



NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF ENGINEERING

DEPARTMENT OF INDUSTRIAL AND MANUFACTURING ENGINEERING

BENG HONOURS DEGREE IN INDUSTRIAL & MANUFACTURING ENGINEERING

DYNAMICS

EIE 2111

FIRST SEMESTER EXAMINATION

DECEMBER 2024

This examination paper consists of **5** printed pages

Time Allowed: 3 hours
Total Marks: 100
Examiner's Name: W. TUMBUDZUKU

INSTRUCTIONS AND INFORMATION TO CANDIDATE

1. Answer any FIVE (5) Questions.
2. Each Question carries a total of 20 Marks.
3. Start the answer to each full question on a fresh page.
4. Ensure neatness and legibility of work.

QUESTION 1

(a) Give some significant contributions to the field of dynamics made by the following scientists:

- (i) Isaac Newton [3 Marks]
- (ii) Galileo Galilei [3 Marks]
- (iii) Aristotle [3 Marks]
- (iv) Archimedes [3 Marks]

(b) The acceleration of a particle is given by $a = 2t - 10$, where a is in meters per second squared and t is in seconds. Determine the velocity and displacement as functions of time. Take the initial displacement at $t = 0$ as $S_0 = -4\text{m}$ and the initial velocity is $V_0 = 3\text{m/s}$. [8 Marks]

QUESTION 2

(a) Define a projectile and state the equation of trajectory for projectile motion. [5 Marks]

(b) A long-range artillery rifle at A (as shown in Figure Q1) is aimed at an angle of 45° with the horizontal, and its shell is just able to clear the mountain peak at the top of its trajectory. Determine the following;

- (i) Magnitude u of the muzzle velocity [5 Marks]
- (ii) The height H of the mountain above sea level [5 Marks]
- (iii) The range R to the sea [5 Marks]

