ECE 310 Recitation 7 Solution
Thursday Apr 1, 2021

Concept check

- √ Frequency response
  - $\mathcal{H}\{e^{j\omega_0 n}\} = H_d(\omega_0)e^{j\omega_0 n} = |H_d(\omega_0)|e^{j(\omega_0 n + \angle H_d(\omega_0))}$
  - For real system: $h[n]$ real or $H_d(\omega) = H_d^*(-\omega)$
    - $\mathcal{H}\{\cos(\omega_o n + \phi_0)\} = |H_d(\omega_0)|\cos(\omega_0 n + \phi_0 + \angle H_d(\omega_0))$
- √ Sampling: A/D converter
  - Time domain: $x[n] = x_a(nT)$
  - Frequency domain: $X_d(\omega) = \frac{1}{T}\sum_{l=-\infty}^{\infty} X_a(\frac{\omega+2l\pi}{T})$
  - Nyquist criterion: $f_S > 2f_{max}$
  - Aliasing effect

Exercise

1. The frequency responses of two LSI systems are respectively $H_{d1}(\omega) = cos\omega e^{jsin\omega}$ and $H_{d2}(\omega) = sin\omega e^{jcos\omega}$.
   The input is $x[n] = 5 + 10\cos\left(\frac{\pi}{4}n + 45°\right) + j^n$
   Determine the corresponding system output $y_1[n]$ and $y_2[n]$.

2. A continuous-time signal $x_a(t) = \sin(at)$ is sampled with a sampling period T to obtain a discrete-time signal $x[n] = \sin(bn)$, where a, b are constants. Determine a set of choices of T consistent with the information given.

3. Suppose $x[n] = x_a(nT)$, prove that $X_d(\omega) = \frac{1}{T}\sum_{l=-\infty}^{\infty} X_a(\frac{\omega+2l\pi}{T})$.