2506/103
2507/103
ENGINEERING MATHEMATICS I AND
ENGINEERING SCIENCE I
Oct./Nov. 2018
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN AERONAUTICAL ENGINEERING

(AIRFRAMES AND ENGINES OPTION)
(AVIONICS OPTION)

MODULE I

ENGINEERING MATHEMATICS I AND ENGINEERING SCIENCE I

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:
Drawing instruments;
Mathematical tables/Non-programmable scientific calculator;
Answer booklet.
*This paper consists of **EIGHT** questions in **TWO** sections; **A** and **B**.*
*Answer **THREE** questions from Section **A** and **TWO** questions from section **B**.*
Maximum marks for each part of a question are as indicated.
Candidates should answer the questions in English.

(Take: $g = 10$ N/kg).

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.

Turn over

SECTION A: ENGINEERING MATHEMATICS I

*Answer **THREE** questions from this section.*

1. (a) Solve the equations:

(i) $2^{2x} - 3(2^x) + 2 = 0$

(ii) $x^{3.2} = 41.15$

correct to 4 significant figures. (9 marks)

(b) Solve the simultaneous equations:

$$\frac{x-1}{3} + \frac{y+2}{5} = \frac{2}{15}$$

$$\frac{1-x}{6} + \frac{5+y}{2} = \frac{5}{6}$$

(6 marks)

(c) Solve the equation $2x^2 + 5x = 3$ by completing the square. (5 marks)

2. (a) Evaluate $\frac{3\tan 60° - 2\cos 30°}{\tan 30°}$ without using tables or a calculator. (3 marks)

(b) Solve the equation $1 + \cos\theta = 2\sin^2\theta$ for $0° \leq \theta \leq 360°$. (6 marks)

(c) A triangle ABC has sides a = 9.0 cm, b = 7.5 cm and c = 6.5 cm. Determine the:

(i) magnitudes of the three angles;

(ii) the area of the triangle.

(11 marks)

3. (a) Express $\left(\frac{2+j}{3-2j}\right)^2$ in the form $a + jb$. (4 marks)

(b) If $Pe^x + Qe^{-x} = 3\cosh x - 4\sinh x$, find the values of P and Q. (4 marks)

(c) (i) Determine the middle term in the binomial expansion of $(3x + 2y)^{10}$.

(ii) Find the first three terms of the binomial expansion of $\sqrt{1-x}$. Hence by substituting $x = \frac{1}{9}$, find the value of $\sqrt{8}$.

(12 marks)

4. (a) Differentiate:

(i) $y = 5\tan^3 2x$

(ii) $y = 5\sqrt{t}\ \ln 3t$

(9 marks)

(b) Determine the stationary points of the function $f(x,y) = 2x^3 + 6xy^2 - 3y^3 - 150$.

(11 marks)

5. (a) Evaluate the integrals:

(i) $\int 2x(2x^2+5)^6\,dx$;

(ii) $\int \sin^3 x \cos^2 x\,dx$;

(iii) $\int x^5 \ln x\,dx$.

(15 marks)

(b) Find the area bounded above by $y = 3x + 2$, below by x- axis between $x = 1$ and $x = 3$. (5 marks)

SECTION B: ENGINEERING SCIENCE I

*Answer **TWO** questions from this section.*

6. (a) (i) Outline **two** types of electromagnetic waves.

(ii) Figure 1 shows a snapshot of a wave form in a string. The numbers in the diagram show the scale in centimetres. The speed of the wave is 10 m/s.

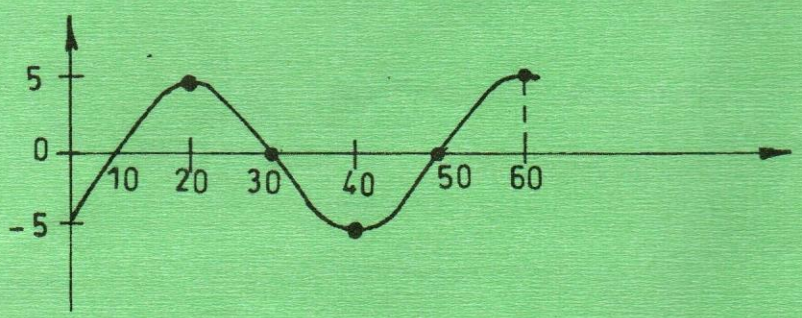

Fig. 1

Determine the:

(I) wavelength;

(II) amptitude;

(III) frequency;

(IV) period of oscillation.

(8 marks)

(b) (i) Outline **four** forms of energy.

(ii) Calculate the work done by a stone mason in lifting a stone of mass 15 kg through a height of 3.0 m.

(8 marks)

(c) An electric motor raises a 50 kg load at a constant velocity. Calculate the power of the motor if it takes 40 seconds to raise the load through a height of 24 m.

(4 marks)

7. (a) (i) State the principle of moments.

(ii) A uniform meter rule pivoted at its centre is balanced by a force of 9.6 N at the 20 cm mark and some other forces, P and 4.0 N on the 66 cm and 90 cm marks respectively. Calculate the force P. (10 marks)

(b) A wooden box of mass 50 kg rests on a rough floor. The coefficient of friction between the floor and the box is 0.4.

(i) Calculate the force required to just move the box.

(ii) If a force of 120 N is applied to the box, determine its acceleration.

(5 marks)

(c) A car of mass 2400 kg travelling at 90 m/s is brought to rest in 6 seconds. Calculate the:

(i) average retardation of the car;

(ii) average force applied by the brakes.

(5 marks)

8. (a) A block and tackle pulley system is used to lift a mass of 200 kg. This machine has a velocity ratio of 5 and efficiency of 80%.

(i) Sketch a possible arrangement of the pulleys, showing how the rope is wound.

(ii) Calculate the effort applied.

(8 marks)

(b) The volume V of a gas at pressure P is reduced to $\frac{2}{7}$ V without change of temperature. Determine the new pressure of the gas. (4 marks)

(c) A certain mass of a gas occupies $220\,cm^3$ at 18^oC and 740 mmHg pressure. Determine the temperature of the gas when it is compressed to a volume of $180\,cm^3$ and pressure of 770 mmHg. (3 marks)

(d) A model Aircraft engine-block alloy contains 50 kg of Iron and 5.0 kg of Aluminium. Calculate the heat capacity of the engine-block alloy.

Take:

specific heat capacity of Iron	=	460 J/kgK;
specific heat capacity of Aluminium	=	880 J/kgK.

(5 marks)

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