2006 Quals J. Cioffi

TOTAL - 10 pts

Noise- 10 pts

A continuous uniform random variable is used to model the quantization error (or noise) of a digital-to-analog converter (DAC). This error is between $-\frac{\Delta}{2}$ and $+\frac{\Delta}{2}$.

a). What is the mean of this error. (0.5 pt)

b). What is the variance of this error (or energy of the noise)? (1 pt)

c). Two independent signals both occupy the same electrical medium and both were generated by identical DACs of the form in this exam. Provide the distribution, mean, and variance of the sum of the errors (or new noise). (2 pts)

d). Extend part c to 20 signals (say an unlicensed wireless band) to determine the distribution, mean, and variance. (3 pts)

e). Suppose all the DACs have $\Delta = .001$ and the signals themselves have unit energy. What is the signal to noise ratio for a single signal with no others occupying the medium. (1 pt)

f). Now suppose that all signals but one have very small transmit energy but their DACs continue to have the same noise even when zero signal is transmitted (the designer saved some money and did not care about quantization noise if not transmitting). What is the new SNR for that one signal? (1 pt)

g). Qualitatively describe what you expect would happen to the distribution of the noise if the situation in part f applied, but each of the DACs had a different Δ. (1.5 pts).