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

Lecture 4 Sample Problem Solutions

Problem 4.1

Define $e[n] = \sum_{p=-\infty}^{\infty} \delta[n - pP]$. This is periodic with a period of P, so it has a DTFS whose coefficients are given by

$$E_m = \frac{1}{P} \sum_{n=0}^{P-1} e[n] e^{-j\omega_0 nm} = \frac{1}{P}$$

Problem 4.2

$$R_{xx}[n] = \sum_{m=-\infty}^{\infty} h[m]h[m-n] = r_{hh}[n]$$

$$S_{xx}(\omega) = H(e^{j\omega})H(e^{-j\omega})$$

Since $h[n]$ is real, we can also write

$$S_{xx}(\omega) = H(e^{j\omega})H^*(e^{j\omega}) = |H(e^{j\omega})|^2$$

Problem 4.3

Filtering $x[n] = e^{jm\omega_0 n}$ through $H(e^{j\omega})$ gives output signal $y[n] = H(e^{jm\omega_0})e^{jm\omega_0 n}$, so

$$S_m = \frac{1}{P} H(e^{jm\omega_0})$$

Problem 4.4

$$S(e^{j\omega}) = \sum_{m=0}^{P-1} \frac{2\pi}{P} H(e^{jm\omega_0}) \delta\left(\langle \omega - m\omega_0 \rangle_{2\pi}\right)$$