

Scilab Manual for
Digital Signal Processing Lab-1
by Prof Jeevan Reddy Koya
Electronics Engineering
Sreenidhi Institute Of Science And
Technology¹

Solutions provided by
Mr Sai Sugun L
Electronics Engineering
Sreenidhi Institute Of Science & Technology

May 18, 2024

¹Funded by a grant from the National Mission on Education through ICT, <http://spoken-tutorial.org/NMEICT-Intro>. This Scilab Manual and Scilab codes written in it can be downloaded from the "Migrated Labs" section at the website <http://scilab.in>

Contents

List of Scilab Solutions	3
1 Power spectral density estimation using n-point dft	5
2 PSD estimation via window based technique	10
3 Direct Sequence Spread Spectrum(DS-BPSK)	23
4 Constellation Diagram For Binary PSK	28
5 Repetition Code	31
6 Continuous Time Fourier Series of Sine Signal	33
7 Spectrum of Signal (Frequency Response)-Blackmann Window	35
8 Comparision Of Different Power Spectrum Estimates	37
9 Continuous Time Fourier Transform Of An Exponential Signal	39
10 FIR Band Pass Filter - Remez Algorithm-LPF	43

List of Experiments

Solution 1.1	1	5
Solution 2.2	2	10
Solution 3.3	3	23
Solution 4.4	4	28
Solution 5.5	5	31
Solution 6.6	6	33
Solution 7.7	7	35
Solution 8.8	8	37
Solution 9.9	9	39
Solution 10.10	10	43
AP 1	RepetitionCode	46
AP 2	DSSS	49

List of Figures

1.1	1	6
1.2	1	6
2.1	2	11
3.1	3	24
3.2	3	24
4.1	4	29
7.1	7	36
9.1	9	40
9.2	9	40
10.1	10	44

Experiment: 1

Power spectral density estimation using n-point dft

Scilab code Solution 1.1 1

```
1
2 //Power spectrum evaluation of a discrete sequence
   Using N-point DFT
3 //OS:Windows 10
4 //Scilab 5.5.2
5
6 clear all;
7 clc;
8 close;
9
10 N =16; //Number of samples in given sequence
11 n =0:N-1;
12 delta_f = [0.06,0.01]; //frequency separation
13 x1 = sin(2*%pi*0.315*n)+cos(2*%pi*(0.315+delta_f(1))
   *n);
```

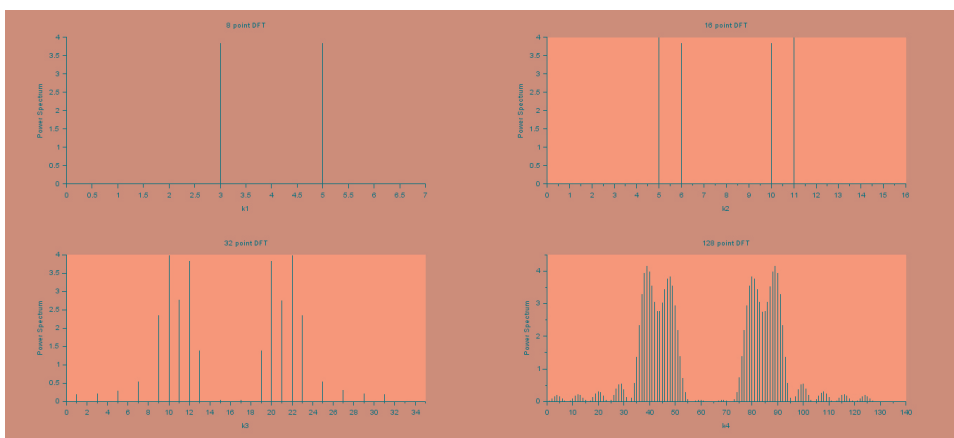


Figure 1.1: 1

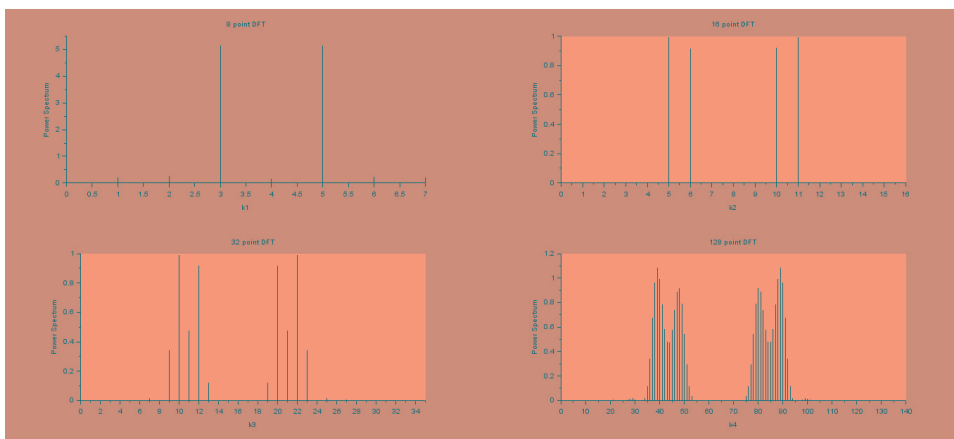


Figure 1.2: 1

```

14 x2 = sin(2*%pi*0.315*n)+cos(2*%pi*(0.315+delta_f(2))
    *n);
15 L = [8,16,32,128];
16 k1 = 0:L(1)-1;
17 k2 = 0:L(2)-1;
18 k3 = 0:L(3)-1;
19 k4 = 0:L(4)-1;
20 fk1 = k1./L(1);
21 fk2 = k2./L(2);
22 fk3 = k3./L(3);
23 fk4 = k4./L(4);
24 for i =1:length(fk1)
25     Pxx1_fk1(i) = 0;
26     Pxx2_fk1(i) = 0;
27     for m = 1:N
28         Pxx1_fk1(i)=Pxx1_fk1(i)+x1(m)*exp(-sqrt(-1)*2*
            %pi*(m-1)*fk1(i));
29         Pxx2_fk1(i)=Pxx1_fk1(i)+x1(m)*exp(-sqrt(-1)*2*
            %pi*(m-1)*fk1(i));
30     end
31     Pxx1_fk1(i) = (Pxx1_fk1(i)^2)/N;
32     Pxx2_fk1(i) = (Pxx2_fk1(i)^2)/N;
33 end
34 for i =1:length(fk2)
35     Pxx1_fk2(i) = 0;
36     Pxx2_fk2(i) = 0;
37     for m = 1:N
38         Pxx1_fk2(i)=Pxx1_fk2(i)+x1(m)*exp(-sqrt(-1)*2*
            %pi*(m-1)*fk2(i));
39         Pxx2_fk2(i)=Pxx1_fk2(i)+x1(m)*exp(-sqrt(-1)*2*
            %pi*(m-1)*fk2(i));
40     end
41     Pxx1_fk2(i) = (Pxx1_fk2(i)^2)/N;
42     Pxx2_fk2(i) = (Pxx1_fk2(i)^2)/N;
43 end
44 for i =1:length(fk3)
45     Pxx1_fk3(i) = 0;
46     Pxx2_fk3(i) = 0;

