NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF ENGINEERING

DEPARTMENT OF FIBRE AND POLYMER MATERIALS ENGINEERING

ENGINEERING MECHANICS II – DYNAMICS

TFE 2106

First Semester Examination Paper

December 2024

This examination paper consists of 5 pages

Time Allowed:	**3 hours**
Total Marks:	**100**
Special Requirements:	**Calculator**
Examiner's Name:	**Mr. L.K. Ncube**

INSTRUCTIONS

1. Answer **ALL** Questions in Section A and **ANY THREE** Questions in Section B.
2. The first fifteen minutes should be spent reading the question paper and making notes.
3. **Do not** open your answer sheet until told to do so.
4. Marks will be awarded for skill in appreciating the scope of questions, clarity of argument and conciseness of presentation as well as for the knowledge displayed by the candidate.

MARK ALLOCATION

QUESTION	MARKS
1	40
2	20
3	20
4	20
5	20

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SECTION A
(Answer **ALL** Questions- **TOTAL 40 Marks**)

QUESTION 1

a. Define the following terms;
    - (i.)   Particle
    - (ii.)   Rigid body
    - (iii.) Mass
    - (iv.)   Time
    - (v.)   Power
    - (vi.)   Mechanical efficiency   **[12 Marks]**

b. List the four basic concepts used in mechanics.   **[4 Marks]**
c. Study the movement of the mechanism shown in **Figure Q1c** and state the type of rigid body motion of the identified bodies A, B, C, D, and E.   **[10 Marks]**
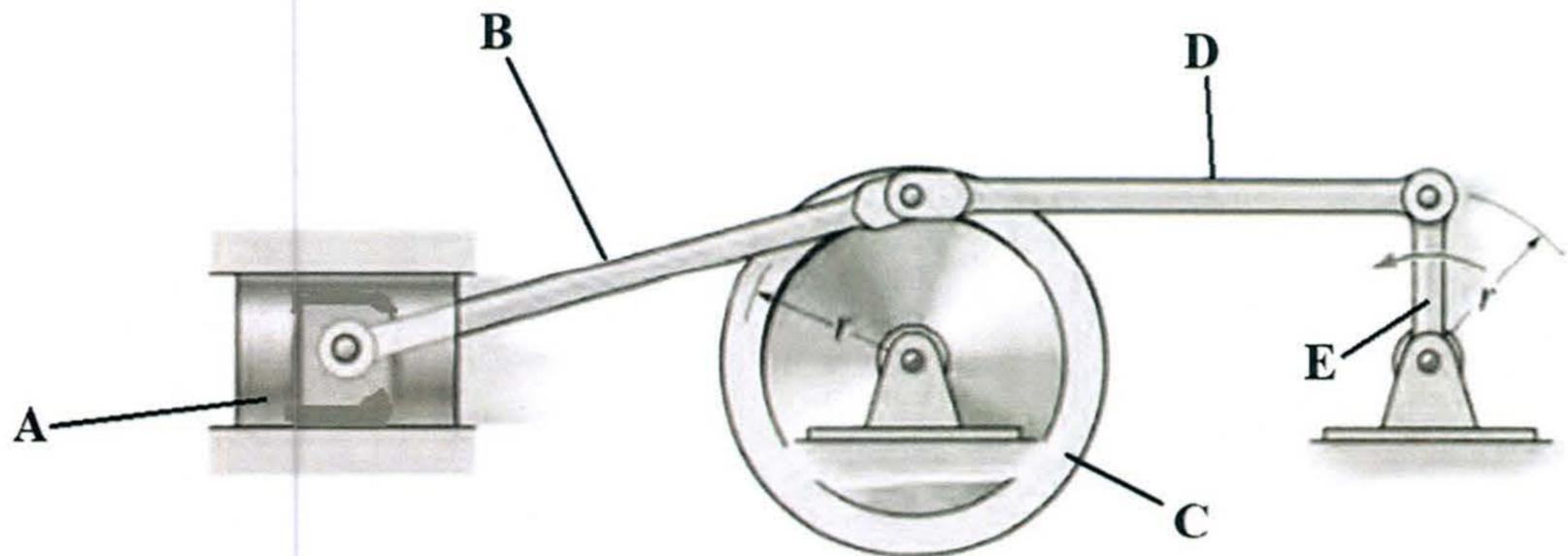

