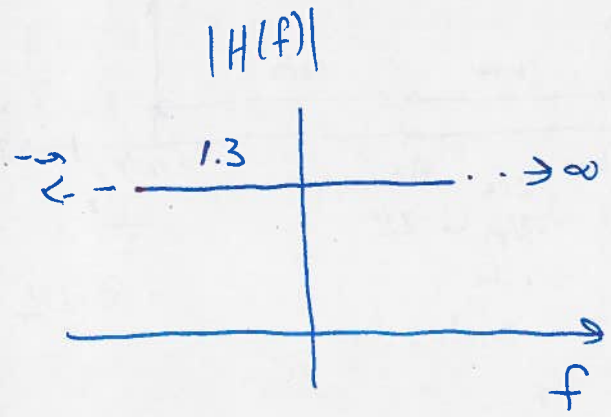
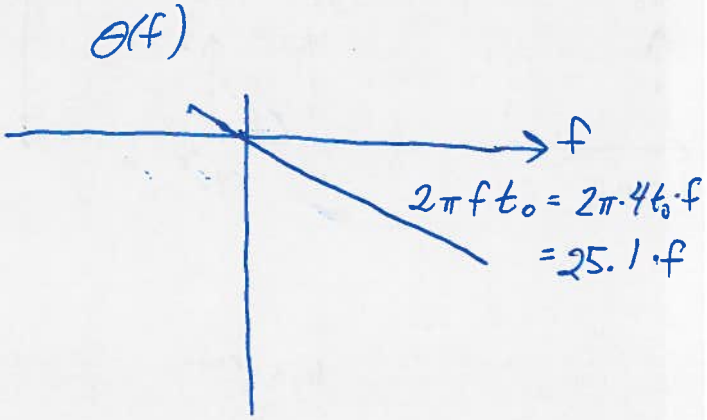
LE/EECS 4214 Digital Communication Fall 2015
Quiz #2, Thurs. Oct. 15, 2015

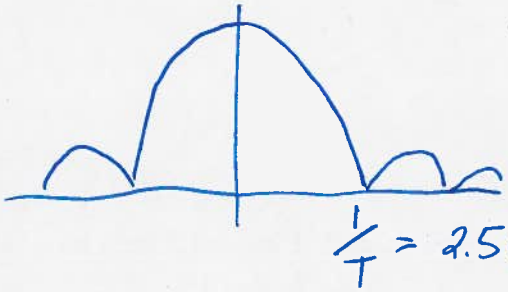
Name: _____

1. (*4 points*) A system's input signal as a function of time, t, is $x(t)$ and its output signal is $y(t)$. They are related by $y(t) = 1.3x(t-4)$ where the time is measured in seconds. Sketch the system's magnitude and phase response. Quantify as many features of your plots as you can.



