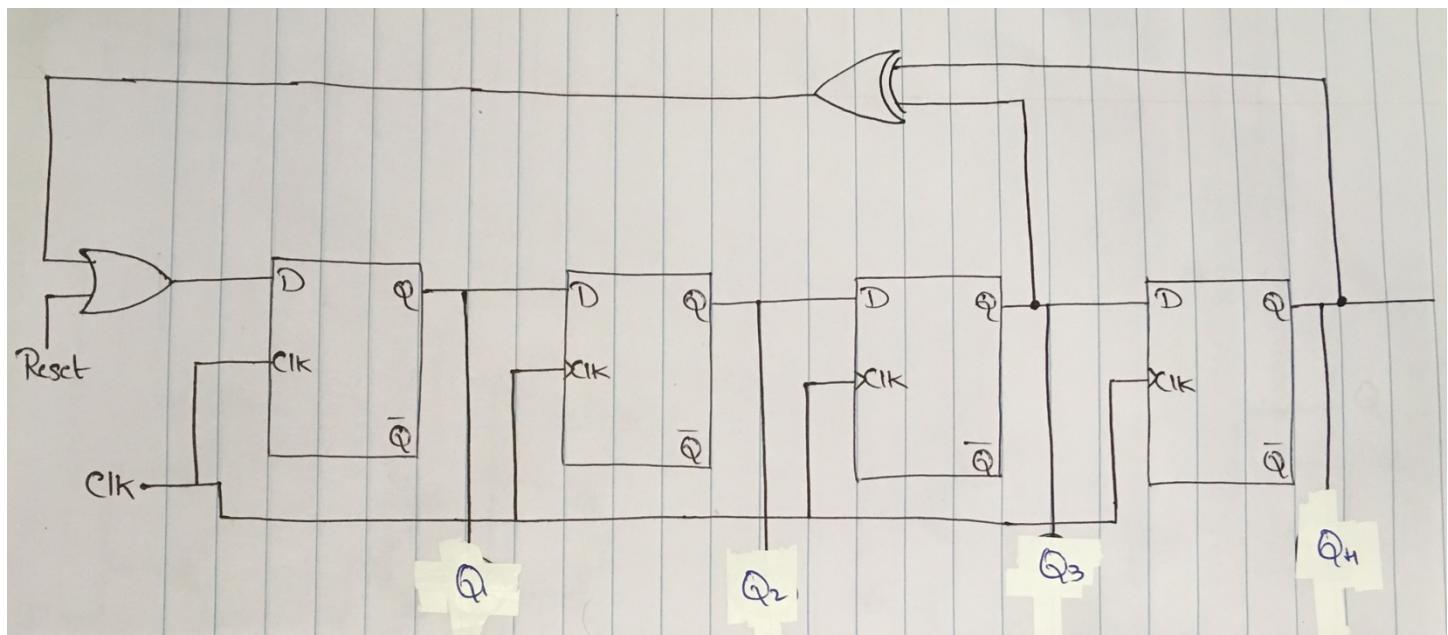
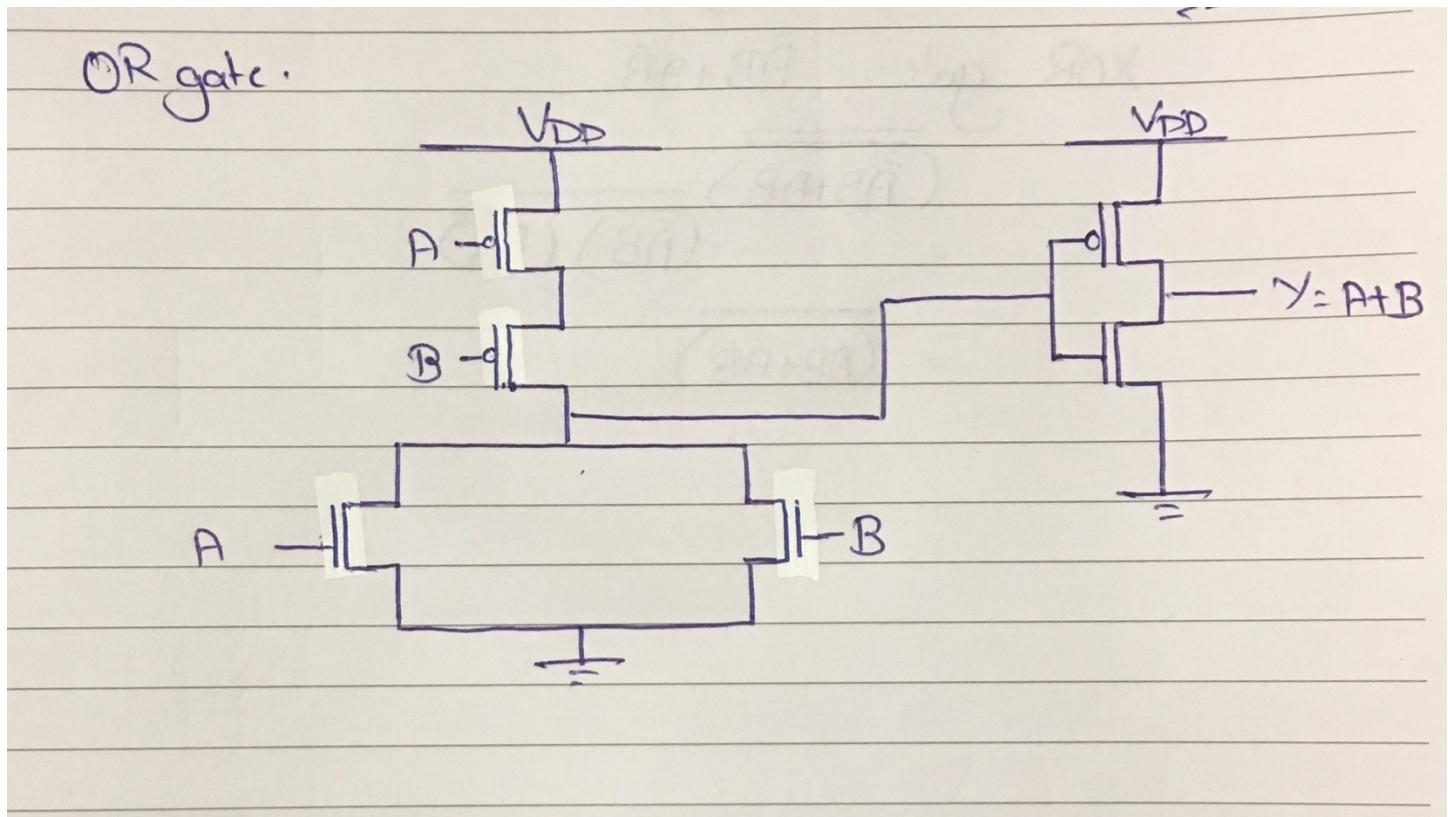


