HOMEWORK ASSIGNMENT 4

Reading: Text, Section 3.2 and 3.4.1, and Lathi, Chapter 4

Due Date: February 20, 2003 (in class)

1. If $\hat{m}(t)$ is the Hilbert transform of $m(t)$, then show that the Hilbert transform of $\hat{m}(t)$ is $-m(t)$. Also show that the energies of $\hat{m}(t)$ and $m(t)$ are equal.

2. Problem 3.8 on page 132 of text

3. Problem 3.16 on page 135 of text

4. Suppose the message signal
$$m(t) = \text{sinc}(t)$$
is modulated using a 10 Hz carrier $c(t)$ which is given by
$$c(t) = 10\cos(20\pi t).$$

   (a) Carefully plot Fourier transforms (spectra) of the DSB-SC signal and the LSB signal. (Note that the LSB signal is obtained by first scaling the the DSB-SC signal by 2 and then chopping off the USB.)

   (b) From the plot of the Fourier transform of the LSB signal, show that the LSB signal is given by
$$v_\ell(t) = 10\cos(19.5\pi t)\text{sinc}(t/2)$$

   (c) Show that the Hilbert transform of $m(t)$ is given by:
$$\hat{m}(t) = \text{sinc}(t/2)\ \sin(\pi t/2)$$

   (d) Now show that
$$10[m(t)\cos(20\pi t) + \hat{m}(t)\sin(20\pi t)]$$
   equals $v_\ell(t)$ of part (b). (This confirms that the equation we derived in class for the LSB signal is correct.)

5. (From Lathi.) A transmitter transmits an AM signal with a carrier frequency of 1500 kHz. When an inexpensive radio receiver (which has poor selectivity in the RF-stage bandpass filter) is tuned to 1500 kHz the signal is heard loud and clear. The same signal is also heard (not so loud) at another setting. State, with reasons, at what frequency you will hear this station. The IF frequency is 455 kHz.