

**B.E. FOOD TECHNOLOGY AND BIO-CHEMICAL ENGINEERING
SECOND YEAR FIRST SEMESTER SUPPLEMENTARY EXAM 2024**

HEAT TRANSFER

Time: 3 hrs

(50 Marks for each Part)

Full Marks: 100

Part-I

Use Separate Answer scripts for each Part

Group-A

Answer any one question

1×5 =5

1. Write and explain the Furrier's laws for heat transfer.
2. Define thermal conductivity and heat transfer coefficient and their units. Is there any correlation of these terms?

Group-B

Answer any three questions

3×15 = 45

3. (a) What are the different modes of heat transfer? Define thermal conductivity and write its unit.
(b) The inner surface of furnace wall is at 200°C and outer surface at 50°C. Calculate the heat lost per m² area of the wall. If thermal conductivity of the brick is 0.5 W/m⁰C & the wall thickness is 200mm. 5+10 = 15
4. (a) What is overall heat transfer coefficient? What is fouling factor? Write the effect of fouling in boiler.
(b) A double glazed window is made of 2 glass panes of 6 mm thick each with an air gap of 6 mm between them. Assuming that the air layer is stagnant and only conduction is involved, determine the thermal resistance and overall heat transfer coefficient. The inside is exposed to convection with $h = 1.5 \text{ W/m}^2\text{K}$ and the outside to $9 \text{ W/m}^2\text{K}$. Compare the values with that of a single glass of 12 mm thickness. The conductivity of the glass = 1.4 W/m K and that for air is 0.025 W/m K. 5+10 = 15
5. (a) Write and explain Stephan-Boltzman Law for radiative heat transfer.
(b) Two large plates are maintained at a temperature of 900 K and 500 K respectively. Each plate has area of 6m². Compare the net heat exchange between the plates for the following cases. (i) Both plates are black (ii) Plates have an emissivity of 0.5. 5+10 = 15
6. (a) What do you mean by LMTD? What is its significance?
(b) Applesauce is being cooled from 80°C to 20°C in a swept surface heat exchanger. The overall coefficient of heat transfer based on the inside surface area is 568 W/m²· K. The applesauce has a specific heat of 3187 J/kg · K and is being cooled at the rate of 50 kg/h.

[Turn over

Cooling water enters in countercurrent flow at 10°C and leaves the heat exchanger at 17°C. Calculate: (a) the quantity of cooling water required; (b) the required heat transfer surface area for the heat exchanger.

7. (a) Define Nusselt number, Prandtl number and Reynolds number and write their significance.
- (b) Write short note on natural convection
- © What do you mean by hydraulic boundary layer and thermal boundary layer? Write their correlation.

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SUPPLEMENTARY EXAM - 2024

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FM: 100

Part: II (50)

Answers 1 or 2 and all the following question

1. a) Calculates the temperature of the butter at the surface and at 22.5 mm below the surface after 4 hr of exposure when a square slab of butter which is 40 mm thick at a temperature of 277.6 K in a cooler is removed and placed at a temperature of 292K. The side and bottom is considered to be insulated. The convective coefficient is constant at 8.52 W/m². K. 10
2. With neat sketches explain the life history of a bubble in a boiling liquid. What do you mean by effectiveness of heat exchanger? 10
3. Using SI units, Calculate the average heat-transfer coefficient when a Saturated steam at 65 kPa is condensing on a vertical tube 0.4 m long having an outer diameter of 0.039 m and a surface temperature of 85^o C. Use the following data for properties of water and steam
 $T_{\text{sat}} = 90^{\circ}\text{C}$, $h_{\text{fg}} = 2.283 \times 10^6 \text{ J/kg}$, $\rho_l = 966.7 \text{ kg/m}^3$, $\rho_v = 0.391 \text{ kg/m}^3$, $\mu_l = 3.24 \times 10^{-4} \text{ Pa.s}$,
 $k_l = 0.675 \text{ W/m.K}$. 20
4. Discuss how do fouling factor affects heat transfer and Draw the profile of heat transfer coefficient as against 'quality' during liquid forced convection boiling? What do you mean by effectiveness of heat exchanger? What do you mean by Log-Mean-Temperature-Difference correction factor? 6+8+6=20