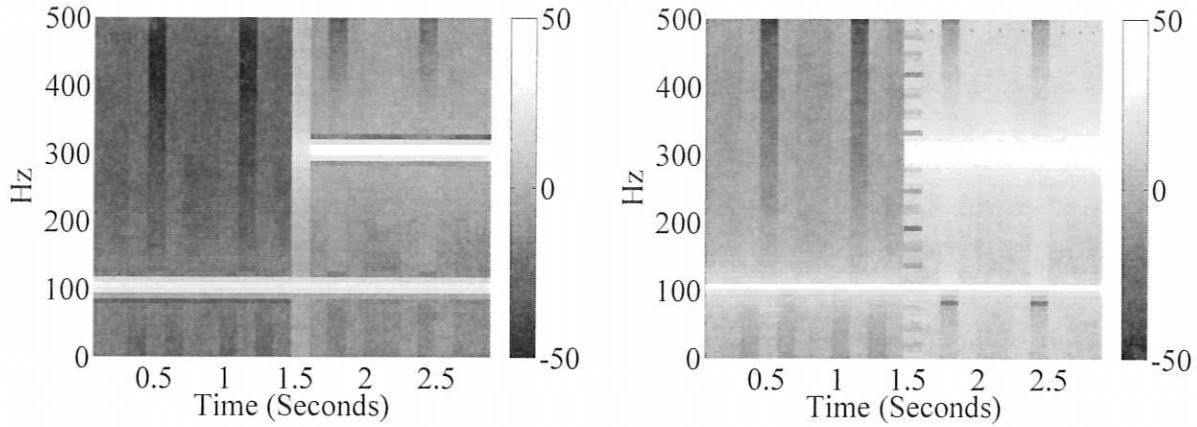
ECEn 487 - Introduction to Digital Signal Processing

Winter 2013

Quiz 12

1. I sampled a signal at a rate of 1 kHz. I then produced two spectrograms of the signals using a Hamming window and a rectangular window, both of length $L = 2^n$. The color scale is in dB.



a) (2 pts) Which spectrogram was produced with a Hamming window? How can you tell?

The one on the left was produced with the Hamming window because it has a wider main lobe and lower magnitude side-lobes.

b) (2 pts) What is the length of the window used?

$$\frac{3 \text{ sec} \times 1000 \text{ samples/sec}}{\sim 22 \text{ bands}} \approx 136$$

The Length is $L = 128$

2. Suppose I have white noise with variance σ_x^2 as an random variable input X to an LTI system with impulse response resulting in a output random variable Y.

$$h[n] = \begin{cases} 1, & n = 0 \\ 2, & n = 1 \\ 3, & n = 2 \\ 0, & \text{otherwise} \end{cases}$$

a) (2 pts) What is the mean of Y?

$$m_y = m_x \sum_{k=-\infty}^{\infty} h[k] = 0.$$

a) (2 pts) What is the cross correlation ϕ_{yx}?

$$\phi_{yx}[n] = h[n] * \phi_{xx}[n] = h[n] * \sigma_x^2 \delta[n] = \sigma_x^2 h[n]$$

b) (2 pts) What is the autocorrelation ϕ_{yy}?

$$\phi_{yy}[n] = \phi_{xx}[n] * h[n] * h[-n]$$

$$= \begin{cases} 3\sigma_x^2, & n = -2 \\ 8\sigma_x^2, & n = -1 \\ 14\sigma_x^2, & n = 0 \\ 8\sigma_x^2, & n = 1 \\ 3\sigma_x^2, & n = 2 \\ 0, & \text{otherwise} \end{cases}$$

		1	2	3	
$h=-2$	1	2	3		$= 3$
$h=-1$		1	2	3	8
$h=0$			1	2	3	14
$h=1$				1	2	3	8
$h=2$					1	2	3	3