

NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF INDUSTRIAL TECHNOLOGY
BACHELOR OF ENGINEERING (HONS) DEGREE
Part Three Examination May 2011

TCE3005 Fluid-Solid Systems

Duration of Examination 3Hours

Instructions to Candidates

1. Answer any **FOUR** questions.
2. Show all your steps clearly in your calculation.
3. Start the answers for each question on a new page.

1. a) With the aid of a diagram explain how the ‘saltation’ velocity can be used to mark the boundary between dilute phase and lean phase conveying in horizontal pipelines. [10]

b) Explain the effects of decreasing the gas superficial velocity on the pressure drop per unit length of pipeline for a vertical pneumatic transport system of initial solids feed-rate G . [15]

2. a) Derive from first principles the terminal falling velocity of a particle of diameter d_p and density ρ_p in a fluid of density ρ_f . Assume that the particle motion is under gravity in the Newton’s law range. $C_D = 4/9$. [10]

b) Explain how you would determine the terminal falling velocity, V_t for a given particle diameter d_p when it is not known which region of operation is relevant. [15]

Hint: Use the equation below:

$$C_D \text{Re}_t^2 = \frac{4\rho_f d_p^3 g (\rho_p - \rho_f)}{3\mu^2}$$

3. a) Explain the effect of increasing fluidizing gas velocity on bed-surface heat transfer coefficient in a fluidized bed. [10]

b) 1500kg of powder is fluidized in a vessel of cross sectional area, $A = 1.2\text{m}^2$ and achieves a bed height 0.8m.

i) What is the bed density? [4]

ii) If the particle density of the solids is 3000kg/m^3 what is the voidage? [6]

4. a) Describe the fluidization behavior of the four classes of particulates according to Geldart's classification citing examples of real materials that fall within those classes. [8]
- b) State and explain five methods employed in filter cleaning. [5]
- c) Using diagrams, briefly explain the mechanisms of particle capture in gas cleaning. [12]
- 5.

END OF EXAM