



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: APRIL 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:
- $$Q = \vartheta_{av} (\Delta T_1 + \Delta T_2 + \Delta T_3) A$$
- (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 55m². If the initial rate of drying is 0.3g/m²s. 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. Determine the greater exchange area for an overall heat transfer coefficient of 300w/m²°k. cp 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/m² and evaporation takes place at 13.5KN/m². If the overall heat transfer coefficient is 3kw/(m²°k), calculate the heating surface required and the amount of steam used if the feed to the evaporator is at 294k and the condense 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)