DSP Matlab Homework 1 Solutions

This document has been prepared for showing solutions of EHB 315E Digital Signal Processing Matlab Homework 1 by Research Assistant Hasan Hüseyin Karaoğlu.

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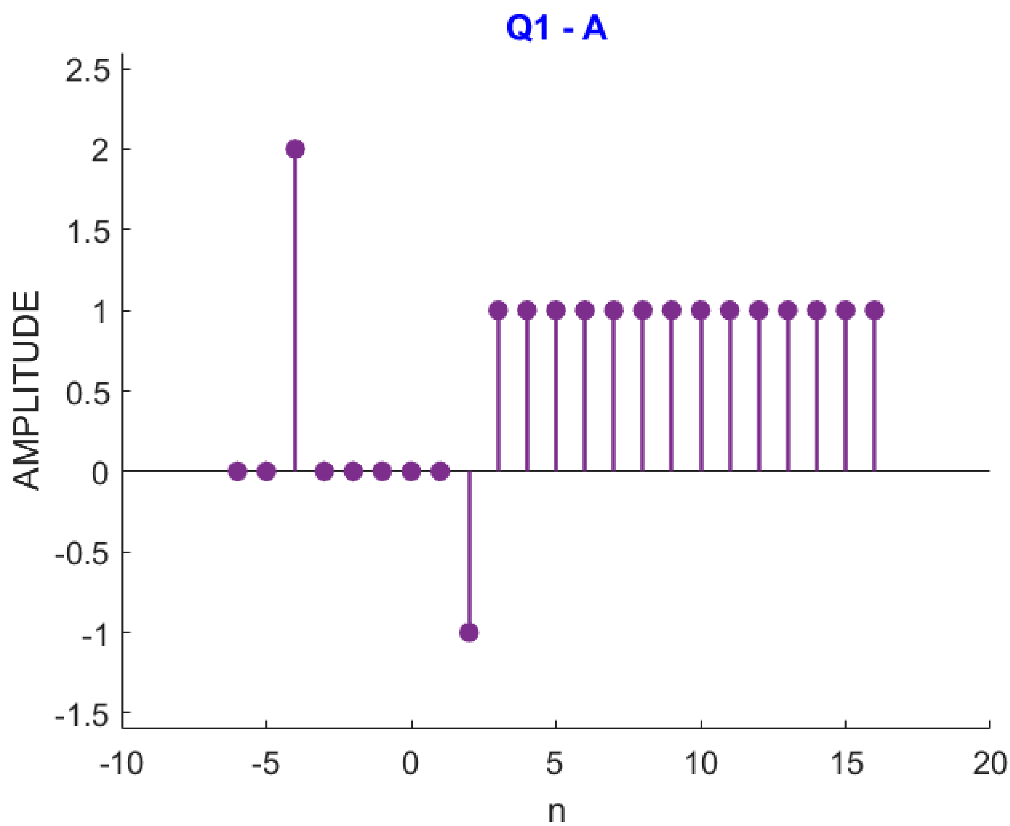
