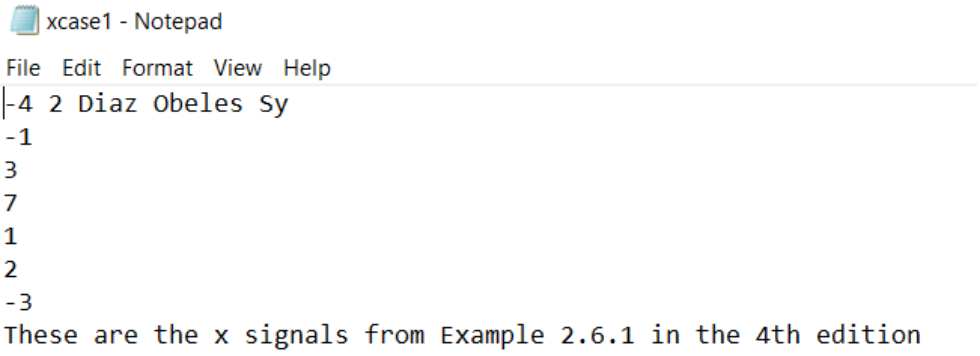
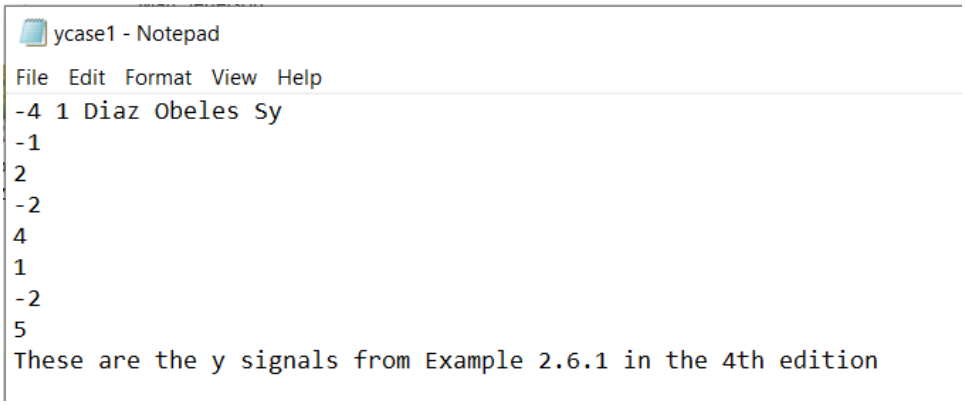
Andreas Josef C. Diaz
191679
ENGG 151.01 – A

Project 1: Normalized Crosscorrelation

Documentation

- Case 1: Using the signals from example 2.6.1 in the 4th Edition Proakis & Manolakis.
  - Starting indices of both x and y signals are equal.
  - x signal starting index is set to -4
  - y signal starting index is set to -4





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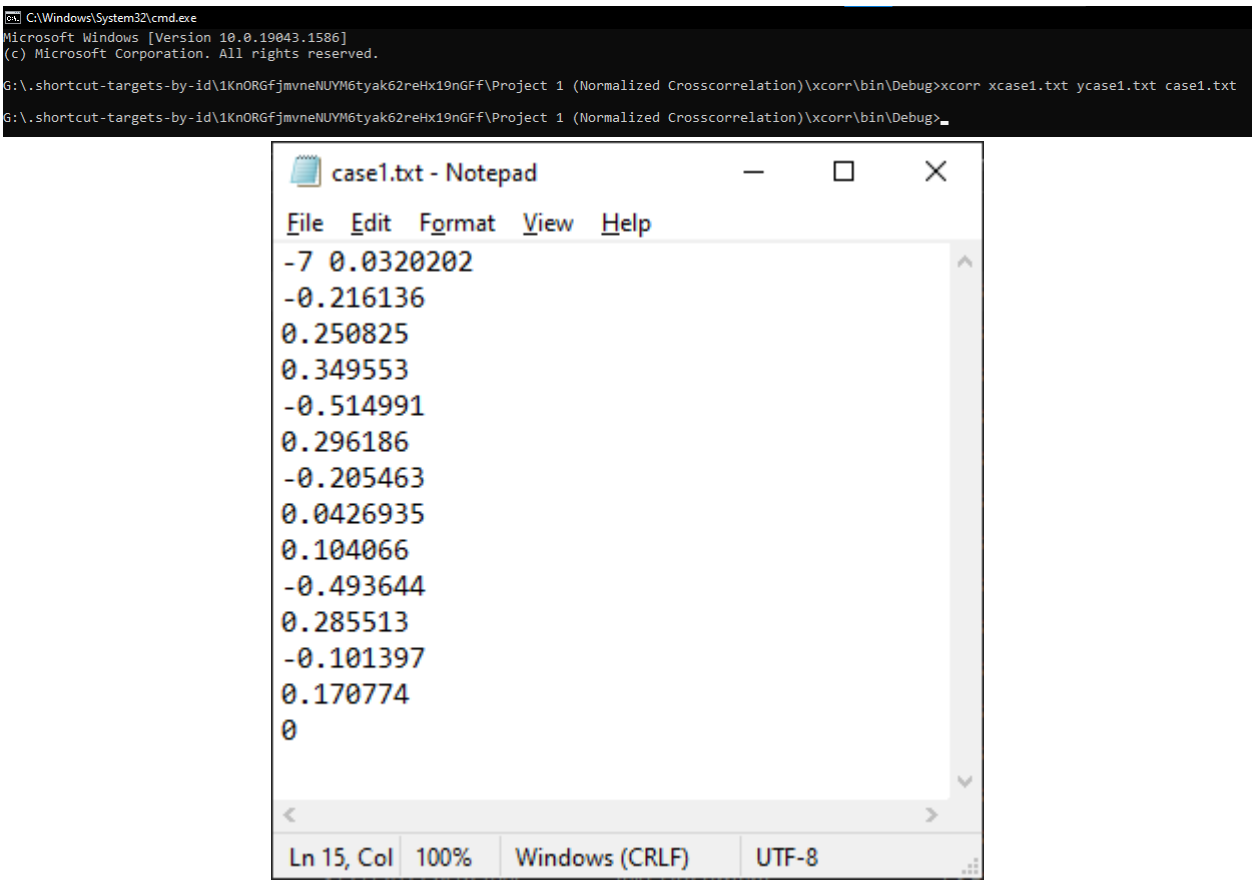
n	x(n)	y(n)	x(n) – Average	y(n) – Average	l	r_{xx}(l)	r_{yy}(l)	r_{xy}(l)	Normalized Cross Correlation p_{xy}(l)	
-10					-10					
-9					-9					
-8					-8					
-7					-7			1.714285714	0.0320201576975303	1
-6					-6	-1.95918367346939	-8	-11.57142857	-0.21613606445833	2
-5					-5	11.9387755102041	10	13.42857143	0.250824568630654	3
-4	2	1	0.428571428571429	0	-4	-7.87755102040816	-15	18.71428571	0.349553388198039	4
-3	-1	-1	-2.57142857142857	-2	-3	-20.4081632653061	15	-27.57142857	-0.514990869635279	5
-2	3	2	1.42857142857143	1	-2	-9.22448979591837	0	15.85714286	0.296186458702155	6
-1	7	-2	5.42857142857143	-3	-1	-2.3265306122449	-26	-11	-0.205462678559153	7
0	1	4	-0.571428571428571	3	0	59.7142857142857	48	2.285714286	0.0426935435967071	8
1	2	1	0.428571428571429	0	1	-2.3265306122449	-26	5.571428571	0.104065512516974	9
2	-3	-2	-4.57142857142857	-3	2	-9.22448979591837	0	-26.42857143	-0.493644097836926	10
3		5		4	3	-20.4081632653061	15	15.28571429	0.285513072802979	11
4					4	-7.87755102040816	-15	-5.428571429	-0.101397166042179	12
5					5	11.9387755102041	10	9.142857143	0.170774174386828	13
6					6	-1.95918367346939	-8	0	0	14
7					7					
8					8					
9					9					
10					10					
Average	1.571428571	1	0	0	Normalization Coefficient	53.53770367027				



Case 1 Output

- Case 2: Using signals from example 2.6.1 in the 4th Edition Proakis & Manolakis.
  - Starting index of x signal is less than (<) starting index of y signal
  - x signal starting index is set to -8
  - y signal starting index is set to -4

xcase2 - Notepad

File Edit Format View Help

```
-8 2 Diaz Obeles Sy
-1
3
7
1
2
-3
These are the x signals from Example 2.6.1 in the 4th edition
```

*ycase2 - Notepad

File Edit Format View Help

```
-4 1 Diaz Obeles Sy
-1
2
-2
4
1
-2
5
These are the y signals from Example 2.6.1 in the 4th edition
```