Design Project Report

Likith Nandigam

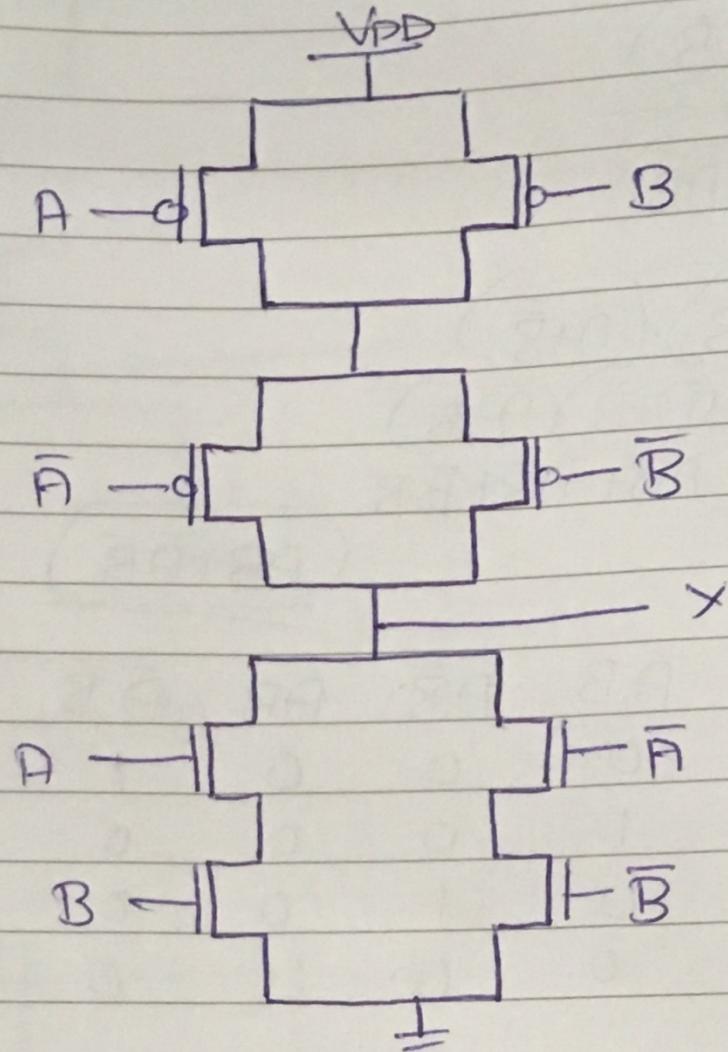


Schematic of a Pseudo Random Noise Generator constructed using D-Flipflops



Transistor Schematic of OR Gate

$$\overline{AB + \bar{A}\bar{B}}$$

