

**MANICALAND STATE UNIVERSITY OF APPLIED SCIENCES**

**FACULTY OF ENGINEERING**

**Chemical and Processing Engineering Department**

**PARTICULATE TECHNOLOGY**

**CODE: HCHE 325**

**SESSIONAL EXAMINATIONS**

**APRIL 2021**

**DURATION: 3 HOURS**

**EXAMINER: K. NYENYAYI (MR)**

**INSTRUCTIONS**

1. Answer *all questions* in Section A and *any three* from Section B.
2. Each question carries 20 marks.
3. Total marks 100

**ADDITIONAL MATERIALS**

Calculators.

This question paper consists of 4 printed pages

## SECTION A

### QUESTION ONE

- a) Fully explain the meaning of the following terms as applied to particulate technology:
- Aspect ratio
  - Solidity
  - Circularity
  - Convex hull perimeter [4]
- b) Cubic gold ore particles at a How mine gold processing plant have average length of 2.45  $\mu\text{m}$ . Calculate the average surface equivalent sphere diameter ( $D_{\text{surface}}$ ) of the particles. [4]
- c) State any **six** applications of dilute phase conveying systems. [6]
- d) State the factors that determine the settling velocity of particles during centrifugation. [6]

### QUESTION TWO

- a) List five types of impellers which are used in chemical industries for mixing solutions. [5]
- b) Draw a fully labelled schematic diagram showing a basic stirred tank. [5]
- c) A packed bed of solid particles of density 2500  $\text{kg/m}^3$ , occupies a depth of 1 m in a vessel of cross-sectional area 0.04  $\text{m}^2$ . The mass of solids in the bed is 59 kg and the surface-volume mean diameter of the particles is 1 mm. A liquid of density 800  $\text{kg/m}^3$  and viscosity 0.002 Pas flows upwards through the bed.
- Calculate the voidage (volume fraction occupied by voids) of the bed.
  - Calculate the pressure drop across the bed when it becomes fluidized.[7]

d) Briefly explain what is meant by *incipient fluidization point*. [3]

## SECTION B

### QUESTION THREE

a) Identify the three basic views that all laser diffraction instruments rely on. [3]

Briefly explain wet dispersion and dry dispersion approaches to sample dispersion during particle characterisation. [6]

b) Outline the criteria that need to be considered on deciding characterization techniques to be applied in analysing solid ores from a cement manufacturing plant. [7]

c) With aid of diagram describe the *freeboard, bed* and *fluidisation vessel* components of a fluidised bed system. [4]

### QUESTION FOUR

a) Define the terms *distribution, eddies* and *dispersion* that are used to describe mixing mechanisms. [3]

b) A Rushton turbine used to stir 20 L paint tank at 250 rpm using an impeller of 0.5 m diameter. The Reynolds number of the turbine is 11000. If the viscosity of paint slurry is 4 Pa. s, calculate the mixing time and density of the paint if the stirring speed is  $3 \text{ s}^{-1}$ . [6]

c) Paint slurry of viscosity 0.05 Pa s and density  $2000 \text{ kg m}^{-3}$  is agitated in a  $20 \text{ m}^3$  baffled tank using a marine propeller 95 cm diameter. Calculate the power required for a stirred speed of  $0.1 \text{ min}^{-1}$ . Assume that the  $N_p$  value for turbulent regime is 8. [6]

d) In what ways are glass centrifuges different from plastic centrifuges? [5]

### **QUESTION FIVE**

- a) Outline the advantages and disadvantages of using pneumatic conveying systems over mechanical conveying. [8]
- b) What are the key differences between dilute phase pneumatic conveying system and dense phase pneumatic conveying? [12]

### **QUESTION SIX**

- a) Identify any four industrial applications of centrifugation. [4]
- b) Fully describe the different types of centrifuges based on rotor design and intended use. [6]
- c) Compare circulating fluidised bed scrubber to the wet flue gas desulphurisation. [10]

THE END