2705/301 2709/301
2707/301 2710/301
MATHEMATICS III AND
SURVEYING III
Oct./Nov. 2016
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;
Mathematical table/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 and **one** other question from either sections.*
All questions carry equal marks.
Candidates should answer the questions in English.

This paper consists of 7 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) Kaikai manufacturers Ltd maintenance department ensures that all machines are well lubricated monthly so as to reduce the rate of breakdowns. A recent study on oil usage revealed that 0.4 per cent of the machines are lubricated using not more than 20 litres of oil per month. In addition, oil usage in litres per machine is normally distributed with a variance of 0.0025. The firm uses 120 machines to run its operations and it spends Sh 600 per 20 litre gallon of lubricating oil. A machine that requires more than 20.2 litres of lubricating oil in a month lends an extra cost of Sh 300. Determine:

(i) the mean monthly amount of lubricating oil required per machine;
(ii) the firm's expected lubricating costs per month. (7 marks)

(b) Kups telecommunications Ltd distributes two types of mobile phones; Nokia and Samsung. **Table 1** shows the prices of five sampled models of these two types of mobile phones.

Table 1

Model	I	II	III	IV	V
Nokia	Sh 6,550	Sh 13,500	Sh 15,900	Sh 20,000	Sh 26,500
Samsung	Sh 5,900	Sh 12,000	Sh 16,000	Sh 21,500	Sh 26,000

Construct a 95% confidence interval for the difference between the mean prices of the two types of mobile phones. (13 marks)

2. (a) A businessman distributes three types of beverages within Nairobi City; juice, energy drinks and soda. **Table 2** shows the quantity sold (in dozens) of each beverage as well as the sales made in three days.

Table 2

Day	Juice	Energy drinks	Soda	Sales (Shs)
1	10	8	24	17,060
2	12	14	30	23,240
3	9	11	16	15,090

Using Cramer's rule, determine the selling price per dozen of each beverage. (10 marks)

(b) Given that X_n is an approximation to the root of the equation $X^3 + 2X - 6 = 0$, show using the Newton Raphson method that a better approximation X_{n+1} is given by:

$$X_{n+1} = \frac{2X_n^3 + 6}{3X_n^2 + 2}$$

Hence approximate the positive root to the equation correct to three significant figures. (10 marks)

3. (a) A 3-hour examination is given to all prospective sales people of a national retail chain. The time "x" in hours taken to complete the examination has been found to be a random variable with a density function:

$$f(x) = \begin{cases} \frac{10x - x^2}{36} & ; \ 0 \le x \le 3 \\ 0 & ; \ elsewhere \end{cases}$$

Determine:

(i) the probability that someone will complete the exam in one hour or less;
(ii) the variance of the distribution hence the standard deviation. (11 marks)

(b) Let x_1 and x_2 be independent standard normal random variables. Define the random variables y_1 and y_2 as:

$$y_1 = 2x_1 + x_2 \text{ and } y_2 = x_1 - x_2$$

Find:

(i) $E(y_1)$;

(ii) $E(y_2)$;

(iii) $Cov(y_1, y_2)$. (9 marks)

4. (a) Usually, 12% of the items produced by a firm are defective. A quality assurance analyst selects a random sample of 8 items from a day's production run in this firm. Determine:

(i) the expected number of defective items in the selected sample;
(ii) the probability that out of the selected items, none is defective;
(iii) the probability that out of the selected items, between three and five items are defective;
(iv) the variance hence the standard deviation. (13 marks)

(b) **Table 3** shows the effects of different standing positions of a surveyor on the angles of elevation of ten house-tops.

Table 3

House	Angle of elevation in degrees (x)	Distance from foot of the house in metres (y)
1	68	2
2	65	5
3	70	1
4	62	10
5	60	9
6	55	13
7	58	11
8	64	3
9	69	4
10	63	6

Calculate the Spearman's rank coefficient of correlation between the angle of elevation (x) and the distance from the foot of the house (y). (7 marks)

SECTION B: SURVEYING III

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

5. **Table 4** shows readings taken from a theodolite centred at point C. Given the height of the instrument trunnion axis is 1.495 m above point C and the reduced level of point C is 1646.872 M above the mean sea level, calculate:

(i) reduced levels of D and E;

(ii) horizontal distance DE.

