

1a)

Q	Q <sup>+</sup>	D	T
0	0	0	0
0	1	1	1
1	0	0	1
1	1	1	0

	D	
Q	0	1
0	0	1
1	1	0

$T = D\bar{Q} + \bar{D}Q = D \oplus Q$

1b)

Q	Q <sup>+</sup>	T	R	S
0	0	0	φ	0
0	1	1	0	1
1	0	1	1	0
1	1	0	0	φ

	T	
Q	0	1
0	φ	0
1	0	1

	T	
Q	0	1
0	0	1
1	φ	0

$R = Q \cdot T$        $S = \bar{Q} \cdot T$

2 & 3. See the waveforms on next page.

4.

Q	Q <sup>+</sup>	J	K
0	0	0	φ
0	1	1	φ
1	0	φ	1
1	1	φ	0

000 → 011 (a)

C	B	A	C <sup>+</sup>	B <sup>+</sup>	A <sup>+</sup>	J <sub>c</sub>	K <sub>c</sub>	J <sub>B</sub>	K <sub>B</sub>	J <sub>A</sub>	K <sub>A</sub>
0	0	0	φ	φ	φ	φ	φ	φ	φ	φ	φ
0	0	1	0	1	1	0	φ	1	φ	φ	0
0	1	0	1	1	0	1	φ	φ	0	0	φ
0	1	1	0	1	0	0	φ	φ	0	φ	1
1	0	0	0	0	1	φ	1	0	φ	1	φ
1	0	1	1	0	0	φ	0	0	φ	φ	1
1	1	0	1	1	1	φ	0	φ	0	1	φ
1	1	1	1	0	1	φ	0	φ	1	φ	0

	C	B		
A	00	01	11	10
0	φ	1	1	0
1	0	0	1	1

$D_c = C^+ = CA + B\bar{A}$

	C	B		
A	00	01	11	10
0	φ	1	1	0
1	1	1	0	0

$D_B = B^+ = \bar{C} + B\bar{A}$

	C	B		
A	00	01	11	10
0	φ	0	1	1
1	1	0	1	0

$D_A = A^+ = \bar{C}\bar{B} + CB + \bar{B}\bar{A} = C \oplus B + \bar{B}\bar{A}$

(b)

	C	B		
A	00	01	11	10
0	φ	1	φ	φ
1	0	0	φ	φ

$J_c = \bar{A}$

	C	B		
A	00	01	11	10
0	φ	φ	φ	0
1	1	φ	φ	0

$J_B = \bar{C}$

	C	B		
A	00	01	11	10
0	φ	φ	φ	φ
1	φ	φ	φ	φ

$J_A = C$

	C	B		
A	00	01	11	10
0	φ	φ	0	1
1	φ	φ	0	0

$K_c = \bar{B}\bar{A} = \overline{A+B}$

	C	B		
A	00	01	11	10
0	φ	0	0	φ
1	φ	0	1	φ

$K_B = C \cdot A$

	C	B		
A	00	01	11	10
0	φ	φ	φ	φ
1	0	1	0	1

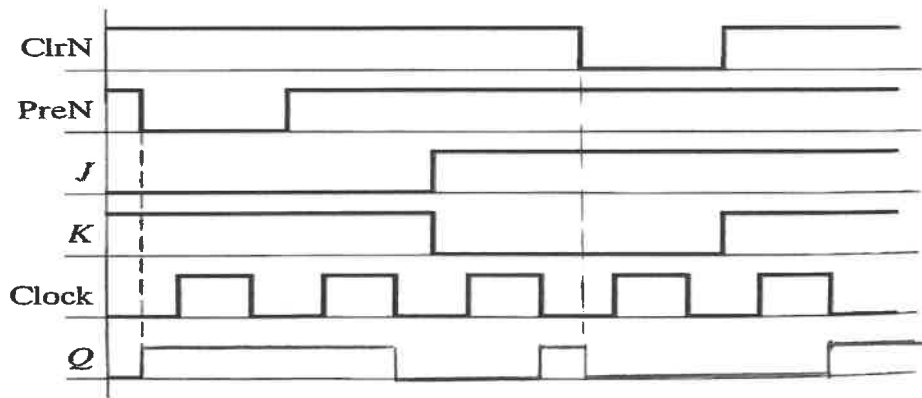
$K_A = C \oplus B$

000 → 110

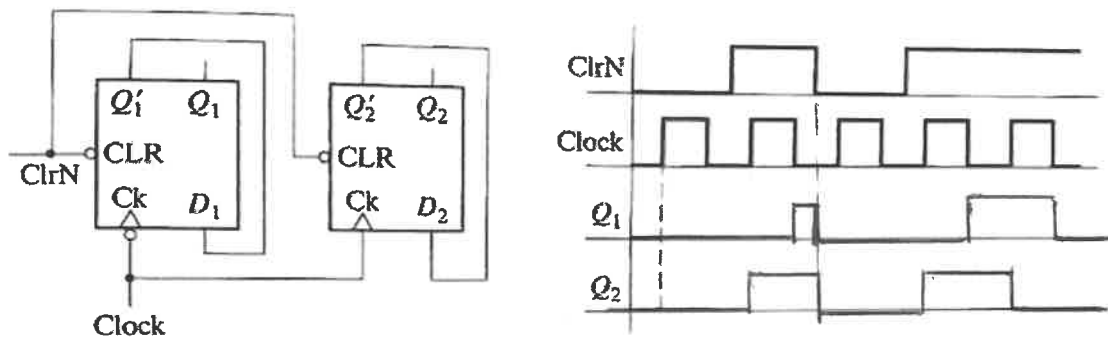
1. Any flip-flop can be implemented from another type of flip-flop with suitable logic applied to the latter's inputs.

- (a) Show how to implement a D flip-flop using a T flip-flop.
- (b) Show how to implement a T flip-flop using a RS flip-flop.

2. Complete the following timing diagram for a JK flip-flop with a falling-edge trigger and asynchronous ClrN (i.e. active-low CLEAR) and PreN (i.e. active-low PRESET) inputs.



3. Complete the timing diagram for the following circuit. Note that the CK inputs on the two flip-flops are different.



4. Design a 3-bit counter which counts in the sequence: 001, 011, 010, 110, 111, 101, 100 (repeat) 001..

- (a) Use D flip-flops;
- (b) Use Jk flip-flops;

In each case, what will happen if the counter is started in state 000?

