Matlab HW3

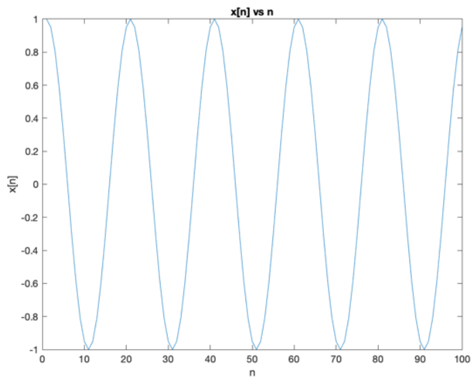
電機二 張甡源(B11901123)

4/28/2024

1. Result

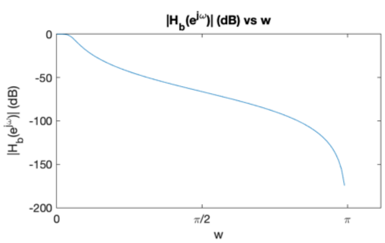
Part I

(a)

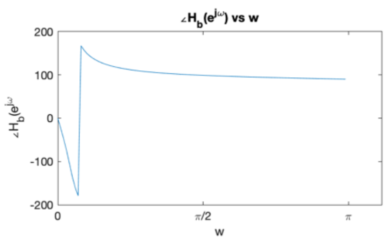


$x[n]$ vs n

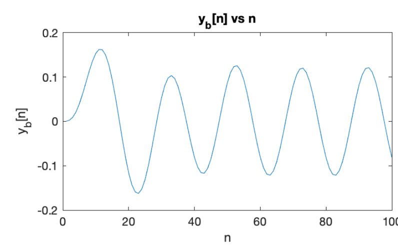
(b)



$\left|H_b(e^{j\omega})\right|$ vs ω



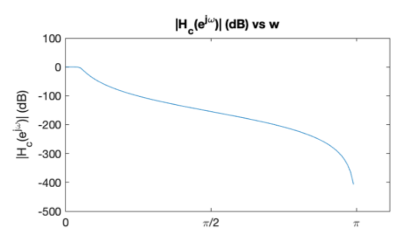
$\angle H_b(e^{j\omega})$ vs ω



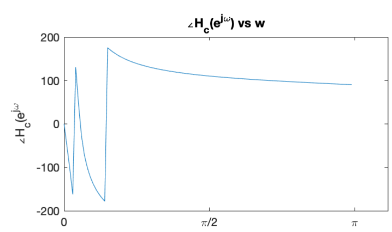
$y_b[\mathrm{n}]$ vs n

$$H_b(e^{j\omega}) = \frac{0.0004 + 0.0012e^{-j\omega} + 0.0012e^{-2j\omega} + 0.0004e^{-3j\omega}}{1 - 2.6862e^{-j\omega} + 2.4197e^{-2j\omega} - 0.7302e^{-3j\omega}}$$

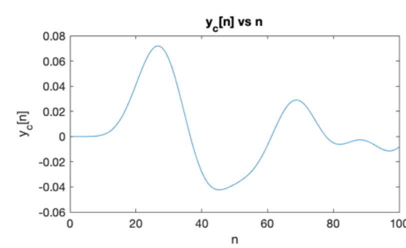
(c)



$\left|H_c(e^{j\omega})\right|$ vs ω



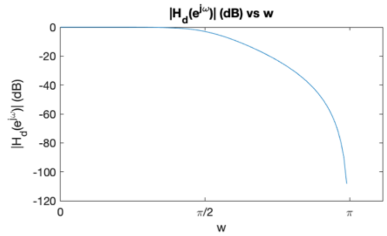
$\angle H_c(e^{j\omega})$ vs ω



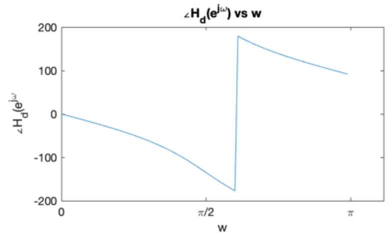
$y_c[\mathrm{n}]$ vs n

$$H_c(e^{j\omega}) = 10^{-6}\frac{0.0131 + 0.0919e^{-j\omega} + 0.2758e^{-2j\omega} + 0.4597e^{-3j\omega} + 0.4597e^{-4j\omega} + 0.2758e^{-5j\omega} + 0.0919e^{-6j\omega} + 0.0131e^{-7j\omega}}{1 - 6.2942e^{-j\omega} + 17.0111e^{-2j\omega} - 25.5884e^{-3j\omega} + 23.1343e^{-4j\omega} - 12.5702e^{-5j\omega} + 3.8005e^{-6j\omega} - 0.4932e^{-7j\omega}}$$

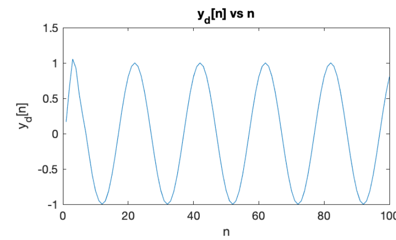
(d)



$\left|H_d(e^{j\omega})\right|$ vs ω



$\angle H_d(e^{j\omega})$ vs ω



y_d[n] vs n

$$H_d(e^{j\omega}) = \frac{0.1667 + 0.5e^{-j\omega} + 0.5e^{-2j\omega} + 0.1667e^{-3j\omega}}{1 + 0.3333e^{-2j\omega}}$$

