



Final Assessment Test – November/December 2023

Course: **BCHE301L - Mechanical Operations**

Class NBR(s): **1571**

Slot: **F2+TF2**

Time: **Three Hours**

Max. Marks: **100**

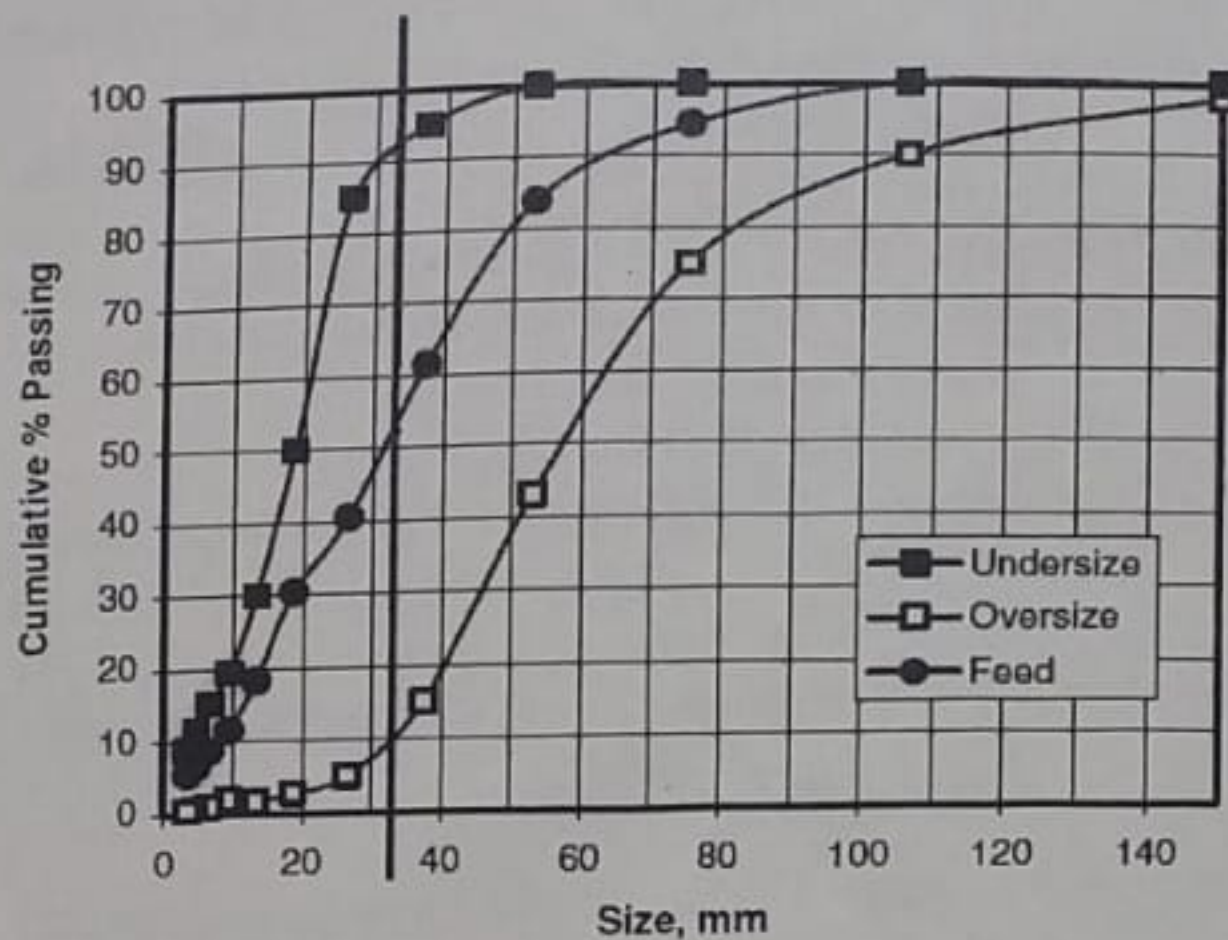
KEEPING MOBILE PHONE/SMART WATCH, EVEN IN "OFF" POSITION, IS TREATED AS EXAM MALPRACTICE

General Instruction: Assume any missing data if necessary. Please provide graph sheets.

