# Lab 4 Report

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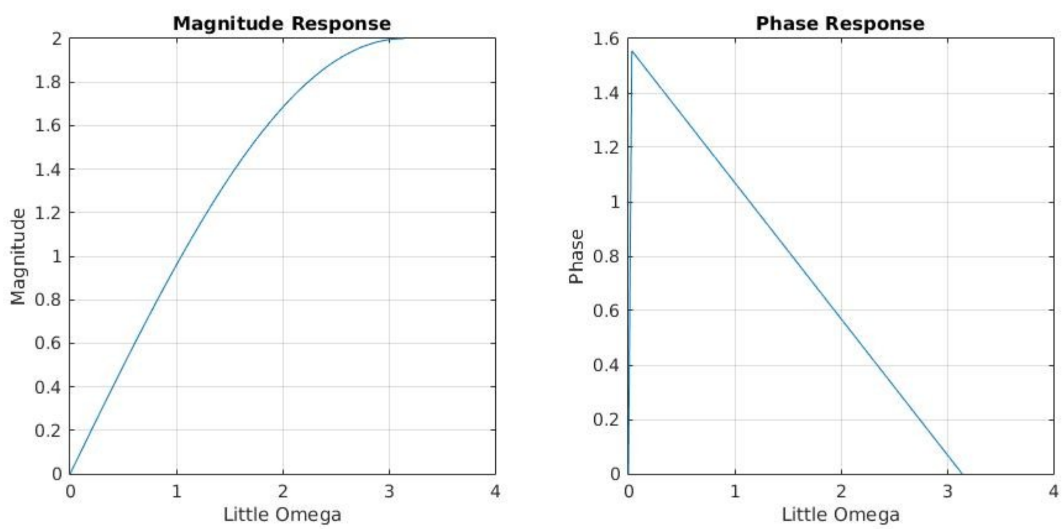
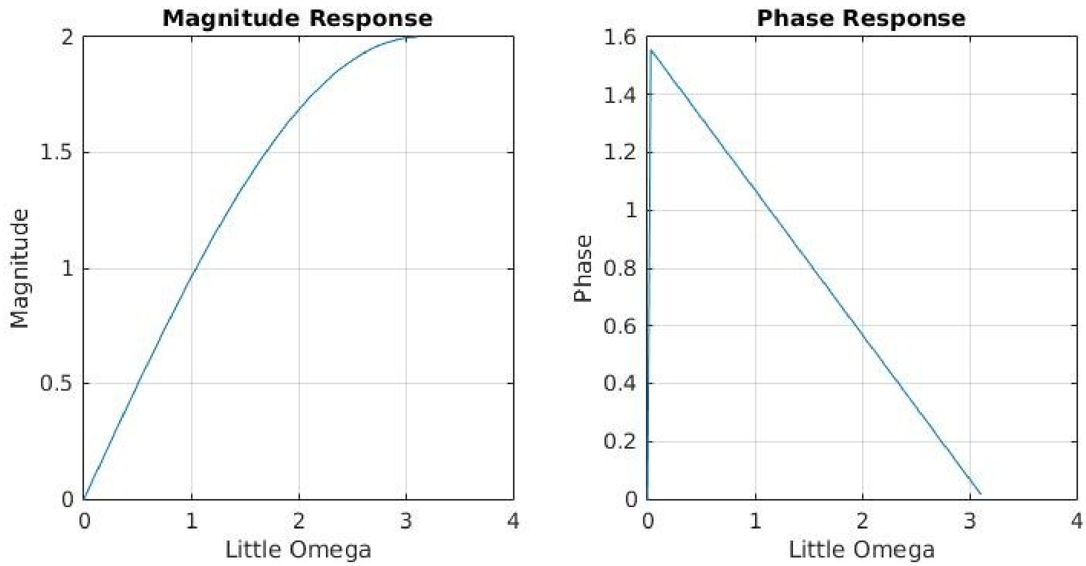
- Report item 0

  1. [h,w] = freqz(b,a,n) returns the n-point frequency response vector, h, and the corresponding angular frequency vector, w, for the digital filter with numerator and denominator polynomial coefficients stored in b and a, respectively.It takes in 3 arguments b - numerator coefficients in the transfer function, a - denominator coefficient in the transfer function, n - the number of evaluation points that we desire between 0 and pi. The output is the frequency response.

