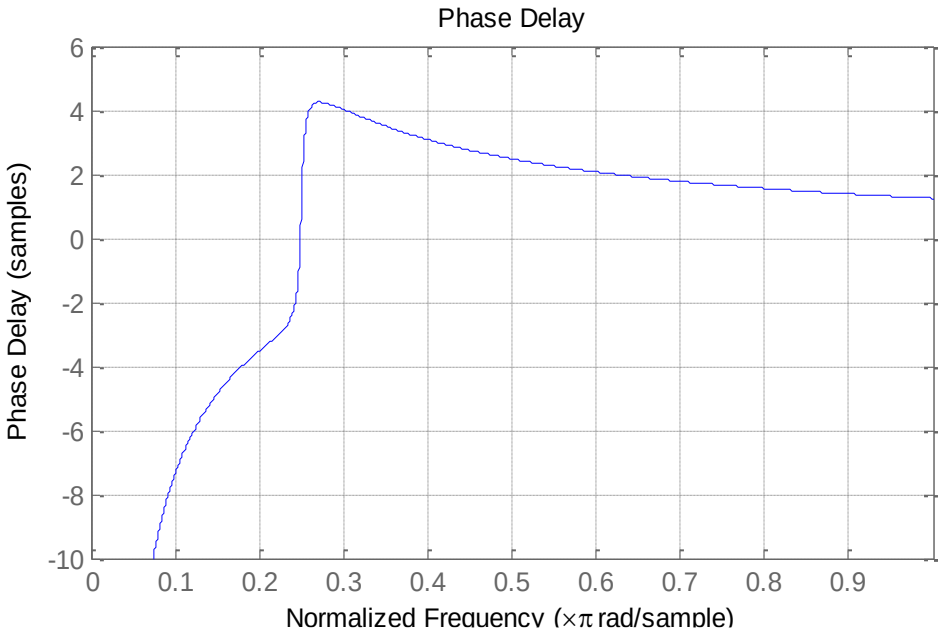
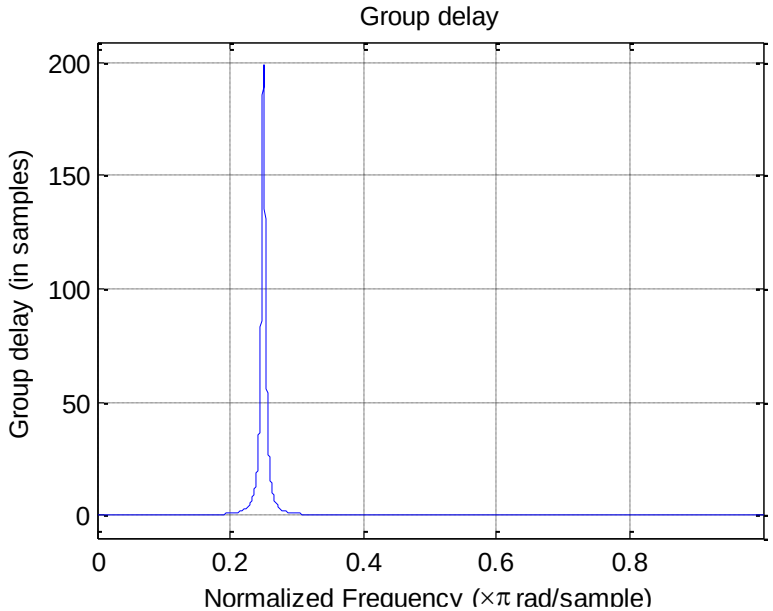
EE 430 Section 2 HW5 Answers Part-1

(For any questions contact Erdal Epçaçan, epcacan@metu.edu.tr, D-122)

1) The magnitude response is zero at $\omega = \theta$. 180° phase shift occurs when ω pass through θ.
2)
3)

a.





