EE-2011 2024 SPRING

信號與系統 Signals and Systems

Mat-Lab HW3

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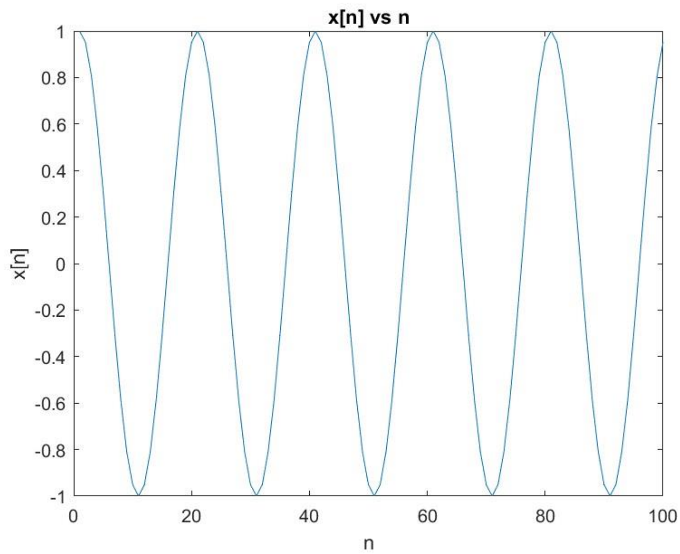
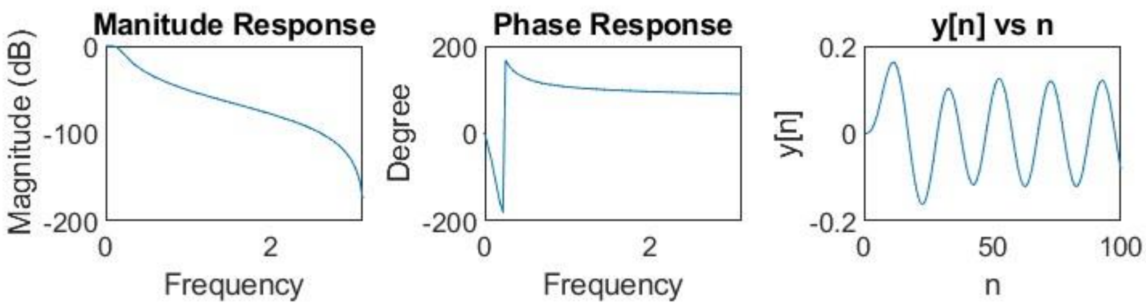
Part I

(a)

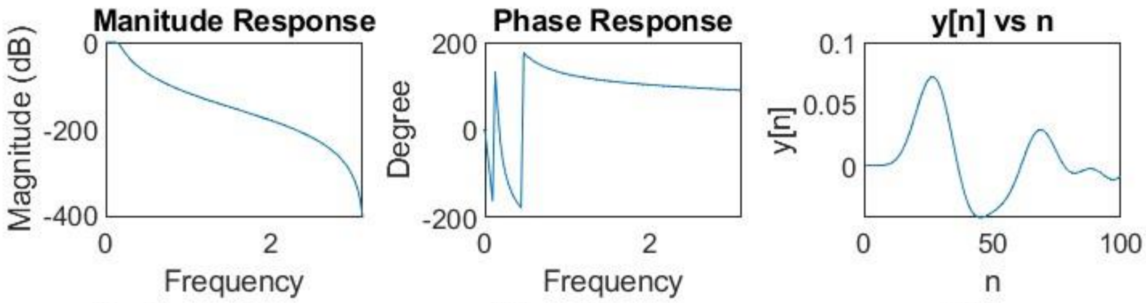


(b)(c)(d) plots

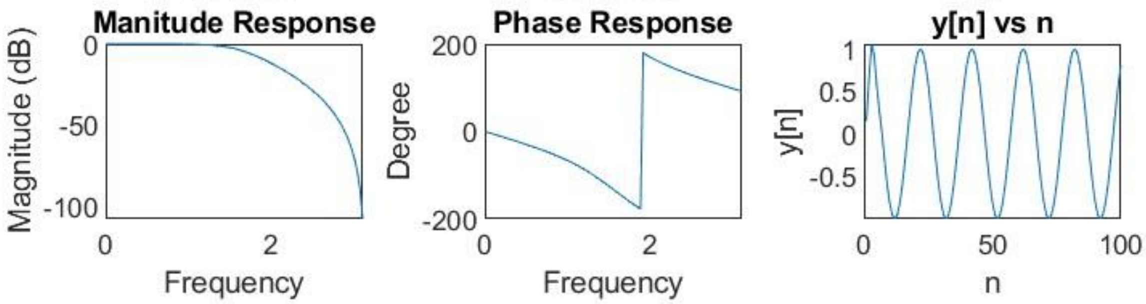
(b)



