

2705/301

2707/301

2709/301

2710/301

**MATHEMATICS III AND
SURVEYING III**

Oct./Nov. 2017

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;

Scientific calculator;

Drawing instruments.

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 questions carry equal marks.

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

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.

SECTION A: MATHEMATICS III

Answer at least TWO questions from this section.

1. (a) Determine the values of
- x
- if matrix
- A
- is singular.

$$A = \begin{bmatrix} 2-x & -1 & 1 \\ -1 & 2-x & -1 \\ 1 & -1 & 2-x \end{bmatrix} \begin{matrix} + \\ - \\ + \end{matrix} \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} \quad (10 \text{ marks})$$

- (b) Three forces
- F_1
- ,
- F_2
- and
- F_3
- in Newtons acting on a structural system satisfy the simultaneous equations:

$$\begin{aligned} 3F_1 + 2F_2 - 2F_3 &= 32 \\ 4F_1 + 3F_2 + 3F_3 &= 4 \\ -2F_1 + F_2 - F_3 &= 2 \end{aligned}$$

$$\begin{pmatrix} F_1 \\ F_2 \\ F_3 \end{pmatrix} + \begin{pmatrix} 3 & 2 & -2 \\ 4 & 3 & 3 \\ -2 & 1 & -1 \end{pmatrix} = \begin{pmatrix} 32 \\ 4 \\ 2 \end{pmatrix}$$

Use the inverse matrix method to determine the values of the forces. (10 marks)

2. (a) Given that
- X_n
- is an approximation to the root of the equation
- $X^2 - 5X + 2 = 0$

- (i) Show, using the Newton-Raphson method, that a better approximation
- X_{n+1}
- , is given by:

$$X_{n+1} = \frac{X_n^2 - 2}{2X_n - 5}$$

- (ii) Hence, find the root of the equation to three decimal places taking the first approximation
- $x_0 = 4$
- . (8 marks)

- (b) Table 1 represents a polynomial
- $f(x)$
- .

Table 1

x	-1	0	1	2	3	4	5	6
$f(x)$	4	3	10	43	120	259	478	795

$$\begin{pmatrix} 6 & 2 \end{pmatrix} = \begin{pmatrix} 10 \\ 01 \end{pmatrix}$$

Use Newton-Gregory interpolation formula to determine:

- (i)
- $f(0.5)$
-
- (ii)
- $f(5.3)$

(12 marks)

3. (a) If 10% of nails produced by machine are defective. Determine the probability that in a random sample of 8 nails, at most two will be defective. (4 marks)
- (b) Concrete blocks produced in a plant have weights that are normally distributed with a mean μ and standard deviation σ . Given that 9.18% have weights less than 35 kg and 3.92% have weights above 95 kg, determine the mean and standard deviation. (5 marks)

(c) The diameter of a steel pipe used in construction is assumed to be a continuous random variable x with a probability density function.

$$f(x) = \begin{cases} kx(1-x^2), & 0 \leq x \leq 1 \\ 0, & \text{elsewhere.} \end{cases}$$

Find the value of

- (i) constant k ;
 (ii) mean of x ;
 (iii) mode of x .
- (11 marks)

4. (a) Two random variables having the least square regression lines with equations

$$4x + 3y - 28 = 0 \text{ and } 7x + 2y - 34 = 0;$$

determine the:

- (i) mean values of x and y .
 (ii) Karl Pearson's coefficient of correlation. (8 marks)

(b) A random sample of 12 components has a mean weight of 50 grams and standard deviation of 9 grams. Determine the:

- (i) 95% confidence limit;
 (ii) 99% confidence interval for the mean of the components. (8 marks)

(c) The mean and standard deviation of a binomial distribution are 40 and 6 respectively. Determine the:

- (i) probability of success;
 (ii) sample size. (4 marks)



$$\begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix}$$

$$2x^2 - 4x + 10 - x^2 + 9x^2 + 5x$$

$$x^2 - 2x + 5$$

$$2(2-x) - x(2-x)$$

$$4 - 2x - 2x + x^2$$

$$-1(2-x)$$

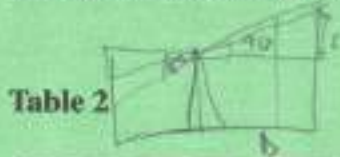
SECTION B: SURVEYING III

Answer at least TWO questions from this section.

