Digital Logic Design – Fall 2024

CA3 – Implementing a pseudo-random number generator unit

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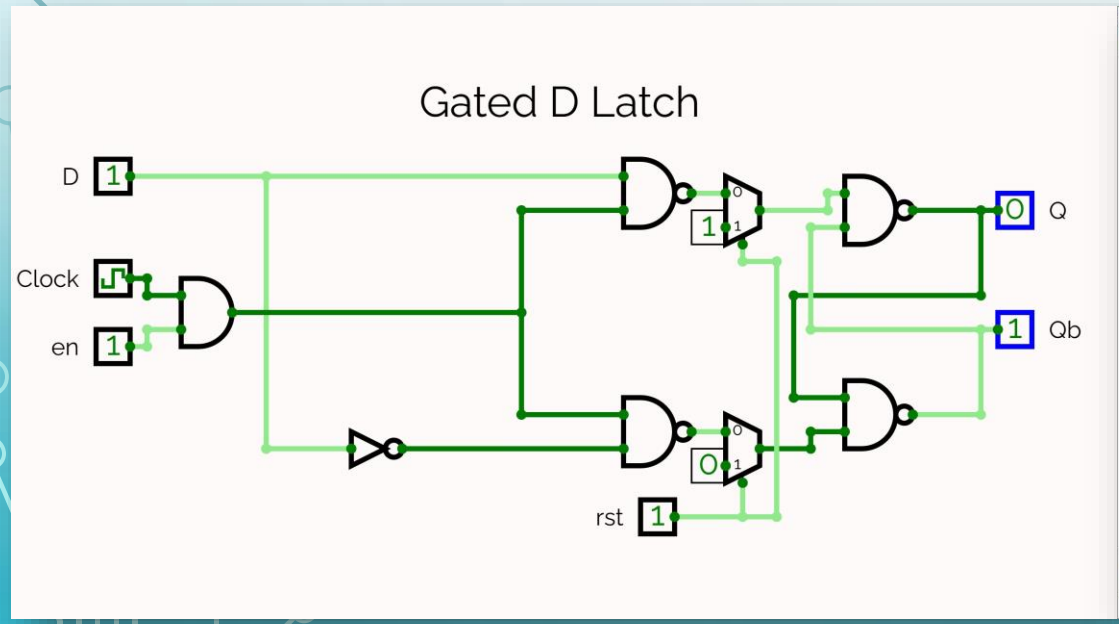
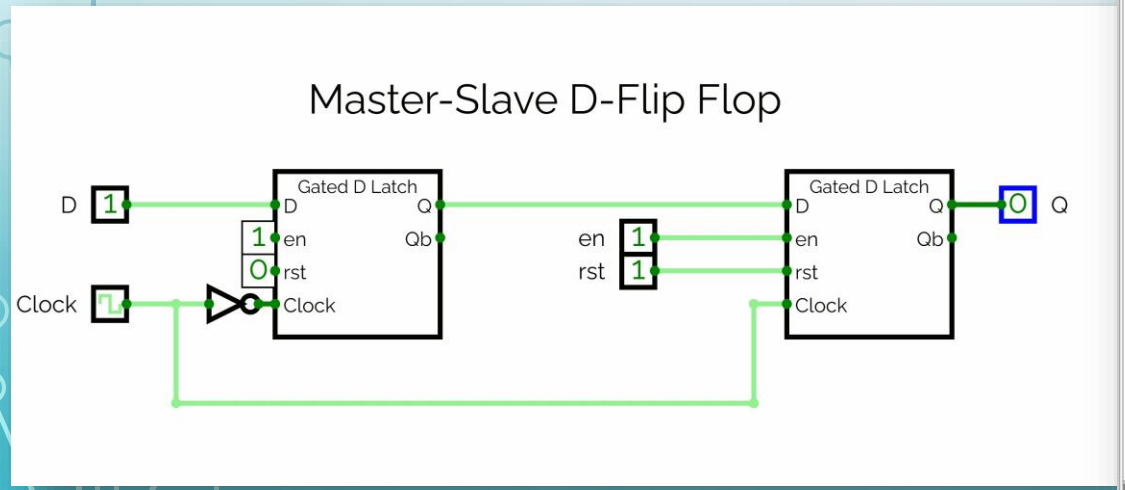
Implementation of a D-Flip Flop