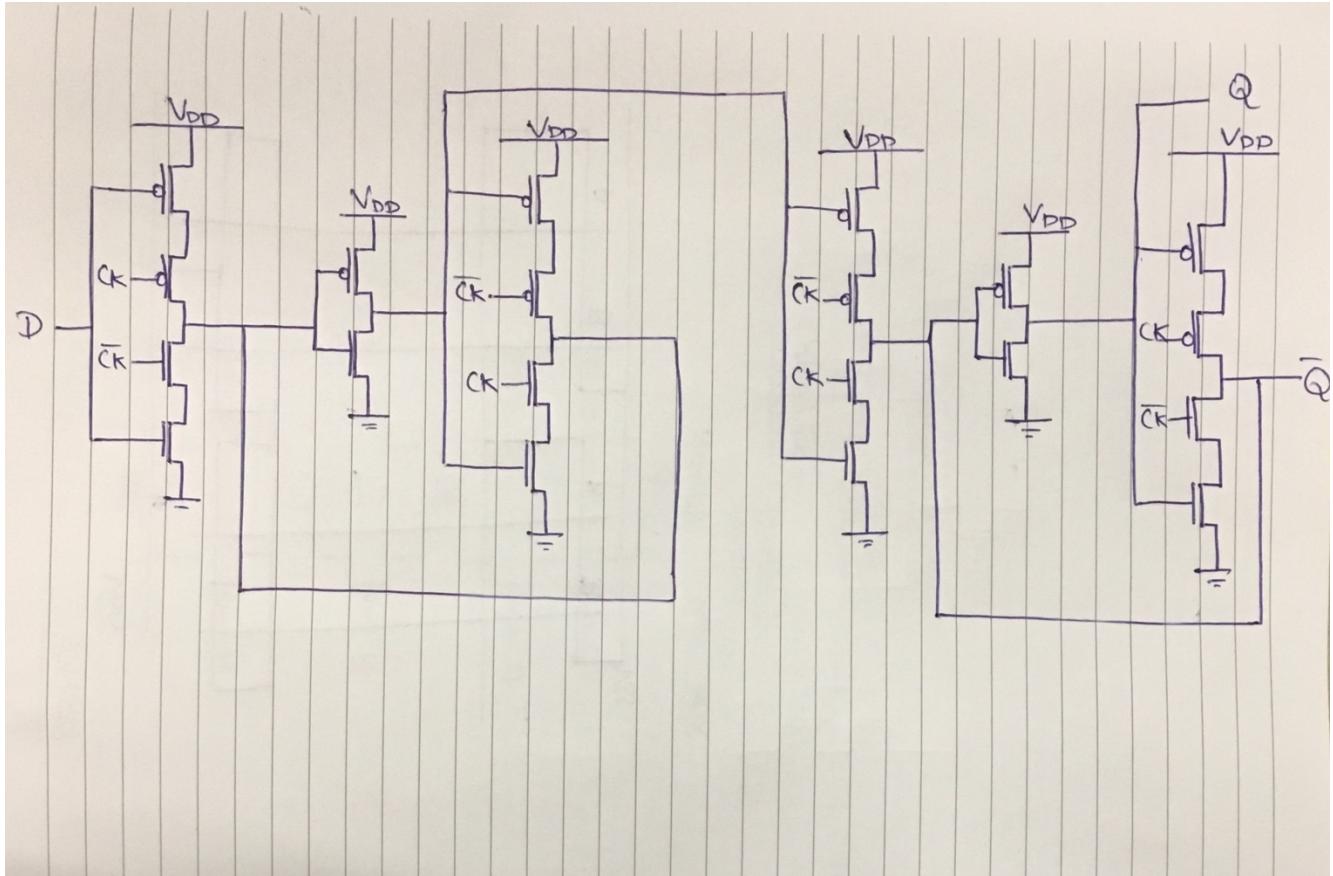


XOR gate: $\overline{\bar{A}B + A\bar{B}}$

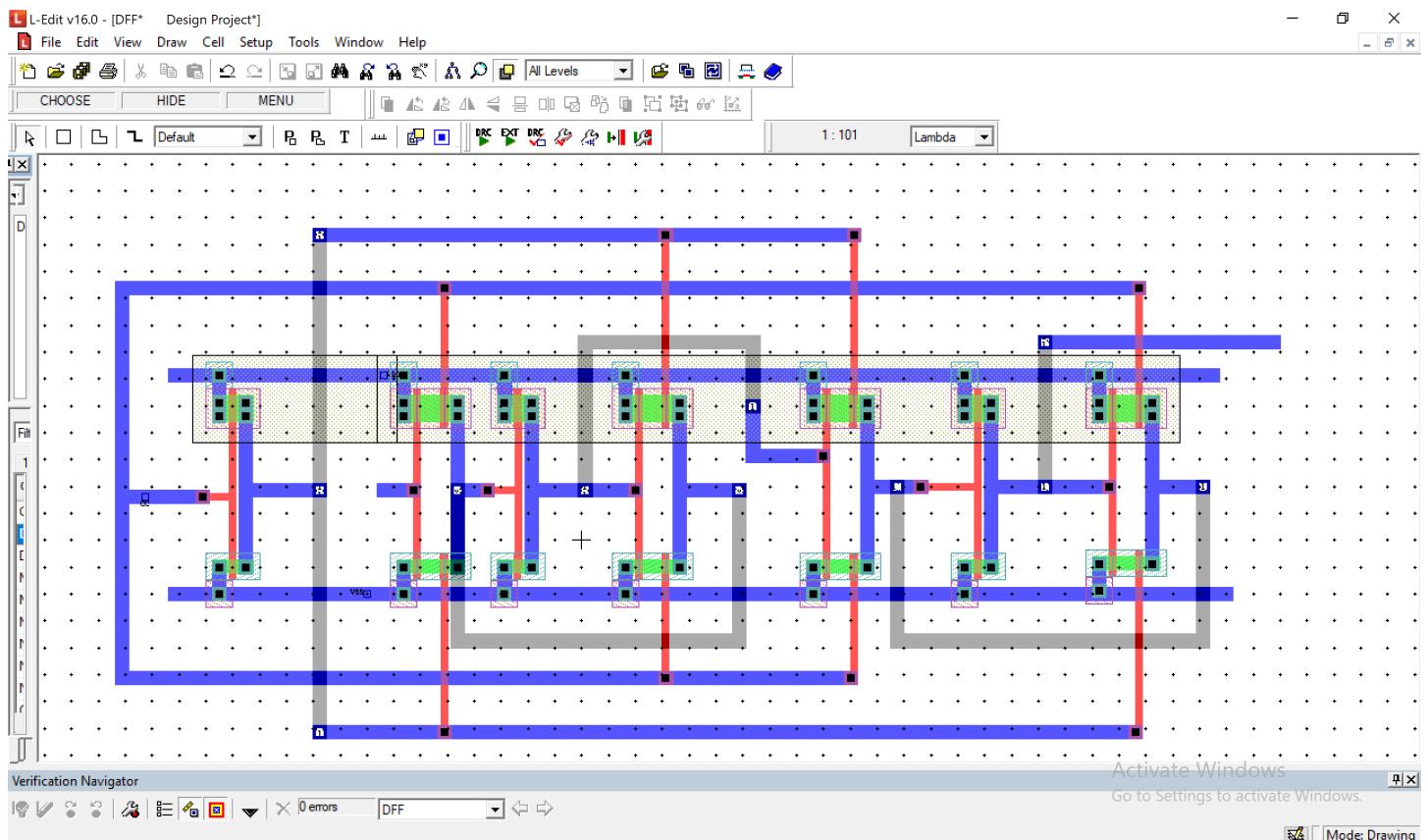
$$= \overline{(\bar{A}B + A\bar{B})} = \overline{(\bar{A}B)} \overline{(A\bar{B})}$$

