ENEE 222: 5/02 Class

Material: Lecture videos **22.1**, **22.2**, **22.3**

1. The frequency response of a FIR filter at frequency $\omega = \omega_0$ is given by

$$H(e^{j\omega_0}) \;=\; \sqrt{3} - j$$

If the filter input sequence is

$$x[n] \;=\; \cos \omega_0 n \;, \qquad n \in \mathbb{Z} \;,$$

which of the following equations describes the output for all time indices n?

A. $y[n] \;=\; \sqrt{3}\, e^{-j\omega_0 n}$

B. $y[n] \;=\; 2\cos(\omega_0 n - \pi/6)$

C. $y[n] \;=\; 2\cos(\omega_0 n - \pi/3)$

D. $y[n] \;=\; 2\cos(\omega_0 n + \pi/3)$

2. The system function $H(z)$ of a FIR filter is such that

$$H(-1 + j\sqrt{3}) \;=\; \frac{\sqrt{2} + j\sqrt{2}}{4}$$

If the filter input sequence is

$$x[n] \;=\; 2^n \cdot \cos\left(\frac{2\pi n}{3}\right) \;, \qquad n \in \mathbb{Z} \;,$$

which of the following equations describes the output for all time indices n?

A. $y[n] \;=\; 2^n \cdot \cos(2\pi n/3 + \pi/4)$

B. $y[n] \;=\; 2^n \cdot \cos(2\pi n/3 - \pi/4)$

C. $y[n] \;=\; 2^{n-1} \cdot \cos(2\pi n/3 + \pi/4)$

D. $y[n] \;=\; 2^{n-1} \cdot \cos(2\pi n/3 - \pi/4)$

3. Consider a FIR filter of order $M = 60$. Instead of the coefficient vector $(b_0, \ldots, b_{60})$, you are given the values of the filter's frequency response $H(e^{j\omega})$ at all frequencies ω which are multiples of $\pi/16$.

Based of the given information, for which (one or more) of the following input sequences $x[\,\cdot\,]$ is it possible to determine the output sequence $y[\,\cdot\,]$?

A. $x[n] \;=\; \cos(3\pi n/8)$ for all n

B. $x[\,\cdot\,]$ is an arbitrary periodic sequence of period $L = 4$

C. $x[\,\cdot\,]$ is an arbitrary periodic sequence of period $L = 10$

D. $x[\,\cdot\,]$ is an arbitrary periodic sequence of period $L = 32$

4. Two FIR filters with input-output relationships

$$y[n] \;=\; x[n] \,-\, x[n-1] \,+\, x[n-2] \,-\, x[n-3] \,+\, x[n-4]$$

and

$$y[n] \;=\; x[n] \,+\, x[n-1]$$

are connected in series (cascade). The resulting input-output relationship is

A. $y[n] \;=\; 2x[n] \,+\, x[n-2] \,-\, x[n-3] \,+\, x[n-4]$

B. $y[n] \;=\; x[n] \,-\, x[n-1] \,+\, x[n-2] \,-\, x[n-3] \,+\, x[n-4] \,-\, x[n-5]$

C. $y[n] \;=\; x[n] \,-\, x[n-5]$

D. $y[n] \;=\; x[n] \,+\, x[n-5]$

5. (HW 26 $\subset$ i) Consider the FIR filter with the following input-output relationship (note the missing coefficient):

$$y[n] \;=\; x[n] + 3x[n-1] + 3x[n-3] + x[n-4]$$

Determine the filter output when the input is given by $x[n] \,=\, 1 + 3^{-n}$ at all times n.

6. (HW 26 $\subset$ i) For the same filter as in **5** above, determine the output when the input is given by

$$x[n] \;=\; 2^{-n} \cdot \cos(n\pi/6) \qquad (n \in \mathbb{Z})$$