

Physics 262

Homework #5

Show your work.

For design problems, work to within 5% of specifications.

1. For the plots in this problem, free to use any sort of graphing application, or draw neatly by hand. Put all of the functions on the same axes so that you can compare them easily. Use different colors or line styles for each function, and include a clearly labeled legend.
 - (a) Plot a sine wave with period T , running from $-T/2$ to $T/2$.
 - (b) Plot the next several harmonics: $n = 2, 3, 4$.
 - (c) Now overplot a square wave: -1 from $-T/2$ to 0 ; and $+1$ from 0 to $T/2$.
 - (d) Explain in words why the even harmonics have zero coefficients in the Fourier series for the square wave.
2. The oscilloscope measures the input voltage at some sampling frequency f_s . In other words, the voltage is measured once every $T_s = 1/f_s$ seconds. When we measure a signal with a frequency that is too high, our limited sampling rate will make the signal look like it has a lower frequency. This is called aliasing. See H&H fig. 11.16.
 - (a) Draw a time axis with five evenly spaced tick marks representing units of T_s from time $t = 0$ to $t = 4T_s$. Sketch on these axes a cosine wave with frequency $f_s/4$ (period $4T_s$), placing dots on the sinewave above or below each tick, showing where the oscilloscope would sample the sinewave.
 - (b) Draw a new time axis and repeat for frequency $f_s/2$. This is called the *Nyquist* frequency, the highest frequency we can represent with measurements taken at sampling rate f_s .
 - (c) Draw a new time axis and repeat for frequency f_s . If all you had were the oscilloscope measurements, what would you think about the frequency of this signal?
 - (d) Draw a new time axis and repeat for frequency $1.5f_s$. What frequency does the signal appear to be?