Problem#1

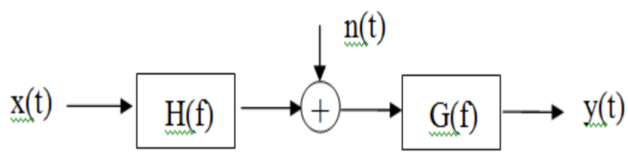
Consider the following analog baseband communication system (no modulation) with additive white Gaussian noise having power spectral density $N_0/2$ and a distorting channel having the frequency response

$$H(f) = \frac{1}{1 + jf/W}.$$

The distortion is compensated by a receiver filter having the frequency response

$$G(f) = \begin{cases} \frac{1}{H(f)}, & f \in [-W,\ W] \\ 0, & \text{otherwise} \end{cases}$$

Find an expression of the output SNR, assuming the power spectral density of the source is Sx(f).



Problem#2

The average noise power per Hz measured at the front end of an AM receiver is 10^{-6} W/Hz. For the modulated signal, the carrier power is 80 watts, and each sideband power is 10 W. The message bandwidth is 4 kHz.

Find the post-detection SNR of the system. By how many dBs is this system inferior to a DSB-SC system?

Solution:

Problem#3

A white noise with power spectral density N0/2 is passed through a filter with frequency response H(f).Find the average power of the output process.

$$H(f) = \begin{cases} 2\sqrt{1-f}, & f \in [0, \ 1], \\ 2\sqrt{1+f}, & f \in [-1, \ 0], \\ 0, & \text{otherwise.} \end{cases}$$

Solution:

Problem#4:

A DSB signal is transmitted through an AWGN channel with the following parameters. Find the Post Detection SNR. $N_0 = 4\times10^{-17}$ watts/Hz, $W = 4\text{kHz}$

$f_c = 200\text{kHz}$,

Solution:

Problem#5:

A bipolar baseband binary signal has rectangular pulse level of +2 V or -2 V and bit duration of T. Additive white Gaussian noise with power spectral density $N_0/2 = 10^{-5}$ Watts/z is added to it.

Find the maximum bit rate that can be transmitted with a bit error probability of $P_e \le 10^{-4}$ using the following table of the Q function. Note: $P_e^{bipolar} = Q\left(\sqrt{\frac{2E_b}{N_0}}\right)$

X	2.3	3.1	3.7	4.2
Q(x)	0.01	0.001	0.0001	0.00001

Solution:

Problem#6:

A random process X(t) is given, where A and B are independent r.v.s uniformly distributed over the interval of [-1,+1]. Find the mean and autocorrelation of X(t). Is X(t) WSS?

$$X(t) = A\cos\omega t + B\sin\omega t$$

Problem#7:

The output of an AM modulator is

$$s(t) = 6\cos(1700\,\pi\,t) + 6\cos(2300\,\pi\,t) + 20\cos(2000\,\pi\,t)$$

Determine the frequency of the carrier and the frequency of the modulating signal (message), and the modulation index. Assume the message is a single tone signal.

Problem#8:

Consider a single tone FM modulated signal with $m(t) = A_m \cos 2\pi f_m t$. For fixed f_m=10 Hz we start increasing A_m gradually until the frequency component at the carrier frequency drops to zero for the first time. What is A_m?

Value of β for which $J_n(\beta) = 0$ for $0 \le \beta \le 9$.

n		β_{n0}	β_{n1}	β_{n2}
0	$J_0(\beta) = 0$	2.4	5.5	8.7
1	$J_1(\beta) = 0$	0	3.8	7.0
2	$J_2(\beta) = 0$	0	5.1	8.4
4	$J_4(\beta) = 0$	0	7.6	-

Problem#9:

For the message signal $m(t) = A\, rect(t/T)$ find the time-domain expression for the Upper-SSB signal, using a carrier at frequency f_c.

Problem#10:

Consider the following band pass signal (frequencies are given in Hz):

$$x(t) = 2\cos(2\pi 90t) + 4\sin(2\pi 120t)$$

(a) **(3 Points)** Find the "complex envelope" of this signal, $\tilde{x}(t)$, with reference to the center frequency $f_c = 100$ Hz.

(b) **(3 Points)** $x(t)$ can also be written in terms of its envelope and phase as follows:

$$x(t) = R(t)\cos(2\pi 100t + \theta(t))$$

What are the values of the envelope and phase of this signal at $t = \frac{1}{40}$ sec? (You **do not** need to find $R(t)$ and $\theta(t)$ for all t.)

Problem#11:

The average noise power per Hz measured at the front end of an AM receiver is 10^{-6} W/Hz. For the modulated signal, the carrier power is 80 watts, and each sideband power is 10 W. The message bandwidth is 4 kHz.

Find the post-detection SNR of the system. By how many dBs is this system inferior to a DSB-SC system?