

**B.E. FOOD TECHNOLOGY AND BIO-CHEMICAL ENGINEERING SECOND YEAR
SECOND SEMESTER EXAM 2024**

MECHANICAL OPERATION

Time: 3hr

Full Marks: 100

Part-I (50 Marks)

(Use Separate Answer scripts for each Part)

GROUP-A

Answer any one question

1×5 = 5

- Briefly describe different types of sedimentation process.
- Define NPSH? What is the cause of cavity formation in pump? What are the difficulties due to cavity formation?

GROUP-B

Answer any three questions

3×15 = 45

- What the different zones are of class I sedimentation? What do you mean by fluidization velocity? Derive the equation for pressure drop per unit length of packed bed. Write the applications of fluidization process. 3+2+7+3 = 15
- (a) Define g value and centrifugation coefficient of centrifuge. What are the different types of centrifuge?
(b) Yeast cells are recovered from a fermentation broth by using tubular centrifuge. Sixty percent (60%) of the cells are recovered at a flow rate of 12 l/min with a rotational speed of 4000 rpm. Recovery is inversely proportional to flow rate.
(i) to increase the recovery of cells to 95% at the same flow rate, what should be the rpm of the centrifuge?
(ii) at a constant rpm of 4000 rpm, what should be the flow rate to result in 95% cell recovery? 5+10 = 15
- (a) Define terminal velocity. Derive the expression for terminal velocity under laminar condition.
(b) In a sedimentation process the column height is 1.8m, loading rate $25\text{m}^2/\text{d}/\text{m}^2$ and initial solid concentration 300 mg/L. the following results were obtained:

Time (min)	0	60	80	100	130	200	240	420
Concentration (mg/L)	300	189	180	168	156	111	78	27

Calculate the percentage solid recovery after 1hr 45 min. 6+9 = 15
- Derive the Ruth equation for filtration rate. Briefly describe different types of industrial filtration systems. 8+7 = 15
- Classify pumps with the help of a chart. Derive the fundamental equation for centrifugal pump. What are the different efficiencies of centrifugal pumps? 4+7+4 = 15

[Turn over

Ref. No.: Ex/FTBE/PC/B/T/226/2024

B.E. FOOD TECHNOLOGY AND BIO-CHEMICAL ENGINEERING

EXAM 2024 (2nd Year, 2nd Semester)

Subject: **MECHANICAL OPERATION (FTBE/PC/B/T/226)**

Time: Three hours

PART II

Full Marks: 50

Answer Q.No. 1(compulsory) and any two from the following:

Q.1.

5×2= 10

- (i) What will be the sphericity of a short size cylindrical particle having its length L equal to D ?
- (ii) Fill in the blanks to fulfill the following table of the screen analysis of a sample having density 6240 kg/m³ and $\phi_s = 0.678$

Mesh size	Screen opening(D_{pi} , mm)	Mass fraction retained(x_i)	Average particle diameter(mm)
6	3.327	0.000	-
8	2.362	0.674	?
10	1.651	0.321	?
Pan	-	?	?

- (iii) Estimate the specific surface of the mixture retained between mesh 6 and mesh 10?
- (iv) Estimate the volume mean diameter for the above problem?
- (v) What is the basic difference between a crusher and a grinder?

Q.2.

In a crushing operation, 500 kW is required to reduce the size from 3 inch in diameter to 1.5 inch in diameter @ feed rate of 250 tons/hr. Estimate the energy requirement to reduce the size from 3 inch in diameter to 1/2 inch for the same particle and the same feed rate? If the feed rate is suddenly increased to 25% then utilizing the same power what will be the fate of the final product, assume the feed size is 3 inch in diameter remains unaltered. Estimate the cost after increasing the feed rate assuming Rs.30/- per kW energy used for the crushing operation.

6+7+4+3 =20

Q.3. Write short notes on the following:

4×5 = 20

- (i) Screen analysis (ii) Ball mill (iii) Gyratory crusher (iv) Roll Crusher

Q.4.

The screen analysis shown in the following table applies to 100 gm sample of crushed material with density 7000 kg/m³ and sphericity (ϕ_s) = 0.792. For the material between 10 mesh to 20 mesh, calculate (i) A_w in m²/kg (ii) volume-surface mean diameter (in SI unit) (iii) No. of particles retained on mesh 14 (iv) Total no. of retained particles excluding pan

8+4+4+4 =20

Mesh size	Average particle diameter (mm)	Mass retained (gm)
8	2.845	0.00
10	2.007	52.6
14	1.409	36.75
20	1.001	10.15
Pan		0.5