b. Let

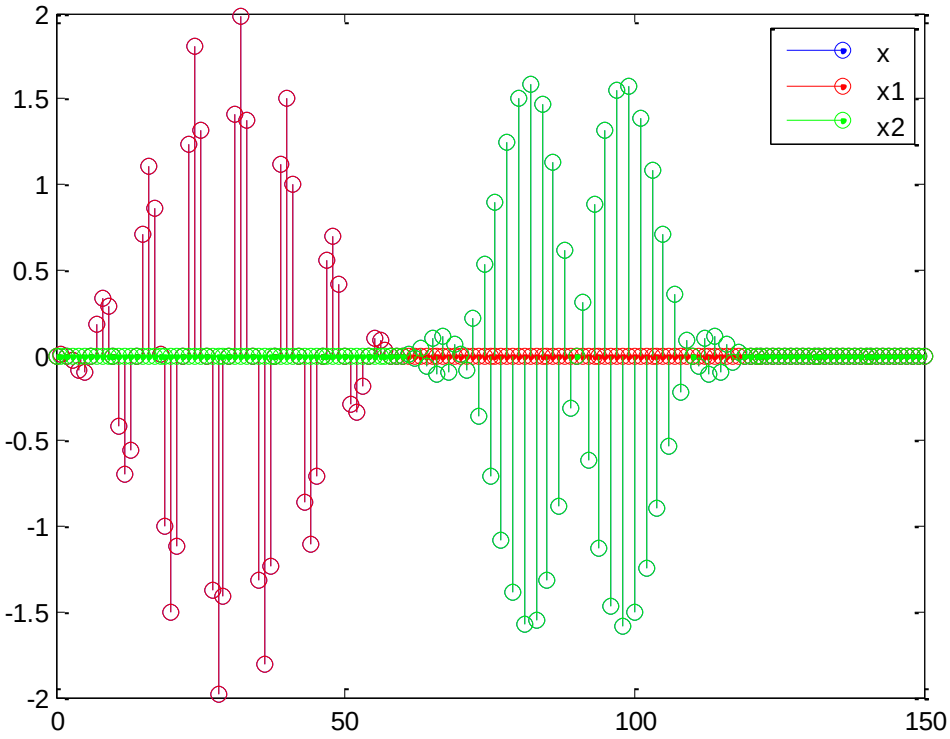
$$x[n] = x_1[n] + x_2[n]$$

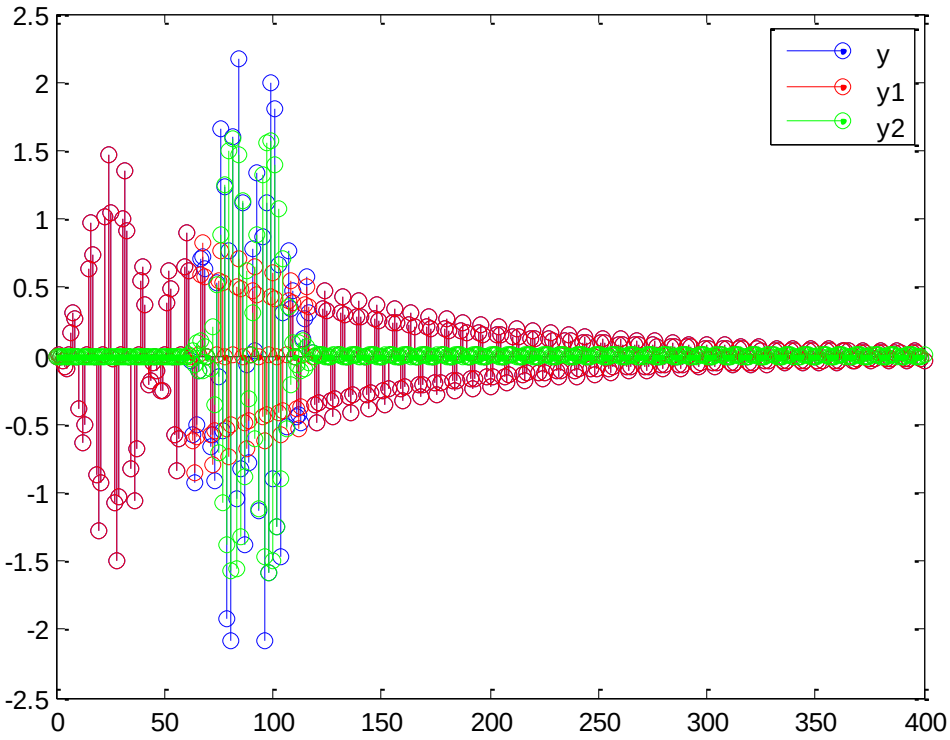
$$x_1[n] = \left(1 - cos\left(\frac{\pi}{30n}\right)\right) cos\left(\frac{\pi}{4}n\right)(u[n] - u[n - 60])$$

