

### QUIZ 4 Solution

1. Sketch the output of an SR latch shown in Fig. 1 for the input waveform shown in Fig. 1b. Assume that the input and output rise and fall times are zero and propagation delay of NOR gate is 10 ns, and each time division shown in Fig. 1b is 10 ns.

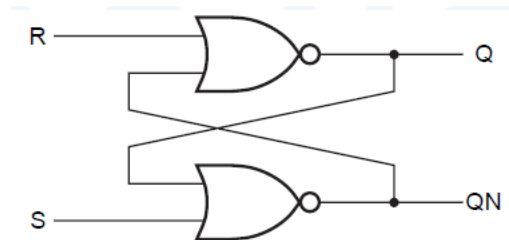


Figure 1a

ANSWER:

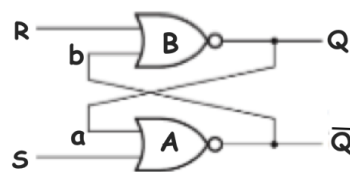
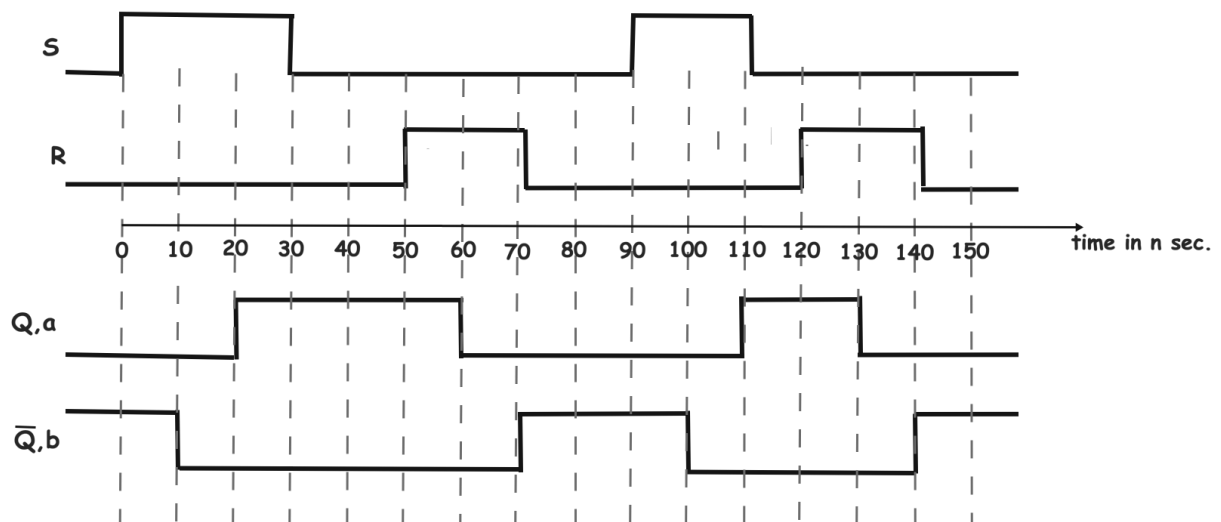


Figure 1a



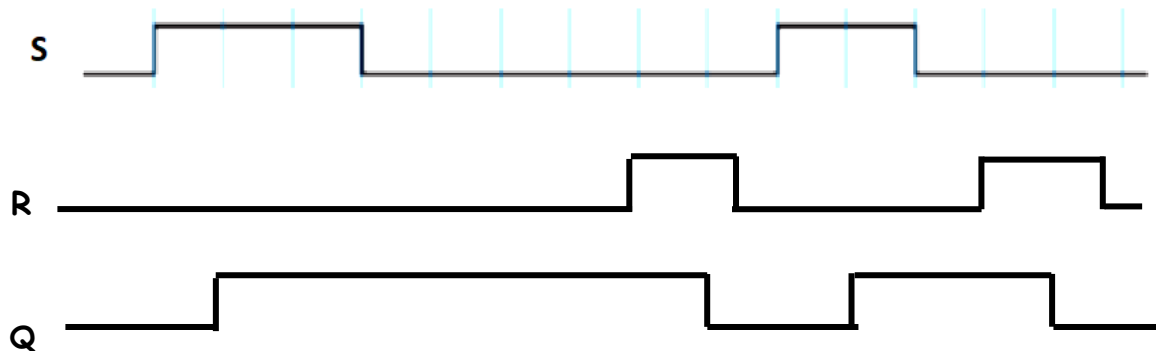
[Explanation: The circuit starts with  $S = R = 0$  and  $Q = 0$  and  $\bar{Q} = 1$

