Name : ………………………………………………………

Roll No. : ………………………………………………………

Invigilator's Signature : ……………………………………

CS/B.Tech(FT)/SEM-5/FT-503/2009-10

2009

FOOD PROCESS ENGINEERING

Time Allotted : 3 Hours   *Full Marks* : 70

The figures in the margin indicate full marks.

*Candidates are required to give their answers in their own words
as far as practicable.*

GROUP – A
(Multiple Choice Type Questions)

1.   Choose the correct alternatives of the following :   10 × 1 = 10

   i)   When the inlet hot air temperatures are the same the problems of overheating arises in the case of

   a)   concurrent system

   b)   counter-current system.

   ii)   Drying of a solid involves

   a)   only heat transfer

   b)   only mass transfer

   c)   both heat and mass transfer

   d)   none of these.

iii) Air is best heated with steam in a heat exchanger of

  a) plate type

  b) double pipe type with fins on steam side

  c) double pipe type with fins on air

  d) shell and tube type.

iv) Water evaporation rate in an evaporator depends on

  a) design and operating parameters of evaporator

  b) type of evaporating liquid

  c) none of these.

  d) all of these.

v) Which type of condenser is used to recover essence from condensate ?

  a) Barometric condenser

  b) Direct contact condenser

  c) Surface condenser

  d) all of these.

vi) Which is not a part of plate heat exchanger ?

    a) Flow controller

    b) Gasket

    c) Ports

    d) Base plate.

vii) Design of heat exchanger depends on

    a) inlet, outlet temperature and heat transfer area

    b) heat transfer coefficient and fouling factor

    c) none of these.

    d) all of these.

viii) The best layout of tube holes in the tube plate of a shell and tube type heat exchanger is

    a) square pitch

    b) triangular pitch

    c) rotated square pitch

    d) any one of these.
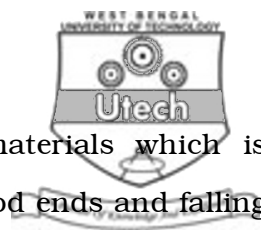
ix) Average moisture content of the materials which is obtained when the constant rate period ends and falling rate period begins, called

    a) equilibrium moisture content

    b) free moisture content

    c) critical moisture content

    d) none of these.

x) Dryers in which the solid is directly exposed to hot gas (generally air) is called

    a) non-adiabatic dryer   b) adiabatic dryer

    c) isochoric dryer   d) none of these

GROUP – B
(Short Answer Type Questions)
Answer any *three* of the following.   3 × 5 = 15

2. What is drying ? Classify the methods used for drying with example.   1 + 4

3. What are the advantages of freeze drying   5

4. With a neat sketch describe the operation of a fluidized bed dryer.   5
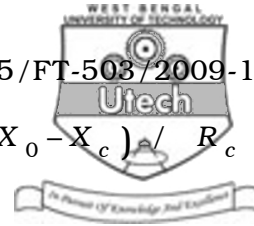
5. Prove that total drying time $t = (X_0 - X_c) / R_c + (X_c / R_c) \, ln \, (X_c / X)$

where X = moisture content at time t

X_0 = Initial moisture content

R_c = Constant drying rate

X_c = Critical moisture content. 5

6. Deduce the mathematical equation for materials and heat balance in continuous drying operation ? 5

GROUP – C
(Long Answer Type Questions)
Answer any *three* of the following. 3 × 15 = 45

7. a) A single drum drier 0·7 m in dia and 0·85 m long operates at 150°C and is fitted with a blade to remove food after $\frac{3}{4}$ revolution. It is used to dry a 0·6 mm layer of 20% w/w solution of gelatin, preheated to 100°C, at atmospheric pressure. Calculate the speed of the drum required to produce a product with a moisture content of 4 kg solid per kg of water.

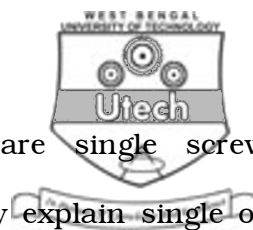(Given : density of gelatin feed is 1020 kg/m^3

overall heat transfer coefficient is 1200 Wm^{-2}K^{-1}

critical moisture content of gelatin is 450%

latent heat of vaporization is 2·257 ∞ 10^6 J/kg).

b) Write the advantages and disadvantages of tray drier.

10 + 5

8. Name some extruded products. Compare single screw extruder with twin screw extruder. Briefly explain single or twin screw extruder. 2 + 3 + 10

9. a) Why do we require to heat milk before homogenization ? Explain the process of two stage homogenization with a neat sketch. What are the advantages of a plate heat exchanger ? 2 + 5 + 2

   b) A solution is being concentrated from 10 to 50% solid in a single effect evaporator. The steam supplied of 15 psig (249°F) and a vacuum of 26 inch of mercury (125°F) is maintained at the vapour space. The heat transfer area of evaporator is 725 sq. ft. The condensate leave at condensing temperature and the solution is assumed to have negligible elevation of boiling point. The specific heat of the feed is 0·9 Btu/lb°F and that of the product is 0·5 Btu/lb°F. What is the feed capacity of this evaporator when the feed enters at 70°F and the overall heat transfer coefficient is 200 Btu/hr ft[20] F. Enthalpy of vapour is 1115·8 Btu/lb and heat of condensation of steam at 249°F is 946 Btu/lb. 6

10. What basic units used in the construction of cold storage ? Discuss how insulation is done.

If a slab of meat is to be frozen between refrigerated plates with the plate temperature at – 34°C, how long will it take to freeze if the slab is 10 cm thick and the meat is wrapped in cardboard 1 mm thick on either side of the slab ? What would be the freezing time if the cardboard were not present ? Assume that for the plate freezer, the surface heat transfer coefficient is 600 $Jm^{-2} s^{-1} °C^{-1}$, the thermal conductivity of cardboard is 0·06 $Jm^{-2} °C^{-1}$, the thermal conductivity of frozen meat is 1·6 $Jm^{-2} °C^{1}$, its latent heat is 2·56 ∞ 10^{5} J kg^{-1} and density 1090 kg m^{-3}. Assume also that meat freezes at – 2·C. 5 + 2 + 8

11. Deduce the mathematical expression for constant drying rate (R_c) considering all the usual notation having their own meaning.

Calculate the constant drying rate for balanced apple slices with air flowing parallel to the surface at 3·65 m/s. The initial moisture content was 85·4% (wet basis) and the slices were in layer 0·5 inch (0·0127) thick. The wet balanced apples had a bulk density of approximately

35 lb/ft ^{3} (560 kg/m ^{3}) at a moisture content of 87% (wet basis). Dehydration proceeds from top to bottom surfaces of tray.

a) Air is at T_{db} = 76·7°C (170°F)

b) T_{wb} = 37·8°C (100°F) 5 + 1 + 9