UNIVERSITY OF ILLINOIS
Department of Electrical and Computer Engineering
ECE 417 Multimedia Signal Processing

Lecture 1 Sample Problem Solutions

Problem 1.1

$$x[n] = -\sin\left(\frac{3\pi n}{5}\right) + 3\cos\left(\frac{2\pi n}{5}\right)$$

Problem 1.2

$$X(j\Omega) = -j\pi\delta(\Omega - 14000\pi) + j\pi\delta(\Omega + 14000\pi) + 3\pi\delta(\Omega - 16000\pi) + 3\pi\delta(\Omega + 16000\pi)$$

Sketch should show delta functions at $\pm 14000\pi$ and $\pm 16000\pi$ with areas of $-j\pi$, $j\pi$, 3π, and 3π.

$$X(e^{j\omega}) = -j\pi\delta\left(\omega - \frac{3\pi}{5}\right) + j\pi\delta\left(\omega + \frac{3\pi}{5}\right) + 3\pi\delta\left(\omega - \frac{2\pi}{5}\right) + 3\pi\delta\left(\omega + \frac{2\pi}{5}\right)$$

Sketch should show delta functions at $\pm 3\pi/5$ and $\pm 2\pi/5$ with areas of $-j\pi$, $j\pi$, 3π, and 3π.

Problem 1.3

$$X(j\Omega) = \left(\frac{1}{2j}\right)\frac{1}{-100\pi - j\left(\Omega - 1000\pi\right)} - \left(\frac{1}{2j}\right)\frac{1}{-100\pi - j\left(\Omega + 1000\pi\right)}$$

Sketch should show peaks at $\approx \pm 1000\pi$ with amplitudes of $1/200\pi$ and bandwidths of 200π.

Problem 1.4

$$X(e^{j\omega}) = \left(\frac{1}{2j}\right)\frac{1}{1 - e^{-\left(\frac{\pi}{20} + j(\omega - \frac{\pi}{2})\right)}} - \left(\frac{1}{2j}\right)\frac{1}{1 - e^{-\left(\frac{\pi}{20} + j(\omega + \frac{\pi}{2})\right)}}$$

Sketch should show peaks at $\approx \pm\pi/2$ with amplitudes of $10/\pi$ and bandwidths of $\pi/10$.