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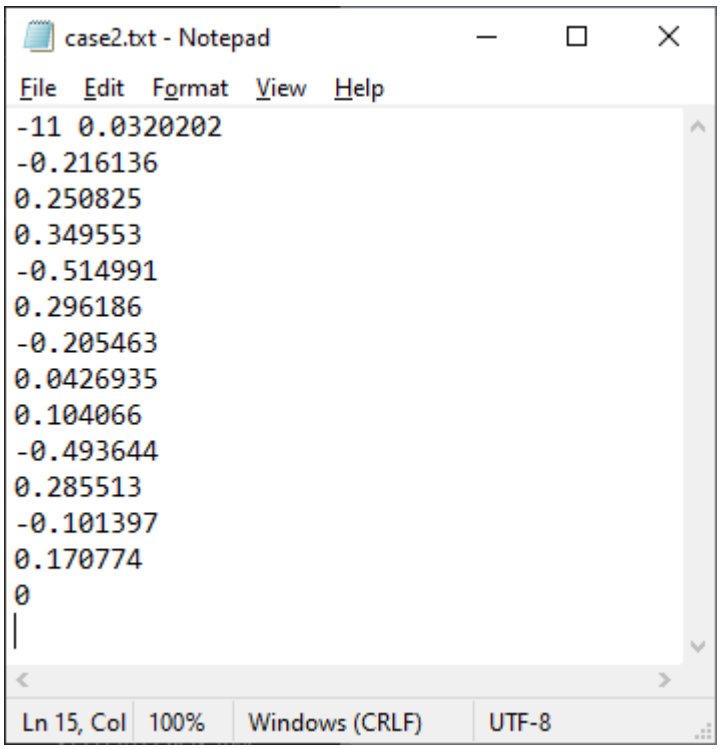
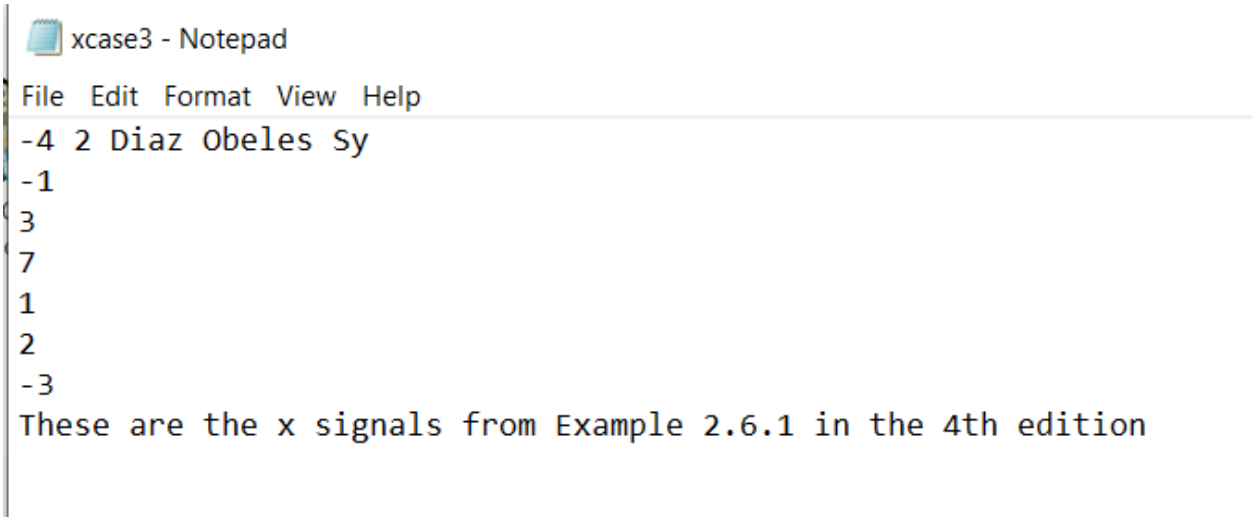
Case 2 Calculation

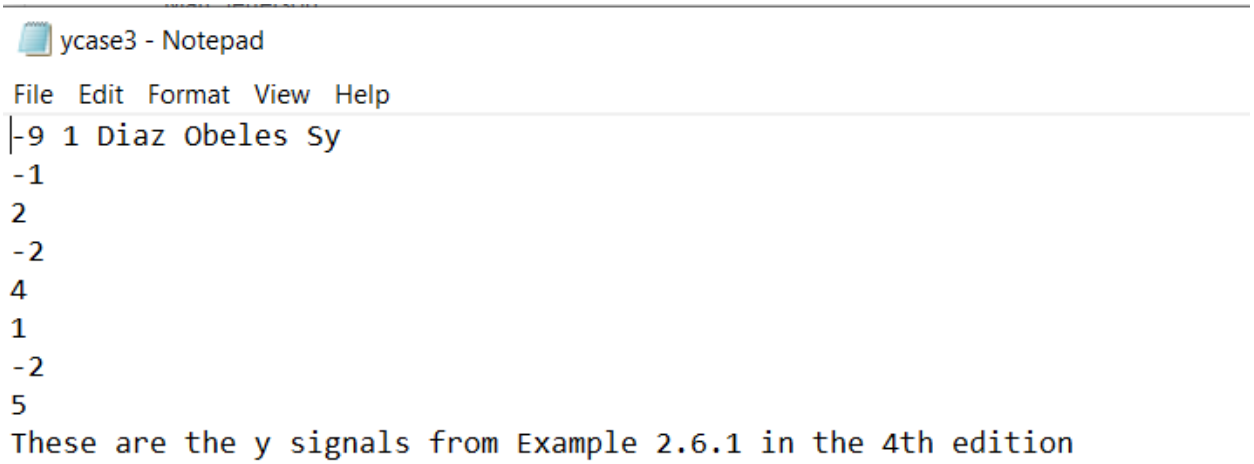
n	x(n)	y(n)	x(n) – Average	y(n) – Average	l	r_{xx}(l)	r_{yy}(l)	r_{xy}(l)	Normalized Cross Correlation p_{xy}(l)
-12					-12			0	0
-11					-11			1.71428571	0.0320201576975303
-10					-10			-11.5714286	-0.21613606445833
-9					-9			13.4285714	0.250824568630654
-8	2		0.428571428571429		-8			18.7142857	0.349553388198039
-7	-1		-2.57142857142857		-7			-27.5714286	-0.514990869635279
-6	3		1.42857142857143		-6	-1.95918367346939	-8	15.8571429	0.296186458702155
-5	7		5.42857142857143		-5	11.9387755102041	10	-11	-0.205462678559153
-4	1	1	-0.57142857142857	0	-4	-7.87755102040816	-15	2.28571429	0.0426935435967071
-3	2	-1	0.428571428571429	-2	-3	-22.734693877551	15	5.57142857	0.104065512516974
-2	-3	2	-4.57142857142857	1	-2	4.12244897959184	0	-26.4285714	-0.493644097836926
-1		-2		-3	-1	-5.30612244897959	-26	15.2857143	0.285513072802979
0		4		3	0	59.7142857142857	48	-5.42857143	-0.101397166042179
1		1		0	1	-2.20408163265306	-26	9.14285714	0.170774174386828
2		-2		-3	2	2.61224489795918	0	0	0
3		5		4	3	0	15	0	0
4					4	0	-15	0	0
5					5	0	10	0	0
6					6	0	-8	0	0
7					7			0	
8					8			0	
9					9				
10					10				
Average	1.57142857	1	0	0	Normalization Coefficient	53.53770367			

```
Microsoft Windows [Version 10.0.19043.1586]
(c) Microsoft Corporation. All rights reserved.

G:\.shortcut-targets-by-id\1KnORGfjmvneNUYM6tyak62reHx19nGFf\Project 1 (Normalized Crosscorrelation)\xcorr\bin\Debug>xcorr xcase2.txt ycase2.txt case2.txt

G:\.shortcut-targets-by-id\1KnORGfjmvneNUYM6tyak62reHx19nGFf\Project 1 (Normalized Crosscorrelation)\xcorr\bin\Debug>
```


case2.txt - Notepad
File Edit Format View Help
-11 0.0320202
-0.216136
0.250825
0.349553
-0.514991
0.296186
-0.205463
0.0426935
0.104066
-0.493644
0.285513
-0.101397
0.170774
0
Ln 15, Col 100% Windows (CRLF) UTF-8

- Case 3: Using signals from example 2.6.1 in the 4th Edition Proakis & Manolakis.
    - Starting index of x signal is greater than (>) starting index of y signal
    - x signal starting index is set to -4
    - y signal starting index is set to -9





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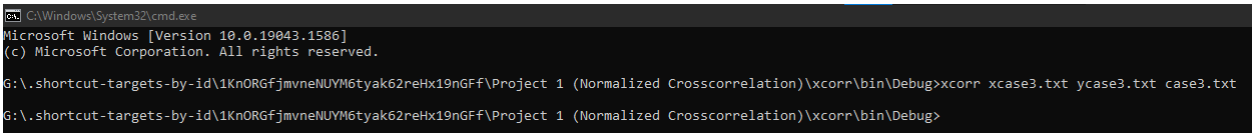
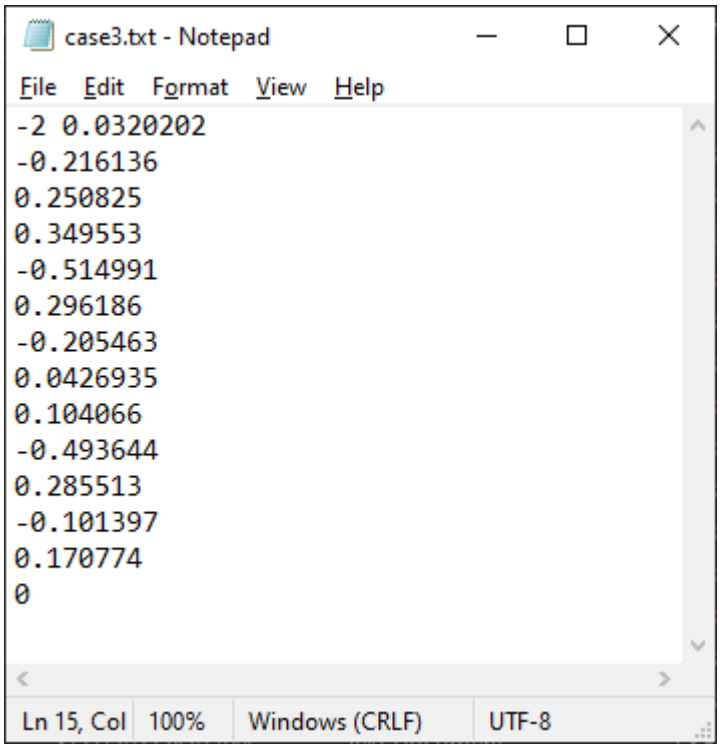
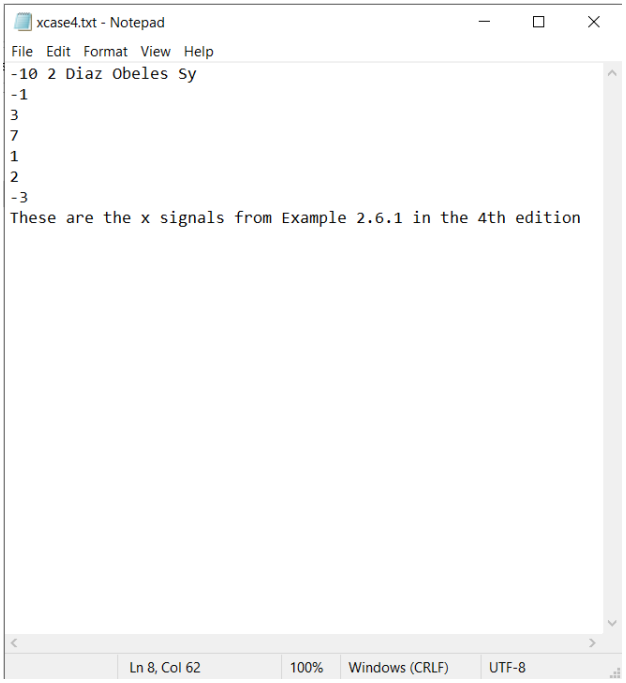
Case 3 Calculation