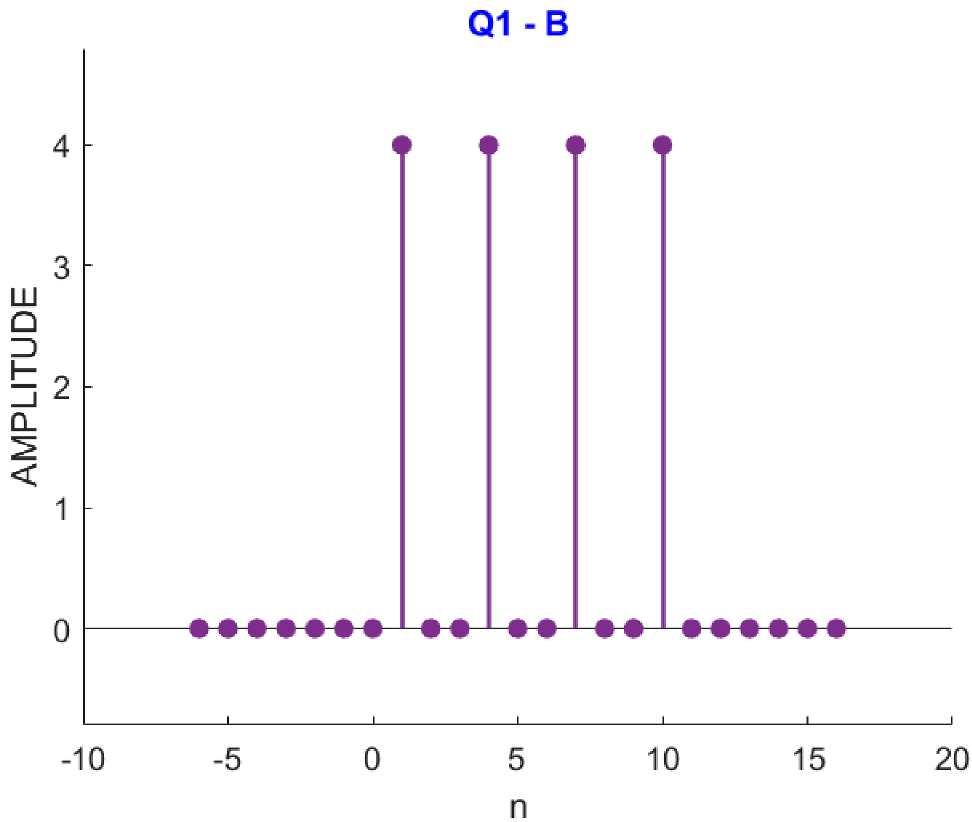
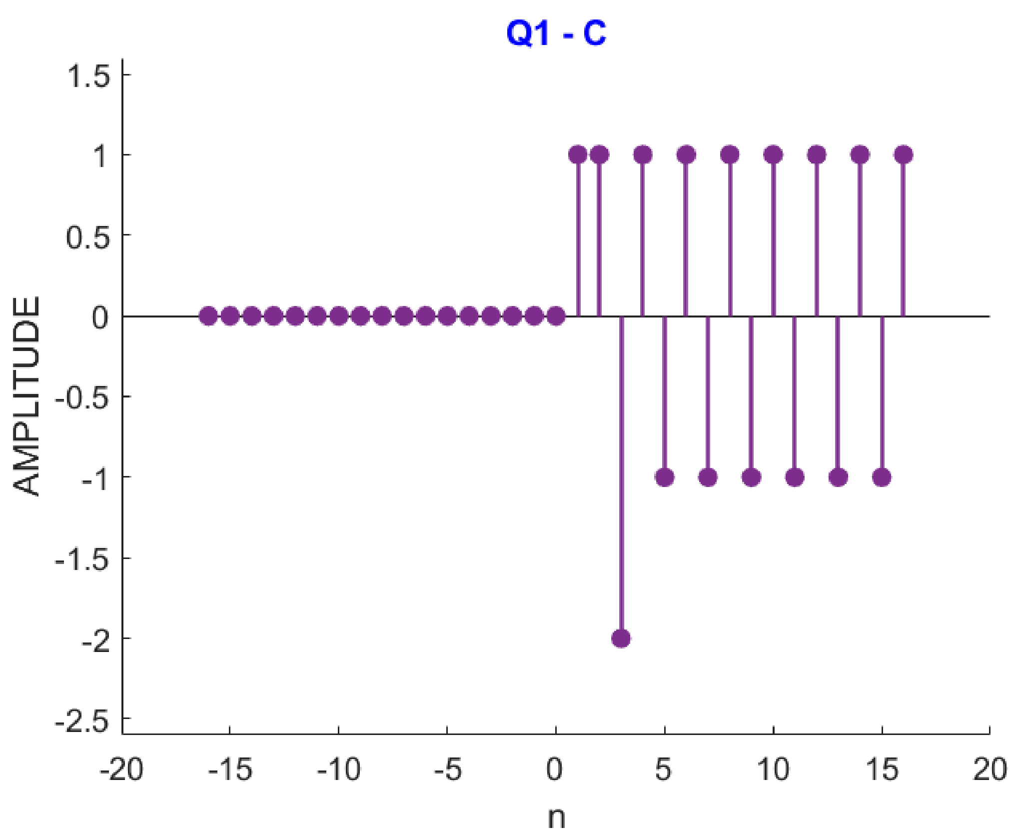
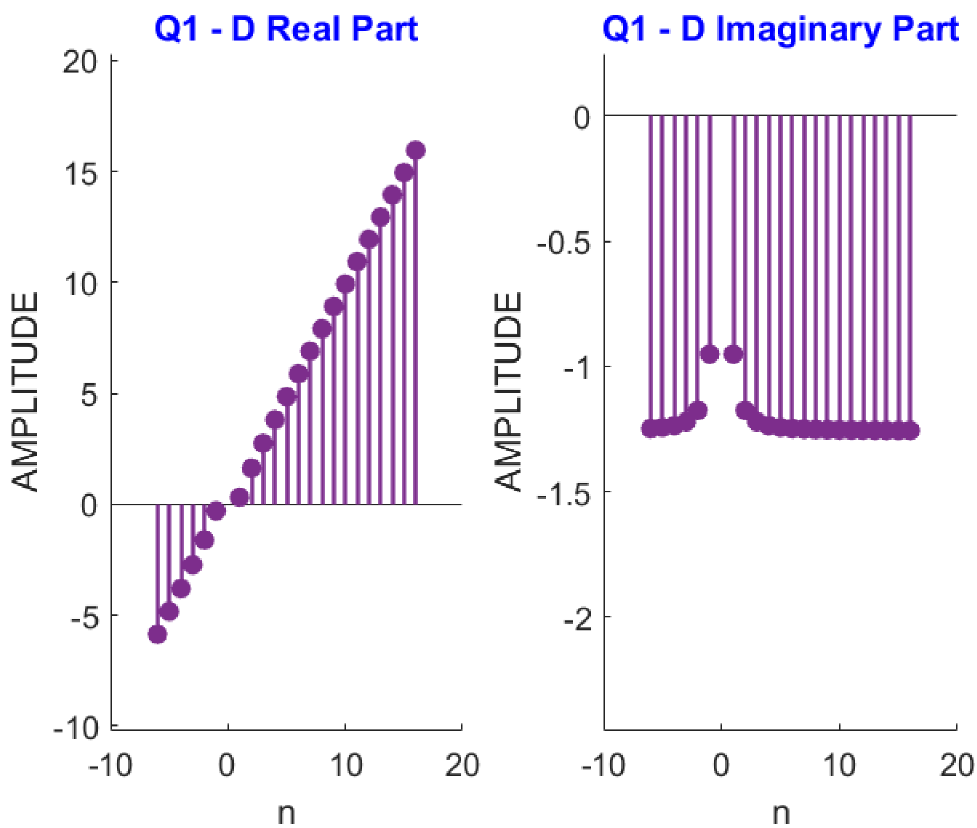
Solution 1

