>> ex4

Task1 (a) $x(n) = \begin{cases} 2 & n=-1 \\ 1 & n=0 \\ \cancel{0}\,2 & n=2 \\ -3 & n=3 \\ 0 & \text{otherwise} \end{cases}$

$$X(z) = \sum_{n=-\infty}^{\infty} x(n) z^{-n} = 2z + 1 + 2z^{-2} - 3z^{-3}$$

(b). $x(n) = \sum_{m=0}^{15} 0.8^m \cancel{u(m)}$

$$X(z) = \sum_{m=0}^{15} 0.8^m z^{-m}$$

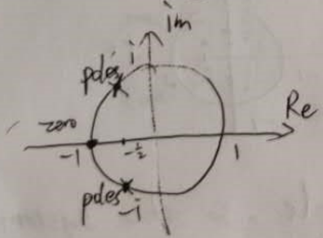
(c). $X_a(e^{iw}) = 2e^{iw} + 1 + 2e^{-2iw} - 3e^{-3iw}$

$$X_b(e^{iw}) = \sum_{m=0}^{15} 0.8^m \cdot e^{-iwm}.$$

Task2. $H(z) = \dfrac{1+2z^{-1}+z^{-2}}{1+z^{-1}+z^{-2}} = \dfrac{z^2+2z+1}{z^2+z+1}$

zeros: $\dfrac{-2 \pm \sqrt{4-4}}{2} = -1$

poles: $\dfrac{-1 \pm \sqrt{1-4}}{2} = \dfrac{-1 \pm i\sqrt{3}}{2}$



poles on the unit circle,

So the filter is not stable.

Task 3: $\omega = \frac{2\pi f}{F_s} = \frac{1}{4} 2\pi$. ①

$H(z) = \sum_{k=-\infty}^{\infty} h(k) z^{-k} = \frac{1}{4} - \frac{1}{2} z^{-1} + \frac{1}{4} z^{-2}$

$H(e^{i\omega}) = \frac{1}{4} - \frac{1}{2} e^{-i\omega} + \frac{1}{4} e^{-2i\omega}$ ②.

from ①, ②.

$H(e^{\frac{1}{4}2\pi i}) = \frac{1}{4} - \frac{1}{2} e^{-\frac{1}{4}2\pi i} + \frac{1}{4} e^{-\frac{1}{2}2\pi i}$

$= \frac{1}{4} - \frac{1}{2}\cos(\frac{1}{2}\pi) - \sin(\frac{1}{2}\pi) i + \frac{1}{4}\cos(\pi) - \sin(\pi) i$

$= \frac{1}{4} - i + \frac{1}{4} = \frac{1}{2} - i$

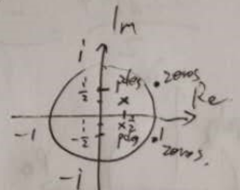
the amplitude is $|\frac{1}{2} - i| = \sqrt{\frac{1}{4} + 1} = \frac{\sqrt{5}}{2}$

Task 4: (1). $Y(z) = X(z) - 2X(z) z^{-1} + \frac{5}{4} X(z) z^{-2} + Y(z) z^{-1} - \frac{5}{16} Y(z) z^{-2}$

$H(z) = \frac{Y(z)}{X(z)} = \frac{1 - 2z^{-1} + \frac{5}{4} z^{-2}}{1 - z^{-1} + \frac{5}{16} z^{-2}} = \frac{z^2 - 2z + \frac{5}{4}}{z^2 - z + \frac{5}{16}}$

(2) zeros: $\frac{2 \pm \sqrt{4-5}}{2} = 1 \pm \frac{1}{2} i$

poles: $\frac{1 \pm \sqrt{1 - \frac{5}{4}}}{2} = \frac{1}{2} \pm \frac{1}{4} i$



(c) poles are in the unit circle, so the system is seable

Task 5. $H(z) = \sum_{k=-\infty}^{\infty} h(k) z^{-k} = \frac{1}{2} + z^{-1} + \frac{1}{2} z^{-2}$

