Reg. No. | | | | | | | | | | | | |

B.E./ B.TECH. DEGREE EXAMINATIONS, MAY 2023

Fourth Semester

CH18401 – MECHANICAL OPERATIONS

(Regulation-2018 / 2018A)

TIME:3 HOURS **MAX. MARKS: 100**

COURSE OUTCOMES	STATEMENT	RBT LEVEL
CO 1	Impart the basic knowledge on the solid handling characteristics and mixed particle size analysis through screening.	2
CO 2	Estimate the power requirement for various comminution through the Laws of size reduction; along with the design of size reduction equipments.	5
CO 3	Classify various solid separation techniques through settling and basic knowledge on such equipment design.	4
CO 4	Apply the principles of filtration, mixing, conveying and storage of solids with related calculations for design of such equipments.	3
CO 5	Select the mechanical operation equipments with and without involving fluid mechanics principles.	5

PART- A(10x2=20Marks)

(Answer all Questions)

		CO	RBT LEVEL
1.	Differentiate Ideal and Actual Screen.	1	2
2.	Define: Shape factor.	1	1
3.	The diameter of ball mill is 1100mm and it is charged with 80mm balls. Find the critical speed of the ball mill.	2	2
4.	List the four main principles involved in size reduction equipments.	2	2
5.	Outline about terminal settling velocity.	3	2
6.	Mention the forces acting on the fluid, when the solid particle is allowed to settle.	3	2
7.	State any two requirements of filter media.	4	2
8.	Classify filters on the basis of mechanism	4	2
9.	Distinguish between mixing and agitation with an example.	5	2
10.	Summarize the industrial applications of belt conveyors used in process industries.	5	2

PART- B (5x 14=70Marks)

			Marks	CO	RBT LEVEL
11. (a)		The screen analysis of crushed graphite sample is given below. The density of the particles is 2260 kg/m^3 and the shape factors are: a = 2 and ϕ_S = 0.65 For the material between 4 mesh and 200 mesh in particle size, Determine D_S, D_V, D_W and A_w in square millimeters per gram and Nw in particles per gram	(14)	1	3

Mesh No.	Screen Opening Dp_i (mm)	Cumulative mass fraction, Xi
4	4.699	0.0000
6	3.327	0.0250
8	2.362	0.1502
10	1.651	0.4790
14	1.168	0.7275
20	0.833	0.8860
28	0.589	0.9414
35	0.417	0.9616
48	0.295	0.9718
65	0.208	0.9795
100	0.147	0.9853
150	0.104	0.9894
200	0.074	0.9925
Pan	-	1.0000

(OR)

(b)	(i)	Develop an expression for screen effectiveness from basic material balance equation.	(7)	1	3
	(ii)	Explain in detail about vibratory screen with a neat sketch.	(7)	1	3
12. (a)	(i)	Explain the working principle of a crusher in which angle of nip is a deciding factor to crush the material and give its significance.	(7)	2	3
	(ii)	Describe the working and salient features of ball mill with neat sketch.	(7)	2	3

(OR)

(b)	(i)	A certain crusher accepts a feed of rock having a volume surface mean diameter 25mm and discharges a product of volume surface mean diameter 6mm. The power required to crush 4 kg/sec of the material is 8 kW. Calculate the power required if the capacity is reduced to 2.5 kg/sec and the volume surface mean diameter of the product is	(7)	2	3

changed to 4mm. Assume the mechanical efficiency remains constant and Rittinger's law holds good.

	(ii)	In a certain jaw crusher, it is necessary to apply a maximum force of 20 tons at a point of toggle block. The toggle block is 135 cm from the pivot. The angle between pitman and toggle bar is 80° maximum. Determine the force on the pitman when the moving jaw is closer to the fixed jaw? Also determine the force on the particle at a distance of 35 cm from the pivot.	**(7)**	**2**	**3**
13. (a)	**(i)**	A mixture of silica (Sp.gr. 2.56) and galena (Sp.gr. 7.5) particles ranging from sizes of 0.0068 cm to 0.0562 cm are to be separated by a rising stream of water. Determine the velocity of water flow will give an un-contaminated product of galena and the size range of product?	**(7)**	**3**	**3**
	(ii)	A falling ball viscometer operates by timing the fall of a steel ball with a diameter of 0.45 cm and density of 9000 Kg/m^3. The steel ball falls a distance of 40 cm. Determine the viscosity of oil if the time of fall is 5 sec. Justify the selection equation. Density of oil = 900 Kg/m^3	**(7)**	**3**	**3**
		(OR)			
(b)	**(i)**	Derive the one dimensional terminal settling equation at various ranges of particle Reynolds number.	**(7)**	**3**	**3**
	(ii)	With a neat sketch explain the working of Dorr thickener and its applications in various industries.	**(7)**	**3**	**3**
14. (a)		Develop the following Kozeny-Carman equation as a starting point to find the overall pressure drop through filter cake.	**(14)**	**4**	**4**

$$\frac{\Delta p}{L} = \frac{150\overline{V}_0\mu}{g_c\Phi_s^2 D_p^2}\frac{(1-\varepsilon)^2}{\varepsilon^3}$$

(OR)

(b)	**(i)**	Analyse the equipment using high static electrical potential difference to separate dust particles from industrial emissions.	**(7)**	**4**	**4**

	(ii)	Suggest a filter working under high pressures and minimum labor requirement with neat sketch.	**(7)**	**4**	**4**
15. (a)	**(i)**	Indicate the various types of impellers and explain any two in detail.	**(7)**	**5**	**4**
	(ii)	Analyse the methods involved in prevention of swirling.	**(7)**	**5**	**4**
		(OR)			
(b)	**(i)**	Explain in detail with neat sketch about bin, hopper and silo.	**(7)**	**5**	**4**
	(ii)	With a neat sketch explain chain and pneumatic conveyors.	**(7)**	**5**	**4**

PART- C (1x 10=10Marks)
(Q.No.16 is compulsory)

		Marks	**CO**	**RBT LEVEL**
16.	A flat blade turbine is installed centrally in a vertical tank. The tank is 3.0 m in diameter, the turbine is 1.0 m in diameter and is positioned 1.0 m from the bottom of the tank. The turbine blades are 160 mm wide. The tank is filled with a depth of 3.0 m with a solution of 75% caustic soda at 60.3°C, which has the viscosity of 12cP and a density of 1498 kg/m^3. The turbine is operated at 75 rpm. (a) Determine the power will be required to operate the mixer if the tank was baffled. Assume K_T = Np = 5.8 (b) Also evaluate power will be required to operate the mixer if the tank was unbaffled. Take Np = 1.05	**(10)**	**5**	**5**