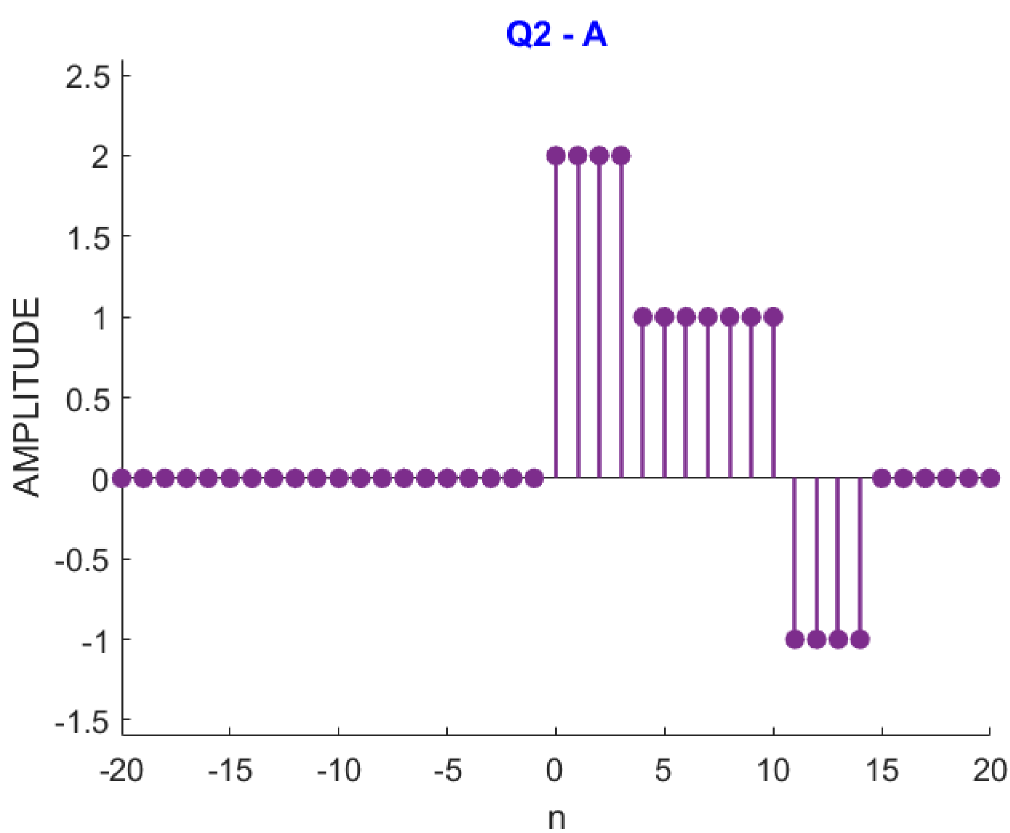


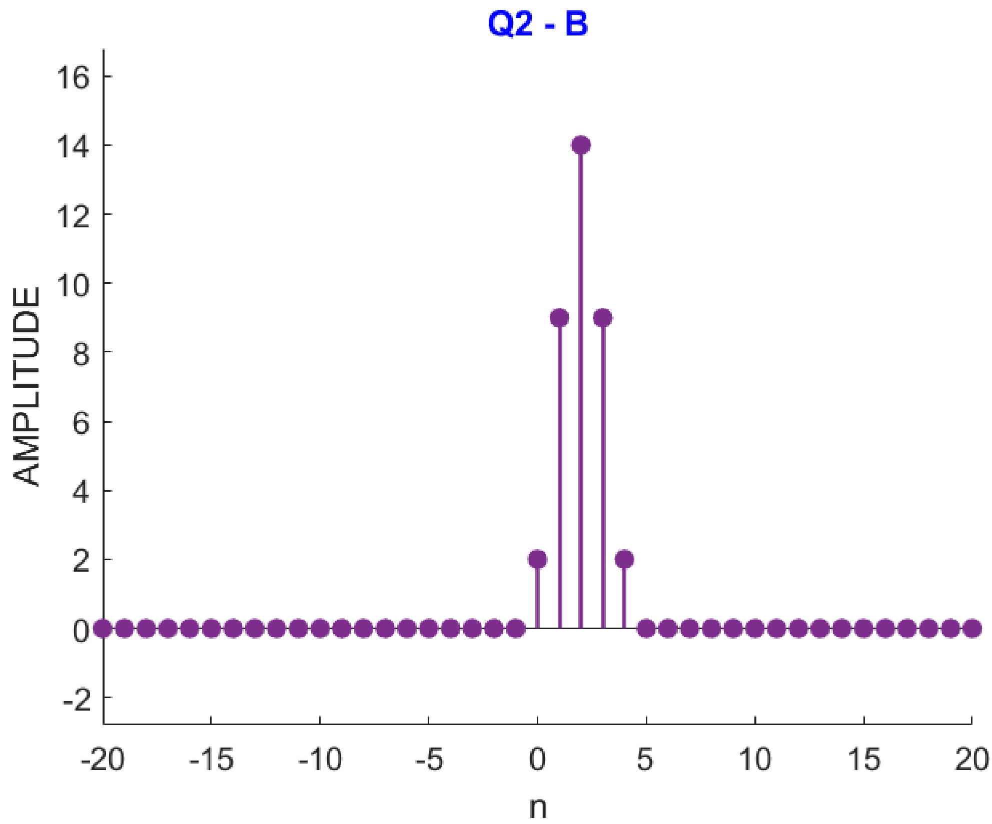

Q1 - B
AMPLITUDE
n
4
3
2
1
0
-10
-5
0
5
10
15
20


Q1 - C
AMPLITUDE
n
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-20
-15
-10
-5
0
5
10
15
20


Q1 - D Real Part
Q1 - D Imaginary Part
AMPLITUDE
n
20
15
10
5
0
-5
-10
-0.5
-1
-1.5
-2
-10
0
10
20

Solution 2


Q2 - A
AMPLITUDE
n
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-20
-15
-10
-5
0
5
10
15
20

