Name : ....

Roll No. : ....

Invigilator's Signature : ....

CS/M.TECH(FT)/SEM-2/MFT-202/2013

2013

ADVANCE FOOD 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 for the following : $10 \times 1 = 10$

    i)   Two fluids milk and rapeseed oil, flowing along pipes of
         same diameter (5 cm) at 20°C and at same velocity of
         3 ms^{-1},

         $\mu_{milk} = 2 \cdot 10 \times 10 \text{ NS/m}^2$

         $\tau_{milk} = 1030 \text{ kg/m}^3$

         $\mu_{rapeseed} = 118 \times 10^{-3} \text{ NS/m}^2$

         $\mu_{rapeseed} = 900 \text{ kgm}^{-3}$

         Flow will be turbulent through the pipeline in case of

         a)   flow of milk   b)   flow of rapeseed oil

         c)   in both cases   d)   none of these.

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ii) Bernoulli's theorem can be applicable

    a) under laminar flow condition

    b) under plug flow condition

    c) under turbulent flow condition

    d) under steady flow condition.

iii) The value for flow behaviour index for Newtonian fluid is

    a) 0   b) $\dfrac{1}{2}$

    c) 1   d) $\dfrac{3}{2}$.

iv) In a fluidized bed, when superficial velocity increases

    a) there is increase in pressure drop

    b) there is increase in porosity of the bed

    c) increase in heat transfer rate

    d) none of these.

v) Pervaporation differs from other membrane separation process because

    a) it is less expensive

    b) it involves phase change in permeate

    c) commercially it is always supplemented to a conventional separation process

    d) very high pressure is applied in the upstream side of the membrane.

vi) In steam distillation, the

    a) temperature is 100°C

    b) temperature is more than 100°C

    c) product must be immiscible with water

    d) temperature is higher than the boiling point of either component.

vii) For incompressible cakes in cake filtration

$$\alpha = \frac{K_2(1-e)}{(\phi_s D_p)^2 \varepsilon^3 \rho_p}$$

Dimension of α will be

a) L^{-1}

b) $ML^{-1}T^2$

c) LM^{-1}

d) M/L .

viii) In case of ultra rapid freezing the rate of freezing is

a) 02 - 5 mm/hr

b) 10 - 20 mm/hr

c) 100 - 1000 mm/hr

d) 50 - 100 mm/hr.

ix) Minimum air velocity needed to convey particles at the time of fluidization is given by

a) $V_g = \dfrac{d_p^2(\rho_p - \rho)g}{18\mu}$

b) $V_g = \sqrt{\dfrac{4d(\rho_p - \rho)g}{3c_D\rho}}$

c) $V_g = \sqrt{\dfrac{3c_D\rho}{4d(\rho_p - \rho)g}}$

d) $V_g = \sqrt{\dfrac{3c_D\rho}{4d(\rho - \rho_p)g}}$.

x) Relative centrifugal field (RCF) is defined as

a) $g/\omega 2R$

where g = Acceleration due to gravity

ω = angular velocity

b) $(1\cdot118 \times 10^{-2})$ (revmin^{-1})^3.R

c) $(1\cdot118 \times 10^{-5})$ (revmin^{-1})^2.R

d) $(1\cdot118)$ revmin^{-1}.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following.　　$3 \times 5 = 15$

2.　a)　How agitating retorts decrease the processing time in case of batch sterilization at the time of processing of can ?

　　b)　Write notes on selected grades of stainless steel in manufacturing pipeline in a food processing plant.

　　　　　　　　　　　　　　　　　　　　　　2 + 3

3.　The browning reaction in milk has been shown to have a $Q10$ value of 1·5. If the product is processed at 285°F and 260°F to an Fo^{22} of 15 in the holding tube of an aseptic canning system, compare the extent of formation of brown pigments between the products processed at these two temperatures.

4.　A loaf of bread having a surface temperature of 373 K is being baked in an oven whose walls and air are at 477·4 K. The bread moves continuously through the large oven on an open chain belt conveyor. The emissivity of the bread is estimated at 0·85 and the loaf can be assumed a rectangular solid 114·3 mm high × 114·3 mm wide × 330 mm long. Calculate the radiation heat-transfer rate to the bread, assuming that it is small compared to the oven and neglecting natural convection heat transfer.

5.　a)　Define regenerative heating system in a continuous sterilization unit.

　　b)　A oil storage tank drains by gravity to a tank truck. The length of the pipeline between the tank and the truck is 60 m and its internal dia is 26 mm. Oil has a velocity of 0·0005 Pa-S and density of 800 kg/m^3. Both tank and the truck are opened to atm and the flow rate of oil is 0·8 l/s. Calculate the difference between the level in the tank and that in the truck.