```



```

47     for m = 1:N
48         Pxx1_fk3(i) = Pxx1_fk3(i) + x1(m) * exp(-sqrt(-1) * 2 *
            %pi * (m-1) * fk3(i));
49         Pxx2_fk3(i) = Pxx1_fk3(i) + x1(m) * exp(-sqrt(-1) * 2 *
            %pi * (m-1) * fk3(i));
50     end
51     Pxx1_fk3(i) = (Pxx1_fk3(i)^2) / N;
52     Pxx2_fk3(i) = (Pxx1_fk3(i)^2) / N;
53 end
54 for i = 1:length(fk4)
55     Pxx1_fk4(i) = 0;
56     Pxx2_fk4(i) = 0;
57     for m = 1:N
58         Pxx1_fk4(i) = Pxx1_fk4(i) + x1(m) * exp(-sqrt(-1) * 2 *
            %pi * (m-1) * fk4(i));
59         Pxx2_fk4(i) = Pxx1_fk4(i) + x1(m) * exp(-sqrt(-1) * 2 *
            %pi * (m-1) * fk4(i));
60     end
61     Pxx1_fk4(i) = (Pxx1_fk4(i)^2) / N;
62     Pxx2_fk4(i) = (Pxx1_fk4(i)^2) / N;
63 end
64
65 figure(1)
66 subplot(2,2,1)
67 plot2d3('gnn',k1,abs(Pxx1_fk1))
68 xtitle('8 point DFT')
69 xlabel('k1')
70 ylabel('Power Spectrum')
71 subplot(2,2,2)
72 plot2d3('gnn',k2,abs(Pxx1_fk2))
73 xtitle('16 point DFT')
74 xlabel('k2')
75 ylabel('Power Spectrum')
76 subplot(2,2,3)
77 plot2d3('gnn',k3,abs(Pxx1_fk3))
78 xtitle('32 point DFT')
79 xlabel('k3')
80 ylabel('Power Spectrum')

```

```

81 subplot(2,2,4)
82 plot2d3('gnn',k4,abs(Pxx1_fk4))
83 xtitle('128 point DFT')
84 xlabel('k4')
85 ylabel('Power Spectrum')
86 figure(2)
87 xlabel('k1')
88 ylabel('Power Spectrum')
89 subplot(2,2,1)
90 plot2d3('gnn',k1,abs(Pxx2_fk1))
91 xtitle('8 point DFT')
92 xlabel('k1')
93 ylabel('Power Spectrum')
94 subplot(2,2,2)
95 plot2d3('gnn',k2,abs(Pxx2_fk2))
96 xtitle('16 point DFT')
97 xlabel('k2')
98 ylabel('Power Spectrum')
99 subplot(2,2,3)
100 plot2d3('gnn',k3,abs(Pxx2_fk3))
101 xtitle('32 point DFT')
102 xlabel('k3')
103 ylabel('Power Spectrum')
104 subplot(2,2,4)
105 plot2d3('gnn',k4,abs(Pxx2_fk4))
106 xtitle('128 point DFT')
107 xlabel('k4')
108 ylabel('Power Spectrum')

```

Experiment: 2

PSD estimation via window based technique

Scilab code Solution 2.2 2

```
1 //Determination of power spectrum of a signal using
   window based techniques
2 //OS:Windows 10
3 //Scilab 5.5.2
4
5 clear all;
6 clc;
7 close;
8
9 //With maximum normalized frequency f = 0.1
10
11 N = 61;
12 cfreq = [0.1 0];
13 [wft,wfm,fr]=wfir('lp',N,cfreq,'re',0);
14 disp(wft,'Time domain filter coefficients hd(n)=');
15 disp(wfm,'Frequency domain filter values Hd(w)=');
16 WFM_dB = 20*log10(wfm); //Frequency response in dB
```

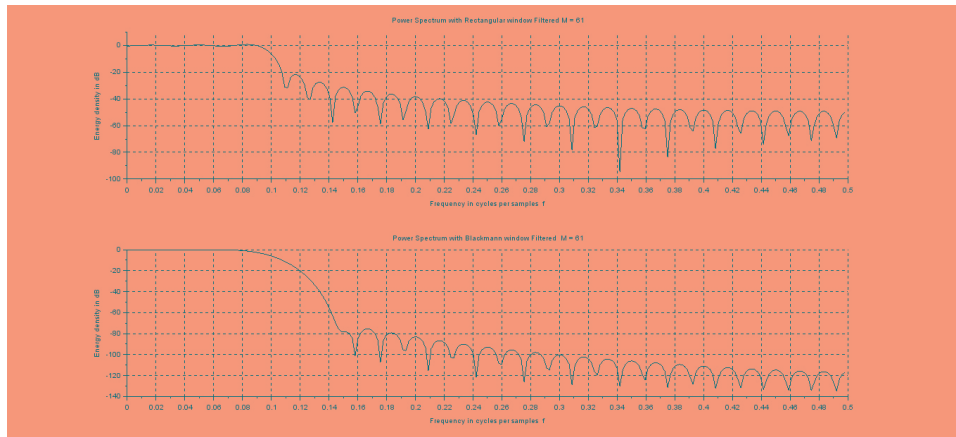


Figure 2.1: 2

```

17 for n = 1:N
18     h_balckmann(n)=0.42-0.5*cos(2*%pi*n/(N-1))+0.08*cos
        (4*%pi*n/(N-1));
19 end
20 wft_blmn = wft' .* h_balckmann;
21 disp(wft_blmn, 'Blackmann window based Filter output
        h(n)=')
22 wfm_blmn = frmag(wft_blmn, length(fr));
23 WFM_blmn_dB = 20*log10(wfm_blmn);
24 subplot(2,1,1)
25 plot2d(fr, WFM_dB)
26 xgrid(1)
27 xtitle('Power Spectrum with Rectangular window
        Filtered M = 61', 'Frequency in cycles per samples
        f', 'Energy density in dB')
28 subplot(2,1,2)
29 plot2d(fr, WFM_blmn_dB)
30 xgrid(1)
31 xtitle('Power Spectrum with Blackmann window
        Filtered M = 61', 'Frequency in cycles per
        samples f', 'Energy density in dB')
32
33 //Output

