2501/203 2503/203 2509/203
2502/203 2508/203
ENGINEERING MATHEMATICS II
Oct./Nov. 2021
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN MECHANICAL ENGINEERING
(PRODUCTION OPTION)
(PLANT OPTION)
(WELDING AND FABRICATION OPTION)
DIPLOMA IN AUTOMOTIVE ENGINEERING
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;*
- *Drawing instruments;*
- *Mathematical tables/Non-programmable scientific calculator.*

*Answer any **FIVE** 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 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.

1. (a) Determine the derivative of $\frac{1}{3-x}$ from first principles. (5 marks)

(b) Given that $y = \ln\left[\frac{\cos x - \sin x}{\cos x + \sin x}\right]$

Show that $\frac{dy}{dx} = -2\sec 2x$

(15 marks)

2. (a) The length distribution of copper rods is shown in Table I.

Table I

Length in cm	0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39
No. of rods	3	4	5	4	6	3	2	3

Using an assumed mean of 13; determine the:

(i) mean;

(ii) standard deviation of the distribution.

(11 marks)

(b) The distribution of marks scored by 105 students in Technical drawing test are shown in Table II. If the modal mark is 24 determine the:

(i) value of a and b;

(ii) median of the distribution.

Table II

Marks	0-10	10-20	20-30	30-40	40-50
Frequency	14	a	27	b	15

(9 marks)

3. (a) Evaluate the integral $\int_0^{\pi/2} 4x^2 \sin x \, dx$

(5 marks)

(b) Determine the integral $\int_0^2 \frac{4x^2 + 3x + 5}{(x+2)(x^2+4)} dx$,

correct to **two** decimal places. (9 marks)

(c) Determine the area bounded by the curves $y = \frac{1}{2}x^2 + 1$, $x = 0$ and $x = 3$ and the x-axis, using the mid-ordinate rule with three strips.

(6 marks)

4. (a) (i) Use Taylor's series to obtain the first **four** terms of the expansion of $\sin\left(\frac{\pi}{4} + h\right)$.

(ii) Use the expansion in 4 (a)(i) to determine $\sin 45°30'$ correct to 4 decimal places.

(9 marks)

(b) Determine the first four terms of the Maclaurin's series expansion of $\sin^{-1}x^2$.

(11 marks)

5. (a) The diameter of metal bolts produced by a factory is normally distributed with a mean of 5 cm and standard deviation of 0.4 cm. Any bolt whose diameter is less than 4.8 cm or more than 6.2 cm is sold at Ksh. 42 otherwise the price is Ksh. 64. If customer orders 110 bolts from the factory. Calculate the amount of money he is likely to spend.

(9 marks)

(b) A continuos random variable T has probability density function defined by:

$$f(t) = \begin{cases} \frac{C^2}{2}e^{-ct}, & t \geq 0 \\ 0 & otherwise; \end{cases}$$

where C is a constant.

Determine the:

(i) value of C;

(ii) mean;

(iii) standard deviation.

(11 marks)

6. (a) Given that $Z = \ln\left(\frac{y}{x}\right)^{(x^2+y^2)}$,

determine $\frac{x\partial z}{\partial x} + y\frac{\partial z}{\partial y}$ in terms of Z.

(7 marks)

(b) The side 'a' of a triangle is calculated from $a^2 = b^2 + c^2 - 2bc\cos A$. If b, c, and A are measured and recorded as 2 mm, 4 mm and 60° respectively and the measurement errors which occur are + 0.1 mm, + 0.15 mm and +2° respectively. Determine using partial differentiation the error in the calculated value of the side 'a' correct to two decimal places. (13 marks)

7. (a) The fourth and the seventh terms of an arithmetic progression are 11 and 17 respectively.
Determine the:

(i) first term and the common difference;

(ii) sum of the first 12 terms.

(7 marks)

(b) The average of the first and fourth terms of a geometric progression is 140. Given that the first term is 64, determine the:

(i) common ratio;

(ii) sum of the first 10 terms.

(10 marks)

(c) A technician joined a firm with a starting salary of K£ 8100 per annum, with an annual increase of 10%. Determine the amount he will have earned at the end of 7 years. (3 marks)

8. (a) Figure 1 shows a right pyramid standing on a rectangular base ABCD. AB = 8 cm, BC = 15 cm and each slant edge is 12 cm long. M is the mid point of BC.

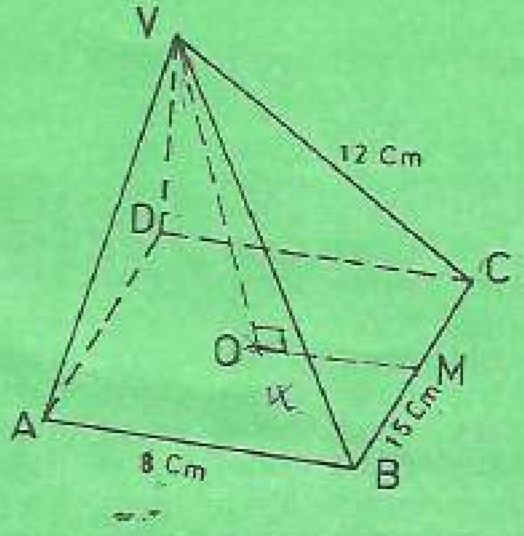

Fig.1

Calculate the:

(i) vertical height;

(ii) volume of the pyramid.

(8 marks)

(b) Prove that the vectors $\underline{A} = 3\underline{i} + \underline{j} - 2\underline{k}$, $\underline{B} = -\underline{i} + 3\underline{j} + 4\underline{k}$ and $\underline{C} = 4\underline{i} - 2\underline{j} - 6\underline{k}$ from the sides of a triangle and hence determine the midpoints of the sides.

(12 marks)