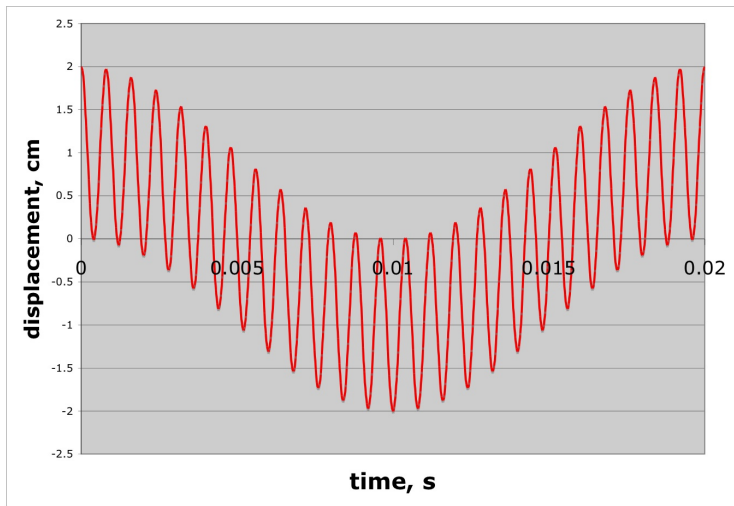
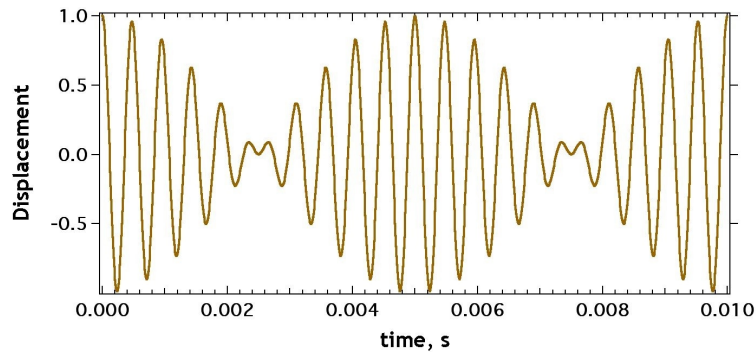


PHYSICS 273 EXAM 2
APRIL 24, 2007

Write your name on this exam. *Closed book examination. Make sure your exam has four problems on it. Continue on the back of the page if you need more space. You may use a 2 recipe cards with equations on it. You may use a scientific calculator. Read questions carefully, show all work, and include units in answers.*

1. An electromagnetic plane wave, with wavelength 3.0 m, travels in free space in the +x direction with its electric vector \mathbf{E} of amplitude 300 V/m, directed along the y axis.
 - (a) What is the direction and amplitude of the magnetic field associated with the wave?
 - (b) If $E = E_m \sin(kx - \omega t)$, what are the values of k and ω ?
 - (c) What is the time averaged rate of energy flow in W/m^2 associated with this wave?
 - (d) If the wave falls upon a perfectly absorbing sheet of area 2.0 m^2 at what rate would momentum be delivered to the sheet?

2. (a) State Fourier's theorem in your own words.
- (b) Carefully draw the fourier spectrum for each of the following waves, labeling each peak with its frequency and magnitude.
- (c) Indicate how long you would need to sample each wave in order to capture most of the signal.



3. A capacitor consisting of two circular plates of radius $R=18$ cm separated by a distance d is connected to a source emf of $\mathcal{E} = \mathcal{E}_m \cos \omega t$ where $\mathcal{E}_m=220$ V and $\omega = 130$ rad/s. The maximum value of the displacement current is $i_d = 7.6\mu\text{A}$.
- (a) What is the maximum value of $d\Phi_E/dt$?
 - (b) Find the maximum value of \mathbf{B} between the plates at a distance $r = 11$ cm from the center?
 - (c) What is the separation d between the plates?

4. A pulse of amplitude 1 cm is propagating along a string toward a boundary where the string is connected to another string having a mass density that is only one half that of the first string.
- (a) Draw the incident, reflected, and transmitted pulses and calculate their amplitudes.
 - (b) What percentage of the energy is reflected?
 - (c) Suppose you wanted to power a load with a resistance of 50Ω . You have a choice between a using a number of different coaxial cables all with an inner conductor radius of 1 mm and an outer conductor radius of 3.25 mm, but they are filled with different dielectrics. What is the dielectric constant of the material in the cable you choose?
 - (d) Explain in terms of the mechanical analogy of the string why you chose your cable.

POSSIBLY USEFUL INFORMATION

$$\begin{aligned}\epsilon_0 &= 8.85 \times 10^{-12} \text{ C}^2/\text{N} \cdot \text{m}^2 & \mu_0 &= 1.26 \times 10^{-6} \text{ N/A}^2 = 4\pi \times 10^{-7} \text{ N/A}^2 \\ \sqrt{\mu_0/\epsilon_0} &= 377 \text{ } \Omega & C &= \epsilon_0 A/d \text{ (parallel plate)}\end{aligned}$$