Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

A Constituent Institution of Manipal University

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

END SEMESTER EXAMINATIONS, NOV/DEC 2016

SUBJECT: MECHANICAL OPERATIONS [CHE 2103]

REVISED CREDIT SYSTEM

Time: 3 Hours (02/12/2016) 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)'of solid particles. Derive an expression to determine the overall effectiveness of the screen. **[10]**

1B. Finely divided spherical particle of decolorizing carbon is used as an adsorbent for the removal of colour in dye effluent. The adsorbent particle has a density of 2.1 g/cc and the screen analysis is given below. Assume that the volume shape factor is 1.992. **[10]**

A	4	8	14	28	48	100	200
B	4.699	2.362	1.168	0.589	0.295	0.147	0.074
C	0	11.2	29.6	27.4	17.2	9.8	4.8

Where A = Mesh no; B = Screen opening (mm); C = Percentage retained (wt%)

Calculate the specific surface area of adsorbent particles in cm^2 per gm and specific number of particles present in the sample mixture by using differential analysis.

2A. (i) Explain the principle, construction and working operation of Hammer mill with neat sketch. **[06]**

(ii) Derive an equation to determine the power (P) required for crushing based on crushing efficiency (η_c). **[06]**

2B. (i) A ore is crushing on 2.5 cm to 0.025 cm in two steps. Step 1: 2.5 cm to 0.25 cm and Step 2: 0.25 cm to 0.025 cm. How do you expect the total energy consumption to be distributed between two steps, when calculated by using Rittingers law and Kicks law. Give your comments. **[04]**

(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. **[04]**

3A. (i) Write the various steps with plot to determine the maximum cross sectional area of continuous thickener. 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 sphalerite 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.	Derive an equation to determine the time required for filtering the solute for the formation of compressible cake in a filtration operation. Give the 2 examples for filter aids.	**[10]**
4B.	Feed slurry of crystals is filtered at constant pressure through a filtration medium consisting of a screen support mounted across the end of a Pyrex pipe. The resistance of the filter medium is negligible and the following data in a laboratory test is given Weight of crystals : 62 gm Pressure of filtration : 15 psi Filter diameter : 5.08 cm Cake volume : 253 cm^3 Filtration time : 163 min Calculate $\frac{\mu\alpha}{2\rho_0}$ in the laboratory test data ? The cake is essentially incompressible. On the basis of the laboratory test data, predict the number of frames (30 inch x 30 inch x 1 inch thickness) needed for a plate and frame filter press. Estimate the time required to filter the slurry for 63 kg crystal formed on the filter medium. In this calculations, assume that the feed pump will deliver 10 psi and that the filtrate from the press is to be reduced to 6.5 psi. (1 psi = 6.894 x 10^3 N/m^2)	**[10]**
5A.	Describe in detail about the following with neat sketch (i) Muller mixer. (ii) Swirling, vortex formation and its prevention.	**[05]** **[05]**
5B.	(i) For fine particles separation through centrifugation operation the ‘stokes region’ is valid. Why?. List out the possible ways to increase the settling velocity of particle through centrifugation operation. (ii) A fine particles are to be separated from a feed solution. Assume that the particles are spherical with diameter 5 μm and density 1.06 g/cc. viscosity of the feed solution is 1.36 mpa per sec. At the temperature of separation, the density of the suspending fluid is 0.997 g/cc. 500 liters of feed solution must be treated every hour for a suitably sized tubular bowl centrifuge. The small size and low density of fine particles are disadvantages in centrifugation. If instead of fine particles, silica particles of diameter 0.1 mm and specific gravity 2.0 are separated from the liquid, by how much percentage (%) of centrifugation coefficient is reduced?. Write the significance of centrifugation coefficient.	**[04]** **[06]**

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