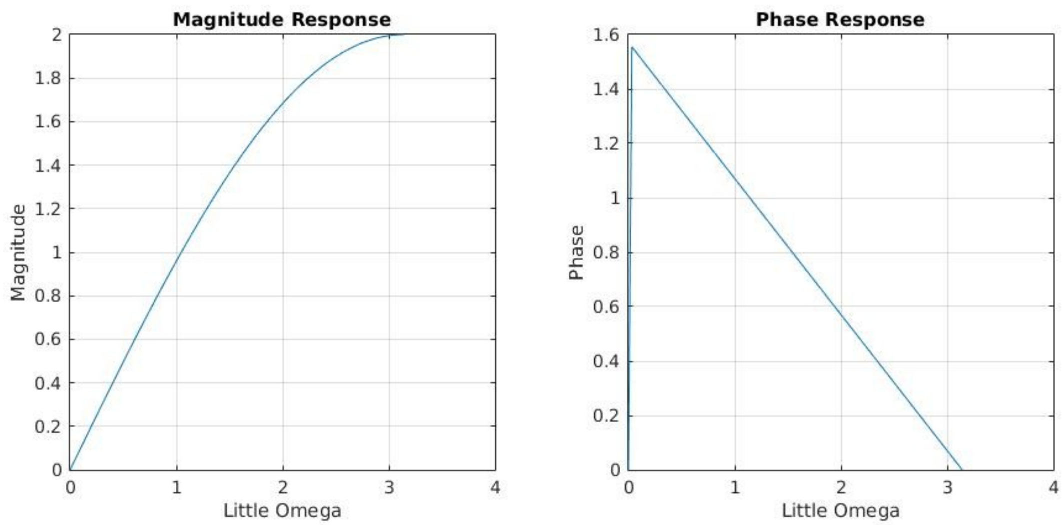
  2 . The first file approaches using z-transform to DFT, and the second file approaches using DTFT.





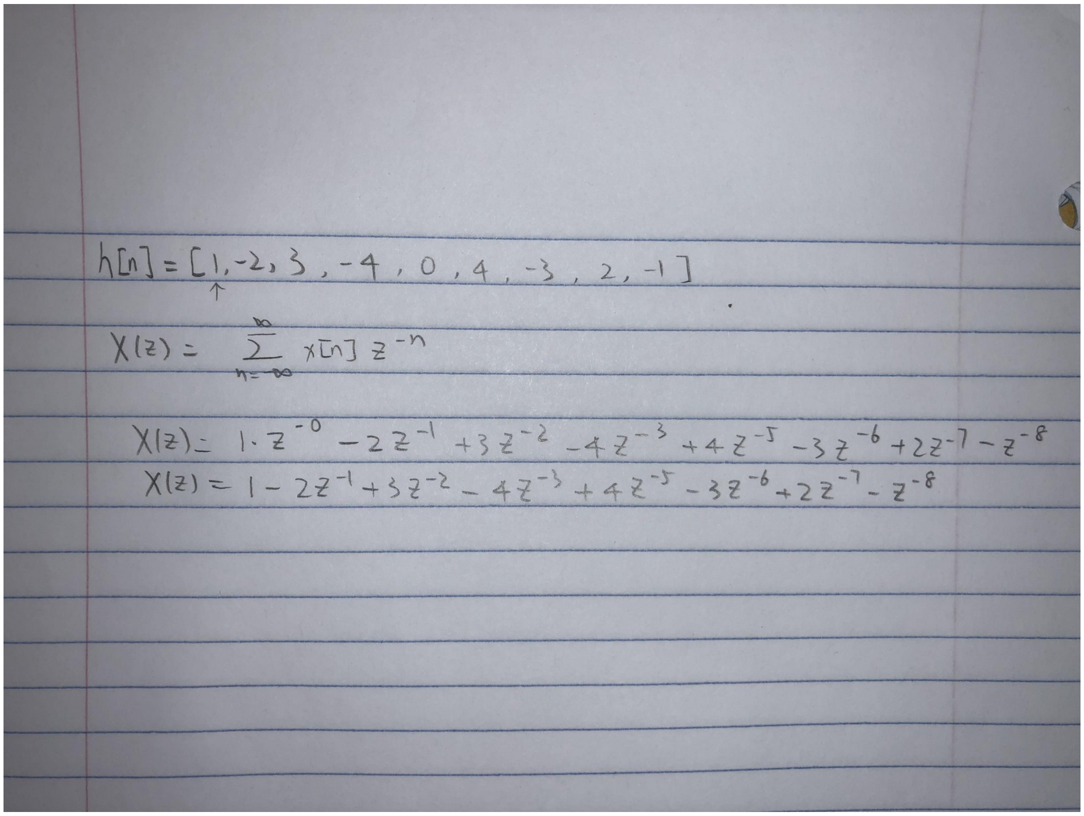

3. The two figure look the same. But for the w > 3.1102, the first figure miss this part. The reason is that for the first program, the ff only goes till 3.1102, so the plot is end when w = 3.1102.

4.




5. P = angle(Z) returns the phase angles, in radians, for each element of complex array Z. The angles lie between ±π.
Y = phase(X) returns the phase angles of a signal, in radians, the phase lie between -infinite to +infinite.

- Report item 1
  (1).