　　　Assume for turbulent flow $f = 0.079\ Re^{-0.25}$

　　　For laminar flow $f = 16/Re$.　　　　　　　2 + 3
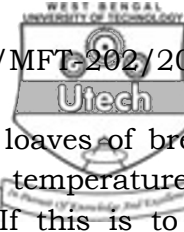
6. It is desired to establish freezing of 10,000 loaves of bread each weighing 0·75 kg from an initial room temperature of 18°C to final store temperature of –18°C. If this is to be carried out in such a way that the maximum heat demand for the freezing is twice the average demand, estimate the maximum demand, if the total freezing time is to be 6 hrs.

Given Cp above freezing 2·93 kJ/kg°C

Cp below freezing 1·42 kJ/kg°C

Latent heat of freezing 115 kJ/kg

Freezing temperature is – 2°C.

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

7. a) Define the terms free and bound moisture content.

   b) Calculate the constant drying rate for blanching apple slice dried 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 a layer 0·0127 m thick. The wet blanched apples had a bulk density of approximately 560 kg/m^3 at moisture content 87% wet basis. Dehydration proceeds from the top and bottom surface of tray. Air is at inlet temperature of 76·7°C and the outlet temperature of 37·8°C. The material shows a constant drying rate of and has an aw of 1 at moisture content above 1·10 kg of H$_2$O/kg of dry matter. How long will it take to dry this material from an initial moisture content of final moisture content of 8% on wet basis ? $3 + 12$

8. a) What is the difference between cross flow and dead-end flow ?

   b) "All membrane fouling are preceded by concentration polarization but all concentration polarization does not lead to membrane fouling." Justify.
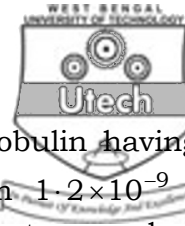
c) The molecular diameter of beta lactoglobulin having a molecular weight of 37,000 daltons in $1 \cdot 2 \times 10^{-9}$ m. When performing ultrafiltration of 30°C at a membrane surface velocity of 1·25 m/s, a solid concentration in the feed of 12% and a transmembrane pressure of 414 KPa, the flux was 6·792 L/(m².h). Calculate the concentration at the membrane surface and the flux under the same condition but at a higher cross membrane velocity of 2·19 m/s. The membrane system was thin channel with a separation of 7·6 mm. The flow path was 30 cm long. The viscosity of the solution at 30°C was 4·8 cp and the density was 1002 kg/m³. 2 + 3 + 10

9. a) What are the bases for designing a continuous sterilizer ?

b) A fluid food product has a viscosity of 5 cp and density of 1009 kg/m³. It is to be pasteurized in a continuous system that involves heating to 82·2°C holding in a 1·5 inch normal sanitary pipe and cooled. A SV value 12 for *S.* aureus D82·2°C = 0·0063 min is desired. Calculate the length of the holding tube for a flow rate of 18l/min. 7 + 8

10. a) What will be flow profile in an extruder in screw and die combined operation ?

b) What are the bases of extruder scale up ?

c) Delicious apples of 70 mm dia and 85% water content initially at uniform temperature of 30°C to be cooled by refrigerated air at –5°C flowing at a velocity of 1·5 m/s. The average heat transfer coefficient between the apples and the air is 21 w/m² °C. Determine how long it will take for the centre temperature of apples to drop to 6°C. Also determine if any part of the apples will freeze during this process.

Thermal conductivity of apples = 0·418 w/m °C

Thermal diffusivity of apples = $0 \cdot 13 \times 10^{-6}$ m²/s

[Given, $1/Bi$ = 0·57, Y = 0·314, Fo = 0·46.] 5 + 5 + 5

11. a) What is break power of a pump ? Define electrical motor efficiency of a pump.

b) Water at 50°C is in an open tank at atmospheric pressure. The pump is 3·0 mt above the tank level. The velocity in the pipe is 0·9 m/s. The friction head loss in the pipe has been calculated as 1·0 m. The required (NPSH)$_R$ for this pump is 2·0 m. Calculate the available NPSH available.

c) Peas which have average diameter of 6 mm and density of 880 kg/m^3 are dried in a fluidized bed drier. The minimum void age is 0·4 and the cross-sectional area of bed 0·25 m^2. Calculate the minimum air velocity to fluidize the bed if air density is 0·96 kg/m^3 and air viscosity has $2·15 \times 10^{-5}$ N/sm^2. Calculate the minimum air velocity needed to convey the particles.   5 + 5 + 5

12. a) What are the working principle of Baking ovens ?

b) What types of bands are used in tunnel oven ?

c) Cookies travelling on a conveyor inside a continuous baking oven occupy most of the area on the surface of the conveyor. The top wall of oven directly above the conveyor has an emissivity of 0·8. If the top wall has a temperature of 180°C, calculate the average rate of heat transfer by radiation between the cookies per unit area on the side which faces the top wall of the oven, when cookies surface temperature is 65°C.   5 + 3 + 7

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