$$x_2[n] = \left(1 - cos\left(\frac{\pi}{30}(n - 60)\right)\right) cos\left(\frac{19\pi}{20}n\right)(u[n - 60] - u[n - 120])$$

Since the system is all pass and group delay is almost zero for $x_2[n]$, it will be observed at the output almost with no change. For $x_1[n]$, $cos\left(\frac{\pi}{4}n\right)$ part will decay very slowly since its frequency is very close to the pole angle (frequency).

c.

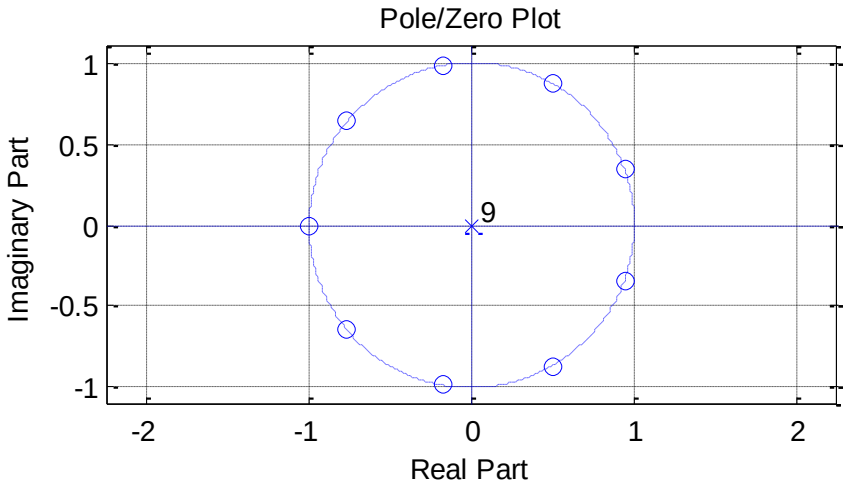


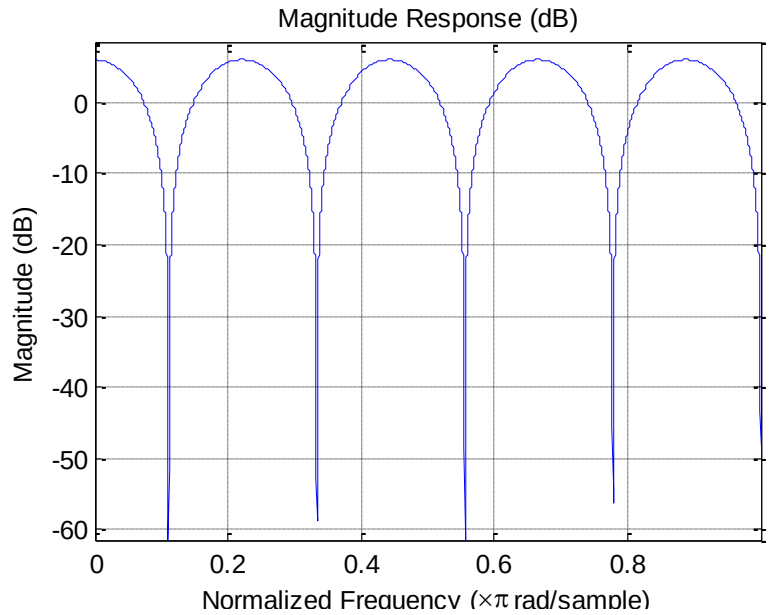


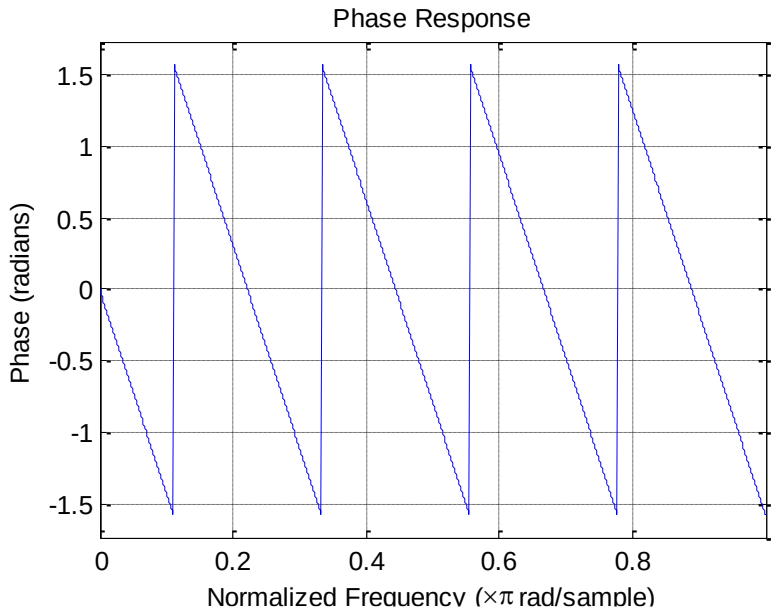
4)

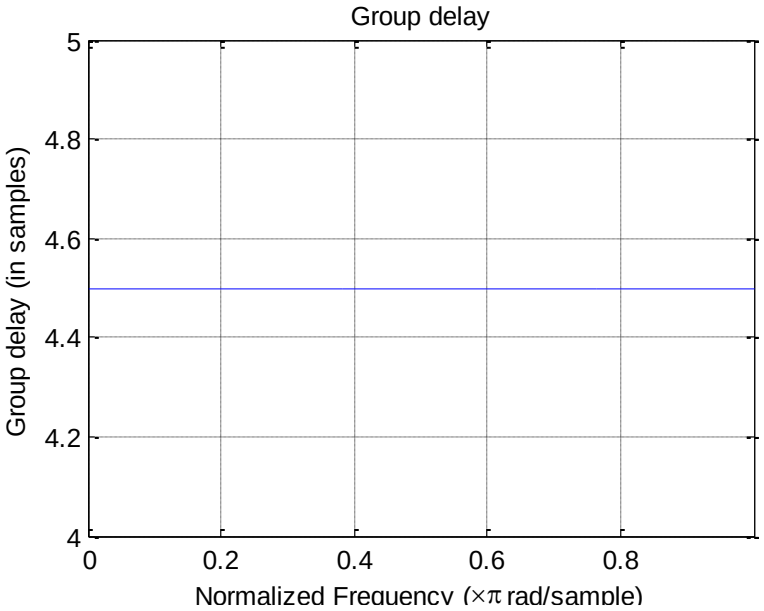
a. $h[n] = \delta[n] - \delta[n-9]$

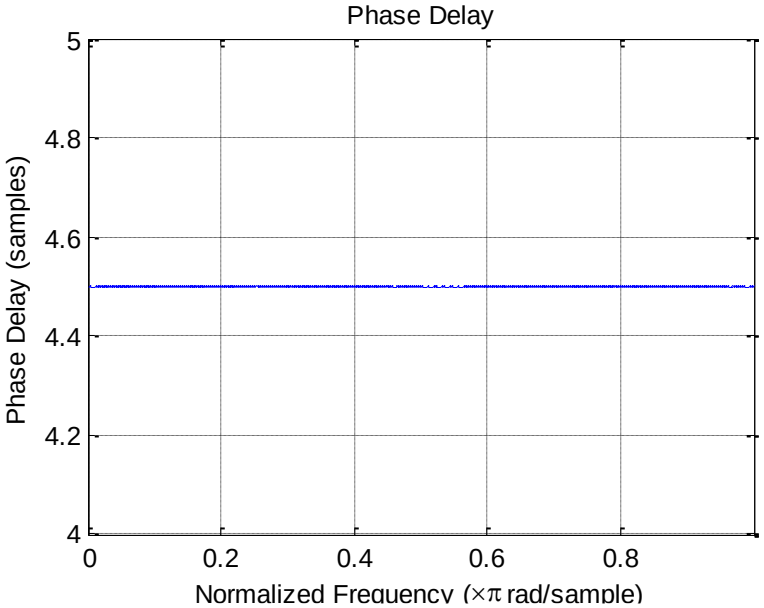
b.




