**B.Tech Odd Semester (CBCS) Exam.,
December—2018**

AGRICULTURAL ENGINEERING

(5th Semester)

Course No. : AE-CC–24

(Thermal Operations in Food Processing)

Full Marks : 50
Pass Marks : 15

Time : 2 hours

Note : 1. Answer any **five** questions.

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 figures in the margin indicate full marks for the questions.

1. *(a)* Derive an expression for overall heat transfer coefficient (U) for a double-pipe heat exchanger. Explain the various terms in this expression. 7

(b) Define the following : 3

 (i) Nusselt number

 (ii) Prandtl number

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2. *(a)* By using Newtonian cooling, derive an expression for calculating temperature of a body at any instant of time. Assume thermal resistance of body is zero. 6

(b) An electric wire having a diameter of $1·5$ mm and covered with a plastic insulation (thickness = $2·5$ mm) is exposed to air at 300 K and h_0 20 W/m^2-K. The insulation has a K of $0·4$ W/m-K. It is assumed that the wire surface temperature is constant at 400 K and is not affected by covering.

 (i) Calculate the value of the critical radius.

 (ii) Calculate the heat loss per meter of wire length with no insulation. 4

3. *(a)* What is heat exchanger? Discuss different types of heat exchanger with neat sketch. 5

(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 75 m^2. What will be the log mean temperature correction factor?. 5

4. *(a)* Discuss the following :   6

    (i) *D* value

    (ii) *Z* value

(b) A suspension, containing 3×10^5 spores of organism *A* having a *D* value of 1·5 min at 121·1°C and 8×10^6 spores of organism *B* having a *D* value of 0·8 min at 121·1°C, is heated at a uniform constant temperature of 121·1°C. Calculate the heating time for this suspension at 121·1°C needed to obtain a probability of spoilage of 1/1000.   4

5. *(a)* Discuss the following :   1½×5=7½

    (i) Pasteurization

    (ii) Sterilization

    (iii) Equilibrium moisture content (EMC)

    (iv) Falling rate drying

    (v) Bound moisture

(b) The *F* value at 121·1°C is equivalent to 99·999% inactivation of a strain of *C.* Botulinum is 1·2 min. Calculate the D_0 value of this organism.   2½

6. *(a)* Explain the freeze drying process with the help of neat sketch and also mention the advantages of freeze drying system.   6

(b) Define effectiveness of a heat exchanger. Also write the expression for effectiveness of parallel flow heat exchanger.   4

7. *(a)* Define water activity. Explain the method for measurement of water activity at high moisture content.   6

(b) An evaporator is used to concentrate orange juice. A feed of 2160 kg/h of a solution containing 10% solids is evaporated producing 74% total solids. Calculate the weight of solution produced and amount of water removed.   4

8. *(a)* Discuss the different physical and chemical properties of a solution which affect the design of evaporator.   6

(b) Calculate the water activity of a 50% sucrose solution. (Given $K \to 2 \cdot 7$, molecular weight of sucrose is 342)   4

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