Answer any TEN Questions

(10 X 10 = 100 Marks)

1. a) Define Sphericity and calculate the Sphericity of a cubical particle having dimensions 2x2x2 cm. [5]
b) Discuss different types of transportation equipment for transporting solid materials. [5]
2. Derive an expression for stresses acting on a silo by considering all the forces with necessary assumptions.
3. A material is crushed in a Blake jaw crusher and the average size of particles is reduced from 5 cm to 1.3 cm with a consumption of $37 \frac{\text{watt hour}}{\text{metric ton}}$. What will be the consumption of energy to crush the same material of average size 8 cm to an average size of 3 cm? Assume that the mechanical efficiency remains unchanged. Use Rittinger's law and Kick's law for estimating the energy consumption.
4. A certain set of crushing rolls has rolls of 100 cm diameter by 38 cm width face. They are set so that the crushing surfaces are 1.25 cm apart at the narrowest point. The manufacturer recommends that they must be run at 50 to 100 rpm. They are used to crush a rock having a specific gravity of 2.35, and the angle of nip is 30°. What are the maximum permissible size of the feed and the maximum actual capacity in tone per hour, if the actual capacity is 12 percent of the theoretical?
5. a) Define screening effectiveness and derive an expression for effectiveness of a screen. [5]
b) A gold ore is screened through a 30 mm screen. The average size distribution of the feed, oversize and undersize were determined and graphed below. Determine the effectiveness of the screen. [5]



6. An analysis was made for flue gas released from a chemical process industry. It shows that flue gas contains the following compounds: particulate matter of $25\text{ }\mu\text{m}$ to $50\text{ }\mu\text{m}$, oxides of sulphur, nitrogen, carbon and a trace amount of hydrocarbons. Being a Chemical Engineer, select a suitable equipment to remove the contaminants from the flue gas and explain their principles with neat sketches.
7. A conventional cyclone with a diameter of 1.0 m and width 0.25 m is to be used to separate particulate matter of density 1500 kg/m^3 from standard air at a flow rate of $2\text{ m}^3/\text{s}$. An analysis of the particles yielded the following size distribution. Consider viscosity of air as $18.6\text{ }\mu\text{Pa}\cdot\text{s}$ and effective number of turns within cyclone as 6. Calculate the overall separation efficiency.

Size, μm	3.0	6.0	10.0	20.0	40.0	80.0	140.0	200.0
Weight fraction	0.03	0.08	0.15	0.33	0.60	0.85	0.96	0.99

8. Define terminal settling velocity and derive an expression for terminal settling velocity of a particle under Stoke's law and Newton's law range.
9. In a mixture of quartz (specific gravity = 2.65) and galena (specific gravity = 7.5), the size of the particles range from 0.00052 cm to 0.0025 cm . On separation in a hydraulic classifier with water as medium, under free settling streamline conditions, three fractions are obtained: one consisting of only quartz, one of only galena and one a mixture of quartz and galena. Estimate the ranges of particle sizes of the two substances in the mixed portion.
10. A slurry consists of 2% by weight of solids (specific gravity = 2.5) is to be clarified by continuous sedimentation. Feed to the clarifier is $5000\text{ m}^3/\text{day}$. The underflow

contains 10% solids. Determine the cross sectional area of thickener. The batch sedimentation data is as follows:

t (min)	0	5	12	24	40	70	250	infinity
H (cm)	40	25	15	8	5	3	1.8	1.7

11. For a sludge filtered in a washing plate and frame, the filtration equation $V^2 = kt$ holds good, where V is the volume of filtrate obtained in time t . When the pressure is constant, 30 m^3 of filtrate is obtained in 10 hours. Calculate the washing time if 3 m^3 of wash water is forced to the cake at the end of filtration. If the filtering area is doubled keeping all other things constant, how long it would take to obtain 30 m^3 of filtrate. Consider the rate of washing is one-fourth of final rate of filtration.
12. A flat blade turbine with six blades is installed centrally in a vertical tank. The tank is 1.83 m in diameter; the turbine is 0.61 m in diameter and is positioned 0.61 m from the bottom of the tank. The tank is filled to a depth of 1.83 m with a solution of 50% caustic soda which has a viscosity of 12 cP and a density of 1.5 g/cc. The turbine is operated at 90 rpm. The tank is fitted with four baffles, each having a width of 19 cm. What will be the power consumption for the operation of the baffled mixer?

Data:

N_{Re}	ϕ
10,000	5.8
60,000	6.0
80,000	6.0

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