

ARQ1 \_ Aula\_14

Tema: Introdução à linguagem Verilog e simulação em Logisim

Atividade: Circuitos sequenciais – Flip-Flops

Todos os circuitos deverão ser simulados no Logisim.

01.) Projetar e descrever em Logisim e Verilog um módulo, com portas e flip-flops tipo JK apenas, para implementar um contador assíncrono decrescente com 5 bits de comprimento.  
DICA: Ver modelo anexo.

02.) Projetar e descrever em Logisim e Verilog um módulo com portas e flip-flops tipo JK apenas, para implementar um contador assíncrono crescente com 5 bits de comprimento.

03.) Projetar e descrever em Logisim e Verilog um módulo, com portas lógicas e flip-flops tipo JK apenas, para implementar um contador decádico crescente com 5 bits de comprimento.  
DICA: Ver modelo anexo.

04.) Projetar e descrever em Logisim e Verilog um módulo com portas e flip-flops tipo JK apenas, para implementar um contador decádico decrescente com 5 bits de comprimento.

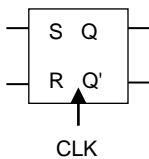
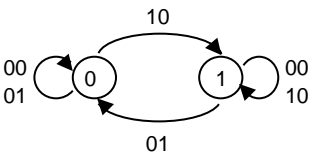
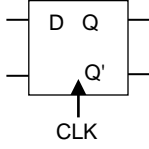
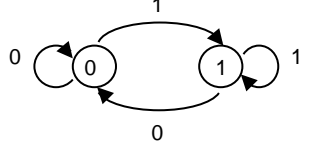
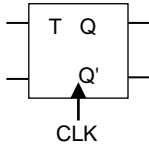
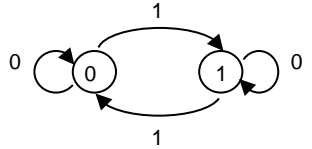
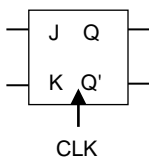
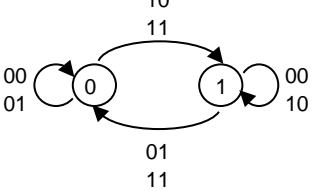
05.) Projetar e descrever em Logisim e Verilog um módulo, com portas e flip-flops tipo T apenas, para implementar um contador módulo 10.  
DICA: Ver modelo anexo.

Extras

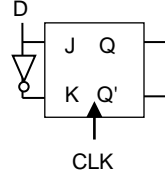
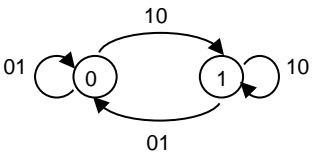
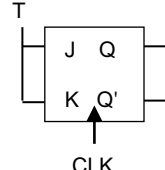
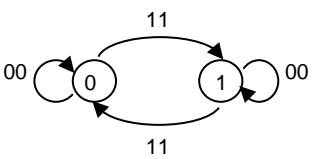
06.) Projetar e descrever em Logisim e Verilog um módulo, com portas e flip-flops tipo JK apenas, para implementar um contador em anel com 5 bits de comprimento.  
DICA: Ver modelo anexo.

07.) Projetar e descrever em Logisim e Verilog um módulo com portas e flip-flops tipo JK apenas, para implementar um contador em anel torcido com 5 bits de comprimento.  
DICA: Ver modelo anexo.

