Subject Code: ICH401 Roll No.:

B.TECH.
(SEM IV) EVEN SEMESTER EXAMINATION 2025-26
MECHANICAL OPERATIONS

[TIME: 3 hrs.] [Max. Marks: 70]

Note: *Attempt All Questions. All Question carry equal marks.*

		Marks
Q1.	Answer ALL parts.	
(a)	Define mesh number and mesh size,	3.5
(b)	What do you understand by differential analysis and cumulative analysis of particle size?	3.5
(c)	Calculate the Sauter mean diameter for material of the following size distribution.	3.5

Wt.% of material	0	3	8	16	90	97	100
With diameter smaller than d*p* (μ)	10	20	30	40	80	100	150

(d) Find the sphericity of a solid particle of cuboid whose length, width, and depth are in the ratio of 3:2:1. 3.5

OR

Size analysis was carried out on a sample a given method. The data for mass fraction xi and average particle diameter is given below. Calculate the volume mean diameter.

Xi	0.2	0.4	0.6
Dpi	5	10	12

Q2. Answer ALL parts.

(a) A sample is crushed in a crusher such that average size of particle is reduced from 50mm to 10mm with energy consumption of 10KWsec/kg. Find out the consumption of energy to crushed the same material from 75mm to 25mm average size using Kick's and Rittinger's law. 7

(b) What is bonds law of crushing and when it is used? Derive the expression and explain the role of work index. 7

OR

Explain in brief jaw crusher with diagram and also draw and distinguished its types.

Q3. Answer ALL parts.

(a) Calculate the settling velocity of the glass sphere having a diameter of 1.554×10^{-4} m in water at 20°C. The slurry contains 60wt.% of solids. The density of the glass spheres is 2467kg/m^3, viscosity of water 998kg/m^3, viscosity of water is 1.005×10^{-3} Pas. 7

(b) Explain and derive the terminal velocity of free-falling spherical particles in laminar flow. 7

OR

What are the methods of particles segregation on the behalf of size and density?

Q4. Answer ALL parts.

(a) A plate and frame filter press contains 20 frames, each of 0.6m by 0.6m inside dimensions. The frames are 0.025m thick. The press is equipped with 1 and 3 bottom plates for washing. The volume of wash water used is 10% of the filtrate per cycle. The time required for filtering at constant pressure is 2hours by which time the frames are full. Washing is done at the same pressure as filtering and the viscosity of wash water is nearly the same pressure as filtering and the viscosity of wash water is nearly the same as that of filtration. What is the time for washing? There is 0.05m^3 of final cake per m^3 of the filtrate. Neglect the filter medium resistance. 7

(b) What are different types of fluidizations? Explain the particulate and aggregative types of fluidizations. 7

OR

What are different types of method for filtration? Explain any one in brief (the principle and working) with the help of neat diagram and also with equation.

Q5. Answer ALL parts. 7

(a) Classification of conveyer selection and their performance.

(b) Write differences between Turbines and Paddles.

OR

Explain about the term Mixing and Agitation. Write three general classes of desired results of mixing of material.

Institute of Engineering &Technology, Lucknow

Department of Chemical Engineering

Date : 27/02/202 **Mechanical operations (ICH 401) CT-I** **MM-20**

Q1. Derive and explain the sphericity. Find out the sphericity of cuboid whose length, width and depth are in ratio of 3:2:1.

Q2. The following table gives the size distribution of a dust as measured by a microscopic. Convert these figures to obtain a distribution on mass basis and calculate the specific surface. Assuming spherical particles of specific gravity 2.65.

Size range (microns)	0 - 2	2 - 4	4 - 8	8 - 12	12 - 16	16 - 20	20 - 24
No. of particles	2000	600	140	40	15	5	2

Q3.Derive the generalized relation of laws of size reduction.

Q4. Calculate the energy required to crush 100 tonnes/hr of limestone if 80% of the feed passes through a screen 3.75 cm aperture and 80% of the product passes through a screen with 0.03cm aperture. The work index for limestone is 12.74, when the capacity is expressed in tonnes/hr, energy required in HP and size of feed and product in feet.