Design of a Gated D-Latch and waveforms

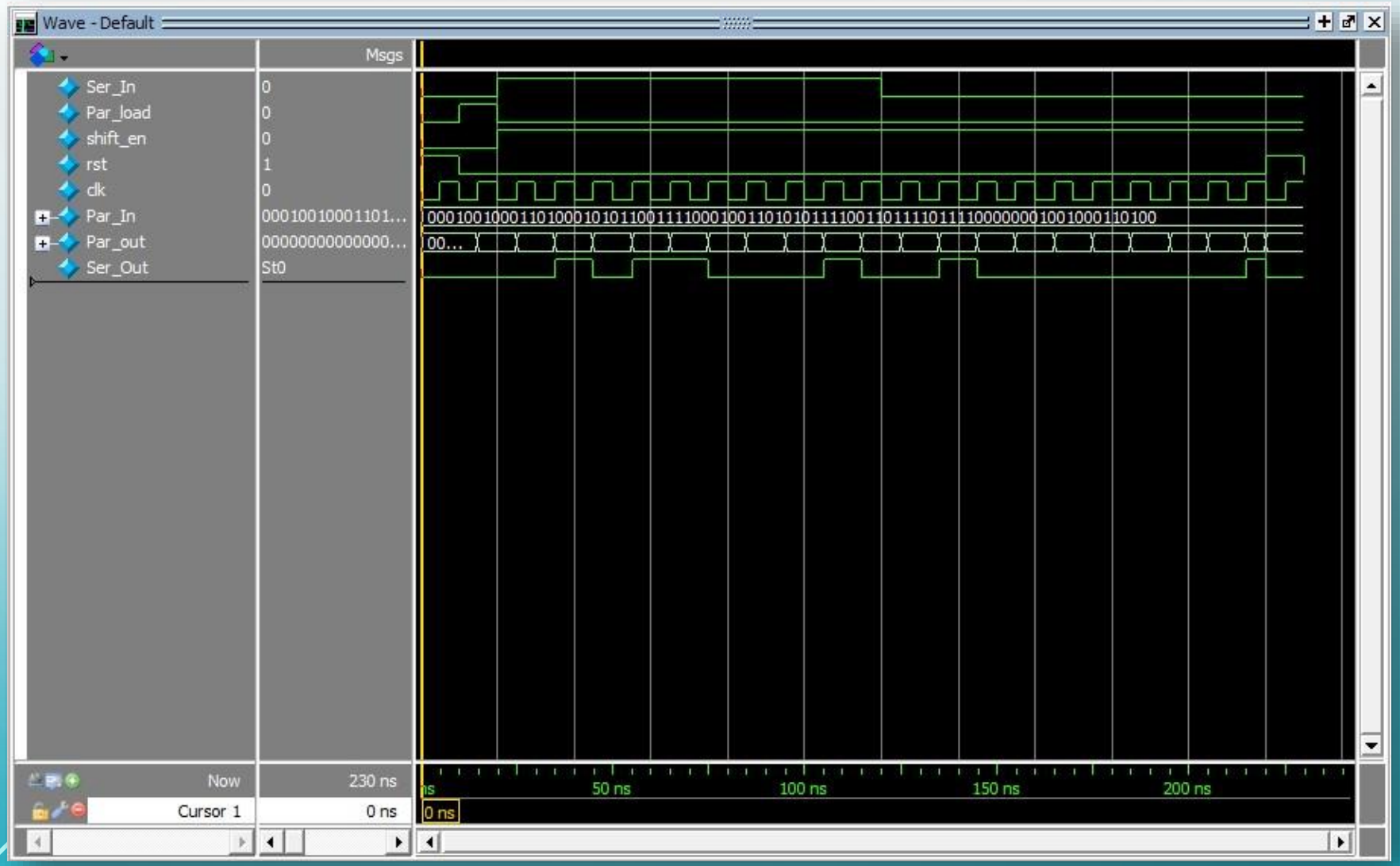


Implementation of a D-Flip Flop

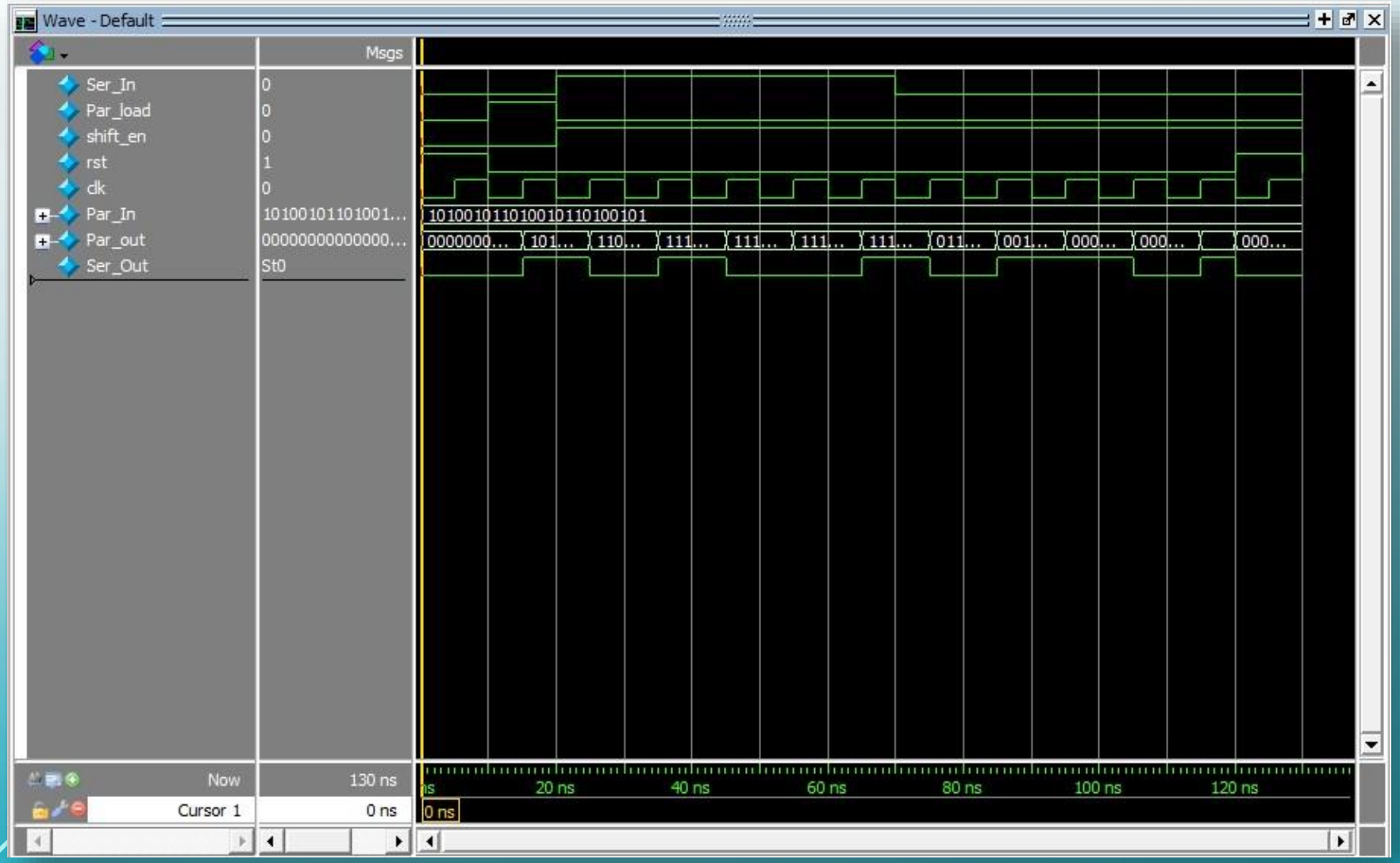
Design of a D-Flip Flop and waveforms



Waveforms of an 80-bit Shift Register



