Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

A Constituent Institution of Manipal University

III SEMESTER B.TECH (CHEMICAL ENGINEERING)

END SEMESTER MAKEUP EXAMINATIONS, DECEMBER 2017

SUBJECT: MECHANICAL OPERATIONS [CHE 2103]

REVISED CREDIT SYSTEM

Time: 3 Hours (30/12/2017 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. Define Sphericity (ϕ_s) of solid particles. Derive an expression to determine the specific number of particles (N_w) in the sample mixture. **[01] [03]**

1B. 2 tons/hr of fine particle dolomite is produced by crushing and screening through a 20 mesh screen. The screen analysis data is 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
Aperture (cm)		0.4699	0.2362	0.1168	0.0589	0.0295	0.0147	0.0104
W	F	14.3	20	20	28.5	8.6	5.7	2.9
	O/F	20	28	28	24	----	----	----
	U/F	----	----	10.5	29.5	30	20	10

where W = weight % retained ; F = Feed; O/F = Overflow; U/F = Underflow

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

(ii) How to determine the efficiency (η_c) of the crushed material? State the difference between open and closed-circuit grinding with neat flow sheet. **[01] [02]**

2B. Granite is being crushed in roller crusher. The average size of the feed is 1.5 cm and the differential screen analysis is given below. **[04]**

A	4/6	6/8	8/20	20/48	48/65	65/150	150/200
B	3215	1197	995	326	206	185	100
C	470	246	24	82	72	42	64

Where A: Mesh No; B: Average particle size (μm); C: Weight retained (gm)

The Rittinger's law constant (K_R) is 10 J-m/kg. Calculate the power required to crush 1 ton/hr of the material.

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

(ii) Write the various steps with plot to determine the maximum cross sectional area of continuous thickener. **[02]**

(iii) Draw a neat sketch and explain the construction and working operation of Hydraulic Jigging. **[03]**

3B.	Estimate the terminal settling velocity for 80-to-100 mesh particles of limestone (density = 2800 kg/m^3) falling in water at 30°C. The density and viscosity of water at 30˚C are 995.7 kg/m^3 and 0.801 mpa-sec respectively. The particle diameter of limestone for 80 mesh is 0.175 mm and 100 mesh is 0.147 mm. How much higher would the velocity be in a centrifugal separator where the acceleration is 50 g?	**[04]**
4A.	Explain the construction, working operation, advantages and limitation of continuous rotary drum vacuum filter with neat sketch. Mention any four important characteristics of filter medium.	**[05]**
4B.	Laboratory filtration was conducted at constant pressure drop and a slurry of $CaCO_3$ in water. The filter area was 0.25 m^2 and the mass of solids deposited per unit volume of filtrate was 22 gm/lit. The pressure drop across the filter is 360 mm Hg and the filtrate viscosity is 1 mNsec/m^2. At the end of 20 minutes 32 liters of filtrate were collected. After that filtration was stopped. It is desired to wash the cake with wash water (i) Calculate the specific cake resistance (ii). What size filter is required to process 4000 lit of feed slurry in 30 min at a pressure drop of 360 mm Hg. Assume that filter medium resistance is negligible.	**[05]**
5A.	Describe in detail about the following with neat sketch (i) Ribbon blender. (ii) Swirling, vortex formation and its prevention.	**[05]**
5B.	(i) Derive an expression to determine the maximum possible volumetric flow rate of liquid (Q) fed in a tubular bowl centrifuge with an expression of centrifugation coefficient. (ii) Small particles with diameter 10^{-2} mm and density 1.03 g/cc are suspended in liquid of density 1.00 g/cc. The viscosity of the liquid is 1.25 cp. A tubular bowl centrifuge of length 70 cm and radius 11.5 cm is used to separate the small fine particles. If the centrifuge is operated at 10,000 rpm, estimate the feed flow rate at which the small particles are remove from the suspension? Assume that the distance between axis of rotation to particle location at the end residence time and distance between axis of rotation to wall of the centrifuge bowl are same.	**[03]** **[02]**

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