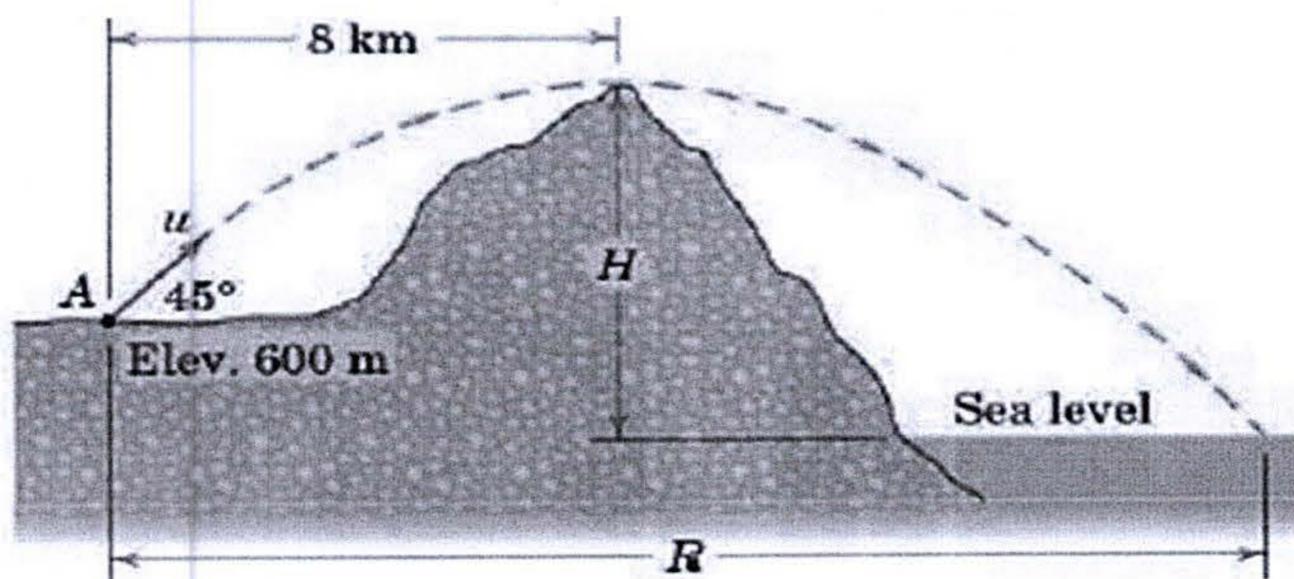


Figure Q1: Projectile Motion

QUESTION 3

- (a) State the differences between forced and free vibrations by paying particular attention to energy transfer and dampening [5 Marks]
- (b) A 20kg block moves between vertical guides (as shown in Figure Q2). The block is pulled 40mm down from its equilibrium position and released. Determine the following for each spring;
- (i) The period of the vibration [5 Marks]
- (ii) The maximum velocity of the block [5 Marks]
- (iii) The maximum acceleration of the block. [5 Marks]

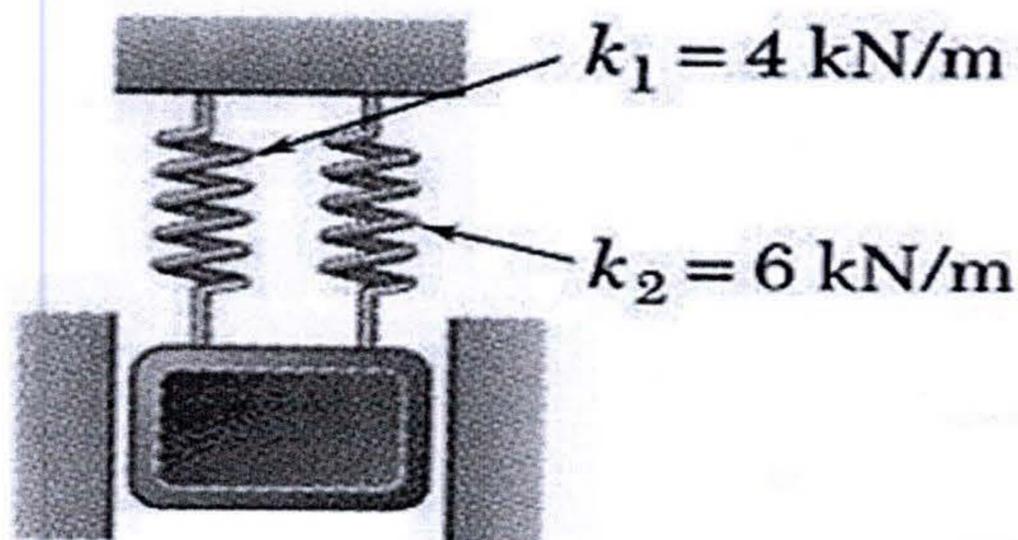


Figure Q2: 20kg Block

QUESTION 4

- (a) With the aid of examples or diagrams, differentiate between the collision of elastic and inelastic bodies. [8 Marks]
- (b) A Puck of mass 0.5kg moves along the x axis with a velocity of 4.00m/s. it collides elastically with another stationary Puck. After the collision the first Puck moves with a velocity of 2.00m/s making an angle α with the horizontal. The other Puck makes an angle β below the horizontal and moves at a velocity V_2 . Find the following;
- (i) Velocity V_2 [4 Marks]
- (ii) Angle α [4 Marks]
- (iii) Angle β [4 Marks]

QUESTION 5

You're an Engineer at a local manufacturing company. You notice the following problems with the machines:

- There is a lot of vibration and machine parts are getting worn out easily.
- The noise levels sometimes exceed the recommended levels.
- Reduced machine life.
- Increased incidence of maintenance.

- (a) Explain how you would use your knowledge of imbalance of machine to counter the effects of the above. [6 Marks]
- (b) Suggest the balancing equipment you can use. [4 Marks]
- (c) Design a performance and testing equipment of a mechanical exciter to generate forced vibrations [10 Marks]

QUESTION 6

- (a) State and explain any three (3) forms of energy that you have learned. [6 Marks]
- (b) Consider a spring of stiffness k acted upon by a constant magnitude force P (as shown in **Figure Q6**). Assume that the spring is uncompressed before the application of the force. Let e represent the compression in the spring resulting from the application of the force P .
- (i) Derive the equilibrium form of the work energy equation for the system. [10 Marks]
- (ii) Use Newton's second law of motion and the work/energy equation to derive an expression for static elongation of the spring. [4 Marks]

