

Name: \_\_\_\_\_ Index No.: \_\_\_\_\_

2501/203  
2503/203

ENGINEERING MATHEMATICS II

Oct./Nov. 2014

Time: 3 hours

Candidate's Signature: \_\_\_\_\_

Date: \_\_\_\_\_



THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN AUTOMOTIVE ENGINEERING  
DIPLOMA IN MECHANICAL ENGINEERING  
(PRODUCTION OPTION)

MODULE II

ENGINEERING MATHEMATICS 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:

Mathematical tables / Non-programmable scientific calculator;  
Drawing instruments.

This paper consists of **EIGHT** questions.

Answer any **FIVE** questions in the spaces provided in this question paper.

All questions carry equal marks.

Maximum marks to 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**

Question	1	2	3	4	5	6	7	8	TOTAL SCORE
Candidate's 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.



1. (a) Evaluate the integral

$$\int_2^6 \frac{1}{\sqrt{2x-1}} dx$$

(5 marks)

- (b) A plane figure bounded by  $y = 5\cos 2x$ , the x-axis and ordinates at  $x = 0$  and  $x = \frac{\pi}{4}$ , is rotated about the x-axis through a complete revolution. For the solid of revolution generated, determine the:

(i) volume;

(ii) centre of gravity.

(15 marks)

2. (a) Use Taylor's Theorem to expand  $\sin\left(\frac{\pi}{6} + t\right)$  upto the term in  $t^4$  hence evaluate  $\sin 31^\circ$  to four decimal places. ✓

(9 marks)

- (b) Find the first four non-zero terms of the Maclaurin expansion of  $\sin^2 x$  and hence evaluate

$$\int_0^1 \frac{\sin^2 x}{x} dx \quad \checkmark$$

(11 marks)

3. (a) Given  $V = \ln(x^2 + y^2)^{\frac{1}{2}}$  show that  $\frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial y^2} = 0$

(4 marks)

- (b) The total surface area,  $s$ , of a cone of base radius,  $r$ , and perpendicular height,  $h$ , is given by

$$s = \pi r^2 + \pi r \sqrt{r^2 + h^2}$$

If  $r$  increases at the rate of 0.4 cm/s while  $h$  increases at the rate of 0.75 cm/s, calculate the rate of increase of  $s$  when  $r = 3$  cm and  $h = 4$  cm, correct to two decimal places.

(8 marks)

- (c) Locate the stationary points of the function  $z = x^3 - 6xy + y^3$  and determine their nature.

(8 marks)



4. The data below shows the mass in grammes to the nearest whole number of bolts found in a workshop cabinet.

22	92	62	46	38	64	73	86	59	74
37	54	41	78	85	67	94	85	40	28
69	65	75	52	67	78	32	43	55	63
42	54	98	68	82	53	93	51	84	45
64	72	56	47	68	79	62	58	67	61

- (a) Construct a frequency distribution table using the classes 20 - 30, 30 - 40, ...  
(b) Construct a histogram and use it to determine the mode.  
(c) Calculate the median.  
(d) Using an assumed mean of 65, calculate the mean and standard deviation. (20 marks)

5. (a) Find  $\frac{\delta y}{\delta x}$  from first principles, given that  $y = \sin 3x$ . (5 marks)  
(b) Differentiate  $\cos\left(\frac{x+2}{x-3}\right)$ . (5 marks)  
(c) The motion of a particle is given by  $s = e^{-t} \sin 2t$ , where  $s$  is the displacement from the mean position at time  $t$ .  
(i) show that the maximum value of  $s$  occurs when  $t = 0.5536$ ;  
(ii) determine the displacement and acceleration at this time. (10 marks)

6. (a) Anne, John and Ali play a game of darts. The chance of either hitting the target is  $\frac{1}{4}$ ,  $\frac{3}{8}$  and  $\frac{1}{3}$  respectively. Calculate the probability of:  
(i) Ali only hitting target;  
(ii) two of them hitting the target. (5 marks)  
(b) A box contains 80 balls of which 16 balls are black. If 6 balls are chosen in turn with replacement, calculate the probability of picking:  
(i) one black ball;  
(ii) more than 4 black balls. (6 marks)



(c) It has been determined that out of 2,000 patients, 0.1% suffer from side effects of drugs administered. Use the Poisson distribution to determine the probability that:

- (i) 4 patients suffer from the side effects;
- (ii) less than 2 encounter the effects of the drugs;
- (iii) between 5 and 7 suffer from the effects of drug. (9 marks)

7. (a) A conical container of radius 14 cm and height 20 cm contains water to a depth of 8 cm. When a spherical ball is dropped inside the container, the water level rises to a depth of 16 cm. Determine the:

- (i) surface area of the frustum formed;
- (ii) volume of the spherical ball;
- (iii) radius of the sphere. (10 marks)

(b) (i) Evaluate correct to 3 decimal places, the integral

$$\int_0^{1.2} e^{-\frac{x^2}{2}} dx$$

Using trapezoidal rule with 6 strips.

(ii) A county council digs a trench 500 m long and of approximately uniform cross-sectional area. The depths of the trench from one side to the other are given in **table 1**.

**Table 1**

<b>Length from end (m)</b>	0	2	4	6	8	10
<b>Depth (m)</b>	1.5	2.0	5.5	4.5	3.5	2.0

Use Simpson's rule to calculate the volume of soil dug-up. (10 marks)



8.  
10

(a) The fourth term of an arithmetic progression is 17 and the eighth term is 33. Determine the number of terms whose sum is 230. (7 marks)

(b) A worker is paid Ksh 25,000 as his starting salary with an annual increment of 2% per annum. Calculate:

- (i) his salary at the end of his 10<sup>th</sup> year;
- (ii) his total earnings after 30 years of service;
- (iii) number of years it would take for him to attain a salary of Ksh 100,000. (9 marks)

(c) Figure 1 represents three forces  $F_1$ ,  $F_2$  and  $F_3$  acting at a point.

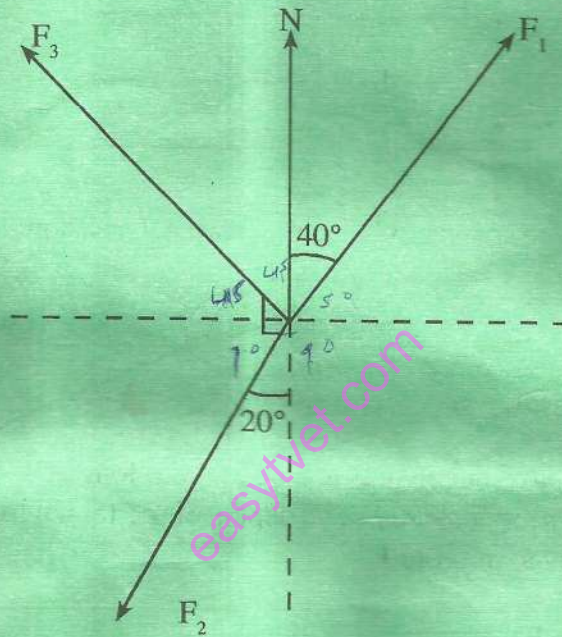


Fig. 1

If  $F_1 = 20\text{ N}$ ,  $F_2 = 45\text{ N}$  and  $F_3 = 30\text{ N}$ , resolve the forces and determine the magnitude and direction of the resultant force. (4 marks)