$$h[n] = [\underset{\uparrow}{1}, -2, 3, -4, 0, 4, -3, 2, -1]$$

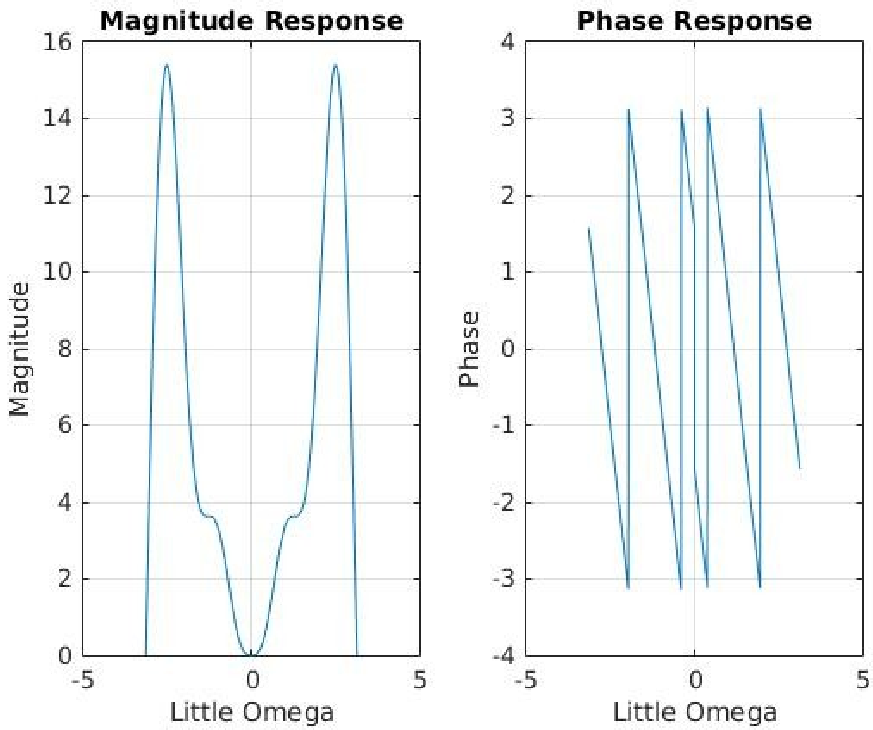
$$X(z) = \sum_{n=-\infty}^{\infty} x[n] z^{-n}$$

$$X(z) = 1 \cdot z^{-0} - 2z^{-1} + 3z^{-2} - 4z^{-3} + 4z^{-5} - 3z^{-6} + 2z^{-7} - z^{-8}$$

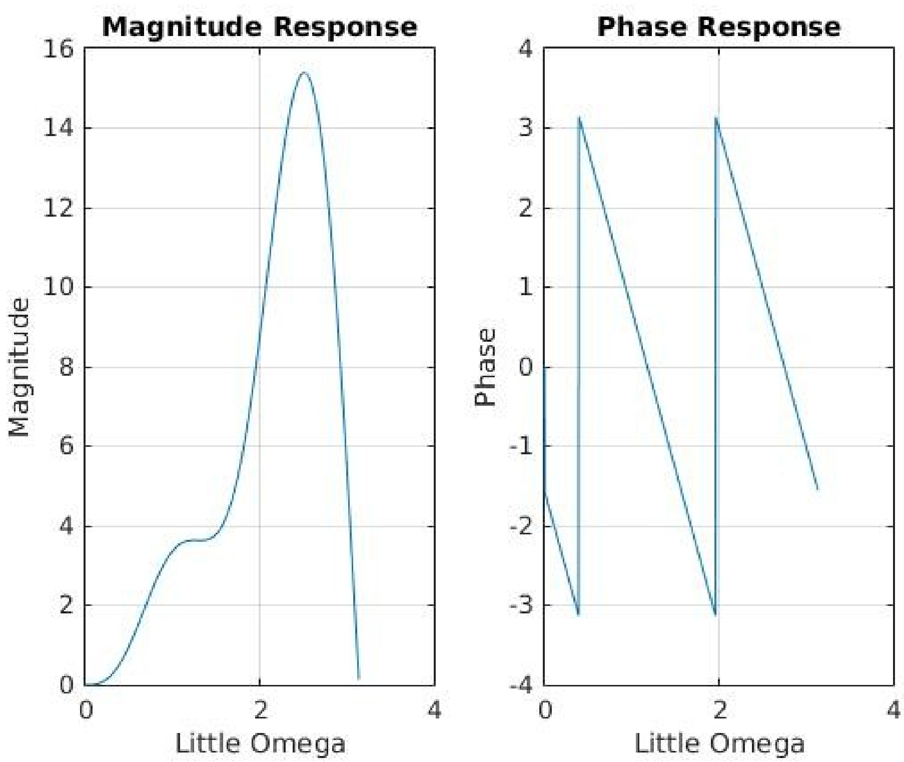
$$X(z) = 1 - 2z^{-1} + 3z^{-2} - 4z^{-3} + 4z^{-5} - 3z^{-6} + 2z^{-7} - z^{-8}$$

H(z) = 1 - 2z-1 + 3z-2 - 4z-3 + 4z-4 - 3z-6 + 2z-7 - z-8
Hd(ω) = 1 − 2e^(−jω) + 3e^(−2jω) − 4e^(−3jω) + 4e^(−4jω) − 3e^(−6jω) + 2e^(−7jω) − e^(−8jω)

(2).