Waveforms of a 24-bit Shift Register

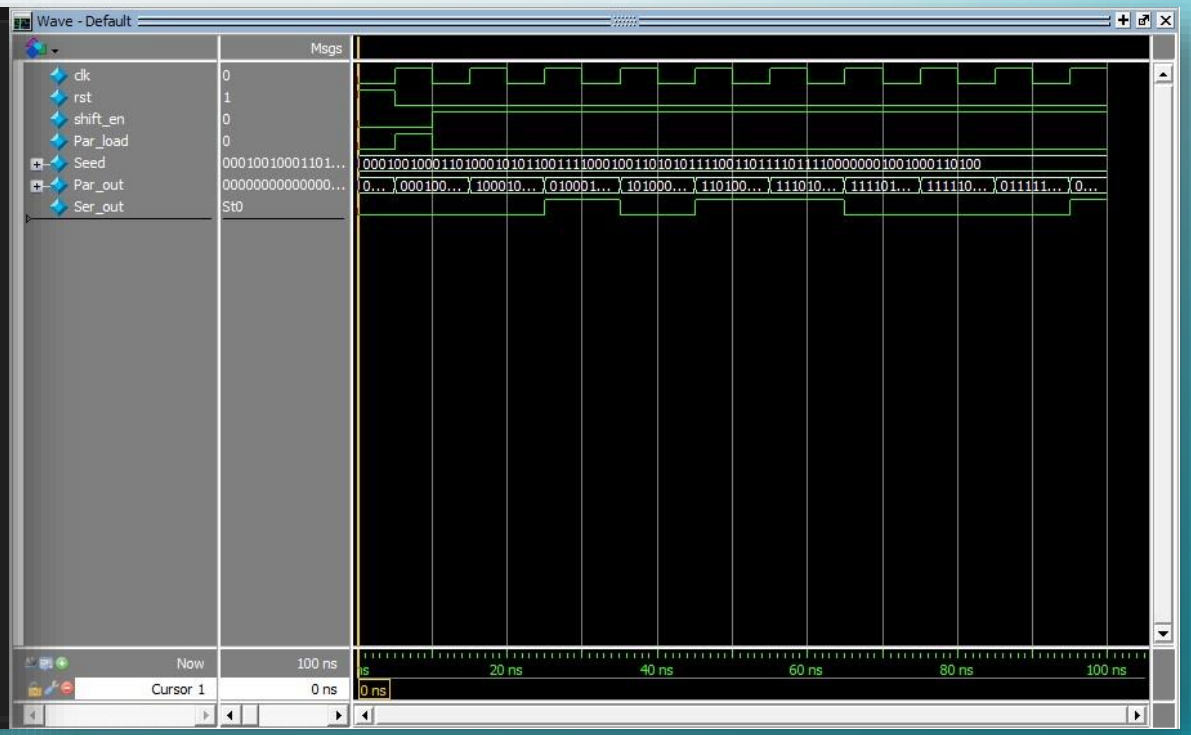


LFSR testing on first seed

Expected output

```
output > LFSR.log
   1    0 , 0x123456789abcdef01234
   2    0 , 0x891a2b3c4d5e6f78091a
   3    1 , 0x448d159e26af37bc048d
   4    0 , 0xa2468acf13579bde0246
   5    1 , 0xd123456789abcdef0123
   6    1 , 0xe891a2b3c4d5e6f78091
   7    0 , 0xf448d159e26af37bc048
   8    0 , 0xfa2468acf13579bde024
   9    0 , 0x7d123456789abcdef012
  10    1 , 0x3e891a2b3c4d5e6f7809
```

