



ZIMBABWE

MINISTRY OF HIGHER AND TERTIARY EDUCATION

**HIGHER EDUCATION EXAMINATIONS COUNCIL
(HEXCO)**

NATIONAL DIPLOMA

IN

**AUTOMOTIVE ENGINEERING: MOTOR VEHICLE TECHNOLOGY AND
AUTOMOBILE ELECTRICS AND ELECTRONICS**

SUBJECT: Engineering Mathematics

PAPER NO: 516/S04

NOVEMBER 2011 EXAMINATION

REQUIREMENTS

Formulae Booklet, Graph Paper and Scientific Calculator

INSTRUCTIONS TO CANDIDATE

1. This paper consist of Section A and Section B.
2. Answer all questions in Section A. Total marks 60.
3. Answer any four (4) questions in Section B. Total marks 40.

This paper consists of 4 printed pages.

SECTION A

QUESTION 1

a) Factorise completely $4x^3 + 8x^2 - x - 2$ (5 marks)

b) Prove that

$$\tan 3A = \frac{3 \tan A - \tan^3 A}{1 - 3 \tan^2 A} \quad (5 \text{ marks})$$

c) Express in partial fractions

$$\frac{2x^3 - x - 1}{(x-3)(x^2 + 1)} \quad (5 \text{ marks})$$

d) Express $\frac{2+3i}{1+i}$ in the form $p + iq$. (5 marks)

e) Evaluate

$$\int_0^{1/3} 4^{3x} dx \quad (5 \text{ marks})$$

f) If $f(x) = x^6 - 5x^4 - 10x^2 + k$, find the value of k for which $x - 1$ is a factor of $f(x)$. (5 marks)

g) Rationalise the denominator and simplify

$$\frac{1}{\sqrt{3-1}} + \frac{1}{\sqrt{3+1}} \quad (5 \text{ marks})$$

h) Find the first term of a GP that has a common ratio of $\frac{3}{5}$ and a sum to infinity of 8. (5 marks)

i) Solve the following for $0 \leq \theta \leq 360^\circ$
 $4 - \sin \theta = 4 \cos^2 \theta$ (5 marks)

j) Using Binomial expression find the series expansion of $(1+x)^{1/2}$ up to and including a term in x^3 (5 marks)

k) Solve $4^x - 6(2^x) - 16 = 0$ (5 marks)

l) Find $\frac{dy}{dx}$ if

i) $x = 3t^2 + 1, y = t^3 + 2t$ (2 marks)

ii) $e^{x+y} = x^2 y^2$ (3 marks)

SECTION B - Answer any four questions.

QUESTION 2

- a) Find the principal values of

$$\arg \left\{ \frac{2+3i}{1+i} \right\} \quad (5 \text{ marks})$$

- b) Solve the differential equation

$$x \frac{dy}{dx} + 2y = \frac{e^x}{x} \quad x > 0$$

given that $y = 1$ when $x = 1$ (5 marks)

QUESTION 3

By first putting the expression into partial fractions or otherwise, find the first and second derivations of the function

$$\frac{3x-1}{(4x-1)(x+5)} \quad (10 \text{ marks})$$

QUESTION 4

Find the following indefinite integrals

a) $\int x \cos 2x \, dx$ (5 marks)

b) $\int x^2 e^{3x} \, dx$ (5 marks)

QUESTION 5

a) Differentiate $3x^2 + 2y^2 - 5x + xy + 6y = 8$ (3 marks)

- b) The volume of a right circular cone is a function of radius of base (r) and the height of cone (h) only. Find the dimensions of the cone of greatest volume when the sum of the height and radius of base is 6. (7 marks)

QUESTION 6

Express $\frac{4x-2}{(x-1)(2x^2+1)}$ in partial fractions and hence find $\int_2^3 \frac{(4x+2)}{(x-1)(2x^2+1)} \, dx$ expressing your answer in the form in $\left(\frac{a}{b}\right)$ where a and b are constants.

QUESTION 7

a) Express each of the following in the form $a + ib$

i) $\frac{20}{3+i}$

ii) $\frac{4i-3}{2+3i}$

(6 marks)

b) Find the angle between the vectors $\vec{a}$ and $\vec{b}$ given that

$\vec{a} = 3i + 4j$ and $\vec{b} = 5i - 12j$

(4 marks)

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