Magnitude Response (dB)
Magnitude (dB)
0
-10
-20
-30
-40
-50
-60
0
0.2
0.4
0.6
0.8
Normalized Frequency (×π rad/sample)


Phase Response
Phase (radians)
1.5
1
0.5
0
-0.5
-1
-1.5
0
0.2
0.4
0.6
0.8
Normalized Frequency (×π rad/sample)

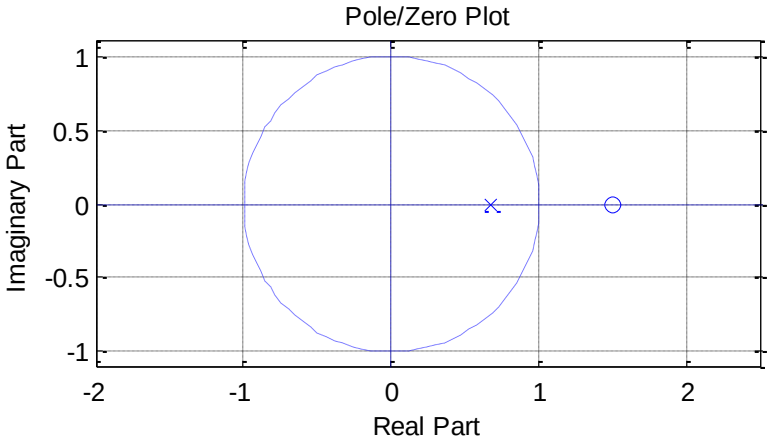

Group delay
Group delay (in samples)
5
4.8
4.6
4.4
4.2
4
0
0.2
0.4
0.6
0.8
Normalized Frequency (×π rad/sample)


Phase Delay
Phase Delay (samples)
5
4.8
4.6
4.4
4.2
4
0
0.2
0.4
0.6
0.8
Normalized Frequency (×π rad/sample)

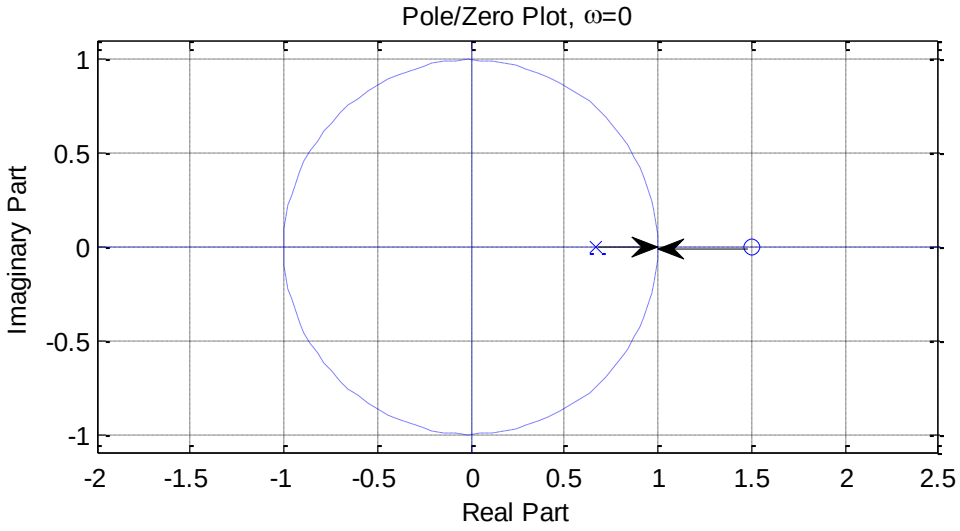
5)