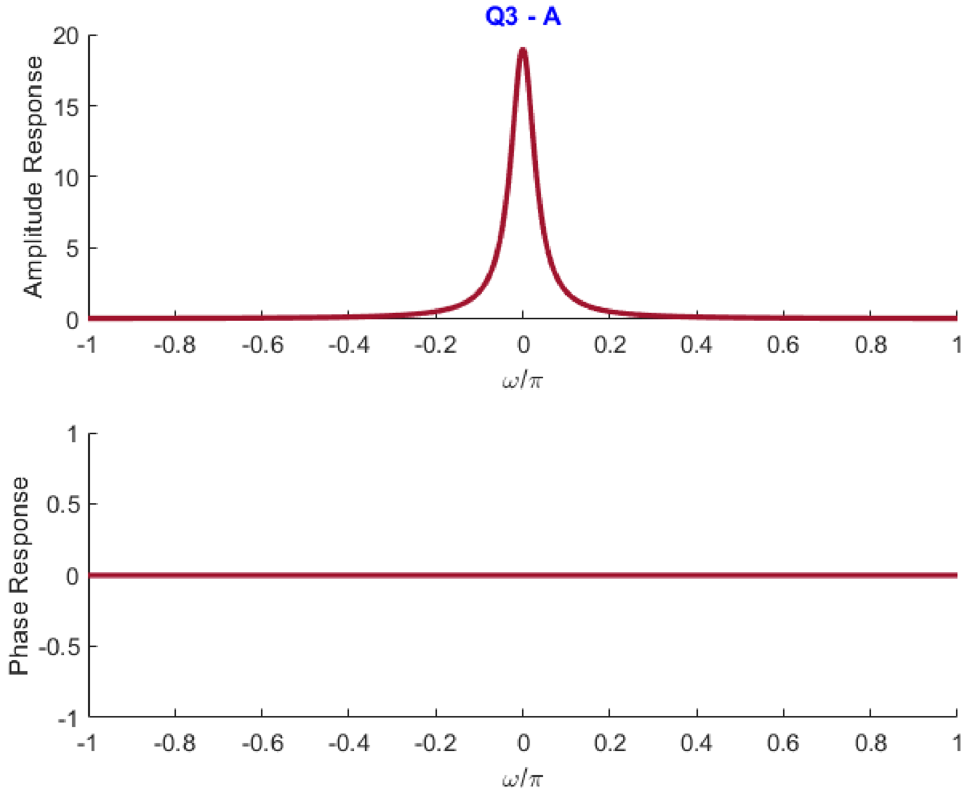


Solution 3

S3-1

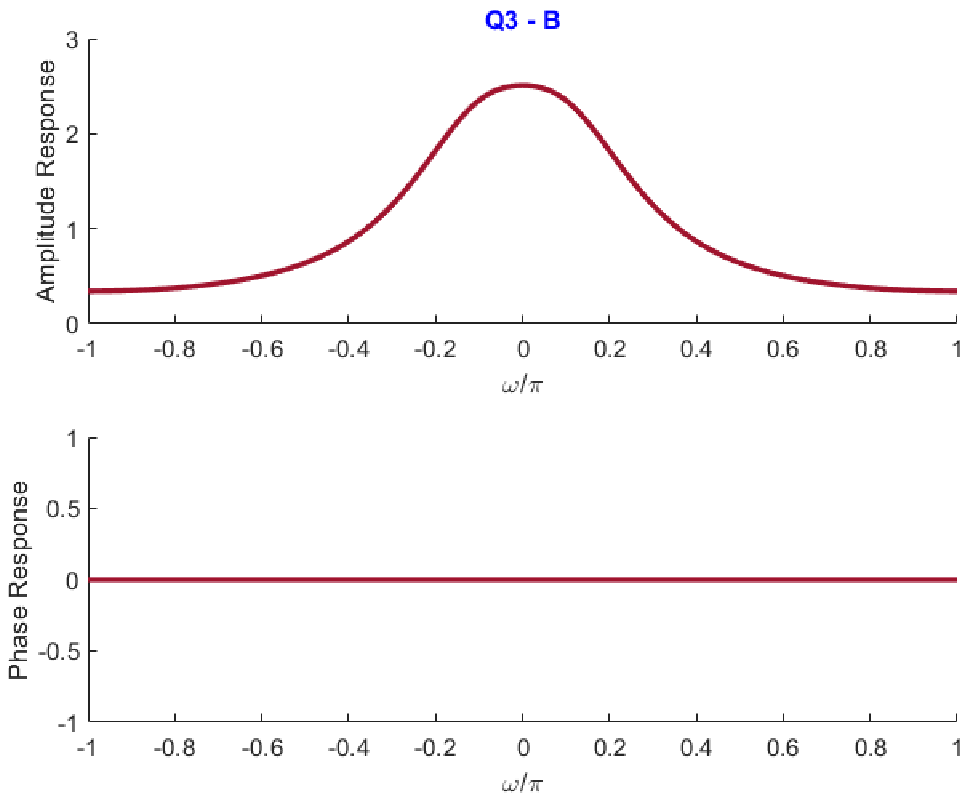
Firstly, we find out the frequenct response of the system.

