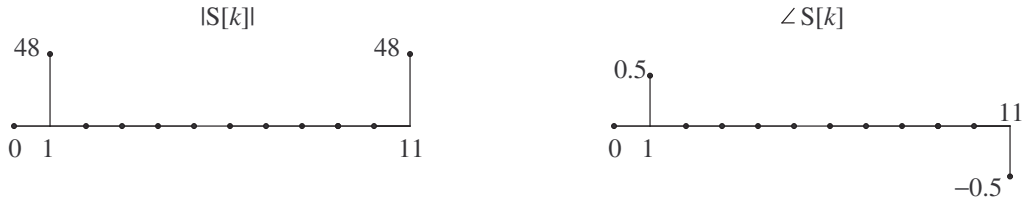
ENEE 222: 3/28 Class

Material: Lecture videos *13.2*, **14.1**, **14.2**

P: circular shift (right/downward) matrix
R: circular reversal matrix
F: Fourier modulation matrix

1. The magnitude and phase spectra of a vector $\mathbf{s} = s[0:11]$ are plotted below.



Which of the following is true (for $n = 0:11$)?

A. $s[n] = 8\cos\left(\frac{\pi n}{12} + 0.5\right)$

B. $s[n] = 8\cos\left(\frac{\pi n}{6} + 0.5\right)$

C. $s[n] = 48\cos\left(\frac{\pi n}{12} + 0.5\right)$

D. $s[n] = 96\cos\left(\frac{\pi n}{6} - 0.5\right)$

2. If

$$\mathbf{x} = [\ a \quad b \quad c \quad d \quad e \quad f \quad g \quad h\ ]^T,$$

which of the following vectors equals $\mathbf{P}^2\mathbf{R}\mathbf{x}$?

A. $[\ a \quad h \quad g \quad f \quad e \quad d \quad c \quad b\ ]^T$

B. $[\ g \quad h \quad a \quad b \quad c \quad d \quad e \quad f\ ]^T$

C. $[\ c \quad b \quad a \quad h \quad g \quad f \quad e \quad d\ ]^T$

D. $[\ g \quad f \quad e \quad d \quad c \quad b \quad a \quad h\ ]^T$

3. If $\mathbf{x}$ has length $N = 32$, then the vector

$$\mathbf{y} = (\mathbf{F}^6 + \mathbf{F}^{-6})\mathbf{x}$$

is also given (for $n = 0:31$) by the equation

A. $y[n] = 2x[n]\cos(3\pi n/8)$

B. $y[n] = 2x[n]\sin(3\pi n/8)$

C. $y[n] = 2x[n]\cos(3\pi n/16)$

D. $y[n] = 2x[n]\sin(3\pi n/16)$

4. (HW 15 $\subset$ v) The real-valued signal vector $\mathbf{s}$ has DFT

$$\mathbf{S} = \begin{bmatrix} 16 & z_1 & z_2 & z_3 & -4 & 7+j & 2j & -4+5j \end{bmatrix}^T$$

The n^{th} sample $s[n]$ can be written as the sum of real sinusoids $A\cos(\omega n + \phi)$, where ω takes values $0,\ \pi/4,\ \pi/2,\ 3\pi/4$ and π. Determine the parameters (A and ϕ) for $\omega = 0,\ \pi/4$ and π.

5. (HW 16 ii) Vector $\mathbf{s}$ is given by

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

Express the following vectors in terms of $\mathbf{P}$, $\mathbf{R}$, $\mathbf{F}$ and $\mathbf{s}$:

- $\mathbf{s}^{(5)} = \begin{bmatrix} h-b & a-c & b-d & c-e & d-f & e-g & f-h & g-a \end{bmatrix}^T$
- $\mathbf{s}^{(6)} = \begin{bmatrix} a+e & b-f & c+g & d-h & e+a & f-b & g+c & h-d \end{bmatrix}^T$
- $\mathbf{s}^{(7)} = \begin{bmatrix} 0 & \sqrt{2}b & 2c & \sqrt{2}d & 0 & -\sqrt{2}f & -2g & -\sqrt{2}h \end{bmatrix}^T$