MERU UNIVERSITY OF SCIENCE AND TECHNOLOGY

UNIVERSITY EXAMINATIONS 2023/2024

FIRST YEAR, SECOND SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN PHYSICS, BACHELOR OF SCIENCE (MATHEMATICS AND PHYSICS) AND BACHELOR OF SCIENCE (PHYSICS) AND BACHELOR OF EDUCATION SCIENCE

SPH 3135:WAVES AND VIBRATIONS

DATE: APRIL 2024   **TIME: 2 HOURS**

INSTRUCTIONS: Answer Question ONE and any other TWO questions.

QUESTION ONE (30 MARKS)

a) State any two properties of a simple harmonic motion (2 Marks)

b) A stone whirled at a constant speed of4m/s round a circular path by a string of length 0.12m. Calculate;

   i.   Amplitude of the motion (1 Marks)

  ii.   Period (3 Marks)

 iii.   Frequency (2 Marks)

c) A progressive wave has maximum particle velocity of 12m/s and amplitude of 2cm. Calculate

   i.   Angular velocity (3 Marks)

  ii.   Maximum acceleration (3 Marks)

d) The equation of a simple harmonic oscillator is given by x = 4cos(7.2t). Find

   i.   Phase angle (2 Marks)

  ii.   Amplitude (1 Mark)

iii.   Angular velocity (2 Marks)

e) The equation of a progressive wave is given by $y = 8sin2\pi \left(\frac{t}{0.2} + \frac{x}{18}\right)$ cm . Find

    i.   Wavelength (2 Marks)

    ii.   Velocity (3 Marks)

f) A hanging spring stretches by 35.0 cm when an object of mass 450 g is hung on it at rest. In this situation, we define its position as x = 0. The object is pulled down an additional 18.0 cm and released from rest to oscillate without friction. What is its position x at a time 84.4 s later?

(6 Marks)

QUESTION TWO (20 MARKS)

a) A particle moving along the x axis in simple harmonic motion starts from its equilibrium position, the origin, at t = 0 and moves to the right. The amplitude of its motion is 2.00 cm, and the frequency is I .50 Hz. Find

    i.   The equation of the motion of the particle (5 Marks)

    ii.   Maximum speed (3 Marks)

    iii. Maximum acceleration (3 Marks)

    iv.   Total distance travelled between time t=0 and s (5 Marks)

    v.   Displacement of the particle at time t=20s (4 Marks)

QUESTION THREE (20 MARKS)

a) A block-spring system oscillates with an amplitude of 3.50 cm. If the spring constant is 2.50 x 102 N/m and the mass of the block is 0.500 kg, determine

    i.   The mechanical energy of the system (3 Marks)

    ii.   Maximum kinetic energy of the block (2 Marks)

    iii. Maximum potential energy of the block (2 Marks)

    iv.   Phase angle (2 Marks)

    v.   Angular velocity (2 Marks)

vi. The time at the first instance when the displacement 2.1 cm (2 Marks)

vii. The velocity at a displacement of 2.1cm (3 Marks)

viii. Kinetic energy at displacement of 2.1 cm (3 Marks)

QUESTION FOUR (20 MARKS)

a) The equation of a wave can be represented by $y = 0.02 sin \frac{2\pi}{0.5} (320 - x)$ where x and y are in metres and t is in seconds. Find

   i. The frequency (4 Marks)

  ii. The amplitude (1 Mark)

 iii. The wavelength (1 Mark)

 iv. The velocity of propagation of the wave (2 Marks)

b) Two vibrating tuning forks produce waves whose equation is given by $y_1 = 5 \sin(240\pi t)$ and $y_2 = 4 \sin(244\pi t)$ Compute the number of beats per second (4 Marks)

c) A sound source, moving at a constant speed of 240 m•s^{-1} towards a detector, emits sound at a constant frequency. The detector records a frequency of 5100 Hz. Take the speed of sound in air as 340 m•s^{-1} . Find the frequency of the emitted sound (4 Marks)

d) The equation of simple harmonic oscillations of a source is $y = 0.1 \sin 2\pi(10t - x/20)$ cm. Find the displacement from the position of equilibrium of a point 10 m away from the source 3 seconds after oscillations begin. The velocity of propagation of waves 200 m/s.