## Flip-flops

Flip-flop	Estados	Característica	Transição	Equação																																								
		<table><tr><th>S</th><th>R</th><th>Q<sub>t+1</sub></th><th>Q'<sub>t+1</sub></th></tr><tr><td>0</td><td>0</td><td>Q<sub>t</sub></td><td>Q'<sub>t</sub></td></tr><tr><td>0</td><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>0</td><td>1</td><td>0</td></tr><tr><td>1</td><td>1</td><td>?</td><td>?</td></tr></table>	S	R	Q <sub>t+1</sub>	Q' <sub>t+1</sub>	0	0	Q <sub>t</sub>	Q' <sub>t</sub>	0	1	0	1	1	0	1	0	1	1	?	?	<table><tr><th>Q<sub>t</sub></th><th>Q<sub>t+1</sub></th><th>S</th><th>R</th></tr><tr><td>0</td><td>0</td><td>0</td><td>X</td></tr><tr><td>0</td><td>1</td><td>1</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>X</td><td>0</td></tr></table>	Q <sub>t</sub>	Q <sub>t+1</sub>	S	R	0	0	0	X	0	1	1	0	1	0	0	1	1	1	X	0	$Q_{t+1}=S+R'.Q_t$
S	R	Q <sub>t+1</sub>	Q' <sub>t+1</sub>																																									
0	0	Q <sub>t</sub>	Q' <sub>t</sub>																																									
0	1	0	1																																									
1	0	1	0																																									
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Q <sub>t</sub>	Q <sub>t+1</sub>	S	R																																									
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1	1	X	0																																									
		<table><tr><th>D</th><th>Q<sub>t+1</sub></th><th>Q'<sub>t+1</sub></th></tr><tr><td>0</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>0</td></tr></table>	D	Q <sub>t+1</sub>	Q' <sub>t+1</sub>	0	0	1	1	1	0	<table><tr><th>Q<sub>t</sub></th><th>Q<sub>t+1</sub></th><th>D</th></tr><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td><td>1</td></tr></table>	Q <sub>t</sub>	Q <sub>t+1</sub>	D	0	0	0	0	1	1	1	0	0	1	1	1	$Q_{t+1} = D$																
D	Q <sub>t+1</sub>	Q' <sub>t+1</sub>																																										
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Q <sub>t</sub>	Q <sub>t+1</sub>	D																																										
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		<table><tr><th>T</th><th>Q<sub>t+1</sub></th><th>Q'<sub>t+1</sub></th></tr><tr><td>0</td><td>Q<sub>t</sub></td><td>Q'<sub>t</sub></td></tr><tr><td>1</td><td>Q'<sub>t</sub></td><td>Q<sub>t</sub></td></tr></table>	T	Q <sub>t+1</sub>	Q' <sub>t+1</sub>	0	Q <sub>t</sub>	Q' <sub>t</sub>	1	Q' <sub>t</sub>	Q <sub>t</sub>	<table><tr><th>Q<sub>t</sub></th><th>Q<sub>t+1</sub></th><th>T</th></tr><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>0</td></tr></table>	Q <sub>t</sub>	Q <sub>t+1</sub>	T	0	0	0	0	1	1	1	0	1	1	1	0	$Q_{t+1} = T \oplus Q_t$																
T	Q <sub>t+1</sub>	Q' <sub>t+1</sub>																																										
0	Q <sub>t</sub>	Q' <sub>t</sub>																																										
1	Q' <sub>t</sub>	Q <sub>t</sub>																																										
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		<table><tr><th>J</th><th>K</th><th>Q<sub>t+1</sub></th><th>Q'<sub>t+1</sub></th></tr><tr><td>0</td><td>0</td><td>Q<sub>t</sub></td><td>Q'<sub>t</sub></td></tr><tr><td>0</td><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>0</td><td>1</td><td>0</td></tr><tr><td>1</td><td>1</td><td>Q'<sub>t</sub></td><td>Q<sub>t</sub></td></tr></table>	J	K	Q <sub>t+1</sub>	Q' <sub>t+1</sub>	0	0	Q <sub>t</sub>	Q' <sub>t</sub>	0	1	0	1	1	0	1	0	1	1	Q' <sub>t</sub>	Q <sub>t</sub>	<table><tr><th>Q<sub>t</sub></th><th>Q<sub>t+1</sub></th><th>J</th><th>K</th></tr><tr><td>0</td><td>0</td><td>0</td><td>X</td></tr><tr><td>0</td><td>1</td><td>1</td><td>X</td></tr><tr><td>1</td><td>0</td><td>X</td><td>1</td></tr><tr><td>1</td><td>1</td><td>X</td><td>0</td></tr></table>	Q <sub>t</sub>	Q <sub>t+1</sub>	J	K	0	0	0	X	0	1	1	X	1	0	X	1	1	1	X	0	$Q_{t+1}=J.Q_t'+K'.Q_t$
J	K	Q <sub>t+1</sub>	Q' <sub>t+1</sub>																																									
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0	0	0	X																																									
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## Configurações especiais