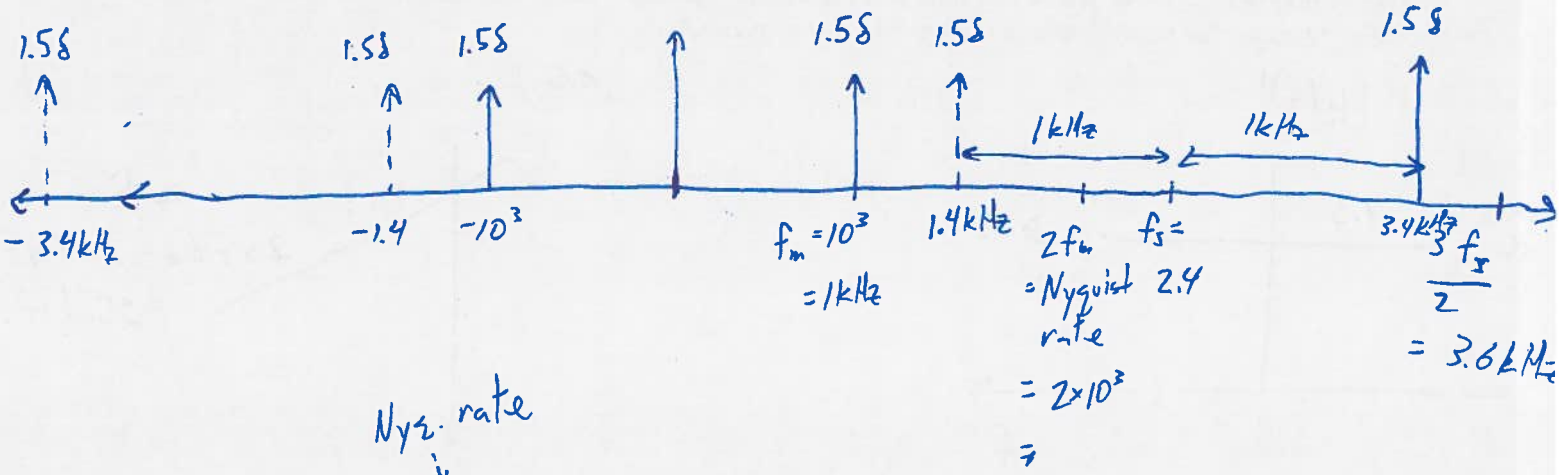


2. (*3 points*) What is the null-to-null bandwidth of a NRZ signal (unless otherwise stated NRZ is a 2-level signal) carrying data at 2.5 Gbps?



= 2.56 GHz = $f_{(n-n)\text{BW}}$

3. *(3 points)* A signal $x(t) = 3\cos(2\pi 10^3 t)$ is impulse sampled at 1.2 times the Nyquist rate. Sketch the double-sided spectrum of the sampled signal $X_s(f)$ up to at least $\pm 3\times$ the Nyquist frequency. Quantify as many features of your graph as you can.



Nyq. rate

$f_s = 1.2 \times 2\times10^3 = 2.4$ kHz

$\frac{f_s}{2} = 1.2$ kHz ← Nyq. freq.

$3\times\frac{f_s}{2} = 3.6$ kHz

$c = 3 \times 10^8$ 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

$$\mathcal{F}\{\text{rect}(t/T)\} = T\text{sinc}(fT) = T\sin(\pi fT)/\pi fT$$
$$\mathcal{F}\{\text{sinc}(t/T)\} = \tfrac{1}{T}\text{rect}(fT), \mathcal{F}\{e^{j\omega_0 t}\} = \delta(f - f_0)$$
$$\mathcal{F}\{1 - |\tau|/T\} = T\text{sinc}^2(fT), X(e^{j\Omega}) = \textstyle\sum_{n=-\infty}^{\infty} x[n]e^{-jn\Omega}$$
$$\sin(a+b) = \sin a\cos b + \cos a\sin b, \cos(a+b) = \cos a\cos b - \sin a\sin b$$
$$\sin(a \pm b) = \sin a\cos b \pm \cos a\sin b, \cos(a \pm b) = \cos a\cos b \mp \sin a\sin b$$
$$\cos^2 a = 0.5(1 + \cos 2a), \sin 2a = 2\sin a\cos a, \cos 2a = \cos^2 a - \sin^2 a = 2\cos^2 a - 1$$
$$\cos a = (e^{ja} + e^{-ja})/2, \sin a = (e^{ja} - e^{-ja})/j2, \tan a = \sin a/\cos a$$
$$\psi_x(f) = |X(f)|^2, G_x(f) = \textstyle\sum |c_n|^2\delta(f - nf_o), G_x(f) = \lim_{T\to\infty} |X_T(f)|^2$$
$$R_x(\tau) = \textstyle\int_{-\infty}^{\infty} x(t)x(t+\tau)\text{d}t, R_x(\tau) = \lim_{T\to\infty} \frac{1}{T}\int_{-\infty}^{\infty} x(t)x(t+\tau)\text{d}t$$
$$\mathcal{F}\{R_X(\tau)\} = G_X(\tau), c_n = \textstyle\int_{-\infty}^{\infty} x(t)\exp(-j2\pi nf_o t)\text{d}t$$
$$\text{SNR [dB]} = 10\log(\text{SNR})$$