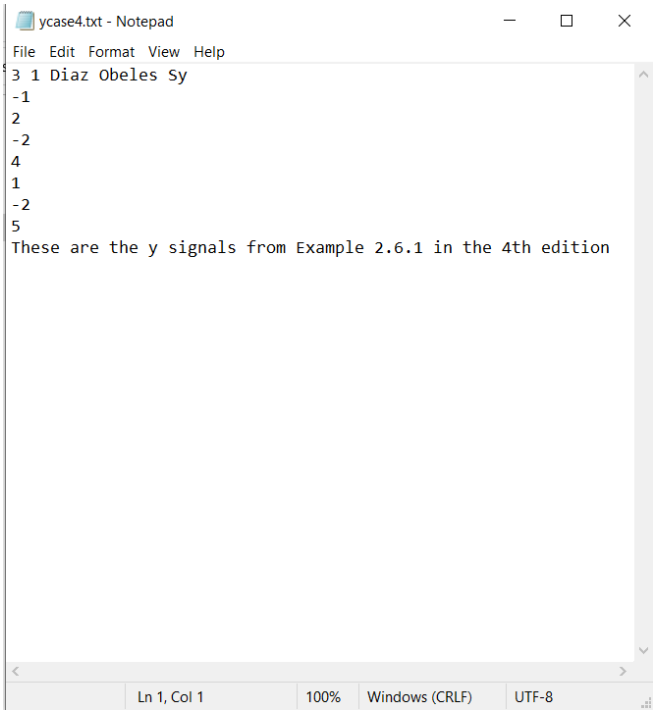
									Normalized Cross Correlation
n	x(n)	y(n)	x(n) – Average	y(n) – Average	l	r_{xx}(l)	r_{yy}(l)	r_{xy}(l)	p_{xy}(l)
-10					-10				
-9		1		0	-9				
-8		-1		-2	-8				
-7		2		1	-7			0	0
-6		-2		-3	-6	-1.95918367346939	-8	0	0
-5		4		3	-5	11.9387755102041	10	0	0
-4	2	1	0.428571428571429	0	-4	-7.87755102040816	-15	0	0
-3	-1	-2	-2.57142857142857	-3	-3	-20.4081632653061	21	0	0
-2	3	5	1.42857142857143	4	-2	-9.22448979591837	-9	1.714285714	0.0320201576975303
-1	7		5.42857142857143		-1	-2.3265306122449	-12	-11.57142857	-0.21613606445833
0	1		-0.571428571428571		0	59.7142857142857	48	13.42857143	0.250824568630654
1	2		0.428571428571429		1	-2.3265306122449	-12	18.71428571	0.349553388198039
2	-3		-4.57142857142857		2	-9.22448979591837	0	-27.57142857	-0.514990869635279
3					3	-20.4081632653061	0	15.85714286	0.296186458702155
4					4	-7.87755102040816	0	-11	-0.205462678559153
5					5	11.9387755102041	0	2.285714286	0.0426935435967071
6					6	-1.95918367346939	0	5.571428571	0.104065512516974
7					7			-26.42857143	-0.493644097836926
8					8			15.28571429	0.285513072802979
9					9			-5.428571429	-0.101397166042179
10					10			9.142857143	0.170774174386828
								0	0
						Normalization Coefficient	53.53770367027		
Average	1.571428571	1	-1.57142857142857	0					

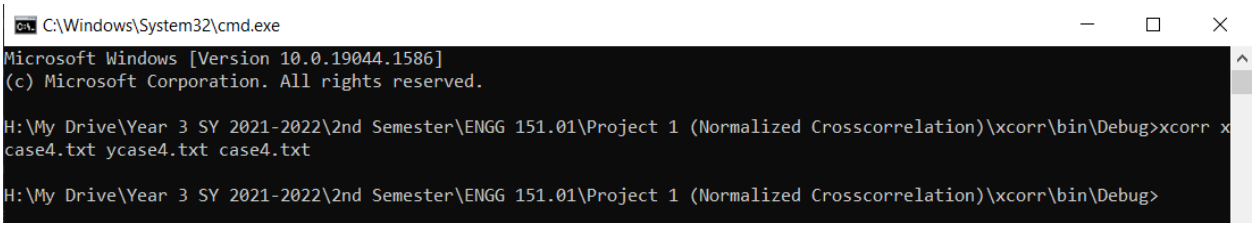


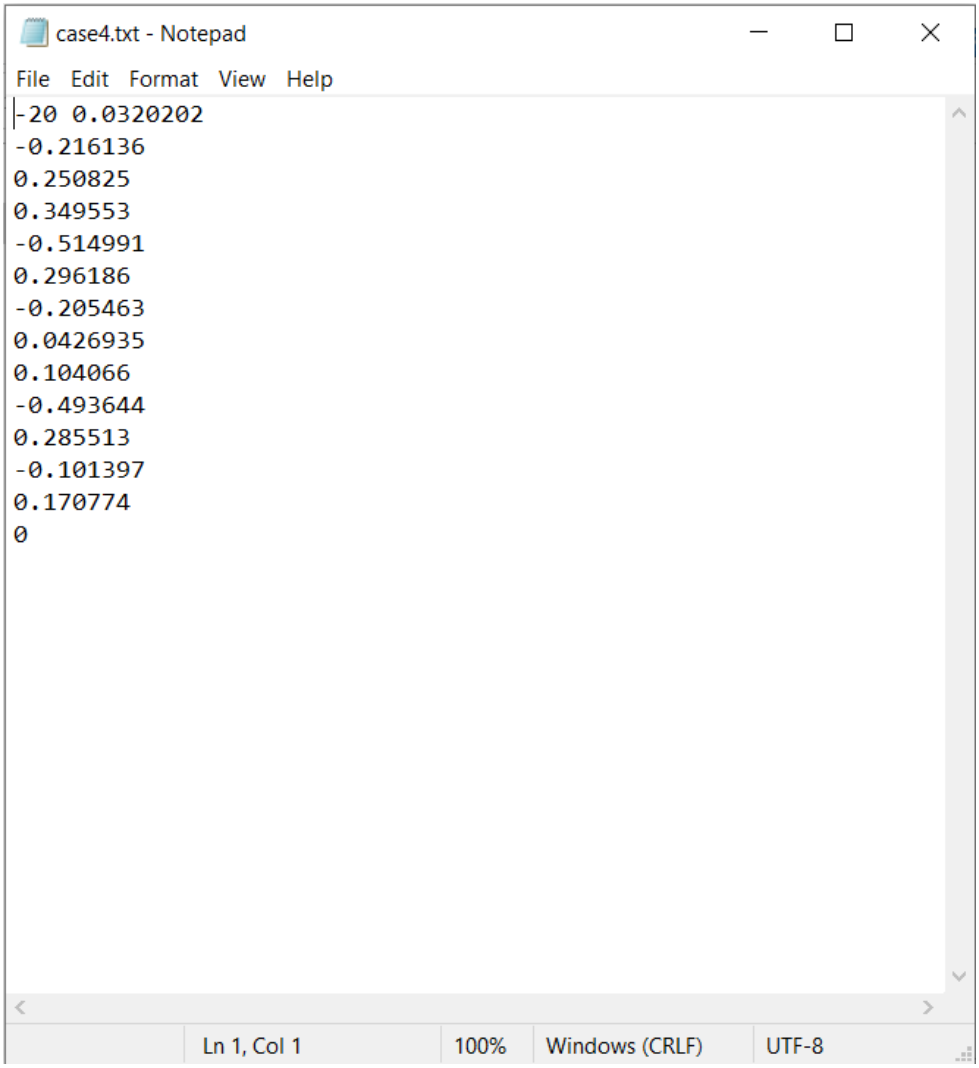


- Case 4: Using signals from example 2.6.1 in the 4th Edition Proakis & Manolakis.
    - Starting index of x signal is set to -10
    - Starting index of y signal is set to 3
    - Checks if the program will still work even if the x signal end index is far from the y signal start index.

