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HW 5

CPE 381

1. a) Hard Real Time: System Must be able to process input as it appears.
   Soft Real Time: System may occasionally be overloaded by input and create a backlog, delaying processing for some time.

b) $f_{input} = 600 Hz$; $1200 cc/sam$; $F_c = 1 MHz$

$f_{sample} =$ at least $2 \times 600 Hz = 1200 Hz$

$1200 Hz \times 1200 cc/sam = 1{,}440{,}000 > 1{,}000{,}000 Hz$

↳ System is not real time.

c) $f_{max} = 600 Hz$, $1200 cc/sam$,

$f_{nyquist} = 2 \times 600 Hz = 1200 Hz$

Minimum Clock: $1200 Hz \times 1200 cc = \boxed{1{,}440{,}000 \ Hz}$

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2. $x(t) = 5\cos(14\pi + \pi/8)$

$5 \rightarrow$ amplitude , $\pi/8 \rightarrow$ phase , $14 \rightarrow$ frequency

$\cos(2\pi t) \rightarrow 1\,Hz$ $\cos(14\pi t) \rightarrow 7\,Hz$

Largest $F_s = 2 \times 7\,Hz = 14\,Hz$, $T_s = 0.07\,s$

$$x[n] = 5\cos(14\pi t + \pi/8)\Big|_{t=0.07n} = \boxed{5\cos(n\pi + \pi/8)}$$

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3. $y[n] = 0.4\, y[n-1] + x[n]$

Transfer Function $H(z) = \frac{Y(z)}{X(z)} = \frac{1}{1 - 0.4z^{-1}}$

Impulse Response $h(n) = Z^{-1}[H(z)] = 0.4^n u[n]$

For the system to be BIBO stable, the poles of $H(z)$ must fall within the unit circle of the zplane.

$H(z) = \frac{1}{1 - 0.4z^{-1}} = \frac{z}{z - 0.4}$, there is a pole at $z = 0.4$, which is inside the unit circle: the system is BIBO stable.

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4\. a) Signal is of minimum frequency $f = 0$ Hz.

b) Signal is of maximum Nyquist frequency $f = \frac{1}{2} F_s$

c) Zeros within unit circle, signal is damped.

d) Zeros outside unit circle, signal increases by some magnitude e^n.

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5.6. $X(z)$ is Z-transform of causal signal $X[n]$.

$$x[0] = \frac{X(z)}{u(0) z^{-0}} = \frac{X(z)}{u(0)}$$

$$\lim_{n \to \infty} x[n] = 0$$

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7. $x[n] = \{\overset{0}{0}, \overset{1}{1}, \overset{2}{1}, \overset{3}{1}, \overset{4}{0}\}$ and $h[n] = \{\overset{0}{1.5}, \overset{1}{1}, \overset{2}{0.5}\}$

Find $y[n] = x[n] * h[n]$.