Flip-flop	Estados	Característica	Transição	Equação																																								
		<table><tr><th>J</th><th>K</th><th>Q<sub>t+1</sub></th><th>Q'<sub>t+1</sub></th></tr><tr><td></td><td></td><td></td><td></td></tr><tr><td>0</td><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>0</td><td>1</td><td>0</td></tr><tr><td></td><td></td><td></td><td></td></tr></table>	J	K	Q <sub>t+1</sub>	Q' <sub>t+1</sub>					0	1	0	1	1	0	1	0					<table><tr><th>Q<sub>t</sub></th><th>Q<sub>t+1</sub></th><th>J/D</th><th>K/D'</th></tr><tr><td>0</td><td>0</td><td>0</td><td>1</td></tr><tr><td>0</td><td>1</td><td>1</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>1</td><td>0</td></tr></table>	Q <sub>t</sub>	Q <sub>t+1</sub>	J/D	K/D'	0	0	0	1	0	1	1	0	1	0	0	1	1	1	1	0	$Q_{t+1}=1.Q_t'+0'.Q_t$ $Q_{t+1}=1$ $Q_{t+1}=0.Q_t'+1'.Q_t$ $Q_{t+1}=0$
J	K	Q <sub>t+1</sub>	Q' <sub>t+1</sub>																																									
0	1	0	1																																									
1	0	1	0																																									
Q <sub>t</sub>	Q <sub>t+1</sub>	J/D	K/D'																																									
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J	K	Q <sub>t+1</sub>	Q' <sub>t+1</sub>																																									
0	0	Q <sub>t</sub>	Q' <sub>t</sub>																																									
1	1	Q <sub>t</sub> '	Q <sub>t</sub>																																									
Q <sub>t</sub>	Q <sub>t+1</sub>	J=T	K=T																																									
0	0	0	0																																									
0	1	1	1																																									
1	0	1	1																																									
1	1	0	0																																									

```

module dff ( output q, output qnot,
             input  d, input clk );
reg q, qnot;

always @( posedge clk )
begin
    q <= d;      qnot <= ~d;
end

endmodule // dff

module jkff ( output q, output qnot,
             input  j, input k,
             input clk, input preset, input clear );

reg  q, qnot;

always @( posedge clk or preset or clear )
begin
    if ( clear )    begin q <= 0; qnot <= 1; end
    else
        if ( preset ) begin q <= 1; qnot <= 0; end
        else
            if ( j & ~k ) begin q <= 1; qnot <= 0; end
            else
                if ( ~j & k ) begin q <= 0; qnot <= 1; end
                else
                    if ( j & k )
                        begin q <= ~q; qnot <= ~qnot; end
end

endmodule // jkff

```

```

module tff ( output q, output qnot,
             input  t, input  clk,
             input  preset, input clear );

reg q, qnot;

always @( posedge clk or ~preset or ~clear)
begin
    if ( ~clear )
        begin  q <= 0;      qnot <= 1;  end
    else
        if ( ~preset )
            begin  q <= 1;      qnot <= 0;  end
        else
            begin
                if ( t ) begin q <= ~q; qnot <= ~qnot; end
            end
end

endmodule // tff

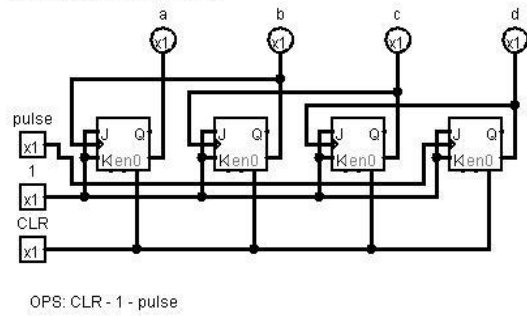
module srff ( output q, output qnot,
             input  s, input  r, input clk );
reg q, qnot;

always @( posedge clk )
begin
    if ( s & ~r ) begin q <= 1;      qnot <= 0; end
    else
        if ( ~s & r ) begin q <= 0;      qnot <= 1; end
    else
        if ( s & r )
            begin  q <= 0; qnot <= 0; // arbitrary end
end

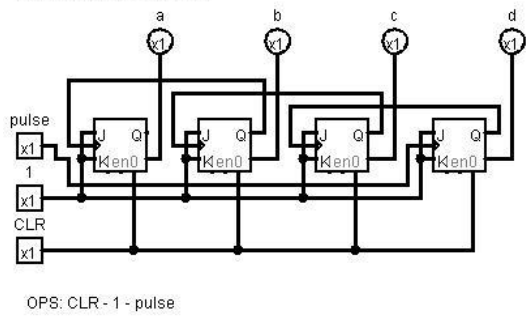
endmodule // srff

