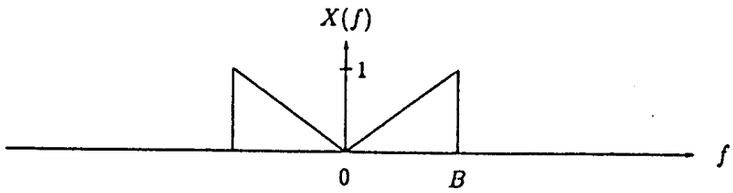
1. (10%)If $y(t) = x(t)\cos 2\pi f_0 t + \hat{x}(t)\sin 2\pi f_0 t$, where $x(t)$ is a lowpass signal with bandwidth $B < f_0$ and $\hat{x}(t)$ is the Hilbert transform of $x(t)$, express the spectrum $Y(f)$ of $y(t)$ in terms of the spectrum $X(f)$ of $x(t)$. Also sketch $Y(f)$ for an $X(f)$ which is shown as below.



2. (10%)If the additive white Gaussian noise with two-sided power spectrum density = $N_0/2$ is passed through an ideal low pass filter with bandwidth = 10 Hz.

   (a) What is the probability density function of the output signal at $t = 10$ Sec?

   (b) What is the joint probability density function of the output signal at $t = 0$ and $t = 1$ Sec?

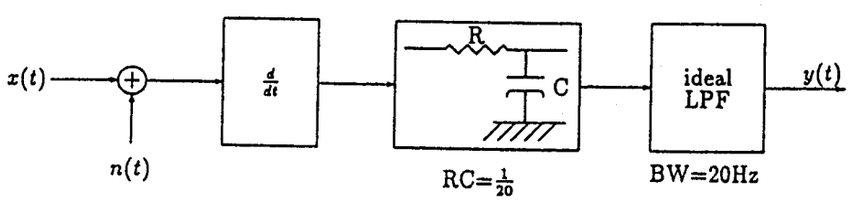
3. (10%)The output of an AM modulator with a real input message is

$$x(t) = A\cos 2\pi(f_c - f_m)t + B\cos 2\pi f_c t + C\cos 2\pi(f_c + f_m)t$$

   If the total output power is 100 W and the modulation index is 1/2. Determine A, B, C, and the power efficiency.

4. (10%)A superheterodyne receiver uses an IF frequency of 455 KHz. The receiver is tuned to a transmitter having a carrier frequency of 1150 KHz. Give two permissible frequencies of the local oscillator and the image frequency for each.

5. (15%)Consider a system as shown below. The input signal is $x(t) = 10\cos 10\pi t$, the power spectrum density of noise $n(t)$ is $N_0/2$. Determine the signal power, noise power and SNR of $y(t)$.



6. (10%)A message source contains A ~ F six symbols with probabilities = 0.05, 0.09, 0.25, 0.15, 0.3, and 0.16 respectively.

   (a) Find the Huffman code for this source.

   (b) What is the efficiency of the designed Huffman code?

7. (10%)A Manchester coding signal $S(t)$ with peak voltage = ± 1 Volt is sent through an AWGN channel with two-sided power spectrum density of the noise = 10^{-6} W/Hz.

   (a) Show the structure of optimal receiver.

   (b) Determine the maximum data rate that can be sent with bit-error-rate $P_b \leq 10^{-5}$. (Note $Q(4.28) = 10^{-5}$)

8. (10%)Three digital communication systems, using coherent BPSK, QPSK, and BFSK modulation respectively, have same peak carrier amplitudes and same value of P_b (bit-error-rate) and N_0 (noise spectrum density). How are the symbol duration T_s of these three systems related?

9. (15%)A linear systematic (n, k) code is generated by a generator matrix G:

$$G = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 1 & 1 & 1 \\ 0 & 1 & 0 & 0 & 1 & 0 & 1 & 1 \\ 0 & 0 & 1 & 0 & 1 & 1 & 0 & 1 \\ 0 & 0 & 0 & 1 & 1 & 1 & 1 & 0 \end{bmatrix}$$

   (a) What are the values of n and k?

   (b) Show the parity check matrix H.

   (c) If message $\underline{m} = [1\ 1\ 0\ 1]$, what is the transmitted codeword $\underline{c}$?

   (d) Determine the minimum distance d_{min} of this code and what are the correcting and detecting capabilities?

   (e) If the received vector $\underline{r} = [1\ 1\ 0\ 0\ 1\ 0\ 1\ 0]$, is $\underline{r}$ a correct codeword? What is the decoded message $\hat{\underline{m}}$?