

# Compteurs synchrones

## Exercice 1

### 1. Compteur synchrone modulo 10

Etat	Q <sub>3</sub>	Q <sub>2</sub>	Q <sub>1</sub>	Q <sub>0</sub>	J <sub>3</sub>	K <sub>3</sub>	J <sub>2</sub>	K <sub>2</sub>	J <sub>1</sub>	K <sub>1</sub>	J <sub>0</sub>	K <sub>0</sub>
0	0	0	0	0	0	x	0	x	0	x	1	x
1	0	0	0	1	0	x	0	x	1	x	x	1
2	0	0	1	0	0	x	0	x	x	0	1	x
3	0	0	1	1	0	x	1	x	x	1	x	1
4	0	1	0	0	0	x	x	0	0	x	1	x
5	0	1	0	1	0	x	x	0	1	x	x	1
6	0	1	1	0	0	x	x	0	x	0	1	x
7	0	1	1	1	1	x	x	1	x	1	x	1
8	1	0	0	0	x	0	0	x	0	x	1	x
9	1	0	0	1	x	1	0	x	0	x	x	1
0	0	0	0	0								

A partir de la table (Q<sub>0</sub>, J<sub>0</sub>, K<sub>0</sub>) on peut tirer J<sub>0</sub> = K<sub>0</sub> = 1

		Q <sub>1</sub> Q <sub>0</sub>			
	Q <sub>3</sub> Q <sub>2</sub>	00	01	11	10
00		0	1	3	2
01		4	5	7	6
11		12	13	15	14
10		8	9	11	10

Les cases 10 à 15 ne sont pas utilisées (compteur modulo 10).  
On peut, donc, les remplir par des x.

		Q <sub>1</sub> Q <sub>0</sub>			
	Q <sub>3</sub> Q <sub>2</sub>	00	01	11	10
00					
01					
11		x	x	x	x
10				x	x

		J <sub>1</sub>			
	Q <sub>3</sub> Q <sub>2</sub>	00	01	11	10
00		0	1	x	x
01		0	1	x	x
11		x	x	x	x
10		0	0	x	x

$$J_1 = \bar{Q}_3 Q_0$$

		K <sub>1</sub>			
	Q <sub>3</sub> Q <sub>2</sub>	00	01	11	10
00		0	x	1	x
01		0	x	1	x
11		x	x	x	x
10		0	0	x	x

$$K_1 = \bar{Q}_3 Q_0$$

$$J_2$$

$Q_3Q_2 \backslash Q_1Q_0$	00	01	11	10
00	0	0	1	0
01	x	x	x	x
11	x	x	x	x
10	0	0	x	x

$$J_2 = Q_1Q_0$$

$$K_2$$

$Q_3Q_2 \backslash Q_1Q_0$	00	01	11	10
00	x	x	x	x
01	0	0	1	0
11	x	x	x	x
10	0	0	x	x

$$K_2 = Q_1Q_0$$

$$J_3$$

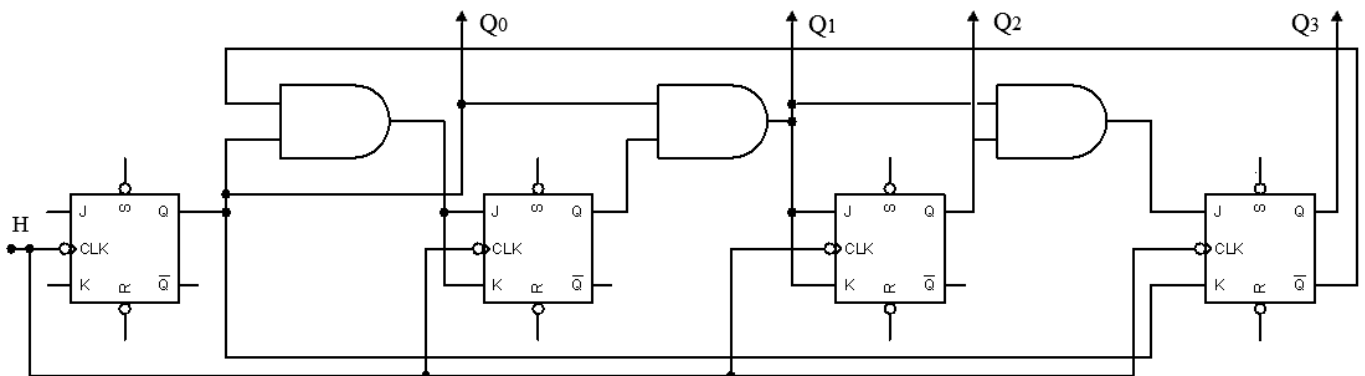
$Q_3Q_2 \backslash Q_1Q_0$	00	01	11	10
00	0	0	0	0
01	0	0	1	0
11	x	x	x	x
10	x	x	x	x