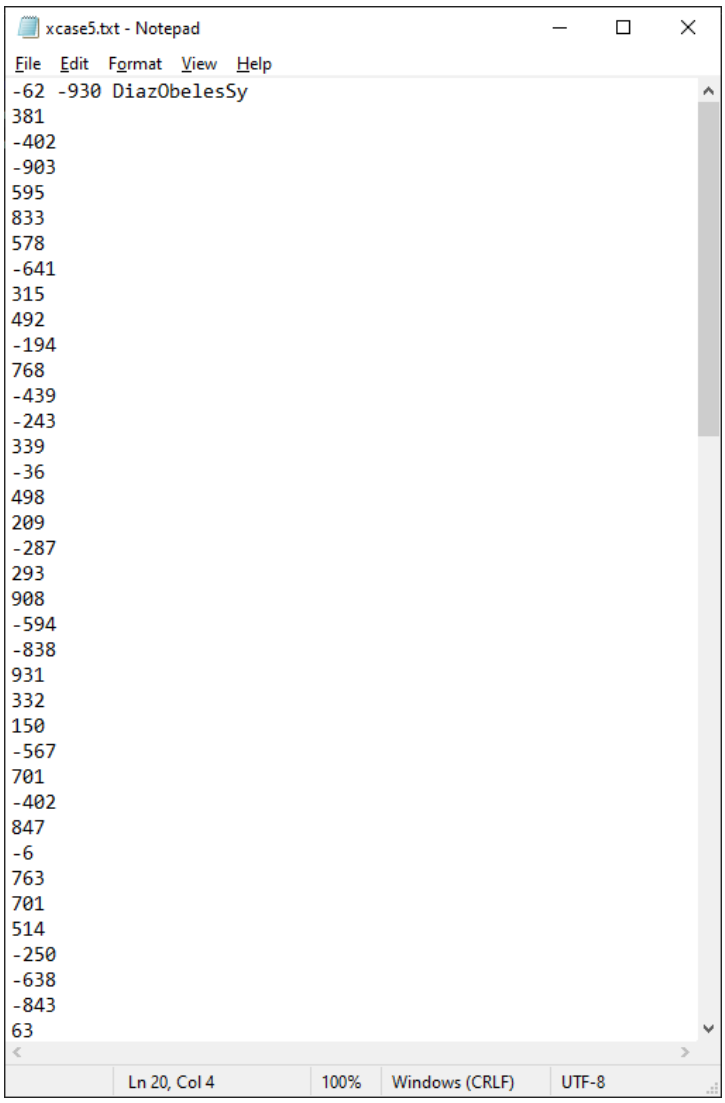


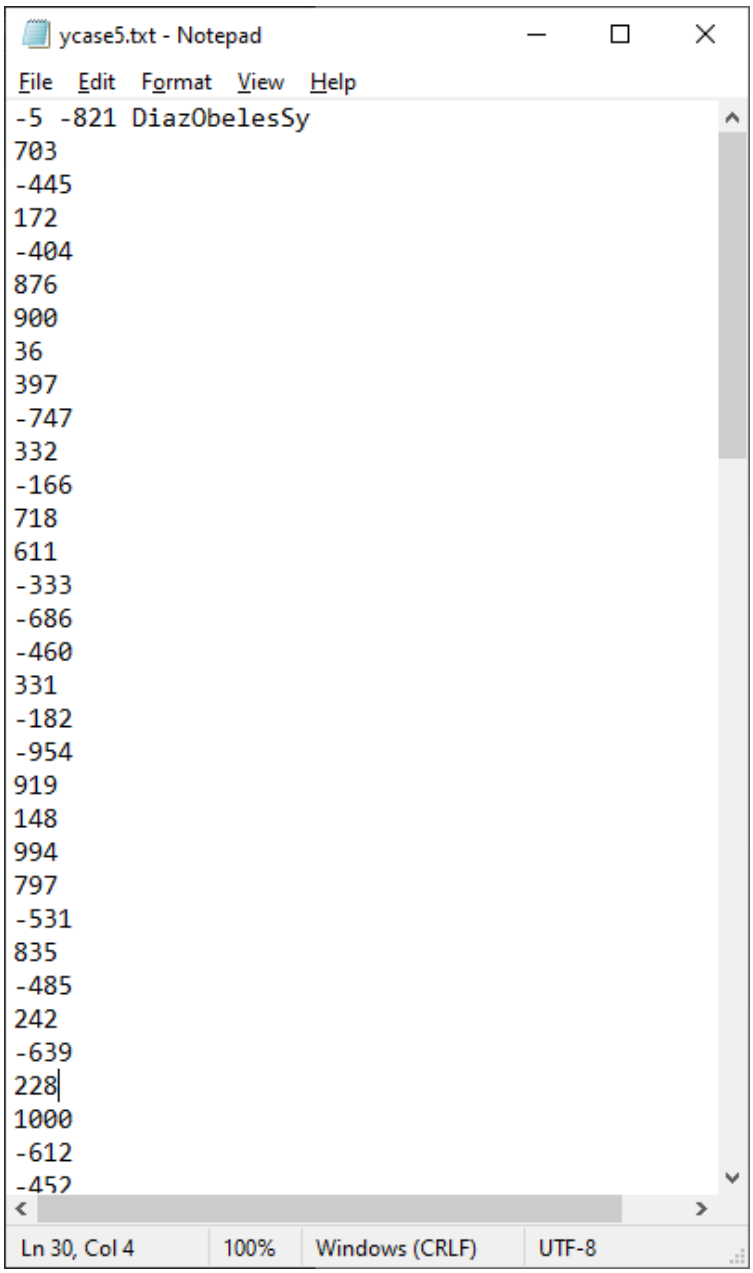





case4.txt - Notepad
File Edit Format View Help
-20 0.0320202
-0.216136
0.250825
0.349553
-0.514991
0.296186
-0.205463
0.0426935
0.104066
-0.493644
0.285513
-0.101397
0.170774
0
Ln 1, Col 1
100%
Windows (CRLF)
UTF-8

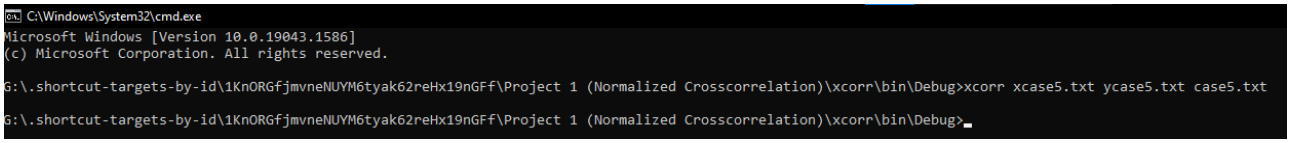
- Case 5: Using signal values generated from Excel
    - Values range from -1000 to 1000 and are only integers
    - Starting index of x signal is set to -62
    - Starting index of y signal is set to -5

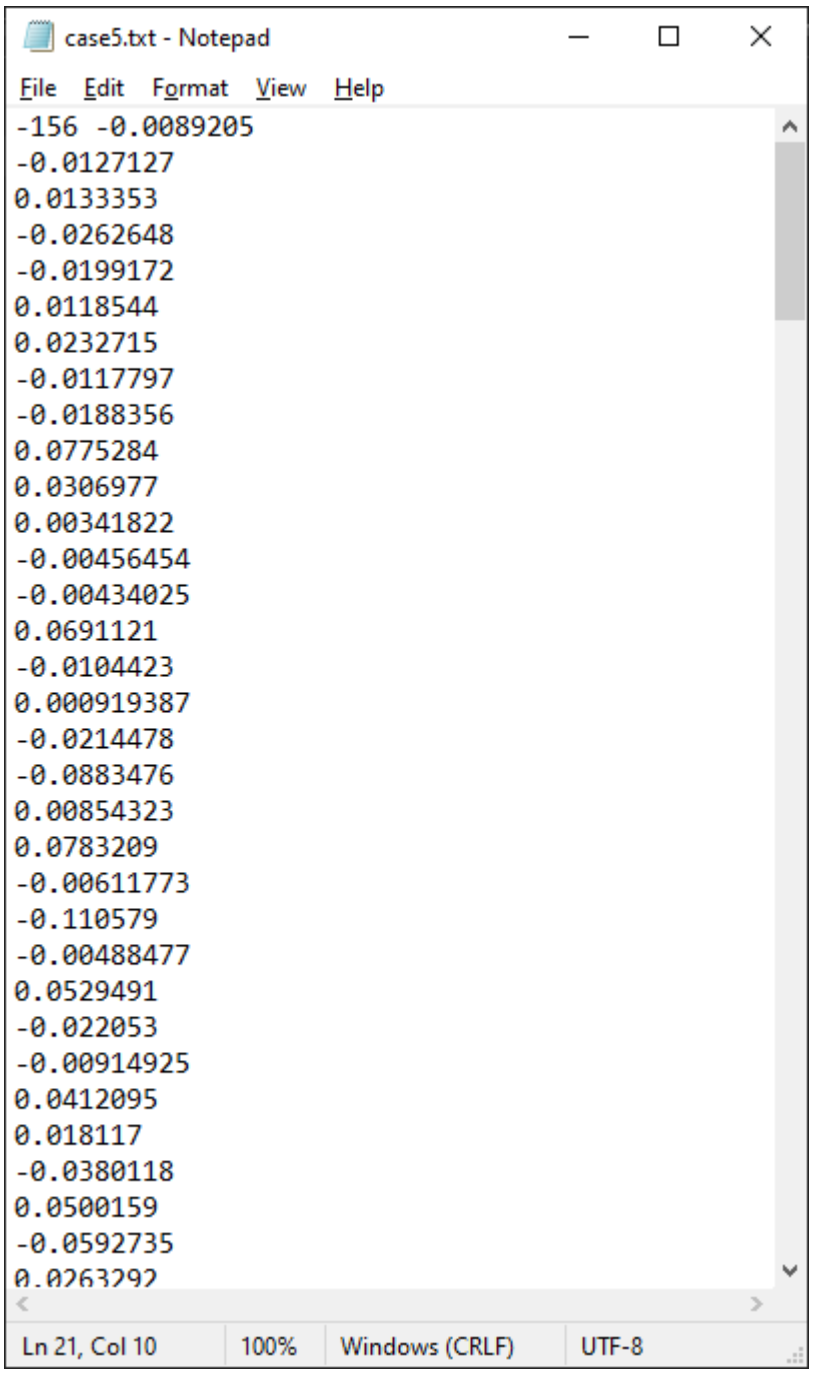



ycase5.txt - Notepad
File Edit Format View Help
-5 -821 DiazObelesSy
703
-445
172
-404
876
900
36
397
-747
332
-166
718
611
-333
-686
-460
331
-182
-954
919
148
994
797
-531
835
-485
242
-639
228
1000
-612
-452
Ln 30, Col 4
100%
Windows (CRLF)
UTF-8

