Date:

Assignment #02

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Section: BSE-1A

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Question: 01

$$v(t) = -\omega x_m \sin(\omega t + \phi)$$

$$4 = -5 \sin\phi$$

$$\phi = \sin^{-1}\left(\frac{-4}{5}\right)$$

$$\phi = -0.927$$

Question: 02

(a) T.E at equilibrium $= \frac{1}{2}mv^2$

$= \frac{1}{2}(0.85)^2(2)$

T.E $= 0.7225\ J$

$\because U = bx^2$

$b = \frac{1}{(0.1)^2}$

$b = 200\ J/m$

at $x = 15$

$U = 200(0.15)^2$

$U = 4.5\ J/m$

it will turn back as P.E

(b) T.E = P.E + K.E

at extrem point K.E = 0 so K.E will be null at point from it will return.

$0.7225 = 0 + bx^2$

$x = \sqrt{\frac{0.7225}{200}}$

$\boxed{x = 0.06\ m}$

OR

$\boxed{x = 6\ cm}$

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Question:03

$m = 2kg$

$F = 20N$

$x_i = 0.200\,m$

Sol:

(a) $F = kx$

$k = \frac{F}{x} = \frac{20}{0.200}$

$\boxed{k = 100\ Nm^{-1}}$

(b) $T = 2\pi\sqrt{\frac{m}{k}} = 2\times3.142\sqrt{\frac{2}{100}}$

$T = 0.888\,sec$

$f = \frac{1}{T} = \frac{1}{0.886}$

$\boxed{f = 1.125\ Hz}$

(c) $v_{max} = -x\omega$

$= (0.200)\left(\sqrt{\frac{k}{m}}\right)$

$= -(0.2)(7.07)$ ∵ at the point where $x = 0$, the velocity will be max.

$v_{max} = -1.414\ m/s$

(d) $a_{max} = -x\omega^2$

$= -(0.2)\left(\sqrt{\frac{k}{m}}\right)^2$

$\boxed{a_{max} = -10\ m/s^2}$

(e) Total energy $= \frac{1}{2}kx^2 = \frac{1}{2}(100)(0.2)^2$

$\boxed{T.E = 2\,J}$

(f) velocity when $x = \frac{1}{3}x$

∵ $v = -x\omega \Rightarrow v = \frac{-x\omega}{3}$

$v = -(1.414)/3$

$\boxed{v = -0.471\ m/s}$

(g) acceleration when $x = \frac{1}{3}x$

$a = \frac{-x\omega^2}{3}$

$\boxed{a = -3.33\ m/s^2}$

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Question 04:

$f = 3\ hz$

$m = 1450\ kg$

$k = ?$

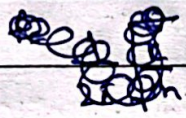
no of spring $= 4$

Sol:

(a) mass of 1 spring $= \frac{1450}{4} = 362.5$

$w = \sqrt{\frac{k}{m}} = f$

$2\pi f = \sqrt{\frac{k}{m}}$



$(2\pi f)^2 \times m = k$

$k = 128831.74\ N/m$

(b) mass of 5 passenger $= 73 \times 5 = 365\ kg$

total mass $= 1450 + 365 = 1815$

mass on each spring $= 1815/4 = 453.75$

as $f = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$

$f = \frac{1}{7 \times 3.142} \times \sqrt{\frac{128831.74}{453.75}}$

$f = 2.68\ hz$

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Question:05

$k = 7580\ N/m$

$m = 0.245\ kg$

$f = ?$

Sol:

k on whole system $= 2 \times 7580$

$= 15160\ N/m$

$\therefore f = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$

$= \frac{1}{2 \times 3.142}\sqrt{\frac{15160}{0.245}}$

$\boxed{f = 39.5\ hz}$

Question:06

$W = 14\ N$

$l = 0.450\ m$

$k = 120\ N/m$

$\theta = 400° = 360 - 400 = 40°$

Sol:- (a) $F = kx$

$F = W\sin\theta$

$W\sin\theta = kx$

$x = \frac{W\sin\theta}{k} = \frac{14 \sin 40}{120}$

$\boxed{x = 0.07\ m}$

Total distance from equilibrium position $= 0.07 + 0.450$

$= 0.525\ m$

(b) $T = 2\pi\sqrt{\frac{m}{k}} = 2\pi\sqrt{\frac{1.4}{120}}$

$\boxed{T = 0.67\ sec}$

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Question: 07

$T = 1.5\,s$

$\phi = \pi/6$ rad

$f = \frac{1}{T} = 0.66$ hz

$t = 0.05$ sec

$x_m = A$

Sol:

$x_2 = x_m \cos(\omega t + \phi)$

$= x_m \cos\left(2\pi(0.66)(0.5) + \pi/6\right)$

$= x_m \cos\left(\frac{62\pi}{\pi}\right)$

$= -x_m (0.855)$

$\boxed{x_2 = -0.855\,A}$

$x_1 = x_m \cos(\omega t + \phi)$

$= A \cos\left(2\pi(0.66)(0.5) + 0\right)$

$\boxed{x_1 = -0.48\,A}$

$\Delta x = x_1 - x_2$

$= -0.48A + 0.855\,A$

$\boxed{\Delta x = 0.375\,A}$

$v_1 = -\omega x_m \sin(\omega t)$

$= -\frac{2\pi}{T} A \sin\left(\frac{2\pi}{T} \cdot t\right)$

$= -\frac{2\pi}{1.5} A \sin\left(\frac{2\pi}{1.5} \cdot 0.5\right)$

$\boxed{v_1 = 3.62\,A\ m/s}$

$v_2 = -\omega x_m \sin(\omega t + \phi)$

$= \frac{-2\pi}{1.5} A \sin\left(\frac{2\pi}{1.5}(0.5) + \frac{\pi}{6}\right)$

$\boxed{v_2 = -2.09\,A\ m/s}$

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Question:08

(a) position & velocity ($\pi/2$) cannot be same
(b) velocity & acceleration ($\pi/2$) cannot be same
(c) position & acceleration (π) always in opposite direction