$$J_3 = Q_2Q_1Q_0$$

$$K_3$$

$Q_3Q_2 \backslash Q_1Q_0$	00	01	11	10
00	x	x	x	x
01	x	x	x	x
11	x	x	x	x
10	0	1	x	x

$$K_3 = Q_0$$



2. Compteur synchrone qui compte de la façon suivante :

→ 0 → 3 → 5 → 7 → 10 → 12 →

$Q_3$	$Q_2$	$Q_1$	$Q_0$	$J_3$	$K_3$	$J_2$	$K_2$	$J_1$	$K_1$	$J_0$	$K_0$
0	0	0	0	0	x	0	x	1	x	1	x
0	0	1	1	0	x	1	x	x	1	x	0
0	1	0	1	0	x	x	0	1	x	x	0
0	1	1	1	1	x	x	1	x	0	x	1
1	0	1	0	x	0	1	x	x	1	0	x
1	1	0	0	x	1	x	1	0	x	0	x

		$J_0$				
		$Q_1Q_0$	00	01	11	10
$Q_3Q_2$		00	1	x	x	x
	01	x	x	x	x	
	11	0	x	x	x	
	10	x	x	x	0	

$J_0 = \bar{Q}_3$

		$K_0$				
		$Q_1Q_0$	00	01	11	10
$Q_3Q_2$		00	x	x	0	x
	01	x	0	1	x	
	11	x	x	x	x	
	10	x	x	x	x	

$K_0 = Q_1Q_2$

		$J_1$				
		$Q_1Q_0$	00	01	11	10
$Q_3Q_2$		00	1	x	x	x
	01	x	1	x	x	
	11	0	x	x	x	
	10	x	x	x	x	

$J_1 = \bar{Q}_3$

		$K_1$				
		$Q_1Q_0$	00	01	11	10
$Q_3Q_2$		00	x	x	1	x
	01	x	x	0	x	
	11	x	x	x	x	
	10	x	x	x	1	

$K_1 = \bar{Q}_2$

		$J_2$				
		$Q_1Q_0$	00	01	11	10
$Q_3Q_2$		00	0	x	1	x
	01	x	x	x	x	
	11	x	x	x	x	
	10	x	x	x	1	

$J_2 = Q_1$

		$K_2$				
		$Q_1Q_0$	00	01	11	10
$Q_3Q_2$		00	x	x	x	x
	01	x	0	1	x	
	11	1	x	x	x	
	10	x	x	x	x	