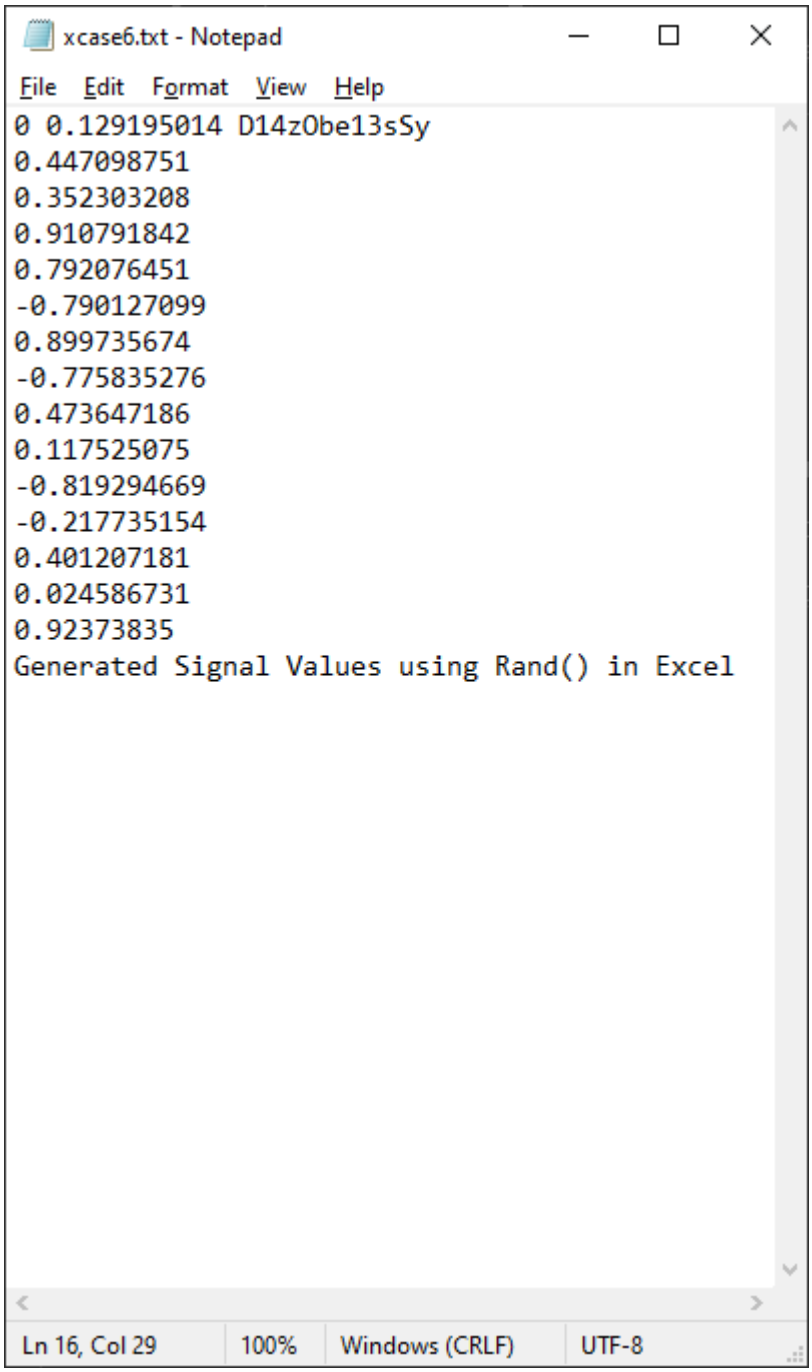
Diaz, Obeles, Sy
ENGG 151.01
Case 5 Calculation

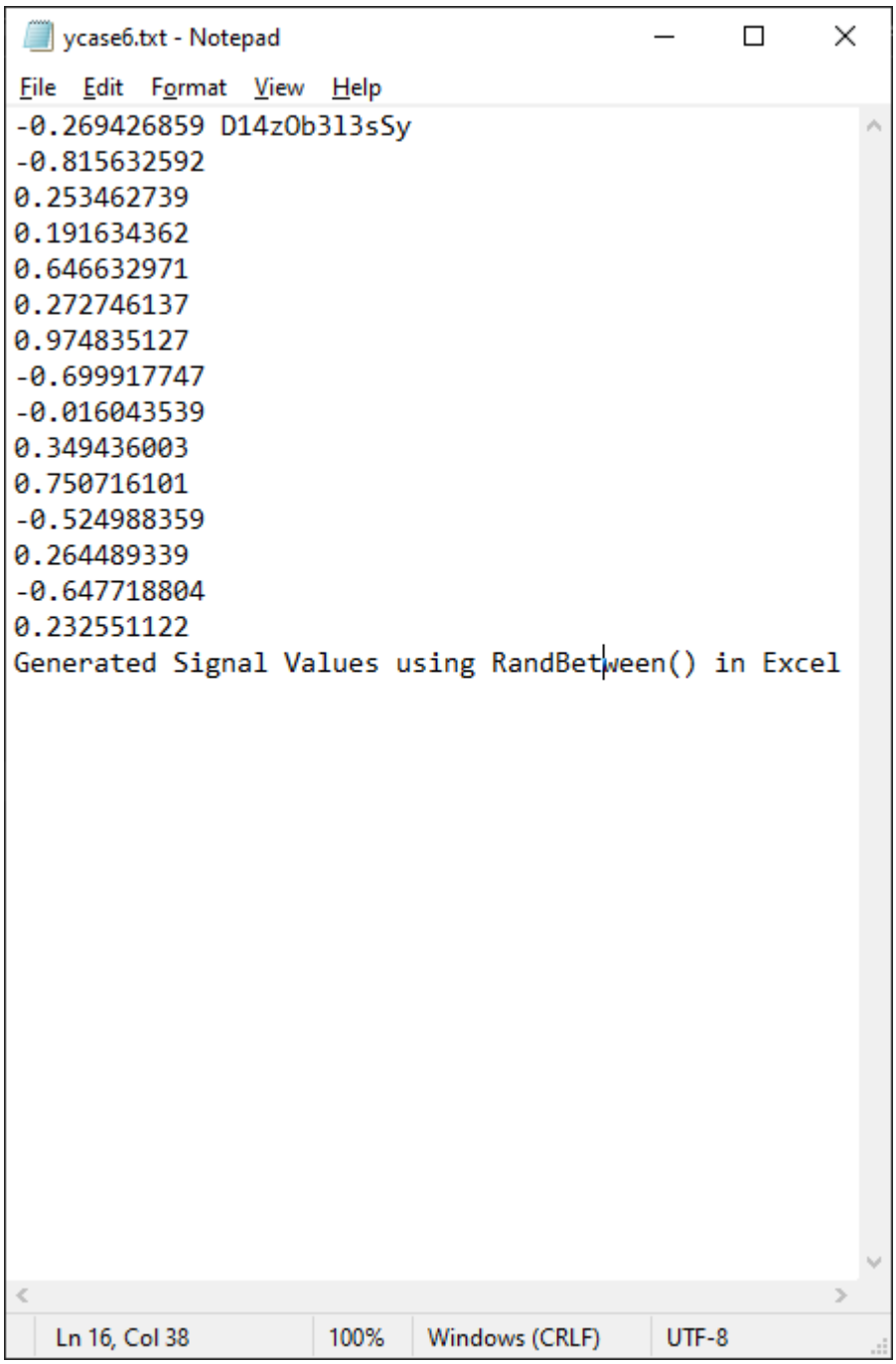
n	x(n)	y(n)	x(n) – Average	y(n) – Average	l	r_{xx}(l)	r_{yy}(l)	r_{xy}(l)	Normalized Cross Correlation p_{xy}(l)
-158					-158				
-157					-157			0	
-156					-156			-308769.7193	-0.00892049774257174
-155					-155			-440030.3986	-0.0127126785174178
-154					-154			461582.0321	0.0133353150195377
-153					-153			-909118.2772	-0.0262648408590023
-152					-152			-689404.9865	-0.0199172238771762
-151					-151			410321.2442	0.011854367523193
-150					-150			805508.8949	0.0232715186413583
-149					-149			-407737.6944	-0.0117797275934389
-148					-148			-651965.4437	-0.0188355784432021
-147					-147			2683529.337	0.0775283840886451
-146					-146			1062554.1277	0.0306976724239556
-145					-145			118316.6384	0.00341822154111689
-144					-144			-157994.7009	-0.00456453882819832
-143					-143			-150231.1202	-0.00434024544779292
-142					-142			2392211.1305	0.069112068494795
-141					-141			-361445.3088	-0.0104423195011582
-140					-140			31823.2219	0.000919387366623521
-139					-139			-742383.3674	-0.0214477934171393
-138					-138			-3058020.4867	-0.0883476038718719
-137					-137			295711.124	0.00854322898008138
-136					-136			2710962.0447	0.0783209275014683




case5.txt - Notepad
File Edit Format View Help
-156 -0.0089205
-0.0127127
0.0133353
-0.0262648
-0.0199172
0.0118544
0.0232715
-0.0117797
-0.0188356
0.0775284
0.0306977
0.00341822
-0.00456454
-0.00434025
0.0691121
-0.0104423
0.000919387
-0.0214478
-0.0883476
0.00854323
0.0783209
-0.00611773
-0.110579
-0.00488477
0.0529491
-0.022053
-0.00914925
0.0412095
0.018117
-0.0380118
0.0500159
-0.0592735
0.0263292
Ln 21, Col 10
100%
Windows (CRLF)
UTF-8

- Case 6: Using signal values generated from Excel
  - Values range from -1 to 1 and can be float/double
  - Starting indices of both x and y signals are not stated, should be automatically set to 0.
  - Comment is a combination of character and integer to test if the parser works.





