EC516 HW 5

4.1

a) $H(z) = \frac{1}{(1-0.9e^{j\frac{\pi}{4}}z^{-1})(1-0.9e^{-j\frac{\pi}{4}}z^{-1})}$

$= \frac{1}{1-0.9\sqrt{2}z^{-1}+0.81z^{-2}}$

$H(z) = \frac{Y(z)}{X(z)}$

$Y(z)(1-0.9\sqrt{2}z^{-1}+0.81z^{-2}) = X(z)$

inverse Z-transform on both sides

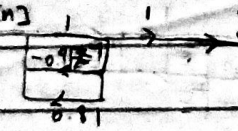
$y[n] - 0.9\sqrt{2}\,y[n-1] + 0.81\,y[n-2] = x[n]$

$y[n] = 0.9\sqrt{2}\,y[n-1] - 0.81\,y[n-2] + x[n]$

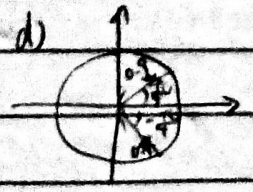
b) the poles of $H(z)$ is a conjugate place $r = 0.9$ and $\omega_1 = \frac{j\pi}{4}$

$\omega_2 = -\frac{j\pi}{4}$

when the ploes of a system are complex conjugate, system will have real-valued coefficients as the unreal parts are guaranteed to be canceld with its conjugate. So yes

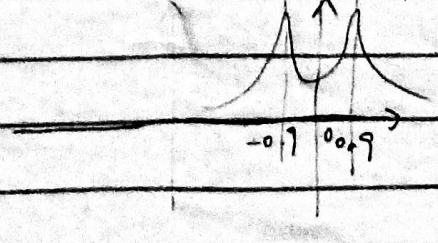
c) 

# of multiplication per output : 2
# of memory retrievals per output : 3
The coefficients are real valued, and the intermediate signals are guaranteed to be real.

d) 

e) $H(e^{j\omega}) = \frac{1}{(1-0.9e^{j(\frac{\pi}{4}-\omega)})(1-0.9e^{-j(\frac{\pi}{4}+\omega)})}$

$|H(e^{j\omega})| = \frac{1}{|1-0.9e^{j(\frac{\pi}{4}-\omega)}||1-0.9e^{-j(\frac{\pi}{4}+\omega)}|}$



there is no zero possible.

c's additional calculation

$V[n] = x[n] - 0.9\sqrt{2}V[n-1] + 0.81V[n-2]$

$y[n] = V[n]$

4.2

a) $H(z) = \frac{1+z^{-2}}{(1-0.9e^{j\frac{\pi}{4}}z^{-1})(1-0.9e^{-j\frac{\pi}{4}}z^{-1})}$

$= \frac{1+z^{-2}}{1-0.9\sqrt{2}z^{-1}+0.81z^{-2}}$

$H(z) = \frac{Y(z)}{X(z)}$

$(1-0.9\sqrt{2}z^{-1}+0.81z^{-2})\,Y(z) = (1+z^{-2})\,X(z)$

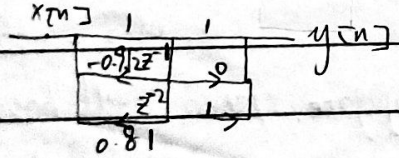
$y[n] = 0.9\sqrt{2}y[n-1] - 0.81y[n-2] + X[n] + X[n-2]$

$y[n] - 0.9\sqrt{2}y[n-1] + 0.81y[n-2] = x[n] + x[n-2]$

b) Yes, since the transfer function has only coefficients that are real valued, so yes.

c) $v[n] = x[n] - 0.9\sqrt{2}v[n-1] + 0.81v[n-2]$

$y[n] = v[n] + v[n-2]$



# of multiplication is 2

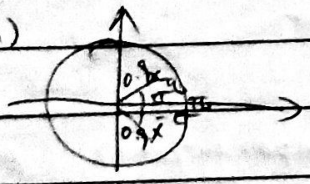
one for $0.9\sqrt{2}y[n-1]$ one for -0.81

