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2705/301 2709/301
2707/301 2710/301
MATHEMATICS III AND SURVEYING III
June/July 2018
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

# DIPLOMA IN BUILDING CONSTRUCTION
# DIPLOMA IN CIVIL ENGINEERING
# DIPLOMA IN ARCHITECTURE

## MODULE III

MATHEMATICS III AND SURVEYING III

**3 hours**

## INSTRUCTIONS TO CANDIDATES

*You should have the following for this examination:*
*Answer booklet;*
*Drawing instruments;*
*Scientific calculator.*
*This paper consists of **EIGHT** questions in **TWO** sections; **A** and **B**.*
*Answer **FIVE** questions choosing at least **TWO** questions from each section.*
*All questions carry equal marks.*
*Maximum marks for each part of a question are as indicated.*
***Candidates should answer the questions in English.***

**This paper consists of 5 printed pages.**

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

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## SECTION A

*Answer at least **TWO** questions from this section.*

1. (a) Determine the value of x for which the determinant of the matrix M is 18.

$$M=\begin{bmatrix} 1 & x & 1+x \\ 1+x & 1 & x \\ x & 1+x & 1 \end{bmatrix}$$

(6 marks)

(b) Use the inverse matrix method to solve the simultaneous equations below.

$$\begin{aligned} 2x-3y+z &= -7 \\ x+4y-2z &= 15 \\ 3x-y+5z &= -14 \end{aligned}$$

(14 marks)

2. (a) An engineer wishes to estimate the mean deviation of the lengths of bolts from the recommended length. He takes a random sample of 20 bolts and obtains the following deviations from the recommended length:
6, 7, 4, 2, 5, 7, 8, 6, 9, 9, 7, 0, 7, 3, 8, 1, 6, 8, 5, 2 (in centimeters)
Assuming that the bolts are normally distributed construct a 95% confidence interval for the mean deviation of the lengths from the recommended. (9 marks)

(b) Given that $\chi_{n+1}=\frac{2\chi_n^2-3}{3\chi_n^2-5}$

Hence taking $\chi_0 = 1.5$, find the root of the equation correct to four decimal places.
(11 marks)

3. (a) Due to high operation cost, Hekima Manufacturers wish to bond all those machines that do not maintain a certain weekly level of output. Currently, the mean weekly production of the machines is 25,000 units with a standard deviation of 5,000 units. The company wishes to bond 10% of the machines with the lowest weekly production. Further, the weekly production levels are assumed to be normally distributed.

Determine the weekly production level that the company should require its machines to maintain in order for them to be bonded. (4 marks)

(b) Find the value of $\lambda$ such that:

$$\begin{vmatrix} 3-\lambda & 6 \\ 4 & 2-\lambda \end{vmatrix}=6$$

(3 marks)

(c) ABC Ltd sells products X, Y and Z. **Table 1** shows how profit varies with the units of products X, Y and Z sold.

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Table 1

| Profit (shs) | 10,100 | 13,300 | 10,940 |
|---|---|---|---|
| X (units) | 20 | 45 | 42 |
| Y (units) | 40 | 50 | 37 |
| Z (units) | 35 | 30 | 27 |

(i) Formulate a system of simultaneous equations to represent the above information.

(ii) Using Cramer's rule, determine the profit realised per unit sold for products X, Y and Z. (13 marks)

4. A supervisor in a motor vehicle assembly plant wishes to assess the relationship between the number of motor vehicles assembled and the efficiency level of a worker. **Table 2** shows the number of motor vehicles assembled by each of 12 sample workers and their efficiency levels in the last one month.

Table 2

| Worker | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Vehicles assembled (x) | 10 | 8 | 14 | 9 | 13 | 8 | 5 | 6 | 8 | 9 | 10 | 15 |
| Efficiency level (%) (y) | 87 | 78 | 92 | 88 | 90 | 74 | 68 | 65 | 76 | 79 | 80 | 89 |

Determine:

(a) The Pearson's coefficient of correlation between the number of motor vehicles assembled and the efficiency level. Interpret your results. (10 marks)

(b) The least squares regression equation of the efficiency level against the number of motor vehicles assembled. (5 marks)

(c) The estimated efficiency level for a worker who assembles 17 motor vehicles in a month. (2 marks)

(d) The estimated number of motor vehicles assembled by a worker whose monthly efficiency level is 95%. (3 marks)

$$r = \frac{n\Sigma xy - (\Sigma x)(\Sigma y)}{\sqrt{n\Sigma x^2 - (\Sigma x)^2}\sqrt{n(\Sigma y^2) - (\Sigma y)^2}}$$

$$y = bx + a$$

$$b = \frac{n\Sigma xy - (\Sigma x)(\Sigma y)}{n\Sigma x^2 - (\Sigma x)^2}$$

$$a = \frac{\Sigma y}{n} - \frac{b\Sigma x}{n}$$

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## SECTION B

*Answer at least **TWO** questions from this section.*

5. (a) List **two** systems of tacheometry. - Tangential tacheometry (2 marks)

(b) Explain the procedure of determining the multiplying constant (k) and additive constants (c) for a given tacheometer. (9 marks)

(c) **Table 3** shows observations carried out to determine the multiplying constant and the additive constant for a tacheometer. Using the information provided in the table, determine the two constants.

