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ECE 431H1S, Digital Signal Processing

Quiz 10 Solutions
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The following table shows x[n], n = 0,1,…,15 and its 16-DFT X[k] in columns 2 and 3 respectively.

n/k	x[n]	X[k]	y[n]	z[n]
0	2	409.000 + 0.000i	6	98
1	1	36.127 + 111.469i	19	4
2	6	76.317 + 101.489i	17	61
3	19	-26.237 + 144.309i	2	6
4	17	-104.000 + 179.000i	1	19
5	2	-48.432 - 62.953i	59	17
6	1	-86.317 + 55.489i	16	2
7	59	-17.458 - 51.793i	11	1
8	16	-37.000 + 0.000i	55	59
9	11	-17.458 + 51.793i	25	16
10	55	-86.317 - 55.489i	6	11
11	25	-48.432 + 62.953i	8	55
12	6	-104.000 - 179.000i	83	25
13	8	-26.237 - 144.309i	98	6
14	83	76.317 - 101.489i	4	8
15	98	36.127 - 111.469i	61	83

The 4th column shows another signal y[n] that is (somehow) related to x[n]. And the 5th column shows yet another signal z[n] that is related to y[n] (and thus, also to x[n]).

Now suppose the 16-DFTs of y[n] and z[n] are respectively Y[k], Z[k], k=0,1,…,15.

Compute the following DFT values:

1. Y[2]
2. Z[2]
3. Y[16-2] and Z[16-2]

<u>Hint</u>: You may need to apply the sliding DFT technique more than once.

<u>**Solutions:**</u>

- The idea is to use the sliding DFT twice for the signal y[n].
- For z[n], an additional application of the circular-shift property of the DFT is needed.

Apply sliding DFT, with N=16, k=2, X[2] = 76.317 + 101.489i, x[n-N]=2, x[n]=4

Y_{TEMP}[2] = exp(j*2*pi*k/N) * (X[2] – x[n-N] + x[n]) = -16.385 + 127.142i

Apply sliding DFT again, with x[n-N] = 1, x[n] = 61

Y[2] = exp(j*2*pi*k/N) * (Y_{TEMP}[2] – x[n-N] + x[n]) = <u>**-59.062 + 120.744i**</u>

Note that z[n] is circular-shifted version of y[n] by 3 units, so with k = 2, r = 3,

Z[2] = Y[2] * exp(-j*2*pi*k*r/N) = <u>**127.142 - 43.615i**</u>

Since x,y,z are all real signals, Y[16-2] and Z[16-2] are <u>**conjugates**</u> of Y[2] and Z[2], respectively.