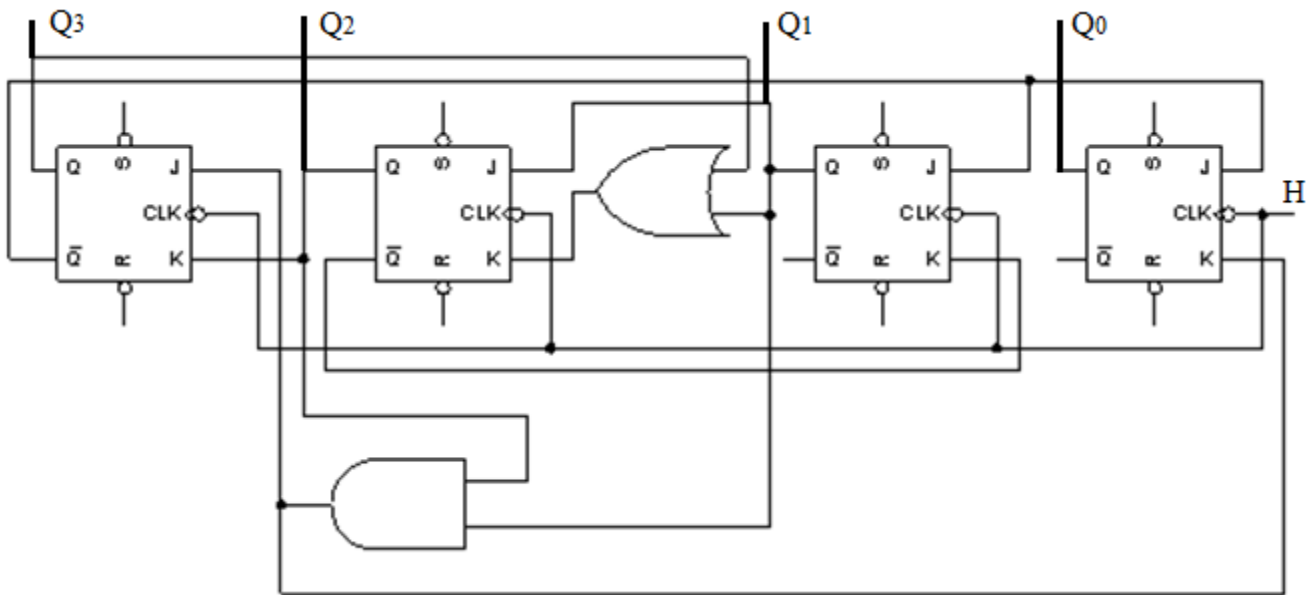
$K_2 = Q_1 + Q_3$

		$J_3$				
		$Q_1Q_0$	00	01	11	10
$Q_3Q_2$		00	0	x	0	x
	01	x	0	1	x	
	11	x	x	x	x	
	10	x	x	x	x	

$J_3 = Q_1Q_2$

		$K_3$				
		$Q_1Q_0$	00	01	11	10
$Q_3Q_2$		00	x	x	x	x
	01	x	x	x	x	
	11	1	x	x	x	
	10	x	x	x	0	

$K_3 = Q_2$



**Exercice 2**

**1. Compteur synchrone modulo 8 à base des bascules D**

Etat	Q <sub>2</sub>	Q <sub>1</sub>	Q <sub>0</sub>	D <sub>2</sub>	D <sub>1</sub>	D <sub>0</sub>
0	0	0	0	0	0	1
1	0	0	1	0	1	0
2	0	1	0	0	1	1
3	0	1	1	1	0	0
4	1	0	0	1	0	1
5	1	0	1	1	1	0
6	1	1	0	1	1	1
7	1	1	1	0	0	0
0	0	0	0			