(c)



(d)



Transfer functions:

(b) L = 3/fc = 0.05

k	1	2	3	4
a_k	1.0000	-2.6862	2.4197	-0.7302
b_k	4.1655e-04	0.0012	0.0012	4.1655e-04

$$H(e^{jw}) = \frac{\sum_{k=1}^{4} b_k e^{-j(k-1)w}}{\sum_{k=1}^{4} a_k e^{-j(k-1)w}}$$

(c) L = 7/fc = 0.05

k	1	2	3	4	5	6	7	8
a_k	1.0000	-6.2942	17.0111	-25.5884	23.1343	-12.5702	3.8005	-0.4932
b_k	1.3134e-08	9.1939e-08	2.7582e-07	4.5969e-07	4.5969e-07	2.7582e-07	9.1939e-08	1.3134e-08

$$H(e^{jw}) = \frac{\sum_{k=1}^{8} b_k e^{-j(k-1)w}}{\sum_{k=1}^{8} a_k e^{-j(k-1)w}}$$

(d) L = 3/fc = 0.5

k	1	2	3	4
a_k	1.0000	-4.9960e-16	0.3333	-1.8504e-17
b_k	0.1667	0.5000	0.5000	0.1667

$$H(e^{jw}) = \frac{\sum_{k=1}^{4} b_k e^{-j(k-1)w}}{\sum_{k=1}^{4} a_k e^{-j(k-1)w}}$$

(e)

Increasing L:

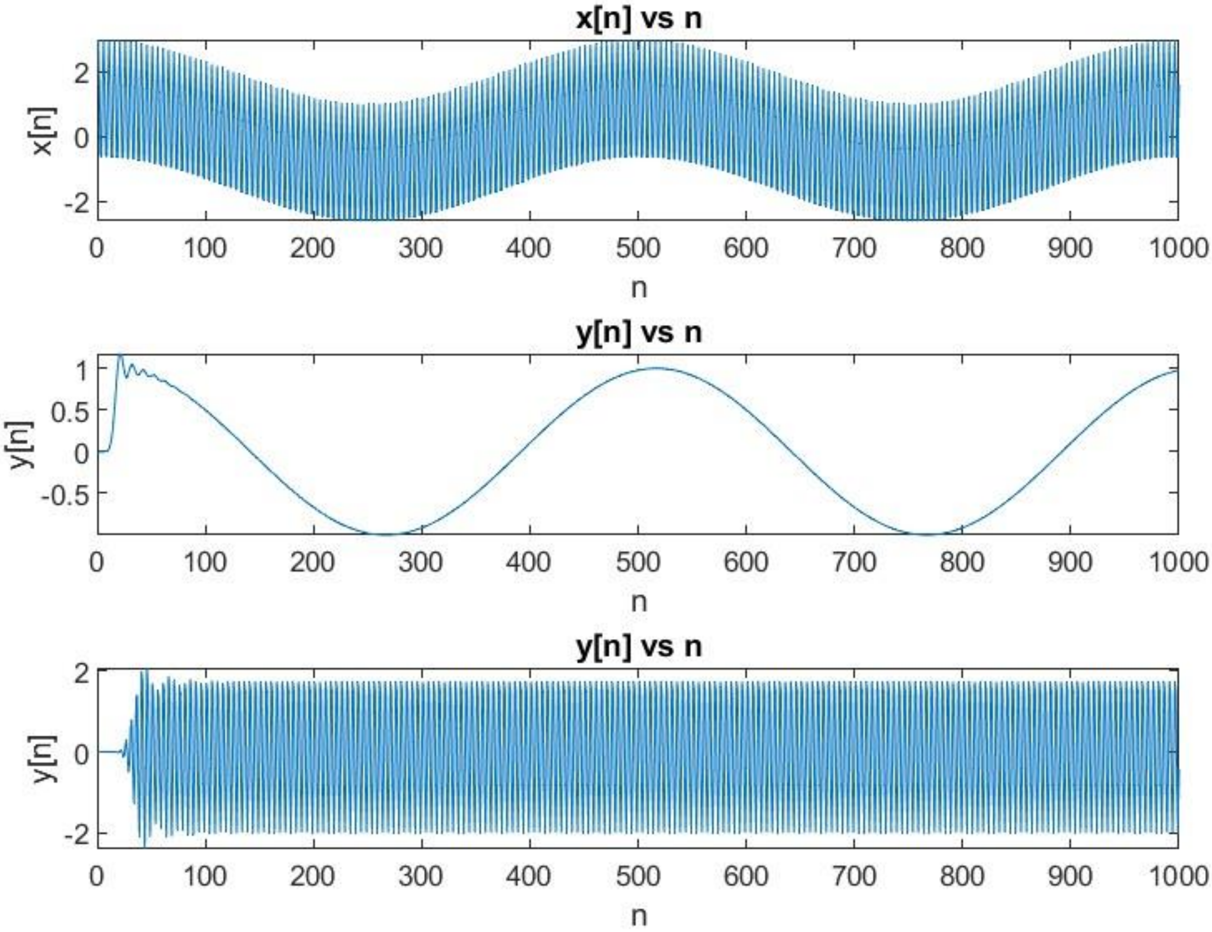
A higher order of a Butterworth low-pass filter will lead to a sharper roll-off in the frequency domain, which means that for the transfer function, there will be steeper on the edge of cutoff frequency. In other words, the transition band becomes smaller, which makes the low pass filter more ideal. As we can see, if we compare the y[n] plots of (b) and (c), the higher frequency component is eliminated more cleanly, so the result of (c) seemingly lacks some high-frequency parts.