- There will be no change in total energy & potential energy as they both are not dependant on mass. Kinetic energy is dependant on mass so it can be changed

Question:09

$$x = (5.00\ cm)\cos(2t + \pi/6)$$
$$t=0 \ ; \ \omega = 2$$

Sol:

(a) position $\Rightarrow$ $x = 500\cos[2(0) + \pi/6]$

$$\boxed{x = 4.33\ cm}$$

(b) velocity $v = -2(5.00)\sin(2t + \pi/6)$

$$\boxed{v = 5\ cm/s}$$

(c) acceleration $a = -\omega^2 x$

$$a = -(2)^2(4.33)$$
$$\boxed{a = -17.32\ cm/s^2}$$

(d) amplitud $\boxed{5\ cm}$

(e) $T = \frac{2\pi}{\omega} = \frac{2\pi}{2} = 3.142\ sec$

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Question: 10

$m = 2.20\ kg$

$K = 250\ N/m$

$T = 0.615\ sec$

Sol:

$$w = \frac{2\pi}{t} = \frac{2\pi}{0.615} = 10.216\ rad/s$$

$$w = \sqrt{\frac{k}{m} - \left(\frac{b}{2m}\right)^2}$$

$$(10.21)^2 = \frac{k}{m} - \frac{b^2}{4m^2}$$

$$104.37 = \frac{4k - b^2}{4m^2}$$

$$4(2.2)^2 (104.37) = 4(250)(2.20) - b^2$$

$$b^2 = 2200 - 2020.6$$

$$b = \sqrt{179.39}$$

$$\boxed{b = 13.39}$$

$$b = \sqrt{mk}$$

$$= \sqrt{250 \times 2.2}$$

$$b = < 23.45$$

system is under damp.

Question: 11

$F_x = -kx$

$k = 580\ N/m$

$m = u = 1.66 \times 10^{-27}\ kg$

Sol:

$$f = \frac{1}{2\pi}\sqrt{\frac{k}{m/2}} \quad \because u = m/2$$

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$$f = \frac{1}{2\pi}\sqrt{\frac{580}{1.66\times10^{-27}/2}}$$

$$\boxed{f = 1.33\times10^{14}\ hz}$$

Question: 12

$m_i = 1.50kg$

$m_B = 275\ g = 0.275kg$

$k = 185\ N/m$

$A = 15cm = 0.15m$

(a) $d_T = ?$

(b) $t = ?$

(c) $\theta = ?$

Sol:

(a) $F = kd$

$mg = kd$

$d = \frac{mg}{k}$

$d = \frac{1.775\times10}{185}$

$\boxed{d = 0.094\ m}$

total height

$\Rightarrow d_T = 15 + 9.4 =$

$\boxed{d_T = 24.4\ cm}$

(b) $x(t) = A\cos(\omega t)$

$\omega = \sqrt{\frac{k}{m}} = \sqrt{\frac{185}{1.775}}$

$\omega = 10.2\ rad/s$

$\cos(\omega t) = \frac{x}{A}$

$\cos\omega t = \frac{9.4}{15}$

$\omega t = \cos^{-1}\left(\frac{9.4}{15}\right)$

$t = \frac{0.900}{10.2}$

$\boxed{t = 0.221\ sec}$

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(c) $T.E = P.E + K.E$

$\frac{1}{2}kx^2 = \frac{1}{2}kx^2 + \frac{1}{2}mv^2$

$kA^2 = kx^2 + mv^2$

$mv^2 = kA^2 - kx^2$

$v = \sqrt{\frac{kA^2 - kx^2}{m}}$

$v = \sqrt{\frac{1.85}{1.775}(0.15^2 - 0.094^2)}$

$v = 1.19 m/s$

Question: 13

$x = 8.6 cm = -0.086 m$

$v(0) = -0.93 m/s$

$a(0) = 48 m/s^2$

Sol:

(a) ω and f

By using acceleration

$a(0) = -\omega^2 A\cos(\omega t + \phi)$

$\because x(0) = -0.086$

$a(0) = -\omega^2 (x(0))$

$48 = -\omega^2 (-0.086)$

$\omega = \sqrt{\frac{48}{0.086}} = 23.62 rad/sec$

$\omega = 23.62 rad/sec$

For f =>

$f = \frac{\omega}{2\pi} = \frac{23.62}{2\pi}$

$f = 3.75 Hz$

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(b) for ϕ

Calculating velocity

$$v(0) = -\omega A \sin(\omega t + \phi) \quad -(1)$$

finding A from $x(0)$

$$A = \frac{x(0)}{\cos(\omega t + \phi)}$$

Replacing (A) in eq(1)

$$v(0) = -\omega \left(\frac{x(0)}{\cos(\omega t + \phi)} \right) \sin(\omega t + \phi)$$

substituting values

$$-0.93 = -(23.62)(0.086)\tan\phi$$

$$\phi = \tan^{-1}\left(\frac{-0.93}{23.62 \times 0.086}\right)$$

$$\phi = 0.429$$

(c) Amplitude

as we have

$$A\cos\phi = -0.086$$

$$A = \frac{-0.086}{\cos\phi}$$

$$A = 9.47\text{cm}$$

OR

$$A = 0.0947\text{m}$$