

Name :

Roll No. :

Invigilator's Signature :

CS/B.Tech (CT)/SEM-4/CHE (CT)-401/2011

2011

UNIT OPERATION – II

Time Allotted : 3 Hours

Full Marks : 70

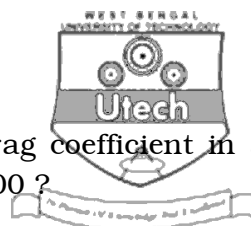
The figures in the margin indicate full marks.

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

GROUP – A

(Objective Type Questions)

1. Write brief answers for any *ten* of the following : $10 \times 1 = 10$
 - i) Give example of one substance that may undergo 'case-hardening'.
 - ii) What kind of flow strategy is preferred for drying a heat sensitive substance in continuous drying ?
 - iii) Which dryer is suitable for drying of Antibiotics ?
 - iv) What is the pore size range of a UF membrane ?
 - v) What type of membrane is used for 'Reverse osmosis' ?
 - vi) What is 'Equivalent diameter' of a particle ?
 - vii) What is 'Specific surface' of a powder mixture ?
 - viii) Which mechanical/physical separation can be used for the classification of powder mixture ?



- ix) What is the approximate value of Drag coefficient in a flow region with Reynolds No. of 10,000 ?
- x) Under what condition does wall effect on free settling become important ?
- xi) Give one technical problem associated with leaf filter.

GROUP – B
(Short Answer Type Questions)

Answer any *three* of the following. 3 × 5 = 15

- 2. It is desired to crush 10 ton/hr of iron ore hematite. The size of the feed is such that 80% passes a 76.2 mm screen and 80% of the product is to pass a 3.175 mm screen. Calculate the gross power required. Use a work index for iron ore hematite of 12.68.
- 3. While drying a solid from 33% to 1% moisture (dry basis), it is found that the constant rate drying time is the same as the falling rate drying time. The equilibrium moisture content is negligible. If the falling drying rate is linear in the moisture content, what is the critical moisture content of the solid ?
- 4. In a spiral round ultrafiltration module for protein separation, the bulk concentration on the feed side is known to be 2 mass % and the rejection coefficient is 0.975. The flux is $1.8 \times 10^{-5} \text{ m}^3/\text{m}^2 \cdot \text{s}$ and the feed side mass transfer coefficient is $4.4 \times 10^{-5} \text{ m/s}$. What is the true rejection coefficient ?
- 5. At the end of the filtration cycle with a plate and frame filter press, a total filtrate volume of 3.37 m^3 is collected in a total time of 269.75. The cake is to be washed by through washing in the plate and frame press using a volume of wash equal to 10% of the filtrate volume. Calculate the time of washing and the total filter cycle time if cleaning the filter takes 20 min.



GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following.

$3 \times 15 = 45$

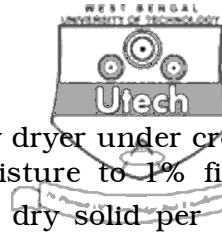
6. a) A mixture of silica and galena solid particles having size range of 5.21×10^{-6} m to 2.50×10^{-5} m is to be washed by hydraulic clarification using free settling condition in water at 293.2 K. Specific gravity of silica is 2.65 and that of galena is 7.5. Calculate the size range of the various fractions obtained in the settling. If the settling is in the laminar region, the drag coefficient will be reasonably close to that for sphere. The following data have also been provided :

Density for water (ρ) = 998 kg/m^3 at 293.2 K

Water viscosity (μ) = $1.005 \times 10^{-3} \text{ kg/m} \cdot \text{s}$. 10

- b) A viscous solution containing particles with a density = 1461 kg/m^3 is to be clarified by centrifugation. The solution density $\rho_p = 1461 \text{ kg/m}^3$ and its viscosity is 0.1 kg/m.s . The centrifuge has a bowl with $r_2 = 0.02225 \text{ m}$; $r_1 = 0.00716 \text{ m}$ and height $I = 0.1970 \text{ m}$. Calculate the critical particle diameter of the largest particles in the exit stream if $N = 23000 \text{ rev/min}$ and the flow rate is $0.002832 \text{ m}^3/\text{h}$. 5

7. a) Derive an expression for terminal velocity for a particle moving through a fluid assuming the particle as rigid sphere. 8
- b) Calculate the settling velocity of glass spheres having a diameter of $1.554 \times 10^{-4} \text{ m}$ in water at 293.2 K. The slurry contains 60 wt% solids. The density of glass sphere is 2467 kg/m^3 , density of water 998 kg/m^3 , viscosity of water is $1.005 \times 10^{-3} \text{ kg/m.s}$. 7



8. a) A granular wet solid is dried on a tray dryer under cross flow of hot air from 30% initial moisture to 1% final moisture. The solid loading is 35 kg dry solid per m^2 tray area. The constant drying rate is $4.5 \text{ kg/m}^2 \cdot \text{h}$. The critical moisture content is 10% and equilibrium moisture is 0.2%.
- Calculate the total drying time if the falling rate is linear in moisture content. 6
 - What is the drying rate when the moisture content is 5% ? 4
- b) A solid is to be dried in the falling rate period from the critical moisture content X_c to one tenth of it ($X_c/10$). The equilibrium moisture content is negligible. If the falling rate is linear in X , the drying rate is t_1 if the drying rate varies as X^2 , the drying time is t_2 . Find out the ratio of t_1 and t_2 . 5
9. a) An enzyme is being concentrated in an ultrafiltration module with the feed in cross flow. Under the given flow condition the mass transfer coefficient at the membrane surface is estimated to be $3 \times 10^{-5} \text{ m/s}$. The bulk concentration is 0.3 mass%. If the water flux is $0.41 \text{ m}^3/\text{m}^2 \cdot \text{h}$, calculate the polarization modulus and the concentration of the enzymes at the membrane surface. The membrane has a distribution of pore sizes and 95% rejection of the solute is achieved. If the diffusivity of the enzyme is $8 \times 10^{-7} \text{ m}^2/\text{s}$, calculate the thickness of the mass transfer film. 7
- b) Write short notes on any *two* of the following : 2 × 4
- Filter media and filter aid
 - Concentration polarization
 - Bound, unbound, equilibrium and free moisture in a solid
 - Muller mixer.