NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY

Faculty of Health, Natural Resources and Applied Sciences

School of Natural and Applied Sciences

Department of Mathematics, Statistics and Actuarial Science

13 Jackson Kaujeua Street
Private Bag 13388
Windhoek
NAMIBIA

T: +264 61 207 2913
E: msas@nust.na
W: www.nust.na

QUALIFICATIONS : **BACHELOR of SCIENCE IN APPLIED MATHEMATICS AND STATISTICS**	
QUALIFICATION CODE: **07BSAM**	LEVEL: **7**
COURSE: **MECHANICS**	COURSE CODE: MSC**702S**
DATE: **JANUARY 2024**	SESSION: **1**
DURATION: **3 HOURS**	MARKS: **80**

SECOND OPPORTUNITY/SUPPLEMENTARY: EXAMINATION QUESTION PAPER

EXAMINER: ***Prof Adetayo S. Eegunjobi, Ms Kornelia David***

MODERATOR: ***Prof Oluwole D. Makinde***

INSTRUCTIONS

1. Answer ALL questions on the separate answer sheet.
2. Please write neatly and legibly.
3. Do not use the left-side margin of the exam paper. This must be allowed for the examiner.
4. No books, notes and other additional aids are allowed.
5. Show all your working /calculation steps.

PERMISSIBLE MATERIALS

1. Non-Programmable Calculator

ATTACHMENTS

1. None

This paper consists of 3 pages including this front page

1. (a) The position of a particle as it moves along a y axis is given by

$$y(t) = 2\sin\frac{\pi t}{4}$$

with t in seconds and y in centimeter

i. What is the average velocity and average acceleration of the particle between $t = 0$ and $t = 2s$? (6)

ii. What is the instantaneous velocity and instantaneous acceleration of the particle at $t = 0s, 1s$ and 2s? (7)

(b) Newton sets out from his home to deliver flyers for her yard sale, traveling due east along his street lined with houses. At 0.5 km and 9 minutes later he runs out of flyers and has to retrace his steps back to his house to get more. This takes an additional 9 minutes. After picking up more flyers, he sets out again on the same path, continuing where he left off, and ends up 1.0 km from his house. This third leg of hiss trip takes 15 minutes. At this point he turns back toward his house,heading west. After 1.75 km and 25 minutes he stops to rest.

i. What is Newtons total displacement to the point where she stops torest? (2)

ii. What is the total distance traveled? (2)

2. (a) An uncooperative cow is leaving the barn as you try harder and harder to push her back in. In coordinates with the originat the barn door, the cow walks from $x = 0$ to $x = 6.9m$ as you apply a force with x-component

$$F_x = -(20N + (3N/m)x.$$

How much work does the force you apply do on the cow during this displacement? (6)

(b) A net force along the x-axis that has x-component $F_x = -12N + (0.3N/m^4)x^2$ is applied to a 5 kg object that is initially at the origin and moving in the -x-direction with a speed of $6m/s$. What is the speed of the object when it reaches the point $x = 5m$? (7)

3. (a) Two football players, one weighing 95 kg and moving at 3.75 m/s, and the other weighing 111 kg and moving at 4.10 m/s, approach each other along a linear trajectory. They eventually collide head-on and become entangled.

i. What is their velocity immediately after the collision? (5)

ii. What are the initial and final kinetic energies of the system? (5)

(b) Two cars have a collision at a perpendicular intersection. In a top-down view of this intersection, the first car, weighing 950 kg, is approaching from the left at a speed of 16 m/s. The second car, with a mass of 1300 kg, is approaching from below at a speed of 21 m/s. After the collision, they merge together. Find the speed and direction of the vehicles just after the collision. Assume there are no external forces (8)

4. (a) A force $\vec{F} = (2i + 9j + 5.3k)N$ acts on 2.9kg object that moves in time interval 2.10s from an initial position $\vec{r_1} = (2.7i - 2.9j + 5.5k)m$ to a final position $\vec{r_2} = (-4.1i + 3.3j + 5.4k)m$.

i. Find the work done on the object by the force in that time interval, (4)

ii. Find the average power due to the force during that time interval (4)

iii. Find the angle between vectors r_1 and r_2, (4)

(b) A small block with mass 0.04 kg is moving in the xy-plane. The net force on the block is described by the potential energy function

$$P(x, y) = (3.85J/m^2)x^2 - (3.65J/m^3)y^3.$$

What are the magnitude and direction of the acceleration of the block when it is atthe point $x = 0.28m, y = 0.57m$? (6)

5. (a) Suppose homas hit a ball 35m/s at an angle of 60° above the horizontal.

i. Determine the maximum height reached by the ball (3)

ii. How long does thee ball stay in the air (3)

iii. Determine the horizontal distance covered by the ball (3)

(b) A soccer ball is kicked from the ground with an initial speed of 12.5m/s at an upward angke of 55°. A player 40m away in the direction of the kick starts running back to meet the ball at that instant. What must be the average speed, if he is to meet the ball just before it hit the ground? (5)

End of Exam!