Name Answers

EE-3220-41 – Dr. Durant – Quiz 6
Winter 2013-'14, Week 8

1. (3 points) A voice signal sampled at 8 kHz is intermittently jammed with a loud, 1 kHz tone. Begin the design an IIR notch filter to suppress this tone. What are the radii and angles of the poles and zeros? Present angles in terms of π (e.g., 0.7π).

$\omega = \frac{1\,kHz}{8\,kHz} \cdot 2\pi = \frac{\pi}{4}$ rad/s

$z = 1\angle \pm\frac{\pi}{4}$

$p = 0.99\angle \pm\frac{\pi}{4}$ ← radii from about 0.8 to 0.9999 are acceptable

2. (2 points) An analog signal is sampled at 16 kHz. A 512-point DFT is computed. What is the resolution of the DFT?

$\frac{F_S}{N} = \frac{16{,}000}{512} = \frac{5^3}{2^2} = 31.25\,Hz$

(-1/2) recip
(-1/2) units

3. (2 points) What is the difference between spectral resolution and spectral density?

Resolution tells you how much information a detail is present.
Density tells you how often that information is sampled.
Eg., 0-padding a signal adds no information, but is a way to trigger a longer DFT w/ greater density.

4. (3 points) A signal containing frequencies up to 500 Hz is sampled, and a DFT is computed. If the frequency spacing of the DFT must be no greater than 0.5 Hz, what is the minimum number of samples needed?

$f_S = 2 f_{max} = 2 \cdot 500Hz = 1000Hz$

$\frac{F_S}{N} = 0.5Hz$

$\frac{1000\,Hz}{N} = 0.5Hz$

$N = \frac{1000Hz}{0.5Hz} = 2000$

Name Answers

EE-3220-21 – Dr. Durant – Quiz 6
Winter 2013-'14, Week 8

1. (3 points) A voice signal sampled at 8 kHz is intermittently jammed with a loud, 2 kHz tone. Begin the design an IIR notch filter to suppress this tone. What are the radii and angles of the poles and zeros? Present angles in terms of π (e.g., 0.7π).

radii
sym.

$\omega = \frac{f}{f_s} \cdot 2\pi = \frac{2}{8} \cdot 2\pi = \pi/2$

$z = 1\angle \pm \pi/2$
$p = 0.99\angle \pm \pi/2$ ← radii of ~0.8 → 0.9999 are acceptable

2. (2 points) An analog signal is sampled at 32 kHz. A 256-point DFT is computed. What is the resolution of the DFT?

$\frac{F_s}{N} = \frac{32000}{256} = \frac{2^8 5^3}{2^8} = 5^3 = 125\,Hz$

3. (2 points) Calculate w_8, the 8th root of unity that represents the minimum magnitude negative angle phase shift in an 8-point DFT. You may use polar form.

scale to this etc.

$e^{-j\frac{2\pi}{8}} = e^{-j\pi/4} = 1\angle\frac{-\pi}{4} = \frac{1}{\sqrt{2}} - j\frac{1}{\sqrt{2}} = \frac{\sqrt{2}}{2} - j\frac{\sqrt{2}}{2}$

4. (3 points) A signal containing frequencies up to 800 Hz is sampled, and a DFT is computed. If the frequency spacing of the DFT must be no greater than 0.2 Hz, what is the minimum number of samples needed?

$f_s = 2f_{max} = 2 \cdot 800\,Hz = 1600\,Hz$

$\frac{f_s}{N} = 0.2\,Hz$

$\frac{1600\,Hz}{N} = 0.2\,Hz$

$N = \frac{1600\,Hz}{0.2\,Hz} = 8000$