



Name :

Roll No. :

Invigilator's Signature :

CS/B.Tech/CHE (NEW)/SEM-4/CHE-403/2013

2013

MECHANICAL OPERATION

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 any *ten* of the following :

10 × 1 = 10

- i) Cyclone separator is generally used for
 - a) liquid-solid separation
 - b) gas-solid separation
 - c) insoluble liquids separation
 - d) none of these.
- ii) The power number in an agitated vessel is
 - a) analogous to a friction factor
 - b) analogous to a drag coefficient
 - c) the dimensionless group
 - d) all of these.



- iii) Sedimentor is called clarifier when desired product from it is
- a) concentrated sludge b) suspended slurry
c) clear liquid d) both (a) and (c).
- iv) Sorting is termed in the separation process of particles according to
- a) sizes b) densities
c) shapes d) viscosities.
- v) Which is the most suitable conveyor for transportation of sticky material ?
- a) Apron conveyor b) Belt conveyor
c) Screw conveyor d) Pneumatic conveyor.
- vi) The critical speed of a trommel (N) is related to its diameter (D) as
- a) $N \propto \frac{1}{\sqrt{D}}$ b) $N \propto \sqrt{D}$
c) $N \propto D$ d) $N \propto \frac{1}{D}$.
- vii) The unit of specific cake resistance is
- a) gm/cm^2 b) cm/gm
c) cm/gm^2 d) gm/gm .



- viii) Which of the following gives the crushing energy required to create new surface ?
- a) Taggart's rule b) Fick's law
c) Rittinger's law d) none of these.
- ix) Diatomaceous earth is a/an
- a) explosive b) filter aid
c) filter media d) catalyst.
- x) With increase in the capacity of screens, the screen effectiveness
- a) remains unchanged
b) increases
c) decreases
d) decreases exponentially.
- xi) For a non-spherical particle, the sphericity
- a) is defined as the ratio of surface area of a sphere having the same volume as the particle to the actual surface area of the particle
b) has the dimension of length
c) is always less than 1
d) is the ratio of volume of a sphere having the same surface area as the particle to the actual volume of the particle.
- xii) For storage of non-homogeneous solids in open piles, it is practiced to keep the 'angle of repose'
- a) equal to angle of friction
b) greater than angle of friction
c) less than angle of friction.



GROUP – B

(Short Answer Type Questions)

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

2. a) What do you mean by critical speed of a ball mill ?
b) Calculate the operating speed of a ball mill from the following data i) Diameter of ball mill = 500 mm, ii) Diameter of ball = 50 mm. Operating speed of the ball mill is 35% of critical speed. $2 + 3$

3. If a centrifuge of 0.9 m dia rotates at 20 Hz, at what speed should a laboratory centrifuge of 150 mm diameter run if it is to duplicate plant conditions.
4. If crushing rolls of 1 m diameter are set so that the crushing surfaces are 12.5 mm. apart and the angle of nip is 31° , what is the maximum size of particle which should be fed to the rolls ?

If the actual capacity of the machine is 12% of the theoretical, calculate the throughput in kg/s when running at 2 m/s if the working face of the rolls is 0.4 m long and the bulk density of the feed is 2500 kg/m^3 . $2 + 3$

5. Derive the expression for terminal velocity of a spherical rigid particle through a stagnant fluid.
6. Write a short note on elutriator with a neat diagram.



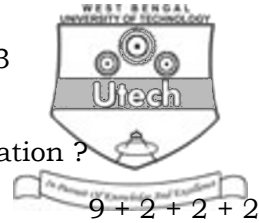
GROUP – C
(Long Answer Type Questions)

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

7. a) Table salt is being fed to a vibrating screen at the rate of 150 kg/hr. The desired product is (– 30 + 20) mesh fraction. A 30 mesh and 20 mesh screen are therefore used (double deck), the feed being introduced on the 30 mesh screen. During the operation, it was observed that the average proportion of oversize (from 30 mesh screen) oversize (from 20 mesh screen) is 2 : 1.5 : 1. Calculate the effectiveness of the screen from the following data :

Mesh	Feed	Over size from 30 mesh screen	Over size from 20 mesh screen	Under size from 20 mesh screen
-85 + 60	0.097	0.197	0.026	0.0005
-60 + 40	0.186	0.389	0.039	0.0009
-40 + 30	0.258	0.337	0.322	0.0036
-30 + 20	0.281	0.066	0.526	0.3490
-20 + 15	0.091	0.005	0.061	0.2990
-15 + 10	0.087	0.006	0.026	0.3470

- b) Distinguish between vibrating screen and trammel.
- c) Draw neat sketch showing the following screw conveyor terminologies :
- i) Screw diameter
 - ii) Screw clearance
 - iii) Shaft diameter.



- d) What are the variables in screen operation ?
8. a) Explain the operation of a Roll Crusher with neat sketch and also define angle of nip for a Roll Crusher.
- b) A certain set of crushing rolls has rolls of 150 cm in diameter by 50 cm width of face. They are set so that the crushing surfaces are 1.25 cm apart at the narrowest point. The manufacturer recommends 100 r.p.m, as the roll speed. They are to crush a rock having a specific gravity of 2.35 and the angle of nip 30° . What are the permissible size of the feed and the maximum actual capacity in tons per hour, if actual capacity is 12% of the theoretical ? (7 + 2) + (3 + 3)
9. Calculate the minimum area and diameter of a thickener with a circular basin to treat $0.1 \text{ m}^3/\text{sec}$ of a slurry of solids concentration 150 kg/m^3 . The results of batch settling test are as follows :

Solid Concentration (kg/m^3)	100	200	300	400	500	600	700	800	900	1000	1100
Settling velocity ($\mu \text{ m/sec}$)	148	91	55.33	33.25	21.40	14.5	10.29	7.38	5.56	4.20	3.27

A value of 1290 kg/m^3 for underflow concentration was selected from the retention time test. Estimate the underflow volumetric flow rate assuming total separation of all solids and a clear overflow is obtained.



10. a) What are the main features of compressible & incompressible cakes ? 5

b) Data for a laboratory filtration of CaCO_3 slurry in water at 25°C are reported as follows at a constant pressure (ΔP) of 338 kN/m^2 . The filter area of the plate and frame press was $A = 0.0439 \text{ m}^2$ and the slurry concentration was $C = 23.47 \text{ kg/m}^3$. Calculate the specific cake resistant (α) and filter media resistant (R_m) from the experimental data given below. 10

Viscosity of water at $25^\circ\text{C} = 8.937 \times 10^{-4} \text{ Pa-S}$.

$t \text{ (s)} \times 10^3$	4.4	16.3	34.7	46.1	59.0	89.4	107.3
$V \text{ (m}^3\text{)} \times 10^3$	0.489	1.501	2.498	3.002	3.506	4.502	5.009

11. a) The following data are given for a screw conveyor for handling moulding sand in a foundry :

Bulk density = 1600 kg/m^3 , diameter of screw = 0.3 m ,
 screw pitch = 0.25 m , conveying length = 10 m ,
 Speed of screw shaft = 27 rpm , loading factor = 0.15 ,
 Determine i) the shaft diameter, ii) the rate of conveying of the material in kg/hr .

b) Explain the importance of particle size analysis.

c) Write down the advantages and disadvantages of rotary drum filter.

d) What is the maximum shaft speed of rotation of phosphor-bronze centrifuge basket, 0.3 m dia and 5 mm thick, when it contains a liquid of density 1000 kg/m^3 and safe working stress as 55 MN/m^2 . 6 + 2 + 2 + 5

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