LAB 4 – Raja Aadhithan

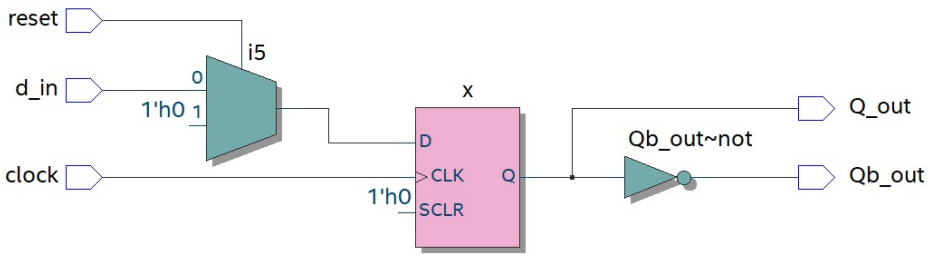
Design – D Flip Flop:

Wave:

Output:

```
VSIM 17> run -all
# @time:   0ps the input: x, reset:x, output is x,x
# @time:   5ps the input: x, reset:1, output is x,x
# @time:  10ps the input: x, reset:1, output is 0,1
# @time:  15ps the input: x, reset:0, output is 0,1
# @time:  20ps the input: x, reset:0, output is x,x
# @time:  25ps the input: 0, reset:0, output is x,x
# @time:  30ps the input: 0, reset:0, output is 0,1
# @time:  35ps the input: 1, reset:0, output is 0,1
# @time:  40ps the input: 1, reset:0, output is 1,0
# @time:  45ps the input: 0, reset:0, output is 1,0
# @time:  50ps the input: 0, reset:0, output is 0,1
# @time:  55ps the input: 1, reset:0, output is 0,1
# @time:  60ps the input: 1, reset:0, output is 1,0
# @time:  75ps the input: 1, reset:1, output is 1,0
# @time:  80ps the input: 1, reset:1, output is 0,1
# @time:  85ps the input: 1, reset:0, output is 0,1
# @time:  90ps the input: 1, reset:0, output is 1,0
# @time:  95ps the input: 0, reset:0, output is 1,0
# @time: 100ps the input: 0, reset:0, output is 0,1
# @time: 105ps the input: 1, reset:0, output is 0,1
# @time: 110ps the input: 1, reset:0, output is 1,0
# ** Note: $finish    : C:/Users/Aadhithan/Documents
#    Time: 115 ps  Iteration: 0  Instance: /dff_tb
```

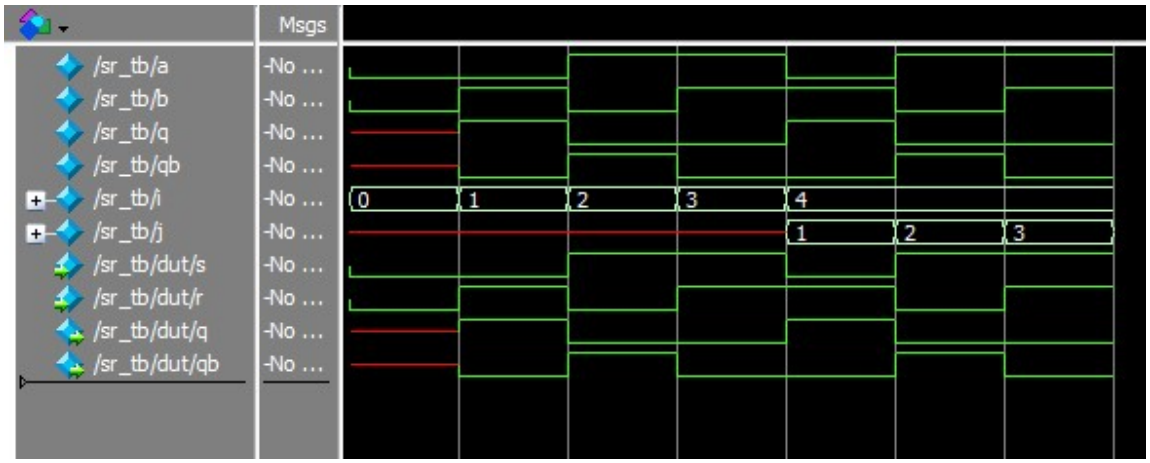
RTL:



