بسم الله الرحمن الرحیم

دانشکده مهندسی برق

Digital Communications Lab

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Experiment 1

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1. مبدل اطّلاعات سری به موازی و موازی به سری

سوال 1: کاربرد مبدّل سری به موازی در کجاست؟ شرح دهید.

در مخابرات برای ارسال به صورت تقسیم زمانی نیاز به دیمالتی پلکسر داریم و میتوان از مبدل استفاده کرد. که این عمل را قبل از ارسال انجام می دهیم.

سوال 2: کاربرد مبدّل موازی به سری در کجاست؟ شرح دهید.

به تبع جواب سوال قبل، برای دریافت اطلاعات که به شکل موازی ارسال شده است باید از مالتی پلکسر استفاده کنیم و رشته های موازی را به رشته سری تبدیل کنیم.

سوال 3: چگونه میتوان مبدّل موازی به موازی (P/P) طراحی کرد؟ برای حالت 8 به 4 یا 8 به 2 مدار طراحی نمایید. کاربرد مبدّل موازی به موازی در کجاست؟ شرح دهید

پیوست شده است. ابتدا تبدیل موازی به سری انجام میدهیم و سپس عکس این عمل را انجام میدهیم،

سوال 4: آیا مبدّل سری به سری (S/S) مفهومی دارد؟ در صورت مثبت بودن جواب، کاربرد آن چیست و چگونه میتوان آن را طراحی کرد؟ شرح دهید

پیوست شده است. ابتدا تبدیل سری به موازی انجام میدهیم و سپس عکس این عمل را انجام میدهیم، بدیهی است که تبدیلات با اندازه های درست تبدیل شوند (مانند ضرب ماتریسی)

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2. مولّد رشته تصادفی با استفاده از LSFRLF

سوال 1: تحقیق نمایید که چگونه میتوان رشته تصادفی باینری غیریکنواخت تولید کرد که احتمالهای وقوع ارقام 0و 1برابر نباشند. با نوشتن برنامه نرمافزاری به صورت m.file، با استفاده از دستور rand که اعداد اعشاری تصادفی بین 0و 1تولید میکند رشته تصادفی باینری غیر یکنواخت را تولید کنید.

پیوست شد. با تغییر دادن مقدار 0.75 میتوان اعداد دودویی با احتمال های مختلف تولید کرد.

```
rand_bin = round(0.75*rand(1,10000));
```[1]

سوال 2: دیده میشود که رشته اطلاعات تولید شده بر اساس این چندجمله ایها متناوب است. دوره تناوب آن در هر یک از دو حالت فوق چقدر است؟ در حالت کلی، بیشترین مقدار دوره تناوب رشته اطلاعات تولیدی چقدر میتواند باشد و با طول شیفت-رجیستر (درجه چندجملهای) چه رابطهای دارد؟ در چه صورت میتوان به بیشترین مقدار آن دست یافت؟

بنا بر مقدار اولیه و tap هایی که انتخاب میکنیم، میتوانیم حلقه هایی از طول های متفاوت داشته باشیم. حلقه ای که تمامی حالات ممکن ترکیب را بررسی کند تا به مقدار اولیه برسد، maximal lengthنامیده می شود.در هنگام کار با اعداد باینری، maximal lengthحلقه برابر 2 به توان n-1 خواهد شد. این حلقه همچنین می تواند حالت اصلی خود را ترک کرده و در یک حلقه کوتاه تر در آن گیر کند ، هرگز به حالت اولیه خود باز نگردد.پیدا کردن مقدار اولیه و tapها که به maximal length برسد، یک امر مهم است. بعضی از معیار های پیدا کردن این tap ها این است که تعداد آنها باید زوج باشد و مقسوم علیه مشترکی غیر از 1 نداشته باشند[2].

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[1] https://www.mathworks.com/matlabcentral/answers/134656-random-binary-sequence-generator

[2] https://vrgl.ir/DcK6H

آزمایش ۱: مبدّل اطّلاعات و مولّد رشته تصادفی

نام و نام‌خانوادگی دانشجویان:

۱-۱- مبدل اطّلاعات سری به موازی و موازی به سری

۱-۱-۱- شبیه‌سازی در محیط MATLAB

با استفاده از دستورات برداری و ماتریسی نرم‌افزار MATLAB :

الف- رشته اطلاعات ۲۵۶ بیتی دلخواه را به ۴، ۸، ۱۶ و ۳۲ رشته موازی متناظر تبدیل نمایید و نمایش دهید.

برنامه نرم‌افزاری:

نتیجه:

ب- رشته‌های موازی ۴ تایی، ۸ تایی، ۱۶ تایی و ۳۲ تایی دلخواه را به رشته‌های سری متناظر تبدیل نمایید.

برنامه نرم‌افزاری:

نتیجه:

Contents


```
%------------------------------------------------------------------------%
%%------------------- Lab 1 Digital Communication --------------------%%
 %--------------- Supervisor: Dr.Shirvani Moghaddam --------------%
  %------- Source by Mohammad Reza Farhadi Nia ----- Date:Oct 2020 --%
%------------------------------------------------------------------------%
%Description: Also We coud use "cat" function
```

```
a = randi([0 1],1,256)

b1 = Ser2Par(a, 4)
b11 = Ser2ParOpt(a, 4)

b2 = Ser2Par(a, 8)
b22 = Ser2ParOpt(a, 8)

b3 = Ser2Par(a, 16)
b33 = Ser2ParOpt(a, 16)

b4 = Ser2Par(a, 32)
b44 = Ser2ParOpt(a, 32)

c1 = Par2Ser(b1, 4, 64)
c11 = Par2SerOpt(b11, 4, 64)

c2 = Par2Ser(b2, 8, 32)
c22 = Par2SerOpt(b22, 8, 32)

c3 = Par2Ser(b3, 16, 16)
c33 = Par2SerOpt(b33, 16, 16)

c4 = Par2Ser(b4, 32, 8)
c44 = Par2SerOpt(b44, 32, 8)
```

```
a =

  Columns 1 through 13

     0     1     0     0     1     0     1     1     1     1     1     0     1

  Columns 14 through 26

     0     1     1     1     0     0     1     1     1     1     0     0     0

  Columns 27 through 39
```

```
   0     0     0     1     0     0     0     0     0     1     0     0     0

Columns 40 through 52

   0     1     1     0     1     0     1     1     1     0     1     0     0

Columns 53 through 65

   1     1     0     1     1     0     1     0     0     0     1     0     0

Columns 66 through 78

   1     0     1     1     1     1     0     0     1     1     0     1     1

Columns 79 through 91

   1     1     1     1     0     0     1     0     1     0     1     0     0

Columns 92 through 104

   1     0     1     1     0     0     1     0     0     0     0     0     1

Columns 105 through 117

   0     0     0     1     0     1     0     0     0     1     1     0     1

Columns 118 through 130

   1     1     1     1     0     0     0     0     1     0     0     0     1

Columns 131 through 143

   0     0     1     1     0     0     0     1     0     1     0     1     1

Columns 144 through 156

   0     1     0     1     1     0     0     1     1     0     0     1     0

Columns 157 through 169

   1     1     0     1     1     1     0     0     1     1     1     1     0

Columns 170 through 182

   1     1     1     1     0     1     0     1     1     1     1     1     1

Columns 183 through 195

   0     0     0     0     0     0     0     1     1     0     0     1     0

Columns 196 through 208

   0     1     1     0     1     1     0     0     1     0     0     0     1

Columns 209 through 221
```

```
    1     0     0     1     0     1     0     0     0     0     0     0     1

  Columns 222 through 234

    0     1     1     1     1     0     0     1     1     1     0     0     1

  Columns 235 through 247

    0     1     1     1     1     0     0     0     0     1     1     0     0

  Columns 248 through 256

    1     0     0     1     0     1     0     0     1
```

Series to Parallel O(n)

```
function Output = Ser2Par(Input, out_len)
    i=1;
    for j = 0:length(Input)-1
        Output(mod(j,out_len)+1,i) = Input(1,j+1);
        if mod(j,out_len)+1 == out_len
            i = i+1;
        end
    end
end
```

```
b1 =

  Columns 1 through 13

    0     1     1     1     1     1     0     0     0     0     1     0     0
    1     0     1     0     0     1     0     1     0     0     1     1     1
    0     1     1     1     0     1     0     0     0     0     0     1     0
    0     1     0     1     1     0     0     0     1     0     1     1     0

  Columns 14 through 26

    1     1     0     0     1     0     1     1     1     1     0     0     0
    1     0     0     1     1     1     1     1     0     0     1     1     0
    0     1     1     0     1     1     1     0     1     0     1     0     0
    1     0     0     1     0     0     1     0     0     1     0     0     1

  Columns 27 through 39

    0     0     0     1     1     0     0     1     0     0     1     0     0
    0     1     1     1     0     1     1     1     1     1     0     0     0
    0     0     1     1     0     0     0     0     0     1     1     1     1
    1     0     0     1     0     0     0     0     1     0     1     1     0

  Columns 40 through 52

    1     1     1     0     1     1     1     0     0     0     1     1     0
    1     1     1     1     0     1     1     0     1     1     1     0     0
```

```
     0     0     1     1     1     1     0     0     1     0     0     0     0
     1     0     1     1     0     1     0     0     0     0     1     1     1

  Columns 53 through 64

     1     0     0     1     1     1     0     1     0     1     0     1
     0     1     0     0     1     1     1     1     0     0     0     0
     0     0     0     1     0     1     0     1     0     0     1     0
     1     0     0     1     0     0     1     0     1     1     0     1


b2 =

  Columns 1 through 13

     0     1     1     0     0     1     0     1     0     0     1     1     0
     1     1     0     0     0     1     1     0     1     1     1     0     1
     0     1     0     0     0     0     0     1     0     1     0     0     0
     0     0     1     0     1     1     0     0     1     0     0     1     0
     1     1     1     0     0     0     1     0     1     1     1     0     0
     0     0     1     1     0     1     1     0     1     1     0     1     0
     1     1     1     0     0     1     0     1     1     1     1     1     0
     1     1     0     0     0     1     1     0     0     1     0     0     1

  Columns 14 through 26

     0     0     1     0     0     1     0     1     0     1     0     0     1
     0     1     0     1     1     0     0     1     1     1     0     1     0
     0     1     0     0     0     1     1     0     1     1     0     0     0
     1     0     0     0     1     1     0     0     1     1     0     0     1
     0     1     0     1     0     0     1     1     1     1     0     1     0
     1     1     1     1     1     0     1     1     0     1     1     1     0
     0     1     0     0     1     1     0     1     1     0     1     0     0
     0     1     0     0     0     1     1     1     0     0     0     1     1

  Columns 27 through 32

     1     0     1     0     0     0
     0     0     1     1     0     0
     0     0     0     0     0     1
     1     0     0     1     1     0
     0     1     1     1     1     1
     1     0     1     1     0     0
     0     1     1     1     0     0
     0     1     0     0     1     1


b3 =

  Columns 1 through 13

     0     1     0     0     0     1     0     0     0     1     1     1     0
     1     0     0     1     1     1     1     1     1     0     1     1     1
     0     0     0     0     0     0     0     1     0     1     0     1     0
```

```
     0     1     1     0     1     0     0     0     0     1     0     1     0
     1     1     0     1     1     1     0     1     1     0     1     1     1
     0     1     0     1     1     0     0     1     1     0     1     1     1
     1     1     0     0     1     1     0     1     0     1     1     0     0
     1     0     0     1     0     0     1     1     0     1     1     0     1
     1     0     1     1     0     1     0     1     0     0     0     0     1
     1     0     1     0     1     0     0     0     1     0     1     0     0
     1     0     0     1     1     0     0     0     0     1     1     0     0
     0     0     1     0     0     1     1     0     1     0     1     0     1
     1     0     0     0     1     0     0     0     0     1     1     0     0
     0     1     1     0     1     1     1     1     1     1     0     1     0
     1     0     1     1     1     1     0     0     1     0     1     1     0
     1     0     1     0     1     0     0     0     0     1     0     0     1

  Columns 14 through 16

     1     1     0
     0     1     0
     0     0     0
     1     0     1
     0     1     1
     1     1     0
     0     1     0
     0     0     1
     0     0     0
     0     1     0
     0     0     1
     0     1     0
     1     1     1
     0     1     0
     1     1     0
     1     0     1


b4 =

     0     0     0     0     0     1     0     1
     1     0     1     1     1     1     1     1
     0     0     0     0     0     0     0     0
     0     1     1     0     0     0     0     0
     1     0     1     0     1     1     1     1
     0     0     1     0     1     1     1     1
     1     0     1     0     0     1     0     1
     1     0     0     1     0     1     1     0
     1     1     0     0     0     0     1     0
     1     1     1     0     1     1     0     1
     1     0     1     0     0     1     0     0
     0     1     0     1     1     1     1     1
     1     0     1     0     0     1     0     1
     0     1     1     1     1     0     0     1
     1     1     1     0     1     1     0     1
     1     1     1     0     0     0     1     0
     1     0     1     0     1     1     1     0
     0     1     1     1     0     1     0     0
     0     0     0     1     1     1     0     0
     1     0     0     0     1     1     1     1
```

```
     1     1     1     1     0     1     0     1
     1     1     0     1     0     1     1     0
     1     0     1     1     1     0     0     0
     0     1     0     1     1     0     0     1
     0     1     1     1     0     0     0     0
     0     0     0     0     0     0     0     0
     0     1     0     0     1     0     0     1
     0     0     1     0     0     0     0     0
     0     0     0     0     1     0     1     1
     1     0     1     1     1     1     0     0
     0     1     1     0     0     1     1     0
     0     0     0     0     1     0     1     1
```

