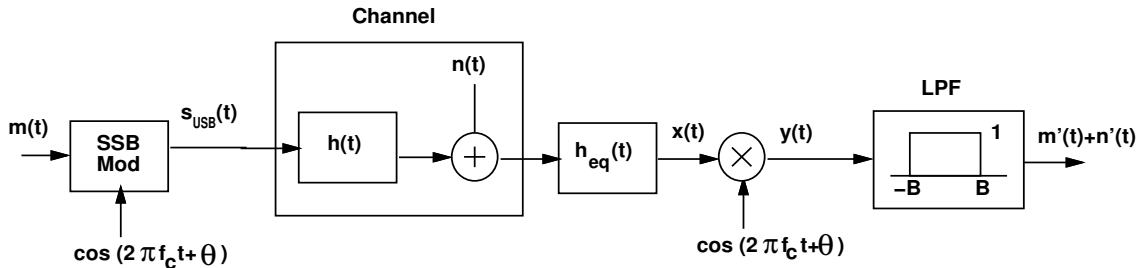


Homework 6: Due May 29 at 4pm.

- (15 points) Text, Chapter 3, Number 3.26
- (20 points) The SSB system shown below, where the modulator is the USB version of an SSB modulator with output  $s_{\text{USB}}(t) = 5A_c[m(t) \cos(2\pi f_c t) - m_h(t) \sin(2\pi f_c t)]$ . The random phase offset  $\theta$  in the carrier is known perfectly in the receiver, is uniform, and is independent of the noise  $n(t)$ .



Assume the noise  $n(t)$  is white Gaussian noise with power spectral density  $S_n(f) = N_0/2 = .1\text{mW/Hz}$ . The PSD  $S_m(f)$  of  $m(t)$  is defined as

$$S_m(f) = \begin{cases} 10\text{mW/Hz} & |f| \leq .5B \\ 5\text{mW/Hz} & .5B < |f| \leq B \\ 0 & |f| > B \end{cases}$$

- What is the total power in  $m(t)$ ?
- Find the SNR of the system output (power in  $m'(t)$  over power in  $n'(t)$ ) assuming  $H(f) = H_{eq}(f) = 1$ .
- Assume now that the frequency response of the channel  $H(f)$  is given by

$$H(f) = \begin{cases} .1 & f_c - .5B \leq |f| \leq f_c + .5B \\ 1 & \text{else} \end{cases}$$

Find the equalizer  $H_{eq}(f)$  such that in the absence of noise (i.e. for  $n(t) = 0$ ),  $m'(t) = m(t)$ . Find the SNR with this equalizer design and also with  $H_{eq}(f) = 1$ .

- Explain qualitatively the tradeoffs involved in the design of the equalizer  $H_{eq}(f)$ .

- (15 points) Text, Chapter 3, Number 3.27
- (15 points) Text, Chapter 3, Number 3.32
- (15 points) Text, Chapter 4, Number 4.13.
- (20 points) Consider an FM modulated signal  $s(t) = 10 \cos \left[ 2\pi f_c t + 2\pi k_f \int_0^t m(\tau) d\tau \right]$ . We know from the book that when  $m(t) = A_m \cos(2\pi f_m t)$ ,  $s(t) = A_c \sum_{n=-\infty}^{\infty} J_n(\beta) \cos[2\pi(f_c + n f_m)t]$ . In this problem assume  $\beta$  small means  $\beta \leq .3$  and  $J_n(\beta) = 0$  for  $|n| > 4$  and any  $\beta$ .
  - Assume the modulating signal  $m(t) = 10 \cos(2\pi f_m t)$  for  $f_m = 1$  KHz. For  $k_f = 10$  find  $s(t)$  and sketch its spectrum  $S(f)$ . Find the exact bandwidth of  $S(f)$  based on your sketch and its approximate value based on Carson's rule.
  - For the same  $m(t)$  as in part (a), sketch  $S(f)$  when  $k_f = 250$ . Find the exact bandwidth of  $S(f)$  based on your sketch and its approximate value based on Carson's rule.