```

```

34
35 // Time domain filter coefficients hd(n)=
36 //
37 //
38 //          column 1 to 6
39 //
40 //      0.   -0.0064517   -0.0108118   -0.0112122
      -0.0071961    0.
41 //
42 //          column 7 to 11
43 //
44 //      0.0077957    0.0131622    0.0137605    0.0089094
      0.
45 //
46 //          column 12 to 16
47 //
48 //      -0.0098473   -0.0168184   -0.0178077   -0.0116936
      0.
49 //
50 //          column 17 to 21
51 //
52 //      0.0133641    0.023287    0.0252276    0.0170089
      0.
53 //
54 //          column 22 to 26
55 //
56 //      -0.0207887   -0.0378413   -0.0432472   -0.031183
      0.
57 //
58 //          column 27 to 31
59 //
60 //      0.0467745    0.1009102    0.1513653    0.1870979
      0.2
61 //
62 //          column 32 to 36
63 //
64 //      0.1870979    0.1513653    0.1009102    0.0467745
      0.

```

```

65 //
66 //          column 37 to 41
67 //
68 //   -0.031183   -0.0432472   -0.0378413   -0.0207887
69 //   0.
70 //
71 //          column 42 to 46
72 //   0.0170089    0.0252276    0.023287    0.0133641
73 //   0.
74 //
75 //          column 47 to 51
76 //   -0.0116936   -0.0178077   -0.0168184   -0.0098473
77 //   0.
78 //
79 //          column 52 to 56
80 //   0.0089094    0.0137605    0.0131622    0.0077957
81 //   0.
82 //
83 //          column 57 to 61
84 //   -0.0071961   -0.0112122   -0.0108118   -0.0064517
85 //   0.
86 // Frequency domain filter values Hd(w)=
87 //
88 //
89 //          column 1 to 4
90 //
91 //   0.9675288    0.9697174    0.9759947    0.9855327
92 //
93 //          column 5 to 8
94 //
95 //   0.9970705    1.0090769    1.0199494    1.0282222
96 //
97 //          column 9 to 12

```

98	//				
99	//	1.0327597	1.0329081	1.0285865	1.0203056
100	//				
101	//	column 13 to 16			
102	//				
103	//	1.0091095	0.9964485	0.9839967	0.9734374
104	//				
105	//	column 17 to 20			
106	//				
107	//	0.9662427	0.9634759	0.9656411	0.9726015
108	//				
109	//	column 21 to 24			
110	//				
111	//	0.9835771	0.9972258	1.0117987	1.0253531
112	//				
113	//	column 25 to 28			
114	//				
115	//	1.0359982	1.0421436	1.0427207	1.0373466
116	//				
117	//	column 29 to 32			
118	//				
119	//	1.0264107	1.0110667	0.9931303	0.9748874
120	//				
121	//	column 33 to 36			
122	//				
123	//	0.9588338	0.9473719	0.9424999	0.9455261
124	//				
125	//	column 37 to 40			
126	//				
127	//	0.9568447	0.9757996	1.0006553	1.0286838
128	//				
129	//	column 41 to 44			
130	//				
131	//	1.0563623	1.0796646	1.0944208	1.0967084
132	//				
133	//	column 45 to 49			
134	//				
135	//	1.083237	1.0516873	1.0009693	0.9313716

```

0.844588
136 //
137 //      column 50 to 54
138 //
139 //      0.7436142      0.6325263      0.51616      0.3997228
0.2883759
140 //
141 //      column 55 to 58
142 //
143 //      0.1868241      0.0989556      0.0275603      0.0258446
144 //
145 //      column 59 to 62
146 //
147 //      0.0610721      0.0792022      0.082409      0.0737002
148 //
149 //      column 63 to 66
150 //
151 //      0.0565962      0.0347843      0.0117814      0.009362
152 //
153 //      column 67 to 70
154 //
155 //      0.0262894      0.0374811      0.0423011      0.0409531
156 //
157 //      column 71 to 74
158 //
159 //      0.0343542      0.0239471      0.0114751      0.0012542
160 //
161 //      column 75 to 78
162 //
163 //      0.0125883      0.0212119      0.0262721      0.0274398
164 //
165 //      column 79 to 82
166 //
167 //      0.0249026      0.0192981      0.0115978      0.0029604
168 //
169 //      column 83 to 87
170 //
171 //      0.0054265      0.0124965      0.017429      0.019734

```



```

0.0192912
172 //
173 //      column 88 to 92
174 //
175 //      0.01634      0.0114257      0.0053107      0.0011358
0.0070546
176 //
177 //      column 93 to 96
178 //
179 //      0.0117055      0.0145548      0.0153314      0.0140473
180 //
181 //      column 97 to 100
182 //
183 //      0.0109805      0.0066249      0.0016159      0.0033586
184 //
185 //      column 101 to 104
186 //
187 //      0.0076495      0.0107281      0.0122486      0.0120842
188 //
189 //      column 105 to 108
190 //
191 //      0.0103331      0.0072958      0.0034271      0.0007296
192 //
193 //      column 109 to 112
194 //
195 //      0.0046165      0.0077345      0.0097054      0.0103164
196 //
197 //      column 113 to 116
198 //
199 //      0.0095408      0.0075343      0.0046078      0.0011806
200 //
201 //      column 117 to 120
202 //
203 //      0.0022776      0.0053107      0.0075345      0.0086846
204 //
205 //      column 121 to 124
206 //
207 //      0.0086466      0.0074659      0.0053365      0.0025704

```

```

208 //
209 //          column 125 to 128
210 //
211 //    0.0004471    0.0033099    0.0056452    0.0071613
212 //
213 //          column 129 to 132
214 //
215 //    0.0076831    0.0071717    0.0057252    0.0035621
216 //
217 //          column 133 to 136
218 //
219 //    0.0009886    0.0016436    0.0039851    0.0057344
220 //
221 //          column 137 to 140
222 //
223 //    0.0066764    0.0067081    0.0058494    0.0042369
224 //
225 //          column 141 to 145
226 //
227 //    0.0021034    0.0002558    0.0025229    0.0044
228 //    0.0056481
229 //
230 //          column 146 to 150
231 //
232 //    0.0061171    0.005763    0.004652    0.0029484
233 //    0.0008913
234 //
235 //          column 151 to 154
236 //
237 //    0.0012388    0.0031582    0.0046169    0.0054315
238 //
239 //          column 155 to 158
240 //
241 //    0.0055074    0.0048499    0.003561    0.0018246
242 //
243 //          column 159 to 162
244 //
245 //    0.0001203    0.0020115    0.0035992    0.0046784