Series to Parallel Optimum O(n)

```
function Output = Ser2ParOpt(Input, out_len)
    for row = 1:ceil(length(Input)/out_len)
        Output(1:out_len, row) = Input(1, (row-1)*out_len+1:row*out_len);
    end
end
```

```
b11 =

  Columns 1 through 13

     0     1     1     1     1     1     0     0     0     0     1     0     0
     1     0     1     0     0     1     0     1     0     0     1     1     1
     0     1     1     1     0     1     0     0     0     0     0     1     0
     0     1     0     1     1     0     0     0     1     0     1     1     0

  Columns 14 through 26

     1     1     0     0     1     0     1     1     1     1     0     0     0
     1     0     0     1     1     1     1     1     0     0     1     1     0
     0     1     1     0     1     1     1     0     1     0     1     0     0
     1     0     0     1     0     0     1     0     0     1     0     0     1

  Columns 27 through 39

     0     0     0     1     1     0     0     1     0     0     1     0     0
     0     1     1     1     0     1     1     1     1     1     0     0     0
     0     0     1     1     0     0     0     0     0     1     1     1     1
     1     0     0     1     0     0     0     0     1     0     1     1     0

  Columns 40 through 52

     1     1     1     0     1     1     1     0     0     0     1     1     0
     1     1     1     1     0     1     1     0     1     1     1     0     0
     0     0     1     1     1     1     0     0     1     0     0     0     0
     1     0     1     1     0     1     0     0     0     0     1     1     1

  Columns 53 through 64
```

```
     1     0     0     1     1     1     0     1     0     1     0     1
     0     1     0     0     1     1     1     1     0     0     0     0
     0     0     0     1     0     1     0     1     0     0     1     0
     1     0     0     1     0     0     1     0     1     1     0     1
```

b22 =

Columns 1 through 13

```
     0     1     1     0     0     1     0     1     0     0     1     1     0
     1     1     0     0     0     1     1     0     1     1     1     0     1
     0     1     0     0     0     0     0     1     0     1     0     0     0
     0     0     1     0     1     1     0     0     1     0     0     1     0
     1     1     1     0     0     0     1     0     1     1     1     0     0
     0     0     1     1     0     1     1     0     1     1     0     1     0
     1     1     1     0     0     1     0     1     1     1     1     1     0
     1     1     0     0     0     1     1     0     0     1     0     0     1
```

Columns 14 through 26

```
     0     0     1     0     0     1     0     1     0     1     0     0     1
     0     1     0     1     1     0     0     1     1     1     0     1     0
     0     1     0     0     0     1     1     0     1     1     0     0     0
     1     0     0     0     1     1     0     0     1     1     0     0     1
     0     1     0     1     0     0     1     1     1     1     0     1     0
     1     1     1     1     1     0     1     1     0     1     1     1     0
     0     1     0     0     1     1     0     1     1     0     1     0     0
     0     1     0     0     0     1     1     1     0     0     0     1     1
```

Columns 27 through 32

```
     1     0     1     0     0     0
     0     0     1     1     0     0
     0     0     0     0     0     1
     1     0     0     1     1     0
     0     1     1     1     1     1
     1     0     1     1     0     0
     0     1     1     1     0     0
     0     1     0     0     1     1
```

b33 =

Columns 1 through 13

```
     0     1     0     0     0     1     0     0     0     1     1     1     0
     1     0     0     1     1     1     1     1     1     0     1     1     1
     0     0     0     0     0     0     0     1     0     1     0     1     0
     0     1     1     0     1     0     0     0     0     1     0     1     0
     1     1     0     1     1     1     0     1     1     0     1     1     1
     0     1     0     1     1     0     0     1     1     0     1     1     1
     1     1     0     0     1     1     0     1     0     1     1     0     0
     1     0     0     1     0     0     1     1     0     1     1     0     1
     1     0     1     1     0     1     0     1     0     0     0     0     1
     1     0     1     0     1     0     0     0     1     0     1     0     0
     1     0     0     1     1     0     0     0     0     1     1     0     0
```

```
     0     0     1     0     0     1     1     0     1     0     1     0     1
     1     0     0     0     1     0     0     0     0     1     1     0     0
     0     1     1     0     1     1     1     1     1     1     0     1     0
     1     0     1     1     1     1     0     0     1     0     1     1     0
     1     0     1     0     1     0     0     0     0     1     0     0     1

  Columns 14 through 16

     1     1     0
     0     1     0
     0     0     0
     1     0     1
     0     1     1
     1     1     0
     0     1     0
     0     0     1
     0     0     0
     0     1     0
     0     0     1
     0     1     0
     1     1     1
     0     1     0
     1     1     0
     1     0     1


b44 =

     0     0     0     0     0     1     0     1
     1     0     1     1     1     1     1     1
     0     0     0     0     0     0     0     0
     0     1     1     0     0     0     0     0
     1     0     1     0     1     1     1     1
     0     0     1     0     1     1     1     1
     1     0     1     0     0     1     0     1
     1     0     0     1     0     1     1     0
     1     1     0     0     0     0     1     0
     1     1     1     0     1     1     0     1
     1     0     1     0     0     1     0     0
     0     1     0     1     1     1     1     1
     1     0     1     0     0     1     0     1
     0     1     1     1     1     0     0     1
     1     1     1     0     1     1     0     1
     1     1     1     0     0     0     1     0
     1     0     1     0     1     1     1     0
     0     1     1     1     0     1     0     0
     0     0     0     1     1     1     0     0
     1     0     0     0     1     1     1     1
     1     1     1     1     0     1     0     1
     1     1     0     1     0     1     1     0
     1     0     1     1     1     0     0     0
     0     1     0     1     1     0     0     1
     0     1     1     1     0     0     0     0
     0     0     0     0     0     0     0     0
     0     1     0     0     1     0     0     1
     0     0     1     0     0     0     0     0
     0     0     0     0     1     0     1     1
```

```
     1     0     1     1     1     1     0     0
     0     1     1     0     0     1     1     0
     0     0     0     0     1     0     1     1
```

Parallel to Series O(n^2)

```
function Output = Par2Ser(Input, row_len, column_len)
    i = 1;
    for column = 1:column_len
        for row = 1:row_len
            Output(1, i) = Input(row, column);
            i = i+1;
        end
    end
end
```

```
c1 =

  Columns 1 through 13

     0     1     0     0     1     0     1     1     1     1     1     0     1

  Columns 14 through 26

     0     1     1     1     0     0     1     1     1     1     0     0     0

  Columns 27 through 39

     0     0     0     1     0     0     0     0     0     1     0     0     0

  Columns 40 through 52

     0     1     1     0     1     0     1     1     1     0     1     0     0

  Columns 53 through 65

     1     1     0     1     1     0     1     0     0     0     1     0     0

  Columns 66 through 78

     1     0     1     1     1     1     0     0     1     1     0     1     1

  Columns 79 through 91

     1     1     1     1     0     0     1     0     1     0     1     0     0

  Columns 92 through 104

     1     0     1     1     0     0     1     0     0     0     0     0     1

  Columns 105 through 117

     0     0     0     1     0     1     0     0     0     1     1     0     1
```

```
  Columns 118 through 130

     1     1     1     1     0     0     0     0     1     0     0     0     1

  Columns 131 through 143

     0     0     1     1     0     0     0     1     0     1     0     1     1

  Columns 144 through 156

     0     1     0     1     1     0     0     1     1     0     0     1     0

  Columns 157 through 169

     1     1     0     1     1     1     0     0     1     1     1     1     0

  Columns 170 through 182

     1     1     1     1     0     1     0     1     1     1     1     1     1

  Columns 183 through 195

     0     0     0     0     0     0     0     1     1     0     0     1     0

  Columns 196 through 208

     0     1     1     0     1     1     0     0     1     0     0     0     1

  Columns 209 through 221

     1     0     0     1     0     1     0     0     0     0     0     0     1

  Columns 222 through 234

     0     1     1     1     1     0     0     1     1     1     0     0     1

  Columns 235 through 247

     0     1     1     1     1     0     0     0     0     1     1     0     0

  Columns 248 through 256

     1     0     0     1     0     1     0     0     1


c2 =

  Columns 1 through 13

     0     1     0     0     1     0     1     1     1     1     1     0     1

  Columns 14 through 26

     0     1     1     1     0     0     1     1     1     1     0     0     0
```

Columns 27 through 39

```
   0     0     0     1     0     0     0     0     0     1     0     0     0
```

Columns 40 through 52

```
   0     1     1     0     1     0     1     1     1     0     1     0     0
```

Columns 53 through 65

```
   1     1     0     1     1     0     1     0     0     0     1     0     0
```

Columns 66 through 78

```
   1     0     1     1     1     1     0     0     1     1     0     1     1
```

Columns 79 through 91

```
   1     1     1     1     0     0     1     0     1     0     1     0     0
```

Columns 92 through 104

```
   1     0     1     1     0     0     1     0     0     0     0     0     1
```

Columns 105 through 117

```
   0     0     0     1     0     1     0     0     0     1     1     0     1
```

Columns 118 through 130

```
   1     1     1     1     0     0     0     0     1     0     0     0     1
```

Columns 131 through 143

```
   0     0     1     1     0     0     0     1     0     1     0     1     1
```

Columns 144 through 156

```
   0     1     0     1     1     0     0     1     1     0     0     1     0
```

Columns 157 through 169

```
   1     1     0     1     1     1     0     0     1     1     1     1     0
```

Columns 170 through 182

```
   1     1     1     1     0     1     0     1     1     1     1     1     1
```

Columns 183 through 195

```
   0     0     0     0     0     0     0     1     1     0     0     1     0
```

Columns 196 through 208

```
   0     1     1     0     1     1     0     0     1     0     0     0     1
```

Columns 209 through 221

```
     1     0     0     1     0     1     0     0     0     0     0     0     1

  Columns 222 through 234

     0     1     1     1     1     0     0     1     1     1     0     0     1

  Columns 235 through 247

     0     1     1     1     1     0     0     0     0     1     1     0     0

  Columns 248 through 256

     1     0     0     1     0     1     0     0     1


c3 =

  Columns 1 through 13

     0     1     0     0     1     0     1     1     1     1     1     0     1

  Columns 14 through 26

     0     1     1     1     0     0     1     1     1     1     0     0     0

  Columns 27 through 39

     0     0     0     1     0     0     0     0     0     1     0     0     0

  Columns 40 through 52

     0     1     1     0     1     0     1     1     1     0     1     0     0

  Columns 53 through 65

     1     1     0     1     1     0     1     0     0     0     1     0     0

  Columns 66 through 78

     1     0     1     1     1     1     0     0     1     1     0     1     1

  Columns 79 through 91

     1     1     1     1     0     0     1     0     1     0     1     0     0

  Columns 92 through 104

     1     0     1     1     0     0     1     0     0     0     0     0     1

  Columns 105 through 117

     0     0     0     1     0     1     0     0     0     1     1     0     1

  Columns 118 through 130
```

```
    1     1     1     1     0     0     0     0     1     0     0     0     1

  Columns 131 through 143

    0     0     1     1     0     0     0     1     0     1     0     1     1

  Columns 144 through 156

    0     1     0     1     1     0     0     1     1     0     0     1     0

  Columns 157 through 169

    1     1     0     1     1     1     0     0     1     1     1     1     0

  Columns 170 through 182

    1     1     1     1     0     1     0     1     1     1     1     1     1

  Columns 183 through 195

    0     0     0     0     0     0     0     1     1     0     0     1     0

  Columns 196 through 208

    0     1     1     0     1     1     0     0     1     0     0     0     1

  Columns 209 through 221

    1     0     0     1     0     1     0     0     0     0     0     0     1

  Columns 222 through 234

    0     1     1     1     1     0     0     1     1     1     0     0     1

  Columns 235 through 247

    0     1     1     1     1     0     0     0     0     1     1     0     0

  Columns 248 through 256

    1     0     0     1     0     1     0     0     1


c4 =

  Columns 1 through 13

    0     1     0     0     1     0     1     1     1     1     1     0     1

  Columns 14 through 26

    0     1     1     1     0     0     1     1     1     1     0     0     0

  Columns 27 through 39

    0     0     0     1     0     0     0     0     0     1     0     0     0
```

Columns 40 through 52

```
   0     1     1     0     1     0     1     1     1     0     1     0     0
```

Columns 53 through 65

```
   1     1     0     1     1     0     1     0     0     0     1     0     0
```

Columns 66 through 78

```
   1     0     1     1     1     1     0     0     1     1     0     1     1
```

Columns 79 through 91

```
   1     1     1     1     0     0     1     0     1     0     1     0     0
```

