Christopher Bero

HW4

CPE 381

1. For a $H(s)$, given K, p_k, z_i.
Know
$$H(s) = K \cdot \left(\frac{s - z_i}{s - p_k}\right)$$
Using script "p1" in Matlab,

a $H_1(s)$: $K = 1$; $p = -1, -1+\pi, -1-\pi$; $z = 1, 1+\pi, 1-\pi$

Numerator: $(s-1)(s-(1+\pi))(s-(1-\pi))$
Denominator: $(s+1)(s-(-1+\pi))(s-(-1-\pi))$
- Is an "all-pass" filter.

a $H_2(s)$: $K = 1$; $p = -1, -1+\pi, -1-\pi$; $z = \pi, -\pi$

Numerator: $(s-\pi)(s+\pi)$
Denominator: $(s+1)(s-(-1+\pi))(s-(-1-\pi))$
- Is a notch filter.

a $H_3(s)$: $K = 1$; $p = -1, -1+\pi, -1-\pi$; $z = 1$

Numerator: $(s-1)$
Denominator: $(s+1)(s-(-1+\pi))(s-(-1-\pi))$
- Is a band pass filter.

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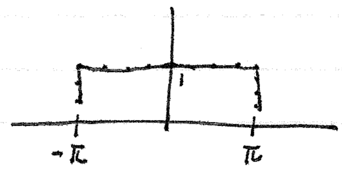
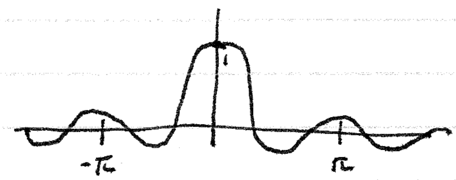
2. a) $h(t) = \sin(t) / t$.

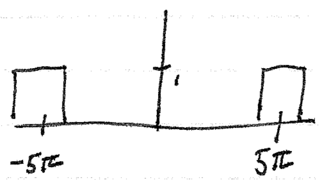
f:

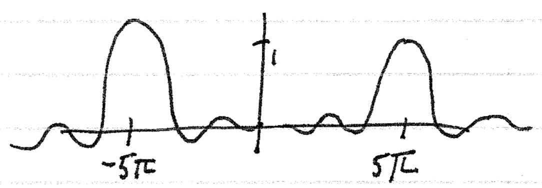


t:



b)





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3. 12-bit ADC, $V_{R-} = 0.5V$, $V_{R+} = 2.5V$

a) Quantization Step: $(V_{R+} - V_{R-})/(2^n - 1)$

$(2.5V - 0.5V)/(4095) = \boxed{0.0004884V} = \Delta$

b) $V_{R-} + (Val \cdot \Delta) = V_{in} \Rightarrow Val \cdot \Delta = V_{in} - V_{R-}$

$Val = (V_{in} - V_{R-})/\Delta$

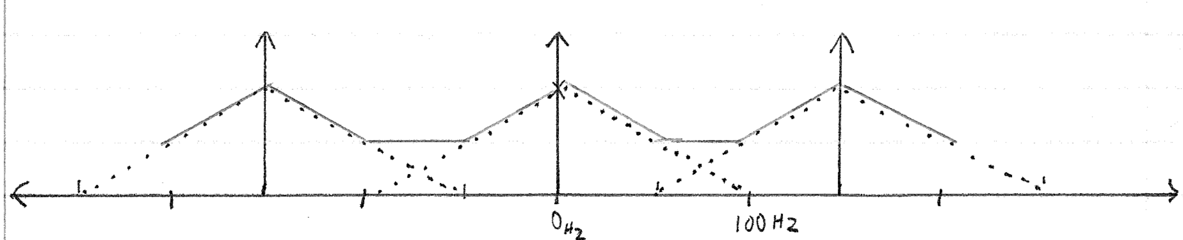
$(2.2V - 0.5V)/0.0004884V = \boxed{3480}$

c) $0.4V < 0.5V_{R-}$, $Val = \boxed{0}$

d) $3V > V_{R+}$, $Val = \boxed{4095}$.

4. $\Omega_{max}: 100 Hz$; $F_s = 150\ Hz$

Sampled Signal:



Because $F_s = 150 Hz \not\geq 2 \cdot \Omega_{max}$, Nyquist Conditions are not met and the sampled signal is distorted.

5. 12 or 16 bit ADC; $f_m = 5KHz$; Range: 2.5V

- Determine sampling period T_s.
  - $f_s = 2 \cdot f_m = 10KH_z$ minimum to satisfy Nyquist Criteria
  - $T_s = 1/f_s = 0.0001s$

- For 12 bit ADC:
  - $\Delta = 2.5V/4095 = 0.000610$
  - Quantization Error: $\emptyset \leq \varepsilon(nT_s) \leq \Delta$

- For 16 bit ADC:
  - $\Delta = 2.5V/65535 = 0.000038$
  - Quantization Error $= \emptyset \leq \varepsilon(nT_s) \leq \Delta$

- Testing with a value from the high end of a given viable range $V_{R-} = 0V$ $V_{R+} = 2.5V$:
  - 12 bit error: $((\Delta)/2.5V) \times 100\% = 0.024\%$
  - 16 bit error: $((\Delta)/2.5V) \times 100\% = 0.002\%$

- Going from a 12 bit to a 16 bit ADC results in more than a magnitude of order reduction in error.

$$y[n] = 0.2 \cdot y[n-2] + x[n]$$

6.

a) $y[n] = h[n] = 0, \quad n<0 \quad ; \quad x[n] = \delta[n]$

$$y[n] = 0.2 \cdot y[n-2] + x[n]$$
$$y[n-2] = 0.2 \cdot y[n-4] + x[n-2]$$
$$y[n] = 0.2\left[0.2 \cdot y[n-4] + x[n-2]\right] + x[n]$$
$$= 0.04 \cdot y[n-4] + (x[n-2] + x[n])$$
$$y[0] = 0.04 \cdot y[-4] + (x[-2] + x[0])$$

$$y[n] = \sum_{k=0}^{n} 0.2^k \cdot x[n-k] \qquad n \geq 0$$

$$h[n] = \sum_{k=0}^{n} 0.2^k \cdot x[n-k] \qquad n \geq 0$$

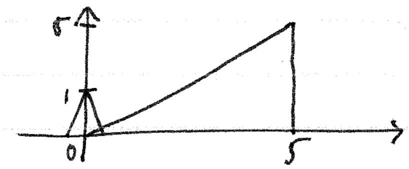
b) $h[0] = 0.2 \cdot \cancel{h[-2]}^{0} + \cancel{\delta[0]}^{1} = \cancel{0.2}^{0} + 1$

$$h[1] = 0.2 \cdot h[-1] + \delta[1] = 0 + 0$$
$$h[2] = 0.2 \cdot h[0] + \delta[2] = \cancel{0.2}^{2} + 0.2$$
$$h[3] = 0.2 \cdot h[1] + \delta[3] = 0$$
$$h[4] = 0.2 \cdot h[2] + \delta[4] = 0.2^2$$

$$h[n] = \cancel{\sum_{k=0}^{n}} \; 0.2^n \text{ for } n \in [\text{Even Numbers}]$$

$$h[n] = \emptyset \text{ for } n \in [\text{Odd Numbers}]$$

7\. a) $h[n] = 0 + \delta[n-1] + 2\delta[n-2] + 3\delta[n-3] + 4\delta[n-4] + 5\delta[n-5]$.



b) for no $n<0$ is $h[n] \neq 0$, is not causal.
Does not damp, is not stable.

d) $h[5] = 5$