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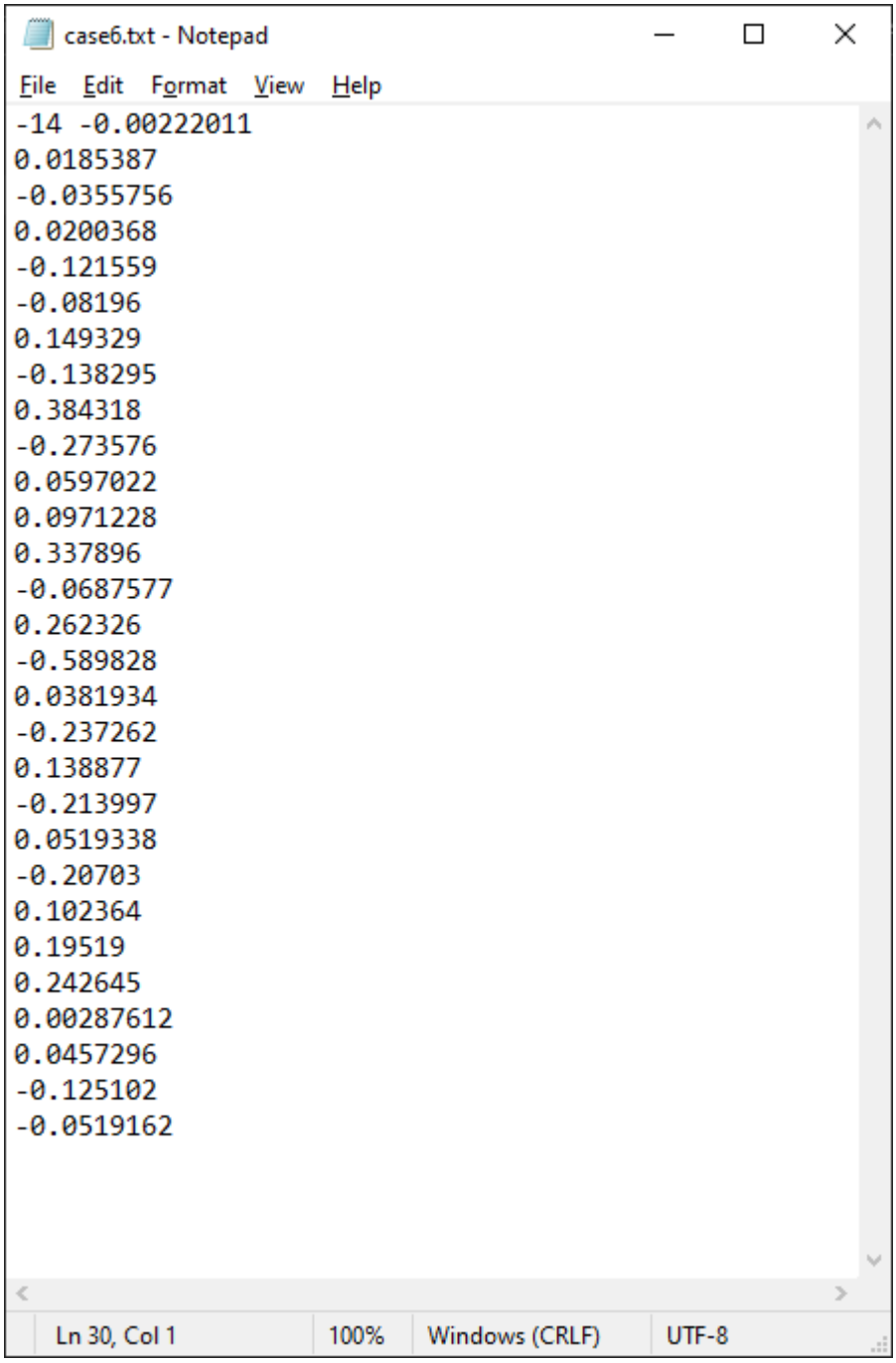
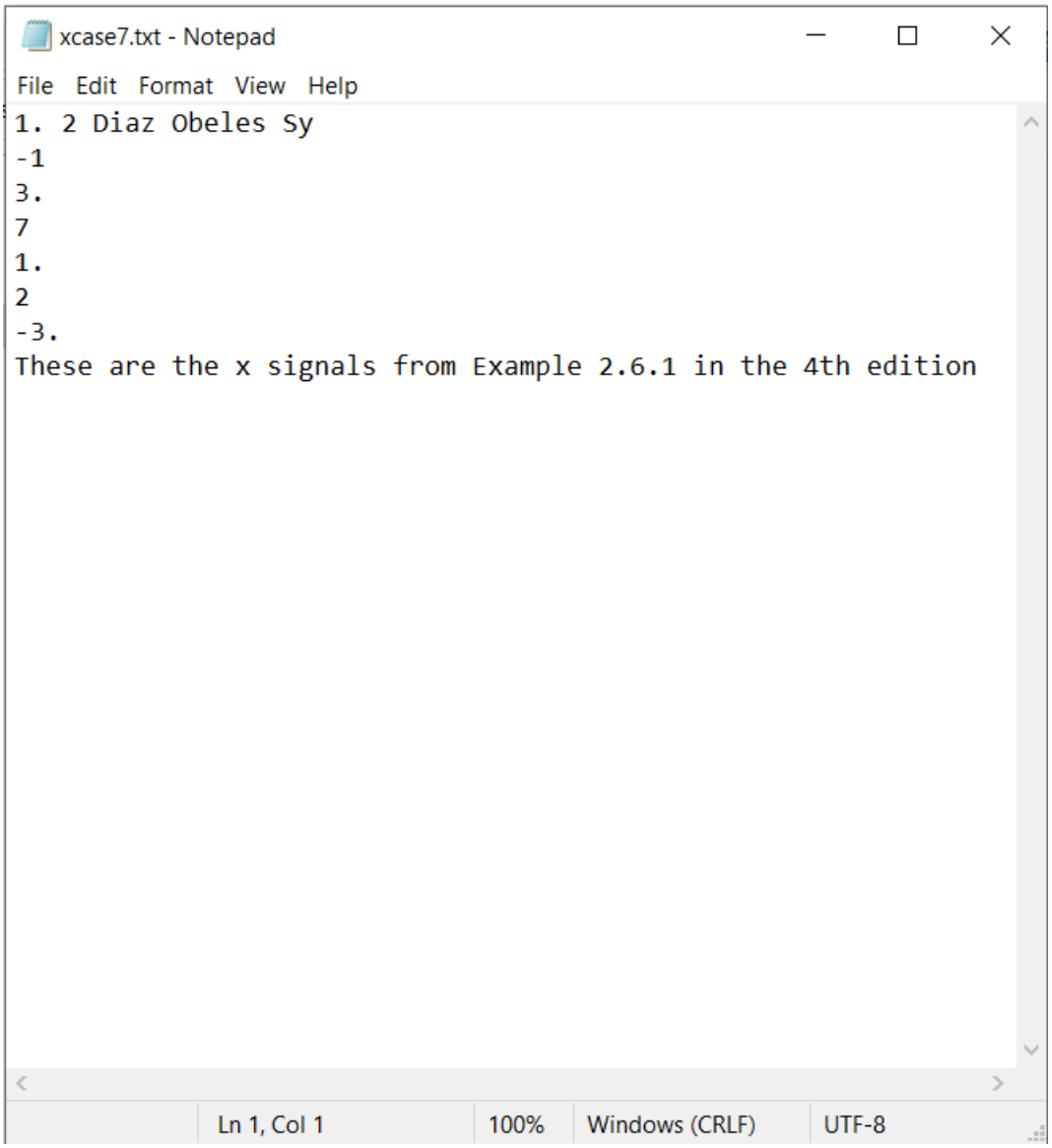
ENGG 151.01
Case 2 Calculation