$$\begin{aligned}
h(n) &= 0.9^{|n|} \\
H(e^{j\omega}) &= \sum_{n=-\infty}^{\infty} 0.9^{|n|} \cdot e^{-j\omega n} \\
&= \sum_{n=0}^{\infty} 0.9^{n} \cdot e^{-j\omega n} + \sum_{n=-\infty}^{0} 0.9^{-n} \cdot e^{-j\omega n} - 1 \\
&= \sum_{n=0}^{\infty} 0.9^{n} \cdot e^{-j\omega n} + \sum_{n=0}^{\infty} 0.9^{n} \cdot e^{j\omega n} - 1 \\
&= \frac{1}{1-0.9e^{-j\omega}} + \frac{1}{1-0.9e^{j\omega}} - 1 \\
&= \frac{0.19}{1.81 - 1.8\cos(\omega)}
\end{aligned}$$



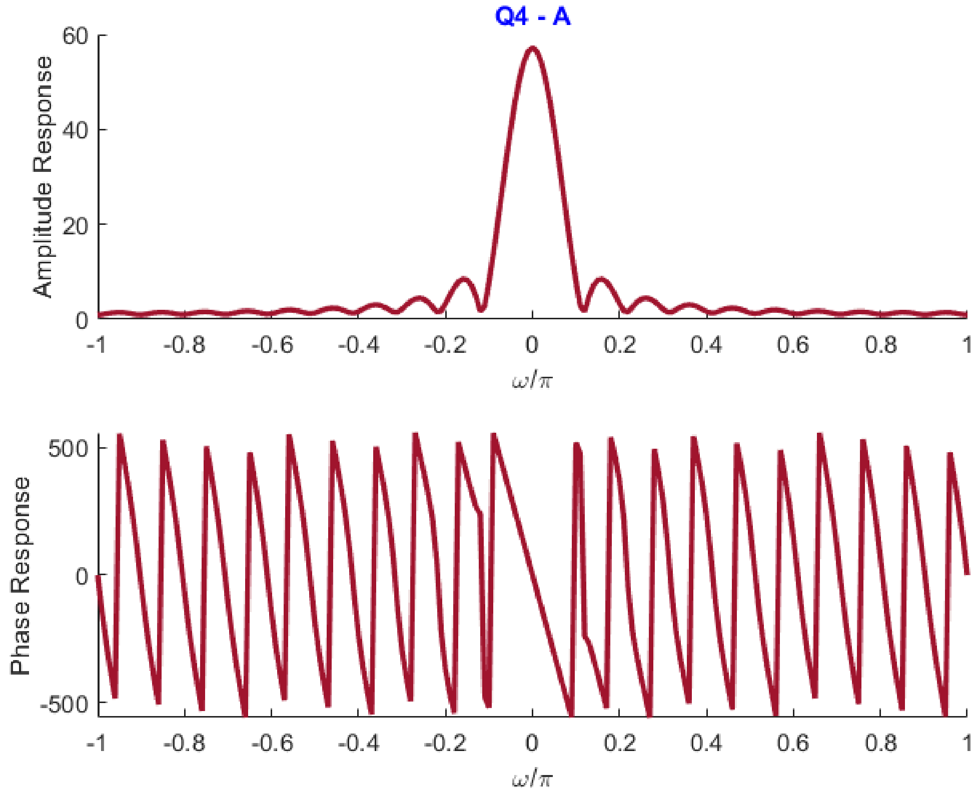
S3-2

$$
\begin{aligned}
H(e^{j\omega}) &= \sum_{n=-\infty}^{\infty} h(n)e^{-j\omega n} \\
&= \frac{1}{2}\left[\sum_{n=-\infty}^{\infty} 0.5^{|n|}e^{-j(\omega-0.1\pi)n} + \sum_{n=-\infty}^{\infty} 0.5^{|n|}e^{-j(\omega+0.1\pi)n}\right] \\
&= \frac{0.5\times 0.75}{1.25-\cos(\omega-0.1\pi)} + \frac{0.5\times 0.75}{1.25-\cos(\omega+0.1\pi)}
\end{aligned}
$$

