

HW8 solutions

1.

Shift 1 : 011011

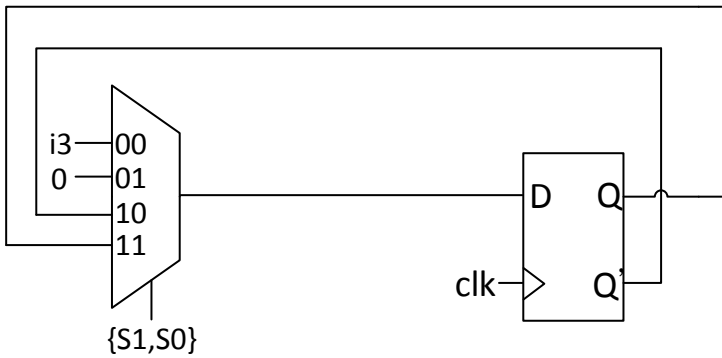
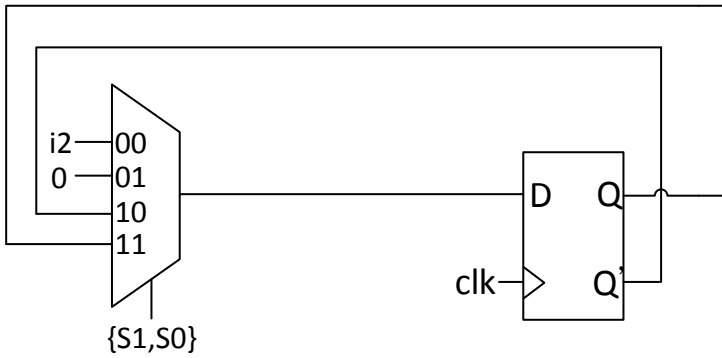
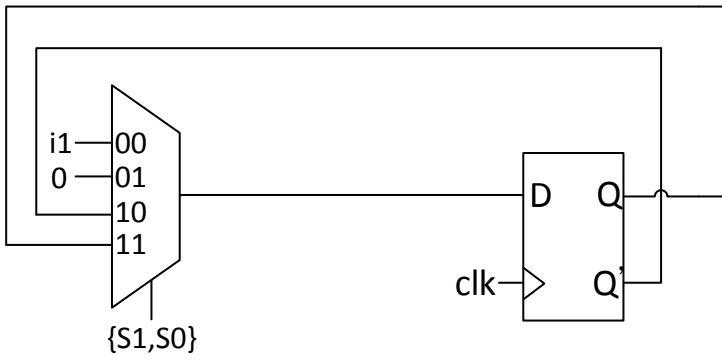
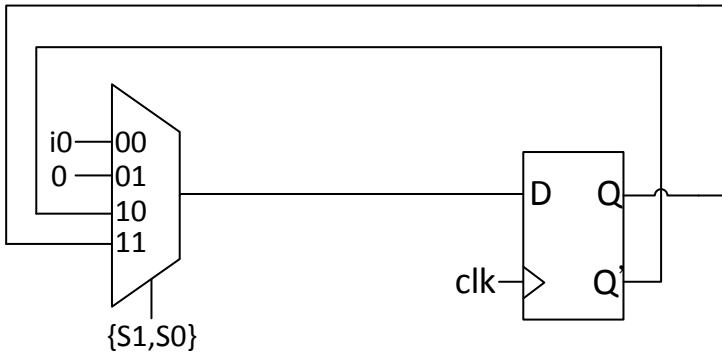
Shift 2 : 110110

Shift 3 : 101101

Shift 4 : 011010

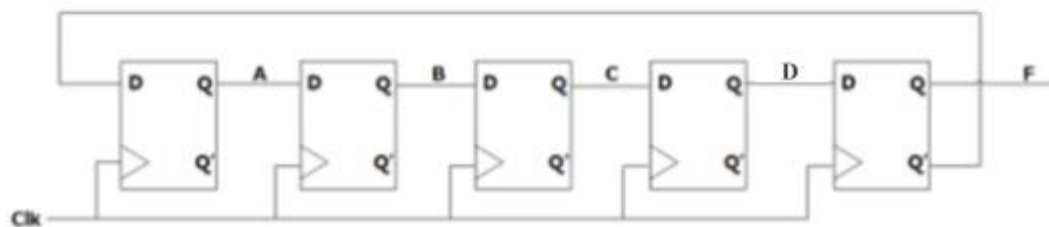
Shift 5 : 110101

2.



