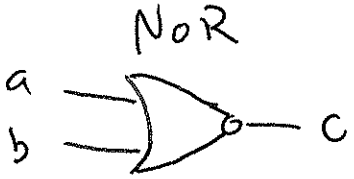
Fun with Flip-Flops:

Flip flops are the basic building blocks of memory systems, counters, serial to parallel conversion, digital data transmission, and arithmetic operations on binary numbers.

Basic Definition:

A flip-flop is a circuit with two output terminals and two stable output states.

NOR - truth table:



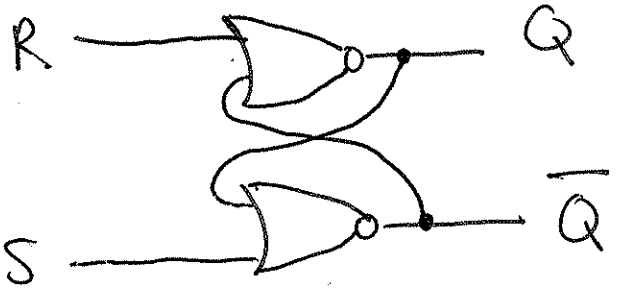
OR

a	b	c
0	0	0
1	0	1
0	1	1
1	1	1

NOR

a	b	c
0	0	1
1	0	0
0	1	0
1	1	0

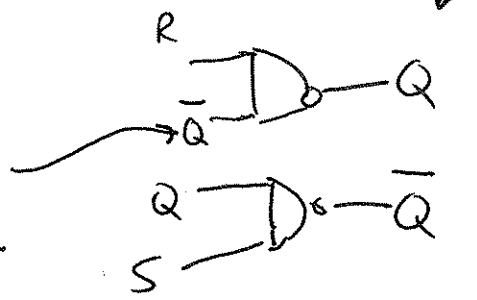
RS - flip-flop w/ NOR gates

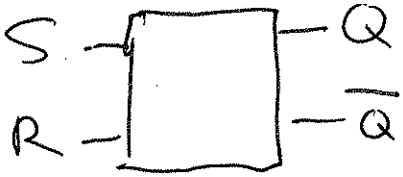


RS - flip flop truth table :

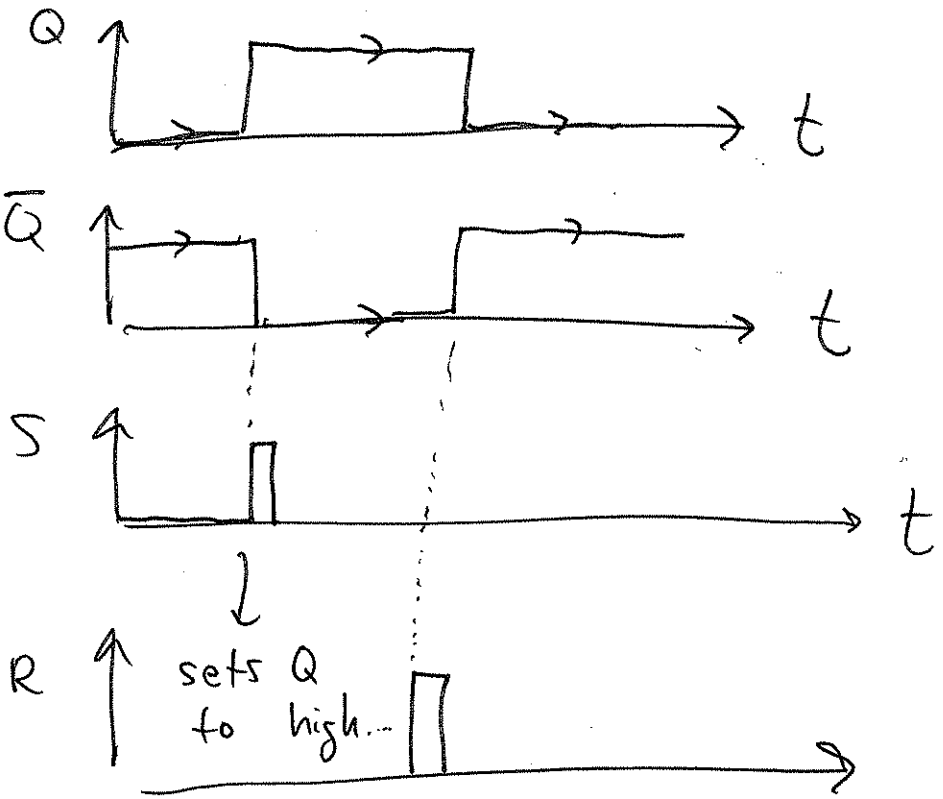
S	R	Q	$\bar{Q}$
0	0	1	0
0	0	0	1
★ 1	0	1	0
0	1	0	1
1	1	?	?

