Birzeit University
Faculty of Science-Department of Physics
Physics of waves and vibrations, Phys236
Spring 2018
Final Exam, June 6th 2018

1. (10 points) The phase velocity v of transverse wave in a crystal of atomic separation a is given by:

$$v = c(\frac{sin(ka/2)}{(ka/2)})$$

where k is the wave number and c is a constat. Find the group velocity and discuss the limits for long wavelength.

2. An object of mass $\boldsymbol{m}$ is connected to a harmonic oscillator with stiffness constant $\boldsymbol{s}$, natural angular frequency ω_0 , and damping constant $\boldsymbol{r}$ is driven by an external force $F(t) = F_0 cos(\omega t)$.
   (a) (10 points) Show that the displacement amplitude is given by:

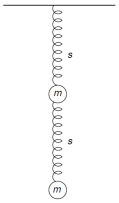
$$x = \frac{F_0}{\omega\sqrt{r^2 + (m\omega - s/\omega)^2}}$$

   (b) (5 points) Show that the displacement amplitude is independent of ω at low frequencies
   (c) (5 points) Show that the velocity amplitude at velocity resonance is independent of ω
   (d) (5 points) Show that the frequency amplitude is independent of ω at high frequencies

3. (20 points) Find the fourier transformation of the function $f(x) = 1 - x^2$ in the interval [-1,1]

4. (20 points) A ring of radius $\boldsymbol{R}$ carries a charge $\boldsymbol{q}$ that is uniformly distributed on its circumference. If an electron is released at point $\boldsymbol{z}$ above its center where $z << R$, show that the electron will exhibit a simple harmonic motion and find its period.

5. The equal masses in the figure oscillate in the vertical direction.



   (a) (15 points) Find the frequencies of the normal modes of oscillation and discuss the relative amplitude of the two masses
   (b) (5 points) What happens when either of the two masses is much larger than the other.

6. For three identical masse that are loaded on a string (the distance between the masses is a) answer the following:
   (a) (8 points) Find the normal frequencies $\omega_j^2 = 2\omega_0^2(1 - cos(\frac{j\pi}{n+1}))$
   (b) (12 points) Find the relative displacement of the three masses for each normal mode frequency $-A_{r-1} + (2 - \frac{ma\omega^2}{T})A_r - A_{r+1} = 0$

7. (25 points) Two acoustic mediums of impedance Z_1 and Z_2 show by applying the boundary conditions that if we insert a quarter wavelength medium of impedance $Z_2 = \sqrt{(Z_1 Z_3)}$ then the coefficient of sound transition is 1

Question:	1	2	3	4	5	6	7	Total
Points:	10	25	20	20	20	20	25	140
Score:								

Good Luck