Exercises:

Design : SR latch:

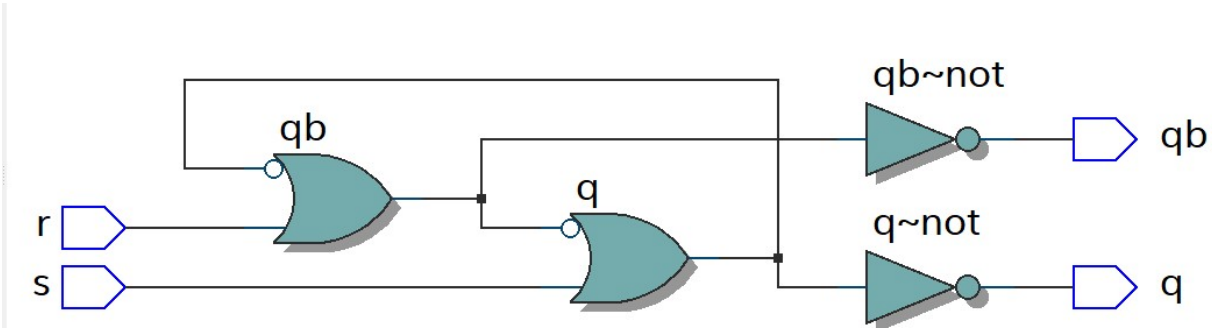
Wave:



Output:

```
VSIM 24> run -all
# @time  0 input is 0,0  - output is x,x
# @time 10 input is 0,1  - output is 1,0
# @time 20 input is 1,0  - output is 0,1
# @time 30 input is 1,1  - output is 0,0
# @time 40 input is 0,1  - output is 1,0
# @time 50 input is 1,0  - output is 0,1
# @time 60 input is 1,1  - output is 0,0
# ** Note: $finish    : C:/Users/Aadhithar
#    Time: 70 ps  Iteration: 0  Instance:
# 1
```

RTL:



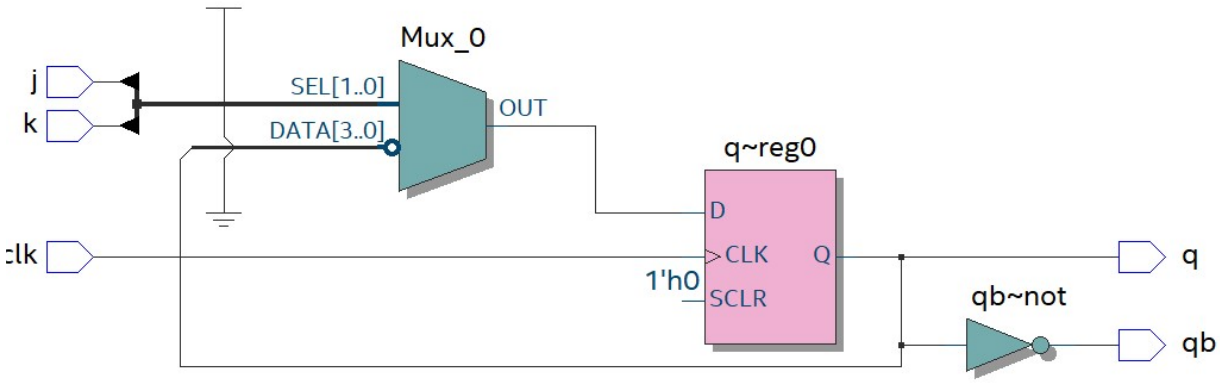
Design: JK Flip Flop:

Wave:

Output:

```
VSIM 28> run -all
# @time :   0: j is 0, k is 0, output is x-x
# @time :  10: j is 0, k is 1, output is 0-1
# @time :  20: j is 1, k is 0, output is 1-0
# @time :  30: j is 1, k is 1, output is 0-1
# @time :  40: j is 0, k is 0, output is 0-1
# @time :  50: j is 0, k is 1, output is 0-1
# @time :  60: j is 1, k is 0, output is 1-0
# @time :  70: j is 1, k is 1, output is 0-1
# ** Note: $finish    : C:/Users/Aadhithan/Docume
b.v(17)
#    Time: 80 ps  Iteration: 0  Instance: /jk_tb
```