Columns 92 through 104

```
   1     0     1     1     0     0     1     0     0     0     0     0     1
```

Columns 105 through 117

```
   0     0     0     1     0     1     0     0     0     1     1     0     1
```

Columns 118 through 130

```
   1     1     1     1     0     0     0     0     1     0     0     0     1
```

Columns 131 through 143

```
   0     0     1     1     0     0     0     1     0     1     0     1     1
```

Columns 144 through 156

```
   0     1     0     1     1     0     0     1     1     0     0     1     0
```

Columns 157 through 169

```
   1     1     0     1     1     1     0     0     1     1     1     1     0
```

Columns 170 through 182

```
   1     1     1     1     0     1     0     1     1     1     1     1     1
```

Columns 183 through 195

```
   0     0     0     0     0     0     0     1     1     0     0     1     0
```

Columns 196 through 208

```
   0     1     1     0     1     1     0     0     1     0     0     0     1
```

Columns 209 through 221

```
   1     0     0     1     0     1     0     0     0     0     0     0     1
```

```
  Columns 222 through 234

     0     1     1     1     1     0     0     1     1     1     0     0     1

  Columns 235 through 247

     0     1     1     1     1     0     0     0     0     1     1     0     0

  Columns 248 through 256

     1     0     0     1     0     1     0     0     1
```

Parallel to Series Optimum O(n)

```
function Output = Par2SerOpt(Input, row_len, column_len)
    for column = 1:column_len
        Output(1, (column-1)*row_len+1:column*row_len) = Input(1:row_len, column);
    end
end
```

```
c11 =

  Columns 1 through 13

     0     1     0     0     1     0     1     1     1     1     1     0     1

  Columns 14 through 26

     0     1     1     1     0     0     1     1     1     1     0     0     0

  Columns 27 through 39

     0     0     0     1     0     0     0     0     0     1     0     0     0

  Columns 40 through 52

     0     1     1     0     1     0     1     1     1     0     1     0     0

  Columns 53 through 65

     1     1     0     1     1     0     1     0     0     0     1     0     0

  Columns 66 through 78

     1     0     1     1     1     1     0     0     1     1     0     1     1

  Columns 79 through 91

     1     1     1     1     0     0     1     0     1     0     1     0     0

  Columns 92 through 104

     1     0     1     1     0     0     1     0     0     0     0     0     1
```

```
  Columns 105 through 117

     0     0     0     1     0     1     0     0     0     1     1     0     1

  Columns 118 through 130

     1     1     1     1     0     0     0     0     1     0     0     0     1

  Columns 131 through 143

     0     0     1     1     0     0     0     1     0     1     0     1     1

  Columns 144 through 156

     0     1     0     1     1     0     0     1     1     0     0     1     0

  Columns 157 through 169

     1     1     0     1     1     1     0     0     1     1     1     1     0

  Columns 170 through 182

     1     1     1     1     0     1     0     1     1     1     1     1     1

  Columns 183 through 195

     0     0     0     0     0     0     0     1     1     0     0     1     0

  Columns 196 through 208

     0     1     1     0     1     1     0     0     1     0     0     0     1

  Columns 209 through 221

     1     0     0     1     0     1     0     0     0     0     0     0     1

  Columns 222 through 234

     0     1     1     1     1     0     0     1     1     1     0     0     1

  Columns 235 through 247

     0     1     1     1     1     0     0     0     0     1     1     0     0

  Columns 248 through 256

     1     0     0     1     0     1     0     0     1


c22 =

  Columns 1 through 13

     0     1     0     0     1     0     1     1     1     1     1     0     1

  Columns 14 through 26
```

```
   0     1     1     1     0     0     1     1     1     1     0     0     0

Columns 27 through 39

   0     0     0     1     0     0     0     0     0     1     0     0     0

Columns 40 through 52

   0     1     1     0     1     0     1     1     1     0     1     0     0

Columns 53 through 65

   1     1     0     1     1     0     1     0     0     0     1     0     0

Columns 66 through 78

   1     0     1     1     1     1     0     0     1     1     0     1     1

Columns 79 through 91

   1     1     1     1     0     0     1     0     1     0     1     0     0

Columns 92 through 104

   1     0     1     1     0     0     1     0     0     0     0     0     1

Columns 105 through 117

   0     0     0     1     0     1     0     0     0     1     1     0     1

Columns 118 through 130

   1     1     1     1     0     0     0     0     1     0     0     0     1

Columns 131 through 143

   0     0     1     1     0     0     0     1     0     1     0     1     1

Columns 144 through 156

   0     1     0     1     1     0     0     1     1     0     0     1     0

Columns 157 through 169

   1     1     0     1     1     1     0     0     1     1     1     1     0

Columns 170 through 182

   1     1     1     1     0     1     0     1     1     1     1     1     1

Columns 183 through 195

   0     0     0     0     0     0     0     1     1     0     0     1     0

Columns 196 through 208
```

```
     0     1     1     0     1     1     0     0     1     0     0     0     1

  Columns 209 through 221

     1     0     0     1     0     1     0     0     0     0     0     0     1

  Columns 222 through 234

     0     1     1     1     1     0     0     1     1     1     0     0     1

  Columns 235 through 247

     0     1     1     1     1     0     0     0     0     1     1     0     0

  Columns 248 through 256

     1     0     0     1     0     1     0     0     1


c33 =

  Columns 1 through 13

     0     1     0     0     1     0     1     1     1     1     1     0     1

  Columns 14 through 26

     0     1     1     1     0     0     1     1     1     1     0     0     0

  Columns 27 through 39

     0     0     0     1     0     0     0     0     0     1     0     0     0

  Columns 40 through 52

     0     1     1     0     1     0     1     1     1     0     1     0     0

  Columns 53 through 65

     1     1     0     1     1     0     1     0     0     0     1     0     0

  Columns 66 through 78

     1     0     1     1     1     1     0     0     1     1     0     1     1

  Columns 79 through 91

     1     1     1     1     0     0     1     0     1     0     1     0     0

  Columns 92 through 104

     1     0     1     1     0     0     1     0     0     0     0     0     1

  Columns 105 through 117

     0     0     0     1     0     1     0     0     0     1     1     0     1
```

```
  Columns 118 through 130

     1     1     1     1     0     0     0     0     1     0     0     0     1

  Columns 131 through 143

     0     0     1     1     0     0     0     1     0     1     0     1     1

  Columns 144 through 156

     0     1     0     1     1     0     0     1     1     0     0     1     0

  Columns 157 through 169

     1     1     0     1     1     1     0     0     1     1     1     1     0

  Columns 170 through 182

     1     1     1     1     0     1     0     1     1     1     1     1     1

  Columns 183 through 195

     0     0     0     0     0     0     0     1     1     0     0     1     0

  Columns 196 through 208

     0     1     1     0     1     1     0     0     1     0     0     0     1

  Columns 209 through 221

     1     0     0     1     0     1     0     0     0     0     0     0     1

  Columns 222 through 234

     0     1     1     1     1     0     0     1     1     1     0     0     1

  Columns 235 through 247

     0     1     1     1     1     0     0     0     0     1     1     0     0

  Columns 248 through 256

     1     0     0     1     0     1     0     0     1


c44 =

  Columns 1 through 13

     0     1     0     0     1     0     1     1     1     1     1     0     1

  Columns 14 through 26

     0     1     1     1     0     0     1     1     1     1     0     0     0

  Columns 27 through 39
```

```
   0     0     0     1     0     0     0     0     0     1     0     0     0

Columns 40 through 52

   0     1     1     0     1     0     1     1     1     0     1     0     0

Columns 53 through 65

   1     1     0     1     1     0     1     0     0     0     1     0     0

Columns 66 through 78

   1     0     1     1     1     1     0     0     1     1     0     1     1

Columns 79 through 91

   1     1     1     1     0     0     1     0     1     0     1     0     0

Columns 92 through 104

   1     0     1     1     0     0     1     0     0     0     0     0     1

Columns 105 through 117

   0     0     0     1     0     1     0     0     0     1     1     0     1

Columns 118 through 130

   1     1     1     1     0     0     0     0     1     0     0     0     1

Columns 131 through 143

   0     0     1     1     0     0     0     1     0     1     0     1     1

Columns 144 through 156

   0     1     0     1     1     0     0     1     1     0     0     1     0

Columns 157 through 169

   1     1     0     1     1     1     0     0     1     1     1     1     0

Columns 170 through 182

   1     1     1     1     0     1     0     1     1     1     1     1     1

Columns 183 through 195

   0     0     0     0     0     0     0     1     1     0     0     1     0

Columns 196 through 208

   0     1     1     0     1     1     0     0     1     0     0     0     1

Columns 209 through 221

   1     0     0     1     0     1     0     0     0     0     0     0     1
```

```
Columns 222 through 234

   0     1     1     1     1     0     0     1     1     1     0     0     1

Columns 235 through 247

   0     1     1     1     1     0     0     0     0     1     1     0     0

Columns 248 through 256

   1     0     0     1     0     1     0     0     1
```

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۲-۱-۱- شبیه‌سازی در محیط PROTEUS

مدار:

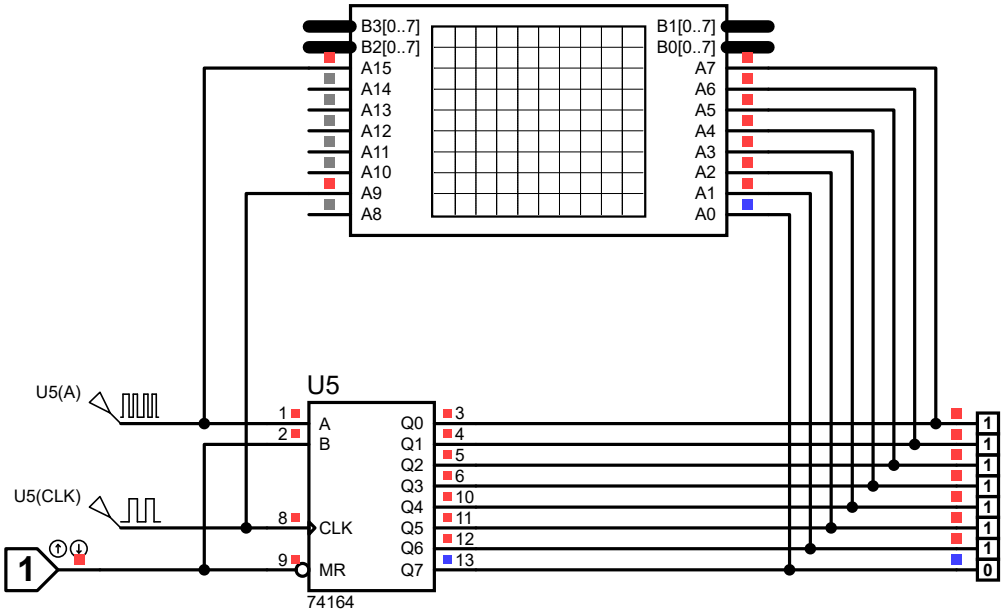
نتایج:

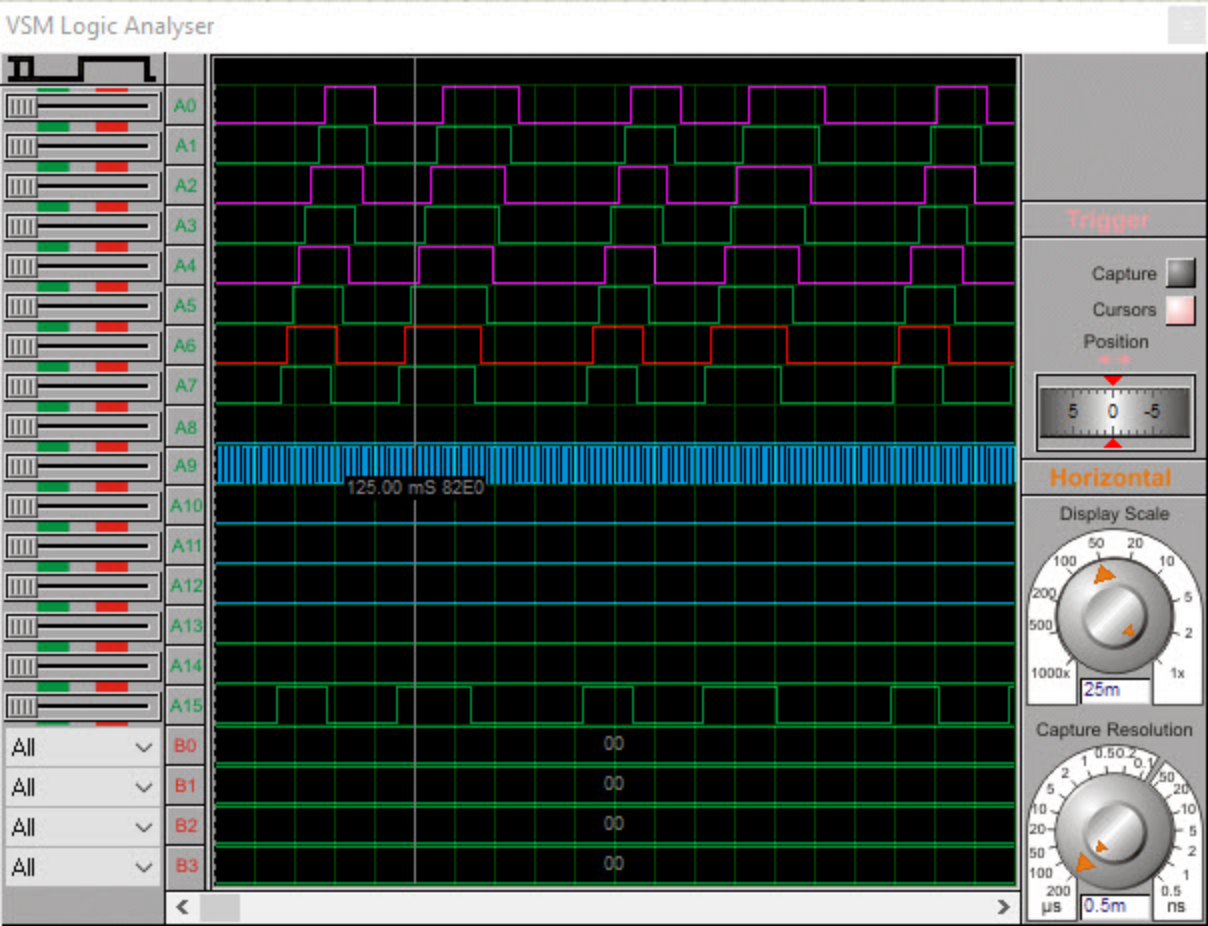
۳-۱-۱- پیاده‌سازی مدار طراحی‌شده در محیط PROTEUS بر روی بِردبورد

