B.E. FOOD TECHNOLOGY AND BIO-CHEMICAL ENGINEERING
THIRD YEAR FIRST SEMESTER EXAM 2019
Mechanical Operation

Time: 3 hrs. Full Marks : 100

Part – I

(Answer any three questions from questions 1 to 4 and question no. 5 is compulsory) (10 x 3 + 20 = 50)

1. (a) Distinguish 'crushing' and 'grinding' with different devices generally used for these purposes.

   (b) With the help of following equation : $(dE / dx) = - (C/x^n)$ (where E is the energy required to produce a change dx in a particle of size x, C and n are constants), find the equation of the following : (i) Kick's Law (ii) Bond's Law (iii) Rittenger's Law

   (c) Prove that $\mu > \tan \alpha$ in case of selection of crushing rolls. (4 + 4 + 2)

2. (a) Match the following :

A	B
Material Balance only	Cyclone separator
Balancing the radial drag force and centrifugal force	Electrostatic precipitator
Electrostatic force and net force	Packed filter

   (b) Advantages and disadvantages of electrostatic precipitator

   (c) Difference between cross-current and counter-current flow system (assuming any process)

   (3 + 3 +4)

3. (a) Classify the methods of measuring fluid

   (b) Mention the advantages of centrifugal pumps over reciprocating pumps

   (c) Prove the following operating line equation:

   $y_{n+1} = (L_n x_n / V_{n+1}) + [(V_1 y_1 - L_0 x_0) / V_{n+1}]$ (2+2+6)

4. Write short note on the following (any five)

   (i) Steady state process

   (ii) Absolute viscosity and kinematic viscosity

   (iii) Reynolds Number

   (iv) Role of friction

(v) Closed circuit grinding

(vi) Types of fluid

(vii) Angle of nip

5. Attempt any two of the following questions :

(a) What should be the diameter of a set of rolls to take feed of a size equivalent to 1.5inch spheres and crush to 0.5 inch, if the coefficient of friction is 0.35? (use $\mu > \tan \alpha$ and action of crushing rolls diagram)

(b) The following table shows the size distribution of a dust sample and the friction efficiency of removal in a gas cleaning equipment. Calculate the collector efficiency .

Dust size	Wt. per 100gm of dust (gm)	Fractional efficiency (η_i), %
<5	2	1
5-10	2	7
10-15	4	16
15-20	7	44
20-25	10	67
25-30	8	81
30-35	7	88
35-40	10	92
40-50	15	93
50-60	20	95
60-70	10	98
>70	5	100

(c) 150 kg of nicotine-water solution containing 1% nicotine is to be extracted with 250 kg of kerosene at 20^0C. Water and kerosene are essentially immiscible in each other. Determine the percentage extraction of nicotine after one stage operation. At dilute condition of the system the equilibrium relationship is $Y^* = 0.789X$ where Y and X are kg nicotine / kg kerosene and kg nicotine / kg water , respectively.

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B.E. FOOD TECHNOLOGY AND BIO-CHEMICAL ENGINEERING

THIRD YEAR, FIRST SEMESTER-2019

Subject: MECHANICAL OPERATION

Time: 3 hrs **Part** **Full Marks: 100**

Use separate answer scripts for each

Part-II **50 marks**

GROUP-A

Answer any one question **10×1 = 10**

1. What do you mean by free settling and hindered settling. Derive the equation for separation of materials by differences in density.
2. Briefly describe about different hydraulic separator.

GROUP-B

Answer any two questions **20×2 = 40**

3. (a) It is desired to separate quartz particles from galena particles by taking advantage of their different specific gravities. A hydraulic classifier is employed under free settling conditions. The specific gravity of quartz is 2.65 and that of gelena 7.5. the original mixture of particles has a size range from 0.00052 to 0.00250 cm. It is found that three fractions are obtained, one of quartz only, one of galena only and one of a mixture of quartz and galena. What are the size ranges of the two substances in this third fraction?

   (b) Briefly describe on different hydraulic classifier. 10+10 = 20

4.(a) Write short note on coagulation and flocculation.

   (b) Biomass present in a filtration broth is to be separated by vacuum filtration. Filter and broth characteristics are given bellow:

   $A = 50m^2$, $\Delta P = 0.01N/m^2$, $C = 15\ kg/m^3$, $\mu = 0.003kg/m\text{-}s$, $\alpha = 2m/kg$.

   (i) If rate of filtration has a constant value of $dV/dt = 50$ l/min, determine the cake and filter resistances at t=30min.

   (ii) Determine the filter surface area (A) required to filter 5000 l broth within 60 min with the same pressure drop across the filter. 6 + 14 = 20

5.(a) What are centrifugal factor and centrifugation coefficient? How scale-up of centrifuge is related with centrifugation coefficient?

[Turn over

(b) Yeast cells are recovered from a fermentation broth by using a tubular centrifuge. Sixty percent (60%) of the cells are recovered at a flow rate of 12 l/min with a rotational speed of 4000 rpm. Recovery is inversely proportional to the flow rate.

(i) to increase the recovery of cells to 95% at the same flow rate, what should be the rpm of the centrifuge?

(ii) At a constant rpm of 4000 rpm, what should be the flow rate to result in 95% cell recovery? 6+14 = 20