BACHELOR OF ENGINEERING IN F.T.B.E. EXAMINATION, 2018

(3rd Year, 1st Semester)

MECHANICAL OPERATION

Time : Three Hours Full Marks : 100

(50 marks for each part)

Use a separate Answer-Script for each part

PART - I

All notation carry their usual meaning.

Two marks are reserved for short and systematic answers.

Attempt ***any three*** questions.

1. a) Differentiate the term "Crushing" and "Grinding".

   b) Clasify the Crushing and Grinding Machinery. 5

   c) With the help of the following equation

   $$\frac{dE}{dx} = -\frac{C}{x^n}$$

   Derive the following equation

   i) Rittinger's Law

   ii) Kicks Law

   iii) Bond's Law 6

   d) With the help of "Action of Crushing Rolls", prove the following equation $\mu > \tan\alpha$ 5

2. a) The following table shows the size distribution of a dust sample and the fraction efficiency of removal in a gas cleaning equipment.

   Calculate the overall collector efficiency.

Dust Size, «	Weight/100 gm of the dust (g)	Fractional Efficiency
< 5	2	1
5 - 10	2	7
10 - 15	4	16
15 - 20	7	44
20 - 25	10	67

Dust Size, «	Weight/100 gm of the dust (g)	Fractional Efficiency
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

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b) With a neat diagram (Howard setting chamber), prove the following equation

$$d_{p_{min}} = \sqrt{\frac{18Q\,\mu g}{nWLg\,(e_e - \rho_g)}}$$ 9

3. a) With the help of balancing the radial drag force and the centrifugal force, find the equation, as given below :

$$v_r = \frac{dp^2(\rho\rho - \rho_g)(1-n)^2Q^2}{18\mu g W^2 r^{2n+1}(r_2^{1-n} - r_1^{1-n})^2}$$ 8

b) A plate-type electrostatic precipitator for use in a cement plant for removing dust particles consists of 10 equal channels. The spacing between the plates is 15 cm, and the plates are 2m high and 2 m long. The unit handles 10000 m^3/n of gas. What is the efficiency of collection ? What should be the length of the plates for achieving 97% collection efficiency, if other condition are the same ? Given $v_{pm} = 0 \cdot 10$ 8

4. Write short notes / Draw the flowsheet on the following ***(any four)*** : 4×4=16

i) Advantages and disadvantages of electrostatic precipritator

ii) Classification of Pumps

iii) Flow sheet for "closed-circuit grinding"

iv) To avoid cavitation, what steps should be taken and why it is ?

v) Mention the different devices for the following classification of separation :

a) Coarse Crushers

b) Intermediate Crushers

c) Fine Grinders

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B.E. FOOD TECHNOLOGY AND BIO-CHEMICAL ENGINEERING

THIRD YEAR FIRST SEMESTER – 2018

Subject: MECHANICAL OPERATION

Time:3 hours **Full Marks:** 100

Part-II

Use Separate Answer scripts for each Part

Answer question No.1 and any two from the rest. 10+20×2 = 50

1. Derive the expression for terminal separation velocity under centrifugal field. Comment on the relationship between bed height and feed rate of a packed bed column reactor. 5+5 = 10

2. (a) Derive the Ruth equation. What assumptions are considered to derive this equation?
(b) Define centrifugal coefficient. What is its expression for tubular type centrifuge? What is S value?
© Yeast cells are recovered from 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 90% 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 90% cell recovery? 7+5+8=20

3. (a) Green peas dried in a fluidized bed dryer. Calculate the minimum fluidization velocity of hot air under given condition:
Characteristics of pea:
Diameter = 2mm;
Specific gravity = 1.2
Fraction of free space in column = 0.3
Characteristics of hot air:
Density = 0.9 kg/m^3
viscosity = 20.94×10^{-6} m^2/s under operating temperature
Calculate the mass flow rate of air if area of the column is 0.75m^2
(b) Derive the settling velocity of separate discrete particle. And hence what is its form under laminar fluid flow condition?
© Classify settling tanks. Derive critical settling velocity of any one type tank. 8+7+5=20

4. (a) Briefly describe the batch settling column test.

(b) A settling analysis is run on a Type 1 suspension in a laboratory column with a port

1.8m below the suspension surface. The data obtained are shown below.

Time (min)	0	3	5	10	20	40	60
TSS (mg/L)	220	116	98	75	35	10	2

What will be the theoretical removal efficiency in a settling basin for an overflow of 432 $m^2/m.day$? 5+15 = 20

5. (a) Briefly describe coagulation and flocculation process.
   (b) What is retention time and rise rate in a flocculation tank?
   © Draw a schematic diagram of the conventional coagulation-flocculation separation system.
   (d) What are the selection criteria of coagulant? 5+5+5+5 = 20