KERALA AGRICULTURAL UNIVERSITY

B. Tech. (Agrl. Engg.) 2022 & Previous Admissions

IV Semester Final Examination – July 2024

Fape.2203 **Heat and Mass Transfer (2+0)** **Marks: 50**

Time: 2 hours

I **Fill in the blanks** **(10x1=10)**

1. Heat transfer by …….. does not require a medium.
2. The rate of heat transfer through a solid is governed by …….. law.
3. In forced convection, the heat transfer is enhanced by the presence of ……
4. The process of converting a substance from a solid to a vapor directly is called ……
5. The rate of mass transfer is proportional to the concentration gradient and the ……

State True or False

6. In conduction, heat transfer occurs due to the movement of fluid particles.
7. Thermal radiation can occur in a vacuum.
8. In natural convection, heat transfer is driven solely by buoyancy forces.
9. The rate of convective heat transfer is independent of the thermal conductivity of the fluid.
10. Mass transfer refers to the transfer of heat between different objects or systems

II **Write short notes on ANY FIVE of the following** **(5x2=10)**

1. What is Fourier's law of heat conduction and how is it mathematically expressed?
2. Describe the concept of thermal resistance in heat transfer and its role in determining the overall heat transfer rate.
3. Explain the difference between steady-state and transient heat conduction, providing an example for each.
4. Discuss Fick's law of diffusion and its significance in mass transfer processes.
5. What is the difference between convective heat transfer coefficient and convective mass transfer coefficient?
6. Define the concept of diffusivity and discuss its role in both heat and mass transfer.
7. Briefly explain the concept of boundary layer in convective heat and mass transfer, and its impact on the overall transfer process.

III **Answer ANY FIVE of the following** **(5x4=20)**

1. An electric hot plate is maintained at a temperature of 350°C, and is used to keep a solution boiling at 95°C. The solution is contained in a cast-iron vessel of wall thickness 25 mm, which is enamelled inside to a thickness of 0.8 mm. The heat transfer coefficient for the boiling solution is 5.5 kW/m^{2}K, and the thermal conductivities of the cast iron and enamel are 50 and 1.05 W/mK, respectively. Calculate:
   (i) The overall heat transfer coefficient.
   (ii) The rate of heat transfer per unit area.
2. If velocity distribution in laminar boundary layer over a flat plate is assumed to be given by second order polynomial $u = a + by + cy^2$, determine its form using the necessary boundary conditions.
3. Assuming the sun to be a black body emitting radiation with maximum intensity $\lambda = 0.49$ pm, calculate the following.
   (i) The surface temperature of the sun
   (ii) The heat flux at surface of the sun

4. The flow rates of hot and cold-water streams running through a parallel flow heat exchanger are 0.2 kg/s and 0.5 kg/s respectively. The inlet temperatures on the hot and cold sides are 75°C and 20°C respectively. The exit temperature of hot water is 45°C. If the individual heat transfer coefficients on both sides are 650 $W/m^2°C$, calculate the area of the heat exchanger.
5. A spherical shaped vessel of 1.4 m diameter is 90 mm thick. Find the rate of heat leakage, if the temperature difference between the inner and outer surfaces is 220°C. Thermal conductivity of the material of the sphere is 0.083 W/m°C.
6. What do you understand by the term Thermal Boundary Layer? How Prandtl number affects thermal and hydraulic boundary layer for a hot surface?
7. Differentiate between a defuse and specular reflector.

IV **Write an essay on ANY ONE of the following** **(1x10=10)**

1. A hot plate 1.2 m wide, 0.35 m high and at 115°C is exposed to the ambient still air at 25°C. Calculate the following:
   - I. Maximum velocity at 180 mm from the leading edge of the plate;
   - II. The boundary layer thickness at 180 mm from the leading edge of the plate;
   - III. Local heat transfer coefficient at 180 mm from the leading edge of the plate;
   - IV. Average heat transfer coefficient over the surface of the plate;
   - V. Total mass flow through the boundary;
   - VI. Heat loss from the plate
   - VII. Rise in temperature of the air passing through the boundary

   Use the approximate solution.
2. Derive the expression for effectiveness of a counter flow heat exchanger in terms of capacity ratio (C) and NTU. Also enumerate the assumptions made for this derivation.

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