Magnitude Response
Phase Response
Magnitude
Phase
Little Omega
Little Omega

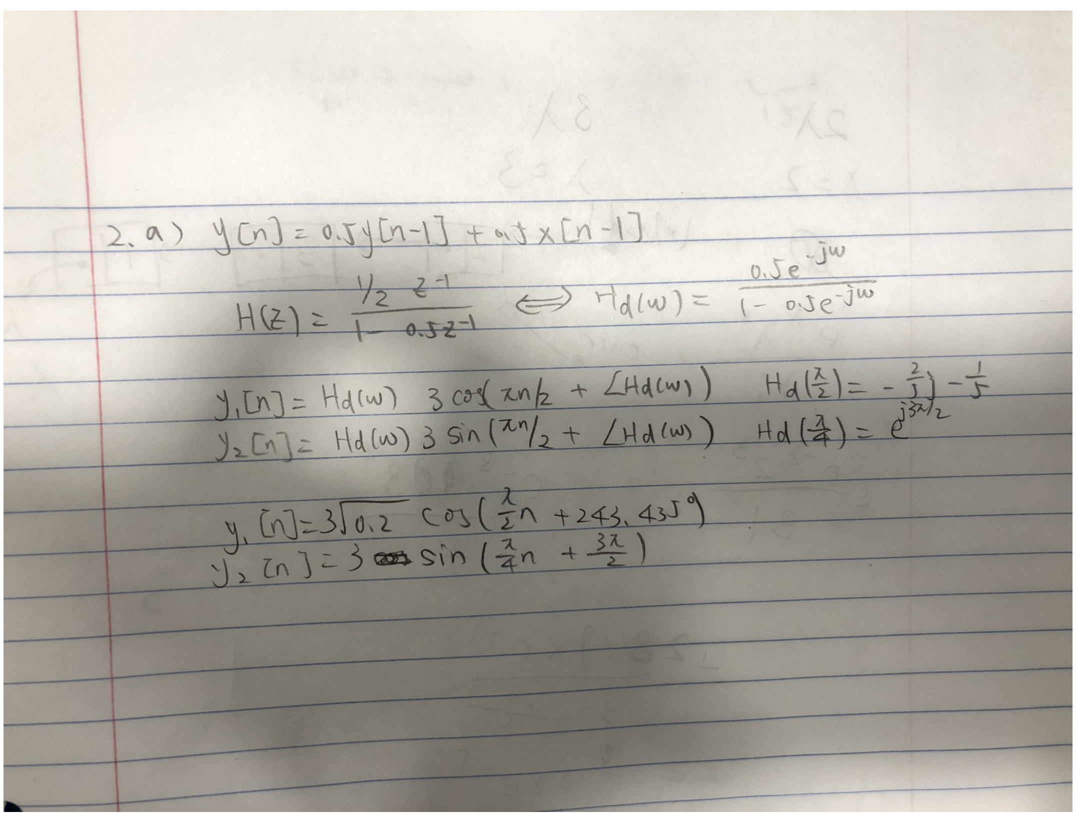
(3).


Magnitude Response
Phase Response
Magnitude
Phase
Little Omega
Little Omega

The responses are the same. The freq() are wrapped between -pi and pi, but looks like the same as (3).

- Report Item 2

(1)



2. a) $y[n] = 0.5y[n-1] + 0.5x[n-1]$

$$H(z) = \frac{\frac{1}{2} z^{-1}}{1 - 0.5z^{-1}} \Longleftrightarrow H_d(w) = \frac{0.5e^{-jw}}{1 - 0.5e^{-jw}}$$

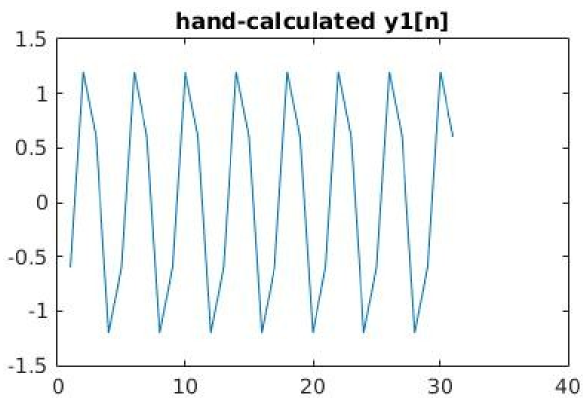
$$y_1[n] = H_d(w)\, 3\cos(\pi n/2 + \angle H_d(w)) \qquad H_d(\tfrac{\pi}{2}) = -\tfrac{2}{5}j - \tfrac{1}{5}$$

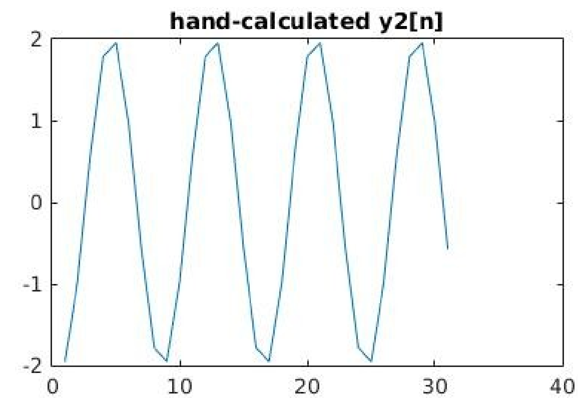
$$y_2[n] = H_d(w)\, 3\sin(\pi n/2 + \angle H_d(w)) \qquad H_d(\tfrac{\pi}{4}) = e^{j3\pi/2}$$