# of memory retrieval is 3

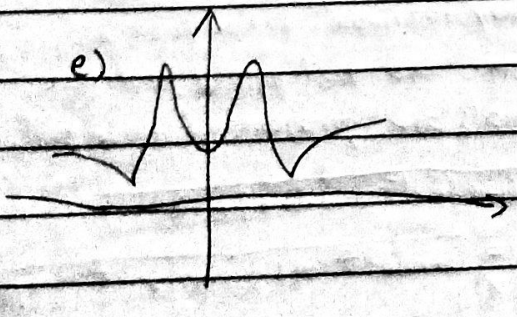
$y[n-1]$ $y[n-2]$ and $x[n-2]$

Yes all coefficients are real.

d)



e)



there is no zeros.

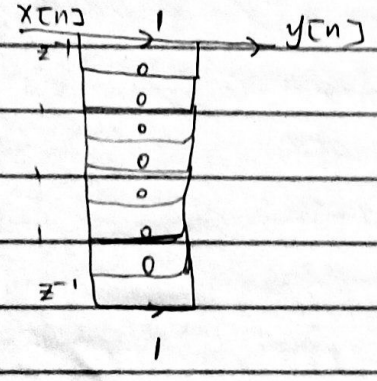
4.3

a) $H(z) = (1 - z^{-8})$

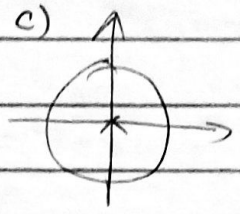
this is a FIR as there is no denominator form which means no poles except at original.

b) $H(z) = 1 - z^{-8}$

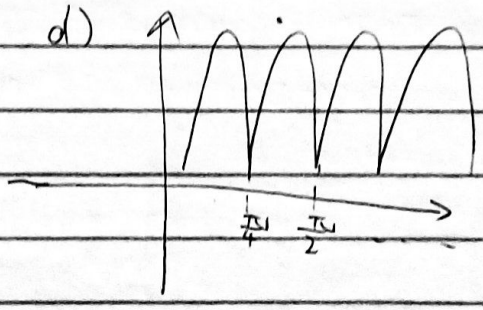
$y[n] = x[n] - x[n-8]$



c)



d)



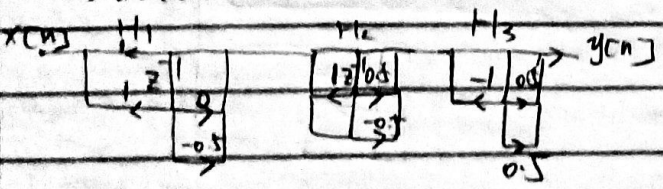
4.4

a) Since the transfer function G contains poles, It will be a IIR not at origin.

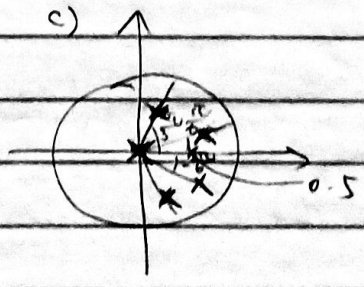
b) $H_1(z) = \frac{1+z^{-1}}{1-0.5z^{-1}}$

$H_2(z) =$

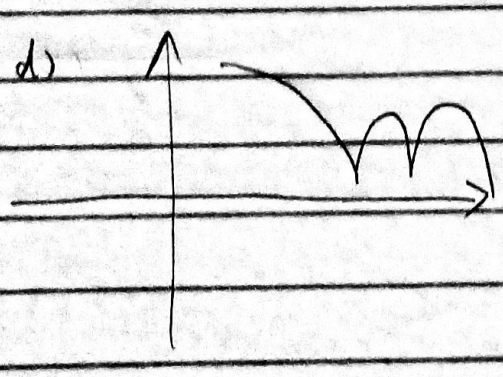
0 and 0.5



c)



d)



The filter seems to allow low frequency signal much more than higher frequency on. So this is low-pass filter.