$\omega = \frac{1}{8} 2\pi.$

$$H(e^{\omega i}) = \frac{1}{2} + e^{-\omega i} + \frac{1}{2} e^{-2\omega i}$$

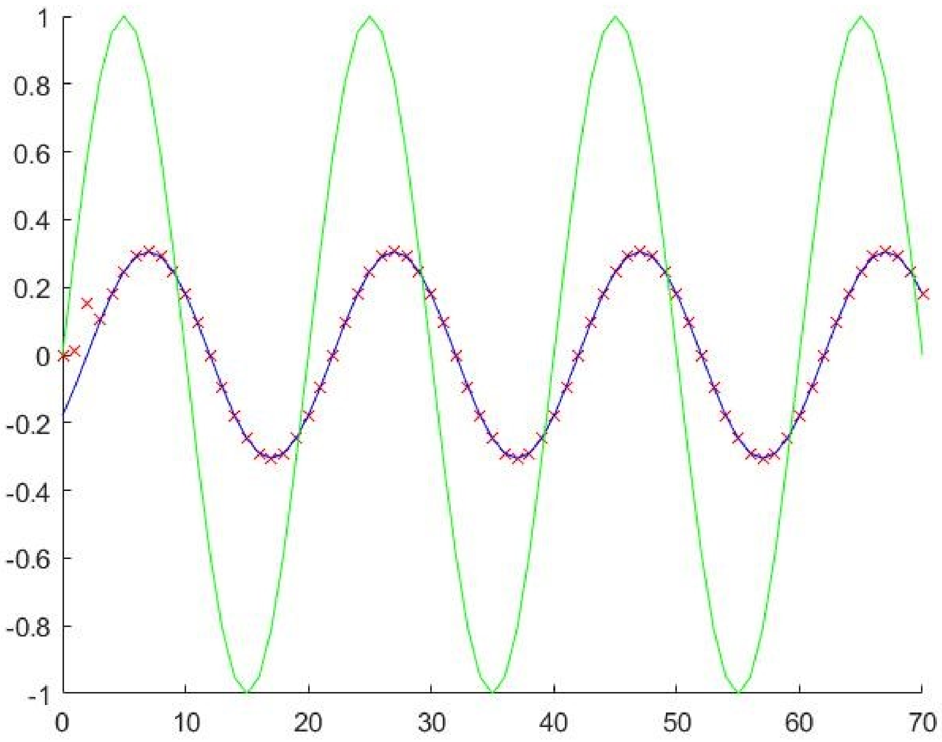
$$= \frac{1}{2} + \cos(\tfrac{1}{4}\pi) - \sin(\tfrac{\pi}{4}) i + \frac{1}{2}\left(\cos(\tfrac{\pi}{2}) - \sin(\tfrac{\pi}{2}) i\right)$$

$$= \frac{1+\sqrt{2}}{2} - \frac{\sqrt{2}+1}{2} i$$

Amplitude $= A = \sqrt{\left(\frac{1+\sqrt{2}}{2}\right)^2 + \left(\frac{1+\sqrt{2}}{2}\right)^2} = \frac{\sqrt{2}+2}{2}$

$\phi =$ phase $= \arctan\left(\frac{\left(-\frac{\sqrt{2}+1}{2}\right)}{\left(\frac{\sqrt{2}+1}{2}\right)}\right) = \arctan(-1) = -\frac{\pi}{4}.$

