Homework Help - Problem Set 8

[**Tomlinson Precoding (3.14)**] This problem investigates the moving of the feedback to the transmitter as a Tomlinson Precoder.

a. The ZF-DFE has an unbiased SBS and monic feedback, which makes the translation to precoder direct. However, the MMSE version has a bias that needs address to t the equivalent FB section $G_U(D)$.

b. It is probably easiest on this problem to write a short recursive matlab segment to compute the precoder outputs. The modulo function is needed at the receiver. There are various matlab commands, but the difference between a value and is floor.m version may be useful.

c. The point of this question is for you to remember why we use the modulo in the first place and not just discard it.

[**Diversity Channel (3.31)**] This is pretty easy. Don't read too much into it, very basic.

a. The difference between the $1 + .9D$ channel and this one is there are TWO receivers. The diversity receiver should consequently do better.

b. This is a really easy channel for both receivers. If that is not obvious in your solution, the diversity effect is not present.

[**DFEcolor Program with Complex (3.53)**] This is a twist on DFEcolor where you are understanding its use and outputs.

a. You have to know what the inputs are to dfecolor.m and what they mean. You don't need to convolve anything here to get this answer.

b. Just because a noise has same energy does not mean the equalized performance will be the same. This is colored noise. What happens?

c. You need to know how to read the feedback section from the program output and then adjust it to corresponding to unbiased detector.

d. The gap formula may be helpful here.

e. You should only use $M = 4$ here in result, but the gap formula is helpful. Do not forget the precoder loss.

f. Recall the relationship $h_{bb}(t) = h(t) \cdot e^{\jmath \cdot \omega_c \cdot t}$. The factor $e^{\jmath \omega_c \cdot t}$ at the symbol rate is $e^{\jmath \cdot 2\pi \cdot f_c \cdot T}$, so the values of h_k can be recovered.

g. Compute the MFB SNR and compare to the DFE SNR given.

h. The first receiver decision device will have more points in a dimension that the second, as it corresponds to the possible values for $x_k - \lambda_k$. What are the possible values for x_k and for λ_k - run through the differences, and count how many values.

[**Multi Bands (3.59)**] This problem illustrates the proper handling of multiple MMSE-DFEs that would be associated with multiple disjoint transmission bands (perhaps as result of water-filling spectra optimization).

a. The lowest channel is given as real baseband and the other two will be complex passband. Find the symbol rate for each, along with carrier frequencies. The baseband has carrier frequency 0.

b. This part asks you to compute the independent bit quantities for each of the 3 separate channels. Use the given gap.

c. Now you need to treat them all as an aggregate single channel - what is the equivalent symbol rate for that?

d. Now the aggregate $\bar{b}$ at the aggregate symbol rate. It should be consistent as weighted average of Part b. There is a "weighted geometric average" of $(1 + SNR)$- like terms for this, see text and lectures.

e. You already know the positive-frequency bandwidth and should double it when multiplying by the two-sided PSD level.

f. The energy per dimension decreases because the transmitter places energy everywhere over the 100 MHz.

g. This requires you to realize that the energy in the previously zeroed bands has a nonzero gap that multiplies the loss of energy in this basically useless band.

[**2nd-Order PLL (6.2)**] This problem takes you through the second-order PLL formula generation.

a. This is just algebra but gets you thinking about the phase error's linearized relationship to the input phase, as a filter.

b. Similarly for the phase estimate. In this form we can see the estimate is incrementing by a little times the phase error and a little times the accumulated phase error, which is the frequency estimate times sampling periods.

c. This last part generates the 2nd-order PLL form that most practicing engineer's will use direct in their digital PLL implementation. It makes sense following Parts a and b.