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MATHEMATICS III AND SURVEYING III

Oct./Nov. 2022

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;

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 indicated.

The standard normal distribution table is attached.

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.

SECTION A: MATHEMATICS III

Answer TWO questions from this section.

1. (a) Given the matrices:

$$P = \begin{bmatrix} 2 & 1 & -2 \\ 3 & -1 & 1 \\ 2 & 4 & 1 \end{bmatrix} \text{ and } Q = \begin{bmatrix} 3 & -2 & 1 \\ 2 & 1 & 1 \\ 1 & 1 & -2 \end{bmatrix},$$

determine the:

- (i) $(P + Q)^2 + 3Q$
 (ii) Q^{-1}

(14 marks)

- (b) Use the result in (a) above to solve the simultaneous equations:

$$3x - 2y + z = 10$$

$$2x + y + z = 3$$

$$x + y - 2z = -7$$

(6 marks)

2. (a) Use Newton-Raphson method to determine the root of the equation $x^4 - 3x^2 + 6 = 0$ near the point $x = 2$.

(11 marks)

- (b) A function $f(x)$ is described by the data in table 1.

Table 1

x	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7
$f(x)$	2.7183	2.8758	3.0042	3.1582	3.3201	3.4903	3.6693	3.8574

Use Newton-Gregory interpolation method to evaluate correct to 3 decimal places, $f(2.04)$.

(9 marks)

3. (a) The number of telephone calls received at an exchange during week day mornings follow a Poisson distribution with a mean of 6 calls per five minutes period. Determine the probability that:
- (i) there are no calls in the next five minutes.
 - (ii) 3 calls are received in the next five minutes.
 - (iii) fewer than 2 calls are received between 11.00 a.m and 11.05 a.m.
- (6 marks)

- (b) A random variable x is normally distributed with mean μ and variance σ^2 . Given that

$$P(x < 42.32) = 0.0287 \text{ and}$$

$$P(x > 59.12) = 0.0217$$

Determine:

- (i) mean;
 - (ii) variance;
 - (iii) probability that x lies between 39.12 and 53.13.
- (14 marks)
4. (a) An experiment was done to determine the effect of acidity on a certain chemical process. The experiment varied the Ph x of the solution and recorded the yield y of the process as shown in table 2.

Table 2

x	1	1	3	3	3	4
y	1.7	1.5	2	3	3.1	3.5

Determine the regression equation of y on x .

(15 marks)

- (b) Given that the observed values of quantities x and y are as shown in table 3.

Table 3

x	2	6	10
y	5	3	7

Determine the sum of the squares of the errors for the regression line $y = 0.25x + 3.5$.
(5 marks)

SECTION B: SURVEYING III

Answer TWO questions from this section.

5. (a) List **three** instruments used in tacheometry. (3 marks)
- (b) The following readings were recorded when using a theodolite stadia lines.

Vertical Angle	Staff Readings
$0^{\circ} 0'$	3.64 m
$-2^{\circ} 36'$	0.52 m

The reduced level of the instruments height of collimation was 28.73 m. The levelling staff was held vertically. Calculate the horizontal distance of the staff station from the instrument and the reduced level of the staff position. (7 marks)

- (c) Explain **three** errors in stadia measurement. (6 marks)
- (d) State **four** features of tacheometer. (4 marks)

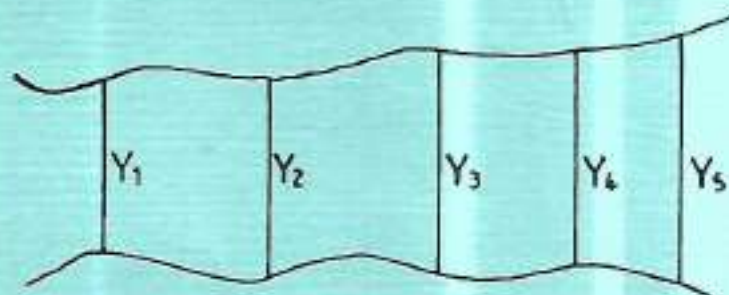
6. (a) Discuss **five** factors that influence the choice of balancing lines in mass haul diagrams. (10 marks)
- (b) A parcel of land has three straight sides AB, BC and CD. The fourth side is irregular. The dimensions of the sides are as follows:

AB	=	168 m
BC	=	255 m
CD	=	180 m
DA	=	240 m
AC	=	340 m

The offsets measured from side DA to the irregular boundary are as shown on the table below.

Distance from point A (m)	0	60	120	180	240
Offsets (m)	0.0	5.8	1.5	4.8	0.0

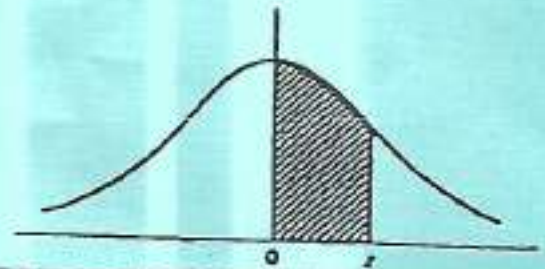
- (i) Sketch the parcel of land. (2 marks)
- (ii) Calculate the area of the land in hectares. (8 marks)
(Use double median distance method)
7. (a) Outline **five** advantages of automatic site plumb in establishing precise vertical alignment. (5 marks)
- (b) Explain the general procedure for setting out works. (12 marks)
- (c) Calculate the area of irregular plot of land. (Use trapezoidal rule). The strip is 20 m wide and the ordinate readings y_1 , y_2 , y_3 , y_4 and y_5 are 65, 68, 70, 73, 75 respectively. (3 marks)