$$y_1[n] = 3\sqrt{0.2}\cos(\tfrac{\pi}{2}n + 243.435°)$$

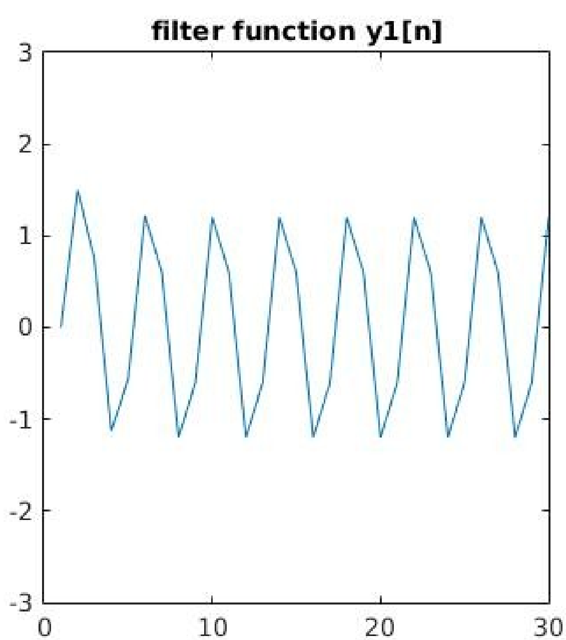
$$y_2[n] = 3\sin(\tfrac{\pi}{4}n + \tfrac{3\pi}{2})$$

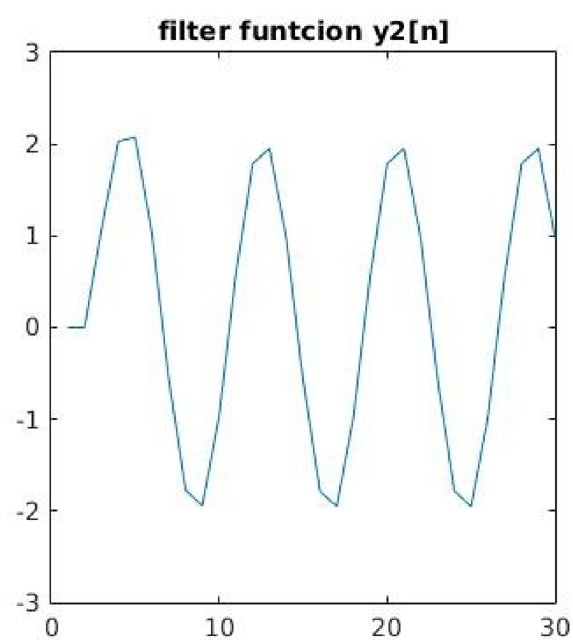
(2)


hand-calculated y1[n]

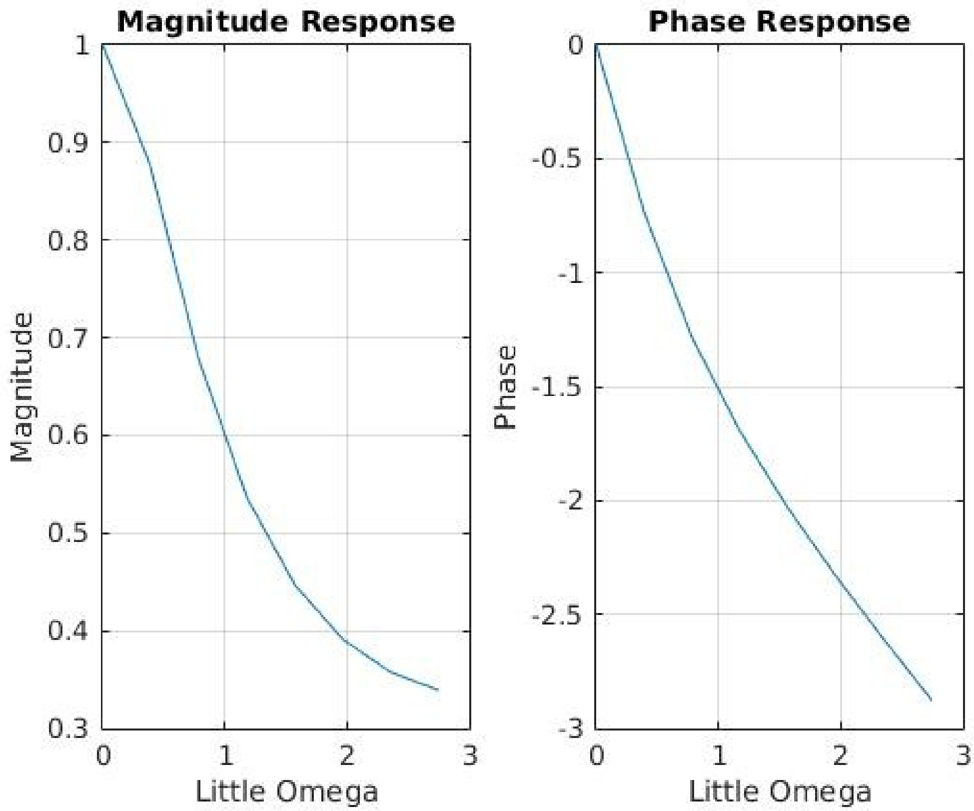

hand-calculated y2[n]

(3)


filter function y1[n]