Take the instrument multiplying and additive constants as 100 and 0 respectively. (20 marks)

Table 4

Staff position	Staff reading			Vertical circle reading	Horizontal bearings
	Upper (m)	Middle (m)	Lower (m)		
D	3.440	3.246	3.052	86° 38' 50"	156° 49' 31"
E	2.758	2.530	2.302	93° 21'33"	198° 07'18"

6. The volumes between section along a 1200 m length of proposed road are shown in **table 5**. Plot a Mass Haul diagram for the length of road using a vertical scale of 1 cm to 1000 m^3 and horizontal scale of 1 cm to 100 m. Hence determine suitable position of balancing line so that:

(i) an equal surplus at chainage O and chainage 1200 m;

(ii) A surplus at chainage 1200 m but none at chainage O;

(iii) a surplus at chainage O but none at chainage 1200 m. (20 marks)

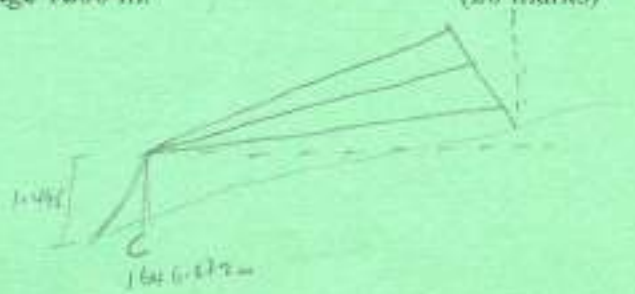

Table 5

Chainage	Volume between sections m^3
0	
	+2100
100	
	+2800
200	
	+1600
300	
	-900
400	
	-2000
500	
	-4600
600	
	-4700
700	
	-2400
800	
	+1100
900	
	+3900
1000	
	+3500
1100	
	+2800
1200	

7. (a) Explain how the following methods are used in setting a point with known coordinates:

(i) polar coordinate;
(ii) intersection. (8 marks)

(b) A tower was photographed from an elevation of 1500 m above datum. The radial distances of the top and bottom of the tower from the principal points are 121.6 mm and 91.2 mm respectively. If the bottom of the tower has an elevation of 300 m, determine the height of the tower. (4 marks)

(c) Three points A, B and C at elevation 1500 m, 900m and 1200 m respectively were selected in order to determine the average scale of an aerial photograph. If the flying height of the aircraft above mean sea level is 3600 m and the focal length of the camera is 220 mm, calculate:

(i) the average scale of the aerial photograph;
(ii) the corresponding length of a line on the ground given that on the aerial photograph it was measured as 152.06 mm;
(iii) the height above datum of the same aircraft if the average altitude of the terrain was 2000 m and the scale of the photograph given as 1 in 5000.

(8 marks)

8. (a) **Table 6** shows offset, 6 m apart measured at right angle from a traverse line to an irregular boundary. Calculate the area enclosed using the Simpson's rule.

(6 marks)

Table 6

Chainage (m)	0	6	12	18	24	30	36	42	48	54
Offsets (m)	1.24	3.16	3.46	4.52	4.82	3.46	2.73	3.49	2.84	1.52

(b) A reservoir is to be formed in a river valley by building a dam across. The lowest point in the reservoir is at reduced level of 250 m above datum while, the top of water level should not exceed a reduced level of 264.5 m. The area enclosed by each contour is given in **table 7**. Calculate the volume of water that can be stored in the reservoir using:

(i) end area method;
(ii) Simpson's rule for volume. (14 marks)

Table 7

Contour (m)	Area enclosed (m^2)
250	1874
251.1	6355
253.0	11070
254.5	14152
256.0	19310
257.5	22605
259.0	24781
260.5	26349
262.0	29830
263.5	33728
265.0	37800

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