task6

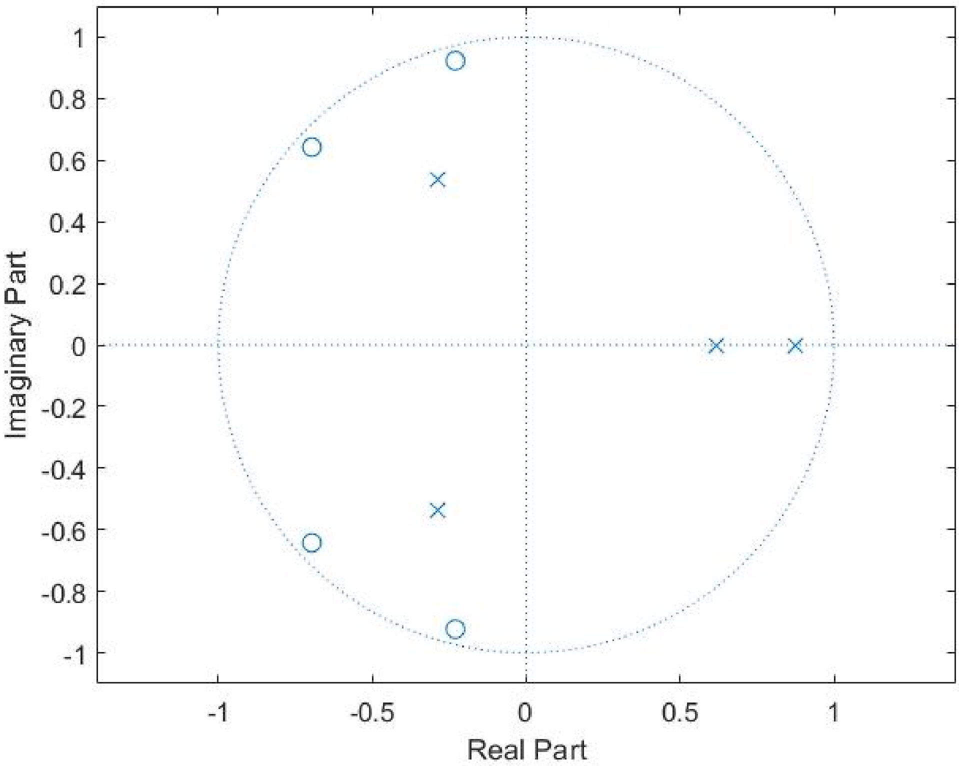


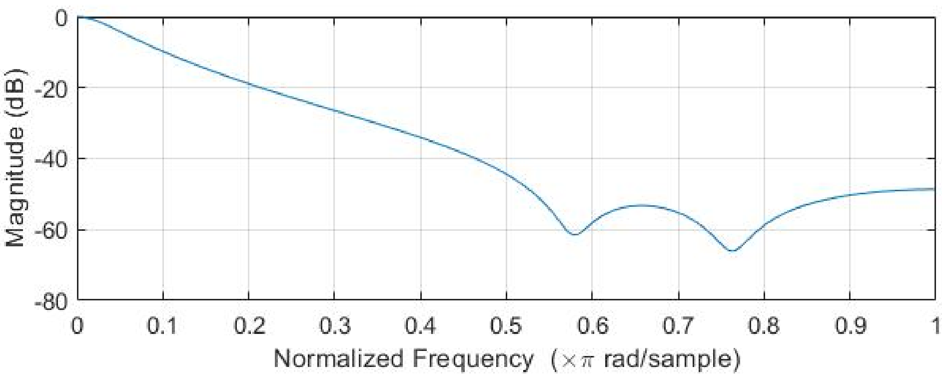
task7

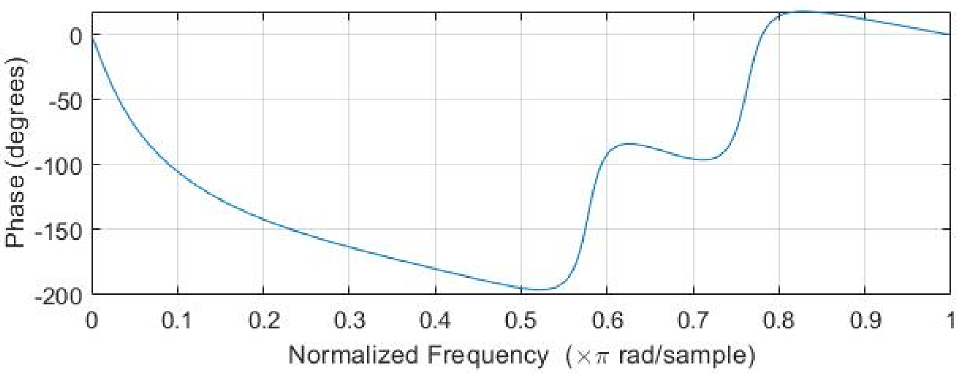