عکس مدار:

نتایج:

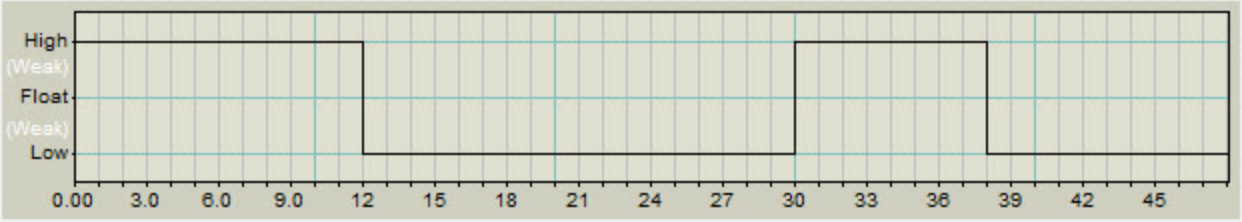
Series to Parallel




VSM Logic Analyser
A0
A1
A2
A3
A4
A5
A6
A7
A8
A9
A10
A11
A12
A13
A14
A15
125.00 mS 82E0
All
All
All
All
B0
B1
B2
B3
00
00
00
00
Trigger
Capture
Cursors
Position
5
0
-5
Horizontal
Display Scale
50
20
10
100
5
200
2
500
1000x
1x
25m
Capture Resolution
0.5
0.2
0.1
1
2
5
10
20
50
100
200
µs
0.5m
ns

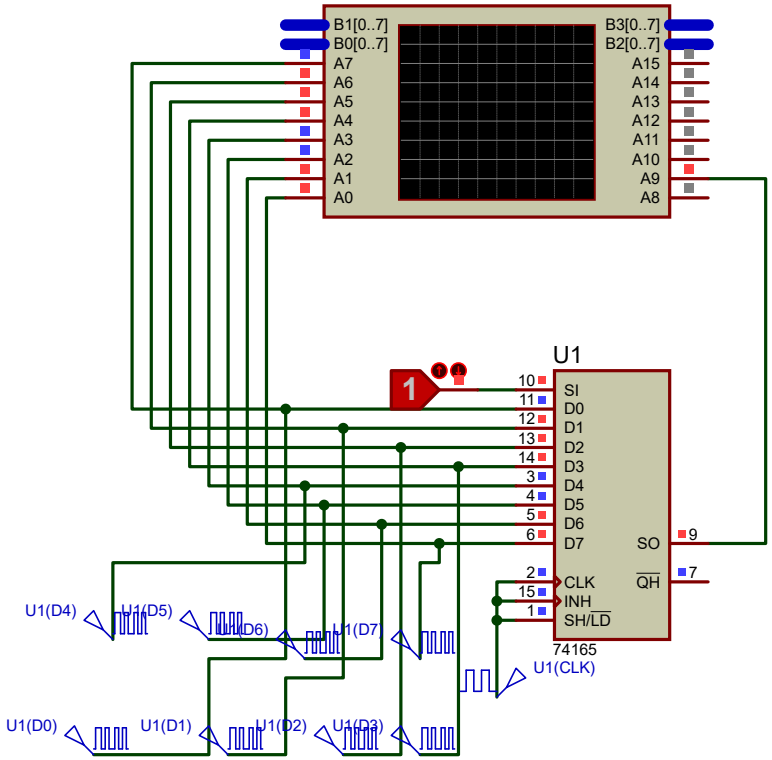
Edit Pattern

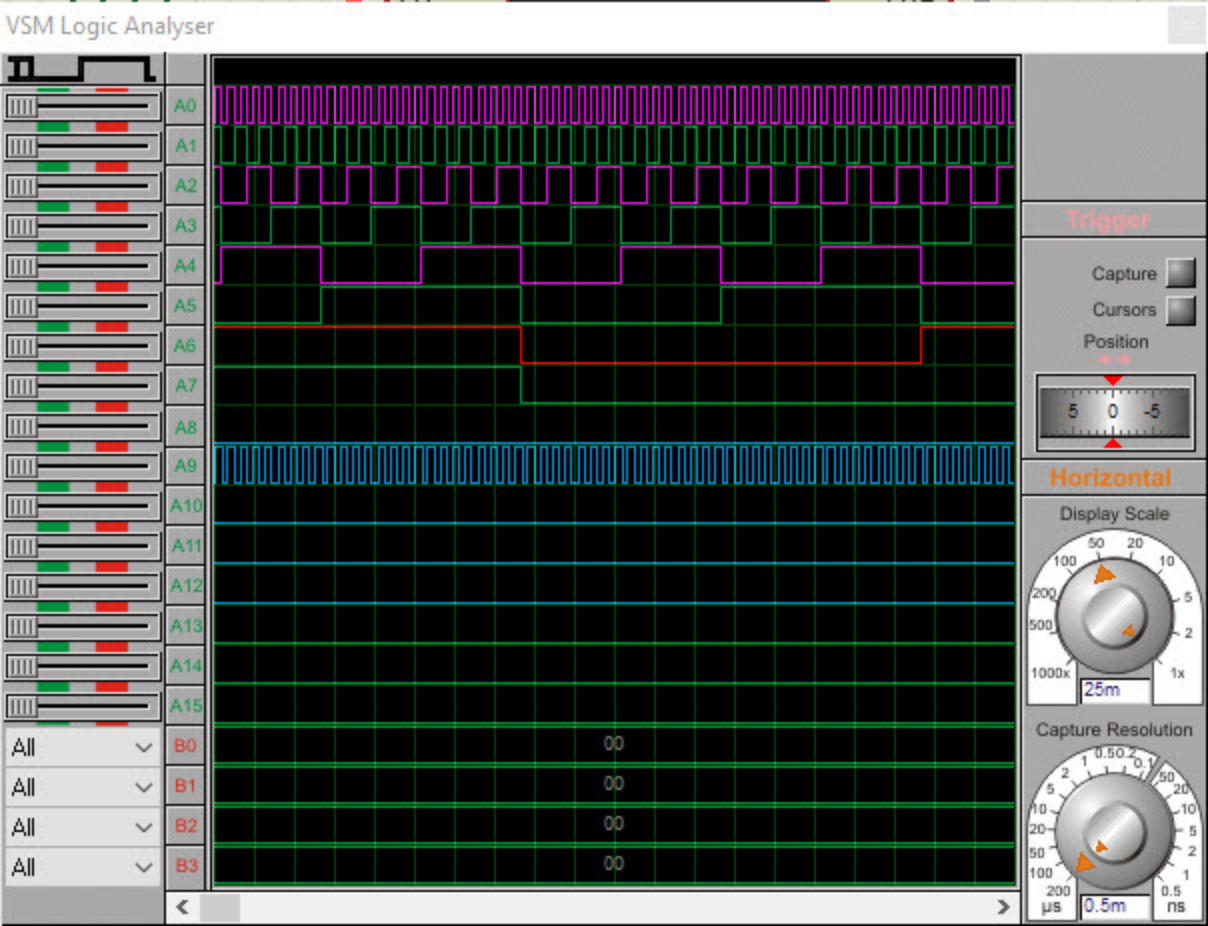
Pattern



OK

Parallel to series




VSM Logic Analyser
A0
A1
A2
A3
A4
A5
A6
A7
A8
A9
A10
A11
A12
A13
A14
A15
All
All
All
All
B0
B1
B2
B3
00
00
00
00
Trigger
Capture
Cursors
Position
5
0
-5
Horizontal
Display Scale
50
20
10
100
5
200
2
500
1000x
1x
25m
Capture Resolution
0.5
0.2
0.1
1
2
5
10
20
50
100
200
µs
0.5m
ns

سوال ۱: کاربرد مبدّل سری به موازی در کجاست؟ شرح دهید.

سوال ۲: کاربرد مبدّل موازی به سری در کجاست؟ شرح دهید.

سوال ۳: چگونه می‌توان مبدّل موازی به موازی (P/P) طراحی کرد؟ برای حالت ۸ به ۴ یا ۸ به ۲ مدار طراحی نمایید. کاربرد مبدّل موازی به موازی در کجاست؟ شرح دهید.

سوال ۴: آیا مبدّل سری به سری (S/S) مفهومی دارد؟ در صورت مثبت بودن جواب، کاربرد آن چیست و چگونه می‌توان آن را طراحی کرد؟ شرح دهید.

Contents


```
%-------------------------------------------------------------------------%
%%------------------- Lab 1 Digital Communication --------------------%%
 %---------------- Supervisor: Dr.Shirvani Moghaddam --------------%
  %------- Source by Mohammad Reza Farhadi Nia ----- Date:Oct 2020 --%
%-------------------------------------------------------------------------%
%Description: Also We could use "cat" function
```

```
%series input
a  = randi([0 1],1,256)

%parallel input
b  = Ser2Par(a, 8)
bb = Ser2ParOpt(a, 8)

%convertion p-p
C  = Par2Ser(b, 8, 32)
CC = Par2SerOpt(bb, 8, 32)
D  = Ser2Par(C, 4)
DD = Ser2ParOpt(CC, 4)

%convertion s-s
E  = Ser2Par(a, 16)
EE = Ser2ParOpt(a, 16)
F  = Par2Ser(E, 16, 16)
FF = Par2SerOpt(EE, 16, 16)
```

```
a =

  Columns 1 through 13

     0     0     1     0     0     1     1     1     1     1     1     0     1

  Columns 14 through 26

     1     0     0     1     0     1     1     0     0     1     0     1     1

  Columns 27 through 39

     1     0     0     0     1     1     1     0     1     0     0     1     0

  Columns 40 through 52

     1     1     1     1     0     1     1     1     0     0     0     1     1
```

Columns 53 through 65

```
   1     0     0     0     1     0     0     1     0     1     0     0     1
```

Columns 66 through 78

```
   0     0     0     1     0     0     0     0     1     0     1     1     0
```

Columns 79 through 91

```
   1     1     0     1     0     1     0     0     1     0     1     0     0
```

Columns 92 through 104

```
   0     1     0     0     1     0     0     1     1     0     0     0     0
```

Columns 105 through 117

```
   0     1     1     1     0     1     0     0     0     0     0     0     0
```

Columns 118 through 130

```
   0     0     0     1     1     1     0     0     0     1     1     1     0
```

Columns 131 through 143

```
   0     1     1     0     0     0     0     1     0     1     0     1     0
```

Columns 144 through 156

```
   0     0     1     1     0     1     0     1     1     1     0     0     0
```

Columns 157 through 169

```
   0     0     1     1     0     0     0     0     0     0     1     1     1
```

Columns 170 through 182

```
   0     0     1     1     1     1     0     1     0     0     0     1     0
```

Columns 183 through 195

```
   0     1     1     1     1     0     1     1     1     0     1     1     0
```

Columns 196 through 208

```
   1     0     1     0     0     0     0     0     1     1     1     0     1
```

Columns 209 through 221

```
   1     1     0     0     1     0     0     1     1     1     1     0     0
```

Columns 222 through 234

```
   1     0     1     1     1     1     1     1     0     0     1     1     0
```

Columns 235 through 247

```
    1     0     1     1     0     0     0     0     0     1     0     1     1

  Columns 248 through 256

    1     0     1     0     1     0     0     0     1
```