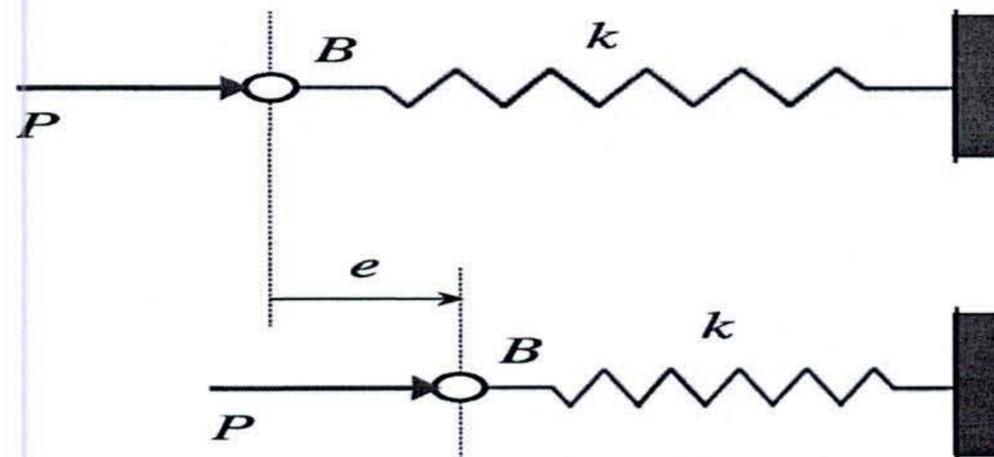


Figure Q6: Spring Compression by Force P

QUESTION 7

(a) A projectile shaped body of mass m has a washer of mass $(m/5)$ resting on its shoulder (as shown in Figure Q7). As the combined body passes downward through an opening with speed v , the washer strikes the solid surface and is left behind. If the duration time of the impact is Δt , determine the following;

(i) The total force exerted on the washer by the surface [10 Marks]

(ii) The percentage loss of system kinetic energy [10 Marks]

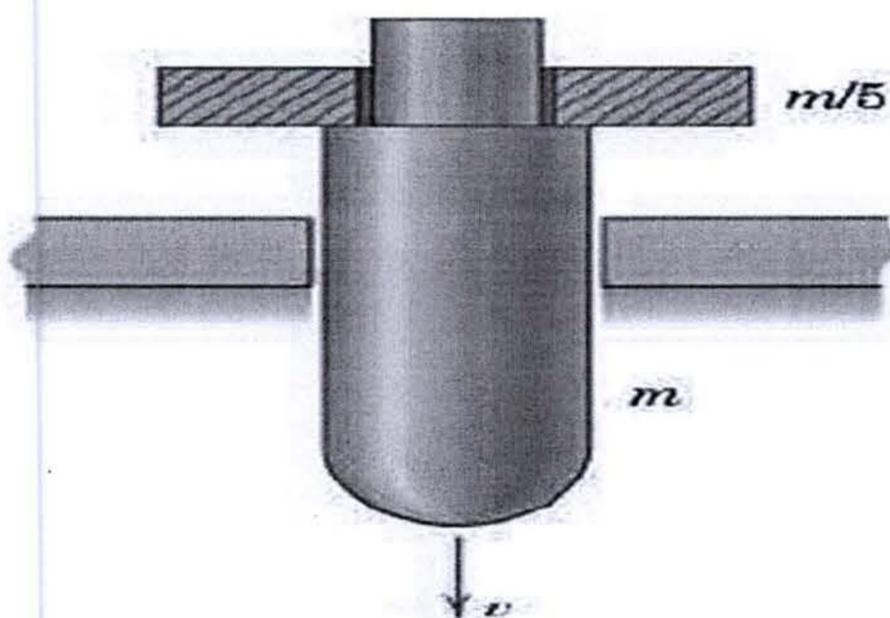


Figure Q7: A Projectile Shaped Body

QUESTION 8

(a) With the aid of diagrams give the differences between passive and active vibration isolation systems. [10 Marks]

(b) Describe in detail two vibration measuring instruments. [10 Marks]

End of Examination Paper