Ref. No.: Ex/FTBE/BS/B/T/217/2023

B.E. FOOD TECHNOLOGY AND BIO-CHEMICAL ENGINEERING SECOND YEAR FIRST SEMESTER EXAM 2023

HEAT TRANSFER

(50 Marks for each Part)

Total Marks: 100 (Use separate answer script for each Part) **Time: 3hrs**

PART I (50 Marks)

Group-A

Answer questions no 1 or 2 and 3 or 4. **2×10 = 20**

1. Express the Fouries's laws of heat transfer. Write assumption (s) of Fourier's 1st law. Define thermal conductivity and write its dimension. How temperature affects the value of thermal conductivity? 4+2+2+2 = 10
2. Define absorptivity, transmitivity and emissivity of a black body. Write their correlation. What is shape factor? What is the shape factor for two large parallel plates? What is fouling factor? 3+2+2+2+1 = 10
3. What is the significance of Prandtl number? How do you calculate the heat transfer coefficient for laminar flow inside a pipe? 3+5+2 = 10
4. Define log mean temperature difference. Derive the expression for log mean temperature difference. 3+7 = 10

Group-B

Answer any three questions **3×10 = 30**

5. (a) What is thermal resistance? Write its dimension.
   (b) A cold storage room is constructed of an inner layer of 12.7 mm of pine, a middle layer of 101.6 mm of cork board and outer layer of 76.2 mm of concrete. The wall surface temperature is 255.4K inside the cold room and 297.1K at the outside surface of the concrete. Thermal conductivities are 0.151, 0.0433 and 0.762 W/m.K for pine, cork board and concrete respectively. Calculate the heat loss in W for $1m^2$ and temperature at the interface between the wood and cork board. 2+8 = 10
6. (a) Write Stefan Boltzmann law for radiative heat transfer.
   (b) Cookies traveling on a conveyor inside a continuous baking oven occupy most of the area on the surface of the conveyor. The top wall of the oven directly above the conveyor has an emissivity of 0.92 and the cookies have an emissivity of 0.8. If the top wall of the oven has a temperature of 175^0C, calculate the average rate of heat transfer by radiation between the cookies per unit area on the side which faces the top wall of the oven when the cookie surface temperature is 70^0C. 3+7 = 10
7. (a) Explain natural and forced convective heat transfer.

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(b) Calculate the rate of heat transfer across a glass pane which consists of two 1.6mm thick glass layers separated by an 0.8mm layer of air. The heat transfer coefficient on the one side, which is at 21^0C, is 2.84 W/m^2.K, and that on the opposite side, which is at -15^0C, is 11.4 W/m^2.K. The thermal conductivity of glass is 0.52 W/m.K, and that of air is 0.031 W/m.K. 3+7 = 10

8. (a) How, heat transfer coefficient is calculated for turbulent flow inside a pipe?
(b) Derive the equation for conductive heat transfer in a multi-layer cylindrical pipe line. 3+7 = 10

9. (a) What do you mean by overall heat transfer coefficient?
(b) Derive the equation for overall heat transfer coefficient of a pipe line. 3+7 = 10

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BACHELOR OF ENGINEERING (F.T.B.E) EXAMINATION, 2023

(2nd year, 2nd Semester)

HEAT TRANSFER

Time: 3 hours FM: 100

Part: II (50 Marks)

Answer question no 4 and any two from the rest

1. A square slab of butter which is 46.2 mm thick at a temperature of 277.6 k in a coolar is removed and placed at a temperature of 292K. The side and bottom is consider to be insulated. The convective coefficient is constant at 8.52 W/m^2. K. calculates the temperature the temperature of the butter at the surface and at 25.4 mm below the surface after 5 hr of exposer. How does fouling affects the heat transfer? 15+5=20
2. Steam condensing on a vertical tube 0.50 m long having an outer diameter of 0.028 m and a surface temperature of 90^0 C. If steam saturated at 75 kPa, calculate the average heat-transfer coefficient using SI units. Use the following data for properties of water and steam

   T_{sat} =90^0 C, h_{fg} = 2.283×10^6 J/kg, ρ_l =966.7 kg/m^3, ρ_v =0.391 kg/m^3, μ_l = 3.24×10^{-4} Pa.s, κ_l =0.675 W/m.K.

   20
3. b) Describe the design procedure of shell and tube heat exchanger. Perfectly pure liquid in contact with flat heating surface requires infinite time to start boiling-explain and Draw the profile of heat transfer coefficient as against 'quality' during liquid forced convection boiling. 10+5+5=20
4. Describe different tube arrangement in shell and tube type heat exchanger. What do you mean by temperature correction factor? 6+4=10