Figure Q1c

d. What is the difference between kinematics and kinetics   **[6 Marks]**
e. What is work of a force and what conditions result in the work of a force being zero **[4 Marks]**
f. With reference to a mechanical system, briefly explain my frictional forces are non-conservative forces.   **[4 Marks]**

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SECTION B
(Answer **ANY THREE** Questions- **TOTAL 60 Marks**)

QUESTION 2

a. When a robot arm of a horizontal FFS packaging machine moves in a straight line such that for a short time its velocity is defined by $v = (3t^2 + 2t) \ m/s$, where t is in seconds. You are given that s = 0 when t = 0. Determine its position, velocity and acceleration when t = 3. **[10 Marks]**

b. Study the motion curve in **Figure Q2b** of a material handling equipment moving in a straight line. Describe the movement of the equipment. **[10 Marks]**
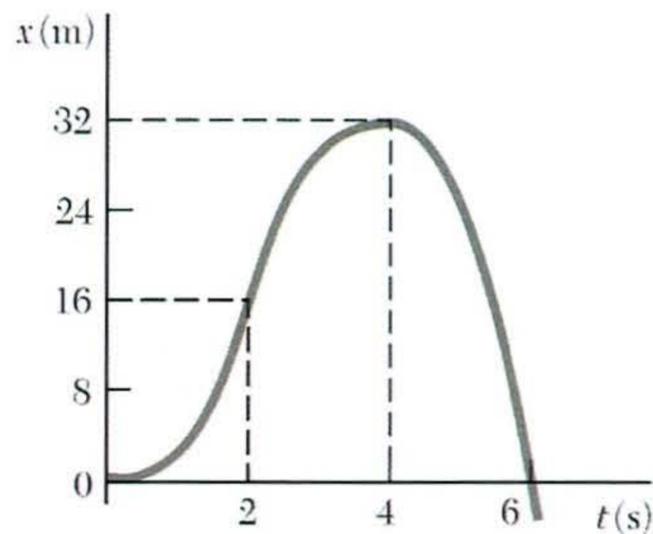

Figure Q2b

QUESTION 3

A projectile is fired from the edge of a 150m cliff with an initial velocity of 180m/s at an angle of 30° with the horizontal. Neglecting air resistance, find;

a. The horizontal distance from the gun to the point where the projectile strikes the ground.

[10 Marks]

b. The greatest elevation above the ground reached by the projectile. **[10 Marks]**

QUESTION 4

a. State Newton's second law of motion and write down the equation of motion. **[5 Marks]**

b. A smooth 4kg collar, shown in **Figure Q4b**, is attached to a spring having a stiffness $k = 3N/m$ and an unstretched length of 0.75m. If the collar is released from rest at A, determine its acceleration and the normal force of the rod on the collar at the instant y = 1m. **[15 Marks]**
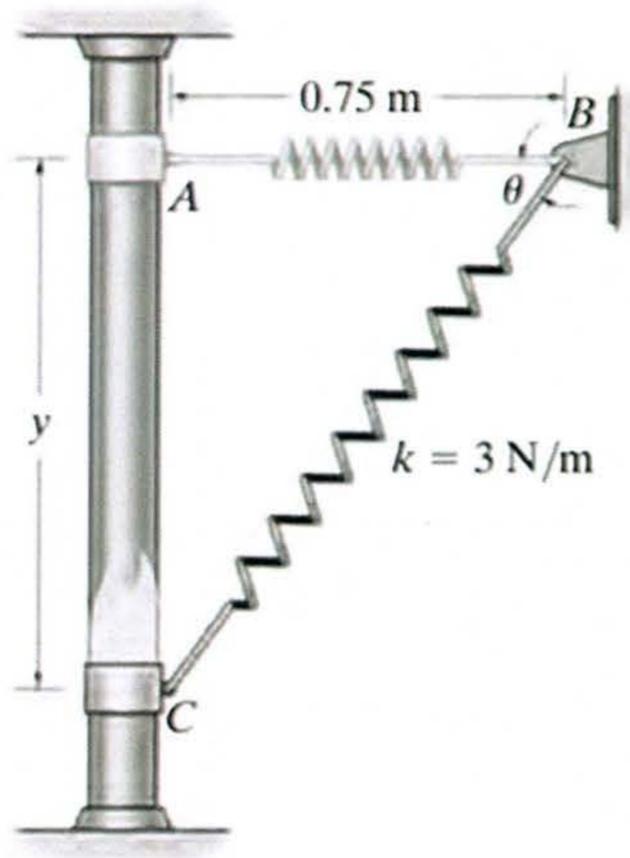
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Figure Q4b

