NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY

FACULTY OF HEALTH AND APPLIED SCIENCES

DEPARTMENT OF MATHEMATICS AND STATISTICS

QUALIFICATION: BACHELOR OF SCIENCE : APPLIED MATHEMATICS AND STATISTICS	
QUALIFICATION CODE: 07BAMS.	**LEVEL: 7**
COURSE: MECHANICS	**COURSE CODE**: MCS702S.
SESSION: JANUARY 2020	**PAPER:** THEORY
DURATION: 180 Minutes	**MARKS:** 100

SUPPLEMENTARY/SECOND OPPORTUNITY EXAMINATION QUESTION PAPER	
EXAMINER:	**Dr IKO AJIBOLA**
MODERATOR:	**Prof D. MAKINDE**

INSTRUCTIONS

1. Answer all the questions in the booklet provided.
2. Show clearly all the steps used in the calculations.
3. All written works must be done in blue or black ink and sketches in pencils

PERMISSIBLE MATERIALS

1. Non-programmable calculator without a cover

THIS QUESTION PAPER CONSISTS OF 3 PAGES (Excluding this front page)

ATTACHMENTS

None

QUESTION 1 (20 marks)

1.1 If $\overline{A} = 16t^2 i + 10tj + 2\sin 5tk$.

1.1 .1 Find the vector $\frac{d^2\overline{A}}{dt^2}$ at $t = 3$ [3]

1.1.2 Determine the magnitude of $\frac{d\overline{A}}{dt}$ at $t = 3$ [2]

1.1.3 Find the unit vector along vector $\frac{d\overline{A}}{dt}$ *at* $t = 3$ in terms of the unit vectors **i** , **j** and **k** [3]

1.1.4 What is the magnitude of the unit vector of $\frac{d\overline{A}}{dt}$ *at* $t = 3$ [2]

1.2 If **R** and **S** are 3-dimensional vectors. Define:

1.2.1 the scalar product of the vectors [2]

1.2.2 the vector or cross product of the vectors. [3]

1.2.3 Find the magnitude and direction cosines of the product vector of $\overline{P} = 5i + 3j - k$ *and* $\overline{Q} = 2i - j + 4k$, in that order. [5]

QUESTION 2(20 marks)

2.1 If $\vec{R} = 10t\underline{i} - 6t\underline{j} - 9t\underline{k}$ and $\vec{S} = 16\underline{i} + t\underline{j} + t^2\underline{k}$ are two position vectors.

Determine $\frac{d}{dt}\left(\vec{S} \bullet \vec{R}\right)$ *at* $t = 2.50$ [6]

2.2 Find $\frac{1}{7}\frac{d}{dt}\left(\vec{S} \times \vec{R}\right)$ *at* $t = 3.0$ [6]

2.3 Find the definite integral $\int_0^2 \left(\vec{S} \times \vec{R}\right) dt$ [8]

QUESTION 3 (19 marks)

3.1

3.1.1 Define the average velocity $v_{av,x}$ of a particle in a straight line motion between two points **A** and B. [3]

3.1.2 Using your result in (3.1.1) obtain the **instantaneous** velocity v_x of the straight line motion. [3]

3.2 Suppose at any time t, the velocity v of a car is given by the equation $V_x = 60m/s + \left(0.500m/s^3\right)t^2$

3.2.1 Find the change in velocity of the car in time interval between $t_1 = 1.00s$ and $t_2 = 3.00s$ [5]

3.2.2 Find the average acceleration in this time interval [3]

3.2.3 Estimate the instantaneous acceleration at $t_1 = 1.00s$ taking $\Delta t = 0.10s$ [5]

QUESTION 4 (17 marks)

4.1 Derive an expression for the work done by a constant force $\vec{F}$ of magnitude *F* of an object that undergoes a displacement $\vec{S}$ along a straight line, when *F* makes an angle ϕ with $\vec{S}$ when acting on the object. [4]

4.2 The acceleration of a point in rectilinear motion is given by $a = -9.8$
It is observed that the velocity *v* is zero, and displacement *x* is +25 when $t = 0$
Determine the equation of the displacement. [6]

4.3.1 Using $\sum \vec{F} = m\vec{a}$ state Newton's second law of motion in its component forms. [3]

4.3.2 A Railway station attendant with spikes on his shoes pulls with a constant horizontal force of magnitude 35N on a box with mass 50kg resting on a flat, frictionless surface.
Determine the acceleration of the box. [4]

QUESTION 5 (24 marks)

5.1 Obtain the formula $F_{total}S = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ of a particle of mass *m* moving with velocity *V* in relationship with the work- kinetic energy theorem $W = K_f - K_i = \Delta K$. [6]

5.2 If total momentum vector $\vec{P}$, has three components derive the three components in the x, y, z axis [3]

5.3 Explain clearly with examples what you understand by conservation of momentum [5]

5.4 A small compact car with mass 1500kg traveling due North, with a speed of 25m/s, collides at an intersection with an Intercampus bus of mass 7500kg traveling due West at 13.5m/s. treating each vehicle as a particle, find the total momentum just before collision. [10]

END OF EXAMINATION