ENEE 222: 4/09 Class

Material: Lecture videos *16.2*, **17.1**, **17.2**, **17.3**

1. Suppose the DFT of the vector

$$[\ a \quad b \quad c \quad d\ ]^T$$

contains no zero entries. Which (one or more) of the following vectors $\mathbf{x}$ is certain to have *exactly* four nonzero entries in its DFT $\mathbf{X}$?

A. $\mathbf{x} = [\ a \quad b \quad c \quad d \quad a \quad b\ ]^T$

B. $\mathbf{x} = [\ a \quad b \quad c \quad d \quad a \quad b \quad c \quad d\ ]^T$

C. $\mathbf{x} = [\ a \quad b \quad c \quad d \quad a \quad b \quad c \quad d \quad a \quad b\ ]^T$

D. $\mathbf{x} = [\ a \quad b \quad c \quad d \quad a \quad b \quad c \quad d \quad a \quad b \quad c \quad d \quad a \quad b \quad c \quad d\ ]^T$

2. If

$$\mathbf{x} = [\ a \quad b \quad c \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0\ ]^T$$

has DFT

$$\mathbf{X} = [\ X_0 \quad X_1 \quad X_2 \quad X_3 \quad X_4 \quad X_5 \quad X_6 \quad X_7 \quad X_8 \quad X_9 \quad X_{10} \quad X_{11}\ ]^T ,$$

then the DFT of $[\ a \quad 0 \quad c \quad b\ ]^T$ is given by

A. $[\ X_0 \quad X_3 \quad X_2 \quad X_1\ ]^T$

B. $[\ X_0 \quad 0 \quad X_2 \quad X_1\ ]^T$

C. $[\ X_0 \quad X_3 \quad X_6 \quad X_9\ ]^T$

D. $[\ X_0 \quad X_9 \quad X_6 \quad X_3\ ]^T$

3.

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x = rand(5,1) ;
DFT1 = fft(x,12) ;
DFT2 = fft(x,32) ;
```

What is the smallest value of `N` such that

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DFT3 = fft(x,N)
```

contains `DFT1` and `DFT2` as subvectors?

A. `N = 44` B. `N = 96` C. `N = 189` D. `N = 384`

4. The continuous-time signal

$$s(t) = 3\cos(40\pi t + 0.8) + 5\cos(96\pi t - 1.7)$$

is sampled at a rate $f_s = 160$ samples/sec. The DFT $\mathbf{S}$ of the sample vector $\mathbf{s} = s[0 : L-1]$ is then computed.

What is the smallest value of L (> 4) such that $\mathbf{S}$ contains exactly four nonzero entries?

A. $L = 20$ B. $L = 40$ C. $L = 48$ D. $L = 96$

5. (HW 20 i ii) The signal

$$\mathbf{x} = \begin{bmatrix} a & b & c & 0 & 0 & 0 & a & b & c & 0 & 0 & 0 \end{bmatrix}^T$$

has DFT $\mathbf{X}$ given by

$$\mathbf{X} = \begin{bmatrix} D_0 & D_1 & D_2 & D_3 & D_4 & D_5 & D_6 & D_7 & D_8 & D_9 & D_{10} & D_{11} \end{bmatrix}^T$$

If $\mathbf{x}^{(1)} = \begin{bmatrix} a & b & c \end{bmatrix}^T$, express the DFT $\mathbf{X}^{(1)}$ in terms of nonzero D_k's.

6. (HW 20 v) (*Cont.*) If the *time-domain* signal $\mathbf{x}^{(4)}$ has DFT

$$\mathbf{X}^{(4)} = \begin{bmatrix} 0 & 0 & 0 & a & b & c \end{bmatrix}^T ,$$

express the entries of $\mathbf{x}^{(4)}$ in terms of nonzero D_k's.

7. (HW 21 iii) Let $\mathbf{s} = s[0:111]$, where

$$s[n] = A_1 \cos\left(\frac{3\pi n}{14} + \phi_1\right) + A_2 \cos\left(\frac{5\pi n}{8} - \phi_2\right)$$

Sketch the DFT magnitude $|S[k]|$ and phase $\angle S[k]$ against frequency index k.