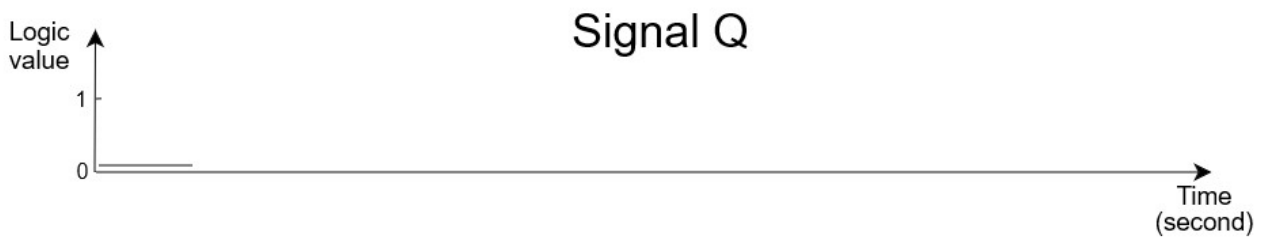
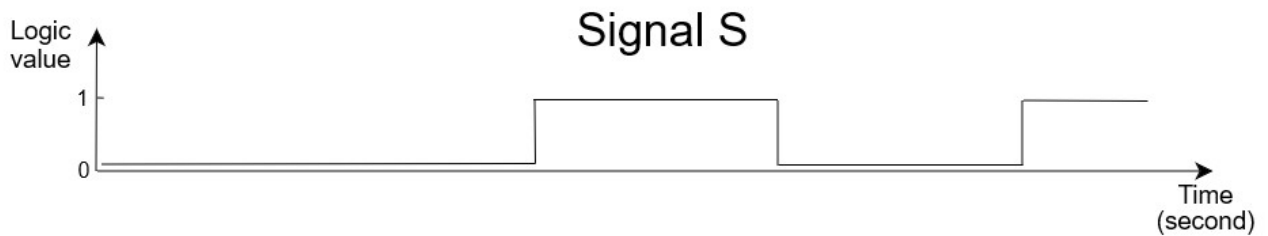


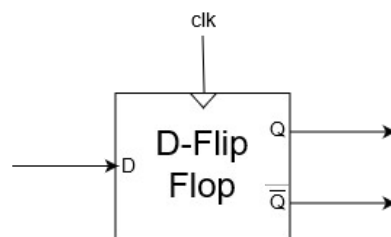
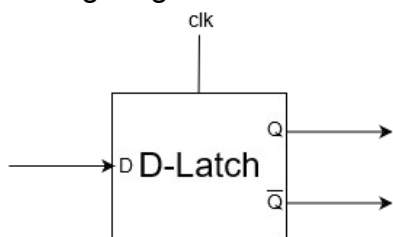
## Problem set 2 (Sequential Circuits)