$$y[n] = \sum_{k=0}^{n} x[k]h[n-k]$$

$y[0] = x[0]h[0] = 0.0$

$y[1] = x[0]h[1] + x[1]h[0] = 1.5$

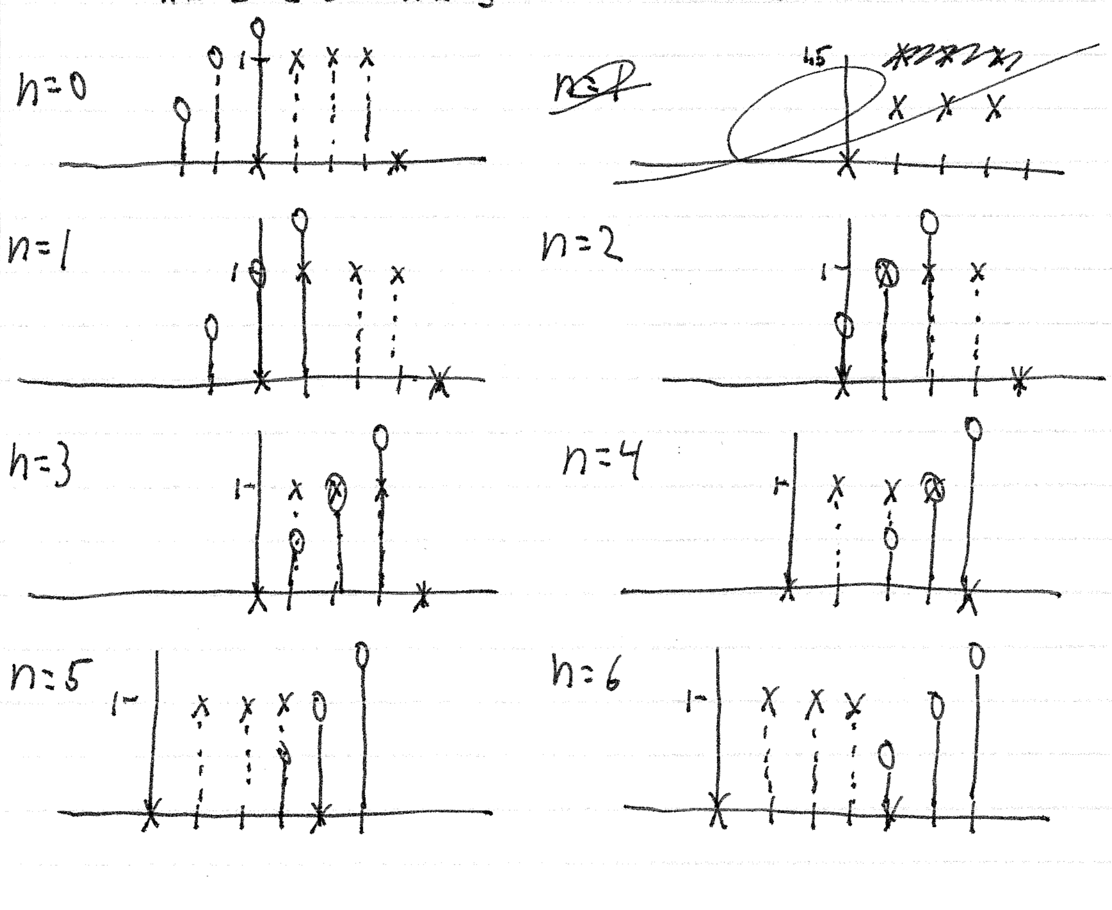
$y[2] = x[0]h[2] + x[1]h[1] + x[2]h[0] = 2.5$

$y[3] = x[0]h[3] + x[1]h[2] + x[2]h[1] + x[3]h[0] = 3.0$

$y[4] = x[0]h[4] + x[1]h[3] + x[2]h[2] + x[3]h[1] + x[4]h[0]$
$= 1.5$

$y[5] = x[0]h[5] + x[1]h[4] + x[2]h[3] + x[3]h[2]$
$+ x[4]h[1] + x[6]h[0] = 0.5$

$y[6] = x[0]h[6] + x[1]h[5] + x[2]h[4] + x[3]h[3] +$
$x[4]h[2] + x[5]h[1] + x[6]h[0] = 0.0$



HW5

8. $x[n] = u[n] - u[n-4]$ $\quad h[n] = 0.5^n u[n]$

$Y(z) = H(z)\,X(z)$

$$= \frac{1}{(1-0.5z^{-1})(1-z^{-1})(1+(z-4)^{-1})}$$

$\frac{1}{2} - 4 = -3.5$

$$= \frac{A}{(1-0.5z^{-1})} + \frac{B}{(1-z^{-1})} + \frac{C}{(1+(z-4)^{-1})}$$

$z = \frac{1}{2},\quad A = -1 \cdot \cancel{9}^{5}/7 = -\cancel{9}^{5}/7$

$z = 1,\quad B = 0.5 \cdot \frac{2}{3} = \frac{1}{3}$

$z = 3,\quad C = \frac{5}{6} \cdot \frac{2}{3} = \frac{5}{9}$

$$Y(z) = \frac{-5/7}{(1-0.5z^{-1})} + \frac{1/3}{(1-z^{-1})} + \frac{5/9}{(1+(z-4)^{-1})}$$

$$y[n] = -\frac{5}{7}(0.5^n)u[n] + (\tfrac{1}{3})u[n] + (\tfrac{5}{9})(-u[n-4])$$