At  $t = 0$ ns  $S$  becomes 1, since it is a NOR based S-R Latch dominant input is logic 1, consequently,  $\bar{Q}$  becomes 0 at 10ns (a gate delay of 10ns for each NOR gate). Once  $\bar{Q}$  and hence  $b$  becomes 0, 10ns later  $Q$  becomes 1 at 20ns. Now at 30ns  $S$  becomes 0 and  $Q$  and  $\bar{Q}$  retain their values. At 50ns,  $R$  becomes 1, this leads to  $Q$  and hence  $b$  becoming 0 at 60ns. Once  $Q$  and hence  $a$  becomes 0, 10ns later  $\bar{Q}$  becomes 1 at 70ns.

Now at 72ns R becomes 0 and Q and  $\bar{Q}$  retain their values. At  $t = 90\text{ns}$  S becomes 1,  $\bar{Q}$  becomes 0 at 100ns. Once  $\bar{Q}$  and hence b becomes 0, 10ns later Q becomes 1 at 110ns. Now at 112ns S becomes 0 and Q and  $\bar{Q}$  retain their values. At 120ns, R becomes 1, this leads to Q and hence b becoming 0 at 130ns. Once Q and hence a becomes 0, 10ns later  $\bar{Q}$  becomes 1 at 140ns. Now at 142ns R becomes 0 and Q and  $\bar{Q}$  retain their values.]

**If waveform drawn correctly as above give 5 marks. (No explanation required.)**

**If the waveforms are drawn for Q and QN as given in following figure, please give 3 Marks only.**



QN waveform will be invert of Q.

Please examine the timing diagram carefully. There is a delay of 10 ns between inputs and outputs. Partially correct waveform Q and QN, one mark each.

Figure 1b

2. Figures 2a and 2b shows two different types of Flip Flops. Identify the Flip Flop by defining the characteristics tables. A, B, C and D are Clock, D, S and R terminals. Give the logical expression for present output Q in terms of inputs and the previous output.

**ANSWER:**

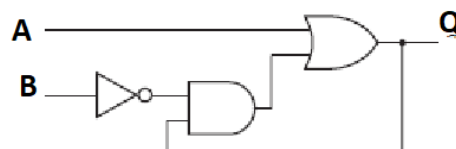


Figure 2a

Characteristic Table

A	B	$Q_{n-1}$	$Q_n$
0	0	0	0
0	0	1	1
0	1	0	0

0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

It is a SR Flip Flop

$$S = A \text{ and } R = B,$$

$$Q_n = S + R' Q_{n-1} = A + B' Q_{n-1}$$

Characteristic Table - 1 mark each.

Identification of FF - 1 mark each

Expression for  $Q_n$  - 0.5 marks each

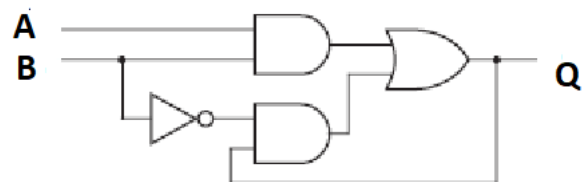


Figure 2b

Characteristic Table

A	B	$Q_{n-1}$	$Q_n$
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

It is a D Flip Flop.

$$D = A \text{ and Clock (C) = B}$$

$$Q_n = A B + A' Q_{n-1} = Q_n = D C + D' Q_{n-1}$$

Characteristic Table - 1 mark each.

Identification of FF - 1 mark each

Expression for  $Q_n$  - 0.5 marks each