QUESTION 5

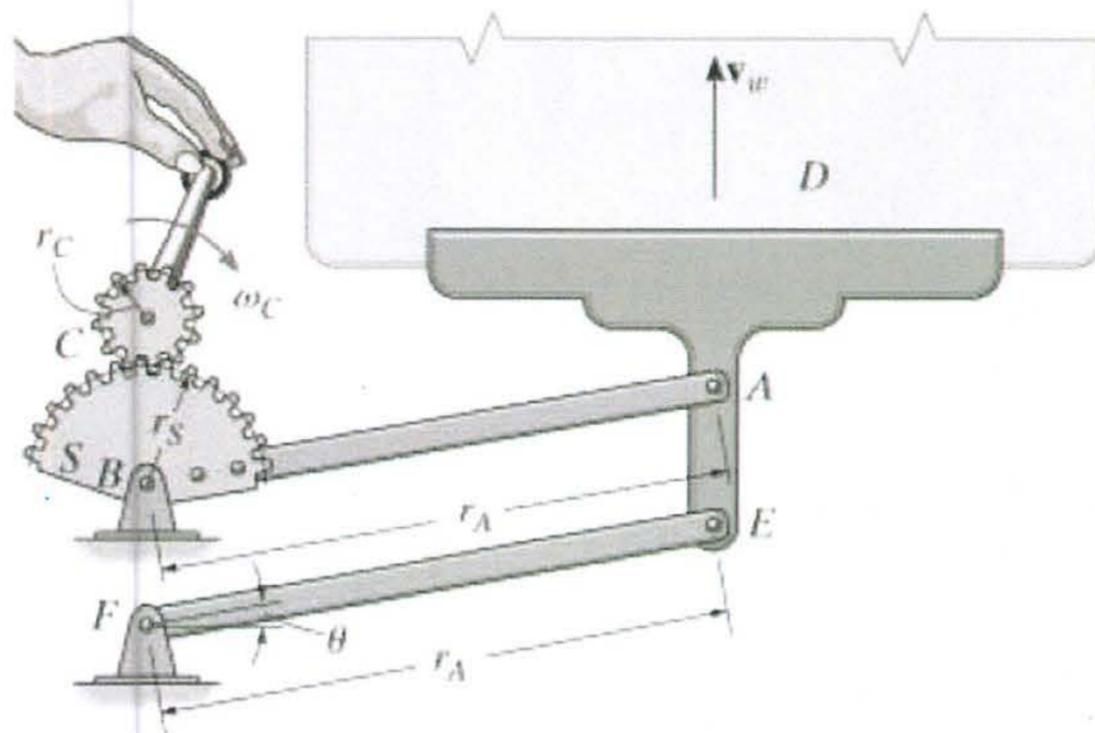A manual mechanism for a car window winder is shown in the **Figure Q5**.

Figure Q5

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The handle turns the small cog (C), which rotates the spur gear (S), thereby rotating the fixed-connected lever AB which raises track D in which the window rests. The window is free to slide on the track. If the handle is wound with angular velocity ω_c, determine the speed of points A and E and the speed v_w of the window at the instant θ. **[20 Marks]**

You are given that;

$$\omega_c = 0.5 \ rad/s$$
$$r_C = 20 \ mm$$
$$\theta = 30°$$
$$r_S = 50 \ mm$$
$$r_A = 200 \ mm$$

END OF EXAMINATION QUESTION PAPER

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