3.

<p>State 1</p> <table border="1"> <tr><td>CD \ AB</td><td>00</td><td>01</td><td>11</td><td>10</td></tr> <tr><td>00</td><td>1</td><td>x</td><td>x</td><td>x</td></tr> <tr><td>01</td><td>x</td><td>x</td><td>x</td><td>x</td></tr> <tr><td>11</td><td>0</td><td>x</td><td>0</td><td>0</td></tr> <tr><td>10</td><td>0</td><td>x</td><td>x</td><td>x</td></tr> </table> <p>$F=0$</p>	CD \ AB	00	01	11	10	00	1	x	x	x	01	x	x	x	x	11	0	x	0	0	10	0	x	x	x	<p>State 2</p> <table border="1"> <tr><td>CD \ AB</td><td>00</td><td>01</td><td>11</td><td>10</td></tr> <tr><td>00</td><td>0</td><td>x</td><td>x</td><td>x</td></tr> <tr><td>01</td><td>x</td><td>x</td><td>x</td><td>x</td></tr> <tr><td>11</td><td>0</td><td>x</td><td>0</td><td>0</td></tr> <tr><td>10</td><td>1</td><td>x</td><td>x</td><td>x</td></tr> </table> <p>$F=0$</p>	CD \ AB	00	01	11	10	00	0	x	x	x	01	x	x	x	x	11	0	x	0	0	10	1	x	x	x	<p>State 3</p> <table border="1"> <tr><td>CD \ AB</td><td>00</td><td>01</td><td>11</td><td>10</td></tr> <tr><td>00</td><td>0</td><td>x</td><td>x</td><td>x</td></tr> <tr><td>01</td><td>x</td><td>x</td><td>x</td><td>x</td></tr> <tr><td>11</td><td>1</td><td>x</td><td>0</td><td>0</td></tr> <tr><td>10</td><td>0</td><td>x</td><td>x</td><td>x</td></tr> </table> <p>$F=0$</p>	CD \ AB	00	01	11	10	00	0	x	x	x	01	x	x	x	x	11	1	x	0	0	10	0	x	x	x	<p>State 4</p> <table border="1"> <tr><td>CD \ AB</td><td>00</td><td>01</td><td>11</td><td>10</td></tr> <tr><td>00</td><td>0</td><td>x</td><td>x</td><td>x</td></tr> <tr><td>01</td><td>x</td><td>x</td><td>x</td><td>x</td></tr> <tr><td>11</td><td>0</td><td>x</td><td>0</td><td>1</td></tr> <tr><td>10</td><td>0</td><td>x</td><td>x</td><td>x</td></tr> </table> <p>$F=0$</p>	CD \ AB	00	01	11	10	00	0	x	x	x	01	x	x	x	x	11	0	x	0	1	10	0	x	x	x
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<p>Output = A'F'</p>	<p>Output = AB'</p>	<p>Output = BC'</p>	<p>Output = CD'</p>																																																																																																				
<p>Output = DF'</p>	<p>Output = AF</p>	<p>Output = A'B</p>	<p>Output = B'C</p>																																																																																																				
<p>Output = C'D</p>	<p>Output = D'F</p>																																																																																																						



Sequence Number	A	B	C	D	F	AND gate for output
1	0	0	0	0	0	$A'F'$
2	1	0	0	0	0	AB'
3	1	1	0	0	0	BC'
4	1	1	1	0	0	CD'
5	1	1	1	1	0	DF'
6	1	1	1	1	1	AF
7	0	1	1	1	1	$A'B$
8	0	0	1	1	1	$B'C$
9	0	0	0	1	1	$C'D$
10	0	0	0	0	1	$D'F$

4.