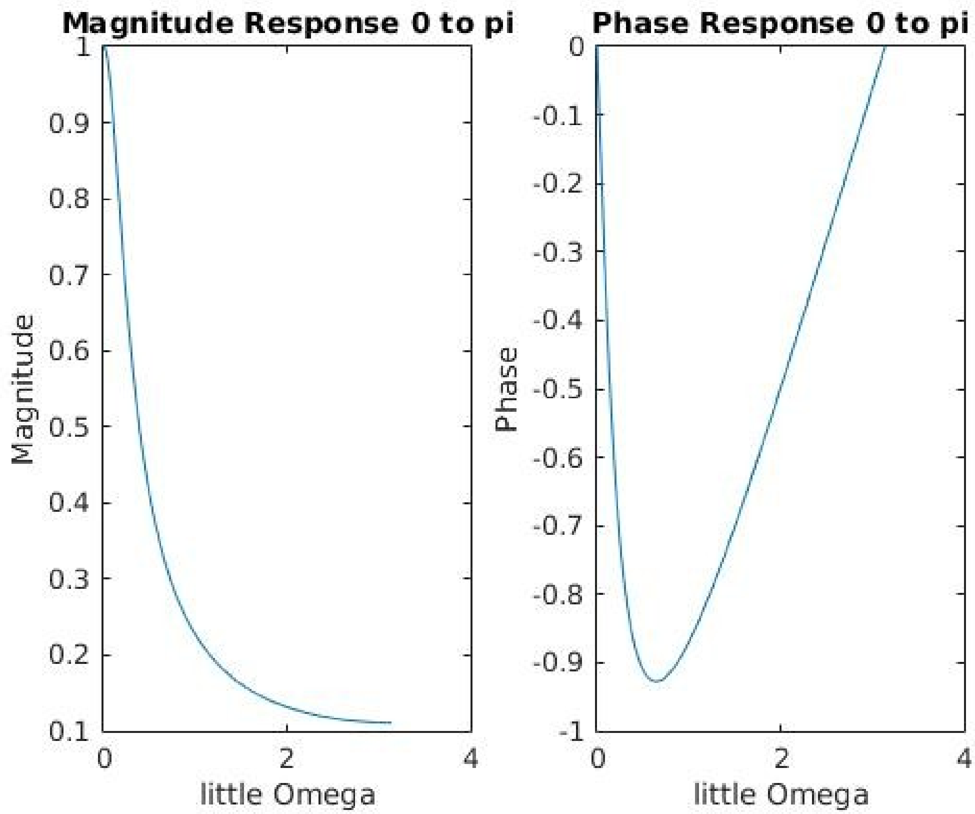

filter funtcion y2[n]

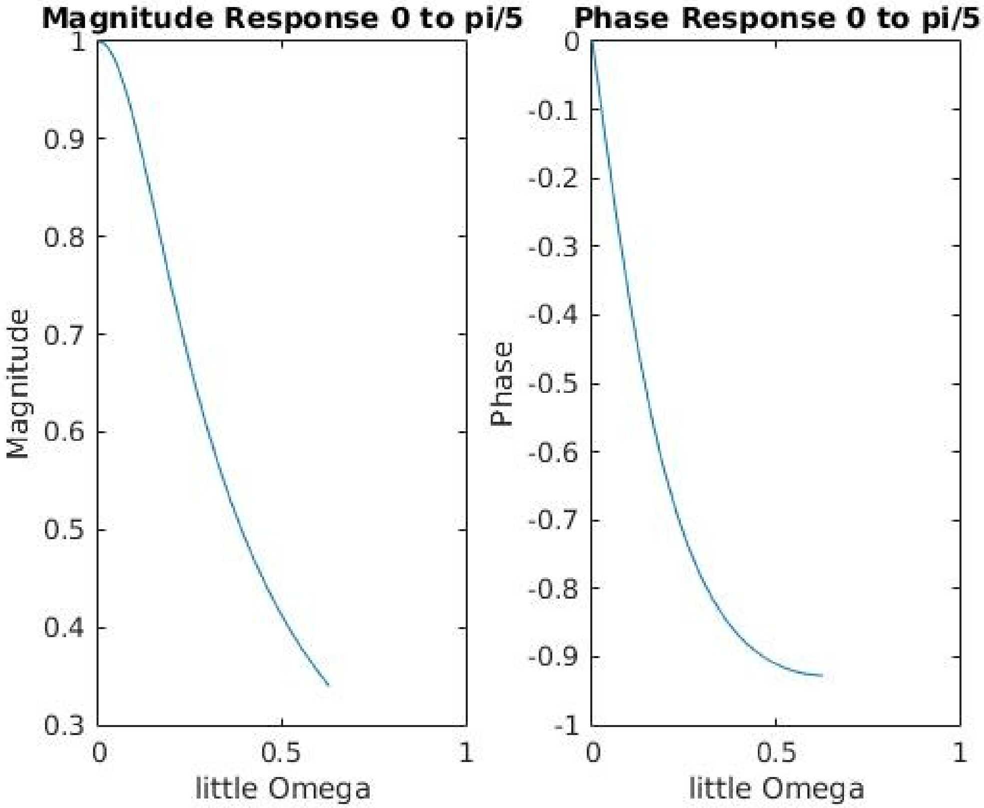
(4)



