat transfer	[5]	1	1,2
Q.2(a)	i) What are the criteria for transition from natural to forced convection? ii) What is the Dittus-Boelter equation, and when is it applied? iii) What are the advantages and drawbacks of dimensional analysis	[5]	2	1,2,3
Q.2 (b)	A furnace inside temperature of 2250 K has a glass circular viewing of 6 cm diameter. If the transmissivity(ε) of the glass is 0.08, make calculations for the heat loss from the glass window due to radiation.	[5]	2,4	3,4
Q.3(a)	i) Define the overall heat transfer coefficient ii) What are the broad classes of heat exchangers found in industry iii) When is LMTD method most applicable to heat exchanger calculations?	[5]	3	2,3
Q.3(b)	Hot water enters a counterflow heat exchanger at 95°C. This hot water is used to heat a cool stream of water from 8 to 40° C. The flow rate of the cool water is 1.2 kg/s, and the flow rate of the hot water is 2.7 kg/s. The overall heat-transfer coefficient is 850 W/m^2°C. What is the area of the heat exchanger and its effectiveness?	[5]	3	2,3,4
Q.4(a)	Describe the key mechanisms of microwave heating.	[5]	1,4	2,3
Q.4(b)	What are the principles of ohmic heating?	[5]	1,4	1,2,3
Q.5 (a)	It is desired to boil water at atmospheric pressure on a copper surface, which is electrically heated. Estimate the heat flux from the surface to the water, if the surface is maintained at 110 °C and the peak heat flux. Given: For water at 100 °C, L=2257kJ/kg; ρ=958.4 kg/m^3; c=4.211 kJ/kg-K; μ=277.5 x 10^{-6} Ns/m^2 ;Pr=1.75; σ=58.9 x 10^{-3} N/m, C_{sf}=0.013, n=1 The Rohsenhow correlation for estimation of heat flux is given by $$\frac{c\Delta T}{LPr^n} = C_{sf}\left[\frac{q}{\mu L}\sqrt{\frac{\sigma}{g(\rho-\rho_v)}}\right]^{0.33}$$ The peak flux is given by $$q_c = \frac{\pi}{24}\rho_v^{0.5}L\left[\sigma g(\rho-\rho_v)\right]^{0.25}$$	[5]	5	2,3,4
Q.5 (b)	Saturated vapour of methanol condenses on a vertical plate at 1 atm. The vertical plate is maintained at 55 °C by cooling water at the other side. Calculate the following, (i) Length of the plate over which the condensate film remains laminar. (ii) What is the thickness of the film at the end of the laminar region? (iii) Determine the average heat transfer coefficient and the rate of condensation in the laminar region.	[5]	5	2,3,4