Reg. No.										

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

III[rd] SEMESTER B.TECH (CHEMICAL ENGINEERING)

END SEMESTER EXAMINATIONS, NOV/DEC 2015

SUBJECT: MECHANICAL OPERATIONS [CHE 2103]

REVISED CREDIT SYSTEM

Time: 3 Hours Max. Marks: 100

Instructions to Candidates:

- **Answer all the questions.**
- **Each questions carry equal marks(5 X 20 = 100).**
- **Missing data, if any, may be suitably assumed.**
- **Write specific and precise answers, Usual notations shall apply.**

1A. Define 'Sphericity Φ_s'. Derive an expression to determine the specific surface area (A_w) of particle in the sample mixture. **[08]**

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. **[12]**

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 construction and working operation of fluid energy mill with neat sketch. **[06]**

(ii) Derive an equation to determine the critical speed (N_c) of the ball mill. **[06]**

2B. Explain the theory of sedimentation and deduce the relationship between the concentration of solid in rate limiting layer (C_L) and initial concentration of solid in slurry (C_o). **[08]**

3A. (i) Compare and contrast between classifier and clarifier. List out any 4 names of classifier. **[04]**

(ii) Draw a neat sketch and explain the construction and working operation of 'cyclone separator'. **[06]**

3B. The particles of sphalerite are settling under the force of gravity in water at 30˚C. The sphalerite particles are spherical in shape and has a density of 4000 kg/m^3, size 0.1016 mm. The volume fraction of sphalerite in water is 0.2. A 3,00,000 lit cylindrical stirred tank is used to separate sphalerite particles. The stirrer is stopped and then the quartz particles are allowed to settle. The tank has a liquid height to diameter ratio of 1.5. Estimate the settling time by assuming that these sphalerite particles settles under hindered settling condition with constant n = 4.2. Assume that the density and viscosity of water is 1 g/cc, 1 cp respectively. **[10]**

4A.	(i) Explain the significance of filter aids during filtration operation. Give the examples of filter aids?	**[03]**
	(ii) Explain the construction, working operation and advantages of plate and frame filter press with neat sketch. Mention any four important characteristics of filter medium.	**[09]**
4B.	A rotary drum vacuum filter with drum diameter 1.5m and filter width 1.2m is used to filter starch from an aqueous slurry. The pressure drop is kept constant at 4.5 psi. The filter operates with 30% of the filter cloth submerged. Resistance due to filter medium is negligible. Laboratory test with a 5 cm^2 filter have shown that 500 ml slurry can be filtered in 23.5 min at a pressure drop of 12 psi. The starch cake was also found to be compressible with cake compressibility factor S = 0.57.(1 psi = 6.894 x 10^3 N/m^2) (i) Evaluate $\alpha_o \mu \rho_o$ from the laboratory test data. (ii) What volume of filtrate must be filtered per revolution to achieve the desired rate of 20 m^3/hr and also calculate the time required per revolution used for cake formation.	**[08]**
5A.	Describe in detail about the following with neat sketch	
	(i) Muller mixer.	**[05]**
	(ii) Prevention of swirling and vortex formation.	**[05]**
5B.	(i) Derive an expression to determine the maximum possible volumetric capacity of tubular bowl centrifuge.	**[05]**
	(ii) A Tubular bowl centrifuge is used to separate very fine particle from the feed stream and it is rotating at a speed of 12000 revolution/min. The centrifuge treats 3 lit per min of feed solution with satisfactory results. It is proposed to use the same centrifuge to separate contaminant particle from the effluent process stream. If the average size of the contaminant is one third that of the very fine particles and viscosity of the effluent process stream is the five times greater than fine particle in the feed stream. What flow rate can be handled, if the centrifuge is operated at the same speed? Assume that the density of both the particles were closely related.	**[05]**

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