Series to Parallel O(n)

```
function Output = Ser2Par(Input, out_len)
    i=1;
    for j = 0:length(Input)-1
        Output(mod(j,out_len)+1,i) = Input(1,j+1);
        if mod(j,out_len)+1 == out_len
            i = i+1;
        end
    end
end
```

```
b =

  Columns 1 through 13

    0     1     1     1     1     1     0     1     1     0     0     1     0
    0     1     0     1     0     1     0     0     0     1     1     0     0
    1     1     1     1     1     1     1     0     0     0     0     0     1
    0     0     1     0     0     0     1     1     0     1     1     0     1
    0     1     0     0     0     1     1     0     1     1     0     1     0
    1     1     0     0     1     1     0     1     0     0     0     0     0
    1     0     1     1     0     1     0     0     0     1     1     0     0
    1     0     0     1     1     0     0     0     0     1     0     1     0

  Columns 14 through 26

    0     0     1     1     0     0     1     0     1     1     1     1     0
    1     0     1     0     1     1     0     0     0     0     1     1     0
    1     0     1     0     0     1     0     0     0     0     1     0     0
    1     0     0     1     1     0     0     0     1     0     0     1     1
    0     0     0     1     0     1     0     0     1     1     1     0     1
    1     0     0     0     1     0     0     0     1     0     1     1     1
    0     0     1     0     0     1     1     1     1     0     1     0     0
    0     0     1     0     0     1     1     1     0     1     0     0     1

  Columns 27 through 32

    1     1     1     1     0     0
    1     1     1     0     0     1
    0     1     1     1     0     0
    0     0     1     0     1     1
    1     0     1     1     0     0
    0     1     0     1     1     0
    0     0     0     0     1     0
    1     1     1     0     1     1
```

```
D =

  Columns 1 through 13

     0     0     1     1     1     0     1     0     1     0     1     1     0
     0     1     1     1     0     0     1     0     0     1     1     1     0
     1     1     1     0     1     1     1     1     1     0     1     1     1
     0     1     0     0     1     0     0     1     0     1     0     0     1

  Columns 14 through 26

     1     1     0     1     1     0     1     0     0     1     1     0     0
     0     0     1     0     0     1     0     1     0     0     0     0     0
     0     0     0     0     0     0     1     0     1     0     0     1     0
     0     1     0     0     0     1     1     1     0     0     1     1     0

  Columns 27 through 39

     0     0     0     0     1     0     1     1     0     0     0     1     1
     1     1     0     0     1     0     0     0     1     1     1     0     0
     1     0     0     0     1     1     0     0     0     0     1     1     0
     1     0     0     0     0     1     1     0     1     0     0     1     0

  Columns 40 through 52

     0     0     0     1     1     1     1     1     1     1     0     0     1
     0     0     0     0     1     0     0     1     1     1     1     0     1
     1     0     1     0     1     0     0     1     1     0     0     0     0
     1     0     1     1     0     0     1     0     0     1     0     1     1

  Columns 53 through 64

     1     1     1     0     1     1     1     1     0     0     0     0
     1     0     1     1     1     0     0     1     0     1     1     0
     0     0     1     0     1     0     1     0     0     1     0     0
     0     1     0     1     1     1     0     0     1     1     1     1



E =

  Columns 1 through 13

     0     1     1     0     1     0     0     0     1     0     0     1     1
     0     0     0     0     0     1     0     0     0     1     0     0     1
     1     1     1     1     0     0     1     0     0     1     0     0     0
     0     1     0     1     0     1     1     0     1     0     0     0     1
     0     0     0     1     1     0     0     0     1     1     0     1     0
     1     0     1     0     0     0     0     0     0     0     0     0     1
     1     1     0     0     0     1     0     0     0     1     1     0     0
     1     0     1     0     0     0     0     0     0     1     1     1     0
     1     1     1     1     0     1     0     1     0     1     1     1     0
     1     1     1     0     1     0     1     1     1     0     0     1     0
```

```
     1     1     1     0     0     0     1     1     0     0     0     1     0
     0     0     0     1     1     0     1     0     1     0     1     0     1
     1     0     1     0     1     1     0     0     0     0     1     1     1
     1     0     1     1     0     0     1     0     1     0     1     1     1
     0     1     1     0     1     0     0     1     0     1     1     1     0
     0     1     0     0     1     1     0     1     0     1     0     0     1

  Columns 14 through 16

     1     1     0
     1     1     0
     0     1     0
     0     1     1
     1     1     0
     0     0     1
     0     0     1
     1     1     1
     1     1     0
     1     0     1
     1     1     0
     0     0     1
     0     1     0
     1     1     0
     0     0     0
     1     0     1
```

Series to Parallel Optimum O(n)

```
function Output = Ser2ParOpt(Input, out_len)
    for row = 1:ceil(length(Input)/out_len)
        Output(1:out_len, row) = Input(1, (row-1)*out_len+1:row*out_len);
    end
end
```

```
bb =

  Columns 1 through 13

     0     1     1     1     1     1     0     1     1     0     0     1     0
     0     1     0     1     0     1     0     0     0     1     1     0     0
     1     1     1     1     1     1     1     0     0     0     0     0     1
     0     0     1     0     0     0     1     1     0     1     1     0     1
     0     1     0     0     0     1     1     0     1     1     0     1     0
     1     1     0     0     1     1     0     1     0     0     0     0     0
     1     0     1     1     0     1     0     0     0     1     1     0     0
     1     0     0     1     1     0     0     0     0     1     0     1     0

  Columns 14 through 26

     0     0     1     1     0     0     1     0     1     1     1     1     0
     1     0     1     0     1     1     0     0     0     0     1     1     0
     1     0     1     0     0     1     0     0     0     0     1     0     0
     1     0     0     1     1     0     0     0     1     0     0     1     1
```

```
     0     0     0     1     0     1     0     0     1     1     1     0     1
     1     0     0     0     1     0     0     0     1     0     1     1     1
     0     0     1     0     0     1     1     1     1     0     1     0     0
     0     0     1     0     0     1     1     1     0     1     0     0     1

  Columns 27 through 32

     1     1     1     1     0     0
     1     1     1     0     0     1
     0     1     1     1     0     0
     0     0     1     0     1     1
     1     0     1     1     0     0
     0     1     0     1     1     0
     0     0     0     0     1     0
     1     1     1     0     1     1



DD =

  Columns 1 through 13

     0     0     1     1     1     0     1     0     1     0     1     1     0
     0     1     1     1     0     0     1     0     0     1     1     1     0
     1     1     1     0     1     1     1     1     1     0     1     1     1
     0     1     0     0     1     0     0     1     0     1     0     0     1

  Columns 14 through 26

     1     1     0     1     1     0     1     0     0     1     1     0     0
     0     0     1     0     0     1     0     1     0     0     0     0     0
     0     0     0     0     0     0     1     0     1     0     0     1     0
     0     1     0     0     0     1     1     1     0     0     1     1     0

  Columns 27 through 39

     0     0     0     0     1     0     1     1     0     0     0     1     1
     1     1     0     0     1     0     0     0     1     1     1     0     0
     1     0     0     0     1     1     0     0     0     0     1     1     0
     1     0     0     0     0     1     1     0     1     0     0     1     0

  Columns 40 through 52

     0     0     0     1     1     1     1     1     1     1     0     0     1
     0     0     0     0     1     0     0     1     1     1     1     0     1
     1     0     1     0     1     0     0     1     1     0     0     0     0
     1     0     1     1     0     0     1     0     0     1     0     1     1

  Columns 53 through 64

     1     1     1     0     1     1     1     1     0     0     0     0
     1     0     1     1     1     0     0     1     0     1     1     0
     0     0     1     0     1     0     1     0     0     1     0     0
     0     1     0     1     1     1     0     0     1     1     1     1



EE =
```

```
  Columns 1 through 13

     0     1     1     0     1     0     0     0     1     0     0     1     1
     0     0     0     0     0     1     0     0     0     1     0     0     1
     1     1     1     1     0     0     1     0     0     1     0     0     0
     0     1     0     1     0     1     1     0     1     0     0     0     1
     0     0     0     1     1     0     0     0     1     1     0     1     0
     1     0     1     0     0     0     0     0     0     0     0     0     1
     1     1     0     0     0     1     0     0     0     1     1     0     0
     1     0     1     0     0     0     0     0     0     1     1     1     0
     1     1     1     1     0     1     0     1     0     1     1     1     0
     1     1     1     0     1     0     1     1     1     0     0     1     0
     1     1     1     0     0     0     1     1     0     0     0     1     0
     0     0     0     1     1     0     1     0     1     0     1     0     1
     1     0     1     0     1     1     0     0     0     0     1     1     1
     1     0     1     1     0     0     1     0     1     0     1     1     1
     0     1     1     0     1     0     0     1     0     1     1     1     0
     0     1     0     0     1     1     0     1     0     1     0     0     1

  Columns 14 through 16

     1     1     0
     1     1     0
     0     1     0
     0     1     1
     1     1     0
     0     0     1
     0     0     1
     1     1     1
     1     1     0
     1     0     1
     1     1     0
     0     0     1
     0     1     0
     1     1     0
     0     0     0
     1     0     1
```

Parallel to Series O(n^2)

```
function Output = Par2Ser(Input, row_len, column_len)
    i = 1;
    for column = 1:column_len
        for row = 1:row_len
            Output(1, i) = Input(row, column);
            i = i+1;
        end
    end
end
```

```
C =
```

Columns 1 through 13

```
   0     0     1     0     0     1     1     1     1     1     1     0     1
```

Columns 14 through 26

```
   1     0     0     1     0     1     1     0     0     1     0     1     1
```

Columns 27 through 39

```
   1     0     0     0     1     1     1     0     1     0     0     1     0
```

Columns 40 through 52

```
   1     1     1     1     0     1     1     1     0     0     0     1     1
```

Columns 53 through 65

```
   1     0     0     0     1     0     0     1     0     1     0     0     1
```

Columns 66 through 78

```
   0     0     0     1     0     0     0     0     1     0     1     1     0
```

Columns 79 through 91

```
   1     1     0     1     0     1     0     0     1     0     1     0     0
```

Columns 92 through 104

```
   0     1     0     0     1     0     0     1     1     0     0     0     0
```

Columns 105 through 117

```
   0     1     1     1     0     1     0     0     0     0     0     0     0
```

Columns 118 through 130

```
   0     0     0     1     1     1     0     0     0     1     1     1     0
```

Columns 131 through 143

```
   0     1     1     0     0     0     0     1     0     1     0     1     0
```

Columns 144 through 156

```
   0     0     1     1     0     1     0     1     1     1     0     0     0
```

Columns 157 through 169

```
   0     0     1     1     0     0     0     0     0     0     1     1     1
```

Columns 170 through 182

```
   0     0     1     1     1     1     0     1     0     0     0     1     0
```

Columns 183 through 195

```
    0     1     1     1     1     0     1     1     1     0     1     1     0

  Columns 196 through 208

    1     0     1     0     0     0     0     0     1     1     1     0     1

  Columns 209 through 221

    1     1     0     0     1     0     0     1     1     1     1     0     0

  Columns 222 through 234

    1     0     1     1     1     1     1     1     0     0     1     1     0

  Columns 235 through 247

    1     0     1     1     0     0     0     0     0     1     0     1     1

  Columns 248 through 256

    1     0     1     0     1     0     0     0     1


F =

  Columns 1 through 13

    0     0     1     0     0     1     1     1     1     1     1     0     1

  Columns 14 through 26

    1     0     0     1     0     1     1     0     0     1     0     1     1

  Columns 27 through 39

    1     0     0     0     1     1     1     0     1     0     0     1     0

  Columns 40 through 52

    1     1     1     1     0     1     1     1     0     0     0     1     1

  Columns 53 through 65

    1     0     0     0     1     0     0     1     0     1     0     0     1

  Columns 66 through 78

    0     0     0     1     0     0     0     0     1     0     1     1     0

  Columns 79 through 91

    1     1     0     1     0     1     0     0     1     0     1     0     0

  Columns 92 through 104
```

```
    0     1     0     0     1     0     0     1     1     0     0     0     0

  Columns 105 through 117

    0     1     1     1     0     1     0     0     0     0     0     0     0

  Columns 118 through 130

    0     0     0     1     1     1     0     0     0     1     1     1     0

  Columns 131 through 143

    0     1     1     0     0     0     0     1     0     1     0     1     0

  Columns 144 through 156

    0     0     1     1     0     1     0     1     1     1     0     0     0

  Columns 157 through 169

    0     0     1     1     0     0     0     0     0     0     1     1     1

  Columns 170 through 182

    0     0     1     1     1     1     0     1     0     0     0     1     0

  Columns 183 through 195

    0     1     1     1     1     0     1     1     1     0     1     1     0

  Columns 196 through 208

    1     0     1     0     0     0     0     0     1     1     1     0     1

  Columns 209 through 221

    1     1     0     0     1     0     0     1     1     1     1     0     0

  Columns 222 through 234

    1     0     1     1     1     1     1     1     0     0     1     1     0

  Columns 235 through 247

    1     0     1     1     0     0     0     0     0     1     0     1     1

  Columns 248 through 256

    1     0     1     0     1     0     0     0     1
```