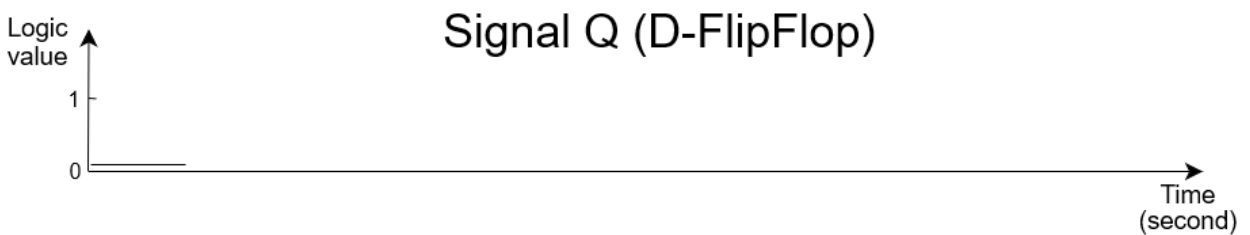
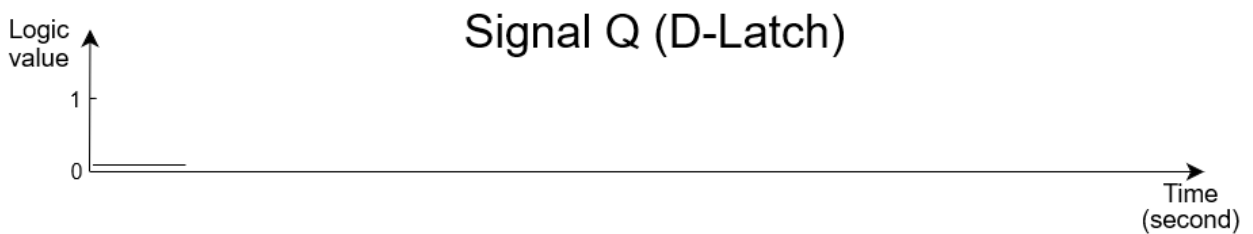
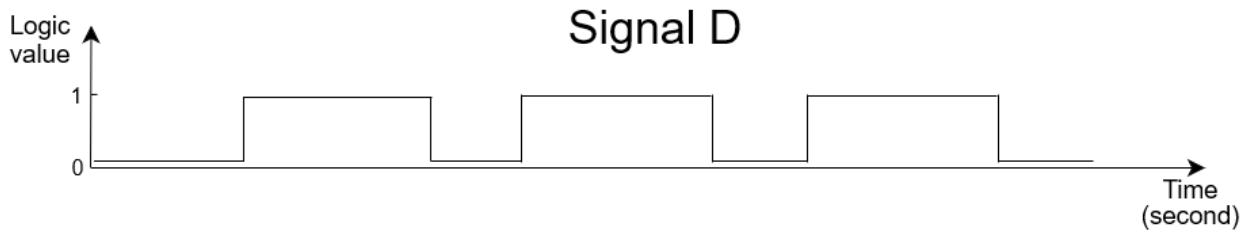
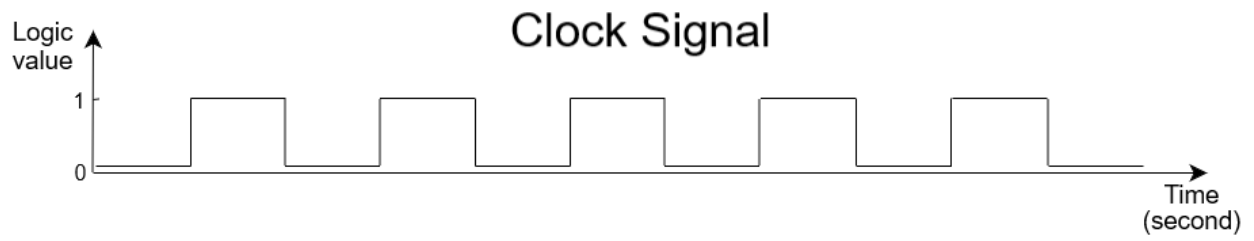
### Exercise 01 :

1) Plot the timing diagram for the Q output of the following RS-Latch circuit :



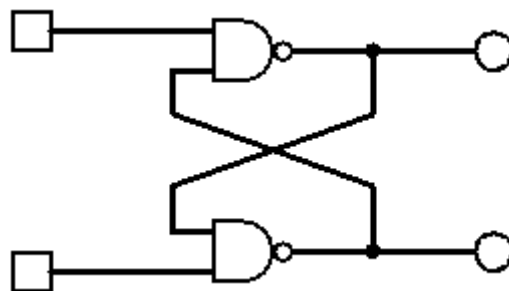
2) Plot the timing diagram for the Q output of the two circuits D-Latch and D-FlipFlop :





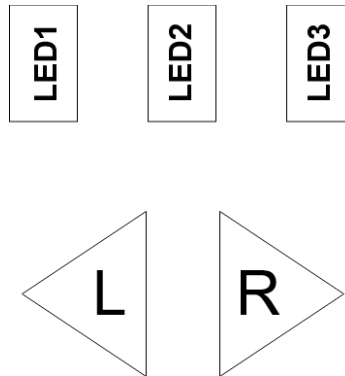
**Exercise 02 :**

1) For performance reasons, memory cells are most often implemented using universal gates. Analyze the operation of the following circuit, and deduce what type of memory cell it is?



### Exercise 03 :

We want to build a Sequential Circuit to manage the level control of any quantity in a machine, such as controlling the sound level of a television using the remote control for example. The circuit uses 2 inputs L (Left) and R (Right), and 3 outputs named LEDs; LED1, LED2, LED3. As in the figure:



Lors du lancement de l'appareil toutes les LED sont éteintes. Appuyer sur D allume la LED1, Appuyer une deuxième fois sur D allume LED2, et ainsi de suite. Et inversement pour G, si par exemple LED1 et LED2 sont allumées, appuyer sur G éteindra LED2, et ainsi de suite.