$$= \overline{(AB + \bar{A}\bar{B})}$$

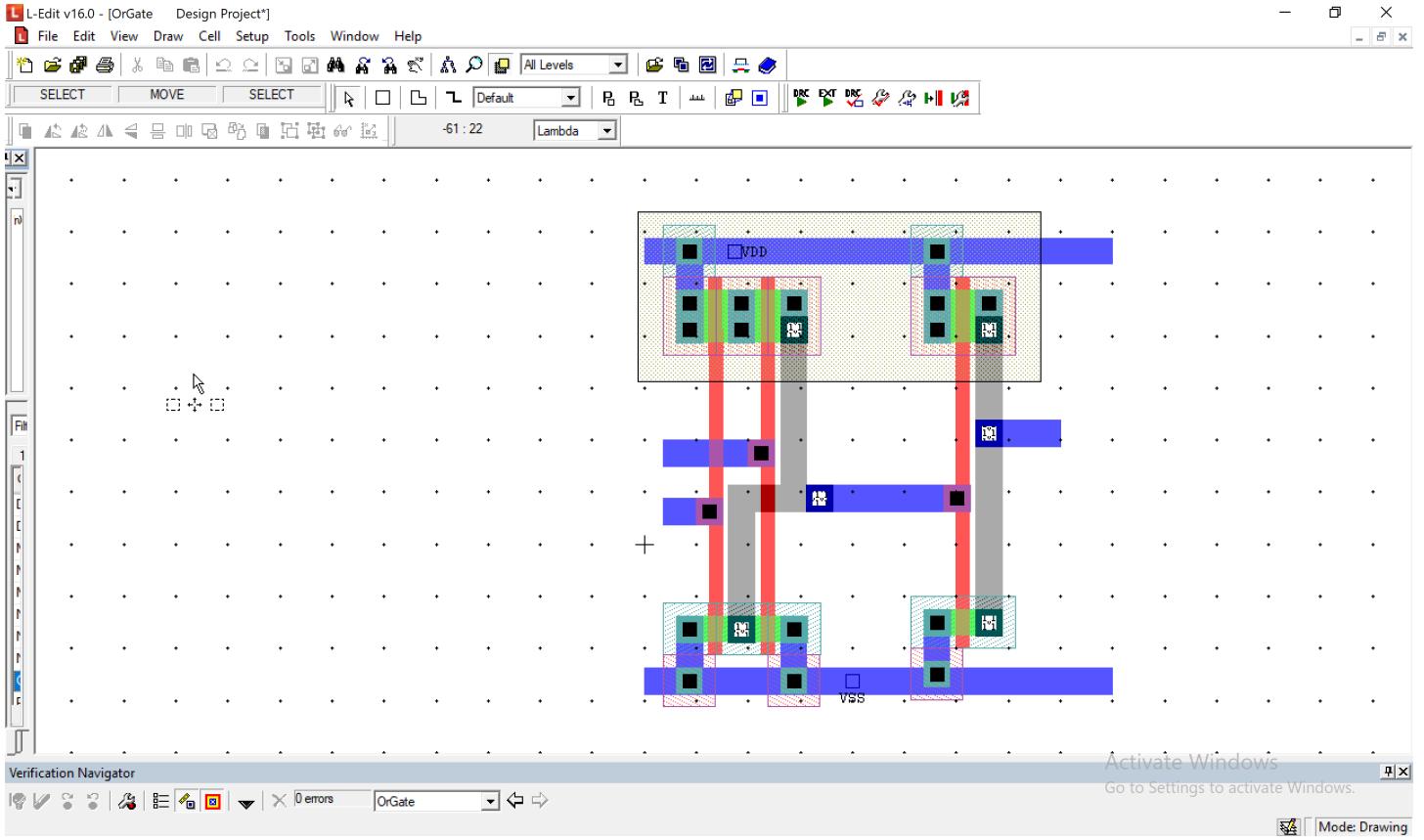
Transistor Schematic of XOR Gate



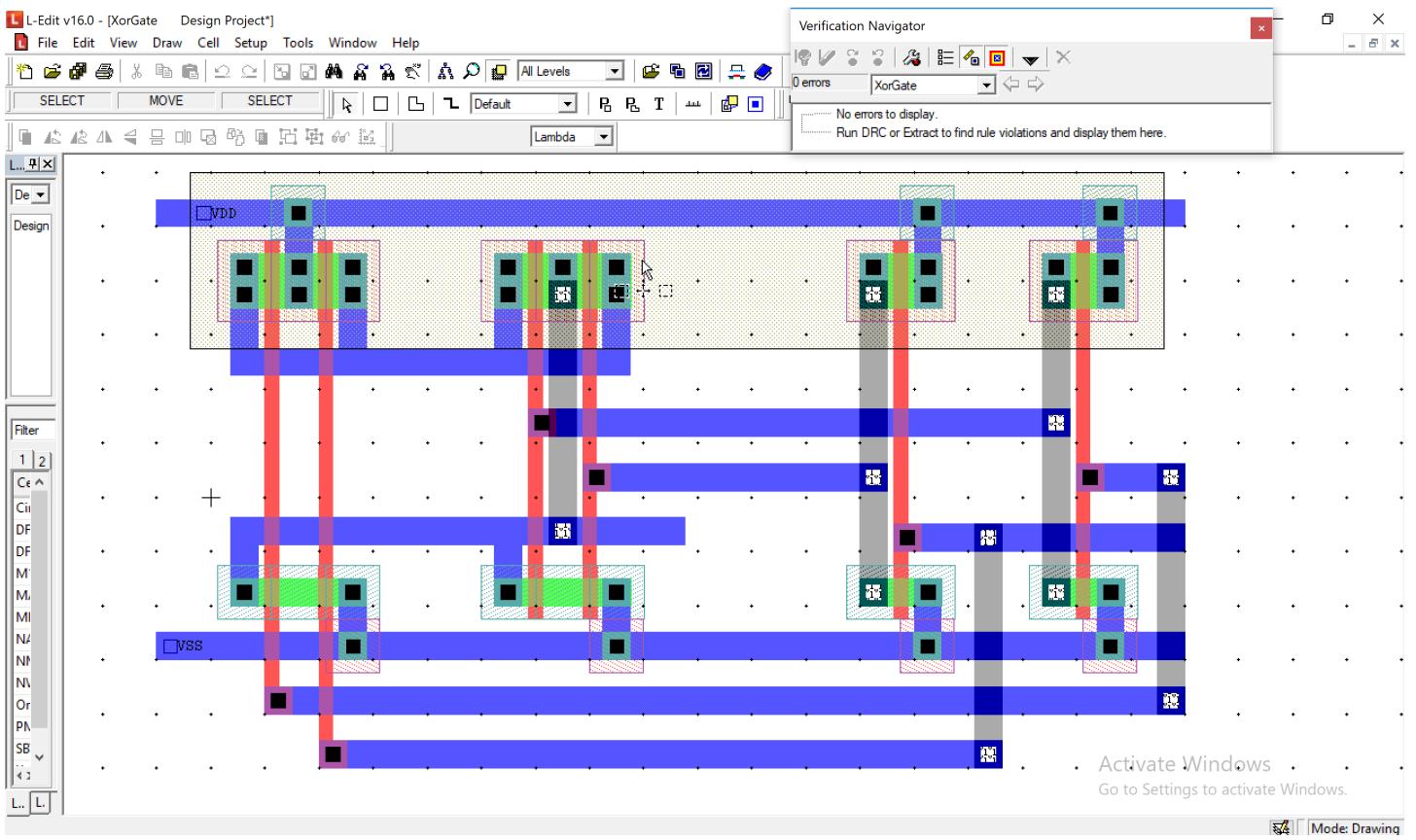
