



**THE MOMBASA POLYTECHNIC UNIVERSITY COLLEGE**  
***Faculty of Engineering and Technology***

DEPARTMENT OF MECHANICAL AND AUTOMOTIVE ENGINEERING

DIPLOMA IN CHEMICAL ENGINEERING

**ECH 2208 UNIT OPERATIONS II**

SUPPLEMENTARY/SPECIAL EXAMINATIONS  
**SERIES: JUNE 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** Sections; **A and B**.
3. Answer **ALL** Questions in Section **A** and any **TWO** Question from Section **B**.
4. Section A carries **30 marks**, while each question in Section **B** carries **20 marks**.

## SECTION A

### Question ONE

- (a) List **FIVE** examples of Unit Operations. (5 Marks)
- (b) Define the following:
- (i) Boiling point-elevation
  - (ii) Heat of dilution
  - (iii) Latent heat
  - (iv) Sensible heat
- (4 Marks)
- (c) Classify the liquors which can be subjected to evaporation. (3 Marks)
- (d) Show that for a triple effect evaporator heat transfer per unit time is given by:
- $$Q = U_{av} (\Delta T_1 + \Delta T_2 + \Delta T_3) A$$
- (6 Marks)
- (e) Give **FOUR** reasons why drying operation is carried out. (4 Marks)
- (f) Explain the following terms:
- (i) Agregation
  - (ii) A glomeration
- (4 Marks)
- (g) State and explain **FOUR** factors affecting the crystallization process. (4 Marks)

### Question TWO

- (a) Define the following terms:
- (I) Magma
  - (II) Mother liquor
  - (III) Nucleation
  - (IV) Seeding
  - (V) Invariant crystals
- (5 Marks)
- (b) Explain the operations of a draft tube-baffle crystalliser. (7 Marks)

- (c) A batch of 1500kg of saturated potassium chloride solution is cooled from 360k to 290k in an unagitated tank. If the solubility of KCL are 53 and 34kg/100g of water at 360k and 290k respectively and water losses due to evaporation may be neglected. What is the yield of crystals?

(8 Marks)

### Question THREE

1Mg of dry mass of a non-porous solid is dried under constant drying conditions in an air stream flowing at 0.75m/s. The area of surface drying is 55m<sup>2</sup>. If the initial rate of drying is 0.3g/m<sup>2</sup>s. How long will it take to dry the material from 0.15 to 0.025kg water/kg dry solid? The critical moisture content of the material may be taken as 0.125kg water/kg dry solid. If the air velocity were increased to 4.0m/s, what would be the anticipated saving in time if the process were surface evaporation controlled.

(20 Marks)

### Question FOUR

- (a) With the help of a sketch, derive the rate of heat transfer through a multi layer thick-walled tube. (10 Marks)
- (b) In a double pipe counter current flow heat exchanger, 10,000kg/hr of an oil having specific heat of 2095J/Kg°K is cooled from 80°C to 50°C by 8000kg/hr of water, entering at 25°C. Determine the heat exchange area for an overall heat transfer coefficient of 300w/m<sup>2</sup>°k.  
C<sub>p</sub> for water = 4180J/Kg°k. (10 Marks)

### Question FIVE

A single effect evaporator is used to concentrate 7kg/s of a solution from 10% to 5% solids. Steam is available at 205kN/m<sup>2</sup> and evaporation takes place at 13.5kN/m<sup>2</sup>. If the overall heat transfer coefficient is 3kW/(m<sup>2</sup>°k), calculate the heating surface required and the amount of steam used if the feed to the evaporator is at 294k and the condensate leaves the heating surface at 352.7k.

$$\begin{aligned} \text{Specific heat of 10\% solution} &= 3.76\text{kJ}/(\text{kg}^\circ\text{k}) \\ \text{Specific heat of 50\% solution} &= 3.14\text{kJ}/(\text{kg}^\circ\text{k}) \end{aligned}$$

(20 Marks)