# Signals and Systems MATLAB HW3

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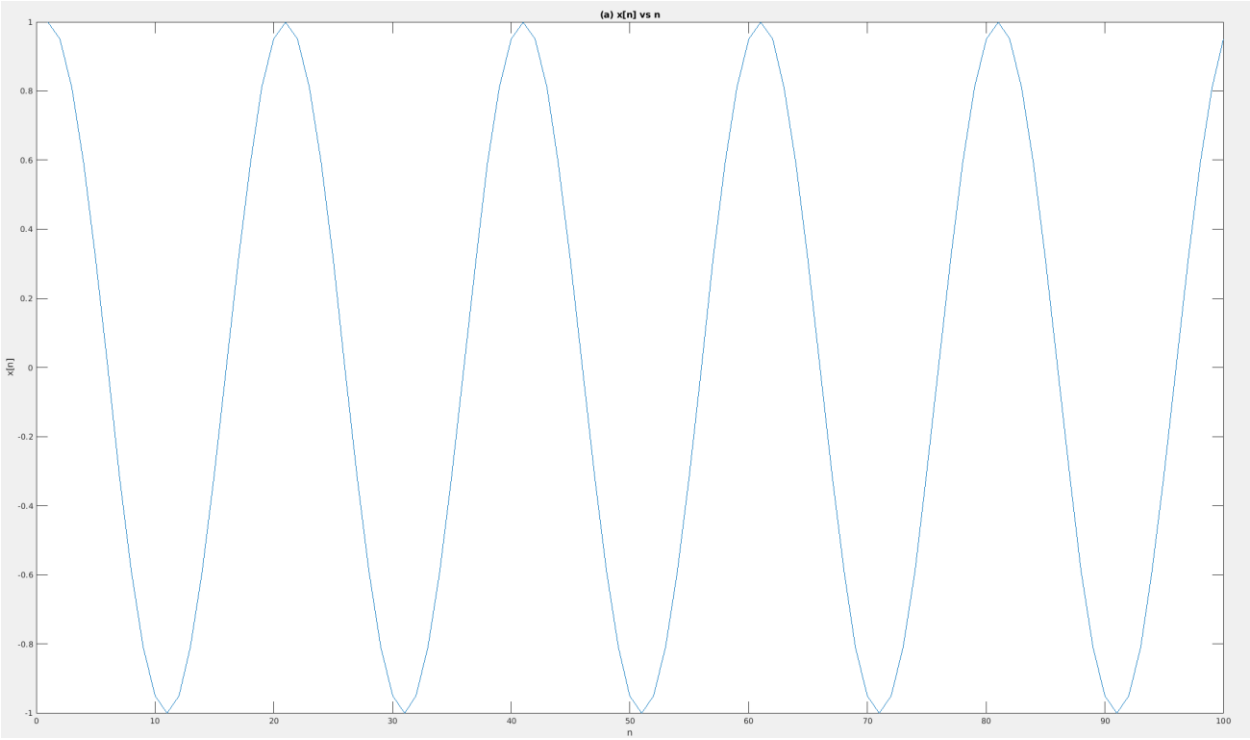
## Part I

(a) $x[n]\ vs\ n$




$$H(e^{jw}) = \frac{b_1 + b_2 e^{-jw} + \cdots + b_{N+1} e^{-jNw}}{a_1 + a_2 e^{-jw} + \cdots + a_{M+1} e^{-jMw}},$$

$$a = [a_1, a_2, \ldots, a_{M+1}]$$

$$b = [b_1, b_2, \ldots, b_{N+1}]$$

(b) $Filter\ order: L = 3, Cutoff\ frequency: fc = 0.05$

$$H(e^{jw}) = \frac{b_1 + b_2 e^{-jw} + \cdots + b_{N+1} e^{-jNw}}{a_1 + a_2 e^{-jw} + \cdots + a_{M+1} e^{-jMw}},$$

