Name *Answers*

EE-3220-11 – Dr. Durant – Quiz 8
Winter 2015-'16, Week 8

1. (1 point) What is the relationship between the DTFT and the DFT? (Hint: Consider the domain where each is defined.)

The DTFT is a function of the continuous variable ω.

The DFT samples the DTFT at N equally spaced frequencies starting at 0 and increasing by $\frac{2\pi}{N}$. (Thus the ~~[illegible]~~ maximum DFT frequency is $2\pi\frac{N-1}{N}$, just under 2π.

2. (3 points) The DFT X(k) = [12 3+3j 0 0 0 3-3j] for a 6-sample signal.

   a. (1 point) How do you know that the signal x(n) is real valued?

   X(k) has conjugate symmetry

   $X(1) = X^*(5) = X^*(5-6) = X^*(-1)$

   2π-periodic

   b. (1 point) What is the DC component's level in x(n)?

   (-1/4) if 12

   $X(0) = 12 = \sum_{n=0}^{5} x(n) \cdot e^{j0} = \Sigma x$

   $DC = \frac{1}{N}\Sigma x = \frac{1}{6}\cdot 12 = \boxed{2}$

   c. (1 point) What is the frequency of the non-DC component? Give both k and ω.

   $k = 1$

   $\omega = \frac{2\pi}{N}\cdot k = \frac{2\pi}{6}\cdot 1 = \boxed{\frac{\pi}{3}}$

3. (1 point) Calculate w_{12}, the 12^{th} root of unity that represents the minimum magnitude negative angle phase shift in a 12-point DFT. Give your answer in polar form with the angle expressed as a multiple of π.

-1/4

$W_{12} = e^{-j\frac{2\pi}{N}} = e^{-j\frac{2\pi}{12}} = e^{-j\frac{\pi}{6}} = \boxed{1\angle -\frac{\pi}{6}}$

4. (1 point) An analog signal is sampled at 48 kHz. A 64-point DFT is computed. What is the resolution of the DFT in hertz?

$res = \frac{Fs}{N} = \frac{48\,kHz}{64} = 750 Hz$

(-1/2) not in hertz

5. (2 points) The 64-point sample above 0-padded to 256 samples and then a 256-point DFT is computed. State both the spectral resolution and spectral density of the result.

resolution is unchanged, $\boxed{750 Hz}$

$density = \frac{fs}{N^*} = \frac{48 kHz}{256} = \boxed{187.5 Hz}$

(-1/2) density only
(-1/4) calculation/simplify

6. (2 points) In MATLAB, x = [4 5 -3 6] and h = [2 -3 -1 2]. y = conv(h,x) is executed and correctly gives y = [8 -2 -25 24 -5 -12 12]. We attempt to perform the convolution in the DFT domain, y2 = ifft(fft(h).*fft(x)), but get the circular convolution result instead. Calculate the values contained in y2.

8 -2 -25 24 wraparound after N=4 samples
\+ -5 -12 12

y2 = [3 -14 -13 24]

(-1/2) erroneous flip of x(4:6) or similar