LE/EECS 4214 Digital Communication Fall 2014
Quiz #1, Thurs. Sept. 25, 2014 Name: _____

1. (*5 points*)

1.) [1] What comes after the channel coder and is sometimes used to help with synchronization?

line coder

2.) [1] What are the units of a signal's energy spectrum?

J/Hz

3.) [1] The continuous, non-periodic signal: $x(t) = \text{rect}(t/T)$ can be further classified as a ...?

energy signal

4.) [1] Besides adding noise and attenuating our signal what else (in one and only one technical word only) can the channel do to it?

distort

5.) [1] Name at least two sub-blocks of an analog-to-digital converter.

sampler, quantizer, encoder

2. (*3 points*)

A signal possesses the two-sided power spectral density of $10^{-7}|f|^3$ [J] for $|f| \leq 5$ kHz (and zero otherwise). What is the average power of the signal? Show units in your final answer.

$$P_x = 2 \cdot \int_0^{5\times10^3} 10^{-7} f^3 \, df$$

$$= 2\times10^{-7} \cdot \frac{f^4}{4}\Bigg|_0^{5\times10^3} = 31.25 \text{ MW}$$

3. (*2 points*) The autocorrelation of a NRZ signal of levels $\pm A$ encoding a signal of bit rate R looks like an isosceles triangle centred at 0 with a peak of A^2 and a base of total length $1/(2R)$. For a NRZ signal with power normalized levels ± 2 and $R = 3.5$ Mbps what is the average power? Show units in your final answer.

$R_x(\tau) = 4\left(1 - |\tau| \cdot 3.5 \times 10^6\right)$

$P_x = R_x(0) = 4$ W

$c = 3 \times 10^8$ m/s (in free space), $c = 2 \times 10^8$ m/s (in media), 1 km $= 10^3$ m, 1 ms $= 10^{-3}$ s, 1 Mb $= 10^6$ b

$$\mathcal{F}\{\text{rect}(t/T)\} = T\text{sinc}(fT) = T\sin(\pi fT)/\pi fT$$
$$\mathcal{F}\{\text{sinc}(t/T)\} = \tfrac{1}{T}\text{rect}(fT)$$
$$\mathcal{F}\{1 - |\tau|/T\} = T\text{sinc}^2(fT)$$
$$\sin(a+b) = \sin a\cos b + \cos a\sin b, \cos(a+b) = \cos a\cos b - \sin a\sin b$$
$$\sin(a \pm b) = \sin a\cos b \pm \cos a\sin b, \cos(a \pm b) = \cos a\cos b \mp \sin a\sin b$$
$$\sin 2a = 2\sin a\cos a, \cos 2a = \cos^2 a - \sin^2 a = 2\cos^2 a - 1$$
$$\cos a = (e^{ja} + e^{-ja})/2, \sin a = (e^{ja} - e^{-ja})/j2, \tan a = \sin a/\cos a$$
$$\psi_x(f) = |X(f)|^2, G_x(f) = \sum |c_n|^2\delta(f - nf_o), G_x(f) = \lim_{T\to\infty}|X_T(f)|^2$$
$$R_x(\tau) = \int_{-\infty}^{\infty} x(t)x(t+\tau)\text{d}t, R_x(\tau) = \lim_{T\to\infty}\tfrac{1}{T}\int_{-\infty}^{\infty} x(t)x(t+\tau)\text{d}t$$
$$c_n = \int_{-\infty}^{\infty} x(t)\exp(-j2\pi nf_o t)\text{d}t$$
$$\text{SNR [dB]} = 10\log(\text{SNR})$$