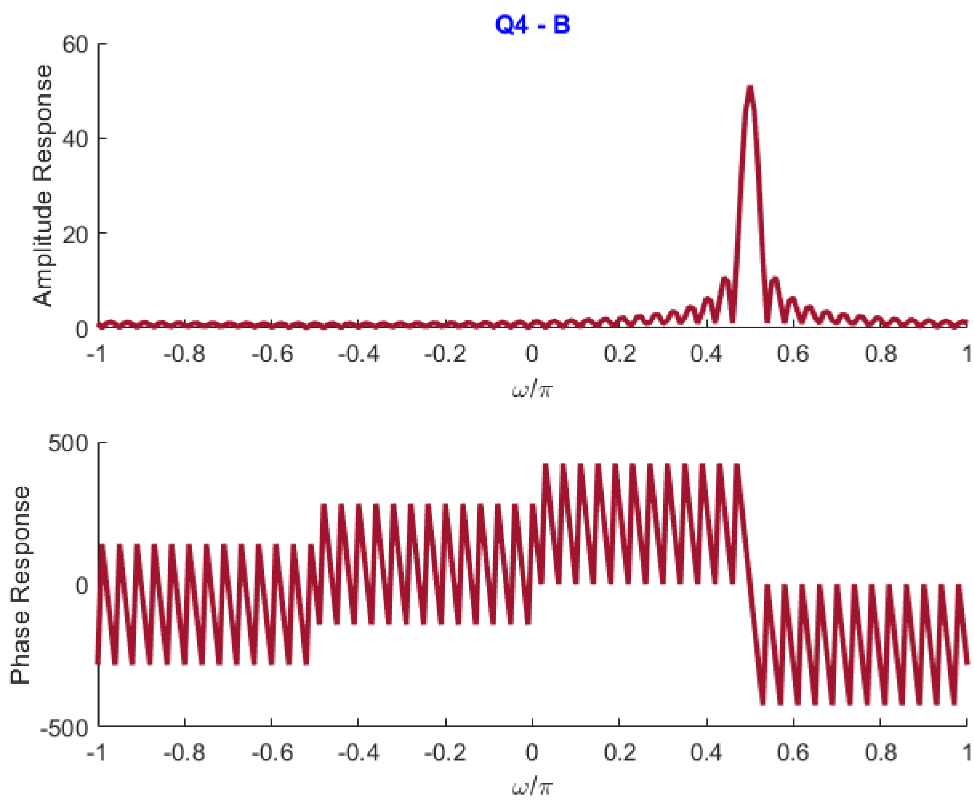


Solution 4

S4-1


Q4 - A
Amplitude Response
Phase Response
60
40
20
0
500
0
-500
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
ω/π

S4-2


Q4 - B
Amplitude Response
Phase Response
60
40
20
0
500
0
-500
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
ω/π

Solution 5

S5-1

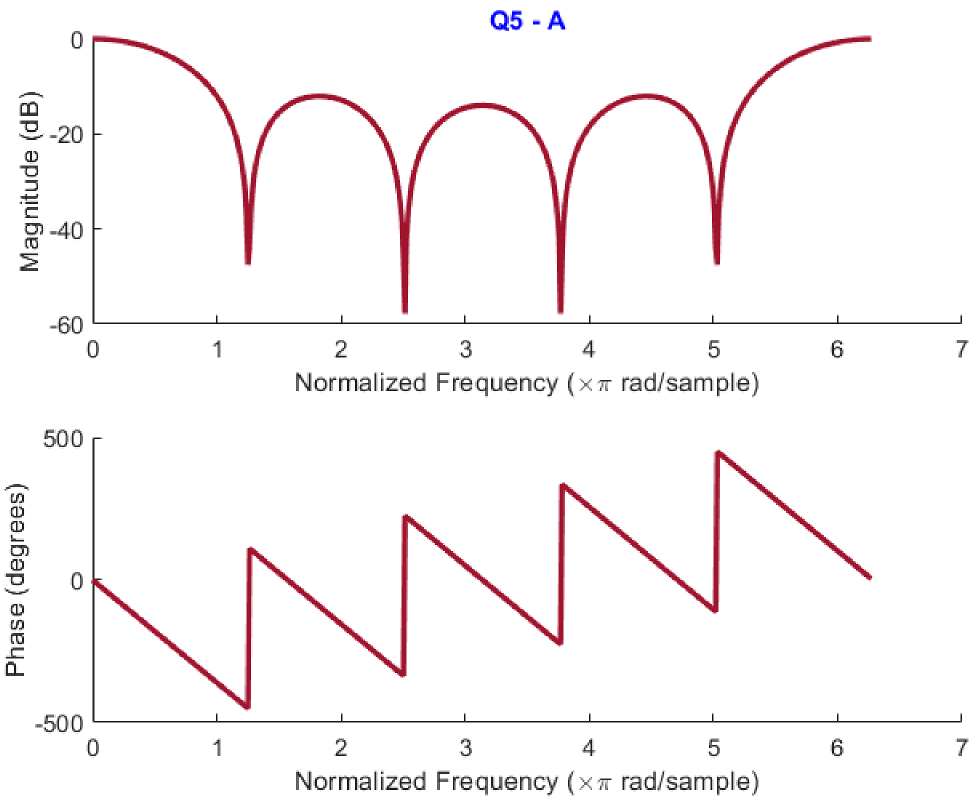
Before we draw frequency response of the system, we need to find the frequency spectrum by hand

$$y(n) = \frac{1}{5}\sum_{m=0}^{4} x(n-m)$$

$$\mathscr{F}[y(n)] = \mathscr{F}[\frac{1}{5}[x(n) + x(n-1) + x(n-2) + x(n-3) + x(n-4)]]$$

$$Y(e^{j\omega}) = \frac{1}{5}X(e^{j\omega})[1 + e^{-j\omega} + e^{-j2\omega} + e^{-j3\omega} + e^{-j4\omega}]$$

