EECS 120 **Fall 2004**

Homework 7 : Due by 8 p.m. on Monday November 01

1. Problem 8.26 on pg. 634 of OWN.
2. Problem 8.35 on pp. 640 -641 of OWN.
3. Problem 8.41 on pp. 646 -648 of OWN.
4. Problem 8.49 on pp. 652 -653 of OWN.
5. This MATLAB problem aims at exploring SSB-AM (single side band amplitude modulation). Let $m(t)$ be the modulating signal, which is assumed to be bandlimited to $[-\omega_M, \omega_M]$ and let $c(t) = A_c cos(\omega_c t)$ be the carrier signal. Also, assume that $\omega_c > \omega_M$.

   The Hilbert transform of the modulating signal is defined as $\hat{m}(t) = m(t) * \frac{1}{\pi t}$. Then, the SSB-AM of the modulating signal onto the carrier is given by

   $$u(t) = \frac{A_c}{2} m(t) \cos\omega_c t \mp \frac{A_c}{2} \hat{m}(t) \sin\omega_c t \tag{1}$$

   where the minus sign corresponds to USSB-AM and the plus sign corresponds to LSSB-AM and $\hat{m}(t)$ is the Hilbert transform of the modulating signal as defined previously.

   The Hilbert transform of a signal can be computed using the MATLAB command **hilbert**. Note, that this function returns a complex sequence whose real part is the original sequence and whose imaginary part is the desired Hilbert transform. Therefore, the Hilbert transform of the sequence is obtained by using the command **imag(hilbert(m))**, where m is an array containing samples of the modulating signal.

   Consider the modulating signal, $m(t) = sinc(200t)$ for $|t| < t_0$ and $m(t) = 0$ otherwise. $m(t)$ modulates the carrier $c(t) = \cos\omega_c t$ using a SSB-AM scheme.

   (a) Plot the modulated signal $u(t)$ for $t_0 = 0.1$ and $\omega_c = 500\pi$ for both USSB-AM and LSSB-AM. (Hint: Use equation (1) to compute $u(t)$.)

   (b) Plot the magnitude spectrum $|U(j\omega)|$, for $u(t)$ as given in part (a) under both USSB-AM and LSSB-AM.

   For part (b) use the following to plot the Fourier transform. First, sample the modulated signal $u(t)$ at every $t_s = 0.001$, i.e., the sampling frequency $\omega_s = 2000\pi$ (note that ω_s is larger than the bandwidth of the system) to get a vector **u** of samples of $u(t)$. Then, use the MATLAB command **U=FFT(u,n)** to calculate the FFT coefficients of the vector u. Here n refers of the length of the FFT sequence. For this problem you can take $n = 2^{17}$. Finally, normalize the FFT coefficients by $f_s = \omega_s/(2\pi)$ to get the Fourier transform. In order to plot the Fourier transform, first use the MATLAB function **FFTSHIFT(U)** to center the zero frequency terms and then plot it for the frequency range $[-f_s/2, f_s/2]$ with a frequency resolution $\Delta = f_s/n$.