Parallel to Series Optimum O(n)

```
function Output = Par2SerOpt(Input, row_len, column_len)
    for column = 1:column_len
        Output(1, (column-1)*row_len+1:column*row_len) = Input(1:row_len, column);
```

```
    end
end
```

```
CC =

  Columns 1 through 13

     0     0     1     0     0     1     1     1     1     1     1     0     1

  Columns 14 through 26

     1     0     0     1     0     1     1     0     0     1     0     1     1

  Columns 27 through 39

     1     0     0     0     1     1     1     0     1     0     0     1     0

  Columns 40 through 52

     1     1     1     1     0     1     1     1     0     0     0     1     1

  Columns 53 through 65

     1     0     0     0     1     0     0     1     0     1     0     0     1

  Columns 66 through 78

     0     0     0     1     0     0     0     0     1     0     1     1     0

  Columns 79 through 91

     1     1     0     1     0     1     0     0     1     0     1     0     0

  Columns 92 through 104

     0     1     0     0     1     0     0     1     1     0     0     0     0

  Columns 105 through 117

     0     1     1     1     0     1     0     0     0     0     0     0     0

  Columns 118 through 130

     0     0     0     1     1     1     0     0     0     1     1     1     0

  Columns 131 through 143

     0     1     1     0     0     0     0     1     0     1     0     1     0

  Columns 144 through 156

     0     0     1     1     0     1     0     1     1     1     0     0     0

  Columns 157 through 169
```

```
     0     0     1     1     0     0     0     0     0     0     1     1     1

  Columns 170 through 182

     0     0     1     1     1     1     0     1     0     0     0     1     0

  Columns 183 through 195

     0     1     1     1     1     0     1     1     1     0     1     1     0

  Columns 196 through 208

     1     0     1     0     0     0     0     0     1     1     1     0     1

  Columns 209 through 221

     1     1     0     0     1     0     0     1     1     1     1     0     0

  Columns 222 through 234

     1     0     1     1     1     1     1     1     0     0     1     1     0

  Columns 235 through 247

     1     0     1     1     0     0     0     0     0     1     0     1     1

  Columns 248 through 256

     1     0     1     0     1     0     0     0     1


FF =

  Columns 1 through 13

     0     0     1     0     0     1     1     1     1     1     1     0     1

  Columns 14 through 26

     1     0     0     1     0     1     1     0     0     1     0     1     1

  Columns 27 through 39

     1     0     0     0     1     1     1     0     1     0     0     1     0

  Columns 40 through 52

     1     1     1     1     0     1     1     1     0     0     0     1     1

  Columns 53 through 65

     1     0     0     0     1     0     0     1     0     1     0     0     1

  Columns 66 through 78

     0     0     0     1     0     0     0     0     1     0     1     1     0
```

Columns 79 through 91

```
   1     1     0     1     0     1     0     0     1     0     1     0     0
```

Columns 92 through 104

```
   0     1     0     0     1     0     0     1     1     0     0     0     0
```

Columns 105 through 117

```
   0     1     1     1     0     1     0     0     0     0     0     0     0
```

Columns 118 through 130

```
   0     0     0     1     1     1     0     0     0     1     1     1     0
```

Columns 131 through 143

```
   0     1     1     0     0     0     0     1     0     1     0     1     0
```

Columns 144 through 156

```
   0     0     1     1     0     1     0     1     1     1     0     0     0
```

Columns 157 through 169

```
   0     0     1     1     0     0     0     0     0     0     1     1     1
```

Columns 170 through 182

```
   0     0     1     1     1     1     0     1     0     0     0     1     0
```

Columns 183 through 195

```
   0     1     1     1     1     0     1     1     1     0     1     1     0
```

Columns 196 through 208

```
   1     0     1     0     0     0     0     0     1     1     1     0     1
```

Columns 209 through 221

```
   1     1     0     0     1     0     0     1     1     1     1     0     0
```

Columns 222 through 234

```
   1     0     1     1     1     1     1     1     0     0     1     1     0
```

Columns 235 through 247

```
   1     0     1     1     0     0     0     0     0     1     0     1     1
```

Columns 248 through 256

```
   1     0     1     0     1     0     0     0     1
```

۱-۲- مولّد رشته تصادفی با استفاده از LFSR

۱-۲-۱- شبیه‌سازی در محیط MATLAB

الف- با استفاده از دستور randi در محیط نرم‌افزاری MATLAB یک رشته تصادفی باینری به طول ۱۰۰ تولید کنید. این اعداد تصادفی دارای توزیع یکنواخت هستند یعنی احتمال وقوع ۰ و ۱ با هم برابر است.

برنامه:

نتیجه:

سوال ۱: تحقیق نمایید که چگونه می‌توان رشته تصادفی باینری غیریکنواخت تولید کرد که احتمال‌های وقوع ارقام ۰ و ۱ برابر نباشند. با نوشتن برنامه نرم‌افزاری به صورت m.file، با استفاده از دستور rand که اعداد اعشاری تصادفی بین ۰ و ۱ تولید می‌کند رشته تصادفی باینری غیر یکنواخت را تولید کنید.

ب- با استفاده از شیفت‌رجیستر با بازخورد خطی (LFSR) مطابق چندجمله‌ای زیر:

$$f(x) = a_0.x^0 + a_1.x + \cdots + a_{n-1}.x^{n-1} \quad , \; a_0 = 1, \; a_i \epsilon \{0,1\}$$

به‌صورت نرم‌افزاری در محیط MATLAB رشته تصادفی باینری را در دو حالت زیر تولید نمایید و برای ۱۰۰ بیت خروجی رشته را بنویسید.

$$f_1(x) = 1 + x^2 + x^3$$

$$f_2(x) = 1 + x^3 + x^5$$

```
%--------------------------------------------------------------------------%
%%------------------ Lab 1 Digital Communication --------------------%%
 %--------------- Supervisor: Dr.Shirvani Moghaddam --------------%
  %------- Source by Mohammad Reza Farhadi Nia ----- Date:Oct 2020 --%
%--------------------------------------------------------------------------%

Pseudo_Random = randi([0,1],1,100)
Random  = rand(10)
rand_bin = round(0.75*rand(1,100))
```

```
Pseudo_Random =

  Columns 1 through 13

     0     1     0     0     1     0     1     1     1     0     1     1     1

  Columns 14 through 26

     1     1     0     0     1     0     0     0     0     1     1     0     0

  Columns 27 through 39

     1     0     1     1     0     0     0     1     0     0     0     0     0

  Columns 40 through 52

     0     1     1     0     1     0     0     1     1     0     1     0     1

  Columns 53 through 65

     1     1     1     1     0     0     1     0     0     1     1     1     0

  Columns 66 through 78

     0     0     1     0     1     1     0     0     0     0     0     1     0

  Columns 79 through 91

     0     1     0     0     1     0     1     1     1     0     1     0     1

  Columns 92 through 100

     1     1     0     1     0     0     0     0     0


Random =

  Columns 1 through 7

    0.4229    0.5309    0.7788    0.5181    0.2548    0.9160    0.1759
    0.0942    0.6544    0.4235    0.9436    0.2240    0.0012    0.7218
    0.5985    0.4076    0.0908    0.6377    0.6678    0.4624    0.4735
    0.4709    0.8200    0.2665    0.9577    0.8444    0.4243    0.1527
    0.6959    0.7184    0.1537    0.2407    0.3445    0.4609    0.3411
```

```
    0.6999    0.9686    0.2810    0.6761    0.7805    0.7702    0.6074
    0.6385    0.5313    0.4401    0.2891    0.6753    0.3225    0.1917
    0.0336    0.3251    0.5271    0.6718    0.0067    0.7847    0.7384
    0.0688    0.1056    0.4574    0.6951    0.6022    0.4714    0.2428
    0.3196    0.6110    0.8754    0.0680    0.3868    0.0358    0.9174

  Columns 8 through 10

    0.2691    0.6476    0.4587
    0.7655    0.6790    0.6619
    0.1887    0.6358    0.7703
    0.2875    0.9452    0.3502
    0.0911    0.2089    0.6620
    0.5762    0.7093    0.4162
    0.6834    0.2362    0.8419
    0.5466    0.1194    0.8329
    0.4257    0.6073    0.2564
    0.6444    0.4501    0.6135


rand_bin =

  Columns 1 through 13

     0     0     1     0     0     0     1     0     0     0     0     0     0

  Columns 14 through 26

     1     0     1     0     0     0     0     0     0     0     1     0     1

  Columns 27 through 39

     1     1     0     0     1     0     0     0     1     0     0     1     1

  Columns 40 through 52

     0     0     0     0     0     0     1     0     0     1     0     1     0

  Columns 53 through 65

     1     1     0     0     0     0     0     0     1     0     1     0     1

  Columns 66 through 78

     0     1     1     0     0     1     1     0     1     0     1     1     0

  Columns 79 through 91

     1     1     0     1     0     0     0     0     1     1     1     0     0

  Columns 92 through 100

     0     0     0     1     0     0     0     0     0
```

برنامه:

نتیجه:

سوال۲: دیده می‌شود که رشته اطلاعات تولید شده بر اساس این چندجمله‌ای‌ها متناوب است. دوره تناوب آن در هر یک از دو حالت فوق چقدر است؟ در حالت کلی، بیشترین مقدار دوره تناوب رشته اطلاعات تولیدی چقدر می‌تواند باشد و با طول شیفت–رجیستر (درجه چندجمله‌ای) چه رابطه‌ای دارد؟ در چه صورت می‌توان به بیشترین مقدار آن دست یافت؟

دانستنی‌ها: جالب است بدانیم که چندجمله‌ای‌های متداول در سیستم‌های مخابراتی معروف کنونی عبارتند از:

