Ref. No.: Ex/FTBE/PC/B/T/226/2025

B.E. FOOD TECHNOLOGY AND BIO-CHEMICAL ENGINEERING
SECOND YEAR SECOND SEMESTER EXAM 2025

MECHANICAL OPERATION

Full Marks: 100 Use separate answer scripts for each Part **Full Time: 3 hrs**

Part – I

GROUP-A

Answer any one question **1×10 = 10**

1. Define critical settling velocity and overflow rate in a sedimentation tank. Find the terminal settling velocity of a spherical discrete particle with diameter 0.5 mm and specific gravity of 2.65 settling through water at 20^0C. $\rho_w = 998.2$ kg / m^3; $\mu = 1.002 \times 10^{-3}$ Ns/m^2. 4+6 = 10
2. Write short note on flocculation process. Briefly describe the different types of sedimentation tanks. 4+6 = 10

GROUP-B

Answer any two questions **2×20 = 40**

3. (a) Derive Ruth equation for filtration of incompressible suspension.
   (b) Gentamycin crystal are filtered through a small test filter medium with a negligible resistance. The following data were obtained:

t (sec)	10	20	30	40
V (l)	0.6	0.78	0.95	1.1

The pressure drop in this test run was 1.8 times that when water was used with a filter area of 100 cm^2. The concentration of gentamycin in solution is 5g/l. How long would it take to filter 5000 l of gentamycin solution through a filter of 1.5 m^2, assuming the pressure drop is constant and $\mu = 1.2$ centipoise? 8+12 = 20

4. (a) Briefly describe the different types of settling processes.
   (b) A settling analysis is run on a Type 1 suspension in a laboratory column with a port 1.8m below the suspension surface. The data obtained are shown below.

Time (min)	0	3	5	10	20	40	60
TSS (mg/l)	200	116	98	75	35	10	2

What will be the theoretical removal efficiency in a settling basin for an overflow of 432 m^2/m.day? 8+12 = 20

5. (a) Derive the equation for settling velocity.
   (b) How do you calculate total solid removal percentage in a sedimentation tank for Type 2 sedimentation process? 8+12 = 20

[Turn over

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B.E. FOOD TECHNOLOGY AND BIO-CHEMICAL ENGINEERINGEXAM 2025 (2nd Year, 2nd Semester)

Subject: MECHNICAL OPERATION (FTBE/PC/B/T/226)

Time: Three hours PART II **(50 Marks)** Full Marks:100

Use separate answer scripts for each Part

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

Q.1. 5×2= 10

(i) What is sphericity? What do you mean by a sphericity of a particle equals to 0.682?

(ii) Fill in the blanks to fulfill the following table of the screen analysis of a sample having density 6240 kg/m3 and $\varphi_s = 0.678$

Mesh size	Screen opening(D_{pi}, mm)	Mass fraction retained(x_i)	Average particle diameter(mm)
6	3.329	0.000	?
8	2.361	0.727	?
10	1.651	?	?
Pan	-	0.009	?

(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, 150 kW is required to reduce the size from 3.54 inch in diameter to 1.5 inch in diameter @ feed rate of 100 tons/hr. Estimate the energy requirement to reduce the size from 3 inch in diameter to 1 inch for the same particle and the same feed rate? If the feed rate is suddenly increased to 20% 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. If the product size is fixed before increasing the feed rate then what would be the necessary steps to be taken ? Estimate the cost of one day such continuous operation assuming Rs.30.6/- per kWhr 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) Crushing law (iii) Specific surface of mixtures (iv) Roll Crushers

Q.4. The screen analysis shown in the following table applies to 100 gm sample of crushed material with density 7200 kg/m^3 and sphericity (φ_s) = 0.825. For the material between 10 mesh to 20 mesh, calculate (i) A_w in m^2/kg (ii) volume-surface mean diameter (in SI unit) (iii) No. of particles retained on mesh 14 (iv) Volume mean diameter (in SI unit) . Assume shape factor to be equal to 0.784

8+4+4+4 =20

Mesh size	Average particle diameter (mm)	Mass retained (gm)
8	2.845	0.00
10	2.007	62.5
14	1.409	26.25
20	1.001	10.75
Pan	-	0.5