

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

**CLASS: IMSC
BRANCH: FOOD TECHNOLOGY**

**SEMESTER: V
SESSION : MO/2019**

SUBJECT : IMF5009 FOOD ENGG-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.
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- Q1 (a) List and explain various modes of heat transfer. [2]
(b) Develop an expression for heat transfer through furnace wall made of three different materials in series. Assume k_1 , k_2 and k_3 be the thermal conductivities of materials and l_1 , l_2 and l_3 be the respective thicknesses. Assume hot face and cold face temperature be T_1 and T_2 respectively. [3]
- Q2 The walls of a house in a cold region consist of three layers outer layer brickwork of 0.15 m thickness and an inner wooden panel of 0.012 m thickness. The intermediate layer is made of an insulating material 0.07 m thick. The thermal conductivity of the brick and the wood used are 0.7 W/m °C and 0.18 W/ m °C, respectively. The inside and outside temperature of the composite wall are 21 °C and -15 °C, respectively. If the layer of insulation offers twice the thermal resistance of the brick wall then determines: [5]
i. The rate of heat loss per unit area of the wall
ii. The thermal conductivity of the insulating material
- Q3 (a) What is Kirchhoff's law of radiation? [2]
(b) The effective temperature of a body having an area of 0.12 m² is 800 K. Determine the total rate of energy emission. Stefan-Boltzmann constant = 5.67×10^{-8} W/m² K⁴ [3]
- Q4 (a) What is the difference between Recuperative and Regenerative type heat exchanger? [2]
(b) A hot fluid enters a double pipe heat exchanger at a temperature of 150 °C and is to be cooled to 94 °C by a cold fluid entering at 38 °C and heated to 66 °C. Determine the logarithmic mean temperature for counter current flow. [3]
- Q5 (a) What is the difference between single effect evaporator and double effect evaporator? [2]
(b) What are the advantages of forced circulation evaporators? [3]
- Q6 (a) What is Fick's law of diffusion? [2]
(b) Carbon dioxide (A) is diffusing through non-diffusing air (B) under steady state conditions at a total pressure of 1.013×10^5 Pa and temperature 300 K. The partial pressure of carbon dioxide is 20,000 Pa at one point and 5,000 Pa at other point. The distance between the points is 0.05 m. Determine the flux (rate of diffusion) of Carbon dioxide in kmol/(m². s). Given that at 300 K and 1.013×10^5 Pa, $D_{AB} = 2 \times 10^{-5}$ m²/s. $R = 8314$ Pa m³/kmol K [3]