LE/EECS 4214 Digital Communication Fall 2014
Quiz #3, Thurs. Nov. 13, 2014 Name: ______________________

1. (*5 points*) An A/D's SNR due to quantization alone is 35-dB. Its SNR due to jitter alone is 30-dB. What is the net SNR of this A/D in dB?

$$SNR_q = 10^{3.5} = 3162$$

$$SNR_j = 10^{3} = 1000$$

$$SNR_t = \frac{1}{\frac{1}{SNR_q} + \frac{1}{SNR_j}} = \frac{SNR_q \, SNR_j}{SNR_q + SNR_j} = 760$$

$$SNR_t|_{dB} = 10 \times \log(SNR_t) = 28.8 \text{ dB}$$

2. (*5 points*) A binary NRZ signal is transmitted along a perfect cable at a data rate of 1.2 Mbps. Assume Gaussian noise with $N_0 = 10^{-7}$ W/Hz. What is the pulse amplitude needed to achieve BER $= 10^{-4}$. Clearly indicate the units of your final answer.

$$P_B = Q\left(\sqrt{\frac{E_d}{2N_0}}\right) = 10^{-4} \approx Q(3.7)$$

$$\sqrt{\frac{E_d}{2N_0}} \approx 3.7$$

$$E_d = 4A^2T$$

$$\frac{2A^2T}{N_0} = (3.7)^2$$

$$A^2 = \frac{N_0(3.7)^2}{2T} = \frac{N_0(3.7)^2 \cdot R}{2}$$

$$A = \sqrt{\frac{N_0(3.7)^2 \cdot R}{2}} = \sqrt{\frac{10^{-7} \cdot (3.7)^2 \cdot 1.2\times10^6}{2}}$$

$$= 0.906\ V$$

$Q(3) = 0.0013$, $Q(3.1) = 9.676\text{E-}04$, $Q(3.2) = 6.871\text{E-}04$, $Q(3.3) = 4.834\text{E-}04$, $Q(3.4) = 3.369\text{E-}04$, $Q(3.5) = 2.326\text{E-}04$, $Q(3.6) = 1.591\text{E-}04$, $Q(3.7) = 1.078\text{E-}04$, $Q(3.8) = 7.235\text{E-}05$, $Q(3.9) = 4.810\text{E-}05$, $Q(4) = 3.167\text{E-}05$

$$\mathcal{F}\{\text{rect}(t/T)\} = T\text{sinc}(fT) = T\sin(\pi fT)/\pi fT$$

$$\mathcal{F}\{\text{sinc}(t/T)\} = T\text{rect}(fT)$$

$$\mathcal{F}\{1 - |\tau|/T\} = T\text{sinc}^2(fT)$$

$$\psi_x(f) = |X(f)|^2, G_x(f) = \sum |c_n|^2\delta(f - nf_o), G_x(f) = \lim_{T\to\infty} \tfrac{1}{T}|X_T(f)|^2$$

$$R_x(\tau) = \int_{-\infty}^{\infty} x(t)x(t+\tau)\text{d}t, R_x(\tau) = \lim_{T\to\infty} \tfrac{1}{T}\int_{-\infty}^{\infty} x(t)x(t+\tau)\text{d}t$$

$$c_n = \int_{-\infty}^{\infty} x(t)\exp(-j2\pi nf_ot)\text{d}t$$

$$\text{SNR [dB]} = 10\log(\text{SNR}), SNR_{q,dB} = 6.02b + 10.8 + 10\log(\sigma_x^2/V_{pp}^2), SNR_j = 3/(\sigma_t^2 + f_H^2)$$

$$P_B = Q[(a_1 - a_2)/(2\sigma_0)], P_B = Q[\sqrt{E_d/(2N_0)}]$$