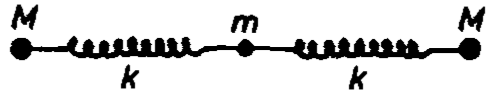
Birzeit University
Faculty of Science-Department of Physics
Physics of waves and vibrations, Phys236
Spring 2018
Second Exam, May 13th 2018

1. Consider the motion of the system of masses and springs shown below, with $M > m$.



   (a) (14 points) What are the normal-mode frequencies of the system?

   (b) (6 points) Describe the motion of the particles

2. The dispersion relation for oscillation of a string (It has a length L) with linear mass density μ and under tension T is given by:

$$\omega = k\sqrt{(T/\mu) + \alpha k^2}$$

   α is a positive constant. The string is fixed at x =0 and x=L. At t=0 The sting displacement is given by:

$$y(x, t = 0) = sin(\frac{\pi x}{L}) + 4sin(\frac{2\pi x}{L}) + 9sin(\frac{3\pi x}{L})$$

   (a) (10 points) Find the phase velocity

   (b) (10 points) Find the group velocity

   (c) (7 points) What are the frequencies of the normal modes

   (d) (3 points) at what time t will the string for the first time have exactly the same shape as it did at time t = 0? Or will this never happen? Justify your answers.

3. A point mass M is concentrated at a point on a string of characteristic impedance ρc. A transverse wave of frequency ω moves in the positive x direction and is partially reflected and transmitted at the mass. The boundary conditions are that the string displacements just to the left and right of the mass are equal ($y_i + y_r = y_t$) and that the difference between the transverse forces just to the left and right of the mass equal the mass times its acceleration. If A_1, B_1 and A_2 are respectively the incident, reflected and transmitted wave amplitudes show that:

   (a) (5 points) $\frac{B_1}{A_1} = \frac{-iq}{1+iq}$

   (b) (5 points) $\frac{A_2}{A_1} = \frac{1}{1+iq}$

   (c) (5 points) If $q = tan\theta$, show that A_2 lags A_1 by θ and that B_1 lags A_1 by $\theta + \pi/2$ for $0 < \theta < \pi/2$.

   (d) (5 points) Show also that the reflected and transmitted energy coefficients are represented by $sin^2\theta$ and $cos^2\theta$, respectively.

   Note: $q = \frac{\omega M}{2\rho c}$

Question:	1	2	3	Total
Points:	20	30	20	70
Score:				

Good Luck