Waveforms from Testbench



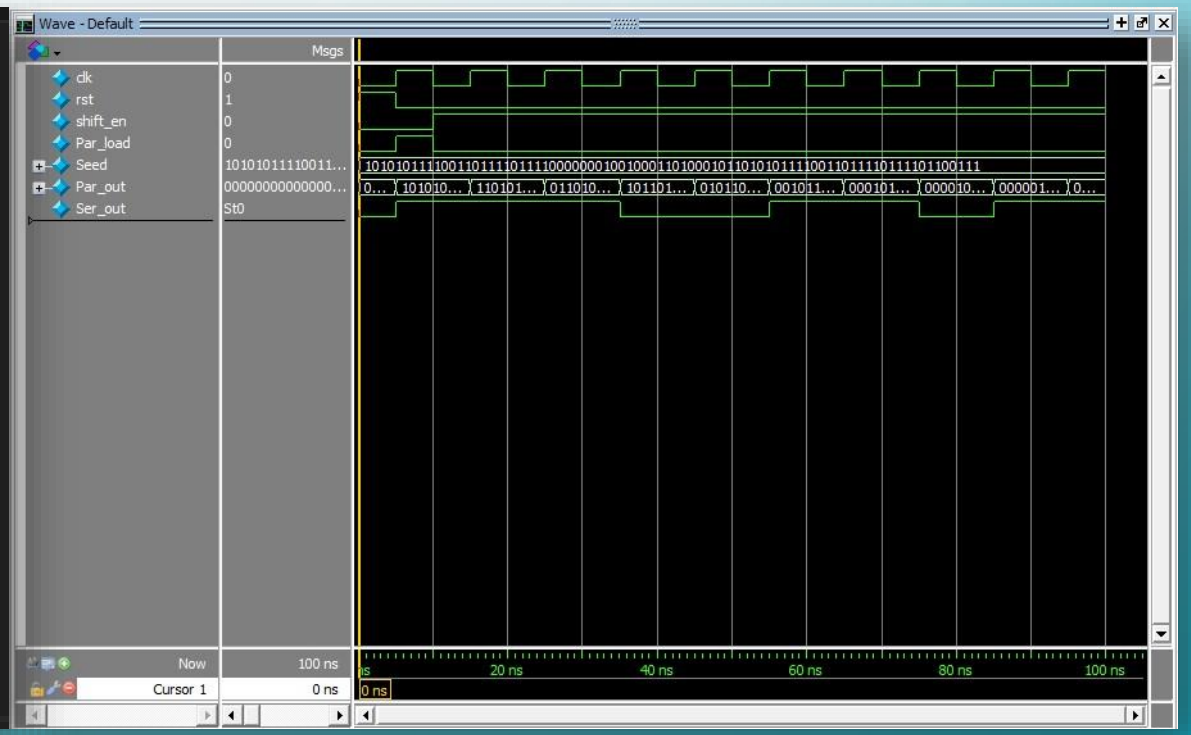
LFSR testing on second seed

Expected output

output > LFSR.log

```
 1    1 , 0xabcdef012345abcdef67
 2    1 , 0xd5e6f78091a2d5e6f7b3
 3    1 , 0x6af37bc048d16af37bd9
 4    0 , 0xb579bde02468b579bdec
 5    0 , 0x5abcdef012345abcdef6
 6    1 , 0x2d5e6f78091a2d5e6f7b
 7    1 , 0x16af37bc048d16af37bd
 8    0 , 0x0b579bde02468b579bde
 9    1 , 0x05abcdef012345abcdef
10    1 , 0x02d5e6f78091a2d5e6f7
```

