ECE 457 Spring 2003
Practice Exam Final

1. Determine whether the following statements are true or false. Give explanations if true, counterexamples if false.

    a) Without prior knowledge about the message signal, one can tell by looking at an angle modulated signal if it is an FM or PM signal.
    b) A message signal with bandwidth 5kHz is transmittedon a baseband communication channel with attenuation of 50dB and $N_0 = 10^{-12} W/Hz$. If the baseband SNR is required to be at least 20dB, then the transmitted signal power must be greater than 0.05W.
    c) If the input to an ideal discriminator with discriminator constant $K_D = 2$, is $10\cos(20\pi t + 10t^2)$, the output voltage is $v(t) = t/2$.
    d) A carrier phase offset of $\pi/4$ in DSB demodulation produces a scaled version of the message signal.
    e) The output SNR for AM modulated signal is 40dB. If it is desired to achieve the same SNR for SSB modulated signal, then the transmitted power for SSB modulation is greater than the transmitted power for AM modulation.

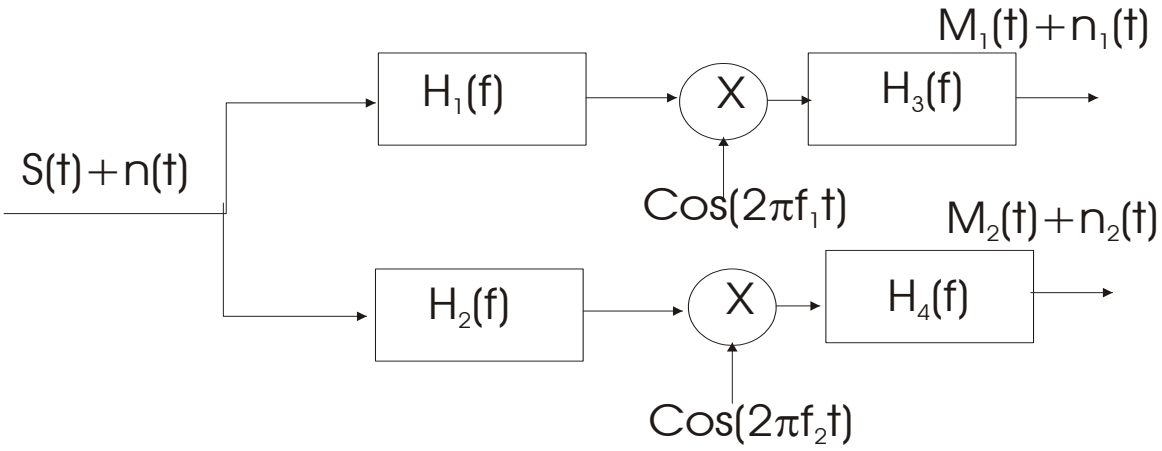
2. The sinusoidal message signal $m(t) = A_m \cos(2\pi f_m t)$ is frequency modulated so that the transmitted signal $s(t)$ is given by $s(t) = A_c \cos(2\pi f_c t + 2\pi f_d \int_{-\infty}^{t} m(\tau) d\tau)$.

    The following parameters are given: $f_c = 9.95MHz, f_m = 25KHz, A_m = 1V$.

    a) Suppose that $f_d = 10KHz/Volt$. What is the bandwidth of the transmitted signal $s(t)$?
    b) Signal $s(t)$ goes through a communication channel that adds noise to it, so that the received signal is $r(t) = s(t) + n(t)$, where $n(t)$ is white Gaussian random process with power spectral density, $S_n(f) = \frac{N_0}{2} = 3 \times 10^{-5} W/Hz$. Signal r(t) is demodulated using a standard FM demodulation scheme like the one we discussed in class. Assuming that the available channel bandwidth is 100KHz, find the minimal required transmitting power so that the signal to noise ratio at the output of the FM demodulator is at least 40dB.
    c) Consider the same problem as in part (b) this time with a deemphasis filter with $|H_{de}(f)| = \frac{1}{\sqrt{1 + (f/5kHz)^2}}$. What should the transmitting power be so that the output SNR is the same as in part b? Compare your results.

3. Consider a SSB system for simultaneously sending two baseband signals. Let $m_1(t)$ and $m_2(t)$ be baseband signals with Fourier transforms, $M_1(f) = rect\left(\frac{f}{2B_1}\right), M_2(f) = tri\left(\frac{f}{B_2}\right)$. Suppose you have a dual SSB modulator that has $m_1(t)$ and $m_2(t)$ as input and generates the transmitted signal $s(t)$ consisting of $m_1(t)$ with USB modulation and $m_2(t)$ with LSB modulation as shown below.

a) Consider the demodulator shown below. Assuming $n(t) = 0$, find f_1, f_2, and ideal filters $H_1(f), H_2(f), H_3(f), H_4(f)$ such that the demodulator yields the desired outputs $m_1(t)$ in the upper branch and $m_2(t)$ in the lower branch.



b) Even without noise a practical (nonideal) implementation of this system design will have some distortion. What types of signals $m_1(t)$ and $m_2(t)$ will exhibit the most distortion? Do the signals given above fall in this category?

c) Now assume that $n(t)$ from part (a) is a random noise process with power spectral density $S_n(f) = \begin{cases} \frac{N_0}{2}, f_c - B_2 \le |f| \le f_c + B_1 \\ 0, \quad otherwise \end{cases}$.

Using the results from part (a), find the PSD of $n_1(t)$ and $n_2(t)$. Also, find the SNR in both branches and compare the results.

4. An AM modulator has output $s(t) = 20\cos(300\pi t) + 6\cos(320\pi t) + 6\cos(280\pi t)$.

   a) Determine the modulation index.
   b) Determine the efficiency.
   c) Assume that this signal is transmitted through a channel with attenuation of 40dB and additive white noise with power spectral density $S_n(f) = \frac{N_0}{2} = 10^{-10} W/Hz$. What's the SNR at the output of the system assuming coherent demodulation at the receiver?
   d) What should the transmitter power for a DSB system be to achieve the same SNR at the output?