RTL:



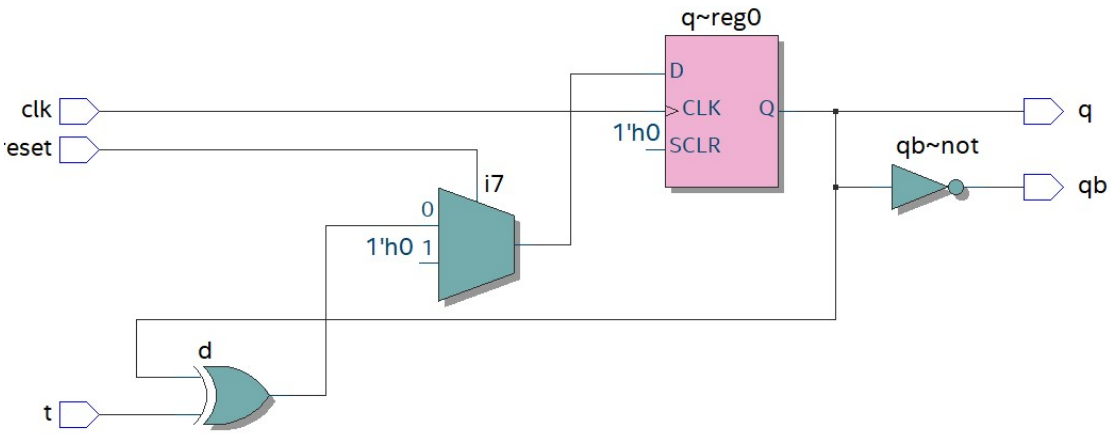
Design : T Flip Flop:

Wave:

Output:

```
VSIM 32> run -all
# @time =    0: T is x and outputs are 0 - 1
# @time =    5: T is 0 and outputs are 0 - 1
# @time =   15: T is 1 and outputs are 0 - 1
# @time =   20: T is 1 and outputs are 1 - 0
# @time =   25: T is 0 and outputs are 1 - 0
# @time =   35: T is 1 and outputs are 1 - 0
# @time =   40: T is 1 and outputs are 0 - 1
# @time =   45: T is 0 and outputs are 0 - 1
# @time =   55: T is 1 and outputs are 0 - 1
# @time =   60: T is 1 and outputs are 1 - 0
# @time =   65: T is 0 and outputs are 1 - 0
# @time =   75: T is 1 and outputs are 1 - 0
# @time =   80: T is 1 and outputs are 0 - 1
# ** Note: $finish    : C:/Users/Aadhithan/Docume
_tb.v(20)
#    Time: 85 ps  Iteration: 0  Instance: /tff_tb
```

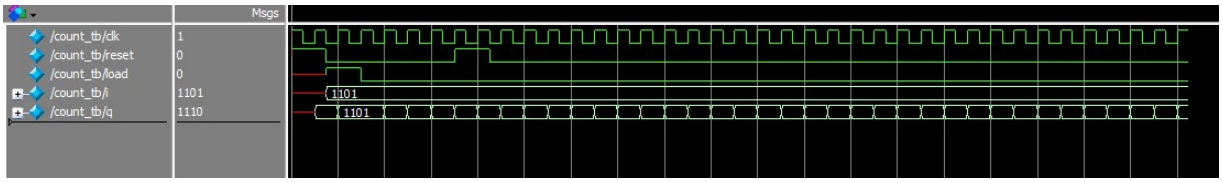
RTL:



Design: 4 bit synchronous up counter:

Wave:

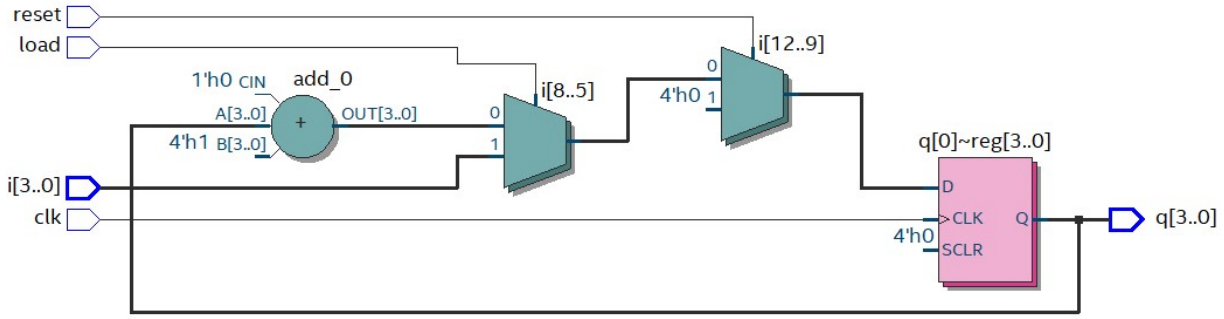
Zoomed out version:



Output:

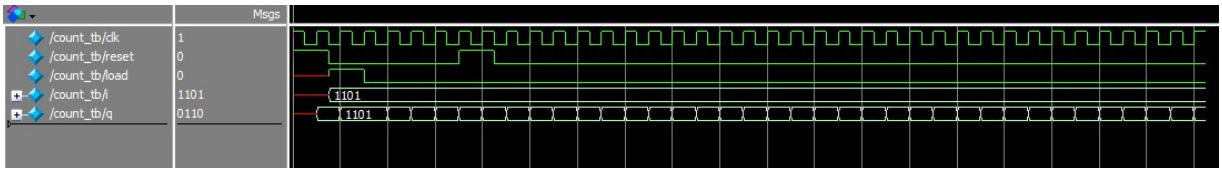
```
VSIM 36> run -all
# @time :   0 - for load = x output is xxxx
# @time :  10 - for load = x output is 0000
# @time :  15 - for load = 1 output is 0000
# @time :  20 - for load = 1 output is 1101
# @time :  30 - for load = 0 output is 1101
# @time :  40 - for load = 0 output is 1110
# @time :  50 - for load = 0 output is 1111
# @time :  60 - for load = 0 output is 0000
# @time :  70 - for load = 0 output is 0001
# @time :  80 - for load = 0 output is 0000
# @time :  90 - for load = 0 output is 0001
# @time : 100 - for load = 0 output is 0010
# @time : 110 - for load = 0 output is 0011
# @time : 120 - for load = 0 output is 0100
# @time : 130 - for load = 0 output is 0101
# @time : 140 - for load = 0 output is 0110
# @time : 150 - for load = 0 output is 0111
# @time : 160 - for load = 0 output is 1000
# @time : 170 - for load = 0 output is 1001
# @time : 180 - for load = 0 output is 1010
# @time : 190 - for load = 0 output is 1011
# @time : 200 - for load = 0 output is 1100
# @time : 210 - for load = 0 output is 1101
# @time : 220 - for load = 0 output is 1110
# @time : 230 - for load = 0 output is 1111
# @time : 240 - for load = 0 output is 0000
# @time : 250 - for load = 0 output is 0001
# @time : 260 - for load = 0 output is 0010
# @time : 270 - for load = 0 output is 0011
# @time : 280 - for load = 0 output is 0100
# @time : 290 - for load = 0 output is 0101
# @time : 300 - for load = 0 output is 0110
# @time : 310 - for load = 0 output is 0111
# @time : 320 - for load = 0 output is 1000
# @time : 330 - for load = 0 output is 1001
# @time : 340 - for load = 0 output is 1010
# @time : 350 - for load = 0 output is 1011
# @time : 360 - for load = 0 output is 1100
# @time : 370 - for load = 0 output is 1101
# @time : 380 - for load = 0 output is 1110
# ** Note: $finish    : C:/Users/Aadhithan/Documents/
/count_tb.v(24)
#    Time: 385 ps  Iteration: 0  Instance: /count_tb
# 1
```

RTL:



Design: Mod 12 counter;

Wave:

