2501/103   2508/103
2502/103   2509/103
2503/103
ENGINEERING MATHEMATICS I
June/July 2016
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 I

ENGINEERING MATHEMATICS I

3 hours

INSTRUCTIONS TO CANDIDATES

You should have Mathematical tables/Non programmable electronic calculator for this examination.
Answer any FIVE of the EIGHT questions in the answer booklet provided.
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 3 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

1. (a) Give that $Z_1 = 5 + 6j$, $Z_2 = 8 - 9j$. Find:

   (i) $Z_1 Z_2$;

   (ii) $\dfrac{Z_1}{Z_2}$. (8 marks)

   (b) (i) Expand $\cos 5\theta$ and $\sin 5\theta$ by Demoivres theorem.

   (ii) Use the expansion in (b) (i) above to expand $\tan 5\theta$ in terms of $\tan \theta$. (12 marks)

2. (a) Solve the equations:

   (i) $\log_3^{(3x+4)} - \log_3^{(6x+7)} = 2$

   (ii) $3^{2x} - 3^{x+1} + 2 = 0$ (10 marks)

   (b) Solve the simultaneous equations:

   $x^2 + xy + y^2 = 3$
   $x^2 + 2xy + 2y^2 = 5$ (10 marks)

3. (a) Show that $\cosh^{-1} x = \pm \ln\left[x + \sqrt{x^2 - 1}\right]$. (10 marks)

   (b) Solve the equation $2.97 - 3.16 \sinh x - 4 \cosh x = 0$ correct to 5 decimal places. (10 marks)

4. (a) Solve the equations:

   (i) $8x^2 + 88x + 144 = 0$ using factorisation;

   (ii) $5x^2 + 6x + 1 = 0$ by the formula method. (6 marks)

   (b) Find the sum of the first ten terms of the series $2 + 4 + 6 + \ldots$ (4 marks)

   (c) The following equations were obtained in a research project:

   $\dfrac{1}{x} + \dfrac{2}{y} + \dfrac{2}{z} = 4$;

   $\dfrac{3}{x} - \dfrac{1}{y} + \dfrac{4}{z} = 25$;

   $\dfrac{3}{x} + \dfrac{2}{y} - \dfrac{1}{z} = -4$;

   Use the elimination method to find the value of x, y and z. (10 marks)

5. (a) (i) Use the binomial expansion to obtain the first **three** terms of

$$\sqrt{\frac{1+x}{1-x}}.$$

(ii) By substituting $x = \frac{1}{9}$ in the expansion obtained in (a) (i) above to prove that
$\sqrt{5} \simeq \frac{181}{81}$. (10 marks)

(b) The radius of a right circular cylinder increases by 2% while the height decreases by 3%. Use the first **two** terms of a binomial expansion to determine the percentage change in volume. (10 marks)

6. (a) If $\sin\theta = 0.6$, determine other **five** trigonometric ratios of θ. (6 marks)
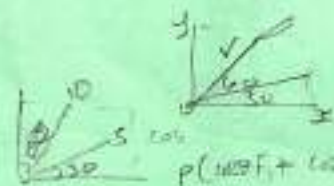
(b) Solve the equation:

$$4\cos\theta + 5\sin\theta = 6, \quad 0° \leq 0 \leq 360°$$

(14 marks)

7. (a) Express the Cartesian equation $x^2 + 3y^2 = 3$ into the Polar form $r^2 = \dfrac{a}{b + k\cos 2\theta}$; where a, b and k are constants.

(7 marks)

(b) The Parametric equations of the rectangular hyperbola $xy = c^2$ are $x = ct, y = \frac{c}{t}$. Find the equation of the:

(i) chord joining the two points whose parameters are t_1 and t_2;

(ii) tangent to the curve at the point t. (13 marks)

8. (a) Two forces of magnitudes 5 N and 10 N act at angles of 30° and 60° to a direction OX. Use complex numbers to find the magnitude and direction of the resultant force. (7 marks)

(b) (i) The formula $T_2 = T_1 e^{\mu\theta}$ is used in connection with belt drives, where T_1 and T_2 are tensions, μ the coefficient of friction and θ the angle of lap in radius. Determine the angle of lap in degrees when $T_1 = 8N$, $T_2 = 14N$ and $\mu = 0.4$.

(ii) Solve the following simultaneous equations:

$$4\log_2 a + 3\log_3 b = 32;$$
$$3\log_2 a - 2\log_3 b = 7.$$

(13 marks)

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