Transistor Schematic of D-Flipflop



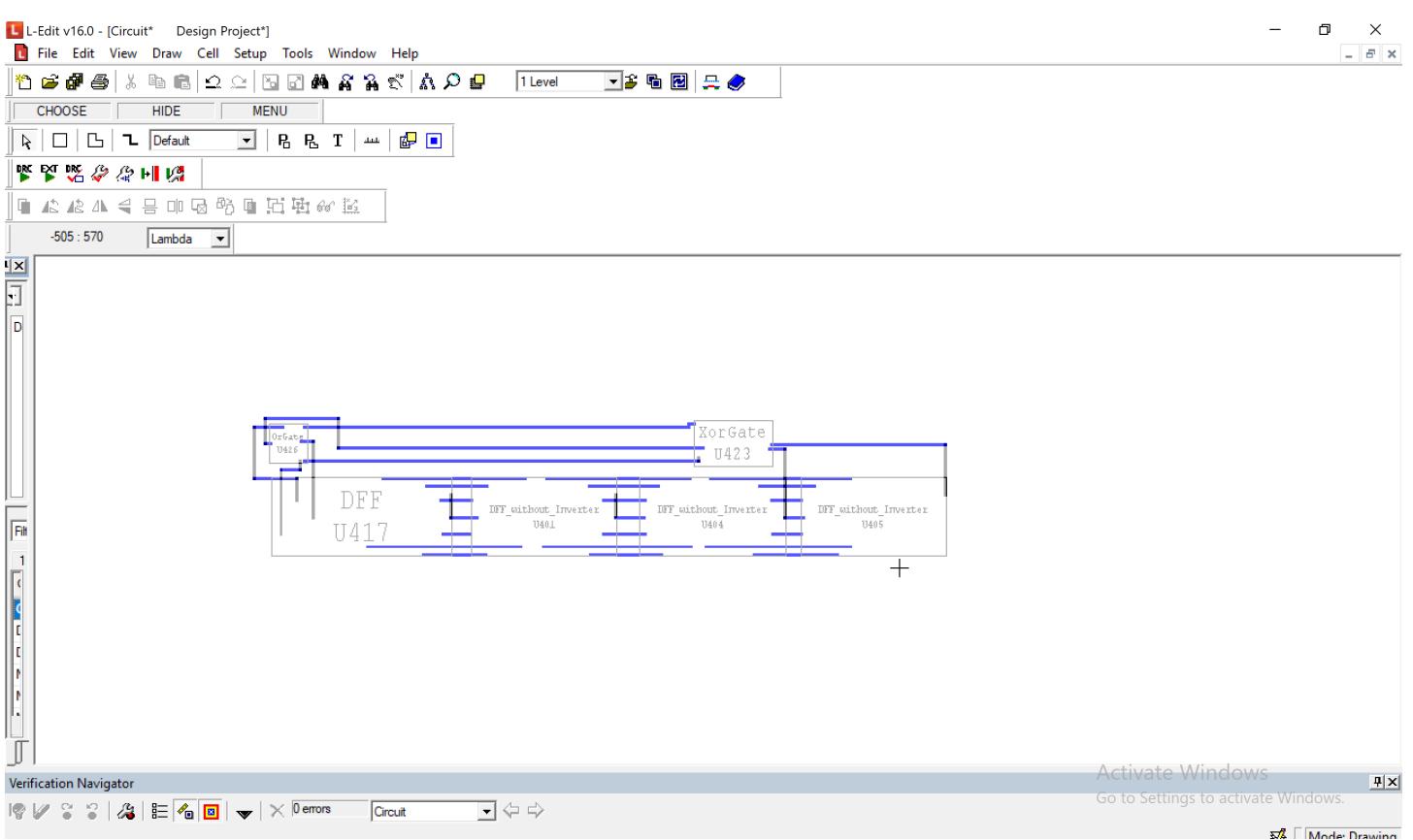
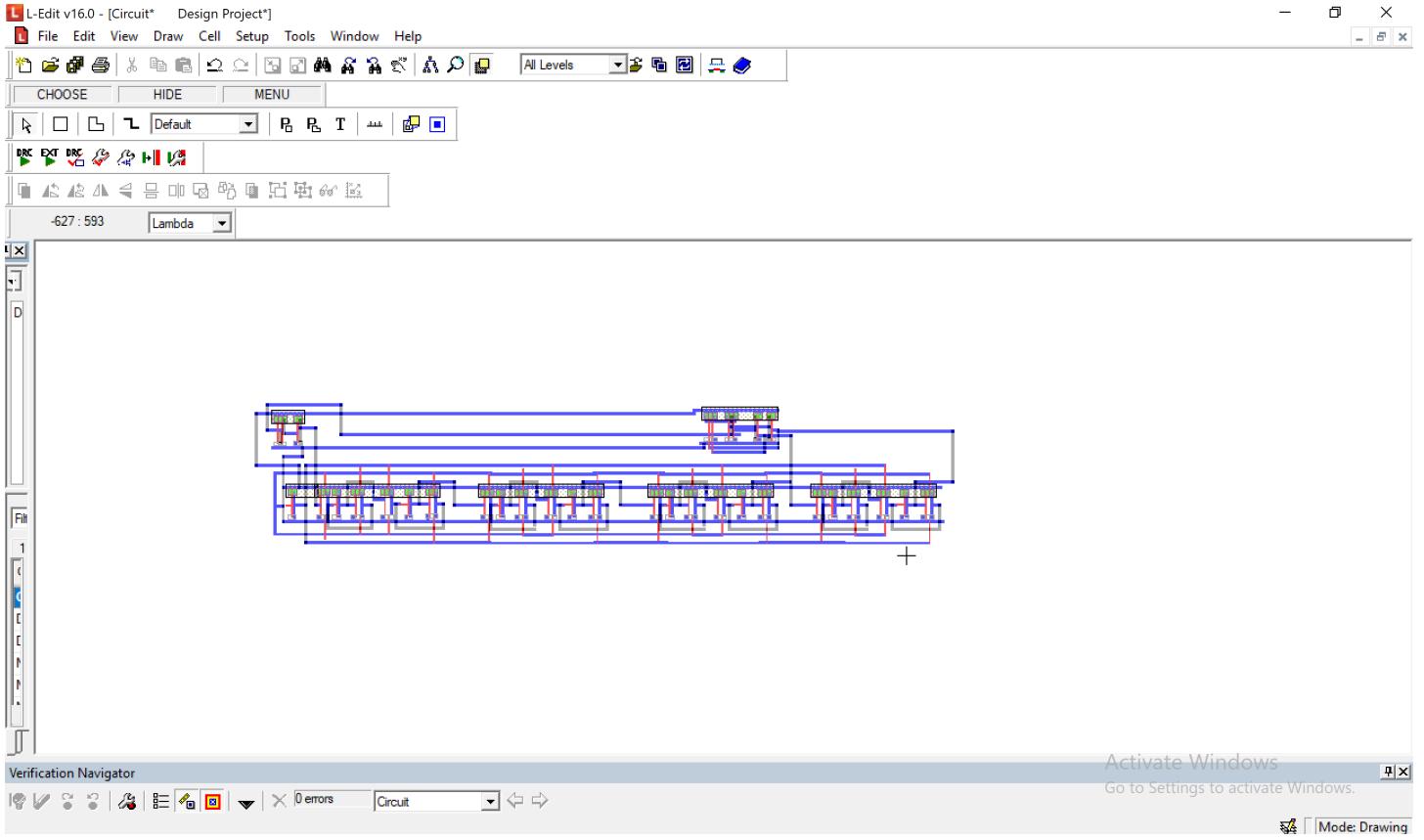
Layout of D-Flipflop after performing DRC