```

```

244 //
245 //          column 163 to 167
246 //
247 //    0.0051154    0.004864    0.0039702    0.002564
      0.0008414
248 //
249 //          column 168 to 171
250 //
251 //    0.0009635    0.0026096    0.0038807    0.0046144
252 //
253 //          column 172 to 175
254 //
255 //    0.004722    0.0041992    0.0031255    0.0016524
256 //
257 //          column 176 to 179
258 //
259 //    0.0000183    0.0016613    0.0030588    0.0040284
260 //
261 //          column 180 to 183
262 //
263 //    0.0044474    0.004268    0.0035224    0.0023176
264 //
265 //          column 184 to 187
266 //
267 //    0.0008202    0.0007666    0.0022306    0.0033785
268 //
269 //          column 188 to 191
270 //
271 //    0.0040614    0.0041944    0.0037665    0.0028415
272 //
273 //          column 192 to 195
274 //
275 //    0.0015484    0.0000637    0.0014125    0.0026839
276 //
277 //          column 196 to 199
278 //
279 //    0.0035833    0.0039949    0.0038691    0.0032282
280 //

```

```

281 //          column 200 to 203
282 //
283 //    0.0021631    0.0008199    0.0006196    0.0019626
284 //
285 //          column 204 to 207
286 //
287 //    0.003031    0.0036848    0.0038407    0.0034824
288 //
289 //          column 208 to 211
290 //
291 //    0.0026621    0.0014932    0.0001345    0.0012312
292 //
293 //          column 212 to 215
294 //
295 //    0.0024216    0.0032793    0.0036924    0.003609
296 //
297 //          column 216 to 219
298 //
299 //    0.0030439    0.002076    0.0008371    0.0005054
300 //
301 //          column 220 to 223
302 //
303 //    0.0017717    0.0027931    0.0034349    0.0036136
304 //
305 //          column 224 to 228
306 //
307 //    0.003308    0.0025617    0.0014769    0.0002001
308 //    0.001097
309 //
310 //          column 229 to 233
311 //    0.002241    0.0030797    0.0035026    0.003455
312 //    0.0029452
313 //
314 //          column 234 to 237
315 //    0.0020432    0.0008713    0.000413    0.0016374
316 //

```

```

317 //          column 238 to 241
318 //
319 //      0.0026386    0.0032833    0.0034864    0.0032221
320 //
321 //          column 242 to 245
322 //
323 //      0.0025269    0.0014951    0.0002654    0.0009971
324 //
325 //          column 246 to 249
326 //
327 //      0.0021236    0.0029635    0.0034049    0.0033894
328 //
329 //          column 250 to 253
330 //
331 //      0.0029197    0.0020592    0.0009236    0.0003348
332 //
333 //          column 254 to 256
334 //
335 //      0.0015476    0.0025522    0.0032144
336 //
337 // Blackmann window based Filter output h(n)=
338 //
339 //      -7.725D-21
340 //      -0.0000259
341 //      -0.0000994
342 //      -0.0001879
343 //      -0.0001942
344 //      3.135D-19
345 //      0.0004427
346 //      0.0010144
347 //      0.0013951
348 //      0.0011582
349 //      -1.272D-18
350 //      -0.001977
351 //      -0.0040862
352 //      -0.005155
353 //      -0.0039758
354 //      3.072D-18

```

355	//	0.0060255
356	//	0.0118714
357	//	0.0143756
358	//	0.0107156
359	//	-5.373D-18
360	//	-0.0155126
361	//	-0.0302706
362	//	-0.0367268
363	//	-0.0278468
364	//	7.253D-18
365	//	0.0449152
366	//	0.0991097
367	//	0.1506861
368	//	0.1870979
369	//	0.1991026
370	//	0.1837596
371	//	0.1453485
372	//	0.0938771
373	//	0.0417702
374	//	6.621D-18
375	//	-0.0249443
376	//	-0.0322712
377	//	-0.0260792
378	//	-0.0130968
379	//	-4.443D-18
380	//	0.0086709
381	//	0.0113744
382	//	0.0091754
383	//	0.0045438
384	//	2.257D-18
385	//	-0.0028411
386	//	-0.0035753
387	//	-0.0027431
388	//	-0.0012801
389	//	-7.904D-19
390	//	0.0006867
391	//	0.0007815
392	//	0.0005293

393	//	0.0002104
394	//	1.306D−19
395	//	−0.0000662
396	//	−0.000045
397	//	−0.0000107
398	//	8.953D−20
399	//	−7.725D−21

Experiment: 3

Direct Sequence Spread Spectrum(DS-BPSK)

check Appendix [AP 2](#) for dependency:

DS_Spread_Spectrum.sci

Scilab code Solution 3.3 3

```
1
2 //Direct Sequence Spread Spectrum(DS-BPSK)
3 //OS:Windows 10
4 //Scilab 5.5.2
5
6 clear all;
7 clc;
8 close;
9
10 function [st,mt]= DS_Spread_Spectrum(bt,ct_polar)
```

