

2501/203 2508/203

2502/203 2509/203

2503/203

ENGINEERING MATHEMATICS II

Oct./Nov. 2018

Time: 3 hours



THE KENYA NATIONAL EXAMINATIONS COUNCIL

**DIPLOMA IN MECHANICAL ENGINEERING
(PRODUCTION OPTION)**

(INDUSTRIAL PLANT OPTION)

DIPLOMA IN AUTOMOTIVE ENGINEERING

DIPLOMA IN WELDING AND FABRICATION

DIPLOMA IN CONSTRUCTION PLANT ENGINEERING

MODULE II

ENGINEERING MATHEMATICS II

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:

Answer booklet;

Mathematical tables/Non-programmable scientific calculator.

*Answer **FIVE** questions of the following **EIGHT** questions.*

All questions carry equal marks.

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

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.

1. (a) Differentiate $f(x) = \cos(x+2)$ from first principles. (6 marks)
- (b) Find $\frac{dy}{dx}$, given that
- (i) $y = \cos^3 2x$;
- (ii) $y = \frac{1-x^2}{1+x^2}$;
- (iii) $x^2 + 2xy + y^4 = 4$. (9 marks)
- (c) Determine the maximum area of a rectangular piece of land that is enclosed by 1200 metres of fence. (5 marks)
2. (a) Evaluate the integrals:
- (i) $\int_0^{\pi} (4\sin x + 3\cos x - 2x) dx$;
- (ii) $\int_0^1 \frac{2x+3}{\sqrt{x^2+3x+2}} dx$;
- (iii) $\int \frac{3x^2}{(x-2)(x^2+4)} dx$. (12 marks)
- (b) Sketch the region bounded by the curves $y^2 = 9x$ and $y = \frac{x^2}{\sqrt{3}}$, and use integration to determine the area of the region. (8 marks)
3. (a) (i) Obtain the first four non-zero terms in the Maclaurin's series expansion of $f(x) = \cos^2 x$.
- (ii) Hence, determine $\int_0^1 \frac{\cos^2 x}{x^{\frac{1}{2}}} dx$, correct to three decimal places. (12 marks)
- (b) Use Taylor's theorem to expand $\sin\left(\frac{\pi}{3} + h\right)$ in ascending powers of h as far as the term in h^3 . Hence determine $\sin 62^\circ$ correct to four decimal places. (8 marks)

4. (a) Given that $Z = x^2 \cos(x - 3y)$, show that:

$$\frac{\partial^2 Z}{\partial x \partial y} = \frac{\partial^2 Z}{\partial y \partial x}$$

(4 marks)

- (b) The rate of flow of a gas in a pipe is given by the equation $V = \frac{cd^{\frac{1}{2}}}{T^{\frac{1}{2}}}$,

Where c is a constant, d is the diameter of the pipe and T is the thermodynamic temperature of the gas. Use partial differentiation to determine the approximate percentage change in V , if d increases by 2% and T decreases by 1.2%. (6 marks)

- (c) Locate the stationary point of the function $Z = 2x^3 - 12xy + 2y^3$ and determine their nature. (10 marks)

5. (a) Find the sum of all the numbers between 4 and 208 which are exactly divisible by 2. (5 marks)

- (b) In a geometric progression the product and sum of the first three terms are 512 and 28 respectively. Determine the:

- (i) first term;
- (ii) common ratio;
- (iii) sum of the first seven terms.

(8 marks)

- (c) If Ksh. 50,000 is invested at compound interest of 6% per annum, determine using geometric progression the:

- (i) value after 5 years;
- (ii) time taken for the investment to amount to more than Ksh. 120,000 correct to the nearest year.

(7 marks)

6. (a) Given the vectors $\underline{A} = \underline{i} - 3\underline{j} + \underline{k}$, $\underline{B} = -2\underline{i} + 3\underline{j} + 2\underline{k}$ and $\underline{C} = 3\underline{i} + 4\underline{j} - \underline{k}$, determine the magnitude of the vector $\underline{D} = \underline{A} + 3\underline{B} - 2\underline{C}$. (5 marks)

- (b) Determine the area of a triangle whose sides are 11 cm, 8 cm and 7 cm. (4 marks)

- (c) The frustum of a pyramid has a square top of side 4 cm and a square base of side 6 cm. If the slant edge of the frustum is 4.5 cm. Determine the volume of the frustum. (11 marks)

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7. (a) Table 1 shows the lengths in centimeters of 40 steel rods in a workshop.

Table 1

Length in cm	32 - 34	35 - 37	38 - 40	41 - 43	44 - 46	47 - 49
Frequency	6	5	10	12	4	3

Determine the:

- (i) mode;
(ii) median.

(7 marks)

- (b) Table 2 shows the weights in kilograms of 50 students in a class.

Table 2

46	59	82	80	56	31	61
37	44	72	62	34	55	73
55	53	60	60	51	43	
36	28	46	48	82	53	
50	48	57	51	59	41	
51	51	32	58	52	72	
75	76	47	32	25	66	
80	37	51	50	60		

$0 = 1$
 $2 = 1$
 3
 $0 = 1$
 $1 = 5$
 $K = 6$
 $1 = 10$
 $2 = 15$
 $3 = 20$
 $4 = 25$
 $5 = 30$
 $6 = 35$
 $7 = 40$
 $8 = 45$
 $9 = 50$

Group the data into a frequency distribution using classes of 16 - 25, 26 - 35, 36 - 45, ...
Hence determine the:

- (i) mean;
(ii) standard deviation;
(iii) coefficient of variation.

(13 marks)

8. (a) A machine produces 20% defective bearings. If a sample of 20 bearings are drawn at random, determine using the Poisson's distribution the probability that there will be:
- (i) no defective bearing;
 - (ii) at most two defective bearings;
 - (iii) at least three defective bearings.

(8 marks)

- (b) The diameter of a bolt is a continuous random variable x with a probability density function:

$$f(x) = \begin{cases} kx(4-x) & 0 \leq x \leq 2 \\ 0 & \text{elsewhere} \end{cases}$$

Determine the:

- (i) value of the constant k ;
- (ii) mean;
- (iii) mode;
- (iv) $P(1 \leq x \leq 2)$.

(12 marks)

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