MECHANICAL OPERATION
(CHEN 2101)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

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

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) Which of the following terminology is not used for size reduction of materials to fine powders?
(a) Comminution (b) Dispersion
(c) Pulverisation (d) Compression.

(ii) Kick's law assumes that the energy required for size reduction is proportional to the logarithm of the ratio between the initial and the final diameters. The unit of Kick's constant is
(a) KW.sec/kg (b) KWh/kg
(c) KWh/sec.kg (d) kg/sec.

(iii) Energy requirement (per unit mass of material crushed/ground) is highest for
(a) jaw crusher (b) rod mill
(c) ball mill (d) fluid energy mill.

(iv) The power number for a stirred tank becomes constant at high Reynolds number. In this limit, the variation of power input with impeller rotational speed (N) is proportional to
(a) N^0 (b) N^1 (c) N^2 (d) N^3.

(v) Cyclone separator is generally used for
(a) Liquid liquid separation (b) Gas solid separation
(c) Gas liquid separation (d) Solid liquid separation.

(vi) Which of the following gives the crushing energy required to create new surface?
(a) Taggart's rule (b) Kick's law
(c) Rittenger's law (d) Bond's law.

(vii) Which of the following conveyors cannot be recommended for transportation of abrasive materials?
(a) Belt conveyor (b) Apron conveyor
(c) Flight conveyor (d) Chain conveyor.

(viii) Spitzkasten is a
(a) Classification equipment (b) Flotation equipment
(c) Size reduction equipment (d) Filtration equipment.

(ix) Solid particles of different densities are separated by
(a) Filters (b) Sorting classifier
(c) Rotary drum filters (d) Thickeners.

(x) Sedimentor is called clarifier when desired product is
(a) Concentrated sludge (b) Suspended slurry
(c) Clear liquid (d) Compressed slurry.

Group – B

2. Powder coal with following screen analysis is fed to a vibrating 48 mesh screen. The particle size distribution data of feed, oversize, and under size is shown in the table. Determine (i) effectiveness of the screen, taking oversize as the product and taking undersize as the product, (ii) ratio of quantity oversize and quantity undersize to feed.

Mesh No.	% Mass feed fraction	Fraction retained oversize	Fraction retained under size
4	0.017	0.18	0
6	0.0235	0.033	0
8	0.0672	0.088	0
10	0.0864	0.112	0
14	0.1087	0.142	0
20	0.1759	0.29	0
28	0.1397	0.18	0
35	0.1077	0.104	0.1195
48	0.1013	0.065	0.2198
65	0.0746	0.025	0.2391
100	0.0501	0.002	0.1827
150	0.033	0	0.1427
200	0.0212	0	0.0912

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3. (a) Define sphericity. Describe size reduction and what are the machines commonly used for it.

(b) What is the difference between Martin and Feret particles average diameter? What are ideal and actual screens?

(c) What does mesh size mean? Write a short note on fluidized bed dryer.

(2 + 2) + (3 + 2) + 3 = 12

Group – C

4. (a) What are the laws of comminution? What are the limitations of Kick's law and Rittenrger's law?

(b) Describe the three laws of comminution using a single differential equation.

(3 + 2 + 2) + 5 = 12

5. (a) Describe the working and salient features of Gyratory crusher and Hammer mill with sketches.

(b) What is the power required to crush 150 ton/h of limestone if 85% of the feed passes through a 2 inch screen and 85% of product through a 1/8 inch screen?

(3 + 3) + 6 = 12

Group – D

6. (a) Derive the expression for terminal velocity of a rigid spherical particle through a stagnant fluid.

(b) State the significance of power number, Froude number, Reynolds number in connection with agitation operation.

(c) Briefly state Kynch theory.

5 + 5 + 2 = 12

7. (a) Calculate the minimum area and diameter of a thickener with a circular basin to treat a slurry consisting of 4% by weight of solids (specific gravity = 2.5). Feed to the clarifier is 4000 m^3 per day. The underflow contains 10% solids. A batch sedimentation test on the feed material gave the following information:

Time (min)	0	5	12	24	40	70	250	α
Height of interface (cm)	40	25	15	8	5	3	1.8	1.7

(b) Describe the effect of system geometry on power correlation

8 + 4 = 12

Group – E

8. (a) Compare compressible and incompressible cakes.

(b) Discuss the principle and operation of rotary drum filter with the help of a neat flow diagram.

5 + 7 = 12

9. A leaf filter with 1.0 m^2 of filtering surface operated at a constant pressure of 1.8 bar gave the following results:

Filtrate volume (m^3)	3.99	6.09	7.65	9.63	11.33
Time (min)	10	20	30	45	60

The original slurry contained 10% by weight of sodium calcium carbonate (specific gravity = 2.72) in water and the cake formed is essentially incompressible. Determine the time required to wash the cake formed at the end of 70 minutes of filtering at the same pressure using 3.0 m^3 of wash water.

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