King Fahd University of Petroleum & Minerals
Electrical Engineering Department
EE571: Digital Communications I (081)
Quiz 2 (Take Home)

Serial #
0
- 1 points for not writing your serial number

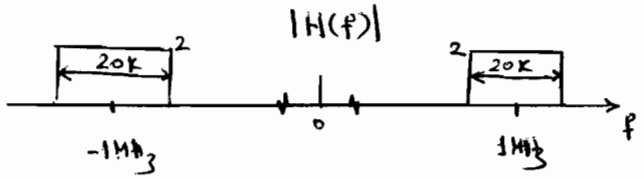
Name: KEY

Consider a white Gaussian noise, $w(t)$ of zero mean and N_0= 4 μWatts/Hz, which is passed through an ideal band-pass filter of passband magnitude equals to 2, midband frequency f_c=1 MHz, and bandwith 20 kHz

$$2W\ \mathrm{sinc}(2Wt) \Leftrightarrow \Pi\left(\frac{f}{2W}\right)$$

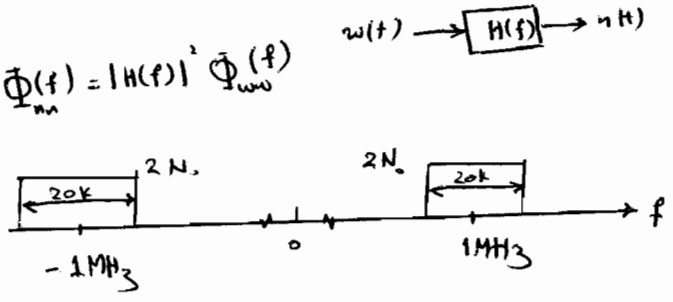
3 1) Sketch the transfer function of the ideal filter.
2) Sketch the power spectral density of the filtered noise.
2 3) Find the auto correlation of the filtered noise and sketch it. (*Show all important values*)
2 4) Sketch the power spectral density of the in-phase and quadrature components of the filtered noise
2 5) Find the auto correlation of the in-phase and quadrature components and sketch it. (Show all important values)+
2 6) If the input signal is sinusoidal wave corrupted with noise: $3\cos(2\pi(1\times10^6)t)+w(t)$, What would be the signal to noise power ratio at the output.

1)



2)

$\Phi_{nn}(f) = |H(f)|^2 \Phi_{ww}(f)$



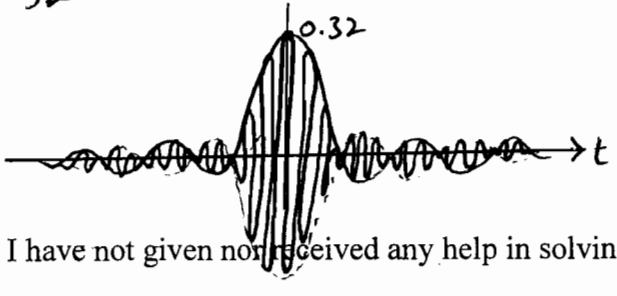
3) $\Phi_{nn}(f) = 2N_0\,\Pi\left(\frac{f-f_c}{BW}\right) + 2N_0\,\Pi\left(\frac{f+f_c}{BW}\right)$

Using Fourier Transform.

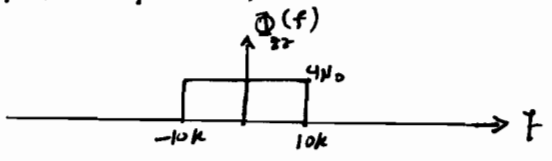
$2N_0(BW)\,\mathrm{sinc}(BWt)\,e^{j2\pi f_c t} + 2N_0(BW)\,\mathrm{sinc}(BWt)\,e^{-j2\pi f_c t}$

$= 4N_0(BW)\,\mathrm{sinc}(BWt)\cos(2\pi f_c t)$

$= 0.32\,\mathrm{sinc}(20kt)\cos(2\pi(1MHz)t)$



4) The low pass Equivalent is $\Phi_{zz}(f)$



See Eq. (4.1-59) p 158

$\phi_{zz}(\tau) = \phi_{xx}(\tau) = \phi_{yy}(\tau)$ hence

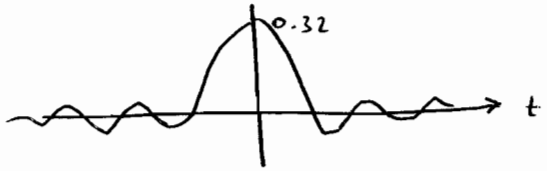
$\Phi_{zz}(f) = \Phi_{xx}(f) = \Phi_{yy}(f)$ Same.

5) $\Phi_{zz}(f) = 4N_0\,\Pi\left(\frac{f}{BW}\right)$

By inverse Fourier Transform.

$\phi_{zz}(\tau) = 4N_0(BW)\,\mathrm{sinc}(BW\tau)$

$= 0.32\,\mathrm{sinc}(20k\tau)$



6) Output signal. $6\cos(2\pi(1\times10^6)t)$

Power $= \frac{6^2}{2} = 18$

out noise power $= \phi_{nn}(0) = 0.32$

It is also Equal to area under $\Phi_{nn}(f)$

$= 20k(4)N_0 = 80k\,4\mu = 320m = 0.32$

$SNR = \frac{18}{0.32} = 56.25$

I have not given nor received any help in solving this quiz _____

Let us learn from our mistakes Good Luck, **Dr. Ali Muqaibel**