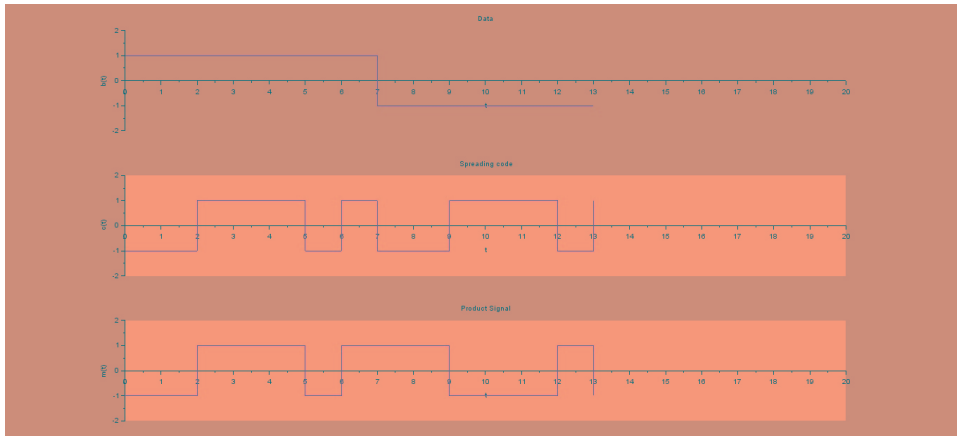



Figure 3.1: 3

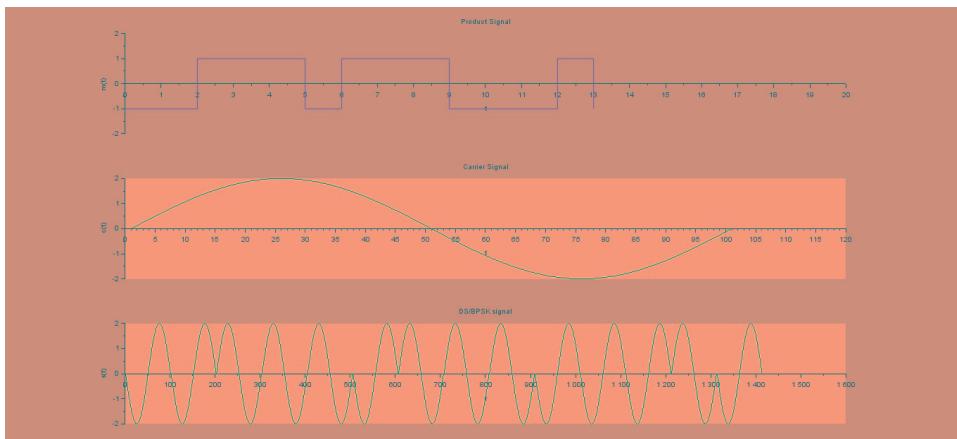


Figure 3.2: 3

```

11 //Generation of waveforms in DS/BPSK spread spectrum
    transmitter
12 //bt: Input Data Sequence (bipolar format)
13 //ct_polar: Spreading code (bipolar format)
14 Ft = 0:0.01:1;
15 //bt = [1*ones(1,N) -1*ones(1,N)];
16 t = 0:length(bt)-1;
17 //ct_polar = [-1,-1,1,1,1,-1,1,-1,-1,1,1,1,-1,1];
18 mt = bt.*ct_polar;
19 Carrier = 2*sin(Ft*2*pi);
20 st = [];
21 for i = 1:length(mt)
22     st = [st mt(i)*Carrier];
23 end
24
25 figure
26 subplot(3,1,1)
27 a = gca();
28 a.x_location = "origin";
29 a.y_location = "origin";
30 a.data_bounds = [0,-2;20,2];
31 plot2d2(t,bt,5)
32 xlabel('
    t')
33 ylabel('
    b(t)')
34 title('Data')
35 subplot(3,1,2)
36 a = gca();
37 a.x_location = "origin";
38 a.y_location = "origin";
39 a.data_bounds = [0,-2;20,2];
40 plot2d2(t,ct_polar,5)
41 xlabel('
    t')

```

```

42 ylabel('

        c(t)')
43 title('Spreading code')
44 subplot(3,1,3)
45 a = gca();
46 a.x_location = "origin";
47 a.y_location = "origin";
48 a.data_bounds = [0,-2;20,2];
49 plot2d2(t,mt,5)
50 xlabel('

        t')
51 ylabel('

        m(t)')
52 title('Product Signal')
53
54 figure
55 subplot(3,1,1)
56 a = gca();
57 a.x_location = "origin";
58 a.y_location = "origin";
59 a.data_bounds = [0,-2;20,2];
60 plot2d2(t,mt,5)
61 xlabel('

        t')
62 ylabel('

        m(t)')
63 title('Product Signal')
64 subplot(3,1,2)
65 a = gca();
66 a.x_location = "origin";
67 a.y_location = "origin";
68 a.data_bounds = [0,-2;20,2];
69 plot(Carrier)

```

```

70 xlabel('
    t')
71 ylabel('
    c(t)')
72 title('Carrier Signal')
73 subplot(3,1,3)
74 a = gca();
75 a.x_location = "origin";
76 a.y_location = "origin";
77 a.data_bounds = [0,-2;20,2];
78 plot(st)
79 xlabel('
    t')
80 ylabel('
    s(t)')
81 title('DS/BPSK signal')
82 endfunction
83
84 bt = [1,1,1,1,1,1,1,-1,-1,-1,-1,-1,-1,-1]
85 ct_polar = [-1,-1,1,1,1,-1,1,-1,-1,1,1,1,-1,1]
86 [st,mt]= DS_Spread_Spectrum(bt,ct_polar)

```

Experiment: 4

Constellation Diagram For Binary PSK

Scilab code Solution 4.4 4

```
1 // Constellation Diagram For Binary PSK
2 // OS: Windows 10
3 // Scilab 5.5.2
4
5 clear all;
6 clc;
7 close;
8
9 function [y]= Constellation_BPSK()
10 M =2;
11 i = 1:M;
12 y = cos(2*%pi+(i-1)*%pi);
13 annot = dec2bin([length(y)-1:-1:0], log2(M));
14 disp(y, 'coordinates of message points')
15 disp(annot, 'Message points')
16 figure;
17 a = gca();
```

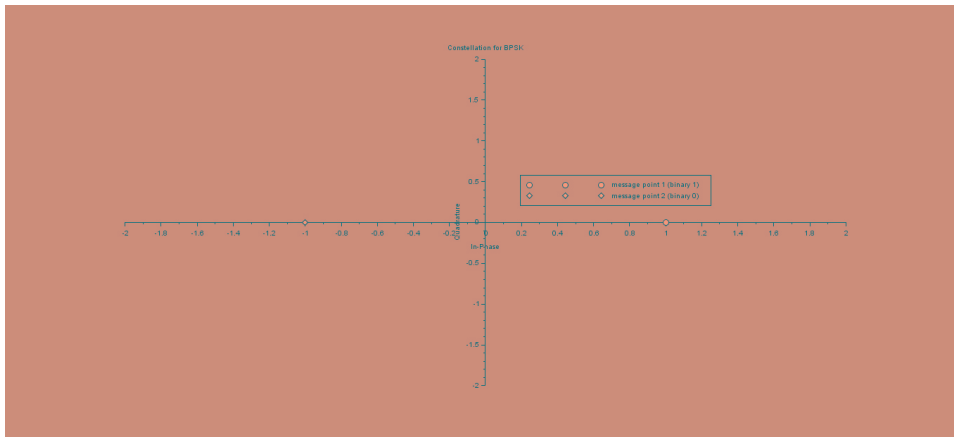


Figure 4.1: 4

```

18 a.data_bounds = [-2,-2;2,2];
19 a.x_location = "origin";
20 a.y_location = "origin";
21 plot2d(real(y(1)),imag(y(1)),-9)
22 plot2d(real(y(2)),imag(y(2)),-5)
23 xlabel('
    In-Phase');
24 ylabel('
    Quadrature');
25 title('Constellation for BPSK')
26 legend(['message point 1 (binary 1)'; 'message point
    2 (binary 0)'],5)
27 endfunction
28
29 Constellation_BPSK()
30
31 //Output
32 //coordinates of message points
33 //
34 //    1.   -1.
35 //