attenuation =

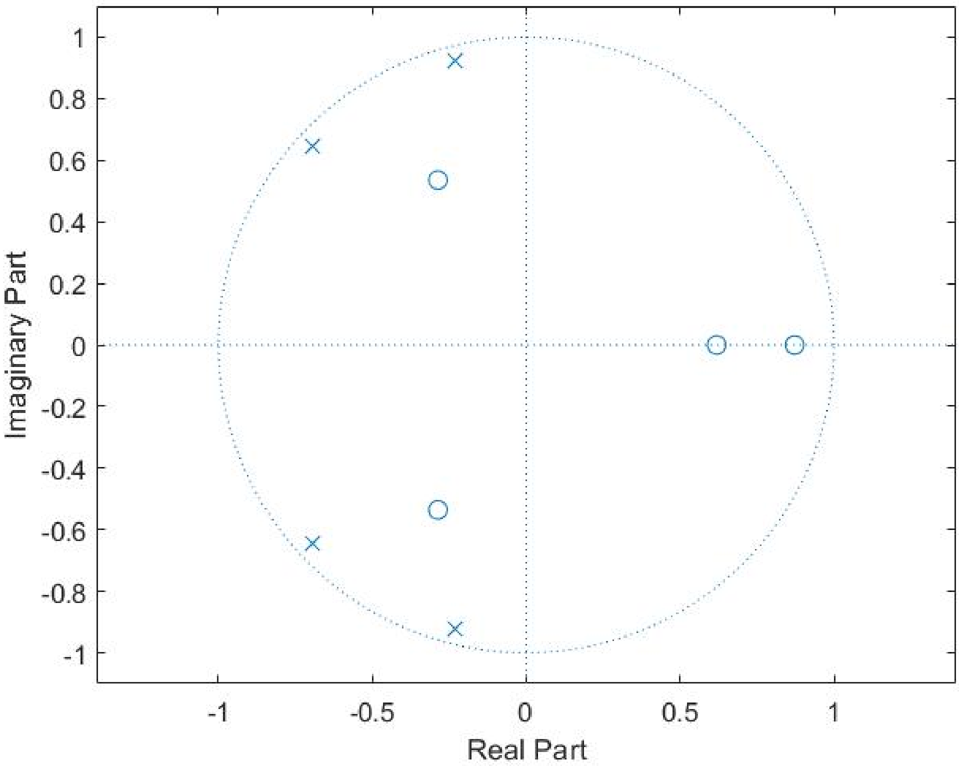
-22.5399

task8

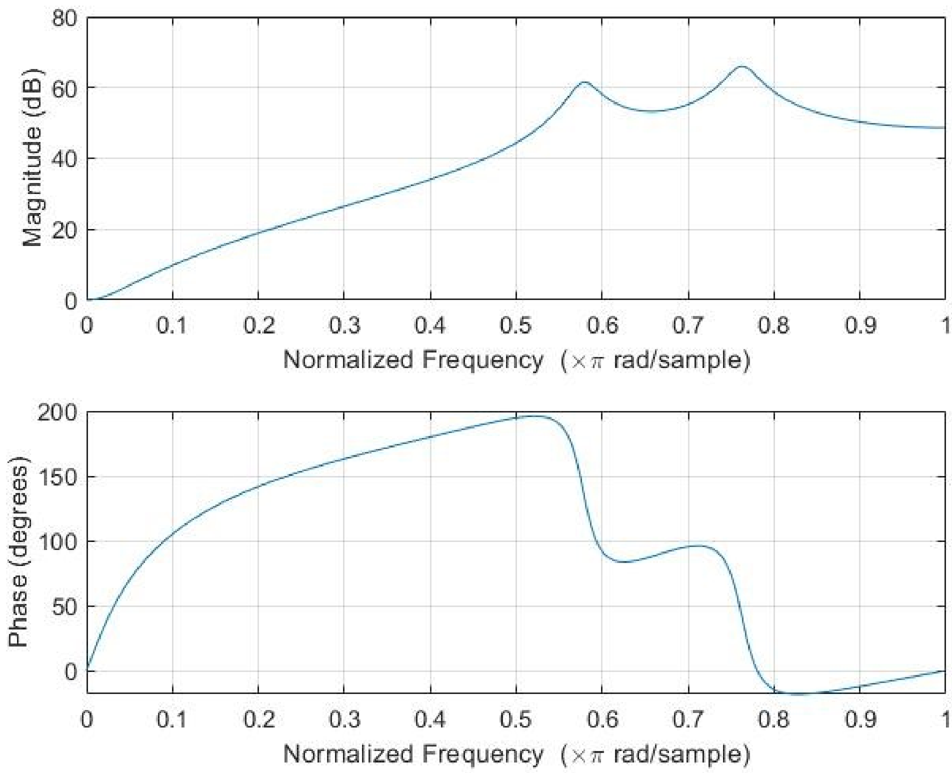

Imaginary Part
Real Part


