WRITE ON BOARD: $e^{j2\pi f_0 t} \xleftrightarrow{\mathcal{F}} \delta(f-f_0)$

$\boxed{\text{SOLUTIONS}}$

ALSO POINT OUT:

- NOT TOO WORRIED ABOUT AMPLITUDES IN FREQ. DOMAIN
- IN (e) USE $T_S = 2$ ms.

Quiz #4

ECEn 380: Signals & Systems

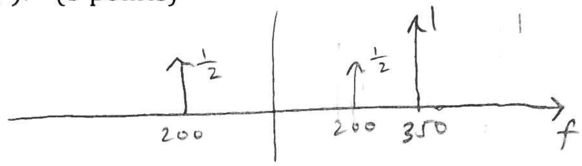
Fall 2014

Closed book, closed note, closed neighbor, no calculators allowed. *Time limit is 15 minutes. 20 points total possible.*

1. The continuous-time signal $x(t) = e^{j700\pi t} + \cos(400\pi t)$ is to be impulse-train (delta-train) sampled by a system with sampling period (or sampling interval) T_S = 2 ms.

   a. Sketch the Fourier transform of $x(t)$, with the frequency axis in Hertz (cycles/s). That is, sketch $\cancel{X}X(f)$. (3 points)

   TYPO!!



   b. What is the Nyquist rate (in **samples/s**) of the signal $x(t)$? (2 points)

   HIGHEST FREQUENCY IS 350 Hz, SO $\boxed{\text{NYQUIST RATE} = 700 \text{ sam/s}}$

   c. Will it be possible to perfectly recover $x(t)$ from the sampled signal at the proposed sampling period T_S = 2 ms? **Why or why not?** (3 points)

   NO. IF $T_S = 2$ ms, $f_S = \frac{1}{2\text{ ms}} = 500$ SAMPLES/s, WHICH IS WELL BELOW THE NYQUIST RATE!

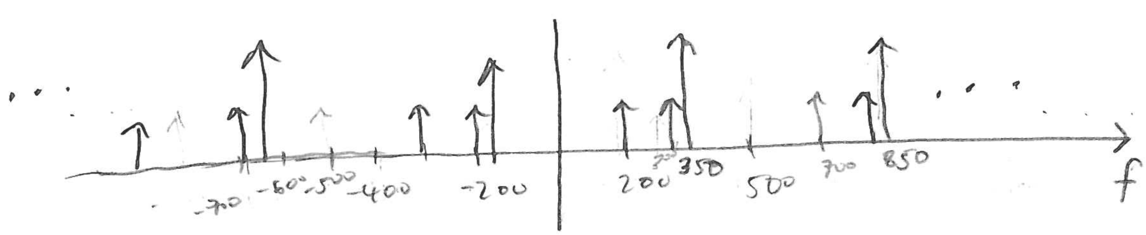
   d. If we desire to avoid aliasing when we sample the signal $x(t)$ (using the proposed sampling period of T_S = 2 ms) what is an acceptable cut-off frequency (in **cycles/s**) for an anti-aliasing filter to band-limit $x(t)$? (2 points)

   HOW ABOUT $\boxed{250 \text{ Hz}}$?

   (ALTHOUGH IN THIS CASE ANYTHING BETWEEN 200 AND 350 Hz WILL WORK)

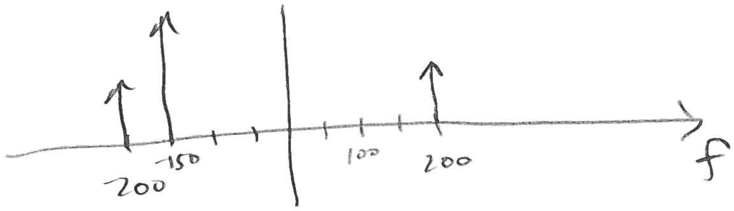
   e. Assuming we **do not** send $x(t)$ through an anti-aliasing filter prior to sampling, sketch the **Fourier transform** of the impulse-train sampled signal $x_S(t)$. That is, sketch $X_S(f)$. (4 points)

   NOTE: Sketch your graph with a frequency axis in Hertz (cycles/s), not angular frequency.



You now wish to reconstruct your sampled signal by passing $x_S(t)$ from part (e) through an ideal low-pass filter with cut-off frequency 250 Hertz and gain of 1.

a. Sketch the resulting signal in the frequency domain (with frequency axis in Hertz). (3 points)



b. Write an expression for the resulting signal in the time domain? (3 points)

$$\boxed{x(t) \propto \cos(400\pi t) + \underbrace{e^{-j300\pi t}}}$$

ALIASED SIGNAL!!

PROPORTIONAL TO - REMEMBER, I DIDN'T PAY ATTENTION TO AMPLITUDE SCALING...