```

```
36 // Message points
37 //
38 //!1 0 !
```

Experiment: 5

Repetition Code

check Appendix [AP 1](#) for dependency:

RepetitionCode.sci

Scilab code Solution 5.5 5

```
1 //Repetition Code
2 //OS:Windows 10
3 //Scilab 5.5.2
4
5 clear all;
6 clc;
7 close;
8
9 function [G,H,x]=RepetitionCode(n,k,m)
10 //Repetition Codes
11 //n =block of identical 'n' bits
12 //k =1 one bit
13 //m = 1;// bit value = 1
14 I = eye(n-k,n-k); //Identity matrix
15 P = ones(1,n-k); //coefficient matrix
16 H = [I P']; //parity-check matrix
17 G = [P 1]; //generator matrix
```



```

18 x = m.*G; //code word
19 disp(G,'generator matrix');
20 disp(H,'parity-check matrix');
21 disp(x,'code word for binary one input');
22 endfunction
23
24 n=5;
25 k=1;
26 m=1;
27 [G,H,x]=RepetitionCode(n,k,m)
28
29 //Output
30 // generator matrix
31 //
32 //      1.      1.      1.      1.      1.
33 //
34 // parity-check matrix
35 //
36 //      1.      0.      0.      0.      1.
37 //      0.      1.      0.      0.      1.
38 //      0.      0.      1.      0.      1.
39 //      0.      0.      0.      1.      1.
40 //
41 // code word for binary one input
42 //
43 //      1.      1.      1.      1.      1.

```

Experiment: 6

Continuous Time Fourier Series of Sine Signal

Scilab code Solution 6.6 6

```
1 //Continuous Time Fourier Series of Sine Signal
2 //OS:Windows 10
3 //Scilab 5.5.2
4
5 clear;
6 clc;
7 close;
8
9 //periodic sine signal  $x(t) = \sin(Wot)$ 
10
11 t = 0:0.01:1;
12 T = 1;
13 Wo = 2*%pi/T;
14 xt = sin(Wo*t);
15 for k = 0:5
16     C(k+1,:) = exp(-sqrt(-1)*Wo*t.*k);
17     a(k+1) = xt*C(k+1,:)' / length(t); //fourier series
18     is done
19     if(abs(a(k+1)) <= 0.01)
```

```

19     a(k+1)=0;
20     end
21 end
22 a =a';
23 ak = [-a($:-1:1),a(2:$)];
24 disp(ak,'Continuous Time Fourier Series Coefficients
      are: ')
25
26 //Output
27 // Continuous Time Fourier Series Coefficients are:
28 //
29 //
30 //          column 1 to 9
31 //
32 //    0.    0.    0.    0.    0.4950495i    0.   -0.4950495
      i    0.    0.
33 //
34 //          column 10 to 11
35 //
36 //    0.    0.

```

Experiment: 7

Spectrum of Signal (Frequency Response)-Blackmann Window

Scilab code Solution 7.7 7

```
1 //SPECTRUM OF SIGNAL (FREQUENCY RESPONSE)– BLACKMANN
  WINDOW
2 //OS:Windows 10
3 //Scilab 5.5.2
4
5 clear all;
6 clc;
7 close;
8
9 //With maximum normalized frequency f = 0.4
10
11 N = 11;
12 cfreq = [0.4 0];
13 [wft,wfm,fr]=wfirm('lp',N,cfreq,'re',0);
14 wft; // Time domain filter
    coefficients
15 wfm; // Frequency domain filter
```

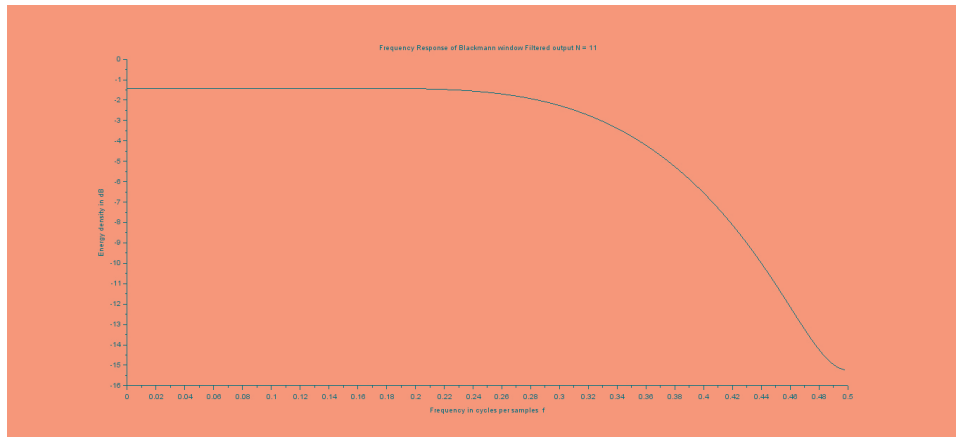


Figure 7.1: 7

```

values
16 fr;                                // Frequency sample points
17 for n = 1:N
18     h_blackmann(n)=0.42-0.5*cos(2*pi*n/(N-1))+0.08*
        cos(4*pi*n/(N-1));
19     wft_blmn(n) = wft(n)*h_blackmann(n);
20 end
21 wfm_blmn = frmag(wft_blmn,length(fr));
22 WFM_blmn_dB =20*log10(wfm_blmn);
23 plot2d(fr,WFM_blmn_dB)
24 xtitle('Frequency Response of Blackmann window
    Filtered output N = 11','Frequency in cycles per
    samples f','Energy density in dB')

