8. (a) Explain the freeze drying process and also mention the advantages of freeze drying system. 8

(b) Find an expression for the calculation of total drying time in solid food. 6

UNIT-V

9. (a) An evaporator is used to concentrate cane sugar. A feed of 100 Kg/h of a solution containing 38% sugar is evaporated producing a 74% solution calculate the weight of solution produced and amount of water removed? 6

(b) Define water activity. Explain the method for measurement of water activity at high moisture content. 8

10. (a) Write down methods of operation of evaporators and calculation methods for single-effect evaporators? 8

(b) Calculate the water activity of a 50 % sucrose solution. (Given: K = 2.7, Molecular weight of sucrose is 342) 6

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B.Tech Even Semester Examination, May, 2025

Agricultural Engineering

(6th Semester)

Course No: AE-601

(Thermal Operation in Food Processing)

Full Marks: 70
Pass Marks: 28
Time: 3 hours

Note:
1. Attempt any five questions taking one from each unit.
2. Begin each answer in a new page
3. Answer parts of a question at a place
4. Assume reasonable data wherever required
5. The figure in the right margin indicates full marks for the question
6. All the mathematical symbols and abbreviations have their usual meanings.

UNIT-I

1. (a) Define Fourier law of heat transfer for steady state. Also, find the rate of heat flow through a cylinder (assume as per requirement). 8

(b) Heat is flowing across the layers of air, concrete and air. The convective heat transfer coefficient for two layers of air are 100 W/m^2K and 10 W/m^2K. The overall heat transfer coefficient for the composite layers is 8 W/m^2K. What is the thickness of concrete layer (thermal conductivity = 0.76 W/mK)? 6

2. (a) By using Newtonian cooling, derive the expression for calculating temperature and the total amount of heat transfer from a

body at any instant of time. Assume the thermal resistance of the body is zero. 8

(b) Define the following 6

(i) Nusselt Number (ii) Prandtl Number

(iii) Biot Number (iv) unsteady state heat transfer

UNIT-II

3. (a) What is heat exchanger? Discuss different type of heat exchanger with neat sketch. 6

(b) A simple counter flow heat exchanger operates under the following condition.

Fluid-A, Inlet and outlet temperatures 80^0C and 40^0C.

Fluid-B, Inlet and outlet temperatures 20^0C and 40^0C.

The exchanger is cleaned, causing an increase in the overall heat co-efficient by 10% and inlet temperature of fluid B is changed to 30^0C. What will be the new outlet temperature of fluid A and of fluid B? Assume heat transfer co-efficient and capacity rate are unaltered by temperature changes. 8

4. (a) What is effectiveness of heat exchanger? Write the equation for the effectiveness of a parallel flow and counter flow heat exchanger. 8

(b) Hot water at 95°C is used in a plate heat exchanger for heating 2 kgs^{-1} fruit juice from 45°C to 75°C. Specific heat capacity of fruit juice is 3.7 $kJkg^{-1}K^{-1}$. Final temperature of the hot water is 70°C. Overall heat transfer coefficient is 1122 $wm^{-2}K^{-1}$. Heat transfer area is 12.75m^2. What will be the log mean temperature correction factor? 6

UNIT-II

5. (a) Discuss the following: 9

i) D-Value (ii) Z-Value (iii) Arrhenius Equation

(b) A suspension containing $3x10^5$ spores of organism A having a D-value of 1.5 min at 121.1^0C and $8x10^6$ spores of organism B having a D-value of 0.8 min at 121.1^0C is heated at a uniform constant temperature of 121.1^0C. Calculate the heating time for this suspension at 121.1^0C. Calculate the heating time for this suspension needed to obtain a probability of spoilage of 1/1000. 5

6. (a) What is critical thickness of insulation on a small diameter wire or pipe, explain its physical significance and derive an expression for the same. 8

(b) Write short notes on: 6

(i) pasteurization (ii) sterilization (iii) UHT Processing

UNIT-IV

7. (a) Explain the drying mechanism of moisture removal in solid food. 7

(b) Explain the working function of a tray dryer with the help of a neat diagram. 7