Waveforms from Testbench



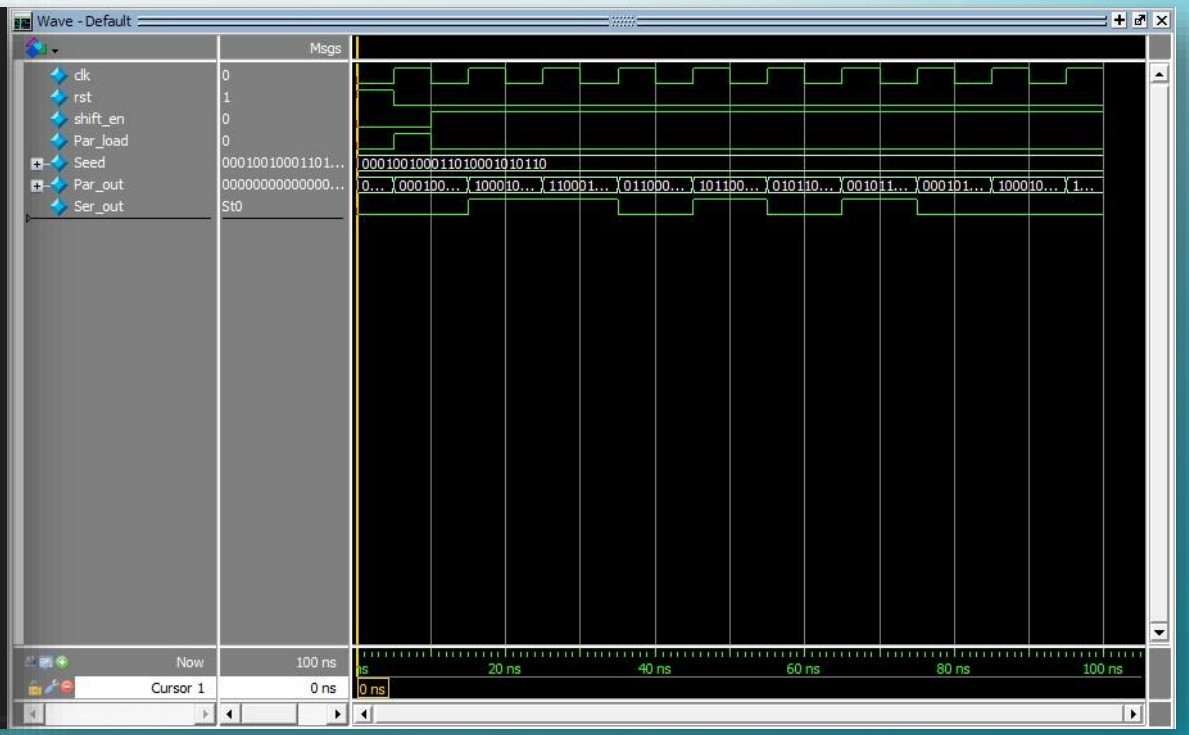
NFSR testing on first seed

Expected output

output > NFSR.log

```
 1    0 , 0x123456
 2    1 , 0x891a2b
 3    1 , 0xc48d15
 4    0 , 0x62468a
 5    1 , 0xb12345
 6    0 , 0x5891a2
 7    1 , 0x2c48d1
 8    0 , 0x162468
 9    0 , 0x8b1234
10    0 , 0xc5891a
```

Waveforms from Testbench



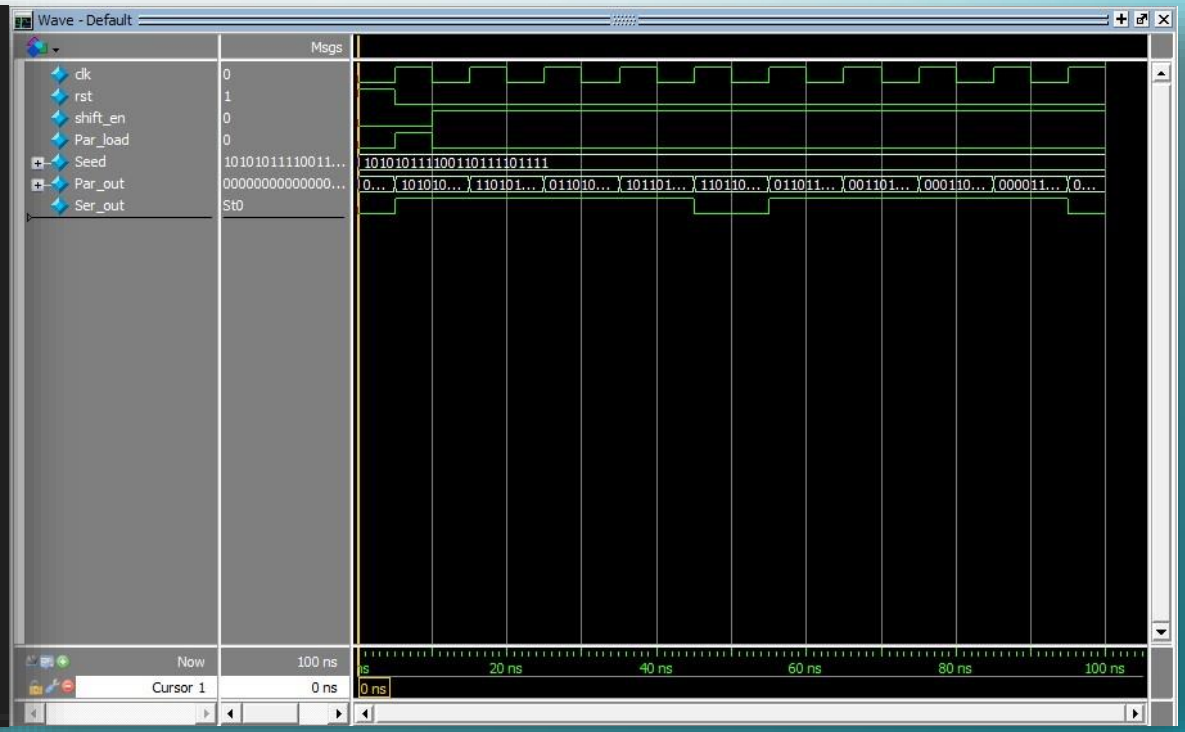
NFSR testing on second seed

Expected output

output > NFSR.log

```
 1    1 , 0xabcdef
 2    1 , 0xd5e6f7
 3    1 , 0x6af37b
 4    1 , 0xb579bd
 5    0 , 0xdabcde
 6    1 , 0x6d5e6f
 7    1 , 0x36af37
 8    1 , 0x1b579b
 9    1 , 0x0dabcd
10    0 , 0x06d5e6
```

