THE MOMBASA POLYTECHNIC UNIVERSITY COLLEGE

FACULTY OF ENGINEERING & TECHNOLOGY

DEPARTMENT OF MECHANICAL AND AUTOMOTIVE ENGINEERING

DIPLOMA IN CHEMICAL ENGINEERING

ECH 2206

UNIT OPERATIONS II

YEAR II SEMESTER II

SUPPLEMENTARY/SPECIAL EXAMINATIONS

SERIES : OCTOBER, 2011

TIME : 2HRS

INSTRUCTION TO CANDIDATES

You should have the following for this examination

- Battery Operated Scientific Calculator
- Answer Booklet
- Drawing Instruments

This paper consists of **FIVE** questions in **TWO** sections; A and B.

Answer question **ONE** and any other **TWO** question from section B

Maximum marks for each part of a question are as shown.

This paper consists of ***THREE*** *Printed Pages*.

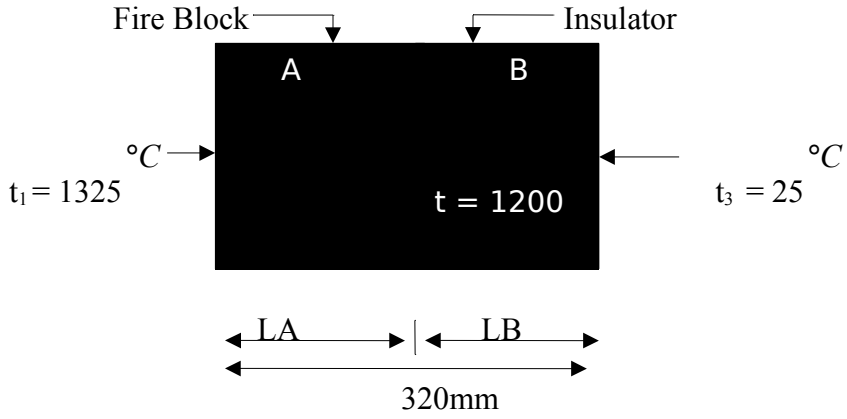
SECTION A

Q1 The inner surface of a plane brick wall is at $60°C$ and the outer surface is at $35°C$. Calculate the rate of heat transfer per m^2 of surface area of the wall, which is 220mm thick. The thermal conductivity of the brick is 0.51wm$/°C$. **(8 Marks)**

Q2 A rector's wall 320mm thick is made up of an inner layer of fire brick (k=0.84w/m$°C$) covered with a layer of insulation (k=0.16w/m$°C$). The reactor operates at a temperature of 1325 $°C$ and the ambient temperature is $25°C$.

(i) Determine the thickness of fire brick and insulation which gives minimum heat loss. **(8 Marks)**

(ii) Calculate heat loss presuming that the insulating material has a maximum temperature of $1200°C$. **(3 Marks)**



Q3 A mild steel tank of wall thickness 12mm contains water at 95 $°C$. The thermal conductivity of mild steel is 50w/m$°C$, and the heat transfer coefficient for the inside and outside the tank are 2850 and 10w/$m^2°C$ respectively. If the atmospheric temperature is 15 $°C$. Calculate:

(i) The rate of heat loss per m^2 of the tank surface area. **(8 Marks)**

(ii) The temperature of the outside surface of the tank. **(3 Marks)**

SECTION B

Q1 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 $55m^2$. If the initial rate of drying is $0.3g/m^2s$. How long will it take to dry the material from 0.15 to 0.025kg water 1kg dry solid? The critical moisture content of the material may be taken as 0.125kg water 1kg dry solid. **(20 Marks)**

Q2 Hydrochloric acid (A) diffuses through a thin film of water (B) 4.0mm thick at 282k. The concentration of HCl at point 1 on the boundary of the film is 12wt% (density $\rho_1 = 1060.7 kg/m^3$) and on the other boundary, at point 2, is 4wt% (density $\rho_2 = 1020.15 kg/m^3$). The diffusivity of HCl in water is $2.5\times10^{-9} m^2/s$. Calculate the flux of HCl considering water to be stagnant. **(20 Marks)**

Q3 A furnace wall is made up of the three layers of thickness 250mm, 100mm and 150mm with thermal conductivities of 1.65, k and 9.2w/m $^\circ C$ coefficient of $12w/m^2$ $^\circ C$. Determine:

(i) The unknown thermal conductivity 't'. **(8 Marks)**
(ii) The overall heat transfer coefficient **(5 Marks)**
(iii) All surface temperatures **(7 Marks)**

Q4 Derive the equation for Logarithmic Mean Temperature Difference for "Parallel-flow" (LMTD)? **(20 Marks)**