Q <sub>2</sub> \ Q <sub>1</sub> Q <sub>0</sub>	00	01	11	10
0	0	1	3	2
1	4	5	7	6

Q <sub>2</sub> \ Q <sub>1</sub> Q <sub>0</sub>	00	01	11	10
0	1	0	0	1
1	1	0	0	1

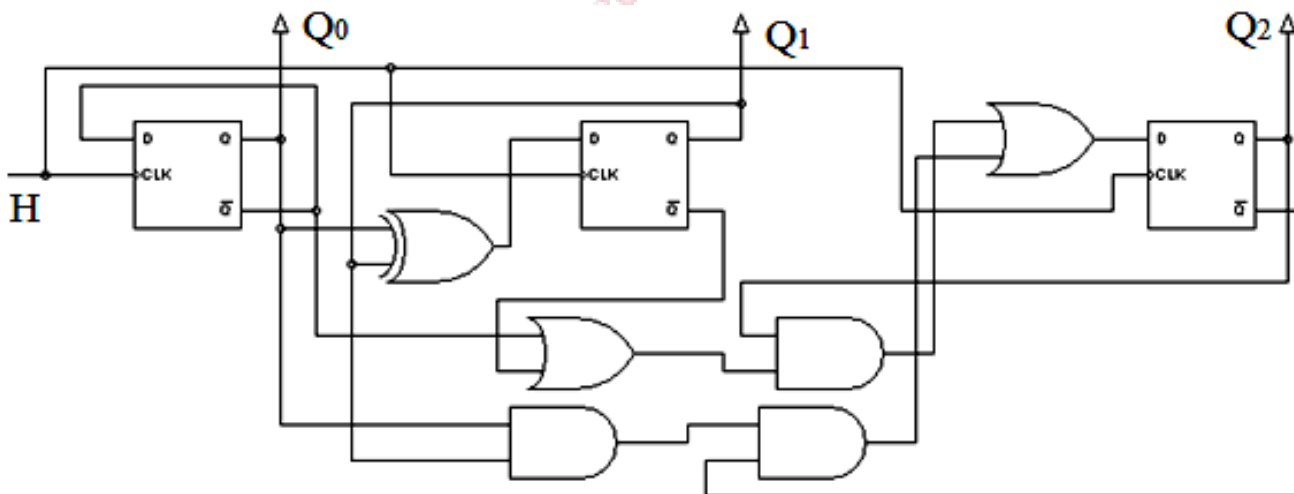
$$D_0 = \bar{Q}_0$$

	$Q_1Q_0$	00	01	11	10
$Q_2$	0	0	1	0	1
	1	0	1	0	1

$$D_1 = \bar{Q}_0Q_1 + Q_0\bar{Q}_1$$

	$Q_1Q_0$	00	01	11	10
$Q_2$	0	0	0	1	0
	1	1	1	0	1

$$D_2 = \bar{Q}_0Q_2 + \bar{Q}_1Q_2 + Q_0Q_1\bar{Q}_2$$



2. Compteur synchrone :  $\rightarrow 0 \rightarrow 3 \rightarrow 4 \rightarrow 7 \rightarrow$

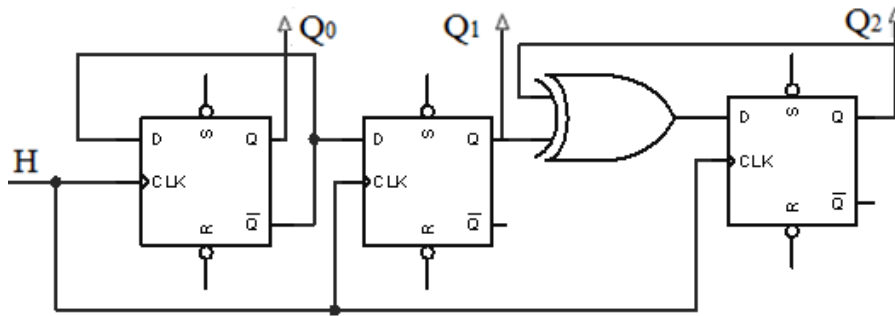
$Q_2$	$Q_1$	$Q_0$	$D_2$	$D_1$	$D_0$
0	0	0	0	1	1
0	1	1	1	0	0
1	0	0	1	1	1
1	1	1	0	0	0

