QUESTION (2): (12 Points)

A block of mass m = 2 kg attached to a damped spring with $k = 8\ N.m^{-1}$, and damping constant $b = 8\ kg.s^{-1}$ is resting in equilibrium at time t = 0, when it receives an impulse that gives it an initial velocity of -3 m/s.

(a) Which kind of damping describes the subsequent motion of the block? Explain your answer. (2 Points)

(b) Use the information given to determine the values of all constants in the appropriate x(t) equation, and thus specify the displacement of the block as functions of time. (6 points)

(c) Find the time at which the block is farthest from its equilibrium position, and determine the displacement at this time. (4 points)

QUESTION (3): (15 Points)

(3-1) A string of length L and total mass M is under a tension F. One end of it is fixed in place at x = 0, while the other end is free to move up and down at x = L.

(3-1a) Starting from the standard form of $y(x,t) = 2A\sin(kx)\cos(\omega t)$, for a harmonic standing wave, derive the wavelengths of the normal modes on this string: $\lambda_n = 4L/n$. State clearly what values of n are allowed. [Hint: x = 0 is a node, i.e., y=0, but x = L is an antinode, i.e., y =±2A.] Obtain the normal-mode frequencies f_n in terms of L, M, F, and n , and write the full wave functions in these terms. Sketch the first two allowed harmonics, indicating the positions of all nodes and antinodes. (6 Points)

(3-1b) With L = 2 m and M = 8 g, the string supports the standing wave, y(x, t) = 0.03 sin(3.25π x) cos(162.5π t), for x and y measured in metres and t in seconds. Find (i) the value of n for this particular harmonic ; (ii) the tension in the string. (6 points)

(3-2) A siren radiates sound energy uniformly in all directions. When you stand a distance 100 m away from the siren you hear a sound level of 90 dB. If you move to a distance of 10 m from the siren, the sound level is given by .....(3 points)

QUESTION (4): (8 Points)

Monochromatic light illuminates two slits separated by 1.2 mm, creating a fringe pattern on a screen 3.6 m from the slits. The distance between the third and sixth dark fringes on the screen is 5.3 mm.

(a) What is the wavelength of the light? .....[5 points]

(b) The width of each slit in part (a) is a = 0.15 mm. What is the width of the central diffraction maximum on the screen, and how many bright fringes (i.e., interference maxima) are contained within it?

Good Luck

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