(a) (輸入不可為 2.5.6 以外的值)

x	y	z	Dx	Dy	Dz
0	0	0	x	x	x
0	0	1	x	x	x
0	1	0	1	0	1
0	1	1	x	x	x
1	0	0	x	x	x
1	0	1	1	1	0
1	1	0	0	1	0
1	1	1	x	x	x

Dx

x \ yz	00	01	11	10
0	x	x	x	1
1	x	1	x	0

$$Dx = x' + z$$

Dy

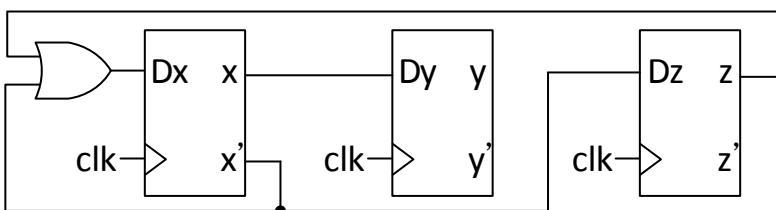
x \ yz	00	01	11	10
0	x	x	x	0
1	x	1	x	1

$$Dy = x$$

Dz

x \ yz	00	01	11	10
0	x	x	x	1
1	x	0	x	0

$$Dz = x'$$



(b) (輸入不可為 0,1,3,5,7 以外的值)

x	y	z	Dx	Dy	Dz
0	0	0	0	0	1
0	0	1	0	1	1
0	1	0	x	x	x
0	1	1	1	0	1
1	0	0	x	x	x
1	0	1	1	1	1
1	1	0	x	x	x
1	1	1	0	0	0

Dx

x \ yz	00	01	11	10
0	0	0	1	x
1	x	1	0	x

$$Dx = x'y + xy'$$

Dy

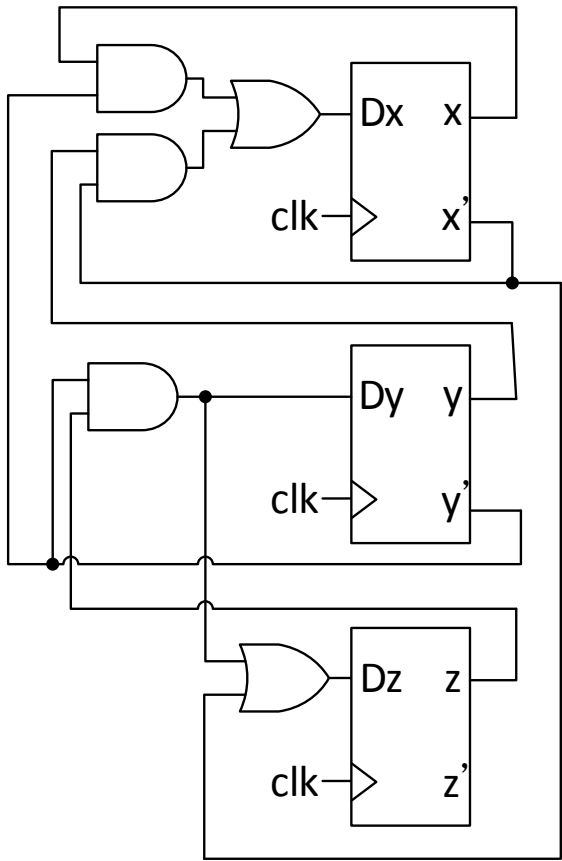
x \ yz	00	01	11	10
0	0	1	0	x
1	x	1	0	x

$$Dy = y'z$$

Dz

x \ yz	00	01	11	10
0	1	1	1	x
1	x	1	0	x

$$Dz = x' + y'z$$



5.