Draw like this ↓





timing diagram :



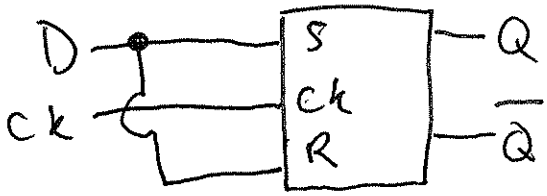
D-type Flip Flop:

"Data latch" Flip-Flop has one data input and one clock.

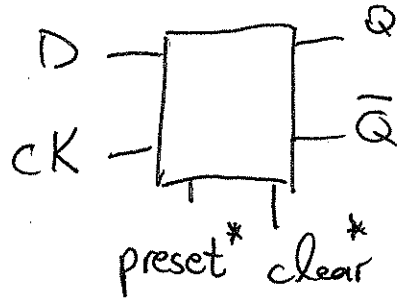
(I) If the clock is high, then Q is affected by D.

(II) If clock = low, then Q is unaffected.

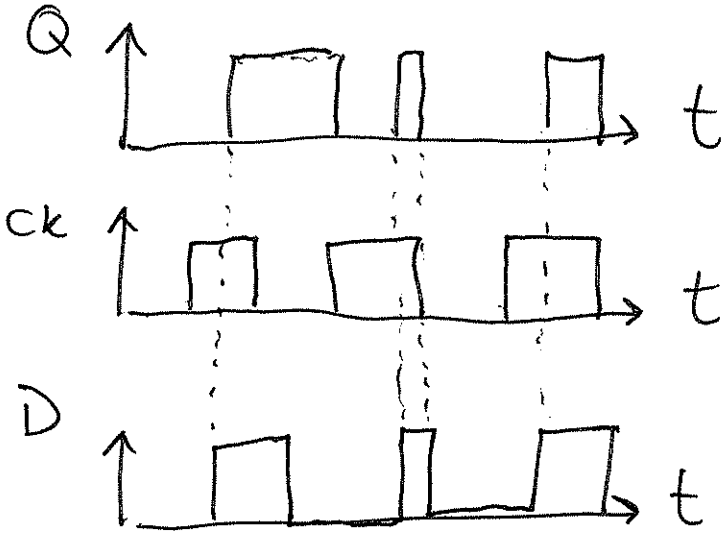
RS version:



circuit schematic:



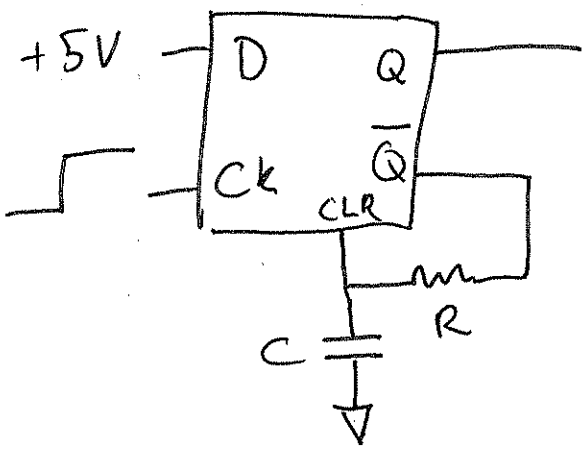
* active low



Lab Tasks:

① Verify the truth table.

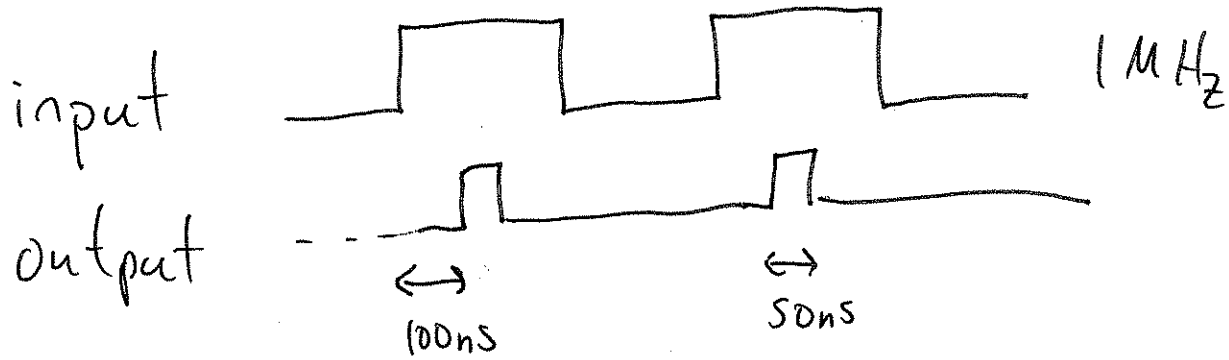
② Build a "one shot" or "monostable multivibrator"



Draw timing diagrams:

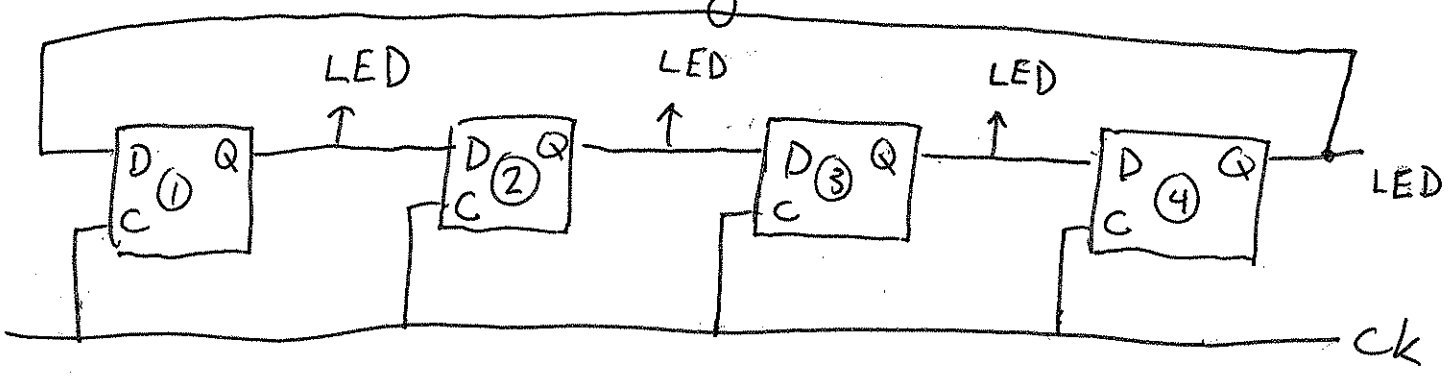
CK, Q, $\overline{Q}$, CLR

③ Build a circuit that generates a 50ns pulse 100 ns after an input pulse by using two one-shots.



④ Now try again using the 74LS123 chip.

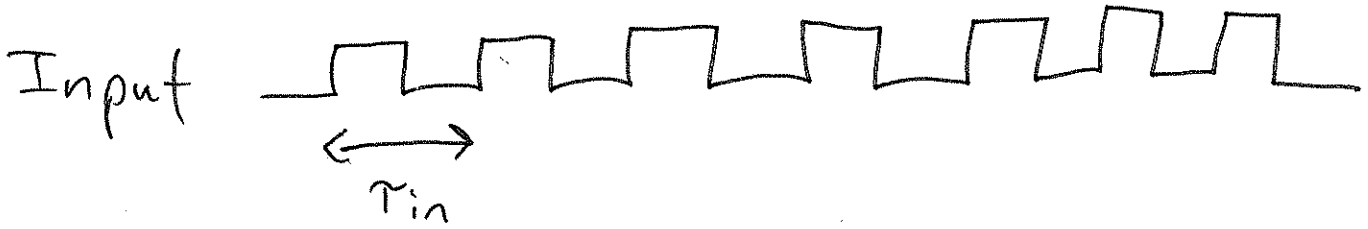
(5) Build the following shift register

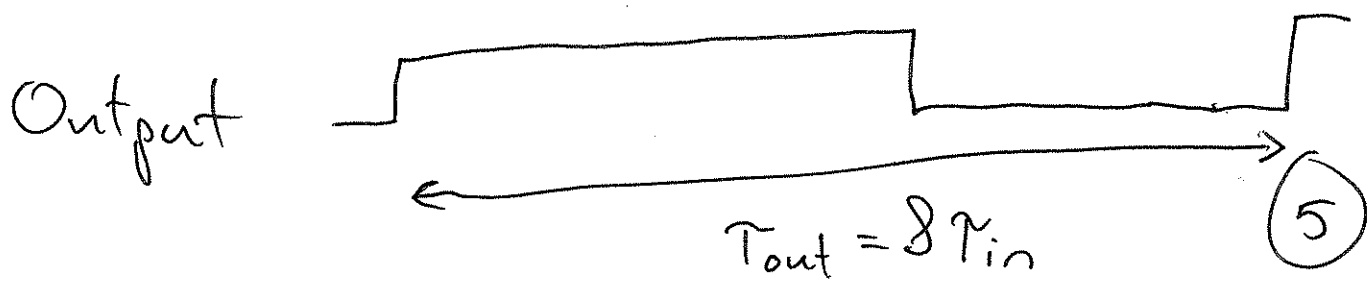


(a) with no clock set $Q_1 = 1$, $Q_2 = 1$, $Q_3 = 0$, $Q_4 = 0$.

(b) Apply a clock and observe and explain behavior.

(6) Build a "divide by 2^n" circuit, why does this work? It's also a binary counter. (Add LED's to Q's to show this.)





(7) Add a summing amplifier such that 3 bit counter is the digital input to a Digital to analog converter (DAC). Observe analog behavior and explain.