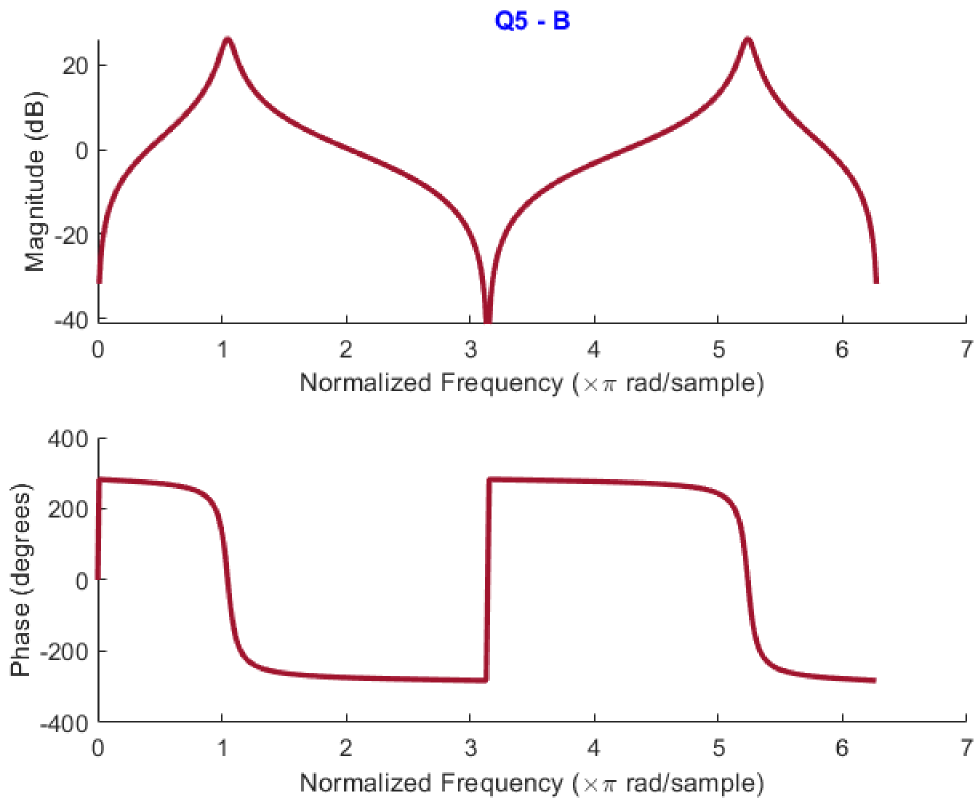
$$H(e^{j\omega}) = \frac{Y(e^{j\omega})}{X(e^{j\omega})} = \frac{1 + e^{-j\omega} + e^{-j2\omega} + e^{-j3\omega} + e^{-j4\omega}}{5}$$



S5-2

As previously mentioned, we need to find the frequency spectrum by hand to draw it

$$y(n) = x(n) - x(n-2) + 0.95y(n-1) - 0.9025y(n-2)$$
$$\mathscr{F}[y(n) - 0.95y(n-1) + 0.9025y(n-2)] = \mathscr{F}[x(n) - x(n-2)]$$
$$Y(e^{j\omega})(1 - 0.95e^{-j\omega} + 0.9025e^{-j2\omega}) = X(e^{j\omega})(1 - e^{-j2\omega})$$
$$H(e^{j\omega}) = \frac{Y(e^{j\omega})}{X(e^{j\omega})} = \frac{1 - e^{-j2\omega}}{1 - 0.95e^{-j\omega} + 0.9025.e^{-j2\omega}}$$



Q5 - B
Magnitude (dB)
20
0
-20
-40
0
1
2
3
4
5
6
7
Normalized Frequency (×π rad/sample)
Phase (degrees)
400
200
0
-200
-400
0
1
2
3
4
5
6
7
Normalized Frequency (×π rad/sample)