2705/301 2709/301
2707/301 2710/301
MATHEMATICS III AND SURVEYING III
June/July 2019
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

You should have the following for this examination:
Answer booklet;
Scientific calculator;
Mathematical tables;
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**, at least **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 indicated.
Use the tables provided in the question paper.
Candidates should answer the questions in English.

This paper consists of 6 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.*

1. (a) Given that X_n is an approximation to the root of equation $x^3 - 5x + 3 = 0$, use Newton Raphson method to show that a better approximation is given by:

$$x_{n+1} = \frac{2x_n^3 - 3}{3x_n^2 - 5}$$

hence, by taking $x_0 = 0.5$, determine the root correct to five decimal places. (9 marks)

(b) **Table 1** represents a polynomial function $f(x)$:

Table 1:

x	−1	0	1	2	3	4	5
$f(x)$	8	3	−2	−1	12	43	98

Use the Newton-Gregory interpolation to determine $f(x)$, and hence calculate:

(i) $f(-1.5)$,

(ii) $f(4.6)$.

(11 marks)

2. (a) Given the matrices:

$$A = \begin{pmatrix} 2 & -1 & 1 \\ 1 & 0 & -2 \\ 3 & 4 & 2 \end{pmatrix} \text{ and } B = \begin{pmatrix} 1 & 0 & 4 \\ 2 & -2 & -1 \\ 3 & -1 & 0 \end{pmatrix}$$

Show that $(AB)^T = B^T A^T$.

(9 marks)

(b) Tensions T_1, T_2 and T_3 in Newton's acting on a mechanical system satisfy the simultaneous equations below:

$$3T_1 + 2T_2 + T_3 = 14,$$
$$T1 - T_2 + 3T_3 = 4,$$
$$4T_1 + 3T_2 + 5T_3 = 23.$$

Use the inverse matrix method to determine the value of the tensions.

(11 marks)

3. (a) The life span of 1800 light bulbs is normally distributed with a mean of 900 and standard deviation of 150 hours. Determine the number of light bulbs with life span of:

(i) more than 1200 hours;

(ii) between 600 and 1050 hours.

(8 marks)

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

$$f(x)\begin{cases} Ke^{-3x}, x \geq 0 \\ 0, \ elsewhere \end{cases}$$

Determine:

(i) value of constant K;

(ii) mean;

(iii) $P(0 \leq x \leq 0.5)$.

(12 marks)

4. (a) A structural engineer is asked to grade a junior college trainee. In order to ensure that he treats the trainee fairly, the engineer repeats his grading. The results are tabulated in **table 2**.

Table 2:

Criteria	A	B	C	D	E	F	G	H	I	J	K	L
1st grading	55	53	78	50	48	61	66	76	85	90	69	45
2nd grading	75	80	89	63	67	69	73	93	87	95	92	59

Using Spearman Rank correlation determine if the two gradings are consistent.

(10 marks)

(b) An experiment was carried out on a small cantilevered steel beam. Various masses were placed on the end of the beam and corresponding deflections measured as shown in **Table 3.**

Table 3:

Mass x (grammes)	Deflection y (mm)
0	0
50.15	0.6
99.90	1.8
150.05	3.0
200.05	3.6
250.20	4.8
299.95	6.0
350.05	6.2
401.00	7.5

(i) Determine the regression equation.

(ii) Predict the deflection when the mass is 220 grams.

(10 marks)

SECTION B: SURVEYING III

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

5. (a) State **three** sources of errors in horizontal tacheometry. (3 marks)

(b) **Table 4** shows tacheometric observations taken at point R with the instrument height being 1.50 m. The tacheometric constants were 100 and zero. The distance between X and Y was measured as 183.42 m. Assuming the ground was level within the triangle RXY and the reduced level at point R was 1042.80 m above datum level. Calculate the volume of filling required to make the area level with the highest point. (17 marks)

Table 4:

Instrument Station	Vertical Angle	Staff readings (m)			Staff Station
		Bottom	Middle	Top	
R	+10°30′	1.80	3.05	4.30	X
	+8°05′	2.40	3.15	3.90	Y

6. (a) State **four** characteristics of mass haul diagram.

(b) A proposed embarkment on a ground sloping at 1 in 20 has side slopes of 1 in 2.5. If the width of road formation is 20 m and its formation height is 5.0 m above the ground. Sketch and label the cross section of embarkment and determine:

(i) the side widths;

(ii) the area of the cross section. (16 marks)

7. (a) **Table 5** shows levels taken during a survey carried out to lay a sewer line. The distance between manhole A and manhole B is 30 m and the distance between manhole B and manhole C is 43 m. The gradient of sewer line is 1:100.

Determine:

(i) ground reduced levels for manhole B and C;

(ii) inverted levels for manhole A, B and C;

(iii) height of sight rails above the ground level at manhole A, B and C when the boning rod is 1.5 m in length.

(14 marks)

Table 5:

Instrument Station	Staff readings (m)			
	I.L at MLA	G.L at Mh A	G.L at Mh B	G.L at Mh C
A	3.578	2.987	2.163	1.985

Reduced level at Ground level at MH A = 1895.86 m

G.L = Ground level
I.L = Inverted level
Mh = Man hole

(b) State **six** factors considered during the setting out of road alignment. (6 marks)

8. (a) Define photogrammetry.

(b) Describe the following methods of photogrammetry:

(i) aerial photogrammetry;

(ii) terrestrial photogrammetry. (6 marks)

(c) State **three** advantages and **three** disadvantages of photographs. (6 marks)

(d) Sketch and label the parts of a vertical aerial photograph. (6 marks)

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