THE MOMBASA POLYTECHNIC UNIVERSITY COLLEGE

Faculty of Engineering and Technology

DEPARTMENT OF MECHANICAL AND AUTOMOTIVE ENGINEERING

DIPLOMA IN CHEMICAL ENGINEERING

ECH 2211 UNIT OPERATIONS I

SUPPLEMENTARY/SPECIAL EXAMINATIONS

SERIES: MAY 2011

TIME: 2 HOURS

Instructions to Candidates:

1. You should have the following for this examination:
   - Answer booklet
   - Battery operated scientific calculator
   - Steam tables (SI Units)

2. This paper consists of **TWO** Section; **A and B**.
3. Answer all questions in Section **A** and any **TWO** Questions from Section **B**.

4. Section A carries 30 marks, while each question in Section **B** carriers 20 Marks.

Question ONE

(a) Define the following terms:

(i) Flaw
(ii) Elastic deformation
(iii) Channelling

(3 Marks)

(b) Differentiate between agitation and mixing. (2 Marks)

(c) Describe the **THREE** types of impellers used in the chemical industries. (6 Marks)

(d) Explain the **FOUR** factors that determine the flow patterns in a mixing vessel. (6 Marks)

(e) List **FOUR** advantages and **FOUR** disadvantages of size reduction. (4 Marks)

(f) List **FOUR** factors to be considered when selecting size reduction equipment. (4 Marks)

(g) Explain how the following influence the size of the products in a ball mill.

(i) Rate of feed
(ii) The diameter of balls
(iii) Slope of the mill
(iv) Discharge freedom
(v) Speed of rotation of the mill

(5 Marks)

Question TWO

(a) A solid material is crush in a blake jaw crusher such that the average size of the particle is reduced from 60mm to 15mm with consumption of energy 13.0kW/(KgS^{-1}). Calculate the energy required to crush the same material of average size 75mm to 20mm.

(i) Using Kicks law.
(ii) Using Rittingers law.

(8 Marks)

(b) Describe the methods of application of force to the particles by size reduction machines. (6 Marks)

(c) Its is desired to separate particles of relatively dense materials $A(\rho_A)$ from particles of a less dense material $B(\rho_A)$. The terminal velocity of the largest particles of B may be greater than those of the smallest particles of A. Show that the maximum range of size that can be separated is given by the equation: (6 Marks)

$$\frac{d_B}{d_A} = \left[\frac{\rho_A - \rho}{\rho_B - \rho}\right]^S$$

Where d_B/d_A are sizes of particles of A & B respect ρ_- density of the liquid. (6 Marks)

Question THREE

(a) Define filtration. (2 Marks)

(b) Explain the working mechanism of a suspended batch centrifuge. (8 Marks)

(c) (i) List **FOUR (4)** requirements that must be met by filter medium (septum). (4 Marks)
(ii) Give **TWO** examples of filter aids. (2 Marks)

(d) Describe **TWO** ways of administering filter aids in a filtration process. (4 Marks)

Question FOUR

(a) Describe the major features of a mixing vessel which enables it achieve its function. (6 Marks)

(b) Experimentally the power consumption is found to be proportional to the square of the speed of rotation. By what factor would the power increase if the speed was doubled. (6 Marks)

(c) State any **FOUR** purposes for agitation of fluids in the process industries. (4 Marks)

(d) Explain the following types of flows:
(i). Axial flow
(ii). Radial flow
(4 Marks)

Question FIVE

In particle analysis experiment the following results were obtained:

d_p (μm)	5690	4013	2845	2007	1410	1000	711
Mass (g)	500	750	1000	1000	750	600	400

(a) Calculate mass mean diameter. (15 Marks)

(b) Derive Bonds Empirical Law. (5 Marks)