**ECE 53800 Digital Signal Processing I** **Homework 1**

*Uploaded to Brightspace, Friday by midnight, 3 October 2025*

**My New Version of Problem.** *2.65.* pp. 144-145 of 4th Ed. Proakis and Manolakis Textbook. It's Problem CP 2.16 in the 5th Ed BUT they scaled the problem back dramatically, so that's not helpful to look at.
This is the model to simulate for all parts:

$$y[n] = x[n-20] + a_2 x[n-D_2] + v[n], \quad n = 0, 1, ..., 199.$$

where for every value of $n$, $v[n]$ is a zero-mean, independent, Gaussian random variable with a standard deviation of 1, for all parts.
For each of 3 different sequences,

(a) $x[n]$ of length $M = 15$ generated according to shift-register defined in Prob. 2.65. $x[n] = \{-1, -1, -1, 1, 1, 1, 1, -1, 1, -1, 1, 1, -1, -1, 1\}$ ($M = 15$) The shift-register is of length 4.

(b) $x[n]$ of length $M = 63$ generated according to shift-register defined in Prob. 2.65. The shift-register is of length 6.

(c) $x[n]$ of length $M = 127$ generated according to shift-register defined in Prob. 2.65. The shift-register is of length 7.

Simulate 3 different values of the parameter pair $\{a_2, D_2\}$,

(1) $a_2 = 1$, $D_2 = 22$

(2) $a_2 = 1$, $D_2 = 21$

(3) $a_2 = -1$, $D_2 = 21$

and do the following 3 plots.

(i) Plot the values of the autocorrelation $r_{xx}[n]$, for $n = -(M-1), ..., -1, 0, 1, ..., M-1$, where $M$ is either 15, 63, or 127.

(ii) Plot the values of $y[n]$, for $n = 0, 1, ..., 199$.

(iii) Plot the cross-correlation $r_{yx}(\ell)$, for $n = 0, 1, ..., 59$.

Put 3 plots per page so that there is a total of 9 pages of plots. Label each page with the values of $M$, $a_2$, and $D_2$. You can do either stem plots or line plots.

Page 1: $a_2 = 1$, $D_2 = 22$, $M = 15$: do plots (i), (ii), and (iii)

Page 2: $a_2 = 1$, $D_2 = 21$, $M = 15$: do plots (i), (ii), and (iii)

Page 3: $a_2 = -1$, $D_2 = 21$, $M = 15$: do plots (i), (ii), and (iii)

Page 4: $a_2 = 1$, $D_2 = 22$, $M = 63$: do plots (i), (ii), and (iii)

Page 5: $a_2 = 1$, $D_2 = 21$, $M = 63$: do plots (i), (ii), and (iii)

Page 6: $a_2 = -1$, $D_2 = 21$, $M = 63$: do plots (i), (ii), and (iii)

Page 7: $a_2 = 1$, $D_2 = 22$, $M = 127$ : do plots (i), (ii), and (iii)

Page 8: $a_2 = 1$, $D_2 = 21$, $M = 127$ : do plots (i), (ii), and (iii)

Page 9: $a_2 = -1$, $D_2 = 21$, $M = 127$: do plots (i), (ii), and (iii)

*Note 1:* This homework is worth 15/3=5 points of your final grade.

*Note 2:* The goal of this Matlab homework is to exercise you on the practical applications of discrete-time cross-correlation. An additional goal is to get you started on using Matlab.

**General Information.**

Deliverables for this project include 27 plots. Each plot should be clearly labeled, and should be accompanied by a brief explanation. The collection of plots and accompanying explanations should be put together in a cohesive manner in the form of a very brief report. Don't go overboard – this is simply a homework, **not** a project. Append source code to the report.

You may use any Matlab command you like in solving these problems. Each student is expected to do his/her own work and each must turn in his/her own report. Again, your write-up for this homework should be in the form of a very brief report. Handwriting is acceptable but please be sure it is legible. Your report should include:

- The 27 plots and observations/explanations