HOMEWORK ASSIGNMENT 2

Reading: Text, Section 3.1 and 3.2, and Lathi, Section 3.5

Due Date: February 6, 2003 (in class)

1. *Short Q/A's*

   (a) Suppose $x(t)$ is bandlimited to W Hz, i.e., $X(f) = 0$ for $|f| \geq W$. Show that $x(t)$ can be represented as

   $$x(t) = 2\lambda \left[x(t) * \text{sinc}(2\lambda t)\right]$$

   for all $\lambda > W$.

   (b) Prapti, the ECE 359 TA, has been experimenting with various waveforms to use in her new electronic music machine. She is now searching for a signal that is amplitude limited between the values A and -A and has maximum power at a particular frequency f_0. What waveform should Prapti use? Justify your answer clearly.

2. Design an analog lowpass Butterworth filter with bandwidth of 1 kHz. Find the order n such the a 25 kHz signal is attenuated to a level that is no more than 5% of its input amplitude. (You have to prove that your n works.)

3. Use the Matlab function `butter.m` (don't forget the 's' option for analog filters) to design the transfer function of the Butterworth filter from the previous question. Plot the magnitude and phase of the frequency response of your filter using the Matlab function `bode.m`

4. Determine the 99% essential bandwidth of the signal

   $$x(t) = \frac{2}{4 + t^2}$$

   Hint: Find $X(f)$ using duality on one of the FT pairs given in Table 2.1 on page 38 of the book.

   Also find the half power (3 dB) bandwidth of the signal.

5. Problem 3.2 on page 131 of text.

6. Problem 3.3 on page 131 of text.

