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

CLASS: IMSC **SEMESTER: V**
BRANCH: FOOD TECHNOLOGY **SESSION : MO/2018**

SUBJECT : IMF5009 FOOD ENGINEERING II -HEAT AND MASS TRANSFER

TIME: 1.5 HOURS **FULL MARKS: 25**

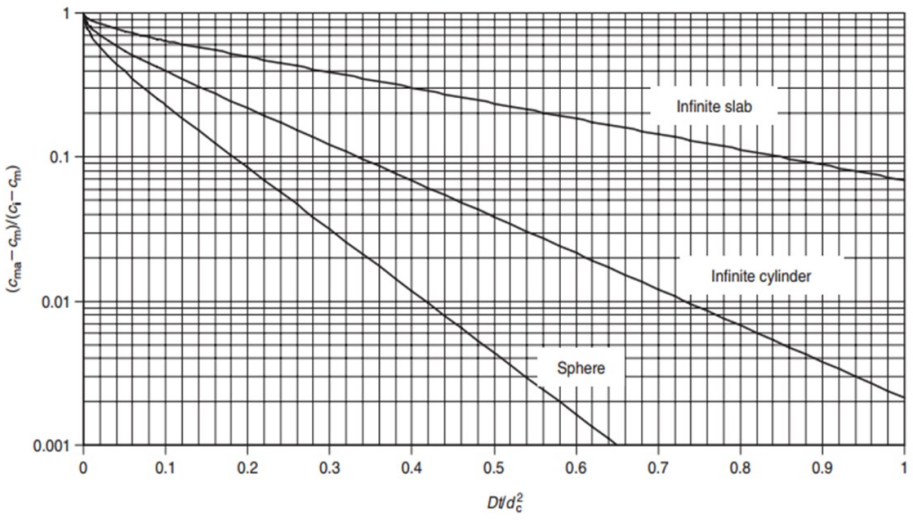
INSTRUCTIONS:
1. The total marks of the questions are 30.
2. Candidates may attempt for all 30 marks.
3. In those cases where the marks obtained exceed 25 marks, the excess will be ignored.
4. Before attempting the question paper, be sure that you have got the correct question paper.
5. The missing data, if any, may be assumed suitably.

Q1 (a) Distinguish between overall and individual mass Transfer coefficient. Derive a relationship between them. [2]

(b) A 0.3175 cm sphere of glucose is placed in a water stream flowing at a rate of 0.15 m/s. The temperature of water is 25C. The diffusivity of glucose in water is 0.69 x 10^{-5} cm^2/s. Determine the mass transfer of coefficient. [3]
[Density of water L 997.1 kg/m^3, Viscosity = *880.637x 10 $^{-6}$ Pa s*]

Q2 (a) Define and mention significance of Biot Number and Fourier Number in mass transfer [2]

(b) Salt is being used to preserve a 5.0mm slice of meat. The concentration of salt at the surface is 0.533 kg/kg salt free meat (SFM), and the initial concentration is 0.012 kg/kg SFM. If the mass diffusivity, *D*, of salt in meat is $8.00x\ 10^{-11}\ m^2/s$, determine the time required for the mass average concentration to reach 0.3 kg/kg SFM. [3]
X coordinate=$\frac{Dt}{d_c^2}$; Y Coordinate=$\frac{c_{ma}-c_m}{c_i-c_m}$



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Q3 (a) State Roults law and define relative volatility. [2]

(b) What is Flash distillation? What are its application in food processing?A liquid mixture containing 15% (weight), ethanol, is heated and flashed at 1 atm pressure. Determine (a) temperature of flash chamber (b) composition of two outlet stream when 50% is vapourized [3]

Mass Fraction Ehanol	Enthalpy, kJ/kg mixture	
	Liquid	Vapour
0	418.9	2675
.1	371.7	2517
.3	314.0	2193
.5	285.9	1870
.7	258.4	1544
.9	224.7	1223
1.0	207.0	1064

Temp^oC	100	95.2	87.3	83.2	81.0	79.1	78.2	78.1	78.2	78.3
x_A	0	0.50	0.200	0.400	0.600	0.800	0.940	0.960	0.980	1.0
y_A	0	0.377	0.656	0.746	0.794	0.858	0.942	0.959	0.978	1.0

Q4 (a) What is Ostwald ripening? State Kelvin's equation. [2]

(b) Calculate crystal yield when a 100 kg hot saturated sucrose solution at 90^oC is cooled to 30^oC. [3]

Temperature ^oC	0	10	20	30	40	60	80	100
Sucrose, g/100 g water	179	190	204	219	238	287	362	487

Q5 (a) Define Fourier Law of heat conduction and find the expression for thermal resistance. [2]

(b) A rod of 5 cm diameter and 30 cm length is maintained at 200 ^oC hot end and colder end is at 10 ^oC. These temperature conditions are attained when there is a heat flow 10 watts. If the cylindrical surface of the rod is completely insulated, determine the thermal conductivity of the rod material. [3]

Q6 (a) An exterior wall of a house may be approximated by 10 cm layer of common brick (k = 0.75 W/m-K) followed by 4 cm layer of gypsum plaster (k= 0.5 W/m-K). What thickness of loosely packed rock wool insulation (k= 0.065 W/m-K) should be added to reduce the heat loss or gain through the wall by 75%. [2]

(b) Find an expression for critical thickness of insulation for cylindrical surface. [3]

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