Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

A Constituent Institution of Manipal University

III SEMESTER B.TECH (CHEMICAL ENGINEERING)

END SEMESTER EXAMINATIONS, NOVEMBER 2018

SUBJECT: MECHANICAL OPERATIONS [CHE 2103]

REVISED CREDIT SYSTEM

Time: 3 Hours (29/11/2018 FN) Max. Marks: 50

Instructions to Candidates:

- **Answer all the questions.**
- **Each questions carry equal marks (5 X 10 = 50).**
- **Missing data, if any, may be suitably assumed.**
- **Write specific and precise answers, Usual notations shall apply.**

1A. (i) State the difference between ideal and actual screen (any 4 points). **[01]**

(ii) Define Sphericity (ϕ_s) of solid particles. Derive an expression to determine the specific number of particles (A_w) in the sample mixture. **[03]**

1B. 3 tons/hr of dolomite is produced by crushing and screening through a 24 mesh screen from the screen analysis shown below. Calculate the overall effectiveness of the screen and total feed of the crushed material. **[06]**

Mesh No		4	8	14	28	48	100	150
Screen size opening, cm		0.4699	0.2362	0.1170	0.0589	0.0295	0.0147	0.0104
Weight retained (%)	Feed	14.3	20	20	28.5	8.6	5.7	2.9
	Overflow	20	28	28	24	------	------	------
	Underflow	------	------	10.5	29.5	30	20	10

2A. (i) Explain the principle, construction and working operation of Jaw crusher with neat sketch. **[03]**

(ii) Derive an equation to determine the power (P) required for crushing based on crushing efficiency (η_c). **[2.5]**

2B. (i) In a crushing operation a 5 mm feed was reduced in size such that 80% of product passes through 0.5 mm screen. Now it is desired to alter the product size such that the 80% of product passes through 0.2 mm screen with the same feed size. What is the percentage increase in power consumption? **[2.5]**

(ii) Calculate the operating speed of the ball mill from the data given below. The diameter of the ball mill is 800 mm and diameter of the balls are 60 mm. (a) If the operating speed is 55% less than the critical speed (b) If the critical speed is 40% more than the operating speed. **[02]**

3A. (i) Compare and contrast between classifier and clarifier. **[01]**

(ii) Obtain an entire expression to determine the terminal settling velocity (U_t) of spherical particle settle in a low viscous medium with its suitable assumptions. **[06]**

3B.	Draw a neat sketch and explain the construction and working operation of Hydraulic Jigging.	**[03]**
4A.	Derive an equation to determine the speed (N) of rotary drum vacuum filter for the formation of compressible cake. Explain the importance of filter aids in filtration operation with examples.	**[05]**
4B.	A slurry of 2.15% by weight calcium carbonate ($CaCO_3$) in water is filtered at constant pressure drop in a laboratory scale leaf filter. The filter area was 0.25 m^2 and the ratio of mass of wet cake to dry cake was 1.438. The pressure drop across the filter is 360 mm Hg and the filtrate viscosity is 1 mN-sec/m^2. At the end of 20 minutes 32 liters of filtrate were collected. After filtration the cake was washed with wash water. (i) Calculate the specific cake resistance (ii). What size filter is required to process 4000 liters of feed slurry in 30 min at a pressure drop of 360 mm Hg. Assume that filter medium resistance is negligible. Assume that the density of calcium carbonate and water are is 2.63 and 1 g/cc, respectively.	**[05]**
5A.	Describe in detail about the following with neat sketch (i) Muller mixer. (ii) Various types of flow patterns in an agitated vessel with swirling and vortex formation.	**[02]** **[03]**
5B.	(i) Explain the significance of centrifugation factor during the separation of fine particles in a centrifugation operation. (ii) A tubular bowl centrifuge is used to separate small fine quartz particles. The bowl of this unit has a radius of 12.7 cm and length of 73 cm. The speed of the bowl is 16,000 rpm and the volumetric capacity is 200 liters/hr. Under these conditions, this centrifuge works well. (a) Calculate the effective diameter of the quartz particles in the suspension. The density difference between the fine particles and the liquid was 0. 25 g/cc, and the viscosity of the liquid is 1.1 cp. (b) The same centrifuge is used to separate very small fine size of same particles in another liquid suspension. The particle size is about ½ of the original small fine particles and the viscosity of another liquid suspension is 4 times higher than original liquid solution. Estimate the volumetric capacity of this same centrifuge operating under these new conditions? Assume that the centrifuge operates at the same speed and efficiency.	**[01]** **[04]**

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