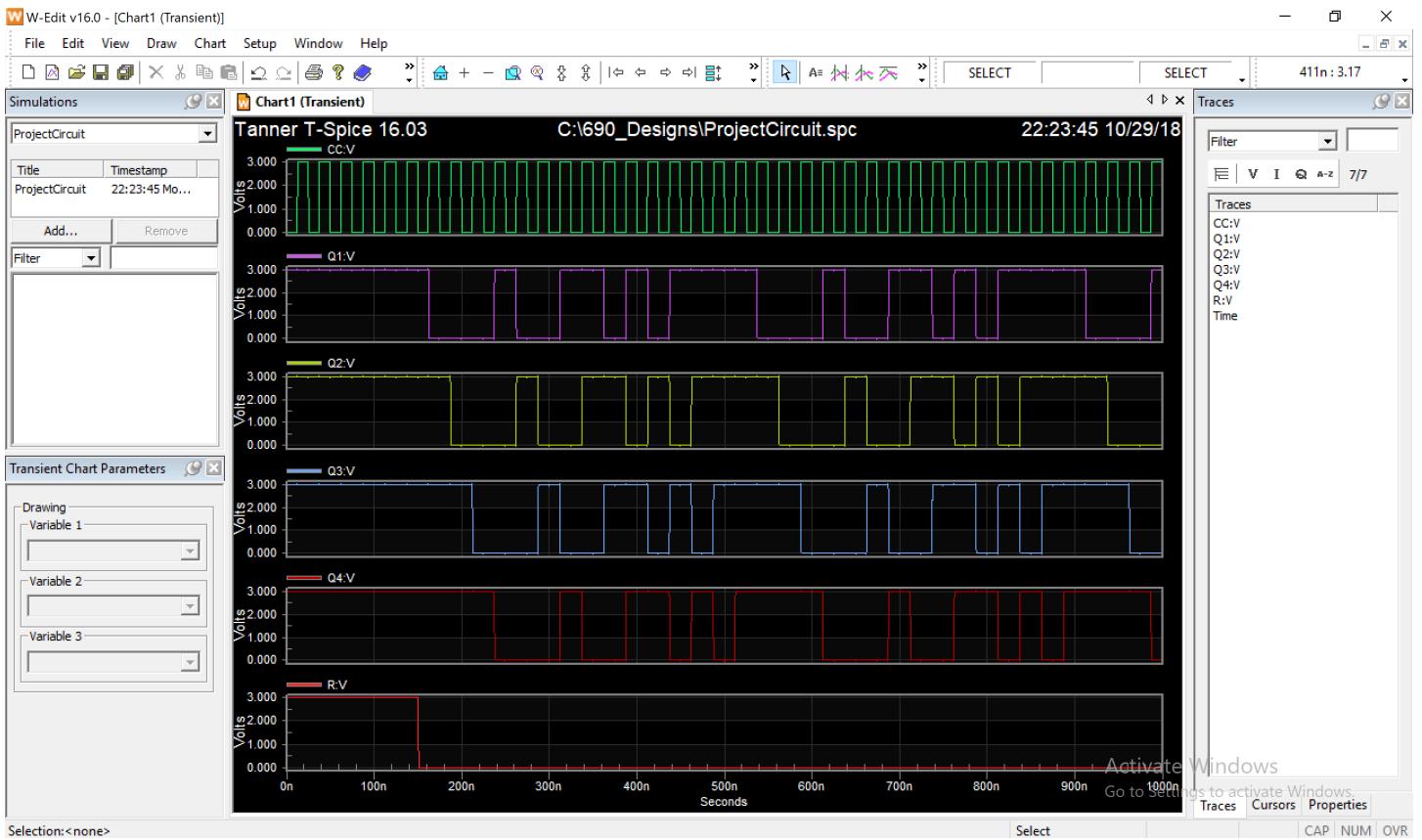


Layout of OR Gate after performing DRC



Layout of XOR Gate after performing DRC





T-Spice v16.0 - [Simulation Status]