5. (a) Outline:

- (i) two systems of tacheometry
- (ii) the field procedure of determining the tacheometric constants. (10 marks)

(b) Use the information in Table 2 to determine the tacheometric constants. (10 marks)



$D = k_1 + k_2$
 $k_1 = 0$
 $k_2 = 100$
 $S = 100 \sin^2 \alpha$
 $48 = 2 \cdot 0 \cdot 14 + k_2$

Stadia readings		Vertical Circle reading	Horizontal distances (m)
Top	Mid		
1.509	1.286	90° 00' 58"	48
2.847	2.448	85° 17' 48"	60

6. ✓

(a) Differentiate between haul and average haul distance as used in earth work. (4 marks)

- (b) (i) Define a mass haul diagram.
- (ii) Outline the procedure of constructing mass haul diagram. (6 marks)

(c) Table 3 shows observations made using a tacheometer fitted with an anallactic lens. Use this information to calculate:

- (i) the distance PQ;
- (ii) the reduced levels of P and Q. (10 marks)

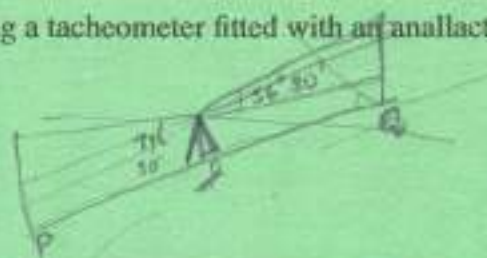


Table 3

Instrument station	Staff station	Bearing	Slope angle	Hair readings	Remark
R	P	56° 30'	07° 30'	2.155	Reduced level of R = 230 m
				2.755	
				3.355	
	Q	97° 30'	12° 30'	2.250	
				3.000	
				3.750	

$b = 100 \sin^2 \theta$
 $H = 50 \sin 2\theta$
 $R_{LA} = R_{LB} + (i + H) - m \tan^2 \theta$
 $R_{LC} = R_{LB} + (i - H) - m \tan^2 \theta$

7.

(a) With the aid of sketches, outline the procedure for setting out a rectangular structure using a theodolite and a tape. (9 marks)

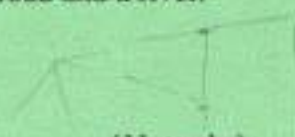


(b) Table 4 shows the chainages and offsets of a strip of land between a road and a river. Compute the area of the land in hectares using

- (i) Simpson's rule;
- (ii) Trapezoidal rule.

$$\frac{W}{2} (A_1 + A_n + 2 \sum_{i=1}^{n-1} A_i)$$

$$\frac{W}{2} (A_1 + A_n + 4E + 2O)$$



(11 marks)

Table 4

Chainage (m)	0	10	20	40	60	90	120	130	140
Offset (m)	35.8	66.2	65.7	74.6	77	75.4	67.8	58.4	47

8. (a) Define the term "photogrammetry". (2 marks)

(b) State three differences between a map and a photograph. (6 marks)

(c) A vertical photograph at a scale of 1: 10,000 is to be taken of an area whose mean ground level is 400 m above mean sea level. If the camera has a focal length of 152 mm, find the flying height above mean sea level. (3 marks)

(d) In a pair of overlapping photographs, the mean photo base length is 99.85 mm and the mean ground level is 80 m above datum. Two near by points are observed and the following information in Table 5 was obtained.

Table 5

Point	Height above datum (m)	Parallax bar reading (mm)
R	68	8.34
S		10.56

If the flying height is 3200 m above datum and the focal length of the camera is 210 mm find the height of S above datum. (9 marks)

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