**Table 3**

| Station | Distance m) | Staff readings (m) | | |
|---|---|---|---|---|
| A | 209.641 | 0.800 | 1.855 | 2.910 |
| B | 306.047 | 0.660 | 2.200 | 3.740 |

(9 marks)

6. (a) A tacheometer was fitted with an anallatic lens and was set up at point P. Given the observations in **table 4**. Compute distance TS.

**Table 4**

| Station | Bearings | Staff readings (m) | | | Vertical angle |
|---|---|---|---|---|---|
| T | 335° 30′ | 0.900 | 1.855 | 3.010 | 6° 30′ |
| S | 60° 50′ | 0.560 | 2.200 | 3.640 | − 4° 50′ |

(14 marks)

(b) State **three:**

(i) Sources of errors in tacheometry. - Climatic conditions, Curvature & refraction

(ii) Uses of tacheometry. - Measuring unknown heights

(6 marks)

7. (a) **Figure 1** shows a distribution of spot heights within a rectangular area with regular spacing of 20 m between the spots heights. Calculate the volume of the area. (14 marks)

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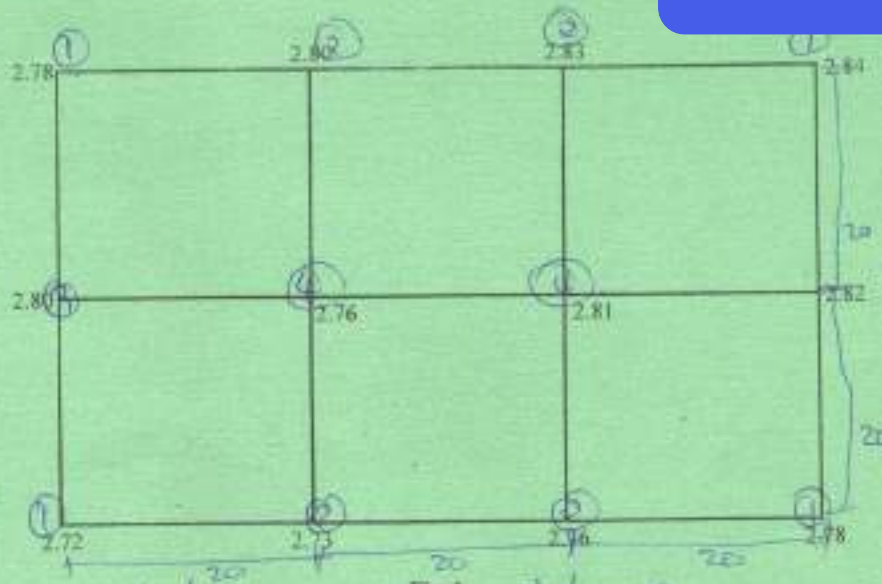


Fig. 1

(b) Using illustrations explain the balancing line and the haul on a mass-haul diagram. (6 marks)

8. **Figure 2** shows a piece of land with a straight and irregular boundaries. Offset were measure from line RU to the irregular boundary at an interval of 30 m as shown in **table 5**. Use the information provided to determine the area of the piece of land in hectares.

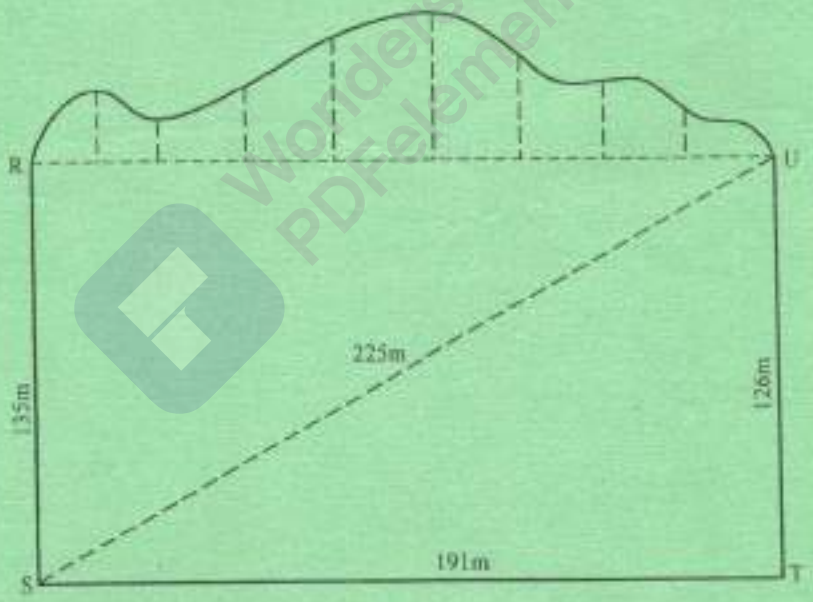


Fig. 2

**Table 5**

| Distance from R (m) | 0.00 | 30 | 60 | 90 | 120 | 150 | 180 |
|---|---|---|---|---|---|---|---|
| Offset (m) | 0.00 | 3.7 | 4.9 | 4.2 | 2.8 | 3.6 | 0.00 |

(20 marks)

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## SECTION B

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(b) Explain the procedure of determining the multiplying constant (k) and additive constants (c) for a given tacheometer. (9 marks)

(c) **Table 3** shows observations carried out to determine the multiplying constant and the additive constant for a tacheometer. Using the information provided in the table, determine the two constants.

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(i) Sources of errors in tacheometry.

(ii) Uses of tacheometry.

(6 marks)

7. (a) **Figure 1** shows a distribution of spot heights within a rectangular area with regular spacing of 20 m between the spots heights. Calculate the volume of the area. (14 marks)