



GWANDA STATE UNIVERSITY
FACULTY OF ENGINEERING AND ENVIRONMENT
DEPARTMENT OF METALLURGICAL ENGINEERING
PARTICULATE SYSTEMS

EMR 5201

Part V Second Semester Examination Paper

AUGUST 2021

This examination paper consists of 4 printed pages

Time Allowed: **3 hours**

Total Marks: **100**

Examiner **Mr Fortune Nkomo**

INSTRUCTIONS

1. Answer **ALL** questions in Section A and any **TWO** from Section B
2. Each question carries 25 marks
3. Use of calculators is permissible

Additional Requirements

MARK ALLOCATION

Section A	50 Marks
Section B	50 Marks
Part Questions	As shown in each part question
Total Attainable	100

SECTION A

ANSWER ALL QUESTIONS

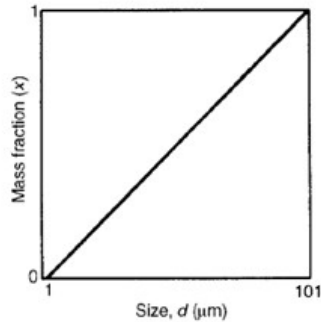
Question A1

- i. Consider a binary powder made up of equal weights of particles of weight 0.05 and 0.10 g. What is the expected variation, assuming perfect sampling, for a 50g sample removed from a bulk of 800 g. **[5 Marks]**
- ii. Determine the minimum sample size of quartz of density 2.65 g/cm³ to give an expected sampling error $e = 5\%$ if the coarsest size range of 105 to 75 μm contains 5% of the total weight. **[5 Marks]**
- iii. Determine the minimum increment weight for a powder falling from a belt conveyer at a rate of 30 tons per hour if the size of the largest particle is 100 μm and the sampling cutter speed is 0.6 m/s **[5 Marks]**
- iv. A mixture of quartz and galena of a size range from 0.015 mm to 0.065 mm is to be separated into two pure fractions using a hindered settling process. What is the minimum apparent density of the fluid that will give this separation? The density of galena is 7500 kg/m³ and the density of quartz is 2650 kg/m³ **[5 Marks]**
- v. Oil, of density 900 kg/m³ and viscosity 3 mNs/m², is passed vertically upwards through a bed of catalyst consisting of approximately spherical particles of diameter 0.1 mm and density 2600 kg/m³. At approximately what mass rate of flow per unit area of bed will

(a) fluidization, and (b) transport of particles occur? **[5 Marks]**

Question A2

- i. The size analysis of a powdered material on a mass basis is represented by a straight line from 0 per cent mass at 1 μm particle size to 100 per cent mass at 101 μm particle size as shown in Figure QA 1. Calculate the surface mean diameter of the particles constituting the system. **[6 Marks]**



- ii. A ball mill, 1.2 m in diameter, is run at 0.80 Hz and it is found that the mill is not working properly. Should any modification in the conditions of operation be suggested? **[7 Marks]**
- iii. A material is crushed in a Blake jaw crusher such that the average size of particle is reduced from 50 mm to 10 mm with the consumption of energy of 13.0 kW/(kg/s). What would be the consumption of energy needed to crush the same material of average size 75 mm to an average size of 25 mm:
- assuming Rittinger's law applies?
 - assuming Kick's law applies?

Which of these results would be regarded as being more reliable and why? **[12 Marks]**

SECTION B

ANSWER ANY TWO QUESTIONS

Question B 1

Discuss any five types of pneumatic conveyor systems and their application **[25 Marks]**

Question B2

A slurry is filtered in a plate and frame press containing 12 frames, each 0.3 m square and 25 mm thick. During the first 180s the pressure difference for filtration is slowly raised to the final value of 400 kN/m² and, during this period, the rate of filtration is maintained constant. After the

initial period, filtration is carried out at constant pressure and the cakes are completely formed in a further 900 s. The cakes are then washed with a pressure difference of 275 kN/m² for 600 s using thorough washing. What is the volume of filtrate collected per cycle and how much wash water is used? (A sample of the slurry had previously been tested with a leaf filter of 0.05 m² filtering surface using a vacuum giving a pressure difference of 71.3 kN/m². The volume of filtrate collected in the first 300s, was 250 cm³ and, after a further 300s, an additional 150 cm³ was collected. It may be assumed that the cake is incompressible, and that the cloth resistance is the same in the leaf as in the filter press.) **[25 Marks]**

Question B3

In a test on a centrifuge all particles of a mineral of density 2800 kg/m³ and of size 5 μm, equivalent spherical diameter, were separated from suspension in water fed at a volumetric throughput rate of 0.25 m³/s. Calculate the value of the capacity factor Σ . What will be the corresponding size cut for a suspension of coal particles in oil fed at the rate of 0.04 m³/s? The density of coal is 1300 kg/m³ and the density of the oil is 850 kg/m³ and its viscosity is 0.01 Ns/m². It may be assumed that Stokes' law is applicable. **[10 Marks]**

A centrifuge is fitted with a conical disc stack with an included angle of 2θ, and there are n flow passages between the discs. A suspension enters at radius R₁ and leaves at radius R₂. Obtain an expression for the separating power Σ of the centrifuge. It may be assumed that the resistance force acting on the particles is given by Stokes' law. **[15 Marks]**

END OF QUESTION PAPER