$$f_{Wi-Fi}(x) = 1 + x^4 + x^7$$

$$f_{Wi-Max}(x) = 1 + x^{14} + x^{15}$$

$$f_{LTE}(x) = 1 + x^{28} + x^{29} + x^{30} + x^{31}$$

LFSR by Script

```
%------------------------------------------------------------------------%
%%------------------ Lab 1 Digital Communication --------------------%%
 %--------------- Supervisor: Dr.Shirvani Moghaddam --------------%
%Source by Matlab Help Edited by Mohammad Reza Farhadi Nia Date:Oct 2020%
%------------------------------------------------------------------------%
pnSequence1 = comm.PNSequence('Polynomial',[3 2 0], ...
    'SamplesPerFrame',21,'InitialConditions',[0 0 1]);
x1 = pnSequence();
[x1(1:7) x1(8:14) x1(15:21)]

pnSequence2 = comm.PNSequence('Polynomial','x^5+x^3+1', ...
    'InitialConditions',[0 0 0 0 1],'SamplesPerFrame',93);
x2 = pnSequence2();
[x2(1:31) x2(32:62) x2(63:93)]
```

```
ans =

     1     1     1
     0     0     0
     0     0     0
     1     1     1
     1     1     1
     1     1     1
     0     0     0

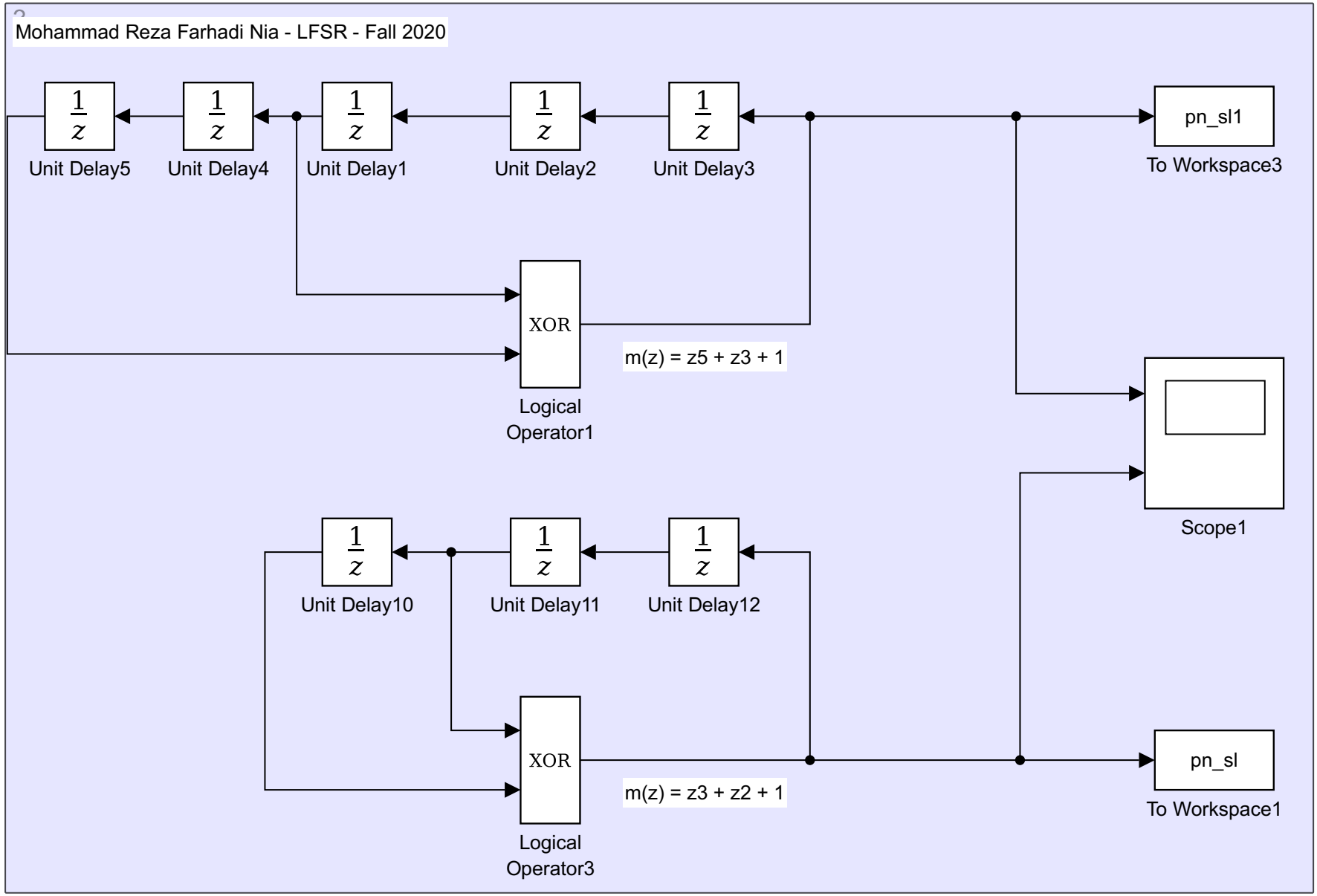

ans =

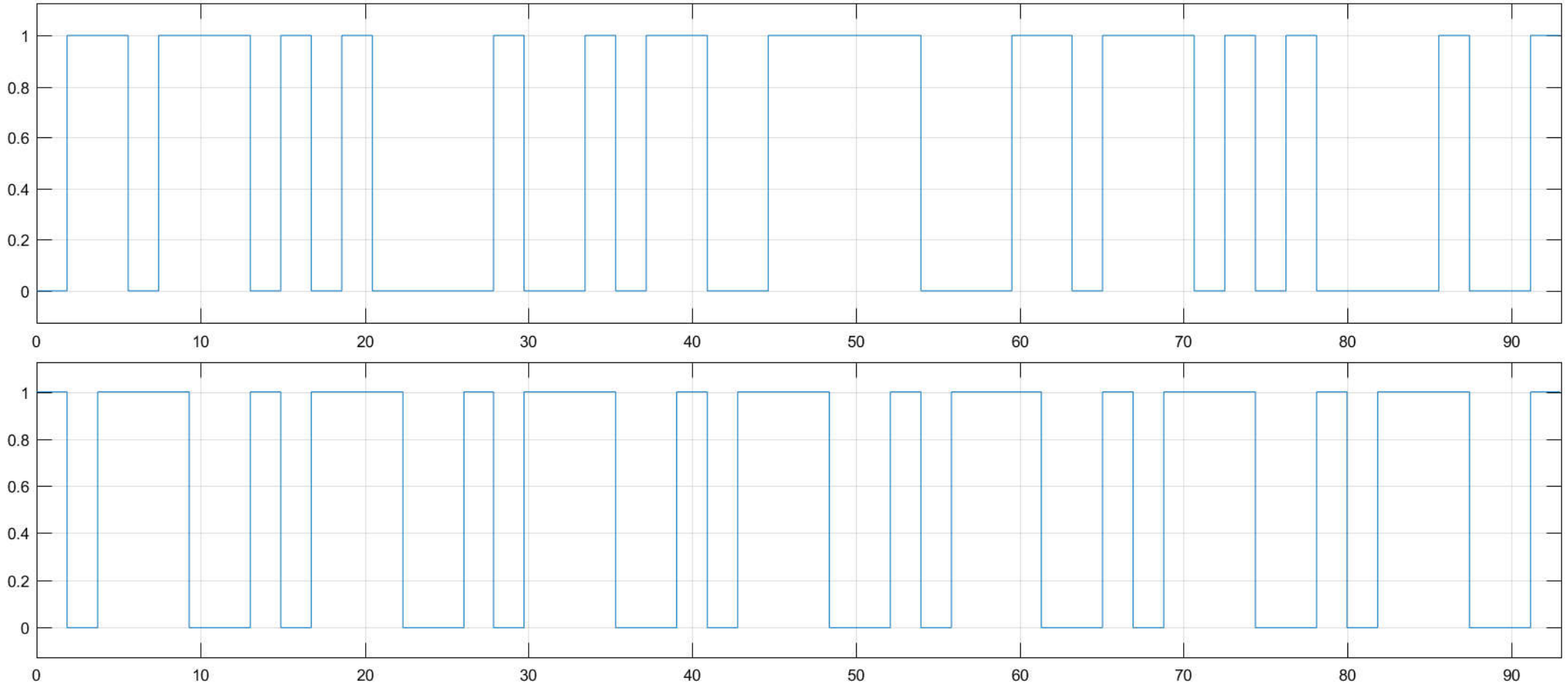
     1     1     1
     0     0     0
     0     0     0
     0     0     0
     0     0     0
     1     1     1
     0     0     0
     1     1     1
     0     0     0
     1     1     1
     1     1     1
     1     1     1
     0     0     0
     1     1     1
     1     1     1
     0     0     0
     0     0     0
     0     0     0
     1     1     1
     1     1     1
     1     1     1
     1     1     1
     1     1     1
     0     0     0
     0     0     0
     1     1     1
```

```
     1     1     1
     0     0     0
     1     1     1
     0     0     0
     0     0     0
```

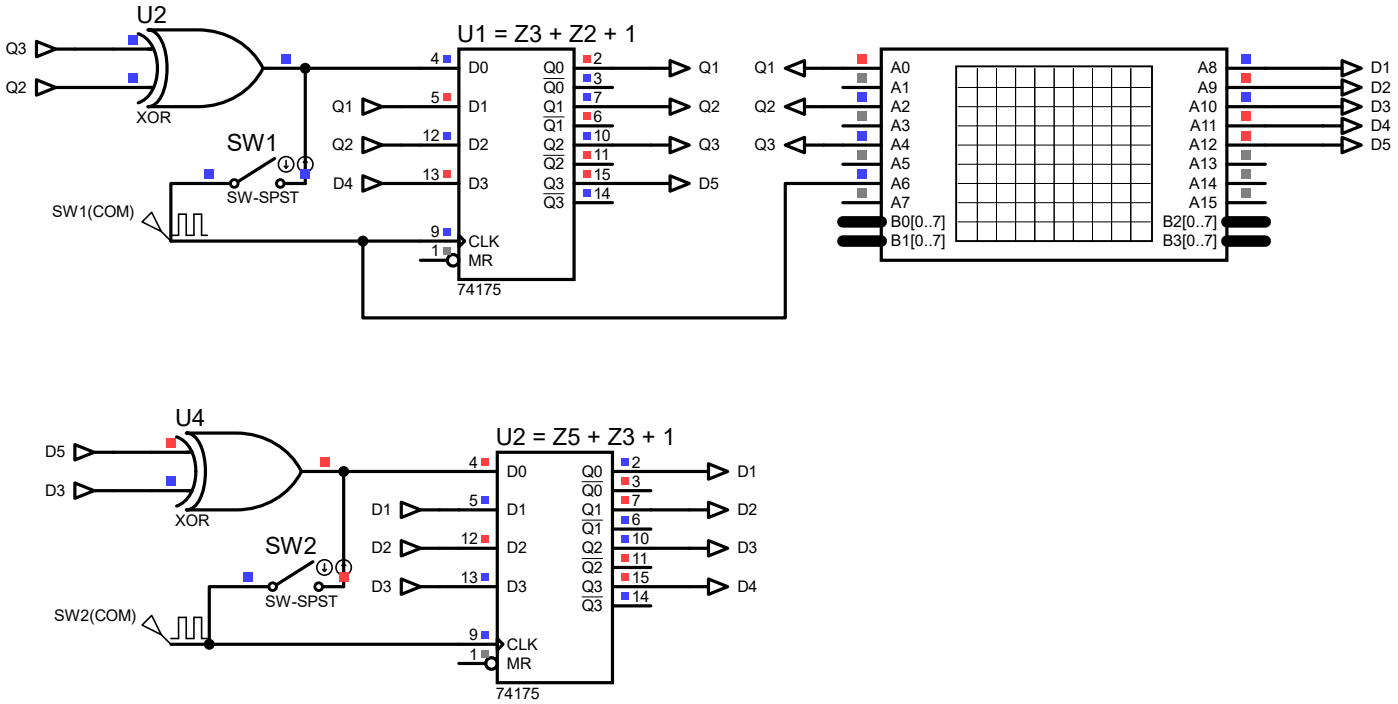
Published with MATLAB® R2016b

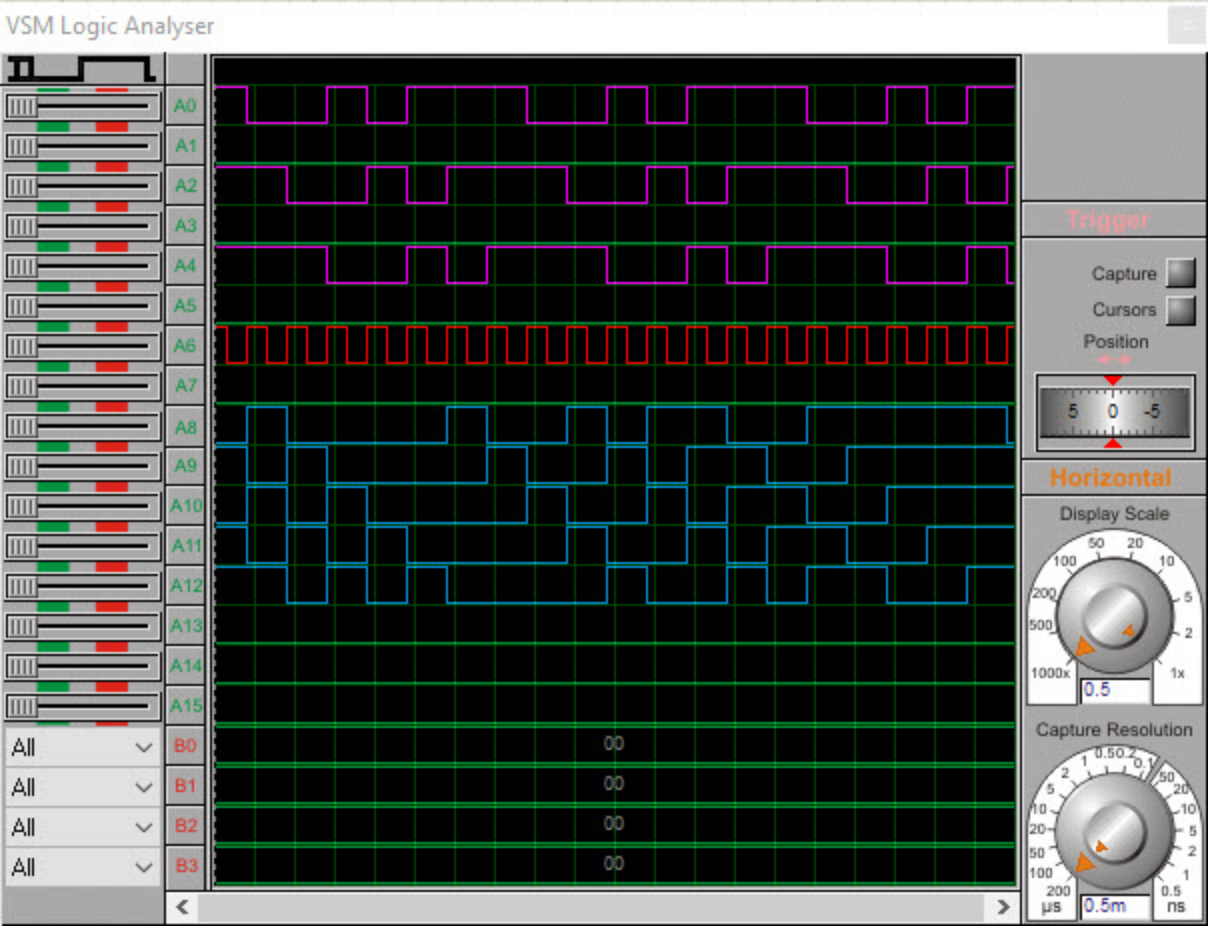
LFSR by Simulink




1
0.8
0.6
0.4
0.2
0
0
10
20
30
40
50
60
70
80
90
1
0.8
0.6
0.4
0.2
0
0
10
20
30
40
50
60
70
80
90

LSFSR - Scheme




VSM Logic Analyser
A0
A1
A2
A3
A4
A5
A6
A7
A8
A9
A10
A11
A12
A13
A14
A15
All
All
All
All
B0
B1
B2
B3
00
00
00
00
Trigger
Capture
Cursors
Position
5
0
-5
Horizontal
Display Scale
50
20
10
100
200
5
500
2
1000x
1x
0.5
Capture Resolution
0.5
0.2
0.1
1
2
5
10
20
50
100
200
50
20
10
5
2
1
0.5
µs
0.5m
ns

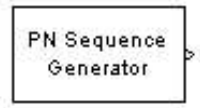
Attachment from Matlab help for research

PN Sequence Generator

Generate pseudonoise sequence

Library

Sequence Generators sublibrary of Comm Sources

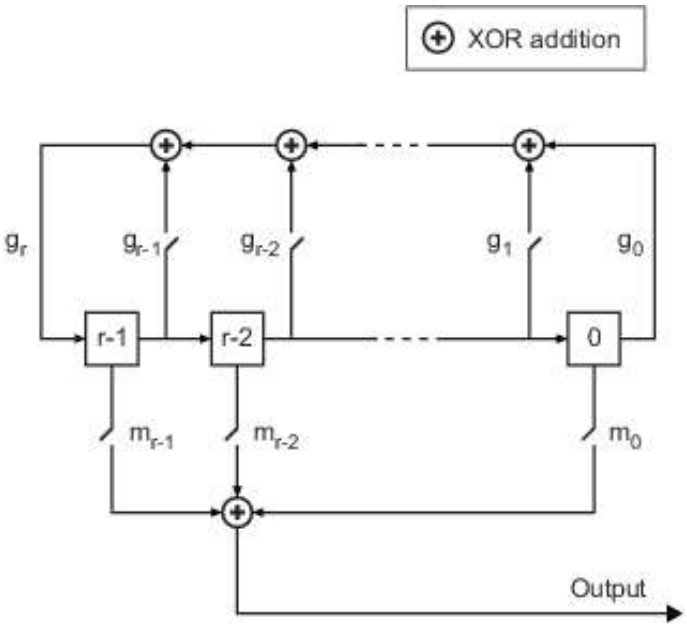


Description

The PN Sequence Generator block generates a sequence of pseudorandom binary numbers using a linear-feedback shift register (LFSR). This block implements LFSR using a simple shift register generator (SSRG, or Fibonacci) configuration. A pseudonoise sequence can be used in a pseudorandom scrambler and descrambler. It can also be used in a direct-sequence spread-spectrum system.