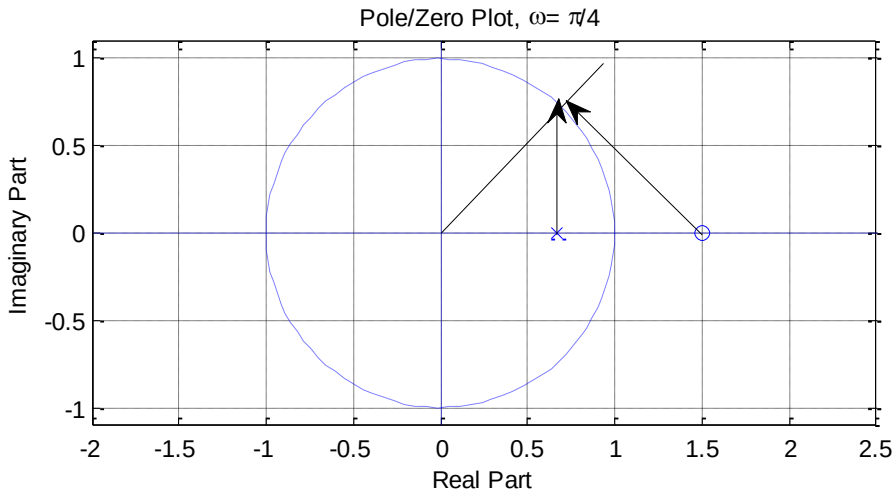
6)

a.


Pole/Zero Plot
Imaginary Part
Real Part
1
0.5
0
-0.5
-1
-2
-1
0
1
2

b.


Pole/Zero Plot, ω=0
Imaginary Part
Real Part
1
0.5
0
-0.5
-1
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
2.5

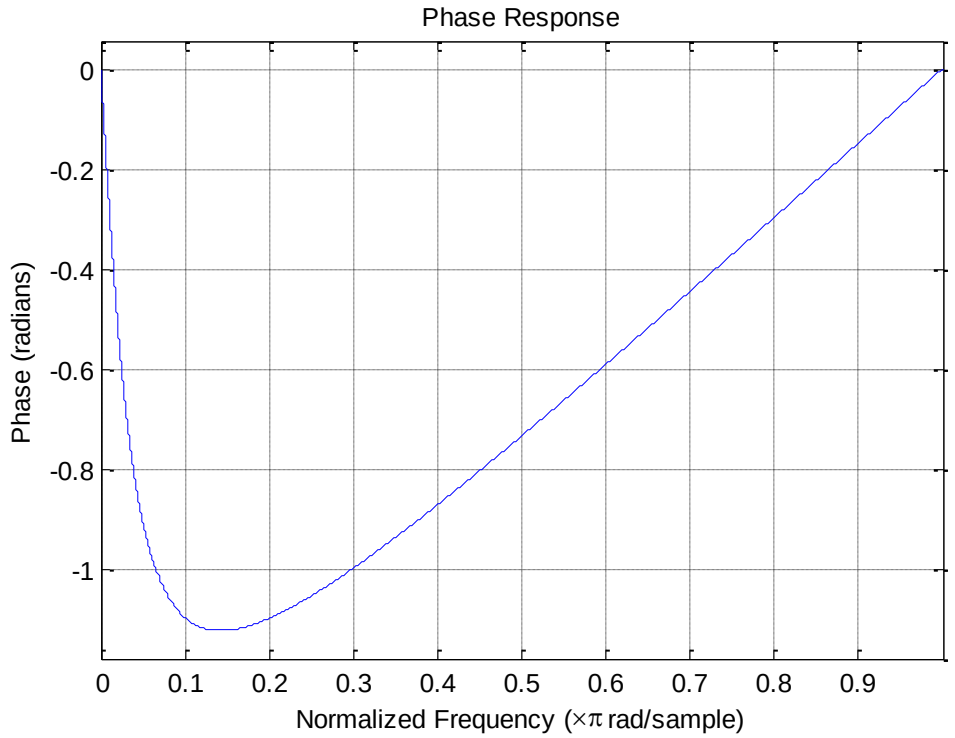

Pole/Zero Plot, ω= π/4
Imaginary Part
Real Part
1
0.5
0
-0.5
-1
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
2.5

