Ahmad Malik
ECE310 HW1
Fontaine

1)

a) 40KHz, 60KHz, 90KHz, 110KHz, 160KHz, 140KHz, 190KHz

b) $\frac{fs}{2} = 25kHz$

c) Analog Radian frequency: $2\pi f_a = 2\pi(10000) =$ **62,832 rad/sec**

Normalized digital Radian frequency: $2\pi \frac{f_o}{f_s} = 2\pi\left(\frac{10KHz}{50KHz}\right) =$ **1.257 rad**

Digital frequency normalized to Sampling Rate: $\frac{f_o}{f_s} = \frac{10KHz}{50KHz} = \frac{1}{5}$

Digital frequency normalized to Nyquist Bandwidth: $\frac{f_o}{\frac{f_s}{2}} = \frac{2}{5}$

d) Assuming no Aliasing and no Anti-Imaging filter for D/A

$2\pi \frac{f_o}{f_s} = 2\pi \frac{f_d}{f_{s2}}$, $2\pi\left(\frac{10k}{50k}\right) = 2\pi\left(\frac{f_d}{100k}\right)$

$f_d = 20k$

20kHz, 80kHz, 120KHz, 180kHz

e) $\frac{f_s}{2} =$ **50kHz**

3) $h = \{3, -1, 2, 1\}$, $0 \le n \le 3$

$x = \{2, -1, 2, 3\}$, $0 \le n \le 3$

$y_L[n] = h[n] * x[n]$, $0 \le n \le 6$

$$y_L[n] = \sum_{k=0}^{6} x[k]\, h[n-k]$$

$$y_L[2] = x[0]h[2] + x[1]h[1] + x[2]h[0]$$

$$= (2)(2) + (-1)(-1) + (2)(3)$$

$$\boxed{y_L[2] = 11}$$

$$y_4[2] = x[0]h[2] + x[1]h[1] + x[2]h[0] + x[3] + h[3]$$

$$= (2)(2) + (-1)(-1) + (2)(3) + (1)(3)$$

$$= 4 + 1 + 6 + 3$$

$$\boxed{y_4[2] = 14}$$

$$y_8[2] = x[0]h[2] + x[1]h[1] + x[2]h[0] + x[3]h[7]$$
$$x[4]h[6] + x[5]h[5] + x[6]h[4] + x[7]h[3]$$

$$y_8[2] = (2)(2) + (-1)(1) + (2)(3)$$

$$\boxed{y_8[2] = 11}$$

4)

a)

$$W[k] = \sum w[n] e^{-j\frac{2\pi}{N} nk}$$

$$W_0[k] = \sum W_0[n] e^{-j\frac{2\pi}{N} nk}$$

Since $W_0[n]$ contains a quarter as many 1s as $W[n]$:

$$W_0(k) = \sum \frac{w[n]}{4} e^{-j\frac{2\pi}{N} \cdot 4nk}$$

$$W_0(k) = \frac{1}{4} w(4n)$$