



MERU UNIVERSITY OF SCIENCE AND TECHNOLOGY

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University Examinations 2023/2024

**FIRST YEAR, SECOND SEMESTER, EXAMINATION FOR DIPLOMA IN
AUTOMOTIVE TECHNICIAN, CIVIL ENGINEERING, ELECTRICAL
ENGINEERING, MECHANICAL PLANT TECHNOLOGY, MECHANICAL
PRODUCTION TECHNOLOGY, WATER & SANITATION, MECHATRONIC
TECHNOLOGY, BUILDING & CONSTRUCTION**

SME 2150 : ENGINEERING MATHEMATICS II

DATE: APRIL 2024

TIME: 2 HOURS

INSTRUCTIONS: Answer *all* question *Section A* and any other *three* questions in *Section B*

Section A (40 Marks)

Answer all questions in this section

QUESTION ONE (40 Marks)

- a) Solve the quadratic equation $2x^2 + 3x + 4 = 0$ [3 Marks]
- b) Evaluate $(-2 + j6) - (3 - j2)$ and represent it on an Argand diagram [3 Marks]
- c) Evaluate the following integrals:
- i) $\int_2^4 2x^3 dx$ [4 Marks]

- ii) $\int_0^{\frac{\pi}{2}} 3 \sin 2x \, dx$ [4 Marks]
- iii) $\int_1^2 4e^{2x} \, dx$ [4 Marks]
- d) Solve the equation $(x - j2y) - (y - jx) = 2 + j$ [3 Marks]
- e) Find the rate of change of y with respect to x given that $y = 3\sqrt{x} \ln 2x$ [3 marks]
- f) Evaluate $\frac{dy}{dx}$ at $\theta = \frac{\pi}{6}$ radians for the hyperbola whose parametric equations are $x = 3 \sec \theta$, $y = 6 \tan \theta$. [4 Marks]
- g) Find $\frac{dy}{dx}$ given $4x^2 + 2xy^3 - 5y^2 = 0$ [4 Marks]
- h) Determine the equations of the tangent and normal to the curve $y = \frac{x^3}{5}$ at the point $(-1, -\frac{1}{5})$ [4 Marks]
- i) Resolve the acceleration vector of 17 m/s^2 at an angle of 120° to the horizontal into a horizontal and a vertical component [4 Marks]

SECTION B (60 Marks)

Answer any **three** questions in this section

QUESTION TWO (20 Marks)

- a) Given the vectors $\vec{A} = 2\mathbf{i} + 3\mathbf{j} - 2\mathbf{k}$ and $\vec{B} = -3\mathbf{i} + \mathbf{j} + \mathbf{k}$ find;
- i. $\vec{A} \cdot \vec{B}$ [5 Marks]
- ii. $\vec{A} \times \vec{B}$ [7 Marks]
- b) Calculate the magnitude and direction of the resultant of these three coplanar forces when they act at a point.

Force A, 10 N acting at 45° from the positive horizontal axis.

Force B, 87 N acting at 120° from the positive horizontal axis.

Force C, 15 N acting at 210° from the positive horizontal axis.

[8

Marks]

QUESTION THREE (20 Marks)

a) It is expected that 10% of production from a continuous process will be defective. Find the probability that in a sample of 10 units chosen at random;

i) Exactly two will be defective [3
Marks]

ii) At least two will be defective [3
Marks]

iii) At most one will be defective [3
Marks]

b) If the mean and variance of a binomial distribution are 12 and 4 respectively. Determine the number of trials (n) and probability of success (p). [5
Marks]

c) If 4% of pesticides manufactured by a firm are ineffective, find the probability that in a sample of 200 pesticides;

i) At most 2 are ineffective [3
Marks]

ii) At least 3 are ineffective [3
Marks]

QUESTION FOUR (20 Marks)

a) Determine;

i) $\int \frac{2x^3 - 3x}{4x} dx$ [3
Marks]

ii) $\int (1 - t)^2 dt$ [3
Marks]

iii) $\int x^3 \ln x dx$ [4
Marks]

b) Using the substitution $u = 1 + \sin x$, evaluate $\int_0^{\frac{\pi}{2}} \frac{\cos x}{1 + \sin x} dx$

[5

Marks]

c) The velocity at time t of a particle moving along a straight line is given by the equation $v = 3t^2 - 4t + 4$. Find the distance the particle covered between $t = 2$ and $t = 5$ [5

Marks]

QUESTION FIVE (20 Marks)

a) Given $Z_1 = 1 + j2$, $Z_2 = 4 - j3$, $Z_3 = -2 + j3$, $Z_4 = -5 - j$. Evaluate in the form $a + jb$

i. $Z_1 + Z_2 - Z_3$ [2

Marks]

ii. $Z_1 Z_2$ [3

Marks]

iii. $Z_1 Z_2 Z_3$ [2

Marks]

iv. $\frac{Z_1 Z_3}{Z_1 + Z_3}$ [4

Marks]

b) State De Moivre's theorem and therefore express in polar form $(-2 - j)^5$ [4 Marks]

c) Find the modulus and argument of $\frac{-9 + 3j}{1 - 2j}$ where $j = \sqrt{-1}$ [5

marks]