```

Experiment: 8

Comparision Of Different Power Spectrum Estimates

Scilab code Solution 8.8 8

```
1 //COMPARISON OF DIFFERENT POWER SPECTRUM ESTIMATES
2 //OS: Windows 10
3 //Scilab 5.5.2
4
5 clear all;
6 clc;
7 close;
8
9 Q = 10; //Quality factor
10 N = 1000; //Length of the sample sequence
11 //Bartlett Method
12 F_Bartlett = Q/(1.11*N);
13 disp(F_Bartlett, 'Frequency Resolution of Bartlett
    Power Spectrum Estimation')
14 //Welch Method
15 F_Welch = Q/(1.39*N);
16 disp(F_Welch, 'Frequency Resolution of Welch Power
    Spectrum Estimation')
17 //Blackmann–Tukey Method
```

```

18 F_Blackmann_Tukey = Q/(2.34*N);
19 disp(F_Blackmann_Tukey, 'Frequency Resolution of
    Blackmann Tukey Power Spectrum Estimation')
20
21
22 //Output
23 // Frequency Resolution of Bartlett Power Spectrum
    Estimation
24 //
25 //    0.009009
26 //
27 // Frequency Resolution of Welch Power Spectrum
    Estimation
28 //
29 //    0.0071942
30 //
31 // Frequency Resolution of Blackmann Tukey Power
    Spectrum Esti
32 // mation
33 //    0.0042735

```

Experiment: 9

Continuous Time Fourier Transform Of An Exponential Signal

Scilab code Solution 9.9 9

```
1 //CONTINUOUS TIME FOURIER TRANSFORM OF A EXPONENTIAL
  SIGNAL
2 //OS:Windows 10
3 //Scilab 5.5.2
4
5 clear all;
6 clc;
7 close;
8
9 //Continuous Time Exponential Signal  $x(t) = \exp(-A*t)$ 
   $u(t)$ ,  $A > 0$ 
10
11 // Analog Signal
```

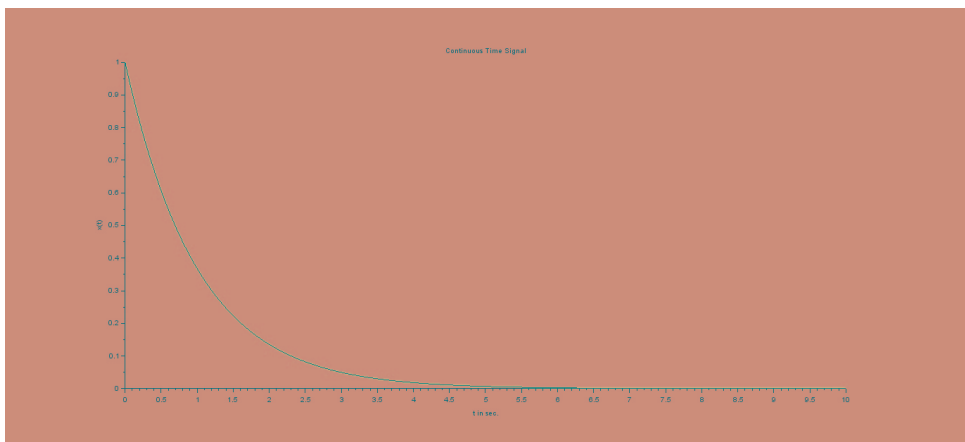



Figure 9.1: 9

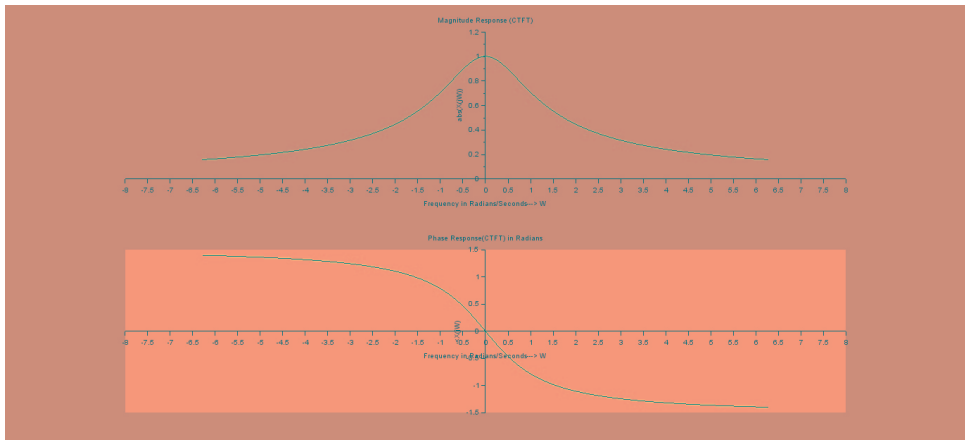


Figure 9.2: 9

```

12 A =1;           //Amplitude
13 Dt = 0.005;
14 t = 0:Dt:10;
15 xt = exp(-A*t);
16
17 // Continuous-time Fourier Transform
18 Wmax = 2*pi*1;           //Analog Frequency = 1Hz
19 K = 4;
20 k = 0:(K/1000):K;
21 W = k*Wmax/K;
22 XW = xt* exp(-sqrt(-1)*t'*W) * Dt;
23 XW_Mag = abs(XW);
24 W = [-mtlbfliplr(W), W(2:1001)]; // Omega from -
    Wmax to Wmax
25 XW_Mag = [mtlbfliplr(XW_Mag), XW_Mag(2:1001)];
26 [XW_Phase,db] = phasemag(XW);
27 XW_Phase = [-mtlbfliplr(XW_Phase),XW_Phase(2:1001)
    ];
28
29 //Plotting Continuous Time Signal
30 figure
31 a = gca();
32 a.y_location = "origin";
33 plot(t,xt);
34 xlabel('t in sec. ');
35 ylabel('x(t)')
36 title('Continuous Time Signal')
37
38 //Plotting Magnitude Response of CTS
39 figure
40 subplot(2,1,1);
41 a = gca();
42 a.y_location = "origin";
43 plot(W,XW_Mag);
44 xlabel('Frequency in Radians/Seconds—> W');
45 ylabel('abs(X(jW))')
46 title('Magnitude Response (CTFT)')
47

```

```

48 //Plotting Phase Reponse of CTS
49 subplot(2,1,2);
50 a = gca();
51 a.y_location = "origin";
52 a.x_location = "origin";
53 plot(W,XW_Phase*%pi/180);
54 xlabel('                                Frequency in
        Radians/Seconds—> W');
55 ylabel('                                <X
        (jW) ')
56 title('Phase Response(CTFT) in Radians')

