KERALA AGRICULTURAL UNIVERSITY
B.Tech.(Food Technology)
III Semester Final Re - Examination – February 2026
2023 & Previous admission

Pafe.2115 **Heat and Mass Transfer in Food Processing (2+1)** **Marks: 50**
Time: 2 hours

I **Answer the following** **(10x1=10)**

1. Define thermal diffusivity.
2. Name the general mode of heat transfer in Solids
3. Define fins or extended surfaces.
4. Define efficiency of fin.
5. What is turbulent flow? Define it.
6. Define Stefan-Boltzmann's law.
7. Define overall heat transfer co-efficient.
8. Define convection
9. Define Nusselt number (Nu).
10. What is free convective mass transfer?

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

1. State Newton's law of cooling.
2. What do you mean by critical radius of insulation?
3. What is Biot number? What is its physical significance?
4. Differentiate between Hydrodynamic and thermal boundary layer thickness.
5. Explain black body, opaque body, white body and grey body.
6. Define Nusselt number, Prandtl number and Grashof number
7. Give the examples of mass transfer

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

1. Derive an expression for heat conduction through a composite wall.
2. It is required to heat oil to about 300 °C for frying purpose. A ladle is used in the frying. The section of the handle is 5 mm x 18 mm the surroundings are at 30 °C. The conductivity of the material is 205 W/m °C. If the temperature at a distance of 380 mm from the oil should not reach 40 °C, determine the convective heat transfer coefficient.
3. Derive and explain critical radius in detail.
4. A spherical ball 6 cm in diameter and 310 K is placed inside a large spherical furnace at 600 K. Estimate the diameter of the spherical furnace such that 20% of the energy emitted by the furnace reaches the spherical ball. Assume the surfaces as black. What is the net exchange of energy between the two surfaces?
5. A counter flow heat exchanger is to heat air entering at 400°C with a flow rate of 6 kg/s by the exhaust gas entering at 800°C with a flow rate of 4 kg/s. The overall heat transfer coefficient is 100 W/m^2 K and the outlet temperature of air is 551.5°C. Specific heat of air, Cp, for both air and exhaust gas can be taken as 1100 J/kg K. Calculate
   (i) the heat transfer area needed and
   (ii) the number of transfer units
6. A heavy lubricating oil (μ = 0.8 N s/m^2, k = 0.15 W/m K) flows in the clearance between a shaft and its bearing. If the bearing and shaft are kept at 10°C and 30°C respectively and the clearance between them is 2 mm, determine the maximum temperature in the oil and the heat flux to the plates for a velocity U = 6 m/s.

7. A deep narrow cylindrical vessel which is open at the top contains some water at the bottom. The air within the vessel is considered motionless, but there is sufficient air current at the top surface of the vessel so that any water vapour arriving at the top surface is immediately removed to ensure zero water vapour concentration. The entire system is at 1 atm, 298 K. The diffusivity of air-water vapour is $D = 0.26 \times 10^{-4}$ m^2/s and the saturated vapour pressure of water at the surface is 0.032 atm. Determine the rate of vaporisation of water into the air per unit area if the distance between the water surface and the top of the vessel is 1.524 m.

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

1. The flow rates of hot and cold water streams running through a parallel flow heat exchangers are 0.2 kg/s and 0.5 kg/s respectively the inlet temperatures 75 °C and 20°C respectively. The exit temperature of hot water is 45 °C. If the individual heat transfer coefficient on both sides are 650 $W/m^2°C$. Calculate:
   (i) The area of heat exchanger
   (ii) The rate of heat transfer.
2. Derive an equation for free convection by use of dimensional analysis.

****