File Edit View Simulation Setup Window Help

Input file: ProjectCircuit.spc Progress: Simulation completed

Total nodes: 63 Active devices: 100 Independent sources: 0
Total devices: 108 Passive devices: 4 Controlled sources: 0

```

Model Definitions -      2
Computed Models -      2
Independent nodes -    58
Boundary nodes -       5
Total nodes -          63
Warning : Source VinR DC OP value (0) differs from the transient time 0 value (3)

Measure information will be written to file "C:\690_Designs\ProjectCircuit\ProjectCircuit.measure"

Measurement result summary
tpdr      = 149.8730n
tpdf      = 133.7980p
trise     = 272.1746p
tfall     = 269.8008p

Parsing           0.04 seconds
Setup            0.06 seconds
DC operating point 0.08 seconds
Transient Analysis 2.20 seconds
Overhead         1.63 seconds
-----
Total             4.01 seconds

Simulation completed with 1 Warning

```

Status	Input file	Start Time/D...	Elaps...
finished	ProjectCircuit.spc	22:28:41 Oc...	00:0...
finished	ProjectCircuit.spc	22:29:51 Oc...	00:0...
finished	ProjectCircuit.spc	22:30:28 Oc...	00:0...
finished	ProjectCircuit.spc	22:31:26 Oc...	00:0...
finished	ProjectCircuit.spc	22:33:53 Oc...	00:0...

Activate Windows Go to Settings to activate Windows

Simulation done...

Delay at -25°C and 3.5V

T-Spice v16.0 - [Simulation Status]

File Edit View Simulation Setup Window Help

Input file: ProjectCircuit.spc
Progress: Simulation completed

Total nodes:	63	Active devices:	100	Independent sources:	0
Total devices:	108	Passive devices:	4	Controlled sources:	0

```

Model Definitions -      2
Computed Models -      2
Independent nodes -    58
Boundary nodes -       5
Total nodes -          63
Warning : Source VinR DC OP value (0) differs from the transient time 0 value (3)
Measure information will be written to file "C:\690_Designs\ProjectCircuit\ProjectCircuit.measure"

Measurement result summary
tpdr      = 149.8830n
tpdf      = 124.5097p
trise     = 277.9849p
tfall     = 261.2746p

Parsing           0.04 seconds
Setup            0.02 seconds
DC operating point 0.03 seconds
Transient Analysis 2.02 seconds
Overhead         1.68 seconds
-----
Total             3.79 seconds

Simulation completed with 1 Warning

```

Status | Input file | Start Time/D... | Elaps...
finished ProjectCircuit.spc 22:26:14 Oc... 00:0...
failed ProjectCircuit.spc 22:27:15 Oc... 00:0...
finished ProjectCircuit.spc 22:27:47 Oc... 00:0...
finished ProjectCircuit.spc 22:28:41 Oc... 00:0...
finished ProjectCircuit.spc 22:29:51 Oc... 00:0...

Activate Windows
Go to Settings to activate Windows

Simulation done...

Delay at -25°C and 3V

T-Spice v16.0 - [Simulation Status]

File Edit View Simulation Setup Window Help

Input file: ProjectCircuit.spc
Progress: Simulation completed

Total nodes:	63	Active devices:	100	Independent sources:	0
Total devices:	108	Passive devices:	4	Controlled sources:	0

```

Model Definitions -      2
Computed Models -      2
Independent nodes -    58
Boundary nodes -       5
Total nodes -          63
Warning : Source VinR DC OP value (0) differs from the transient time 0 value (3)
Measure information will be written to file "C:\690_Designs\ProjectCircuit\ProjectCircuit.measure"

Measurement result summary
tpdr      = 149.9036n
tpdf      = 108.6190p
trise     = 322.1836p
tfall     = 266.6972p

Parsing           0.03 seconds
Setup            0.05 seconds
DC operating point 0.05 seconds
Transient Analysis 1.98 seconds
Overhead         1.79 seconds
-----
Total             3.90 seconds

Simulation completed with 1 Warning

```

Status | Input file | Start Time/D... | Elaps...
finished ProjectCircuit.spc 22:36:28 Oc... 00:0...
finished ProjectCircuit.spc 22:37:13 Oc... 00:0...
finished ProjectCircuit.spc 22:38:28 Oc... 00:0...
finished ProjectCircuit.spc 22:38:39 Oc... 00:0...
finished ProjectCircuit.spc 22:39:16 Oc... 00:0...

Activate Windows
Go to Settings to activate Windows

Simulation done...

Delay at 25°C and 2.5V

T-Spice v16.0 - [Simulation Status]

File Edit View Simulation Setup Window Help

Input file: ProjectCircuit.spc
Progress: Simulation completed

Total nodes:	63	Active devices:	100	Independent sources:	0
Total devices:	108	Passive devices:	4	Controlled sources:	0

```

Model Definitions -      2
Computed Models -      2
Independent nodes -    58
Boundary nodes -       5
Total nodes -          63
Warning : Source VinR DC OP value (0) differs from the transient time 0 value (3)
Measure information will be written to file "C:\690_Designs\ProjectCircuit\ProjectCircuit.measure"

Measurement result summary
tpdr      = 149.8723n
tpdf      = 135.1127p
trise     = 277.8964p
tfall     = 267.6221p

Parsing           0.03 seconds
Setup            0.06 seconds
DC operating point 0.03 seconds
Transient Analysis 2.05 seconds
Overhead         1.59 seconds
-----
Total             3.76 seconds

Simulation completed with 1 Warning

```

Status Input file Start Time/D... Elaps...

finished ProjectCircuit.spc 22:30:28 Oc... 00:0...

finished ProjectCircuit.spc 22:31:26 Oc... 00:0...

finished ProjectCircuit.spc 22:33:53 Oc... 00:0...

finished ProjectCircuit.spc 22:36:12 Oc... 00:0...

finished ProjectCircuit.spc 22:36:28 Oc... 00:0...

Activate Windows
Go to Settings to activate Windows.