Magnitude (dB)
Normalized Frequency (×π rad/sample)

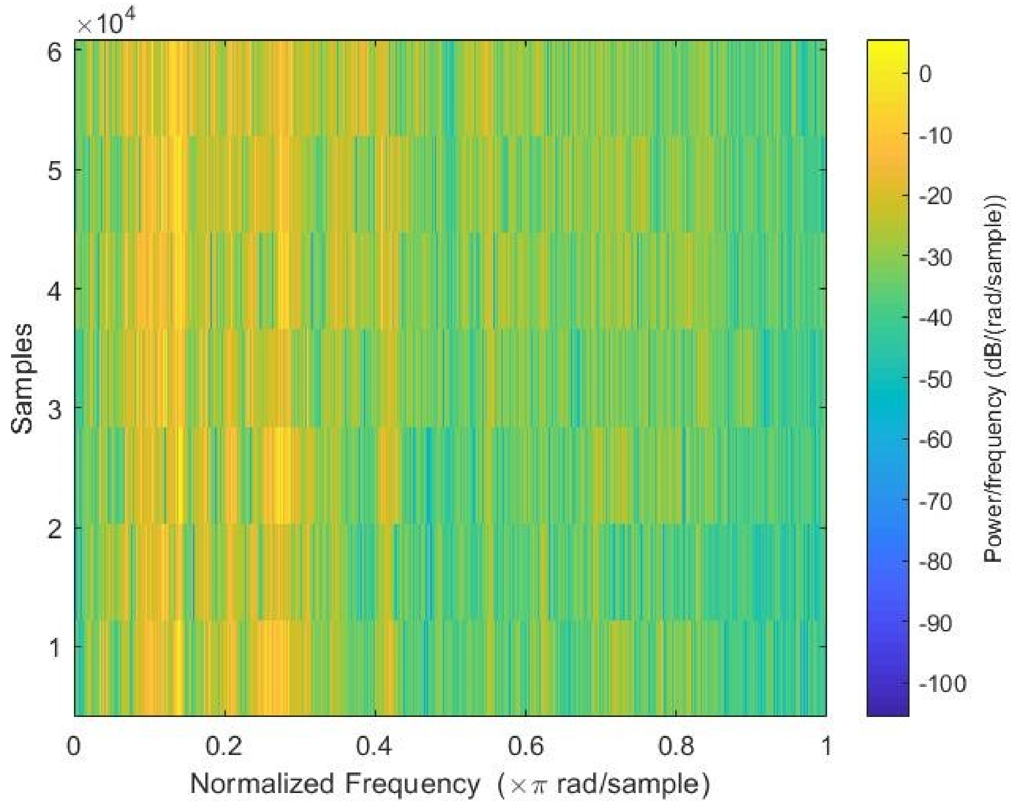

Phase (degrees)
Normalized Frequency (×π rad/sample)

