B.Tech Even Semester (CBCS) Exam., April—2017

AGRICULTURAL ENGINEERING

(6th Semester)

Course No. : AE–601 (C)

(Thermal Operation in Food Processing)

Full Marks : 75
Pass Marks : 30

Time : 3 hours

Note : 1. Attempt one question 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 figures in the margin indicate full marks for the questions.

UNIT—1

1. *(a)* Derive expression for calculating temperature and total amount of heat transfer from a body at any instant of time by using Newtonian cooling. Assume thermal resistance of body is zero. 10

(b) Define Fourier law of heat transfer for steady state. Also find the rate of heat flow through a slab (assume as per requirement). 3+2=5

2. *(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. 9

(b) Define the following : 1½×4=6

(i) Nusselt number

(ii) Prandtl number

(iii) Biot number

(iv) Unsteady state heat transfer

UNIT—2

3. *(a)* Derive an expression for log mean temperature difference (LMTD) of a heat exchanger. 7

(b) A simple counter flow heat exchanger operates under the following condition. Fluid—*A*, inlet and outlet temperatures 80 °C and 40 °C. Fluid–*B*, inlet and outlet temperatures 20 °C and 40 °C. The exchanger is cleaned, causing an

increase in the overall heat coefficient by 10% and inlet temperature of fluid *B* is changed to 30 °C. What will be the new outlet temperature of fluid *A* and of fluid *B* ? Assume heat transfer coefficient and capacity rate are unaltered by temperature changes. 8

4. *(a)* What is effectiveness of heat exchanger? Derive an expression for the effectiveness of a parallel flow heat exchanger. 2+6=8

(b) Nitrobenzene of 0·2 kg/sec is to be cooled from 400 K to 315 K by heating a stream of benzene from 305 K to 345 K. A tubular heat exchanger is available with a shell fitted with 165 tube (OD = 19 mm and ID = 15 mm) each 5 m long. What value of scale resistance on the outer surface of the inner tube could be allowed if these units were used?

The benzene side heat transfer coefficient h_i 1000 w / m^2-k (which flow through the tube) and nitrobenzene side heat transfer coefficient h_0 750 w / m^2-k, temperature correction factor 0 8, specific heat capacity of nitrobenzene 2380 J / kg-k. 7

UNIT—3

5. *(a)* Discuss the following : 3×3=9

(i) *D*-value

(ii) *Z*-value

(iii) Arrhenius equation

(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 needed to obtain a probability of spoilage of 1/1000. 6

6. *(a)* What is order of reaction? Describe zero order and first order reaction. 2+3½+3½=9

(b) Write short notes on : 2×3=6

(i) Pasteurization

(ii) Sterilization

(iii) UHT processing

UNIT—4

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

(b) Find an expression for the calculation of total drying time in solid food. 8

8. *(a)* Explain the working function of a drum dryer with the help of a neat diagram. 7

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

UNIT—5

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. 2+7=9

10. *(a)* Write down the methods of operation of evaporators and calculation methods for single-effect evaporators. 9

(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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