	$Q_1Q_0$	00	01	11	10
$Q_2$	0	1	x	0	x
	1	1	x	0	x

$$D_0 = D_1 = \bar{Q}_0$$

	$Q_1Q_0$	00	01	11	10
$Q_2$	0	0	x	1	x
	1	1	x	0	x

$$D_2 = \bar{Q}_1Q_2 + Q_1\bar{Q}_2 = Q_2 \oplus Q_1$$

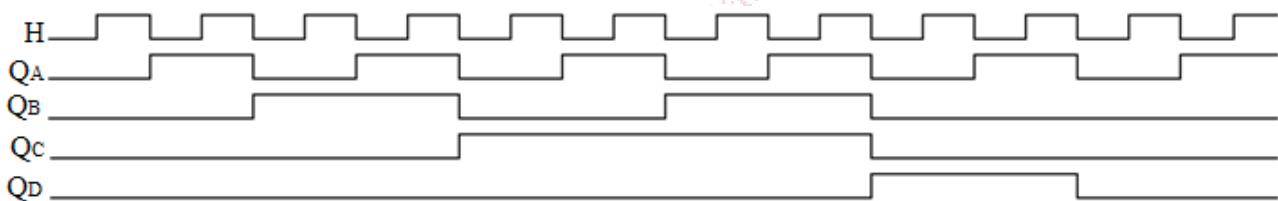


**Exercice 3**

1.  $J_A = K_A = 1$                        $J_B = K_B = \overline{Q_A} + Q_D$   
 $J_C = K_C = Q_A Q_B$                    $J_D = \overline{Q_A} \overline{Q_B} + \overline{Q_C}$                $K_D = Q_A$

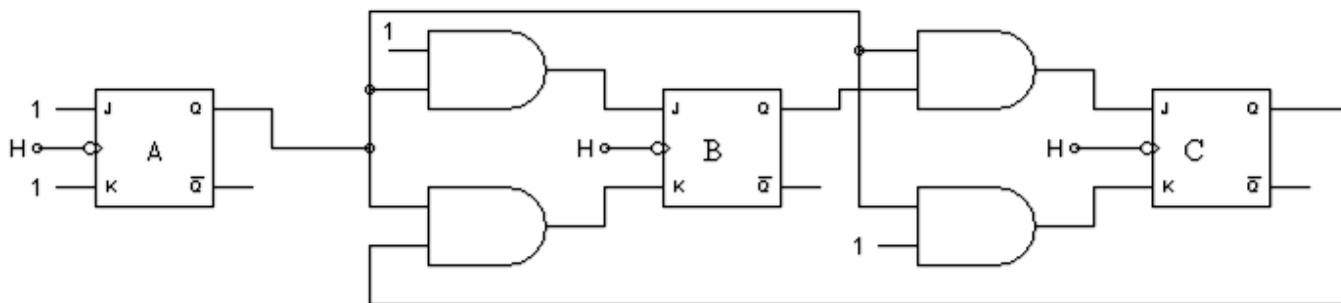
2.

Etat	Q <sub>D</sub>	Q <sub>C</sub>	Q <sub>B</sub>	Q <sub>A</sub>	J <sub>D</sub>	K <sub>D</sub>	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	0	0	0	0	0	0	0	0	1	1
1	0	0	0	1	0	1	0	0	1	1	1	1
2	0	0	1	0	0	0	0	0	0	0	1	1
3	0	0	1	1	0	1	1	1	1	1	1	1
4	0	1	0	0	0	0	0	0	0	0	1	1
5	0	1	0	1	0	1	0	0	1	1	1	1
6	0	1	1	0	0	0	0	0	0	0	1	1
7	0	1	1	1	1	1	1	1	1	1	1	1
8	1	0	0	0	0	0	0	0	0	0	1	1
9	1	0	0	1	0	1	0	0	0	0	1	1
0	0	0	0	0								