(e) <u>The effect of increasing L:</u>

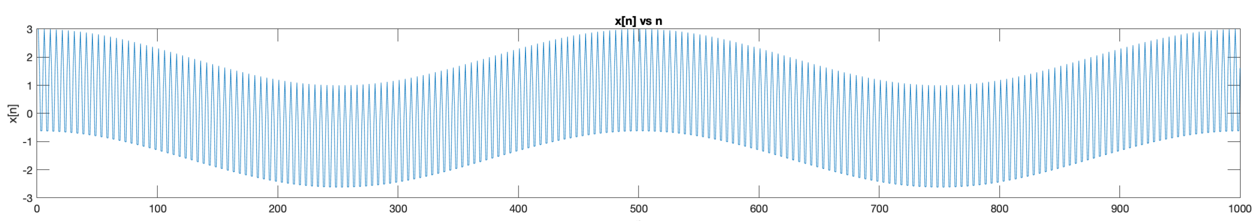
By comparing the plots of questions (b) and (c), we can see that the higher the L, the faster the amplitude response decays after the cutoff frequency.
Another effect of increasing L is the difference in signal delay. By looking at the slope in the phase response plot, we observe that the phase changes more drastically within the transition band, while there is not much difference at the higher frequencies. We can also find that the output signal in (c) differs more significantly to the original signal $x[n]$, whereas the output signal in (b) is much more similar to the original signal $x[n]$.

<u>The effect of increasing f_c:</u>

Increasing f_c allows higher frequencies to pass through the filter. We can see that the original signal $x[n]$ is suppressed in (b) due to the small f_c. When we increase f_c, the signal $x[n]$ can pass through the filter, so the output signal in (d) is almost equivalent to the input $x[n]$.

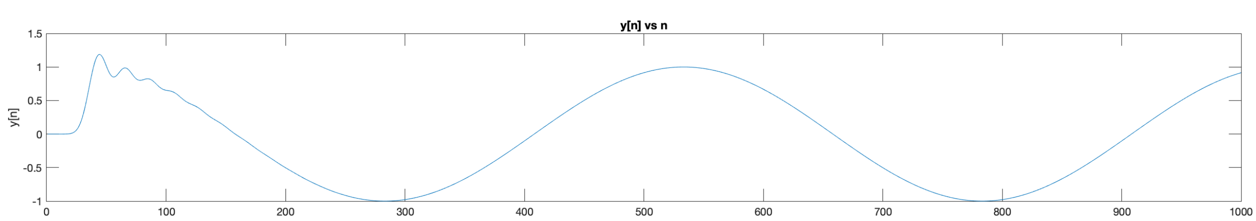
Part II

(a)



$x[n]$ vs n

(b)



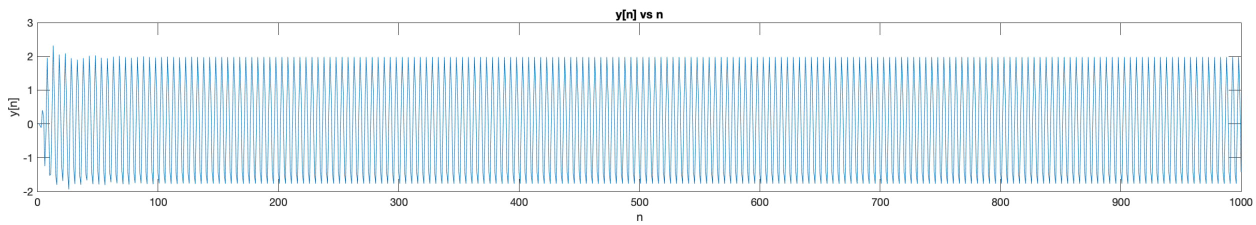
$y[n]$ vs n

- Cutoff Frequency $f_c = 0.15$

- $H(e^{j\omega}) = \frac{\sum_{i=0}^{16} b_i e^{-ij\omega}}{\sum_{i=0}^{16} a_i e^{-ij\omega}}$, with values of a_i and b_i showed below.

k	b_k ($\times 10^{-6}$)	a_k ($\times 10^{3}$)	k	b_k ($\times 10^{-6}$)	a_k ($\times 10^{3}$)
0	0.0000	0.0010	9	0.1222	-0.6114
1	0.0002	-0.0112	10	0.0855	0.3195
2	0.0013	0.0593	11	0.0467	-0.1308
3	0.0060	-0.1970	12	0.0194	0.0411
4	0.0194	0.4596	13	0.0060	-0.0096
5	0.0467	-0.7978	14	0.0013	0.0016
6	0.0855	1.0653	15	0.0002	-0.0002
7	0.1222	-1.1160	16	0.0000	0.0000
8	0.1375	0.9264			

(c)



$y[n]$ vs n

- Bandpass frequency $f_c = [0.15, 0.5]$.

- Transfer Function $H(e^{j\omega}) = \frac{\sum_{i=0}^{32} b_i e^{-ij\omega}}{\sum_{i=0}^{32} a_i e^{-ij\omega}}$, with values of a_i and b_i showed below.

k	b_k	a_k ($\times 10^{4}$)	k	b_k	a_k ($\times 10^{4}$)
0	0	0.0001	17	0	-1.2820
1	0	-0.0013	18	-0.0110	0.7719
2	0	0.0082	19	0	-0.4240
3	0	-0.0350	20	0.0077	0.2120
4	0.0001	0.1129	21	0	-0.0962
5	0	-0.2926	22	-0.0042	0.0394
6	-0.0005	0.6330	23	0	-0.0145
7	0	-1.1735	24	0.0018	0.0048
8	0.0018	1.8994	25	0	-0.0014
9	0	-2.7200	26	-0.0005	0.003
10	-0.0042	3.4806	27	0	-0.0001
11	0	-4.0092	28	0.0001	0
12	0.0077	4.1801	29	0	0
13	0	-3.9611	30	0	0
14	-0.0110	3.4212	31	0	0

15	0	-2.6983	32	0	0
16	0.0124	1.9452			