$$a = [1, -2.686, 2.420, -0.730], M = 3$$

$$b = [4.165e-04, 0.0012, 0.0012, 4.165e-04], N = 3$$

(c) $Filter\ order: L = 7, Cutoff\ frequency: fc = 0.05$

$$H(e^{jw}) = \frac{b_1 + b_2 e^{-jw} + \cdots + b_{N+1} e^{-jNw}}{a_1 + a_2 e^{-jw} + \cdots + a_{M+1} e^{-jMw}},$$

$$a = [1, -6.294, 17.011, -25.588, 23.134, -12.570, 3.800, -0.493], M = 7$$

$$b = [1.313e-08, 9.194e-08, 2.758e-07, 4.597e-07, 4.597e-07, 2.758e-07, 9.19e-08, 1.313e-08]$$

$$, N = 7$$

(d) $Filter\ order: L = 3, Cutoff\ frequency: fc = 0.5$

$$H(e^{jw}) = \frac{b_1 + b_2 e^{-jw} + \cdots + b_{N+1} e^{-jNw}}{a_1 + a_2 e^{-jw} + \cdots + a_{M+1} e^{-jMw}},$$

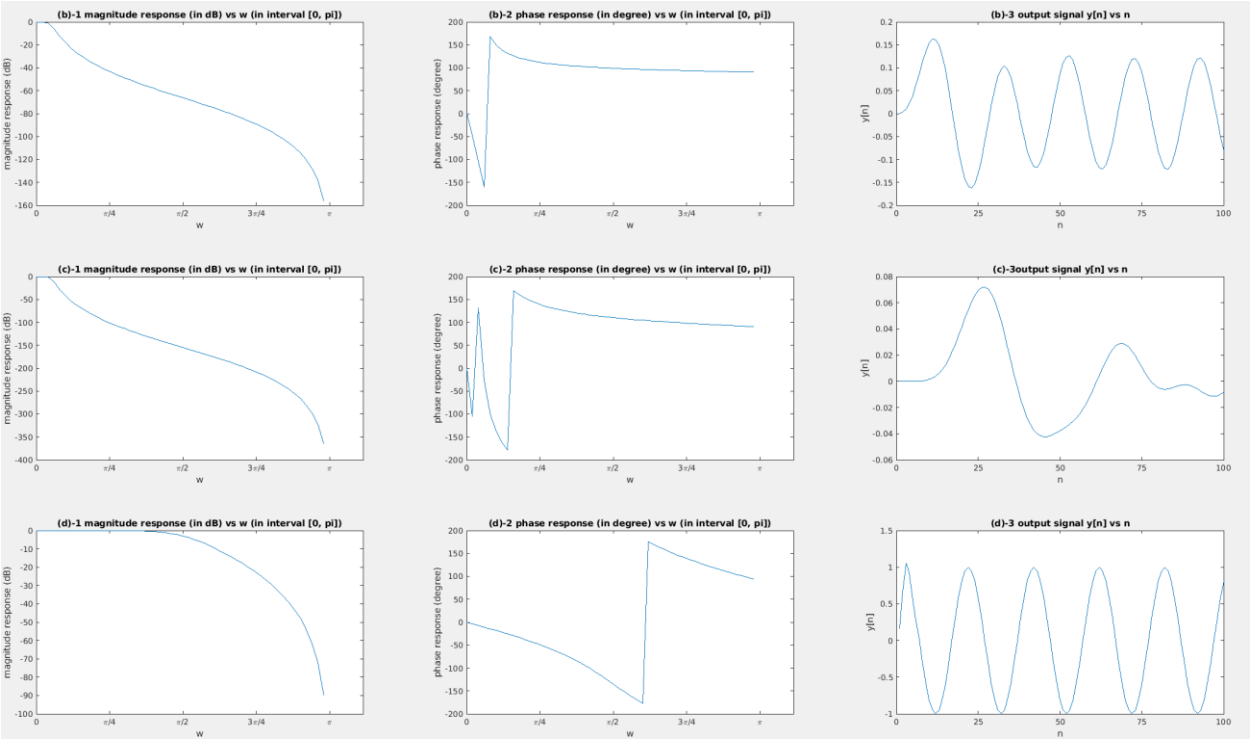
$$a = [1, -4.996e-16, 0.333, -1.8504e-17], M = 3$$

$$b = [0.167, 0.500, 0.500, 0, 0.167], N = 3$$

$$magnitude\ response\ (in\ dB)\ vs\ w\ (in\ interval\ [0, \pi]),$$

$$phase\ response\ (in\ degree)\ vs\ w\ (in\ interval\ [0, \pi]),$$

$$output\ signal\ y[n]\ vs\ n$$




(e) 1. The effect of increasing L: Compare with the slope in (b)-2, the slope in (c)-2 is steeper. Compare with y[n] in (b)-3, y[n] in (c)-3 is more smooth.