While starting the device all LEDs are off. Pressing R turns on LED1, Pressing R a second time turns on LED2, and so on. And vice versa for L, if for example LED1 and LED2 are on, pressing L will turn off LED2, and so on.

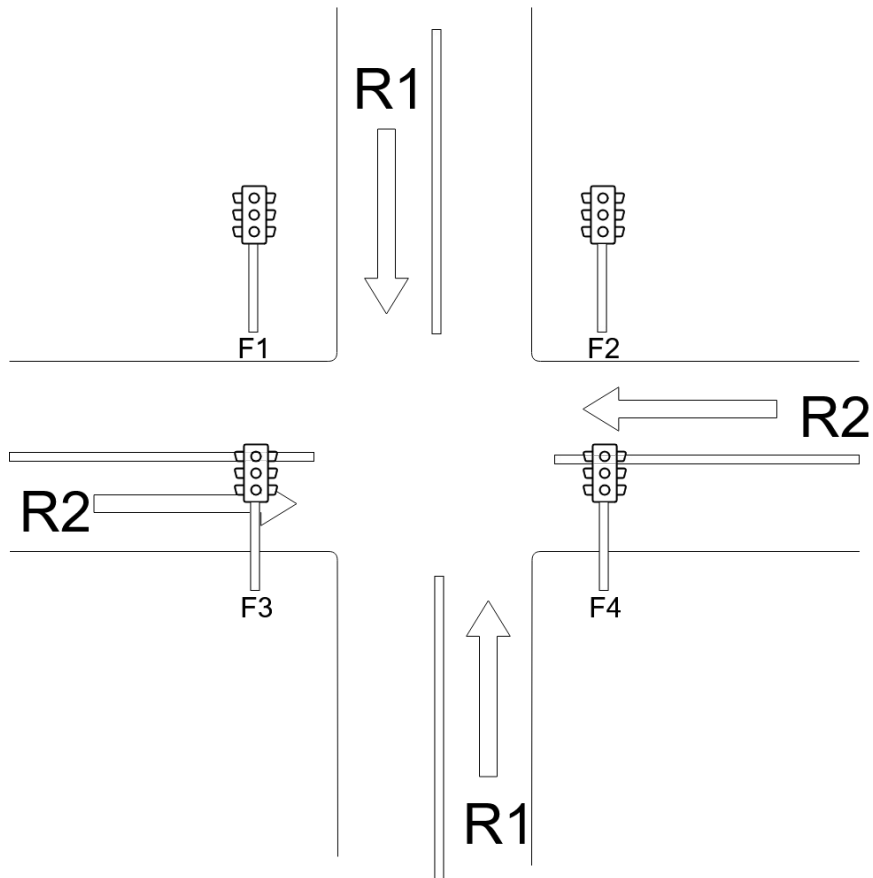
**Question 1 :** Build the Moore Machine for this Sequential Circuit using the 7-step method.

**Question 2 :** What would be the response of the machine if the user presses the 2 buttons L and R at the same time. How is this case represented on the F.S.M. ?

**Question 3 :** Plot a timing diagram for the execution of the machine, tracking the signals of the Register values, Next State circuit, and Outputs circuit. Applying the following input sequence (from left to right): RRLLLR.

### Exercise 04 :

We want to build a Sequential Circuit to control the management of traffic lights on an intersection of 2 roads R1 and R2, as illustrated in the following diagram. Lights F1 and F4 are identical and control the signaling of road R1, and lights F2 and F3 are also identical and control road R2. The way the signaling device works is that the red light must last 30 seconds on a road, at the same time, on the crossed road the green must last 27 seconds, followed by 3 seconds of orange. And vice versa for the next 30 seconds, and so on.



**Question 1 :** Design this Moore Machine Sequential Circuit using the 7-step method, knowing that the input of the circuit is clocked by 2 Timers which repeatedly generate a logic 1 signal every 30 seconds , the second is identical but late (phase shifted) by 27 seconds compared to the first.

**Question 2 :** Plot a timing diagram for the execution of the machine tracking the signals of the outputs, the register, and the next state circuit. Over a time interval of +60 seconds.

### Exercise 05 :

- 1) Implement an 8-bit register with Write functionality.
- 2) Implement a 4-bit SIPO Shifter and a 4-bit PISO Shifter.
- 3) Implement a 4-bit Counter using D-FlipFlop. Then add a mechanism to count up only to value 12.
- 4) Implement a 6-bit Counter using only JK-FlipFlops, and another using only T-FlipFlops.