Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

III SEMESTER B.TECH (CHEMICAL ENGINEERING)

END SEMESTER MAKEUP EXAMINATIONS, DECEMBER 2018

SUBJECT: MECHANICAL OPERATIONS [CHE 2103]

REVISED CREDIT SYSTEM

Time: 3 Hours (31/12/2018 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 Grizzlies and Trommels (write any 4 points). **[01]**

(ii) What is meant by Aperature? Derive an expression to determine the overall effectiveness (E) of the screen with its graphical representation. **[04]**

1B. Finely divided spherical particle of activated carbon is used as an adsorbent in the dye effluent treatment. The adsorbent particle has a density of 2650 kg/m^3 and the screen analysis data is given below. Assume that the volume shape factor is 1.992. Calculate the specific surface area of catalyst particles in cm^2 per gm and specific number of particles present in the sample mixture using differential analysis. **[05]**

A	4	8	14	20	28	48	100	150
B	4.699	2.362	1.168	0.833	0.589	0.295	0.147	0.105
C	0	11.2	18.6	10.0	7.8	12.6	17.2	22.6

Where A: Mesh No; B: Screen opening (mm); C: Percentage retained (wt%)

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

(ii) Derive an equation to determine the critical speed of the ball mill. **[2.5]**

2B. (i) A certain Jaw crusher takes rock whose average particle diameter is 0.025 m and crusher is to give a product whose average particle diameter is 0.018 m at the rate of 20,000 kg/hr. At this rate, the mill takes 684 kgf-m/sec of power and 35 kgf-m/sec power is required to run it empty. What would be the power consumption by Rittinger's law in terms of HP for same capacity if the average particle diameter in the product is 0.008 m with the same feed size. **[02]**

(ii) A certain set of crushing rolls of 100 cm diameter by 38 cm width face. They are set so that the crushing surfaces are 1.25 cm apart at the narrowest point. The manufacturer recommends that they may be run at 50 rpm. They are to crush a rock having a specific gravity of 2.35 and the angle of nip is 30˚. What are the maximum permissible size of the feed and the actual capacity of the equipment in tons/hr, if the actual capacity is 60% of the theoretical capacity? **[2.5]**

3A.	(i) Compare and contrast between free and hindered settling (write any 4 points). (ii) 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).	**[01]** **[04]**
3B.	(i) Urea pellets are made by spraying melted urea with cold air at the top of the tall tower and allowing the material to solidify as it falls. The pellets are 6 mm diameter and made to fall from 25 m height tower containing the air at 15˚C. The density of urea pellets are 1330 kg/m^3 and density of air is 1.2056 kg/m^3. The viscosity of air is 0.017 mPa-sec. What would be the settling time of the urea pellets assuming that the particles settles under free settling conditions?. (ii) Draw a neat sketch, explain the construction and working operation of Spitzkasten classifier.	**[2.5]** **[2.5]**
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.	For a plate and frame filter press, operated at constant pressure the relation between the volume of filtrate 'V_f' and the time in filtration operation 'θ_f' is as follows $V_f^2 = 6.25 \times 10^4 (\theta_f + 0.11)$ .Where 'V_f' is cubic meter of filtrate delivered in filtering time 'θ_f' hours. Rate of filtration can be taken as $dV_f/d\theta_f$. The cake formed in each cycle must be washed with an amount of water equal to one sixteenth times the volume of filtrate delivered per cycle. Washing rate remains constant and is equal to one fourth of the filtrate delivery rate at the end of filtration. The time required per cycle for dismantling, dumping and reassembling of the press is 6 hours. Under the conditions where the proceeding information applies, determine the total cycle time necessary to permit maximum output of filtrate during each 24 hours.	**[05]**
5A.	Describe in detail about the following with neat sketch (i) Ribbon blender. (ii) Types of impeller based on flow pattern with swirling and vortex formation.	 **[02]** **[03]**
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) 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 cp. 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. (a) Specify sigma factor 'Σ' for a suitably sized disc stack centrifuge.(b) The small size and low density of fine particles are disadvantages in centrifugation. If instead of fine particles, quartz particles of diameter 0.1 mm and specific gravity 2.0 are separated from the liquid solution by how much percentage (%) of sigma factor 'Σ' is reduced?	**[2.5]** **[2.5]**

* * * * * *