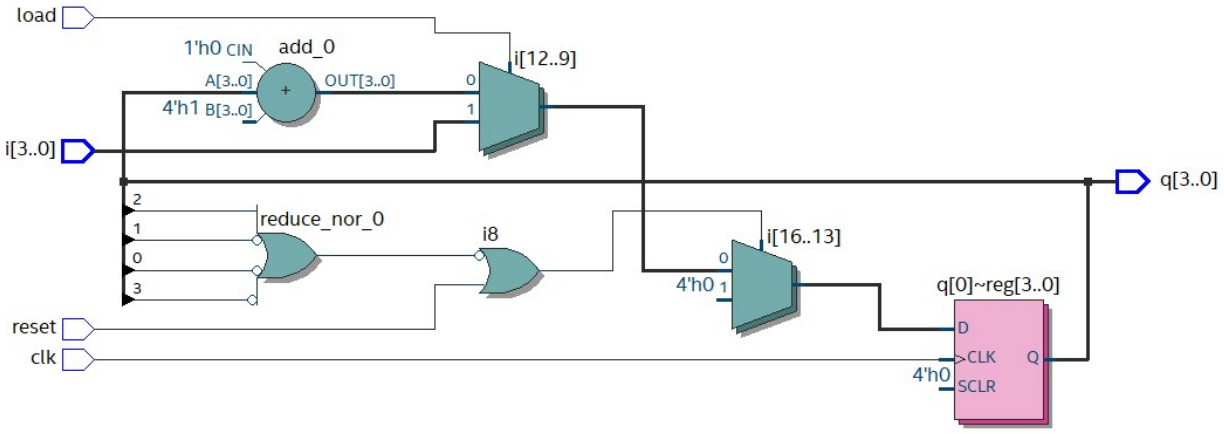


Output:

```
VSIM 40> run -all
# @time :   0 - for load = x output is xxxx
# @time :  10 - for load = x output is 0000
# @time :  15 - for load = 1 output is 0000
# @time :  20 - for load = 1 output is 1101
# @time :  30 - for load = 0 output is 1101
# @time :  40 - for load = 0 output is 1110
# @time :  50 - for load = 0 output is 1111
# @time :  60 - for load = 0 output is 0000
# @time :  70 - for load = 0 output is 0001
# @time :  80 - for load = 0 output is 0000
# @time :  90 - for load = 0 output is 0001
# @time : 100 - for load = 0 output is 0010
# @time : 110 - for load = 0 output is 0011
# @time : 120 - for load = 0 output is 0100
# @time : 130 - for load = 0 output is 0101
# @time : 140 - for load = 0 output is 0110
# @time : 150 - for load = 0 output is 0111
# @time : 160 - for load = 0 output is 1000
# @time : 170 - for load = 0 output is 1001
# @time : 180 - for load = 0 output is 1010
# @time : 190 - for load = 0 output is 1011
# @time : 200 - for load = 0 output is 0000
# @time : 210 - for load = 0 output is 0001
```

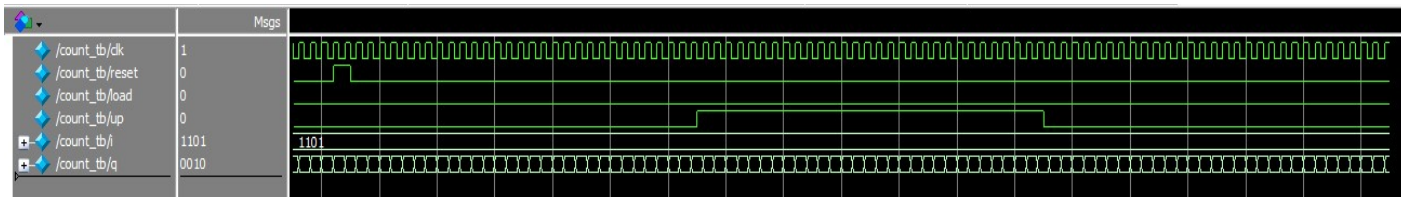
```
# @time : 200 - for load = 0 output is 0000
# @time : 210 - for load = 0 output is 0001
# @time : 220 - for load = 0 output is 0010
# @time : 230 - for load = 0 output is 0011
# @time : 240 - for load = 0 output is 0100
# @time : 250 - for load = 0 output is 0101
# @time : 260 - for load = 0 output is 0110
# @time : 270 - for load = 0 output is 0111
# @time : 280 - for load = 0 output is 1000
# @time : 290 - for load = 0 output is 1001
# @time : 300 - for load = 0 output is 1010
# @time : 310 - for load = 0 output is 1011
# @time : 320 - for load = 0 output is 0000
# @time : 330 - for load = 0 output is 0001
# @time : 340 - for load = 0 output is 0010
# @time : 350 - for load = 0 output is 0011
# @time : 360 - for load = 0 output is 0100
# @time : 370 - for load = 0 output is 0101
# @time : 380 - for load = 0 output is 0110
# ** Note: $finish    : C:/Users/Aadhithan/Documents/count_tb.v(24)
#    Time: 385 ps  Iteration: 0  Instance: /count_tb
# 1
```