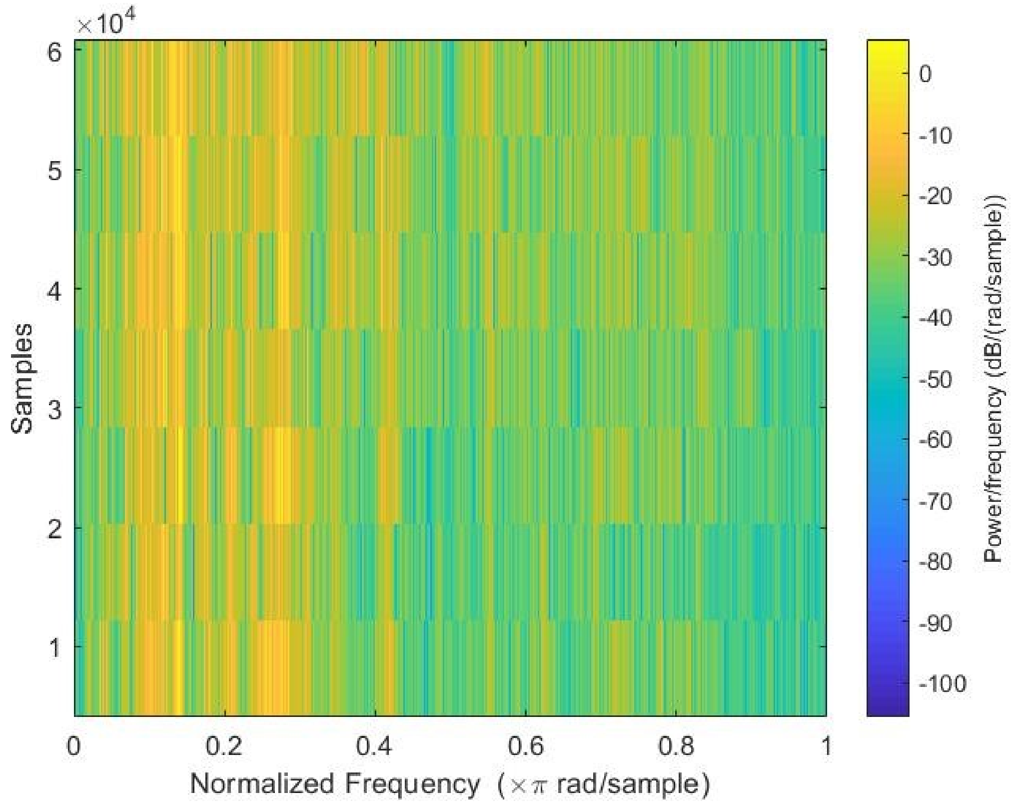


Imaginary Part
Real Part
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1
-0.5
0
0.5
1



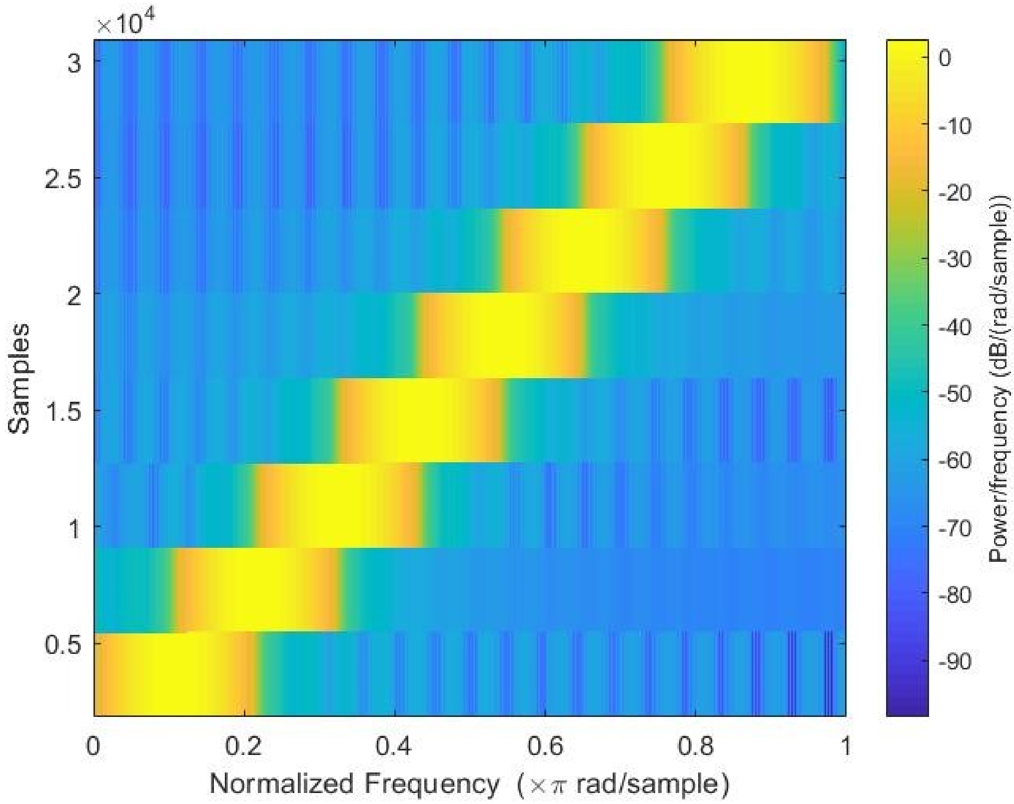
Magnitude (dB)
80
60
40
20
0
Normalized Frequency (×π rad/sample)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Phase (degrees)
200
150
100
50
0
Normalized Frequency (×π rad/sample)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

