Name_____   Index No._____

2705/301
2707/301   Candidate's Signature_____
2709/301
2710/301   Date _____
MATHEMATICS III AND SURVEYING III
Oct/Nov 2014
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN BUILDING TECHNOLOGY
DIPLOMA IN CIVIL ENGINEERING
DIPLOMA IN ARCHITECTURE
MODULE III

MATHEMATICS III AND SURVEYING III

3 hours

INSTRUCTIONS TO CANDIDATES

Write your name and index number in the spaces provided above.
Sign and write the date of the examination in the spaces provided above.
You should have a Scientific Calculator for this examination.
This paper consists of EIGHT questions in TWO Sections; A and B.
Answer FIVE questions choosing at least TWO questions from Section A, TWO questions from Section B and ONE question from either Section.
All answers MUST be written in the spaces provided in this question paper.
Maximum marks for each part of a question are as shown.
Do NOT remove any pages from this booklet.
Candidates should answer the questions in English.

For Examiner's Use Only

Question	1	2	3	4	5	6	7	8	TOTAL
Candidate's Score									

This paper consists of 20 printed pages.

Candidates should check the question paper to ascertain that
all the pages are printed as indicated and that no questions are missing.

Turn over

SECTION A: MATHEMATICS III

*Answer at least **TWO** questions from this Section in the spaces provided.*

1. (a) Given that $A = \begin{bmatrix} 2 & t \\ t & 3 \end{bmatrix}$, $B = \begin{bmatrix} 3 & 2 \\ 5 & 1 \end{bmatrix}$ and AB is a singular matrix, determine the possible values of t. (8 marks)

   (b) Given that $A = \begin{bmatrix} 30 & -6 & -19 \\ -16 & 4 & 10 \\ -10 & 2 & 7 \end{bmatrix}$, $B = \begin{bmatrix} 2 & 1 & 4 \\ 3 & 5 & 1 \\ 2 & 0 & 6 \end{bmatrix}$. Determine:

   (i) AB;

   (ii) A^{-1} and B^{-1};

   (iii) Hence solve the simultaneous equations:

   $$2x + y + 4z = -8$$
   $$3x + 5y + z = 0$$
   $$2x + 6z = -12$$

   (12 marks)

2. (a) Given that X_n is an approximation to the root of the equation: $6x^4 - 15x^2 - 1 = 0$

   (i) Show, using the Newton-Raphson method, that a better approximation X_{n+1} is given by $X_{n+1} = \dfrac{18x_n^4 - 15x_n^2 + 1}{24x_n^3 - 30x_n}$.

   (ii) Hence, find the root of the equation taking the first approximation $x_0 = 1.6$. Given answer correct to five decimal places. (7 marks)

   (b) **Table 1** shows data taken from a table of the normal integral.

   Table 1

x	1.0	1.1	1.2	1.3	1.4	1.5	1.6
$f(x)$	0.3413	0.3643	0.3849	0.4032	0.4192	0.4322	0.4452

   Use Newton Gregory interpolation formula to determine:

   (i) $f(1.17)$

   (ii) $f(1.35)$

   Give the answer correct to four decimal places. (13 marks)

3. (a) The time taken by a water company to deliver water to a construction site is normally distributed with a mean of 12 minutes and a standard deviation of 2 minutes. Water is delivered every day. Estimate the number of days during the year when it takes:

   (i) longer than 17 minutes;

   (ii) less than 10 minutes;

   (iii) between 9 and 13 minutes. (9 marks)

   (b) A continuous random variable x has a probability density function $f(x)$ defined by

   $$f(x)\begin{cases} kx(12 - x), & 0 < x < 1 \\ 0 & elsewhere \end{cases}$$

   Determine:

   (i) the constant k;

   (ii) mean of x;

   (iii) variance of x. (11 marks)

4. (a) Roofing nails are produced by an automatic machine at a defect rate of 6%. A random sample of 100 nails are drawn from the output of the machine.

   (i) If the production is to continue at this rate, determine the type I error for a sample that contains less than 7 defective nails;

   (ii) Determine the type II error for a sample that contains less than 7 defective nails if the defect rate has risen to 12%. (10 marks)

   (b) A manager of some construction firm believes that there is a relationship between total operation cost x and total inventory cost y. The data in **table 2** is available for the purpose of analysis.

Table 2

x (Ksh '000)	19	15	35	52	35
y (Ksh millions)	1.2	1.5	1.5	3.3	2.5

Given that $\Sigma x = 156$, $\Sigma y = 10$, $\Sigma x^2 = 5740$, $\Sigma y^2 = 23.08$ and $\Sigma xy = 356.9$.
Find the regression equation of y on x and use it to find the value of y when $x = 50$. (10 marks)

SECTION B: SURVEYING III

*Answer at least **TWO** questions from this Section in the spaces provided.*

5. (a) With the aid of a sketch, explain the method of determining areas from coordinates.

    (6 marks)

    (b) During the construction of a swimming pool 25 m long and 15 m wide the spot heights for ground surface of the site at 5 m intervals were established as shown in **table 3**.

    Table 3

A4	74.33	B4	74.04	C4	73.42	D4	73.15	E4	72.93	F4	72.48
A3	73.96	B3	73.74	C3	73.30	D3	72.91	E3	72.78	F3	72.04
A2	70.20	B2	73.01	C2	73.14	D2	72.65	E2	72.56	F2	71.96
A1	73.42	B1	73.31	C1	72.86	D1	72.44	E1	72.24	F1	71.88

    If the water level of the pool is to be maintained at 71.00 m and the depths to the left and right are 100 m and 3.00 m respectively, estimate the volume of the earth to be excavated.

    (14 marks)

6. (a) Explain the following terms:

    (i) bulking of soil;

    (ii) sofit level of sewer;

    (iii) road profile.

    (6 marks)

    (b) **Table 4** shows staff readings from one setting of a level in preparing the fixing of sight rails for construction of a drain.

    Table 4

Station	Staff Readings (m)
BM (RL = 1073.450	1.785
Ground level at P	2.800
Invert level at P	3.235
Ground level at Q	2.285
Ground level at R	1.080

    The sewer is to rise from P to R at 1:100 and the distances PQ and QR are 60 m and 75 m respectively. Calculate the:

    (i) reduced levels of inverts at P, Q and R;

    (ii) heights of sight rails at P, Q and R for use with a 2 m bonning rod.

    (14 marks)

7. (a) Derive the formula for the horizontal distance between instrument stations and staff station on a slopping ground (assume staff is held vertical). (8 marks)

(b) **Table 5** shows readings recorded during a tacheometric exercise from instrument point A.

Table 5

Target station	Horizontal angle	Vertical angle	Top reading	Middle reading	Bottom reading
RO	0° 00′				
B	12° 30′	+5° 40′	2.040	1.820	1.600
C	34° 15′	+2° 26′	1.670	1.390	1.110
D	63° 26′	-8° 10′	1.380	1.190	1.000

Taking reduced level at A = 116.210, height of instrument = 1.390, m = 100 and k = 0, calculate:

(i) distances AB, AC and AD;

(ii) difference in level of AB, AC and AD;

(iii) reduced level of BCD. (12 marks)

8. (a) (i) State the overlap required for stereoscopic pairs of aerial photographs;

(ii) Explain how overlapping pairs are obtained. (4 marks)

(b) (i) Calculate the number of exposures required in one strip of 11 km length of the scale is to be 1:4800 and photographs 230 mm square;

(ii) If the area to be surveyed is 5 km wide, calculate the number of parallel flights to be made by the aeroplane. (10 marks)

(c) Distinguish between the **two** types of mosaics. (6 marks)