Name Answers

EE-3220-11 – Dr. Durant – Quiz 9
Spring 2015, Week 9

1. (3 points) Given the symmetric filter h(n) = [5 3 5], use the DTFT to derive its complete frequency response. Recall that $H(e^{j\omega}) = \sum_{n=-\infty}^{\infty} h(n)e^{-j\omega n}$ Factor out the center phase term and simplify to determine the 2 terms that make up the response: the linear phase term (unity gain) and the amplitude response (a real number that varies with frequency).

$H(e^{j\omega}) = 5 + 3e^{-j\omega} + 5e^{-j2\omega} = e^{-j\omega}(5e^{j\omega} + 3 + 5e^{-j\omega})$

$= e^{-j\omega}(3 + 5 \cdot 2 \cdot \cos\omega) = e^{-j\omega}(3 + 10\cos\omega)$

(1) plug in
(1) factor $e^{-j\omega}$
(1) simplify cos

2. (1 point) A real FIR filter has a zero in its z-transform at $0.75\angle\pi/3$. Describe any additional zero(s) that H(z) must have.

$0.75\angle -\pi/3$ (conjugate)

3. (1 point) What additional zero(s), if any, must the filter have if it is symmetric?

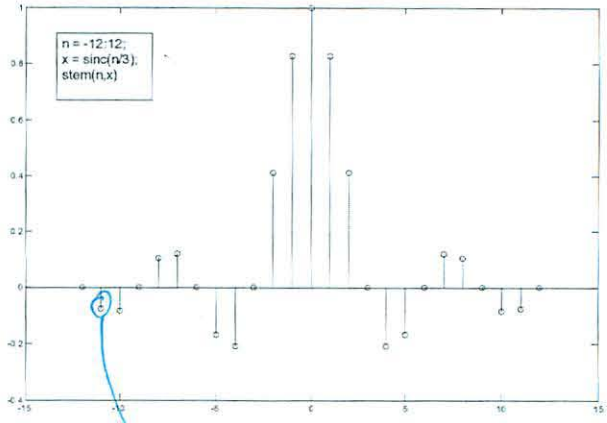
$\frac{1}{0.75}\angle\frac{-\pi}{3} = \frac{4}{3}\angle\frac{-\pi}{3}$

$\frac{1}{0.75}\angle\frac{+\pi}{3} = \frac{4}{3}\angle\frac{+\pi}{3}$

(reciprocals)

Consider the following sinc interpolation filter used to repair the spectrum of an upsampled signal:

4. (1 point) What is the integer upsampling factor (i.e., what was the sampling rate divided by)? Hint: Note where the time-domain (that is, in h(n)) zeros are.



3

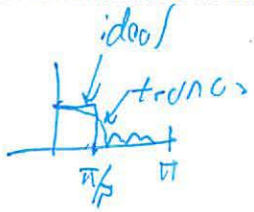
(-1/2) For 4/main lobe c/c

5. (2 points) This sinc filter is not causal. Discuss the practical ramifications of this.

- for real time use, need to delay by 11 samples
- not acceptable to set $h(n)|_{n<0} = 0$ ← (-1/4)

6. (1 point) The sinc filter above was truncated (in time). Discuss the practical ramifications of this.

the LPF response is not ideal



7. (1 point) Fill in the blanks: under the bilinear transform with sampling frequency fs Hz, analog frequencies (Ω) range from 0 to ∞ radians/second and the corresponding digital frequencies (ω) range from 0 to a maximum of π radians/sample.

(-3/4) 2π, 2π
(-1/4) ∞, 2π