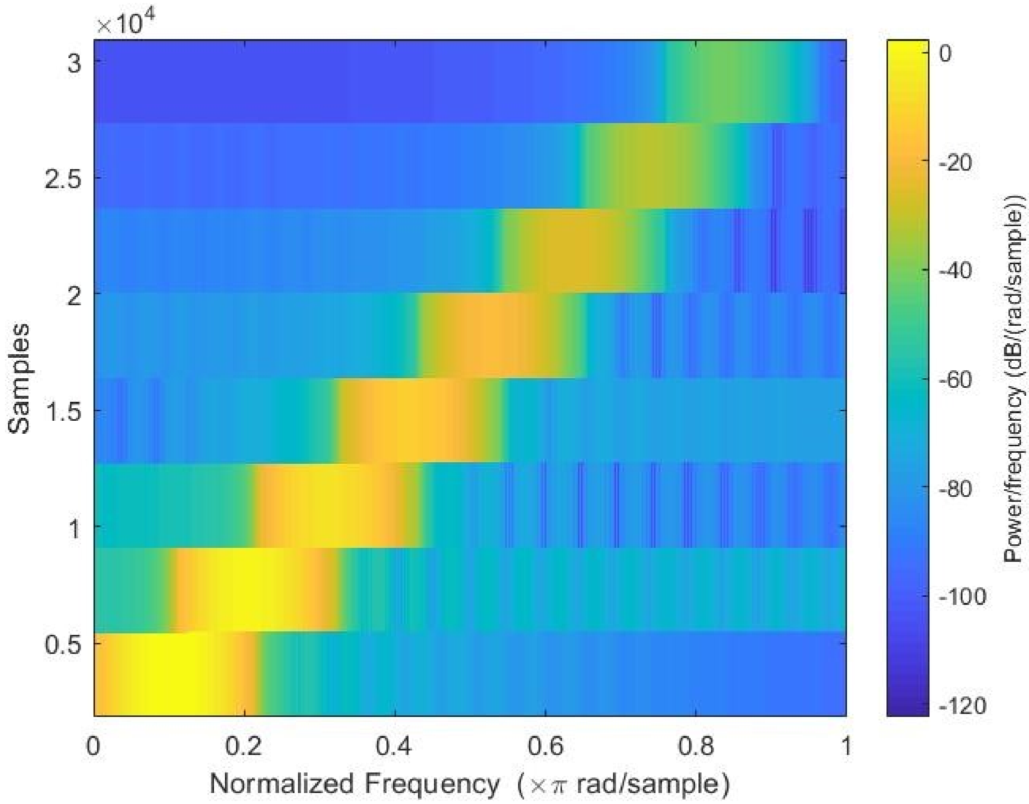




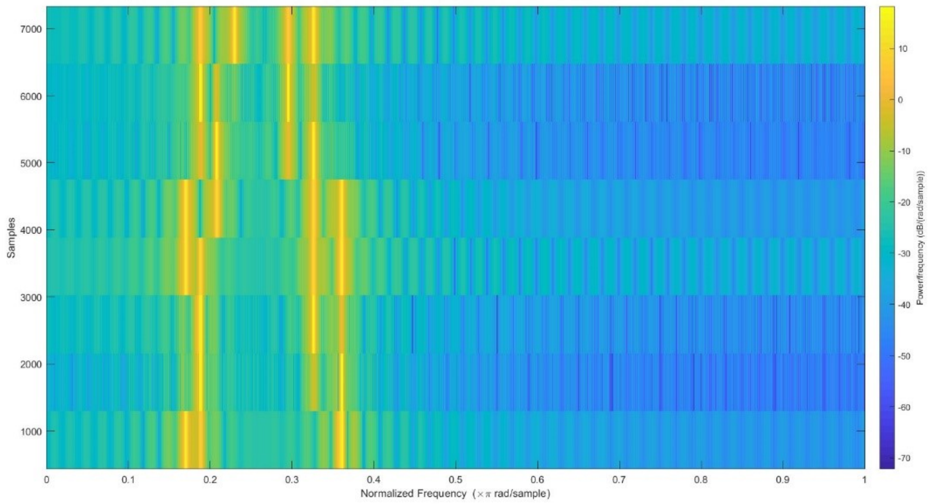
They are similar.

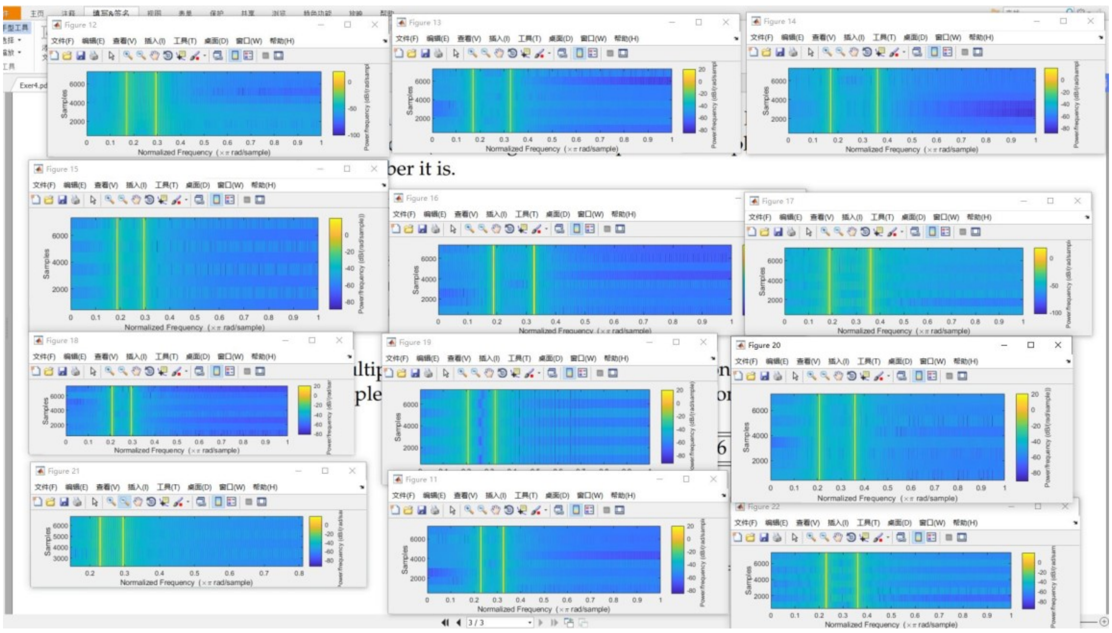
task 9


×10^4
3
2.5
2
1.5
1
0.5
Samples
0
0.2
0.4
0.6
0.8
1
Normalized Frequency (×π rad/sample)
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
Power/frequency (dB/(rad/sample))


×10^4
3
2.5
2
1.5
1
0.5
Samples
0
0.2
0.4
0.6
0.8
1
Normalized Frequency (×π rad/sample)
0
-20
-40
-60
-80
-100
-120
Power/frequency (dB/(rad/sample))

task 10





after check with figure(10),the number is 36533840
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