(輸入不可為 0000 – 1011 之外的值)

Q3	Q2	Q1	Q0	D3	D2	D1	D0
0	0	0	0	0	0	0	1
0	0	0	1	0	0	1	0
0	0	1	0	0	0	1	1
0	0	1	1	0	1	0	0
0	1	0	0	0	1	0	1
0	1	0	1	0	1	1	0
0	1	1	0	0	1	1	1
0	1	1	1	1	0	0	0
1	0	0	0	1	0	0	1
1	0	0	1	1	0	1	0
1	0	1	0	1	0	1	1
1	0	1	1	0	0	0	0

D3

Q1Q0 \ Q3Q2	00	01	11	10
00	0	0	0	0
01	0	0	1	0
11	x	x	x	x
10	1	1	0	1

$$D3 = Q3Q2'Q1' + Q2Q1Q0 + Q3Q1Q0' \text{ or } Q3Q2'Q1' + Q2Q1Q0 + Q3Q2'Q0'$$

D2

Q1Q0 \ Q3Q2	00	01	11	10

00	0	0	1	0
01	1	1	0	1
11	x	x	x	x
10	0	0	0	0

$$D2 = Q3'Q2Q1' + Q3'Q2'Q1Q0 + Q2Q1Q0' \text{ or } Q2Q1' + Q3'Q2'Q1Q0 + Q2Q0'$$

D1

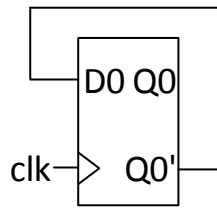
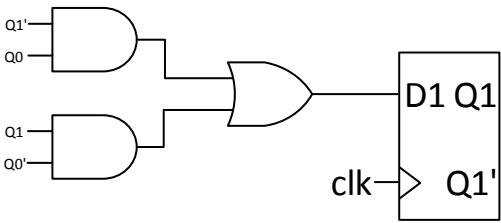
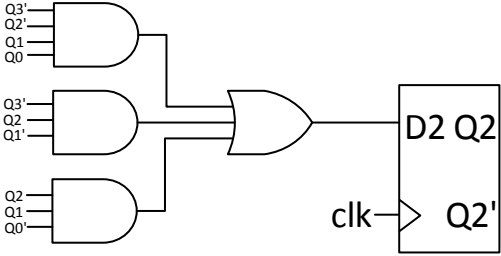
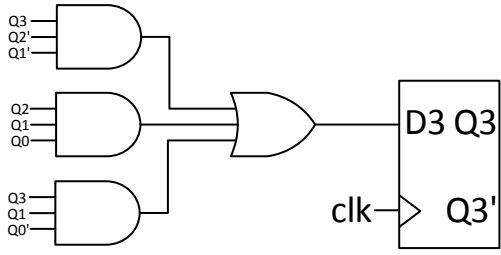
Q1Q0 \ Q3Q2	00	01	11	10
00	0	1	0	1
01	0	1	0	1
11	x	x	x	x
10	0	1	0	1

$$D1 = Q1'Q0 + Q1Q0'$$

D0

Q1Q0 \ Q3Q2	00	01	11	10
00	1	0	0	1
01	1	0	0	1
11	x	x	x	x
10	1	0	0	1

$$D0 = Q0'$$



(輸入為 0000 – 1011 以外的值時回到 0000)

Q3	Q2	Q1	Q0	D3	D2	D1	D0
0	0	0	0	0	0	0	1
0	0	0	1	0	0	1	0
0	0	1	0	0	0	1	1
0	0	1	1	0	1	0	0
0	1	0	0	0	1	0	1
0	1	0	1	0	1	1	0
0	1	1	0	0	1	1	1
0	1	1	1	1	0	0	0
1	0	0	0	1	0	0	1
1	0	0	1	1	0	1	0
1	0	1	0	1	0	1	1
1	0	1	1	0	0	0	0
1	1	0	0	0	0	0	0
1	1	0	1	0	0	0	0
1	1	1	0	0	0	0	0
1	1	1	1	0	0	0	0

