

EE 451

Homework #13

Due November 26, 2001

1. A real continuous-time signal $x_a(t)$ is bandlimited to frequencies below 5 kHz. The signal $x_a(t)$ is sampled with a sampling rate of 10 kHz to produce a sequence $x[n]$. The N -point DFT $X[k]$ of $N = 1000$ samples of $x[n]$ is computed.
 - (a) To what continuous-time frequency does index $k = 150$ in $X[k]$ correspond?
 - (b) To what continuous-time frequency does index $k = 800$ in $X[k]$ correspond?

2. A continuous-time signal $x_a(t)$ is bandlimited to 5 kHz. $x_a(t)$ is sampled with a frequency F_S , producing the sequence $x[n]$. To examine the spectral properties of the signal, we compute the N -point DFT of a segment of N samples of $x[n]$ using a computer program that requires $N = 2^\nu$, where ν is an integer.

Determine the *minimum* value for N and the range of sampling rates

$$F_{min} < F_S < F_{max}$$

such that aliasing is avoided and the effective spacing between DFT values is *less* than 5 Hz; i.e., the equivalent continuous-time frequencies at which the DFT is evaluated are separated by less than 5 Hz.

3. A signal is sampled with a sampling frequency of 10 kHz. It is obvious that there is a predominant signal at one frequency, but you suspect there may be other frequencies with smaller amplitudes present. You want to verify this for any frequency which has an amplitude of at least 1% of the main frequency, and is separated from the main frequency by at least 10 Hz.
 - (a) What windows can you use to see if you are correct?
 - (b) Chose one window from (a). What length DFT do you need to use to see if you are correct?
 - (c) Download the file `signal.mat` from http://www.ee.nmt.edu/rison/ee451/hw/hw13_signal.mat. Load this signal into MATLAB using the command `load signal.mat`. (If you cannot load the binary file `signal.mat`, try the ASCII file `signal.dat`. You will have to use the command `load signal.dat` to load it.) You will have a signal called `x`. Use the MATLAB `fft` function to determine the dominate frequency, and to determine if any other frequencies are present. If other frequencies are present, what are they?