3. Le tableau montre que le modulo de ce compteur est 10.

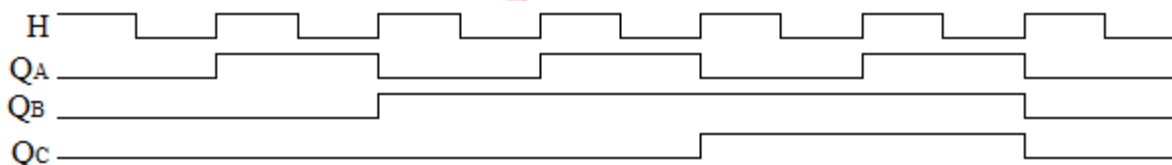
### Exercice 4



1.  $J_A = K_A = 1$      $J_B = Q_A$      $K_B = Q_A Q_C$      $J_C = Q_A Q_B$      $K_C = Q_A$

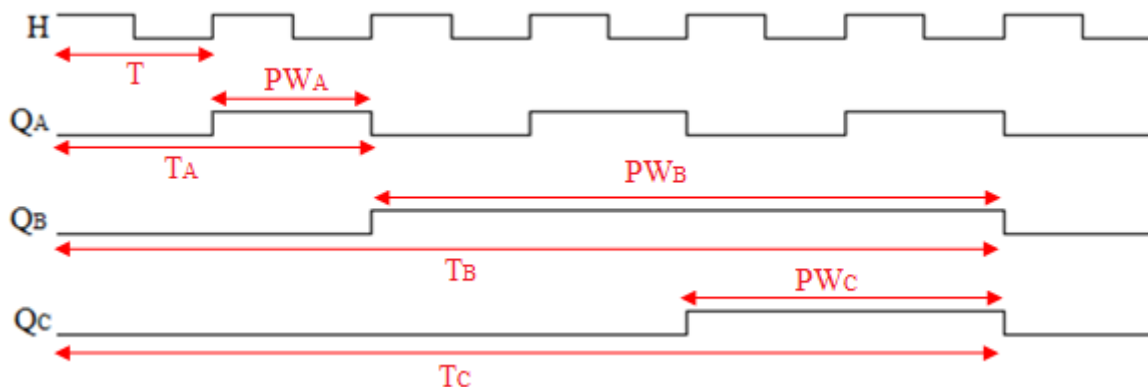
2.

Etat	$Q_C$	$Q_B$	$Q_A$	$J_C$	$K_C$	$J_B$	$K_B$	$J_A$	$K_A$
0	0	0	0	0	0	0	0	1	1
1	0	0	1	0	1	1	0	1	1
2	0	1	0	0	0	0	0	1	1
3	0	1	1	1	1	1	0	1	1
6	1	1	0	0	0	0	0	1	1
7	1	1	1	1	1	1	1	1	1
0	0	0	0						



3. Ce compteur réalise la séquence suivante :  $0 \rightarrow 1 \rightarrow 2 \rightarrow 3 \rightarrow 6 \rightarrow 7 \rightarrow 0$

4.



$$T_A = 2 \times T \quad T_B = 6 \times T \quad T_C = 6 \times T$$

$$f_H = 1 / T$$

$$f_A = 1 / T_A = 1 / 2 \times T = f_H / 2$$

$$f_B = 1 / T_B = 1 / 6 \times T = f_H / 6$$

$$f_C = 1 / T_C = 1 / 6 \times T = f_H / 6$$

$$PW_A = T \quad PW_B = 4 \times T \quad PW_C = 2 \times T$$

$$\alpha_A = PW_A / T_A = T / T_A = 1 / 2$$

$$\alpha_B = PW_B / T_B = 4 \times T / 6 \times T = 4 / 6 = 2 / 3$$

$$\alpha_C = PW_C / T_C = 2 \times T / 6 \times T = 2 / 6 = 1 / 3$$

Fréquence	Rapport cyclique
$f_C = f_H / 6$	$\alpha_C = 1 / 3 = 0,33$
$f_B = f_H / 6$	$\alpha_B = 2 / 3 = 0,66$
$f_A = f_H / 2$	$\alpha_A = 1 / 2 = 0,5$