Increasing f_c:

A larger cut-off frequency will make the pass-band of the low pass filter larger, which means that more high-frequency components won't be filtered at all. Let's compare the plots of (b) and (d). It seems that the response y[n] of (d) carries almost the same frequency as x[n], which implies that the passband of (d) becomes larger enough so that the function of x[n] on the frequency domain passes through the low pass filter successfully.

Part II

(a)(b)(c)



(b)

L = 16/ **Cutoff Frequency:** 0.40 (Where π is normalized to 1)

k	1	2	3	4	5	6	7	8	9
a_k	1.0000	-9.5922	43.9955	-127.7924	262.6519	-404.4528	482.1181	-453.3463	339.5554
b_k	5.8242e-10	9.3187e-09	6.9890e-08	3.2616e-07	1.0600e-06	2.5440e-06	4.6640e-06	6.6629e-06	7.4957e-06
k	10	11	12	13	14	15	16	17	
a_k	-203.1005	96.6268	-36.1596	10.4286	-2.2398	0.3377	-0.03192	0.001424	
b_k	6.6629e-06	4.6640e-06	2.5440e-06	1.0600e-06	3.2616e-07	6.9890e-08	9.3187e-09	5.8242e-10	

$$H(e^{jw}) = \frac{\sum_{k=1}^{17} b_k e^{-j(k-1)w}}{\sum_{k=1}^{17} a_k e^{-j(k-1)w}}$$

(c)

L = 16/**Bandpass Frequency**: [0.3, 0.5] (Where π is normalized to 1)

k	1	2	3	4	5	6	7	8	9
a_k	1.0000	-8.315	42.0959	-154.6111	455.8491	-1126.2839	2406.6052	-4530.1483	7622.3311
b_k	5.8242e-10	0	-9.3187e-09	0	6.9890e-08	0	-3.2616e-07	0	1.0600e-06
k	10	11	12	13	14	15	16	17	18
a_k	-11575.6595	15992.3753	-20211.0703	23471.3176	-25125.2487	24853.0290	-22750.2379	19291.2166	-15155.4874
b_k	0	-2.5440e-06	0	4.6640e-06	0	-6.6629e-06	0	7.4957e-06	0
k	19	20	21	22	23	24	25	26	27
a_k	11027.9569	-7424.2511	4616.9087	-2645.2515	1391.8820	-669.4899	292.7251	-115.4187	40.6422
b_k	-6.6629e-06	0	4.6640e-06	0	-2.5440e-06	0	1.0600e-06	0	-3.2616e-07
k	28	29	30	31	32	33			
a_k	-12.5952	3.3731	-0.7563	0.1361	-0.01778	0.001424			
b_k	0	6.9890e-08	0	-9.3187e-09	0	5.8242e-10			

$$H(e^{jw}) = \frac{\sum_{k=1}^{33} b_k e^{-j(k-1)w}}{\sum_{k=1}^{33} a_k e^{-j(k-1)w}}$$