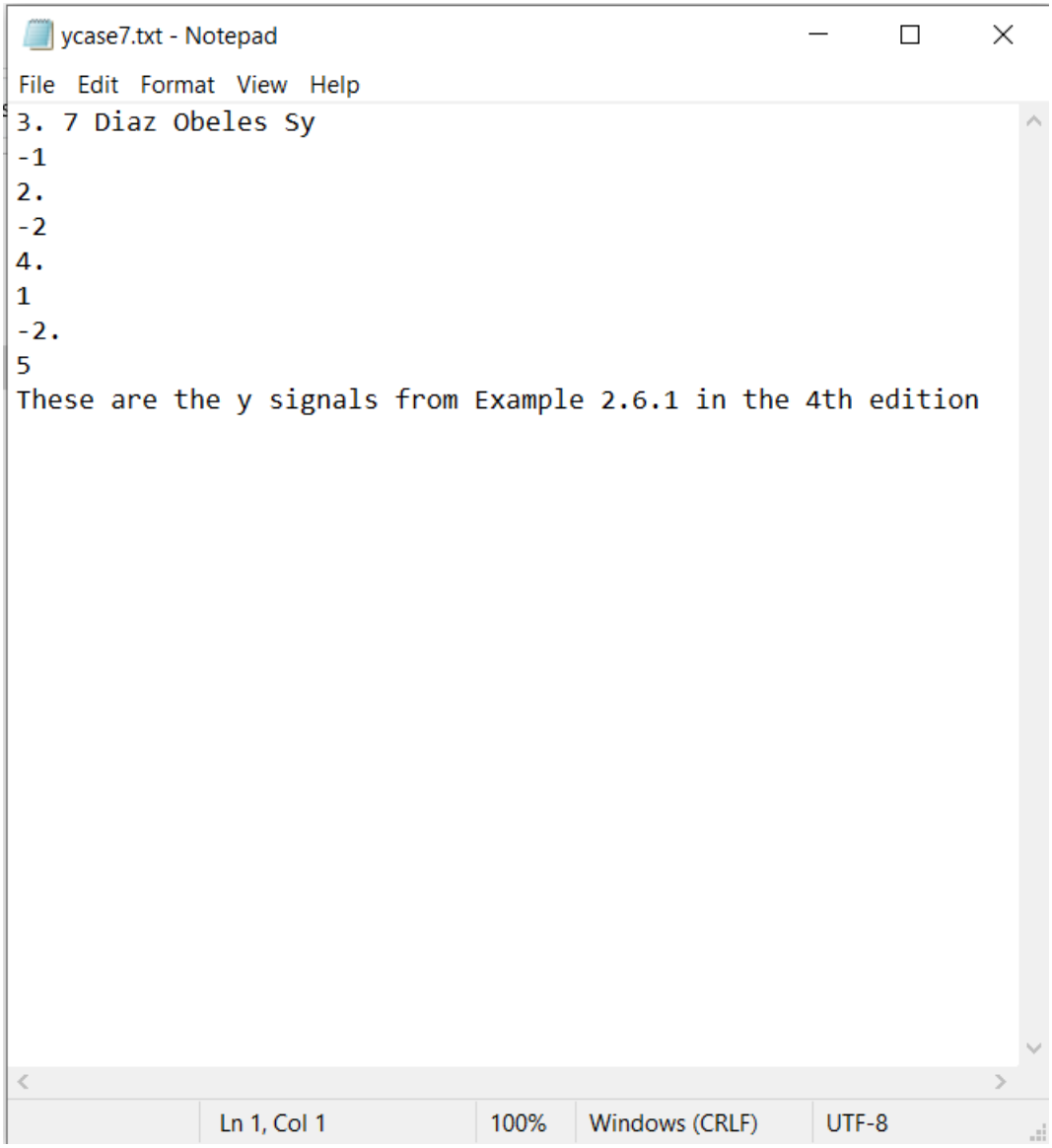
n	x(n)	y(n)	x(n) – Average	y(n) – Average	l	r_{xx}(l)	r_{yy}(l)	r_{xy}(l)	Normalized Cross Correlation p_{xy}(l)
-17					-17				
-16					-16				
-15					-15				
-14					-14			-0.0104497858	-0.00222010929955781
-13					-13			0.08725934573	0.0185386848567101
-12					-12			-0.1674499658	-0.0355755835547174
-11					-11			0.09431091456	0.0200368259580426
-10					-10			-0.57216548	-0.121559420727395
-9					-9			-0.385775796	-0.0819599992218058
-8					-8			0.70287241748	0.149328763965656
-7					-7			-0.6509358851	-0.138294587653225
-6					-6			1.80894050317	0.384318466205362
-5					-5			-1.2876902381	-0.273576237803635
-4					-4			0.2810108458	0.0597021610468851
-3					-3			0.45714539968	0.0971228288223918
-2					-2			1.59043784157	0.337896481833335
-1					-1			-0.3236340107	-0.0687576658100514

```
C:\Windows\System32\cmd.exe
Microsoft Windows [Version 10.0.19043.1586]
(c) Microsoft Corporation. All rights reserved.

G:\.shortcut-targets-by-id\1KnORGfjmvneNUYM6tyak62reHx19nGFf\Project 1 (Normalized Crosscorrelation)\xcorr\bin\Debug>xcorr xcase6.txt ycase6.txt case6.txt

G:\.shortcut-targets-by-id\1KnORGfjmvneNUYM6tyak62reHx19nGFf\Project 1 (Normalized Crosscorrelation)\xcorr\bin\Debug>
```

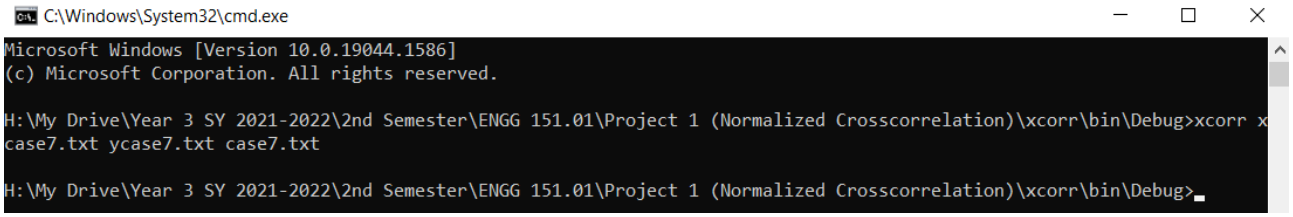


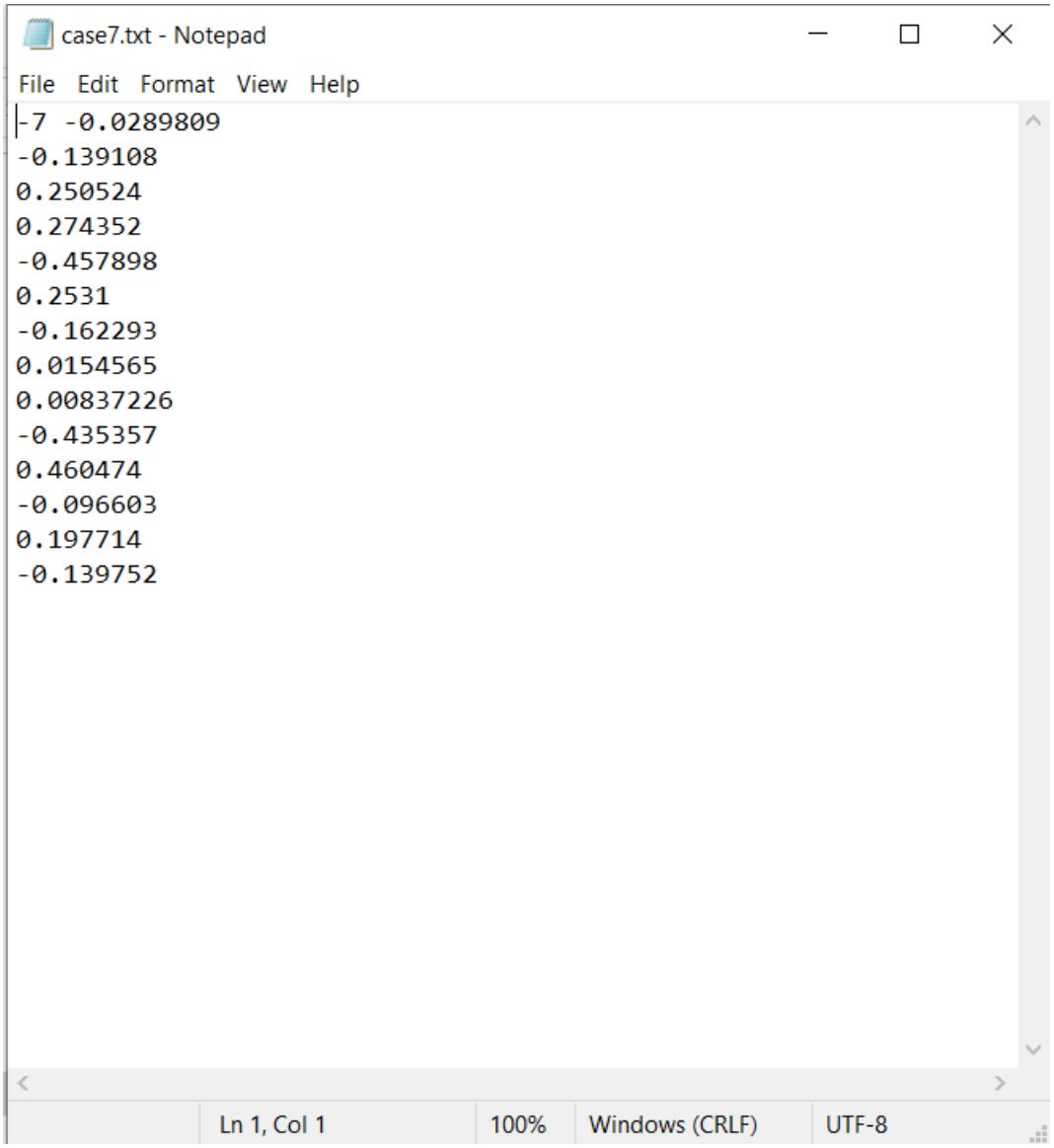
- Case 7. When “starting index” has a “period (.)” character appended to it
    - Should set the starting indices that have this case to 0 and place the “starting index” value as a signal value.