Ready Delay at 25°C and 3.5V

T-Spice v16.0 - [Simulation Status]

File Edit View Simulation Setup Window Help

Input file: ProjectCircuit.spc
Progress: Simulation completed

Total nodes:	63	Active devices:	100	Independent sources:	0
Total devices:	108	Passive devices:	4	Controlled sources:	0

```

Model Definitions -      2
Computed Models -      2
Independent nodes -    58
Boundary nodes -       5
Total nodes -          63
Warning : Source VinR DC OP value (0) differs from the transient time 0 value (3)
Measure information will be written to file "C:\690_Designs\ProjectCircuit\ProjectCircuit.measure"

Measurement result summary
tpdr      = 149.8867n
tpdf      = 122.9089p
trise     = 294.0754p
tfall     = 264.2494p

Parsing           0.03 seconds
Setup            0.03 seconds
DC operating point 0.03 seconds
Transient Analysis 1.94 seconds
Overhead         1.83 seconds
-----
Total             3.87 seconds

Simulation completed with 1 Warning

```

Status Input file Start Time/D... Elaps...

failed ProjectCircuit.spc 22:27:15 Oc... 00:0...

finished ProjectCircuit.spc 22:27:47 Oc... 00:0...

finished ProjectCircuit.spc 22:28:41 Oc... 00:0...

finished ProjectCircuit.spc 22:29:51 Oc... 00:0...

finished ProjectCircuit.spc 22:30:28 Oc... 00:0...

Activate Windows
Go to Settings to activate Windows.

Simulation done... Delay at 25°C and 3V

T-Spice v16.0 - [Simulation Status]

File Edit View Simulation Setup Window Help

Input file: ProjectCircuit.spc
Progress: Simulation completed

Total nodes:	63	Active devices:	100	Independent sources:	0
Total devices:	108	Passive devices:	4	Controlled sources:	0

```

Model Definitions -      2
Computed Models -      2
Independent nodes -    58
Boundary nodes -       5
Total nodes -          63
Warning : Source VinR DC OP value (0) differs from the transient time 0 value (3)
Measure information will be written to file "C:\690_Designs\ProjectCircuit\ProjectCircuit.measure"

Measurement result summary
tpdr      = 149.9109n
tpdf      = 104.7519p
trise     = 360.8648p
tfall     = 274.2011p

Parsing           0.03 seconds
Setup            0.04 seconds
DC operating point 0.04 seconds
Transient Analysis 2.04 seconds
Overhead         1.73 seconds
-----
Total             3.89 seconds

Simulation completed with 1 Warning

```

Status	Input file	Start Time/D...	Elaps...
finished	ProjectCircuit.spc	22:36:12 Oc...	00:0...
finished	ProjectCircuit.spc	22:36:28 Oc...	00:0...
finished	ProjectCircuit.spc	22:37:13 Oc...	00:0...
finished	ProjectCircuit.spc	22:38:28 Oc...	00:0...
finished	ProjectCircuit.spc	22:39:39 Oc...	00:0...

Activate Windows
Go to Settings to activate Windows

Simulation done...

Delay at 100°C and 2.5V

T-Spice v16.0 - [Simulation Status]

File Edit View Simulation Setup Window Help

Input file: ProjectCircuit.spc
Progress: Simulation completed

Total nodes:	63	Active devices:	100	Independent sources:	0
Total devices:	108	Passive devices:	4	Controlled sources:	0

```

Model Definitions -      2
Computed Models -      2
Independent nodes -    58
Boundary nodes -       5
Total nodes -          63
Warning : Source VinR DC OP value (0) differs from the transient time 0 value (3)
Measure information will be written to file "C:\690_Designs\ProjectCircuit\ProjectCircuit.measure"

Measurement result summary
tpdr      = 149.8636n
tpdf      = 143.8734p
trise     = 260.3118p
tfall     = 251.9146p

Parsing           0.03 seconds
Setup            0.04 seconds
DC operating point 0.02 seconds
Transient Analysis 1.89 seconds
Overhead         1.66 seconds
-----
Total             3.64 seconds

Simulation completed with 1 Warning

```

Status	Input file	Start Time/D...	Elaps...
finished	ProjectCircuit.spc	22:31:26 Oc...	00:0...
finished	ProjectCircuit.spc	22:33:53 Oc...	00:0...
finished	ProjectCircuit.spc	22:36:12 Oc...	00:0...
finished	ProjectCircuit.spc	22:36:28 Oc...	00:0...
finished	ProjectCircuit.spc	22:37:13 Oc...	00:0...

Activate Windows
Go to Settings to activate Windows

Simulation done...

Delay at 100°C and 3.5V

T-Spice v16.0 - [Simulation Status]

File Edit View Simulation Setup Window Help

Input file: ProjectCircuit.spc
Progress: Simulation completed

Total nodes:	63	Active devices:	100	Independent sources:	0
Total devices:	108	Passive devices:	4	Controlled sources:	0

```

Model Definitions -      2
Computed Models -      2
Independent nodes -    58
Boundary nodes -       5
Total nodes -          63
Warning : Source VinR DC OP value (0) differs from the transient time 0 value (3)
Measure information will be written to file "C:\690_Designs\ProjectCircuit\ProjectCircuit.measure"

Measurement result summary
tpdr      = 149.8849n
tpdf      = 125.2271p
trise     = 300.4866p
tfall     = 258.3933p

Parsing           0.03 seconds
Setup            0.03 seconds
DC operating point 0.04 seconds
Transient Analysis 1.95 seconds
Overhead         1.70 seconds
-----
Total           3.75 seconds

Simulation completed with 1 Warning

```

Status	Input file	Start Time/D...	Elaps...
finished	ProjectCircuit.spc	22:27:47 Oc...	00:0...
finished	ProjectCircuit.spc	22:28:41 Oc...	00:0...
finished	ProjectCircuit.spc	22:29:51 Oc...	00:0...
finished	ProjectCircuit.spc	22:30:28 Oc...	00:0...
finished	ProjectCircuit.spc	22:31:26 Oc...	00:0...

Activate Windows
Go to Settings to activate Windows

Simulation done...

Delay at 100°C and 3V

I first designed the circuit in a block diagram fashion and broke it down into 3 circuits: 1) D-Flipflop 2) XOR Gate 3) OR Gate. I simulated the individual circuits to check for their proper functioning and did a DRC as I proceeded along. The last step was to cascade all the individual circuits into the Pseudo-Random Noise generator as shown in the first circuit schematic.