RTL:



Design : up/down counter:

Wave:



Output:

```
VSIM 7> run -all
# @time :   0 - for load = x for operation up =x  output is xxxx
# @time :  10 - for load = x for operation up =x  output is 0000
# @time :  15 - for load = 1 for operation up =1  output is 0000
# @time :  20 - for load = 1 for operation up =1  output is 1101
# @time :  30 - for load = 0 for operation up =1  output is 1101
# @time :  40 - for load = 0 for operation up =1  output is 1110
# @time :  50 - for load = 0 for operation up =1  output is 1111
# @time :  60 - for load = 0 for operation up =1  output is 0000
# @time :  70 - for load = 0 for operation up =0  output is 0001
# @time :  80 - for load = 0 for operation up =0  output is 0000
# @time :  90 - for load = 0 for operation up =0  output is 1111
# @time : 100 - for load = 0 for operation up =0  output is 1110
# @time : 110 - for load = 0 for operation up =0  output is 1101
# @time : 120 - for load = 0 for operation up =0  output is 0000
# @time : 130 - for load = 0 for operation up =0  output is 1111
# @time : 140 - for load = 0 for operation up =0  output is 1110
# @time : 150 - for load = 0 for operation up =0  output is 1101
# @time : 160 - for load = 0 for operation up =0  output is 1100
# @time : 170 - for load = 0 for operation up =0  output is 1011
# @time : 180 - for load = 0 for operation up =0  output is 1010
# @time : 190 - for load = 0 for operation up =0  output is 1001
# @time : 200 - for load = 0 for operation up =0  output is 1000
# @time : 210 - for load = 0 for operation up =0  output is 0111
# @time : 220 - for load = 0 for operation up =0  output is 0110
# @time : 230 - for load = 0 for operation up =0  output is 0101
# @time : 240 - for load = 0 for operation up =0  output is 0100
# @time : 250 - for load = 0 for operation up =0  output is 0011
# @time : 260 - for load = 0 for operation up =0  output is 0010
# @time : 270 - for load = 0 for operation up =0  output is 0001
# @time : 280 - for load = 0 for operation up =0  output is 0000
# @time : 290 - for load = 0 for operation up =0  output is 1111
# @time : 300 - for load = 0 for operation up =0  output is 1110
# @time : 310 - for load = 0 for operation up =0  output is 1101
# @time : 320 - for load = 0 for operation up =0  output is 1100
# @time : 330 - for load = 0 for operation up =0  output is 1011
# @time : 340 - for load = 0 for operation up =0  output is 1010
# @time : 350 - for load = 0 for operation up =0  output is 1001
# @time : 360 - for load = 0 for operation up =0  output is 1000
# @time : 370 - for load = 0 for operation up =0  output is 0111
# @time : 380 - for load = 0 for operation up =0  output is 0110
# @time : 390 - for load = 0 for operation up =0  output is 0101
# @time : 400 - for load = 0 for operation up =0  output is 0100
# @time : 410 - for load = 0 for operation up =0  output is 0011
# @time : 420 - for load = 0 for operation up =0  output is 0010
# @time : 425 - for load = 0 for operation up =1  output is 0010
# @time : 430 - for load = 0 for operation up =1  output is 0011
# @time : 440 - for load = 0 for operation up =1  output is 0100
# @time : 450 - for load = 0 for operation up =1  output is 0101
# @time : 460 - for load = 0 for operation up =1  output is 0110
# @time : 470 - for load = 0 for operation up =1  output is 0111
# @time : 480 - for load = 0 for operation up =1  output is 1000
# @time : 490 - for load = 0 for operation up =1  output is 1001
# @time : 500 - for load = 0 for operation up =1  output is 1010
# @time : 510 - for load = 0 for