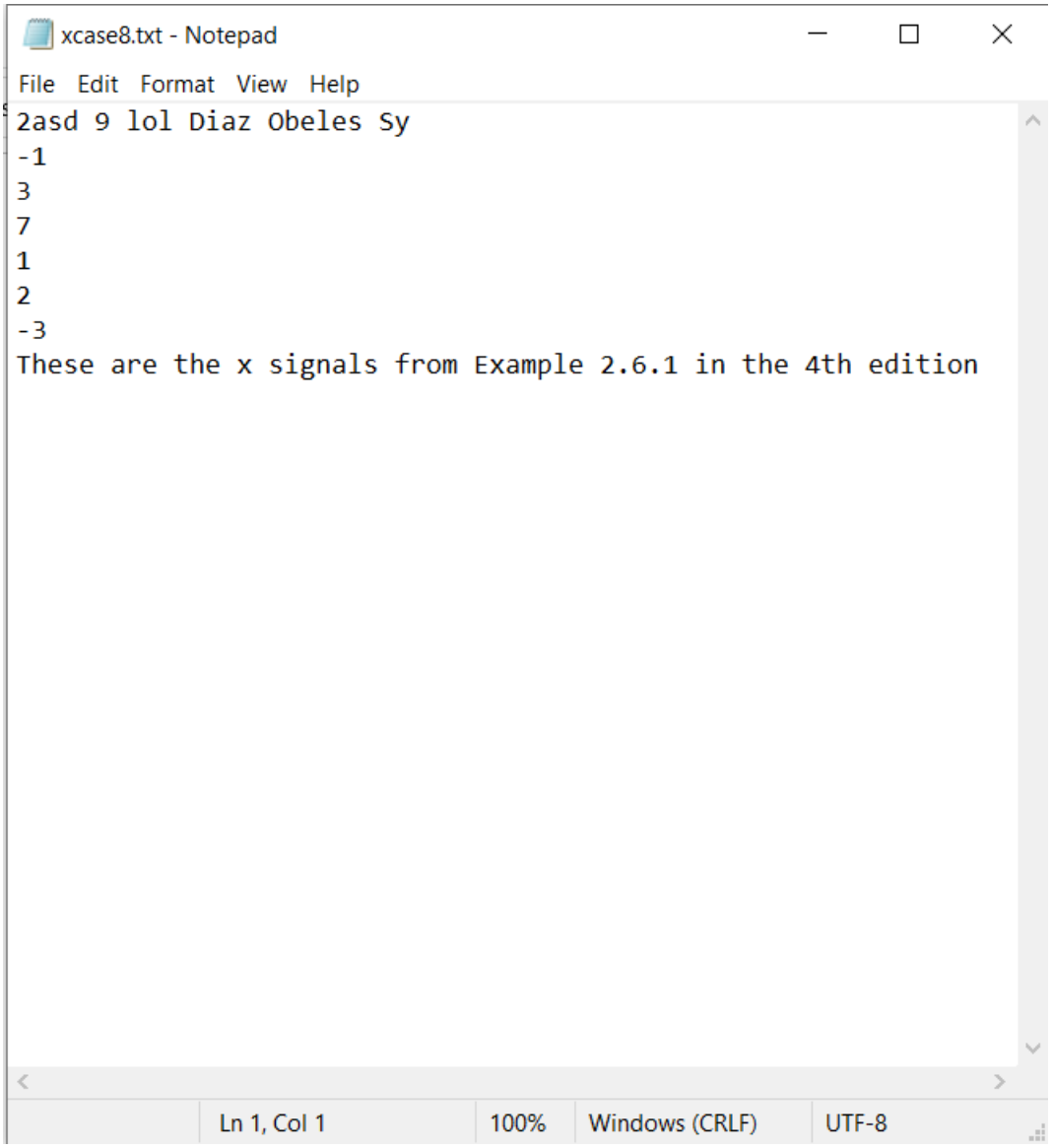


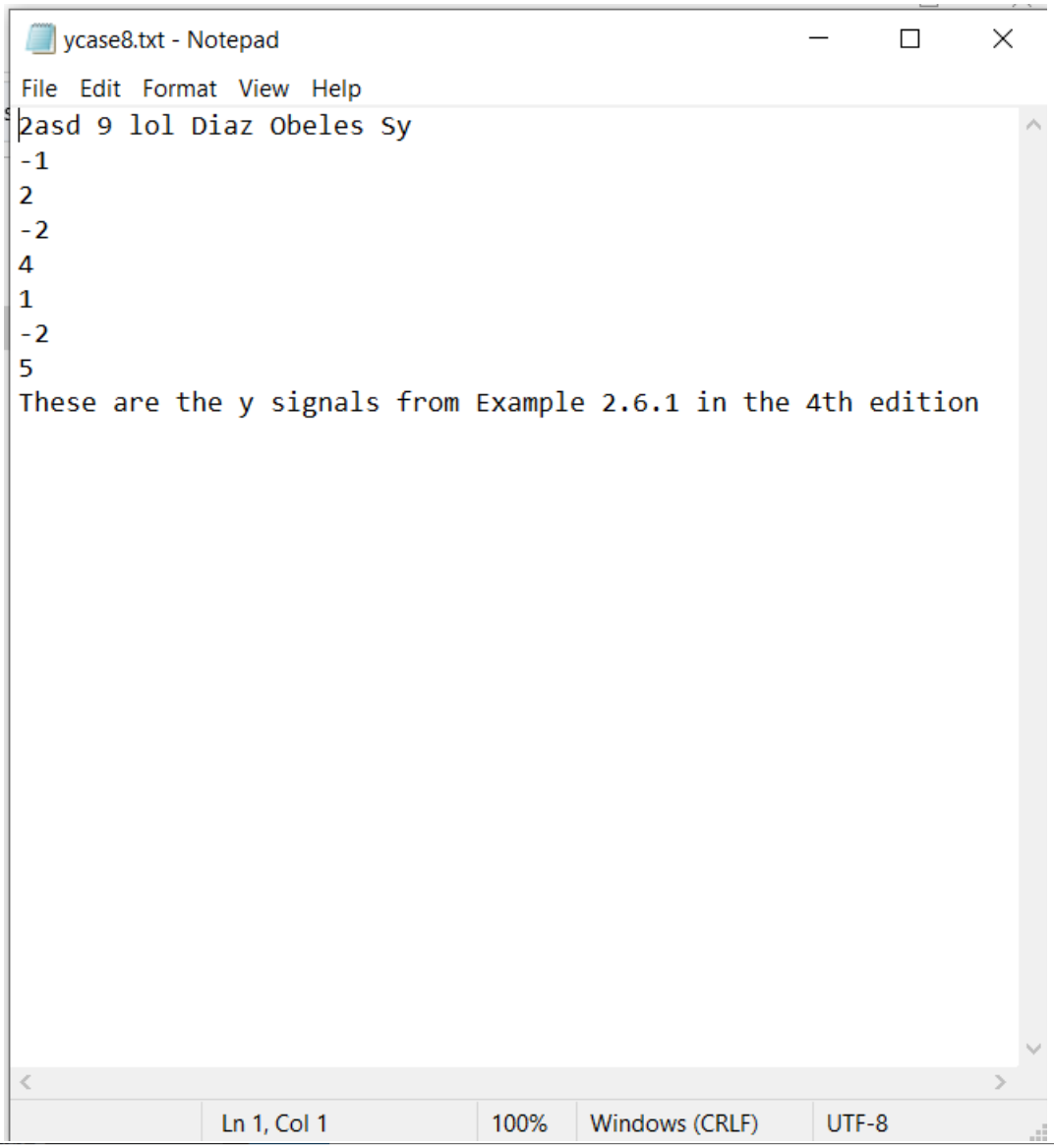
						Normalized Cross Correlation
x(n) – Average	y(n) – Average	l	r_{xx}(l)	r_{yy}(l)	r_{xy}(l)	p_{xy}(l)
		-10				
		-9				
		-8				
		-7			-1.607142857	-0.0289808919055417
		-6			-7.714285714	-0.1391082811466
		-5			13.89285714	0.250523710027905
		-4			15.21428571	0.274352443372461
		-3			-25.39285714	-0.457898092107558
		-2			14.03571429	0.253099789308397
		-1			-9	-0.162292994671033
-0.428571428571429	1.75	0	59.7142857142857	51.5	0.857142857	0.0154564756829556
-2.42857142857143	-2.25	1			0.464285714	0.00837225766160094
1.57142857142857	0.75	2			-24.14285714	-0.435357398403248
5.57142857142857	-3.25	3			25.53571429	0.460474171388051
-0.428571428571429	2.75	4			-5.357142857	-0.0966029730184722
0.571428571428571	-0.25	5			10.96428571	0.197714084777807
-4.42857142857143	-3.25	6			-7.75	-0.139752300966723
	3.75	7				
		8				
		9				
		10				
0	0		Normalization Coefficient	55.45525867116		

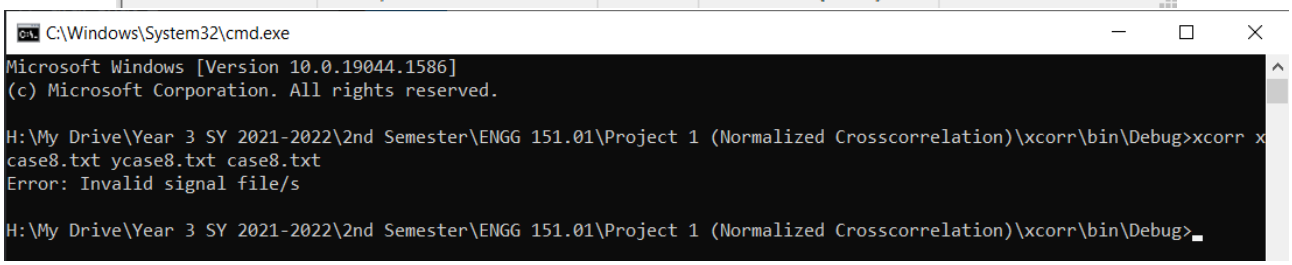

C:\Windows\System32\cmd.exe
Microsoft Windows [Version 10.0.19044.1586]
(c) Microsoft Corporation. All rights reserved.
H:\My Drive\Year 3 SY 2021-2022\2nd Semester\ENGG 151.01\Project 1 (Normalized Crosscorrelation)\xcorr\bin\Debug>xcorr x
case7.txt ycase7.txt case7.txt
H:\My Drive\Year 3 SY 2021-2022\2nd Semester\ENGG 151.01\Project 1 (Normalized Crosscorrelation)\xcorr\bin\Debug>


case7.txt - Notepad
File Edit Format View Help
-7 -0.0289809
-0.139108
0.250524
0.274352
-0.457898
0.2531
-0.162293
0.0154565
0.00837226
-0.435357
0.460474
-0.096603
0.197714
-0.139752
Ln 1, Col 1
100%
Windows (CRLF)
UTF-8

- Case 8. When “starting index” has other characters appended to it.
    - Should return that there is an error and that the signal files are invalid.




ycase8.txt - Notepad
File Edit Format View Help
2asd 9 lol Diaz Obeles Sy
-1
2
-2
4
1
-2
5
These are the y signals from Example 2.6.1 in the 4th edition
Ln 1, Col 1
100%
Windows (CRLF)
UTF-8


C:\Windows\System32\cmd.exe
Microsoft Windows [Version 10.0.19044.1586]
(c) Microsoft Corporation. All rights reserved.
H:\My Drive\Year 3 SY 2021-2022\2nd Semester\ENGG 151.01\Project 1 (Normalized Crosscorrelation)\xcorr\bin\Debug>xcorr x
case8.txt ycase8.txt case8.txt
Error: Invalid signal file/s
H:\My Drive\Year 3 SY 2021-2022\2nd Semester\ENGG 151.01\Project 1 (Normalized Crosscorrelation)\xcorr\bin\Debug>