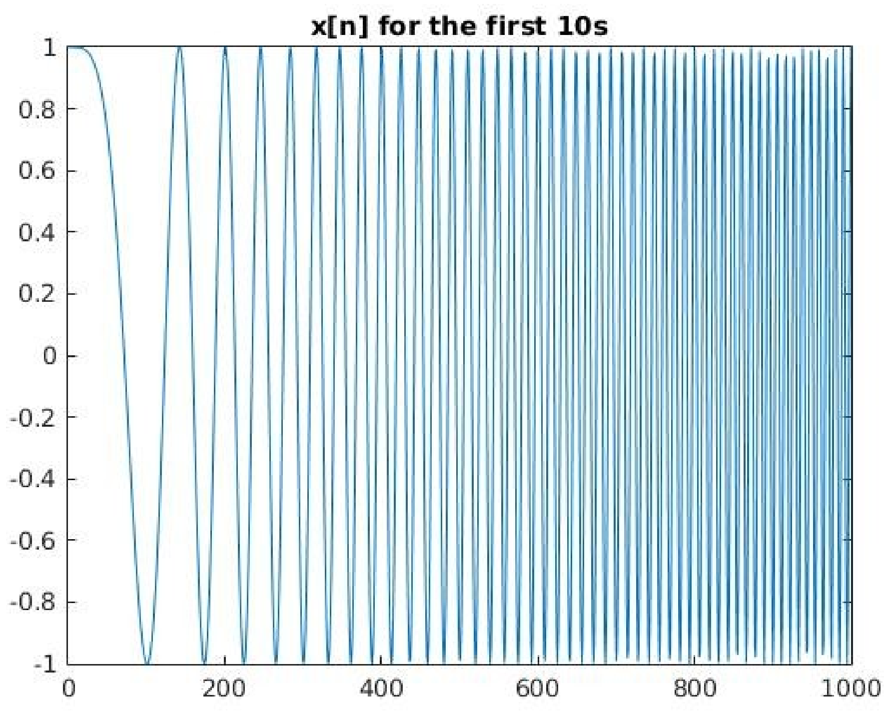

(5). (2) and (3) are different. They have the same shape but looks like both y1[n] and y2[n] computed from hand is shifted right relative to those from filter function.

- Report Item 3
  (1)

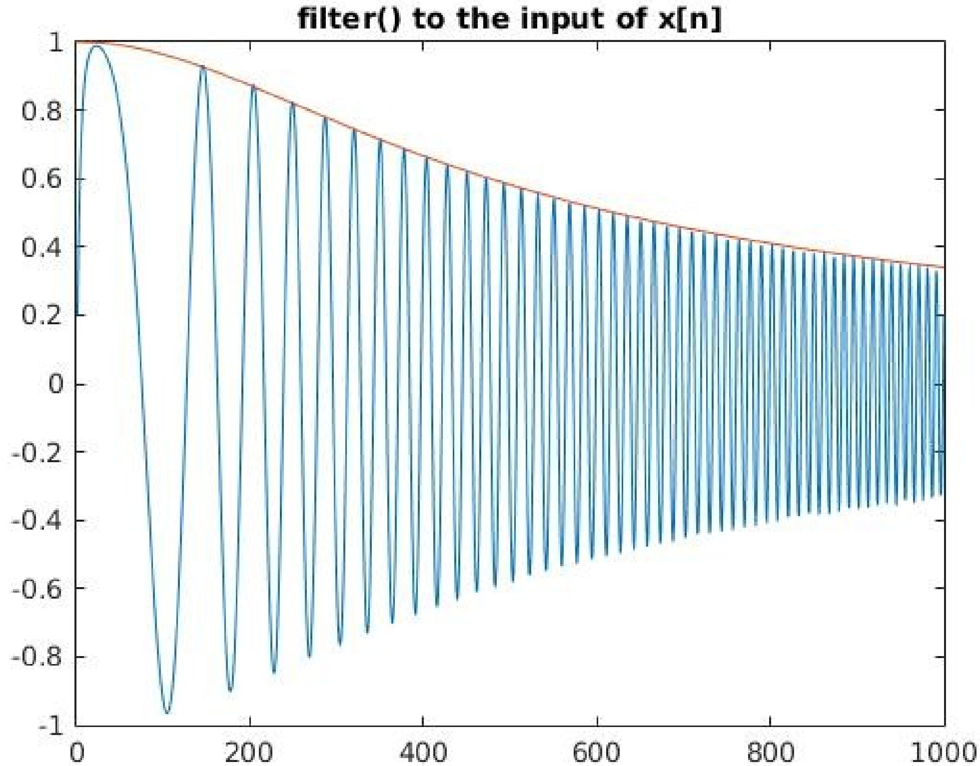

Magnitude Response 0 to pi
Magnitude
little Omega
Phase Response 0 to pi
Phase
little Omega


Magnitude Response 0 to pi/5
Phase Response 0 to pi/5
Magnitude
Phase
little Omega
little Omega
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
-1
0
0.5
1

(2)

