

2705/301 2709/301

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**MATHEMATICS III AND SURVEYING III**

June/July 2019

Time: 3 hours

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**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.**

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:

$$3T_1 + 2T_2 + T_3 = 14,$$

$$T_1 - T_2 + 3T_3 = 4,$$

$$4T_1 + 3T_2 + 5T_3 = 23.$$

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:

$$f(x) \begin{cases} Ke^{-2x}, & x \geq 0 \\ 0, & \text{elsewhere} \end{cases}$$

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
1 <sup>st</sup> grading	55	53	78	50	48	61	66	76	85	90	69	45
2 <sup>nd</sup> 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. (4 marks)
- (b) A proposed embankment 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 embankment 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. (2 marks)
- (b) Describe the following methods of photogrammetry:
- (i) aerial photogrammetry;
  - (ii) terrestrial photogrammetry.
- (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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