```

Experiment: 10

FIR Band Pass Filter - Remez Algorithm-LPF

Scilab code Solution 10.10 10

```
1 //FIR BAND PASS FILTER – REMEZ ALGORITHM –FOR LPF
2 //OS:Windows 10
3 //Scilab 5.5.2
4
5 //Band Pass Filter of length M = 16
6 //Lower Cutoff frequency fp = 0.2 and Upper Cutoff
   frequency fs = 0.3
7
8 clear all;
9 clc;
10 close;
11 hn = 0;
12 hm = 0;
13 hn=eqfir(16,[0 .1;.2 .35;.425 .5],[0 1 0],[10 1 10])
   ;//number of cosine functions,pass band magnitude
   &stop band,weighting function
14 [hm,fr]=frmag(hn,256);
```

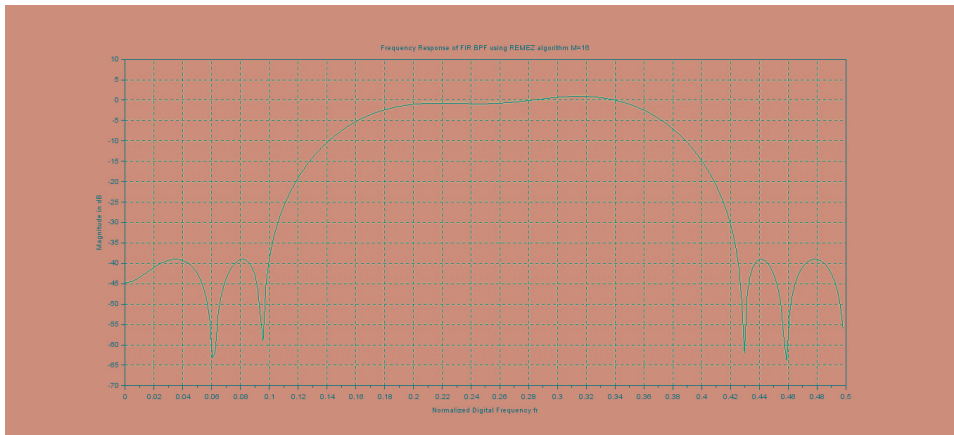


Figure 10.1: 10

```

15 disp(hn,'The Filter Coefficients are:')
16 figure
17 plot(.5*(0:255)/256,20*log10(frmag(hn,256)));
18 a = gca();
19 xlabel('Normalized Digital Frequency fr');
20 ylabel('Magnitude in dB');
21 title('Frequency Response of FIR BPF using REMEZ
        algorithm M=16')
22 xgrid(2)
23
24 //Output
25 //
26 // The Filter Coefficients are:
27 //
28 // -0.0395487
29 // 0.0232284
30 // 0.0480681
31 // -0.0218794
32 // 0.0975735
33 // -0.1012773
34 // -0.2880134
35 // 0.2847346
36 // 0.2847346

```

```
37 // -0.2880134
38 // -0.1012773
39 // 0.0975735
40 // -0.0218794
41 // 0.0480681
42 // 0.0232284
43 // -0.0395487
44 //
```

Appendix

```
Scilab code AP 11 clear all;
2 clc;
3 close;
4
5 function [G,H,x]=RepetitionCode(n,k,m)
6 //Repetition Codes
7 //n =block of identical 'n' bits
8 //k =1 one bit
9 //m = 1;// bit value = 1
10 I = eye(n-k,n-k);//Identity matrix
11 P = ones(1,n-k);//coefficient matrix
12 H = [I P'];//parity-check matrix
13 G = [P 1];//generator matrix
14 x = m.*G; //code word
15 disp(G,'generator matrix');
16 disp(H,'parity-check matrix');
17 disp(x,'code word for binary one input');
18 endfunction
```

RepetitionCode

```
Scilab code AP 12 clear all;
2 clc;
3 close;
4
5 function [st,mt]= DS_Spread_Spectrum(bt,ct_polar)
6 //Generation of waveforms in DS/BPSK spread spectrum
```

```

        transmitter
7 //bt: Input Data Sequence (bipolar format)
8 //ct_polar: Spreading code (bipolar format)
9 Ft = 0:0.01:1;
10 //bt = [1*ones(1,N) -1*ones(1,N)];
11 t = 0:length(bt)-1;
12 //ct_polar = [-1,-1,1,1,1,-1,1,-1,-1,1,1,1,-1,1];
13 mt = bt.*ct_polar;
14 Carrier = 2*sin(Ft*2*pi);
15 st = [];
16 for i = 1:length(mt)
17     st = [st mt(i)*Carrier];
18 end
19
20 figure
21 subplot(3,1,1)
22 a = gca();
23 a.x_location = "origin";
24 a.y_location = "origin";
25 a.data_bounds = [0,-2;20,2];
26 plot2d2(t,bt,5)
27 xlabel('
        t')
28 ylabel('
        b(t)')
29 title('Data')
30 subplot(3,1,2)
31 a = gca();
32 a.x_location = "origin";
33 a.y_location = "origin";
34 a.data_bounds = [0,-2;20,2];
35 plot2d2(t,ct_polar,5)
36 xlabel('
        t')
37 ylabel('

```



```

        c(t)')
38 title('Spreading code')
39 subplot(3,1,3)
40 a = gca();
41 a.x_location = "origin";
42 a.y_location = "origin";
43 a.data_bounds = [0,-2;20,2];
44 plot2d2(t,mt,5)
45 xlabel('

        t')
46 ylabel('

        m(t)')
47 title('Product Signal')
48
49 figure
50 subplot(3,1,1)
51 a = gca();
52 a.x_location = "origin";
53 a.y_location = "origin";
54 a.data_bounds = [0,-2;20,2];
55 plot2d2(t,mt,5)
56 xlabel('

        t')
57 ylabel('

        m(t)')
58 title('Product Signal')
59 subplot(3,1,2)
60 a = gca();
61 a.x_location = "origin";
62 a.y_location = "origin";
63 a.data_bounds = [0,-2;20,2];
64 plot(Carrier)
65 xlabel('

```

```

        t')
66 ylabel('

        c(t)')
67 title('Carrier Signal')
68 subplot(3,1,3)
69 a = gca();
70 a.x_location = "origin";
71 a.y_location = "origin";
72 a.data_bounds = [0,-2;20,2];
73 plot(st)
74 xlabel('

        t')
75 ylabel('

        s(t)')
76 title('DS/BPSK signal')
77 endfunction
DSSS

```