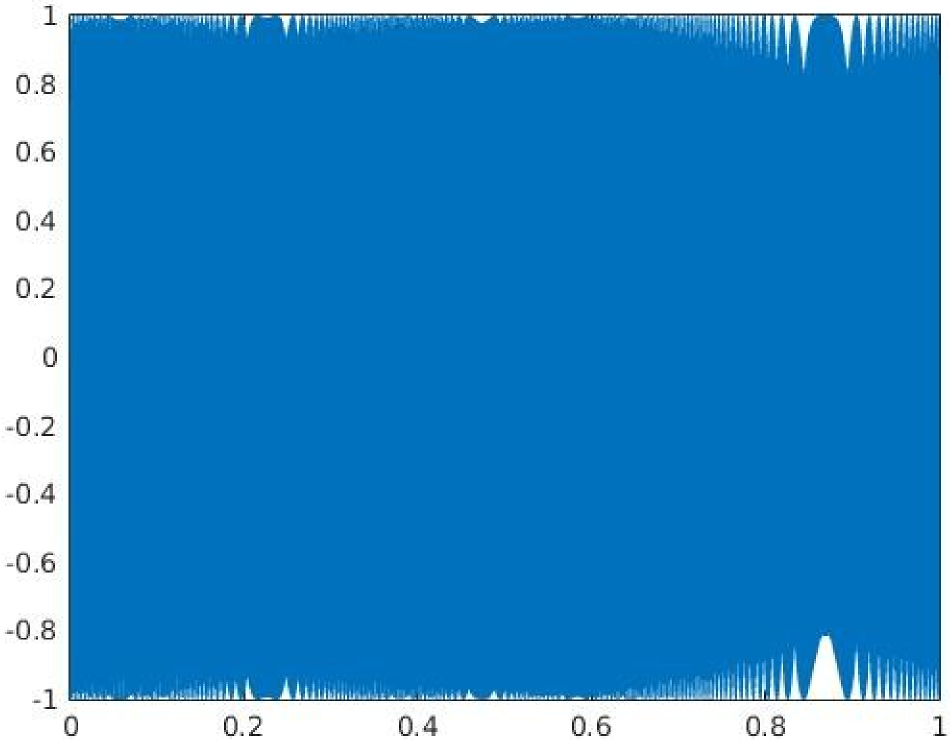

x[n] for the first 10s
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
0
200
400
600
800
1000

(3).




Each instantaneous frequency at time sample n is equal to the frequency at index n of the frequency response, making this valid.

- Report Item 4



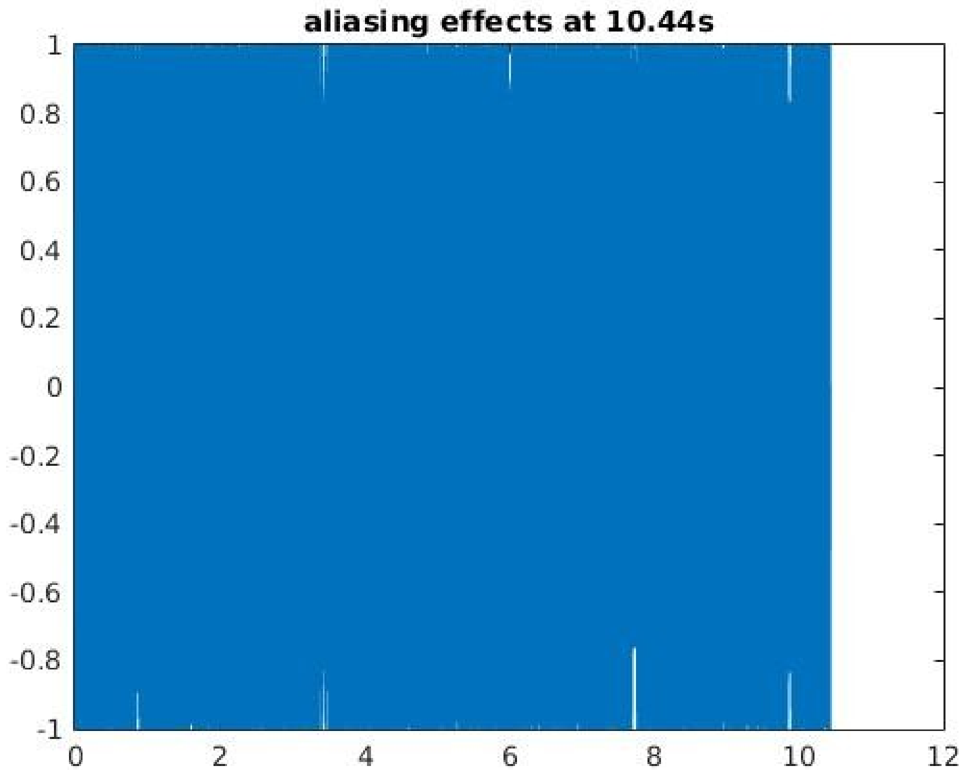

(2).I heard a high frequency increasing in pitch

(3).

$$\Omega_{inst} = \Omega_0 + \beta t \Rightarrow \Omega_{inst} = 2\pi \cdot 3000 + 2000t$$

$$\Omega_{inst} = 8192\pi \Rightarrow t = 3.44S$$

(4).




I hear some decreasing frequencies.