8. (a) Define the following terms as used in photo planes:
- (i) positive;
 - (ii) negative. (2 marks)
- (b) Explain the differences between maps and aerial photographs. (8 marks)
- (c) Outline the procedure for proper orientation of stereo model. (10 marks)

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Partial areas under the
standardised normal curve



$z = \frac{x - \bar{x}}{\sigma}$	0	1	2	3	4	5	6	7	8	9
0.0	0.0000	0.0040	0.0080	0.0120	0.0159	0.0199	0.0239	0.0279	0.0319	0.0359
0.1	0.0398	0.0438	0.0478	0.0517	0.0557	0.0596	0.0636	0.0678	0.0714	0.0753
0.2	0.0793	0.0832	0.0871	0.0910	0.0948	0.0987	0.1026	0.1064	0.1103	0.1141
0.3	0.1179	0.1217	0.1255	0.1293	0.1331	0.1388	0.1406	0.1443	0.1480	0.1517
0.4	0.1554	0.1891	0.1628	0.1664	0.1700	0.1736	0.1772	0.1808	0.1844	0.1879
0.5	0.1915	0.1950	0.1985	0.2019	0.2054	0.2086	0.2123	0.2157	0.2190	0.2224
0.6	0.2257	0.2291	0.2324	0.2357	0.2389	0.2422	0.2454	0.2486	0.2517	0.2549
0.7	0.2580	0.2611	0.2642	0.2673	0.2704	0.2734	0.2760	0.2794	0.2823	0.2852
0.8	0.2881	0.2910	0.2939	0.2967	0.2995	0.3023	0.3051	0.3078	0.3106	0.3133
0.9	0.3159	0.3186	0.3212	0.3238	0.3264	0.3289	0.3215	0.3340	0.3365	0.3389
1.0	0.3413	0.3438	0.3451	0.3485	0.3508	0.3531	0.3554	0.3577	0.3599	0.3621
1.1	0.3643	0.3665	0.3686	0.3708	0.3729	0.3749	0.3770	0.3790	0.3810	0.3830
1.2	0.3849	0.3869	0.3888	0.3907	0.3925	0.3944	0.3962	0.3980	0.3997	0.4015
1.3	0.4032	0.4049	0.4066	0.4082	0.4099	0.4115	0.4131	0.4147	0.4162	0.4177
1.4	0.4192	0.4207	0.4222	0.4236	0.4251	0.4265	0.4279	0.4292	0.4306	0.4319
1.5	0.4332	0.4345	0.4357	0.4370	0.4382	0.4394	0.4406	0.4418	0.4430	0.4441
1.6	0.4452	0.4463	0.4474	0.4484	0.4495	0.4505	0.4515	0.4525	0.4535	0.4545
1.7	0.4554	0.4564	0.4573	0.4582	0.4591	0.4599	0.4608	0.4616	0.4625	0.4633
1.8	0.4641	0.4649	0.4656	0.4664	0.4671	0.4678	0.4686	0.4693	0.4699	0.4706
1.9	0.4713	0.4719	0.4726	0.4732	0.4738	0.4744	0.4750	0.4756	0.4762	0.4767
2.0	0.4772	0.4778	0.4783	0.4785	0.4793	0.4798	0.4803	0.4808	0.4812	0.4817
2.1	0.4821	0.4826	0.4830	0.4834	0.4838	0.4842	0.4846	0.4850	0.4854	0.4857
2.2	0.4861	0.4864	0.4868	0.4871	0.4875	0.4878	0.4881	0.4884	0.4888	0.4890
2.3	0.4893	0.4896	0.4898	0.4901	0.4904	0.4906	0.4909	0.4911	0.4913	0.4916
2.4	0.4918	0.4920	0.4922	0.4925	0.4927	0.4929	0.4931	0.4932	0.4934	0.4936
2.5	0.4938	0.4940	0.4941	0.4943	0.4945	0.4946	0.4948	0.4949	0.4951	0.4952
2.6	0.4953	0.4955	0.4956	0.4957	0.4959	0.4960	0.4961	0.4962	0.4963	0.4964
2.7	0.4965	0.4966	0.4967	0.4968	0.4969	0.4970	0.4971	0.4972	0.4973	0.4974
2.8	0.4974	0.4975	0.4976	0.4977	0.4977	0.4978	0.4979	0.4980	0.4980	0.4981
2.9	0.4981	0.4982	0.4982	0.4983	0.4984	0.4984	0.4985	0.4985	0.4986	0.4986
3.0	0.4987	0.4987	0.4987	0.4988	0.4988	0.4989	0.4989	0.4989	0.4990	0.4990
3.1	0.4990	0.4991	0.4991	0.4991	0.4992	0.4992	0.4992	0.4992	0.4993	0.4993
3.2	0.4993	0.4993	0.4994	0.4994	0.4994	0.4994	0.4994	0.4995	0.4995	0.4995
3.3	0.4995	0.4995	0.4995	0.4996	0.4996	0.4996	0.4996	0.4996	0.4996	0.4997
3.4	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4998
3.5	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998
3.6	0.4998	0.4998	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999
3.7	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999
3.8	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999
3.9	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000

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