



Name :

Roll No. :

Invigilator's Signature :

CS/B.TECH(CHE-NEW)/SEM-4/CHE-403/2012

2012

MECHANICAL OPERATIONS

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.*

Answer Q.N. 1 and any *five* from the rest, taking at least *one* from
each module

(Multiple Choice Type Questions)

1. Choose the correct alternatives for the following :

10 × 1 = 10

- i) As the product becomes finer, the energy required for grinding
 - a) decreases
 - b) increases
 - c) is same as for coarser grinding
 - d) is 1.5 times that for coarser grinding

- ii) A fluid energy mill is used for
 - a) cutting
 - b) grinding
 - c) ultragrinding
 - d) crushing.



- iii) Choke crushing (in case of a Jaw crusher) compared to free crushing
- a) results in increased capacity
 - b) consumes less power
 - c) consumes more power
 - d) both (a) and (c).
- iv) The main differentiation factor between tube mill and ball mill is the
- a) length to diameter ratio
 - b) size of grinding media
 - c) final product size
 - d) operating speed.
- v) Cyclone separator is generally used for
- a) liquid-solid separation
 - b) gas-solid separation
 - c) insoluble liquids separation
 - d) none of these.
- vi) In the Newton's law region, the terminal velocity of a particle is proportional to
- a) square root of particle diameter
 - b) particle diameter
 - c) square of particle diameter
 - d) cubic root of particle diameter



- vii) For coarse reduction of hard solids, we use
- a) Impact
 - b) attrition
 - c) compression
 - d) cutting.
- viii) Bag filters is generally used for
- a) liquid-solid separation
 - b) gas-solid separation
 - c) insoluble liquids separation
 - d) none of these.
- ix) Sedimentor is called clarifier when desired product from it is
- a) concentrated sludge
 - b) suspended slurry
 - c) clear liquid
 - d) both (a) and (c)
- x) Spitzkasten is a
- a) classification equipment
 - b) flotation equipment
 - c) size reduction equipment
 - d) none of these.



Module – I

2. a) What is the utility of screening operation in industries ?
 b) Describe the operation of a trammel with a neat diagram.
 c) Differentiate between ideal and actual screening

3 + 6 + 3

3. a) Calculate the volume-surface mean diameter for the following particulate material :

Size of screen opening (mm)	Mass of particles in the range (g)
- 704 + 352	25
- 352 + 176	37.5
- 176 + 88	62.5
- 88 + 44	75
Pan	50

- b) How can you differentiate between a conveyor and an elevator ?
 c) Write a note on hoppers, bins and silos.

4 + 2 + 6

**MODULE – II**

4. a) State and explain Rittinger's law.
- b) A crusher was used to crush a material whose compressive strength was 22.5 MN/m^2 . The size of the feed was minus 50 mm, plus 40 mm and the energy required was 13 kJ/kg. The screen analysis of the product was as follows :

Size of aperture (mm)	% of product
Through 6·00	100
On 4·00	26
On 2·00	18
On 0·75	23
On 0·50	8
On 0·25	17
On 0·125	3
Through 0·125	5

What would be the power necessary to crush 1 kg/s of a material of compressive strength 45 MN/m^2 from a feed minus 45mm, plus 40 mm to a product of average size 0·5 mm ? 4 + 8

5. a) Discuss the principle and operation of a ball mill. What is critical speed of a ball mill ? Derive an expression for it.
- b) Derive an expression for the angle of nip for a smooth-roll crusher. (4 + 1 + 3) + 4



MODULE – III

6. a) Derive an expression for the terminal settling velocity for a spherical particle settling in the Stoke's Law regime. Differentiate between free and hindered settling.
- b) It is desired to separate quartz particles from galena particles by differential settling. A hydraulic classifier is employed under free settling conditions at 20°C. Specific gravity of quartz and galena at this temperature are 2.65 and 7.5 respectively. The original mixture of particles has a size-range from 0.00052 to 0.0025 cm. Three fractions pure quartz, pure galena and a mixture of quartz and galena are obtained after classification. What are the size-ranges of the two substances in the mixed fraction ? (5 + 2) + 5
7. a) Explain the utility of baffles in agitated vessels.
- b) State the significance of power number and Froude number in connection with agitation operation.
- c) A solution of viscosity 2 cP is being agitated by a turbine running at 100 rpm so as to obtain a Reynold's number of 50000. If the contents of the vessel are replaced by a solution of viscosity 4 cP and the rpm is changed to 200, by how much will the power requirement change ? Assume that the density of the solution remains same in both cases.
- d) Explain mixing effectiveness and mixing index.

3 + 2 + 3 + 4

**MODULE – IV**

8. a) Discuss the principle and operation of a rotary drum filter with the help of a neat diagram.
- b) What are filter aids ?
- c) What should be the characteristics of a good filtering medium ? 7 + 2 + 3
9. A slurry is filtered in a plate and frame press containing 12 frames, each 0.3 meter square and 25 mm thick. During the first 180s the pressure difference for filtration is slowly raised to the final value of 400 kN/m^2 and, during this period, the rate of filtration is maintained constant. After the initial period, filtration is carried out at constant pressure and the cakes are completely formed in a further 900 s. the cakes are then washed with a pressure difference of 275 kN/m^2 for 600 s using thorough washing. What is the volume of filtrate collected per cycle and how much wash water is used ?

Data :

A sample of the slurry had previously been tested with a leaf filter of 0.05 m^2 filtering surface using a vacuum giving a pressure difference of 71.3 kN/m^2 . The volume of filtrate collected in the first 300 s was 250 cm^3 and after a further 300 s, an additional 150 cm^3 was collected. It may be assumed that the cake is incompressible and that the cloth resistance is the same in the leaf as in the filter press. 12
