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**ENGINEERING MATHEMATICS I**

Oct./Nov. 2022

Time: 3 hours



**THE KENYA NATIONAL EXAMINATIONS COUNCIL**  
**DIPLOMA IN MECHANICAL ENGINEERING**  
**(PRODUCTION OPTION)**  
**(PLANT OPTION)**  
**DIPLOMA IN AUTOMOTIVE ENGINEERING**  
**DIPLOMA IN WELDING AND FABRICATION**  
**DIPLOMA IN CONSTRUCTION PLANT ENGINEERING**

**MODULE I**

**ENGINEERING MATHEMATICS I**

**3 hours**

**INSTRUCTIONS TO THE CANDIDATES**

*You should have the following for this examination:*

*Answer booklet;*

*Mathematical tables/Non-programmable scientific calculator;*

*Drawing instrument.*

*This paper consists of EIGHT questions.*

*Answer any FIVE questions in the answer booklet provided.*

*All questions carry equal marks.*

*Maximum marks for each part of a question are as shown.*

*Candidates should answer the questions in English.*

**This paper consists of 4 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) Use indices to simplify  $\frac{\log 64 - \log 1024 + \log 4096}{\log 512 + \log 32768 + \log 262144}$ .

(6 marks)

(b) Solve the equation:

(i)  $(x^2 + 5x) \log_3 9 + (x + 2) \log_3 16 = -12$

(ii)  $9^{x+1} - 3^x = 3^{6+x} - 1$

(15 marks)

2. ✓ (a) Given that  $\cos \theta = \frac{5}{13}$  determine the other five trigonometric ratios of  $\theta$ .

(6 marks)

(b) Prove the trigonometric identity  $\frac{\cos^4 \theta - \cos^2 \theta + \sin^2 \theta}{\cos^2 \theta (1 + \sin \theta) (1 - \sin \theta)} = \tan^4 \theta$

(4 marks)

(c) Solve the equation:

$2 \sin \theta \sin 2\theta - \sin 2\theta + 2 \sin \theta - 1 = 0$ , for  $0 \leq \theta \leq 360^\circ$ .

(10 marks)

3. (a) A committee of 11 members is to be formed from 10 men and 6 women. Determine the number of ways in which it can be done to include at least 4 women. (4 marks)

(b) (i) Use the binomial theorem to expand

$\sqrt{\frac{16+4x}{16-4x}}$  upto the term in  $x^2$ .

(ii) By setting  $x = \frac{1}{20}$  in the result in 3(b)(i) determine the value of  $\sqrt{79}$ .

(11 marks)

(c) Given that  $f = \frac{1}{2\pi\sqrt{LC}}$ , use binomial theorem to determine the percentage change in  $f$  when  $L$  increases by 3% and  $C$  decreases by 4%. (5 marks)

4. (a) Determine the values of  $M$  and  $N$  such that

$4 \cosh 3x + 5 \sinh 3x = Me^{2x} + Ne^{3x}$ .

(5 marks)

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$$\frac{3^{2x+2} - 3^x}{3^{2x} - 1}$$



(b) Prove the identity

$$\frac{\sinh 2\theta + \sinh 4\theta + \sinh 6\theta}{\cosh 2\theta + \cosh 4\theta + \cosh 6\theta} = \frac{2 \tanh 2\theta}{1 + \tanh^2 2\theta}.$$

(6 marks)

(c) Solve the equation:

$$5 \cosh 4x + 9 \sinh 4x = 3.$$

(9 marks)

5. (a) Show that the polar form of the cartesian equation

$$4x^2 + 3y^2 + 2y - 1 = 0 \text{ is } r = \frac{1}{2 + \sin \theta}.$$

(7 marks)

(b) Prove that  $\tan^{-1} \frac{3}{7} + \tan^{-1} \frac{2}{5} = \frac{\pi}{4}$ .

(6 marks)

(c) Determine the logarithmic form of  $\cosh^{-1} 3x$ .

(7 marks)

6. (a) Given the complex numbers  $Z_1 = 4 + 3j$ ,  $Z_2 = 5 - 6j$  and  $Z_3 = 6 + 5j$ ,

determine  $Z = Z_1 + \left[ \frac{Z_2 Z_3}{Z_1 + Z_2} \right]$  in the form  $a + bj$ .

(6 marks)

(b) (i) Show that  $\cos \theta = \cosh j\theta$ .

(ii) Hence express  $\cos^5 \theta$  in terms of the cosines of multiples of  $\theta$ .

(8 marks)

(c) Given that  $Z = 2$  is a root to the equation  $Z^3 - 6Z^2 + 21Z + x = 0$ ,

(i) determine the value of  $x$ ;

(ii) the other roots.

(6 marks)

7. ✓ (a) The 9<sup>th</sup> term of an arithmetic progression is  $\frac{26}{11}$  times the fourth term. If the sum of the first 20 terms is 1220, determine the

(i) first term;

(ii) common difference;

(iii) average of the 15<sup>th</sup> and 21<sup>st</sup> terms.

(13 marks)

- (b) Use geometric progression to convert the recurring decimal  $0.477477$  into a fraction. (7 marks)

8. (a) All Module 1 Automatic Engineering students in a college decided to raise Ksh.3600 for a project. After the initial contributions were made, 5 students changed course to Diploma in Production Engineering and pulled out of the project and recovered their contributions. The remaining number of students shared equally the amount to continue with the project. If the contribution per student increased by Ksh.24, determine the:

- (i) original number of students;  
 (ii) original contribution per student.  
 (iii) new contribution per student.

(12 marks)

- (b) Use eliminations method to solve the simultaneous equations:

$$3x + 5y + 8z = 31$$

$$7x - 3y + 2z = 33$$

$$6x + 9y + 4z = 5$$

(8 marks)

$$\begin{aligned} n &= 3600 \\ x - 5 + (x - 5)24 & & x - 5 + 24(x - 5) &= 3600 \\ x - 5 + 24x - 120 & & 25x - 125 &= 3600 \\ x - 5 + 24x &= 3600 + 120 & 25x + 24x - 125 &= 3600 \\ x - 5 + 24x &= 3720 & 49x - 125 &= 3600 \\ x - 5 + 24x &= 3720 + 125 & 49x &= 3725 \\ x - 5 + 24x &= 3845 & \frac{49x}{49} &= \frac{3725}{49} \\ x + 24x &= 3600 + 5 & & \\ 25x &= 3605 & & \\ \frac{25x}{25} &= \frac{3605}{25} & & \\ x &= 144.20 & & \end{aligned}$$

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$$\begin{aligned} 149 - 5 + 24x \\ 144 - 5 &= 3720 \end{aligned}$$