operation up =1  output is 1011
# @time : 520 - for load = 0 for operation up =1  output is 1100
# @time : 530 - for load = 0 for operation up =1  output is 1101
# @time : 540 - for load = 0 for operation up =1  output is 1110
# @time : 550 - for load = 0 for operation up =1  output is 1111
# @time : 560 - for load = 0 for operation up =1  output is 0000
# @time : 570 - for load = 0 for operation up =1  output is 0001
# @time : 580 - for load = 0 for operation up =1  output is 0010
# @time : 590 - for load = 0 for operation up =1  output is 0011
# @time : 600 - for load = 0 for operation up =1  output is 0100
# @time : 610 - for load = 0 for operation up =1  output is 0101
# @time : 620 - for load = 0 for operation up =1  output is 0110
# @time : 630 - for load = 0 for operation up =1  output is 0111
# @time : 640 - for load = 0 for operation up =1  output is 1000
# @time : 650 - for load = 0 for operation up =1  output is 1001
# @time : 660 - for load = 0 for operation up =1  output is 1010
# @time : 670 - for load = 0 for operation up =1  output is 1011
# @time : 680 - for load = 0 for operation up =1  output is 1100
# @time : 690 - for load = 0 for operation up =1  output is 1101
# @time : 700 - for load = 0 for operation up =1  output is 1110
# @time : 710 - for load = 0 for operation up =1  output is 1111
# @time : 720 - for load = 0 for operation up =1  output is 0000
```

```
# @time : 725 - for load = 0 for operation up =0  output is 0000
# @time : 730 - for load = 0 for operation up =0  output is 1111
# @time : 740 - for load = 0 for operation up =0  output is 1110
# @time : 750 - for load = 0 for operation up =0  output is 1101
# @time : 760 - for load = 0 for operation up =0  output is 1100
# @time : 770 - for load = 0 for operation up =0  output is 1011
# @time : 780 - for load = 0 for operation up =0  output is 1010
# @time : 790 - for load = 0 for operation up =0  output is 1001
# @time : 800 - for load = 0 for operation up =0  output is 1000
# @time : 810 - for load = 0 for operation up =0  output is 0111
# @time : 820 - for load = 0 for operation up =0  output is 0110
# @time : 830 - for load = 0 for operation up =0  output is 0101
# @time : 840 - for load = 0 for operation up =0  output is 0100
# @time : 850 - for load = 0 for operation up =0  output is 0011
# @time : 860 - for load = 0 for operation up =0  output is 0010
# @time : 870 - for load = 0 for operation up =0  output is 0001
# @time : 880 - for load = 0 for operation up =0  output is 0000
# @time : 890 - for load = 0 for operation up =0  output is 1111
# @time : 900 - for load = 0 for operation up =0  output is 1110
# @time : 910 - for load = 0 for operation up =0  output is 1101
# @time : 920 - for load = 0 for operation up =0  output is 1100
# @time : 930 - for load = 0 for operation up =0  output is 1011
# @time : 940 - for load = 0 for operation up =0  output is 1010
# @time : 950 - for load = 0 for operation up =0  output is 1001
# @time : 960 - for load = 0 for operation up =0  output is 1000
# @time : 970 - for load = 0 for operation up =0  output is 0111
# @time : 980 - for load = 0 for operation up =0  output is 0110
# @time : 990 - for load = 0 for operation up =0  output is 0101
# @time : 1000 - for load = 0 for operation up =0  output is 0100
# @time : 1010 - for load = 0 for operation up =0  output is 0011
# @time : 1020 - for load = 0 for operation up =0  output is 0010
# ** Note: $finish    : C:/Users/Aadhithan/Documents/Verilog_labs/
#    Time: 1025 ps  Iteration: 0  Instance: /count_tb
```

RTL: