GWANDA STATE UNIVERSITY

FACULTY OF ENGINEERING AND ENVIRONMENT

DEPARTMENT OF METALLURGICAL ENGINEERING

PARTICULATE SYSTEMS

EMR 5201

Part V Second Semester Examination Paper

April 2024

This examination paper consists of 4 printed pages

Time Allowed: **3 hours**

Total Marks: **100**

INSTRUCTIONS

1. Answer **any FIVE questions**
2. Each question carries 20 marks
3. Use of calculators is permissible

Additional Requirements

1. Calculator
2. Graph paper

MARK ALLOCATION

Part Marks	As shown in each part question
Total Attainable	100

ANSWER ANY FIVE (5) QUESTIONS

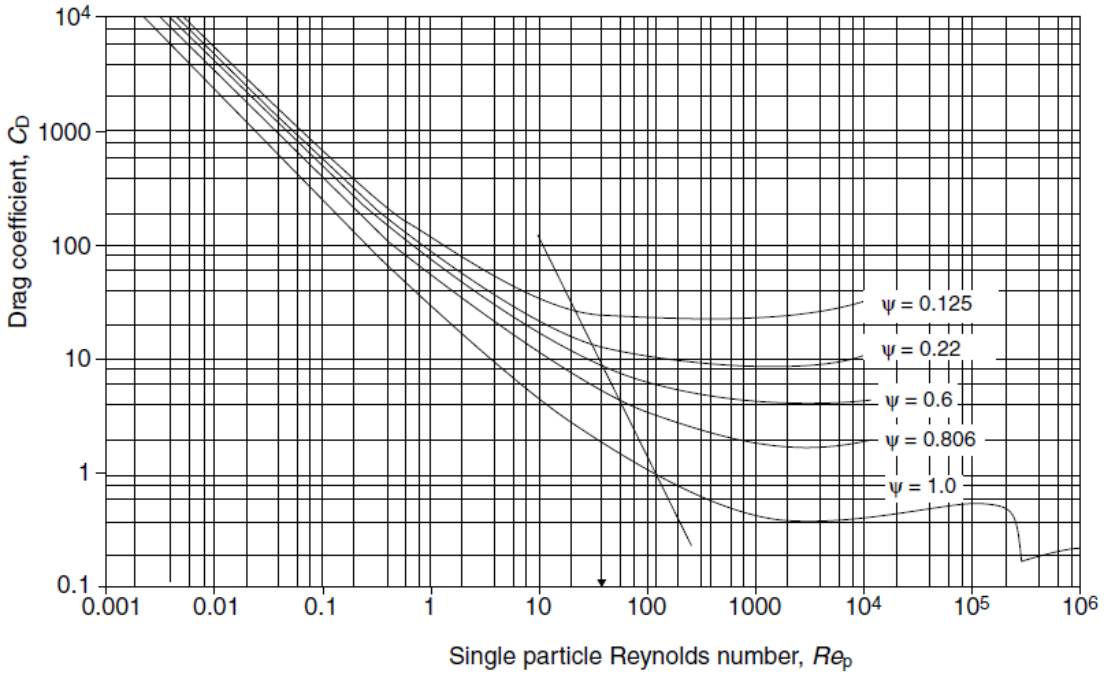
Question 1

a) Explain using two examples why we assume that the solid particles we are processing are spherical during process and equipment design **[6]**

b) Describe how buoyancy and gravity affect the downward motion of a particle through a fluid **[4]**

c) Explain the effects of cake formation on rate of filtration **[6]**

d) A particle of equivalent sphere volume diameter 0.2 mm, density 2500 kg/m^3 and sphericity 0.6 falls freely under gravity in a fluid of density 10 kg/m^3 and viscosity 2 x 10^5 Pa s. Estimate the terminal velocity reached by the particle. **[4]**



Question 2

a) Explain an application where the total surface area of particles is an important factor to determine **[3]**

b) Explain three assumptions you will make when using sieving to determine the particle size distribution **[6]**

c) Describe the four stages of the filtration cycle **[4]**

d) You are an engineer for company X. You are required to determine the following diameters for a sample of cylindrical particles. The cylinders have a diameter of 0.1 mm and a length of 1 mm

i. the equivalent volume sphere diameter **[3]**

ii. the equivalent surface sphere diameter **[4]**

Question 3

a) Describe Filtration with cake-formation using an example and diagram **[3]**

b) Draw a diagram showing the pressure drop across a bed of powder against the velocity of the fluid flowing upwards through it. Label the packed bed, incipient fluidisation region and fluidized bed regions. **[5]**

c) Explain three factors that affect the sedimentation of solid particles in a fluid **[6]**

d) A water-based slurry of mineral is being filtred under vacuum with a controlled pressure drop of 38 kPa through a filter paper of 0.07 m^2. The slurry is at 24 kg solids/m^3 of fluid. Use $\mu = 8.9 \times 10^{-4}$ Pa.s and the data below to calculate

i. Medium resistance **[3]**

ii. Specific cake resistance **[3]**

Question 4

a) Explain how the following properties of particles affect their motion in a liquid.

i. Particle size **[2]**

ii. shape **[2]**

iii. density **[3]**

b) You are the metallurgist for mine X. Explain why it is important to determine the composition of gold in ore prior to gold recovery. **[4]**

c) Compare and contrast the mode of operation of vacuum filtration and gravity filtration **[4]**

e) Coal particles having a diameter of 0.24 mm are fluidised using air as the fluid. The particles have a shape factor of 0.79.The air is injected at a pressure of 3 atm at a temperature of 25 ^{o}C. The air has a viscosity of 1.845 x 10^{-5} kg/ms and a molecular weight of 28.97. The voidage of the bed at minimum fluidisation is 0.42. Calculate the minimum fluidisation velocity **[4]**

Question 5

a) Explain two advantages and two disadvantages of vacuum filtration **[4]**

b) Define the term sphericity **[2]**

c) Compare and contrast particulate and aggregative fluidisation. Explain where each of these is used **[6]**

d) 15 kg of particles of particle density 2000 kg/m^3 are fluidized in a vessel of cross sectional area 0.03 m^2 by a fluid of density 900 kg/m^3.

i. What is the frictional pressure drop across the bed? **[4]**

ii. If the bed height is 0.6 m, what is the bed voidage? **[4]**

Question 6

a) Explain how you can determine the total surface area of a mixture of gold particles that have different particle size. **[6]**

b) Explain why it is important to determine the physical properties of particles using an example **[4]**

c) Coal particles are dried using a spouted bed fluidisation at a pressure drop through the bed of 200 Pa. The diameter of the column is 15 cm and the air inlet diameter is 1.25 cm. The granules of coal are 2 mm in diameter and their density is 1500 kg/m^3.Calculate

i. Height of the bed **[4]**

ii. the minimum spoutable velocity of the coal particles **[6]**

END OF QUESTION PAPER