```

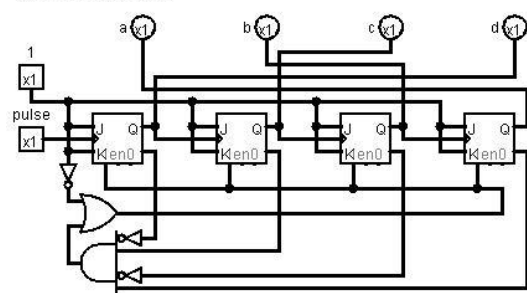
(Down) Asynchronous counter



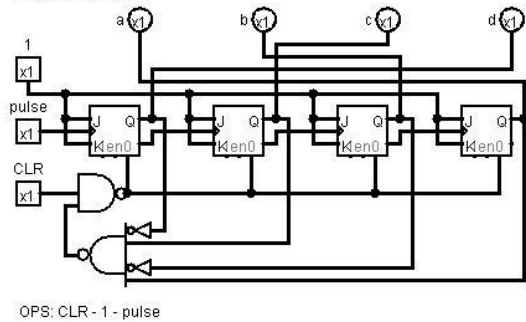
(Up) Asynchronous counter



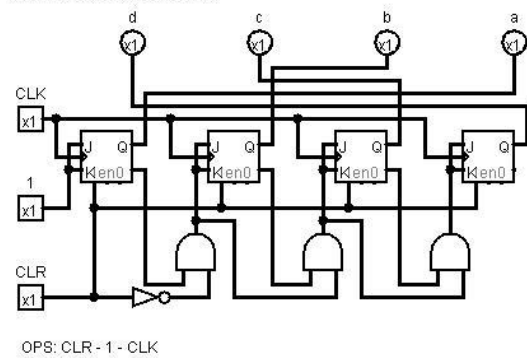
(Down) Decade counter



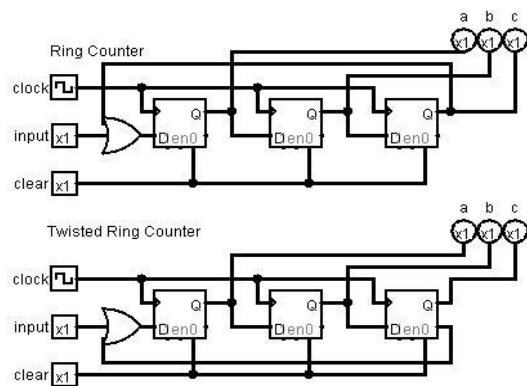
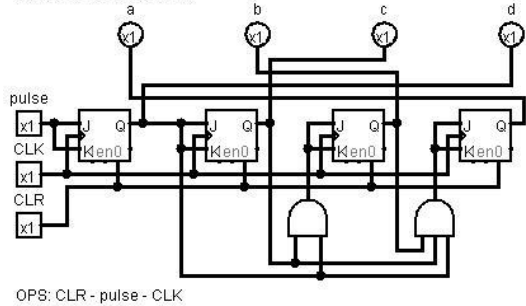
(Up) Decade counter



(Down) Synchronous counter



(Up) Synchronous counter



Counter base 5