D3

Q1Q0 \ Q3Q2	00	01	11	10
00	0	0	0	0
01	0	0	1	0
11	0	0	0	0
10	1	1	0	1

$$D3 = Q3Q2'Q1' + Q3'Q2Q1Q0 + Q3Q2'Q1Q0'$$

D2

Q1Q0 \ Q3Q2	00	01	11	10
00	0	0	1	0
01	1	1	0	1
11	0	0	0	0
10	0	0	0	0

$$D2 = Q3'Q2Q1' + Q3'Q2'Q1Q0 + Q3'Q2Q0'$$

D1

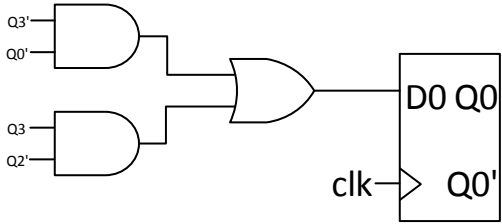
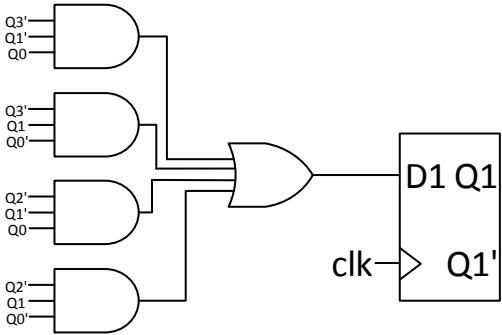
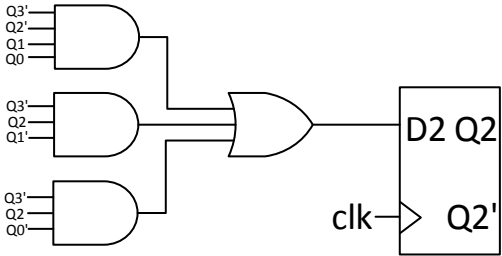
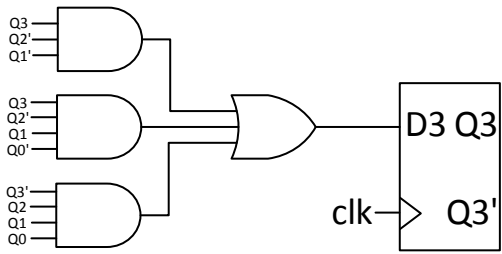
Q1Q0 \ Q3Q2	00	01	11	10
00	0	1	0	1
01	0	1	0	1
11	0	0	0	0
10	0	1	0	1

