Name: _____ Index No.: _____/_____

1501/203
MATHEMATICS II AND MECHANICAL SCIENCE II
June/July 2014
Time: 3 hours

Candidate's Signature: _____

Date: _____

THE KENYA NATIONAL EXAMINATIONS COUNCIL

CRAFT IN MECHANICAL ENGINEERING

MODULE II

MATHEMATICS II AND MECHANICAL SCIENCE II

3 hours

INSTRUCTIONS TO CANDIDATES

Write your name and index number in the spaces provided above.
Sign and write the date of the examination in the spaces provided above.
You should have the following for this examination:
Drawing Instruments;
Scientific calculator/Mathematical tables.
*This paper consists of **TWO** sections; **A** and **B**.*
*Answer any **THREE** questions from section **A** and any **TWO** questions from section **B** in the spaces provided in this question paper.*
All questions carry equal marks.
Maximum marks for each part of a question are as shown.
*Do **NOT** remove any pages from this booklet.*
Candidates should answer the questions in English.

For Examiner's Use Only

Section	Question	Maximum Score	Candidate's Score
A		20	
		20	
		20	
B		20	
		20	
	Total score		

This paper consists of 20 printed pages.

Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing.

SECTION A: MATHEMATICS II

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

1. (a) Table I gives the distribution of monthly income of 90 workers in a certain firm.

Table I

Monthly Income (Ksh '00)	**Number of workers**
0 - 75	8
75 - 150	10
150 - 225	18
225 - 300	20
300 - 375	16
375 - 450	10
450 - 525	8

Determine the:

(i) mean;
(ii) median;
(iii) standard deviation. (13 marks)

(b) The probability of the occurrence of three events A, B, and C are $\frac{1}{8}$, $\frac{1}{6}$ and $\frac{2}{9}$ respectively. Determine the probability of:

(i) all events occurring;
(ii) event A and B but not C occurring;
(iii) only event B occurring. (7 marks)

2. (a) A triangle ABC has sides a = 8 cm , b = 6.5 cm and c = 5.5 cm. Determine the:

(i) **three** angles of triangle ABC;
(ii) area. (10 marks)

(b) Two forces acting at a point have magnitudes 2.5 N at 90° and 3.6 N at 145°. Calculate the;

(i) magnitude;
(ii) direction of the resultant force. (10 marks)

3. (a) Given the matrices

$$A=\begin{bmatrix}13 & -12\\ 14 & 10\end{bmatrix}, B=\begin{bmatrix}15 & 17\\ 12 & 13\end{bmatrix}$$

$$C=\begin{bmatrix}13 & 12\\ 12 & 13\end{bmatrix}$$

(i) Show that $A(B+C) = AB + AC$.

(ii) Determine $B^{-1}C$. (14 marks)

(b) Solve the following simultaneous equations using Cramers's method:

$$3x + 4y = 3$$
$$6x - 8y = -2$$ (6 marks)

4. (a) The radius of a right circular cylinder is increasing at a rate of 8 cm/s and the height is decreasing at a rate of 5 cm/s. Find the rate at which the volume is changing when the radius is 20 cm and the height is 30 cm. (7 marks)

(b) Differentiate the following functions:

(i) $y = 5x^3.e^{2x}$;

(ii) $= \frac{3x^2}{2x}$;

(iii) $y = \text{Sin}^3 x$;

(iv) $y = 5\cos(7x + 2)$. (7 marks)

(c) If $y = x^2 + 5x - 4$, obtain the derivative of y with respect to x from the first principles. (6 marks)

5. (a) Evaluate:

(i) $\int_0^4 (2x^2 + 5x - 2)\,\delta x$;

(ii) $\int_3^5 \frac{4}{x}\delta x$;

(iii) $\int_0^2 \frac{7}{5x+4}\delta x$. (10 marks)

(b) Two companies A and B invested Kshs 50,000 for 5 years at a rate of 5% per annum. If A invested at compound interest and B at simple interest, determine which company earned more and by how much. (10 marks)

SECTION B: MECHANICAL SCIENCE II

6. (a) Define the following terms giving an example of application of each:

(i) simple machine;
(ii) pulley. (6 marks)

(b) In a certain wheel and axle machine, the diameters of the wheel and axle are 525 mm and 70 mm respectively. the efficiency is 97.5 per cent when a body of mass 42 kg is being lifted. Calculate the:

(i) velocity ratio;
(ii) ideal effort;
(iii) actual effort;
(iv) mechanical advantage. (14 marks)

7. (a) Give **three** properties of a gas. (6 marks)

(b) Describe the use of the following instruments:

(i) Manometer;
(ii) Barometer. (4 marks)

(c) A given mass of gas occupies a volume of 250 litres at a temperature of 25°C. Determine the volume of mass of gas at -30° C, under the same pressure conditions. (5 marks)

(d) A quantity of gas occupies a volume of 8 m^3 at a pressure of 150 KN/m^2 absolute. It is then compressed at constant temperature until its pressure is 540 KN/m^2, absolute. Determine the volume of gas at the end of the compression. (5 marks)

8. (a) State the:

(i) Archimede's Principle;
(ii) law of floation. (4 marks)

(b) A ship of mass 2400 tonnes floats in sea-water. Determine the volume of sea-water it displaces. If the ship enters fresh water, what mass of cargo must be unloaded so that the same volume of water is displaced as before?
Relative density of sea-water is 1.03. (8 marks)

(c) A density bottle was used to measure the density of glass in the form of beads and the following measurements were taken:

Mass of empty density bottle = 27.5g
Mass of bottle filled partly with beads = 62.5g
Mass of bottle with beads and topped up with water = 98 g
Mass of bottle filled with water only = 77g

Determine the:

(i) volume of the bottle;
(ii) volume of the beads;
(iii) density of the glass. (8 marks)

9. (a) Define the term 'specific heat capacity'. (2 marks)

(b) A body having a mass of 500 kg is resting on top of a screw-jack. The screw has a lead of 9 mm and an effort of 40 N has to be applied tangentially at a radius of 300 mm to lift the load. Calculate the:

(i) velocity ratio
(ii) mechanical advantage. (6 marks)

(c) The temperature of a piece of copper of mas 500 kg is raised to 200°C and then it is transferred to an aluminium can of mass 20 kg containing 240 kg of methylated spirit at 20°C. Calculate the final steady temperature after the spirit has been well stirred. Neglect the heat capacity of the stirrer and any losses from evaporation and use specific capacities 400 J/kg K, 900 J/kg K and 2400 J/kg K for copper, aluminium and methylated spirit respectively. (12 marks)