Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

A Constituent Institution of Manipal University

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

END SEMESTER MAKEUP EXAMINATIONS, DEC 2016/JAN 2017

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. (i) Derive an expression to determine the specific surface area (A_w) of particles in the sample mixture. **[05]**

(ii) Compare and contrast between ideal and actual screen (any 5 points). **[05]**

1B. It is desired to separate a mixture of crystals into three fractions, a coarse fraction retained on an 8 mesh screen, a middle fraction passing on 8 mesh but retained on a 14 mesh screen, and a fine fraction passing a 14 mesh screen and retained on 20 mesh screen. The Tyler standard. Screen analyses of feed, coarse, medium and fine fractions are given in the following Table. Assuming the analyses are accurate. What do they show about the ratio by weight of overflow to feed and underflow to feed in each of the three fractions? Calculate the overall effectiveness of screen in the three fractions. **[10]**

A		3/4	4/6	6/8	8/10	10/14	14/20	20/28	28/35	35/48
B		0.47	0.332	0.235	0.166	0.117	0.083	0.0588	0.0416	0.0294
C	F	70	300	550	470	320	182	68	26	14
	CF	62.46	219.5	105.36	35.12	17.56	-----	-----	-----	-----
	MF	-----	25.2	214.8	184.8	109.8	61.2	4.2	-----	-----
	FF	-----	-----	-----	192	256.32	193.92	188.16	85.44	44.16

where A = Mesh no; B = Screen opening (cm); C = Weight of particles retained (gm); F = Feed ; CF = Coarse fraction ; MF = Middle fraction; FF = Fine fraction.

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

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

2B. The following experimental results were obtained by crushing iron ore (hemaltite) using Jaw crusher. Weight of the feed is 2 kg, average size of feed is 15 mm. Energy meter reading is 3600 rev=1 kw-hr. Under no load condition the disc takes 25 sec per revolution. Crushing duration of the disc is 15 sec per revolution. The total time required for crushing is 75 sec. Calculate the Rittinger's law constant in KJ-m/kg. **[08]**

A	10	7.5	5.0	3.7	2.5	1.8	1.2	0.9	0.6
B	503	1114	115	62	49	70	22	15	50

where A = Average particle size (mm); B = Mass of particle retained (gm).

3A. Derive an entire expression to determine the terminal settling velocity (U_t) of spherical particle settling freely in a liquid medium under the influence of gravity in an intermediate region. List out the significance of criterion constant with equation. **[12]**

3B. (i) Compare and contrast between classifier and clarifier. **[02]**

(ii) The data given where obtained from a single batch sedimentation test in an ore slurry. Determine the maximum cross sectional area of continuous thickener to handle 670 m^3/hr. If the solids from a feed concentration is 3 % by wt. and the under flow concentration is to be 37.29 % by wt. of solids. The density of the solids was 2.63 g/cc. **[06]**

C_L (g/L)	64.5	70.9	94.3	111.7	139.9	173.9	222	331
V_L (cm/hr)	139.9	103.6	71.9	49.4	27.1	16.8	10	6.40

where V_L= settling rate (cm/hr); C_L= concentration of solids (g/Lit)

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. **[10]**

4B. (i) It is desired to filter a beer containing citric acid on a continuous rotary drum vacuum filter. The filter has an area of 18.1 m^2, a negligible medium resistance, a cycle time of 75 sec, and a pressure difference of close to 1 atm. The cake which forms have a washing efficiency of only 60% but it is incompressible and permeable $\frac{\mu\alpha\rho_o}{2\Delta P} = 86\ \frac{sec}{cm^2}$. The cake retains 7% of filtrate leaving and should be washed until the cake contains only 10 % citric acid originally entrained. Calculate the washing time required to process 3000 lit of beer/hr. **[06]**

(ii) The specific resistance of the cake of solute was found to vary with pressure drop as follows. Find the compressibility of the cake. **[04]**

Pressure drop ΔP (kN/m^2)	134.3	46.1	21.1
Specific cake resistance α (m/kg)	2.16×10^{11}	1.95×10^{11}	1.8410^{11}

5A. Describe in detail about the flow patterns in an agitated vessels with necessary neat sketch. **[10]**

5B. (i) Derive an expression to determine the maximum possible volumetric flow rate of liquid (Q) in a tubular bowl centrifuge. **[05]**

(ii) Fine particles are recovered from a feed solution by using tubular bowl centrifuge. 60% fine particles are recovered at a flow rate of 12 L/min with a rotational speed of 4000 rpm. The percentage recovery is inversely proportional to flow rate. (a) At a constant rpm of 4000 rpm, what should be flow rate to result in 95% particle recovery (b) To increase the recovery of fine particles to 95% at the same flow rate 12 L/min, what should be the rpm of the centrifuge?. **[05]**

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