This block can output sequences that vary in length during simulation. For more information about variable-size signals, see Variable-Size Signal Basics in the Simulink® documentation.

The PN Sequence Generator block uses a shift register to generate sequences, as shown below.



All *r* registers in the generator update their values at each time step, according to the value of the incoming arrow to the shift register. The adders perform addition modulo 2. The shift register is described by the **Generator Polynomial** parameter, which is a primitive binary polynomial in *z*, $g_rz^r+g_{r-1}z^{r-1}+g_{r-2}z^{r-2}+\ldots+g_0$. The coefficient g_k is 1 if there is a connection from the kth register, as labeled in the preceding diagram, to the adder. The leading term g_r and the constant term g_0 of the **Generator Polynomial** parameter must be 1 because the polynomial must be primitive.

You can specify the **Generator polynomial** parameter using these formats:

- A polynomial character vector that includes the number `1`, for example, `'z^4 + z + 1'`.

- A vector that lists the coefficients of the polynomial in descending order of powers. The first and last entries must be 1. Note that the length of this vector is one more than the degree of the generator polynomial.
- A vector containing the exponents of *z* for the nonzero terms of the polynomial in descending order of powers. The last entry must be `0`.

For example, `'z^8 + z^2 + 1'`, `[1 0 0 0 0 0 1 0 1]`, and `[8 2 0]` represent the same polynomial, $p(z) = z^8 + z^2 + 1$.

The **Initial states** parameter is a vector specifying the initial values of the registers. The **Initial states** parameter must satisfy these criteria:

- All elements of the **Initial states** vector must be binary numbers.
- The length of the **Initial states** vector must equal the degree of the generator polynomial.

> **Note** At least one element of the **Initial states** vector must be nonzero in order for the block to generate a nonzero sequence. That is, the initial state of at least one of the registers must be nonzero.

For example, the following table indicates two sets of parameter values that correspond to a generator polynomial of $p(z) = z^8 + z^2 + 1$.

Quantity	**Example 1**	**Example 2**
Generator polynomial	`g1 = [1 0 0 0 0 0 1 0 1]`	`g2 = [8 2 0]`
Degree of generator polynomial	8, which is `length(g1)-1`	8
Initial states	`[1 0 0 0 0 0 1 0]`	`[1 0 0 0 0 0 1 0]`

Output mask vector (or scalar shift value) shifts the starting point of the output sequence. With the default setting for this parameter, the only connection is along the arrow labeled m_0, which corresponds to a shift of 0. The parameter is described in greater detail below.

You can shift the starting point of the PN sequence with **Output mask vector (or scalar shift value)**. You can specify the parameter in either of two ways:

- An integer representing the length of the shift
- A binary vector, called the *mask vector*, whose length is equal to the degree of the generator polynomial

The difference between the block's output when you set **Output mask vector (or scalar shift value)** to 0, versus a positive integer d, is shown in the following table.

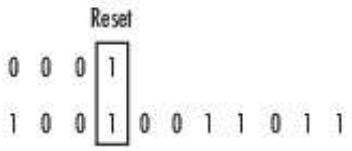
	T = 0	**T = 1**	**T = 2**	**...**	**T = d**	**T = d+1**
Shift = 0	x_0	x_1	x_2	...	x_d	x_{d+1}
Shift = d	x_d	x_{d+1}	x_{d+2}	...	x_{2d}	x_{2d+1}

Alternatively, you can set **Output mask vector (or scalar shift value)** to a binary vector, corresponding to a polynomial in *z*, $m_{r-1}z^{r-1} + m_{r-2}z^{r-2} + \ldots + m_1z + m_0$, of degree at most r-1. The mask vector corresponding to a shift of d is the vector that represents $m(z) = z^d$ modulo $g(z)$, where $g(z)$ is the generator polynomial. For example, if the degree of the generator polynomial is 4, then the mask vector corresponding to d = 2 is `[0 1 0 0]`, which represents the polynomial $m(z) = z^2$. The preceding schematic diagram shows how **Output mask vector (or scalar shift value)** is implemented when you specify it as a mask vector. The default setting for **Output mask vector (or scalar shift value)** is `0`. You can calculate the mask vector using the Communications System Toolbox™ function `shift2mask`.

You can use an external signal to reset the values of the internal shift register to the initial state by selecting **Reset on nonzero input**. This creates an input port for the external signal in the PN Sequence Generator block.

Example: Resetting a Signal

Suppose that the PN Sequence Generator block outputs `[1 0 0 1 1 0 1 1]` when there is no reset. You then select **Reset on nonzero input** and input a reset signal [0 0 0 1]. The following table shows the effect of the reset signal on the PN Sequence Generator block.

Reset Signal Properties	PN Sequence Generator block	Reset Signal, Output Signal
Sample time = 1	**Sample time** = 1	

The PN sequence is reset at the fourth bit, because the fourth bit of the reset signal is a 1 and the **Sample time** is 1.

Sequences of Maximum Length

To generate a maximum length sequence for a generator polynomial having degree, *r*, set **Generator polynomial** to a value from the following table. The maximum sequence length is $2^r - 1$. See [1] for more information about the shift-register configurations that these polynomials represent.

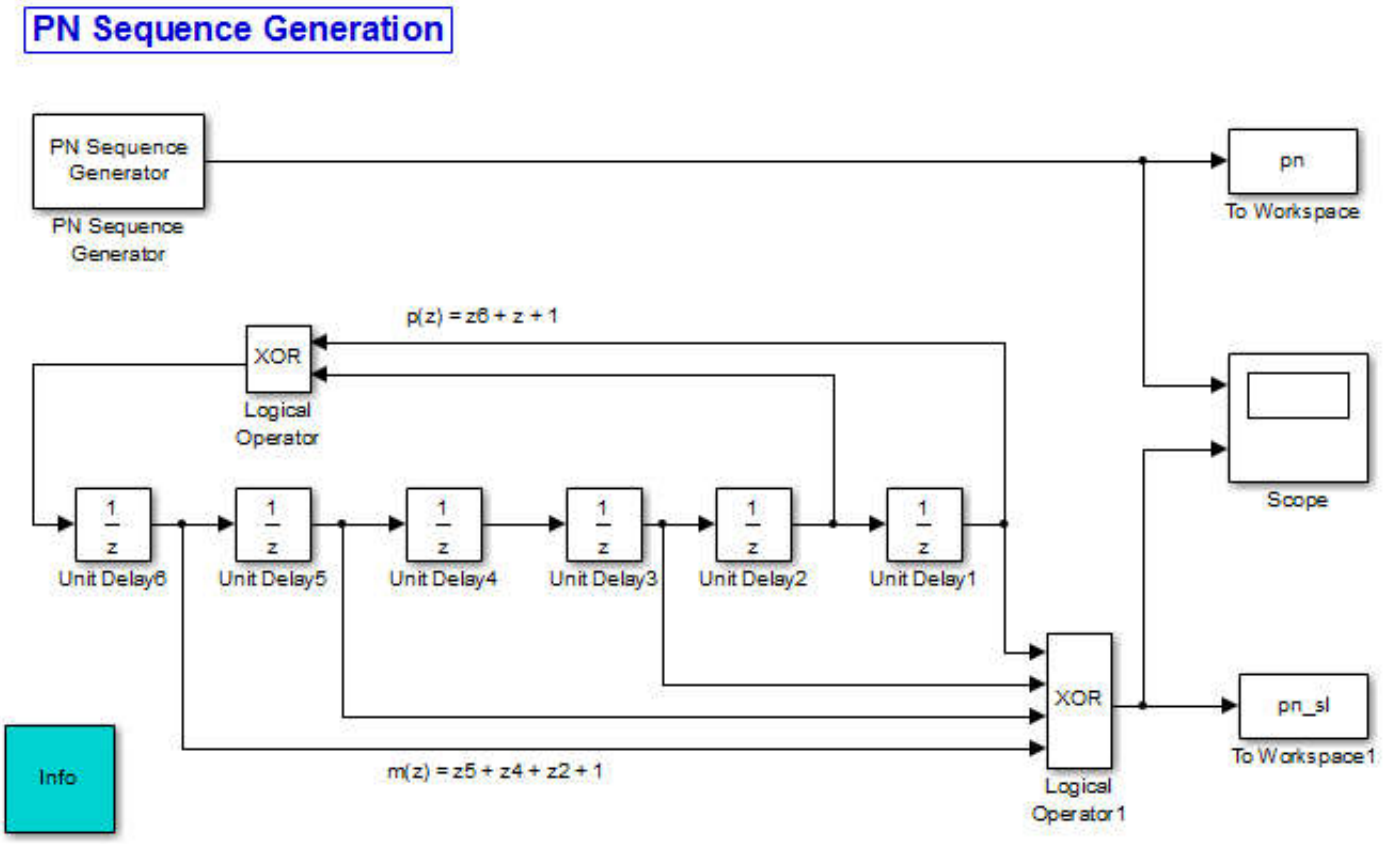
r	Generator Polynomial	r	Generator Polynomial
2	`[2 1 0]`	21	`[21 19 0]`
3	`[3 2 0]`	22	`[22 21 0]`
4	`[4 3 0]`	23	`[23 18 0]`
5	`[5 3 0]`	24	`[24 23 22 17 0]`
6	`[6 5 0]`	25	`[25 22 0]`
7	`[7 6 0]`	26	`[26 25 24 20 0]`
8	`[8 6 5 4 0]`	27	`[27 26 25 22 0]`
9	`[9 5 0]`	28	`[28 25 0]`
10	`[10 7 0]`	29	`[29 27 0]`
11	`[11 9 0]`	30	`[30 29 28 7 0]`
12	`[12 11 8 6 0]`	31	`[31 28 0]`
13	`[13 12 10 9 0]`	32	`[32 31 30 10 0]`
14	`[14 13 8 4 0]`	33	`[33 20 0]`
15	`[15 14 0]`	34	`[34 15 14 1 0]`
16	`[16 15 13 4 0]`	35	`[35 2 0]`
17	`[17 14 0]`	36	`[36 11 0]`
18	`[18 11 0]`	37	[37 12 10 2 0]
19	`[19 18 17 14 0]`	38	[38 6 5 1 0]
20	`[20 17 0]`	39	[39 8 0]
40	`[40 5 4 3 0]`	47	[47 14 0]

41	[41 3 0]	48	[48 28 27 1 0]
42	[42 23 22 1 0]	49	[49 9 0]
43	[43 6 4 3 0]	50	[50 4 3 2 0]
44	[44 6 5 2 0]	51	[51 6 3 1 0]
45	[45 4 3 1 0]	52	[52 3 0]
46	[46 21 10 1 0]	53	[53 6 2 1 0]

Example of PN Sequence Generation

This example clarifies the operation of the `PN Sequence Generator` block by comparing the output sequence from the library block with that generated from primitive Simulink blocks.

To open the model, enter `doc_pnseq2` at the MATLAB® command line.



For the chosen generator polynomial, $p(z) = z^6 + z + 1$, the model generates a PN sequence of period 63, using both the library block and corresponding Simulink blocks. It shows how the two parameters, **Initial states** and **Output mask vector (or scalar shift value)**, are interpreted in the latter schematic.

You can experiment with different initial states, by changing the value of **Initial states** prior to running the simulation. For all values, the two generated sequences are the same.

Using the PN Sequence Generator block allows you to easily generate PN sequences of large periods.

Parameters

Generator polynomial

Polynomial, specified as a character vector or vector, that determines the shift register's feedback connections.