2. The effect of increasing fc: Compare with (b)-3, more original signal can be covered so that it looks like the original signal in (d)-3

# Part II

(a) $x[n]\ vs\ n$

(b) $y[n] \approx cos(2\pi(n-1)Ts), n = 1, 2, \cdots, M$

$$H(e^{jw}) = \frac{b_1 + b_2 e^{-jw} + \cdots + b_{N+1} e^{-jNw}}{a_1 + a_2 e^{-jw} + \cdots + a_{M+1} e^{-jMw}},$$

$$a = [1, -9.59222862172511, 43.9954955549463 - 127.792360962100, 262.651903174174,$$

$$-404.452801036837, 482.118130537541, -453.346274555287, 339.555420586611,$$

$$-203.100547027575, 96.6267966177478, -36.1595582493419, 10.4286341135665,$$

$$-2.23975823009437, 0.337680041507302,$$

$$-0.0319181990553117, 0.00142442541547249], M = 16$$

$$b = [5.82420259710225e-10, 9.31872415536361e-09, 6.98904311652270e-08$$

$$, 3.26155345437726e-07, 1.06000487267261e-06, 2.54401169441426e-06$$

$$, 4.66402143975948e-06, 6.66288777108498e-06, 7.49574874247060e-06$$

$$, 6.66288777108498e-06, 4.66402143975948e-06, 2.54401169441426e-06$$

$$, 1.06000487267261e-06, 3.26155345437726e-07, 6.98904311652270e-08$$

$$, 9.31872415536361e-09, 5.82420259710225e-10], N = 16$$

$$f_c = 0.3$$

(c) $y[n] \approx 2\cos(2\pi f1\,(n-1)Ts)\,, n = 1, 2, \cdots, M$

$$H(e^{jw}) = \frac{b_1 + b_2 e^{-jw} + \cdots + b_{N+1} e^{-jNw}}{a_1 + a_2 e^{-jw} + \cdots + a_{M+1} e^{-jMw}},$$

$$a = [1, -8.31541914969401, 42.0958715533194, -154.611097453109, 455.849121143873,$$

$$-1126.28394882143, 2406.60520296477, -4530.14828162658, 7622.33110209192,$$

$$-11575.6594760299, 15992.3753436321, -20211.070334757523471.3176481667,$$

$$-25125.2487089884, 24853.0290308325, -22750.2379251209, 19291.2166316548,$$

$$-15155.4873789233, 11027.9568709235, -7424.25107760171, 4616.90866614422,$$

$$-2645.25154294741, 1391.88201844916, -669.489886524289, 292.725112367388,$$

$$-115.418746552076, 40.6422316191080, -12.5951641290075, 3.37307706961307,$$

$$-0.756321834433264, 0.136159109646603,$$

$$-0.0177760335141812, 0.00142442541547247], M = 32$$

$$b = [5.82420259710229e-10, 0, -9.31872415536366e-09, 0, 6.98904311652274e-08, 0,$$

$$-3.26155345437728e-07, 0, 1.06000487267262e-06, 0, -2.54401169441428e-06,$$

$$0, 4.66402143975951e-06, 0, -6.66288777108501e-06, 0, 7.49574874247064e-06, 0,$$

$$-6.66288777108501e-06, 0, 4.66402143975951e-06, 0, -2.54401169441428e-06, 0,$$

$$1.06000487267262e-06, 0, -3.26155345437728e-07, 0, 6.98904311652274e-08, 0,$$

$$-9.31872415536366e-09, 0, 5.82420259710229e-10], N = 32$$