Waveforms from Testbench



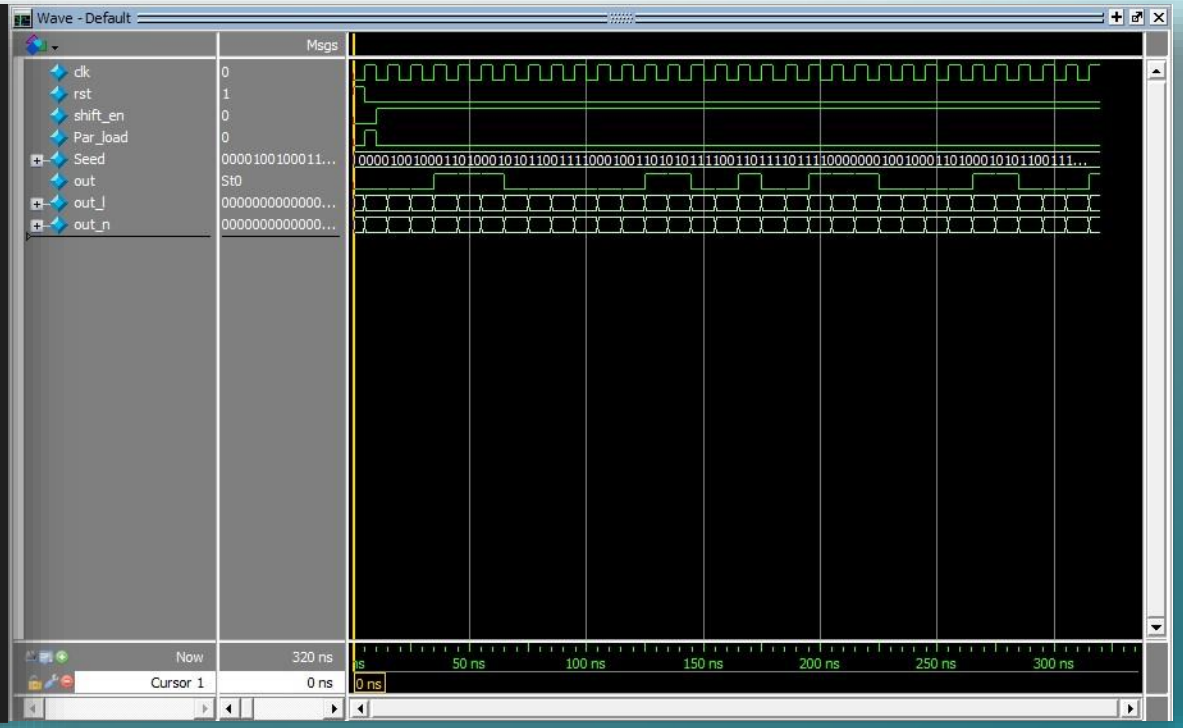
Grain testing on first seed

Expected output

Waveforms from Testbench

output > Grain.log

```
1   0 , 0x789abcdef0123456789a , 0x123456
2   0 , 0x3c4d5e6f78091a2b3c4d , 0x891a2b
3   0 , 0x1e26af37bc048d159e26 , 0x448d15
4   1 , 0x0f13579bde02468acf13 , 0x22468a
5   1 , 0x0789abcdef0123456789 , 0x912345
6   1 , 0x83c4d5e6f78091a2b3c4 , 0xc891a2
7   0 , 0xc1e26af37bc048d159e2 , 0x6448d1
8   0 , 0xe0f13579bde02468acf1 , 0xb22468
9   0 , 0x70789abcdef012345678 , 0x591234
10  0 , 0x383c4d5e6f78091a2b3c , 0xac891a
11  0 , 0x1c1e26af37bc048d159e , 0x56448d
12  0 , 0x0e0f13579bde02468acf , 0xab2246
13  1 , 0x070789abcdef01234567 , 0x559123
14  1 , 0x8383c4d5e6f78091a2b3 , 0xaac891
15  0 , 0xc1c1e26af37bc048d159 , 0xd56448
16  0 , 0x60e0f13579bde02468ac , 0xeab224
17  1 , 0x3070789abcdef0123456 , 0x755912
18  0 , 0x18383c4d5e6f78091a2b , 0x3aac89
19  0 , 0x8c1c1e26af37bc048d15 , 0x9d5644
20  1 , 0xc60e0f13579bde02468a , 0xceab22
21  1 , 0x63070789abcdef012345 , 0x675591
22  1 , 0x318383c4d5e6f78091a2 , 0xb3aac8
23  0 , 0x18c1c1e26af37bc048d1 , 0xd9d564
24  0 , 0x0c60e0f13579bde02468 , 0x6ceab2
25  0 , 0x063070789abcdef01234 , 0xb67559
26  0 , 0x8318383c4d5e6f78091a , 0x5b3aac
27  1 , 0x418c1c1e26af37bc048d , 0x2d9d56
28  1 , 0xa0c60e0f13579bde0246 , 0x96ceab
29  0 , 0xd063070789abcdef0123 , 0xcb6755
30  0 , 0x68318383c4d5e6f78091 , 0x65b3aa
31  0 , 0xb418c1c1e26af37bc048 , 0xb2d9d5