$$D1 = Q3'Q1'Q0 + Q3'Q1Q0' + Q2'Q1'Q0 + Q2'Q1Q0'$$

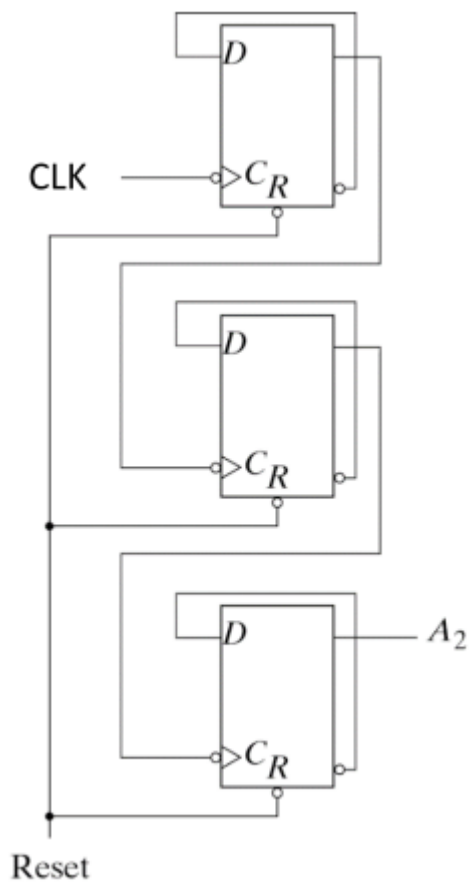
D0

Q1Q0 \ Q3Q2	00	01	11	10
00	1	0	0	1
01	1	0	0	1
11	0	0	0	0
10	1	0	0	1

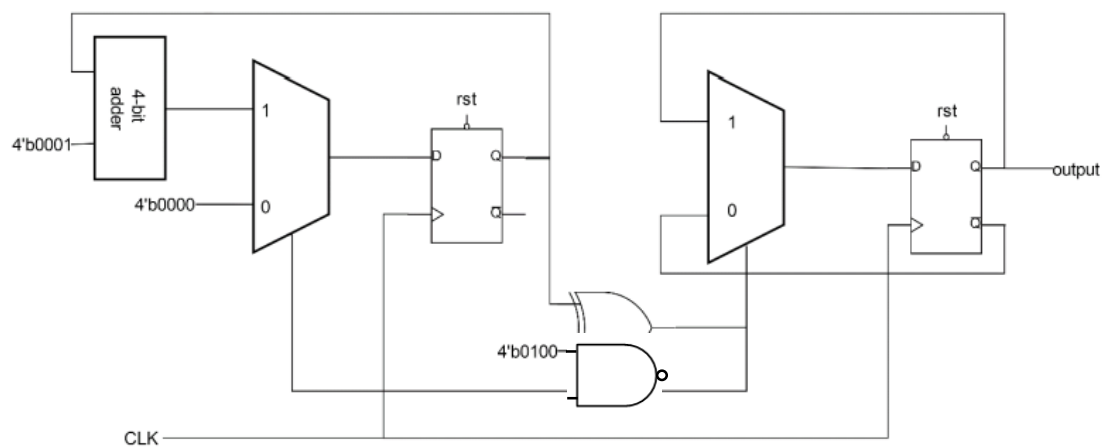
$$D0 = Q3'Q0' + Q2'Q0'$$



6.
(a)



(b)
前半段為累加器，每個周期加一，加到 2(0010)後，nand gate 輸出為 0。此時第一個 mux 選擇 0(將 counter 歸 0)而不是加法器的輸出，形成 0(0000), 1(0001), 2(0010), 0(0000), 1(0001)的循環，第二個 mux 會每 3 個週期反向一次，形成 1/6 的除頻器。



7.
Design

```

module hw8_7(
    clk,
    rst_n,
    clk_div6
);

output reg clk_div6;
input clk,rst_n;

reg [1:0] cnt;

always@(posedge clk or negedge rst_n)
if(~rst_n)
    cnt <= 2'd0;
else
    if(cnt&2'd2)//cnt<2'd2
        cnt <= 2'd0;
    else
        cnt <= cnt + 2'd1;

always@(posedge clk or negedge rst_n)
if(~rst_n)
    clk_div6 <= 1'b0;
else
    if(cnt&2'd2)//cnt==2'd2
        clk_div6 <= ~clk_div6;
    else
        clk_div6 <= clk_div6;

endmodule

```

test

```

module testbench;

wire clk_div6;
reg clk,rst_n;

hw8_7 U0(.clk(clk),.rst_n(rst_n),.clk_div6(clk_div6));

always #5 clk = ~clk;
initial begin

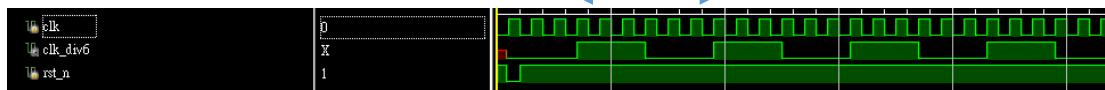
clk=0; rst_n=1;
#4 rst_n=0;
#6 rst_n=1;

end

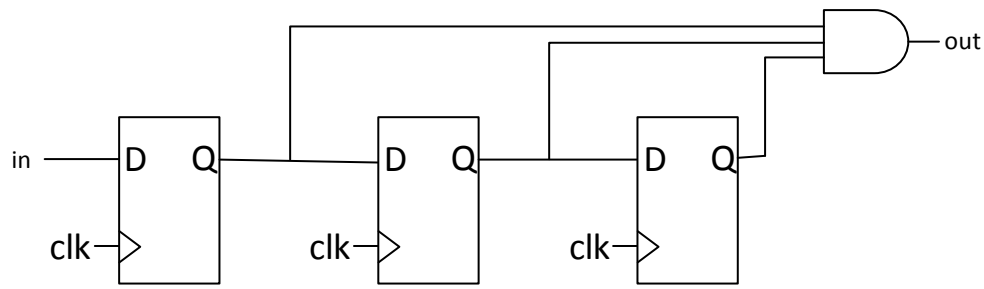
endmodule

```

Waveform



8.



9.

(a)

Shift	State
0	1000
1	0100
2	0010
3	0001
4	1000

(b)

Shift	State
0	10.....0
1	010.....0
2	0010....0
⋮	⋮
n-1	00.....1

∴ n states