ENEE 222: 4/02 Class

Material: Lecture videos *14.2*, **15.1**, **15.2**

1. If

$$\mathbf{x} \;=\; [\; 5 \quad 3-j \quad 4j \quad 2+j \quad 1-2j \;]^T$$

and

$$\mathbf{y} \;=\; [\; 5 \quad 1+2j \quad 2-j \quad -4j \quad 3+j \;]^T \;,$$

then the DFT's $\mathbf{X}$ and $\mathbf{Y}$ are related by

A. $\mathbf{Y} \;=\; \mathbf{R}\mathbf{X}$

B. $\mathbf{Y} \;=\; \mathbf{X}^*$

C. $\mathbf{Y} \;=\; \mathbf{R}\mathbf{X}^*$

D. $\mathbf{Y} \;=\; -\mathbf{X}^*$

2. If

$$[\; a \quad b \quad c \quad d \quad e \quad f \quad g \quad h \;]^T \quad \overset{\text{DFT}}{\longleftrightarrow} \quad [\; A \quad B \quad C \quad D \quad E \quad F \quad G \quad H \;]^T \;,$$

then the DFT of

$$[\; a \quad -h \quad g \quad -f \quad e \quad -d \quad c \quad -b \;]^T$$

is given by

A. $[\; A \quad -H \quad G \quad -F \quad E \quad -D \quad C \quad -B \;]^T$

B. $[\; E \quad -D \quad C \quad -B \quad A \quad -H \quad G \quad -F \;]^T$

C. $[\; E \quad D \quad C \quad B \quad A \quad H \quad G \quad F \;]^T$

D. $[\; A \quad H \quad G \quad F \quad -E \quad -D \quad -C \quad -B \;]^T$

3. If $\mathbf{x}$ is a real-valued signal vector of length $N > 2$, which (one or more) of the signals $\mathbf{s}$ below have the same magnitude spectrum as $\mathbf{x}$ (i.e., $|S[\,\cdot\,]| = |X[\,\cdot\,]|$)?

A. $\mathbf{s} \;=\; \mathbf{R}\mathbf{x}$

B. $\mathbf{s} \;=\; \mathbf{P}\mathbf{x}$

C. $\mathbf{s} \;=\; \mathbf{F}\mathbf{x}$

D. $\mathbf{s} \;=\; (\mathbf{x} + \mathbf{R}\mathbf{x})/2$

4. If $\mathbf{x}$ is a real-valued signal vector of length $N > 2$, which (one or more) of the following vectors has real-valued DFT?

A. $\mathbf{x}$

B. $\mathbf{x} + \mathbf{R}\mathbf{x}$

C. $\mathbf{P}\mathbf{x} + \mathbf{P}^{-1}\mathbf{x}$

D. $\mathbf{F}\mathbf{x} + \mathbf{F}^{-1}\mathbf{x}$

5. (HW 17 $\supset$) The DFT of

$$\mathbf{s} \;=\; \begin{bmatrix} a & b & c & d & e & f & g & h \end{bmatrix}^T$$

is given by

$$\mathbf{S} \;=\; [\; A \quad B \quad C \quad D \quad E \quad F \quad G \quad H \;]^T$$

Determine the DFT's of

- $\mathbf{s}^{(3)} \;=\; 2\begin{bmatrix} a & 0 & -c & 0 & e & 0 & -g & 0 \end{bmatrix}^T$
- $\mathbf{s}^{(5)} \;=\; \begin{bmatrix} h-b & a-c & b-d & c-e & d-f & e-g & f-h & g-a \end{bmatrix}^T$

6. (HW 18 i ii) Let $\mathbf{x}$ be a *real-valued* vector of length $N = 64$, with DFT $\mathbf{X}$ satisfying

$$X[k] \;\neq\; 0 \;\text{ for }\; k = 0:13 \qquad \text{and} \qquad X[k] \;=\; 0 \;\text{ for }\; k = 14:32$$

If

$$x^{(1)}[n] \;=\; x[n]\cos(3\pi n/8) \;\text{ for }\; n = 0:63,$$

for which frequency indices k does $X^{(1)}[k]$ equal zero?

7. (HW 18 $\sim$v) Let $N > 2$. For what values of ω_0 in $(0, \pi]$ is the signal vector $\mathbf{u}$ defined by

$$u[n] \;=\; \cos(\omega_0 n)\,, \qquad n = 0:N-1$$

circularly symmetric?