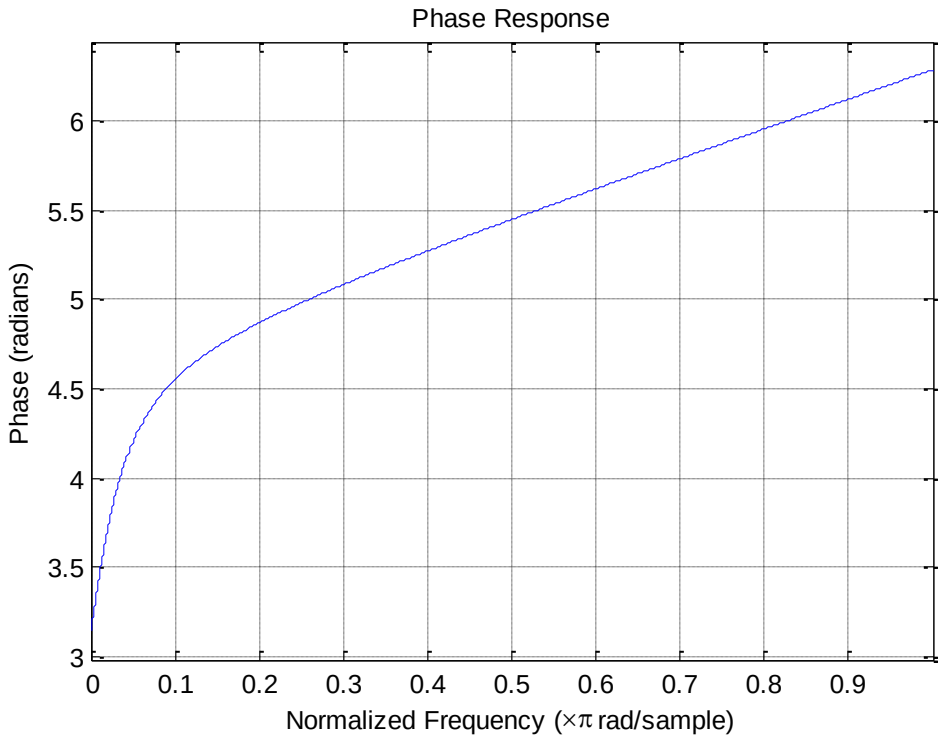
c. 0°

d. Yes

7)

8)


Phase Response
Phase (radians)
Normalized Frequency (×π rad/sample)
0
-0.2
-0.4
-0.6
-0.8
-1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9



When the pole is inside the unit circle, the phase of the pole vector increases as ω changes from 0 to π.

When the pole is outside the unit cirle, the phase of the pole vector first decreases as ω changes from 0 to $\omega = \cos^{-1}\frac{9}{10}$, then increases as ω changes from $\omega = \cos^{-1}\frac{9}{10}$ to π.

9) No, they are not.
10) Yes, they are.

11)
12)

$$H_{all}(z) = \frac{\left(z^{-1} - \frac{1}{2}\right)\left(z^{-1} + \frac{1}{2}\right)}{\left(1 - \frac{1}{2}z^{-1}\right)\left(1 + \frac{1}{2}z^{-1}\right)}$$

$$H_{min}(z) = \frac{-4(2 - z^{-1})}{z^{-2} + z^{-1} + 2}$$

13)
14)
15)
16)

$$H_{lin}(e^{j\omega}) = A(e^{j\omega})e^{j\omega\alpha}$$

$A(e^{j\omega}) > 0$ and real valued

$$H_{glin}(e^{j\omega}) = A(e^{j\omega})e^{j\omega\alpha + j\beta}$$

$A(e^{j\omega})$ real valued but bipolar

17) No, they should obey some symmetry properties due to their special form given in previous question