MURANG'A UNIVERSITY OF TECHNOLOGY

SCHOOL OF PURE APPLIED AND HEALTH SCIENCES

UNIVERSITY ORDINARY EXAMINATION

2020/2021 ACADEMIC YEAR

FIRST YEAR **ONE** SEMESTER EXAMINATION FOR BACHELOR OF
EDUCATION SCIENCE

UNIT CODE: APH: 102

UNIT TITLE: MATHEMATICS FOR PHYSICS I

DURATION: 2 HOURS

Instructions to candidates:

1. Answer question **One** and Any Other **Two** questions.

2. Mobile phones are not allowed in the examination room.

3. You are not allowed to write on this examination question paper.

SECTION A: ANSWER ALL QUESTIONS IN THIS SECTION

QUESTION ONE (30 MARKS)

(a) Simplify $(x^2y^3z)(x^3yz^2)$ then evaluate when x = 1, y = 2, Z = 3   (4 marks)

(b) Solve $2t^3 - \log t = \log 16 + \log t$.   (4 marks)

(c) State two causes of the following types of errors that ,may in laboratory work
    (i)   Random errors   (2 marks)

    (ii)   Systematic errors   (2 marks)

(d) $x = \frac{20t^3}{3} - \frac{23t^2}{2} + 6t + 5$ represents the distance in metres moved by a body in time t seconds.
    Determined the velocity and acceleration at the start.   (4 marks)

(e) Evaluate $\frac{1-i}{1+i}$ (4 marks)

(f) Determine the angle between the forces $\mathbf{F_1} = 3\mathbf{i} + 4\mathbf{j} + 5\mathbf{k}$ and $\mathbf{F_2} = \mathbf{i} + \mathbf{j} + \mathbf{k}$ (5 marks)

(g) Prove the trigonometric identity $\dfrac{\tan x + \sec x}{\sec\left(1 + \frac{\tan x}{\sec x}\right)} = 1$ (5 marks)

SECTION B – ANSWER ANY TWO QUESTIONS IN THIS SECTION

QUESTION TWO (20 MARKS)

(a) The rate at which a body cools is given by $\theta = 250e^{-0.05t}$ where the excess temperature of a
    body above its surrounding at time t minutes is $\theta°C$. Plot a graph showing the natural decay
    curve for the first hour of cooling, hence determine
    (i)   Temperature after 25 minutes.   (4 marks)
    (ii)   The time when the temperature is $195°C$.   (4 marks)

(b) The time of oscillation t of a pendulum is given by $t = 2\pi\sqrt{\frac{L}{g}}$ where L is the length of the
    Pendulum and g is free fall acceleration. Determine
    (i) $\dfrac{\partial t}{\partial L}$ (3 marks)
    (ii) $\dfrac{\partial t}{\partial g}$ (3 marks)

(c) The vertical height h km of a missile varies with horizontal distance d km and is given by $h = 4d - d^2$. Use integration to determine

(i)   The mean height of the missile from d = 0 to d = 4km   (3 marks)

(ii)   The r.m.s value from d = 0 to d= 4km.   (3 marks)

QUESTION THREE (20 MARKS)

(a)   (i) Define the scalar or dot product of two vectors

$\underline{A} = a_1\mathbf{i} + a_2\mathbf{j} + a_3\mathbf{k}$ and $\mathbf{B} = b_1\mathbf{j} + b_2\mathbf{j} + b_3\mathbf{j}$ (2 marks)

(ii) Calculate the work done by a force F = (-5$\mathbf{i}$ + $\mathbf{j}$ + 7$\mathbf{k}$) N when its point of application moves from the point (-2$\mathbf{i}$ – 6$\mathbf{j}$ + $\mathbf{k}$) m to the point ($\mathbf{i}$ - $\mathbf{j}$+ 10$\mathbf{k}$) m.   (4 marks)

(b) (i) Determine the vector product of two vectors
A = a_1 $\mathbf{i}$ + a_2 $\mathbf{j}$ + a_3 $\mathbf{k}$ and   B = b_1 $\mathbf{i}$ + $b_2$$\mathbf{j}$ + b_3 $\mathbf{k}$ (2 marks)

(iii)   Calculate the velocity vector and its magnitude for a particle rotating about the z-axis at an angular velocity of (3$\mathbf{i}$ – $\mathbf{j}$ + 2$\mathbf{k}$) rad/s when the position vector of the particles is at ($\mathbf{i}$ - 5$\mathbf{j}$+4 $\mathbf{k}$)m.
(6marks)

(c) Three bulbs are chosen at random from 15 bulbs of which 5 are defective. Find the probability that

(i)   None is defective   (2 mark)

(ii)   Exactly one is defective   (2 marks)

(iii)   At least one is defective.   (2 marks)

QUESTION FOUR (20 MARKS)

(a) Solve the complex equation (2+i) (3-2i) = a+ bi   (4 marks

(b)An alternating voltage of 400V, 80Hz is connected across an impedance $(50 - i200)$ ohms.
Determine

(i)   The resistance.   (1 mark)

(ii)   The capacitance.   (3 marks)

(iii)   The magnitude of the impedance   (2 marks)

(iv)   The phase angle of the impedance   (2 marks)

(v)   The current flowing.   (2 marks)

(b) A student performed an experiment by first measuring the mass of a sample that was required for use in the experiment. His measured value was 78.9 g . From the given information, determine

(i)   The absolute error.   (2 marks)

(ii)   The relative error   (2 marks)

(iii)   The percentage error.   (2 marks)