DEPARTMENT OF CHEMICAL ENGINEERING, I.E.T LUCKNOW

Mechanical Operation (ICH 401) 2ND CT

Course:B.Tech

Duration: 1 hrs

Date 17/4/2026

MM: 20

Attempt all questions

1	Explain and derive the terminal velocity for free settling under laminar flow	5
2	What is the terminal velocity in m/s , calculated from stokes law, for a particle of diameter 0.1×10^{-3}m, density 2800kg/m^3 settling in water of density 1000kg/m^3 and viscosity 10^{-3}kg/ms (g= 10m/s.)	5
3	Draw neat figure and differentiate two types of filtration mechanism's -cake filtration and deep bed filtration.	5
4	Explain the Entrainment and Elutriation in a fluidized bed.	5

ject Code: ICH -401 Roll No.:

B.Tech.

(SEM IV) EVEN SEMESTER EXAMINATION 2024-25

MECHANICAL OPERATIONS

[TIME: 3 hrs.] [Max. Marks: 70]

Note: *Attempt All Questions. All Question carry equal marks.*

Q1. Answer ALL parts. Marks

(a) Derive the expression for Sauter Mean Diameter 3.5

(b) What is Nominal diameter and how do we calculate the Nominal diameter. 3.5

(c) The following table gives the size distribution of a dust as measured by microscope. Convert these figures to obtain a distribution on mass basis and calculate the specific surface assuming spherical particles of specific gravity 2.65. 3.5

Size range (micron)	0 - 2	2 - 4	4 - 8	8 - 12	12 - 16	16- 20	20 - 24
No .of particles	2000	600	140	40	15	5	2

(d) Find the sphericity of a solid particle of cuboid whose length, width, and depth are in the ratio of 3:2:1 3.5

OR

Size analysis was carried out on a sample a given method. The data for mass fraction xi and average particle diameter is given below. Calculate the volume mean diameter.

Xi	0.2	0.4	0.6
Dpi	5	10	12

Q2. Answer ALL parts.

(a) A sample is crushed in a crusher such that average size of particle is reduced from 50mm to 10mm with energy consumption of 10KWsec/kg. Find out the consumption of energy to crushed the same material from 75mm to 25mm average size using Kick's and Rittinger's law. 7

(b) What is bonds law of crushing. Derive the expression and explain the role of work index. 7

OR

Explain and derive the expression for smooth roll crusher with diagram.

Q3. Answer ALL parts.

(a) A mixture of silica (B) and Galena (A) solid particles having a size range of 5.21×10^{-6} m to 2.50×10^{-5} m is to be separated by hydraulic classification using free settling conditions in water at 20°C . The 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 regions, the drag coefficients will be reasonably close to that for spheres. $\mu_{water} = 1.005 \times 10^{-3}$ Pa.sec. 7

(b) Explain and derive the terminal velocity of free-falling spherical particles in laminar flow. 7

OR

With the help of neat diagram, explain the principle and working of hydro-cyclone and indicate it operation.

Q4. Answer **ALL** parts.

(a) The $CaCO_3$ slurry in water at 25°C is to be filtered in a plate and frame press having 30 frame and $0.873m^2$ area per frame. The pressure 46.2 KN/m^2 will be used in constant pressure filtration process. The slurry concentration (weight of free solids in slurry) is 23.47 Kg solids/ m^3 filtrate. Specific cake resistance $\alpha = 1.095 \times 10^{11}$ m/kg
Filter medium resistance $Rm = 6.46 \times 10^{10}$ m^{-1} Calculate the time to recover 2.26 m^3 of filtrate. At the end, using through washing and 0.283 m^3 of wash water, calculate the time of washing and total filter cycle time if cleaning the press takes 30 min. $\mu = 8.937 \times 10^{-4}$ kg/m.sec

(b) What are different types of fluidizations? Explain the particulate and aggregative types of fluidizations.

OR

With the help of neat diagram, explain the principle and working of leaf filter.

Q5. Answer **ALL** parts.

(a) A helical screw has a diameter of 50cm and rotating at 80rpm in a solution of viscosity 140 poise and density of 0.95 gm/cm^3. Calculate the HP required.

(b) Write differences between Turbines and Paddles.

OR

Explain sink and float method with suitable example.