Full Name: _____ **Lab Section:** _____

EEL 4750 / EEE 5502 (Fall 2018) – HW #05 **Due Date: Oct. 4, 2018**

Homework learning objectives: By the end of this homework, you should be able to:

- Plot the magnitude and of the discrete-time Fourier Transform of a signal
- Determine the Nyquist sampling rate of a signal
- Plot the Fourier transform of a sampled signal

Question #1: *(1 pts)* How many hours did you spend on this homework?

Question #2: *(6 pts)* Consider the discrete-time Fourier transform response

$$Z(\omega) = -\sum_{k=-\infty}^{\infty} 4u(\omega + \pi/2 - 2\pi k) - 4u(\omega - \pi/2 - 2\pi k)$$

(a) Sketch the magnitude of $Z(\omega)$ (i.e., $|Z(\omega)|$) for $-4\pi \leq \omega \leq 4\pi$.

(b) Sketch the phase $Z(\omega)$ (i.e., $\angle Z(\omega)$) for $-4\pi \leq \omega \leq 4\pi$.

(c) Would you describe $Z(\omega)$ as a low pass filter, band pass filter, high pass filter, or none?

Question #3: *(8 pts)* Consider the discrete-time impulse response

$$h[n] = -\delta[n-2] + 2\delta[n-3] - \delta[n-4]$$

(a) Determine the DTFT of $h[n]$, i.e., $H(\omega)$.

(b) Compute and sketch the magnitude of $H(\omega)$ (i.e., $|H(\omega)|$)

(c) Compute and sketch the phase $H(\omega)$ (i.e., $\angle H(\omega)$).

(d) Would you describe $H(\omega)$ as a low pass filter, band pass filter, high pass filter, or none?

Question #4: *(8 pts)* Consider the discrete-time impulse response

$$h[n] = \delta[n-10]$$

(a) Determine the DTFT of $h[n]$, i.e., $H(\omega)$.

(b) Compute and sketch the magnitude of $H(\omega)$ (i.e., $|H(\omega)|$)

(c) Compute and sketch the phase $H(\omega)$ (i.e., $\angle H(\omega)$).

(d) Would you describe $H(\omega)$ as a low pass filter, band pass filter, high pass filter, or none?

Question #5: *(10 pts)* The Nyquist sampling rate of a signal is the minimum rate $\Omega_s = 2\pi/T_s$ for which the signal can be sampled and then perfectly recovered. Determine the Nyquist rate Ω_s (in angular frequency) for the following signals. Use the continuous-time transform tables to answer questions.

(a) $x(t) = \sin(20\pi t + 1)$

(b) $x(t) = 1 + \sin(15t) + \cos(66t)$

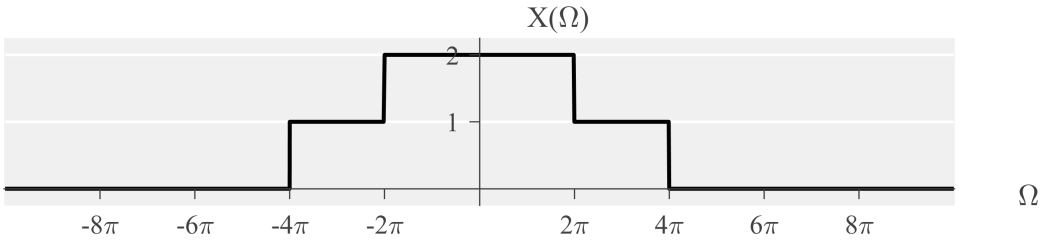
(c) $x(t) = \cos(t)\cos(2t)\cos(3t)\cos(5t)$

(d) $x(t) = e^{-2t}u(t)$

(e) $x(t)$, where the Fourier Trans. of $x(t)$ is $X(\Omega) = \cos(4\Omega)\left[u(\Omega + 4) - u(\Omega - 4)\right]$

(f) $x(t) * e^{-2t}u(t)$, where the Fourier Trans. of $x(t)$ is $X(\Omega) = \cos(4\Omega)\left[u(\Omega + 4) - u(\Omega - 4)\right]$

Question #6: *(10 pts)* Consider the Fourier transform of $x(t)$, shown below.



(a) Determine the Nyquist sampling rate for $X(\Omega)$.

(b) Sketch the Fourier transform $X_s(\Omega)$ of the sampled $x(t)$ with a sampling rate of $\Omega_s = 10\pi$.

(c) Sketch the Fourier transform $X_s(\Omega)$ of the sampled $x(t)$ with a sampling rate of $\Omega_s = 8\pi$.

(d) Sketch the Fourier transform $X_s(\Omega)$ of the sampled $x(t)$ with a sampling rate of $\Omega_s = 6\pi$.

(e) Sketch the Fourier transform $X_s(\Omega)$ of the sampled $x(t)$ with a sampling rate of $\Omega_s = 4\pi$.