32  1 , 0x5a0c60e0f13579bde024 , 0xd96cea
```



Grain testing on second seed

Expected output

output > Grain.log

```
1   0 , 0x123abc12345ab6789cde , 0xabcdef
2   1 , 0x891d5e091a2d5b3c4e6f , 0xd5e6f7
3   0 , 0xc48eaf048d16ad9e2737 , 0xeaf37b
4   0 , 0xe2475782468b56cf139b , 0x7579bd
5   0 , 0xf123abc12345ab6789cd , 0xbabcde
6   0 , 0x7891d5e091a2d5b3c4e6 , 0x5d5e6f
7   1 , 0x3c48eaf048d16ad9e273 , 0x2eaf37
8   1 , 0x9e2475782468b56cf139 , 0x97579b
9   1 , 0xcf123abc12345ab6789c , 0xcbabcd
10  1 , 0xe7891d5e091a2d5b3c4e , 0x65d5e6
11  1 , 0x73c48eaf048d16ad9e27 , 0xb2eaf3
12  1 , 0xb9e2475782468b56cf13 , 0x597579
13  1 , 0xdcf123abc12345ab6789 , 0xacbabc
14  0 , 0x6e7891d5e091a2d5b3c4 , 0x565d5e
15  1 , 0x373c48eaf048d16ad9e2 , 0xab2eaf
16  1 , 0x9b9e2475782468b56cf1 , 0x559757
17  0 , 0xcdcf123abc12345ab678 , 0x2acbab
18  0 , 0x66e7891d5e091a2d5b3c , 0x9565d5
19  0 , 0xb373c48eaf048d16ad9e , 0x4ab2ea
20  0 , 0xd9b9e2475782468b56cf , 0xa55975
21  0 , 0xecdcf123abc12345ab67 , 0x52acba
22  1 , 0x766e7891d5e091a2d5b3 , 0xa9565d
23  0 , 0x3b373c48eaf048d16ad9 , 0x54ab2e
24  1 , 0x9d9b9e2475782468b56c , 0x2a5597
25  1 , 0x4ecdcf123abc12345ab6 , 0x152acb
26  0 , 0xa766e7891d5e091a2d5b , 0x8a9565
27  1 , 0xd3b373c48eaf048d16ad , 0x454ab2
28  1 , 0xe9d9b9e2475782468b56 , 0xa2a559
29  0 , 0xf4ecdcf123abc12345ab , 0x5152ac
30  0 , 0x7a766e7891d5e091a2d5 , 0x28a956
31  0 , 0x3d3b373c48eaf048d16a , 0x9454ab
32  0 , 0x1e9d9b9e2475782468b5 , 0x4a2a55
```

Waveforms from Testbench