ShanghaiTech University

EE 115B: Digital Circuits

Fall 2022

Homework 5

Solution

Total: 100 Points

Assigned: December 13, 2022. Due: December 20, 2022.

1. Assuming that the D and Clock inputs shown in Fig. 1 are applied to the circuits shown in Fig. 2, draw the waveforms for Q_a, Q_b, and Q_c. Assume that the initial states are $Q_a=Q_b=Q_c=0$. Ignore the propagation delays. (30 points, 10 points each.)
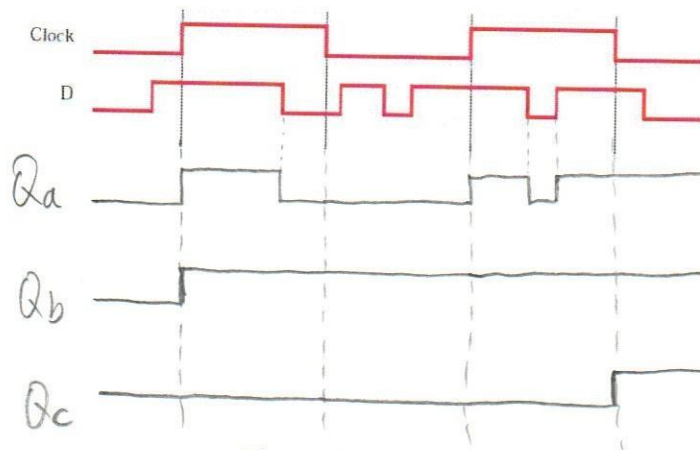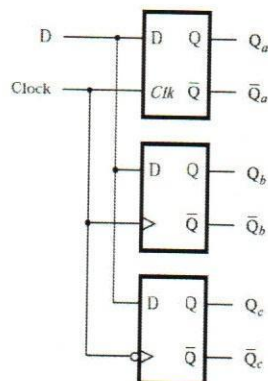

Fig. 1: Timing diagram.

Fig. 2: Circuits.

2. The characteristic table and circuit symbol for a T flip-flop are shown in Fig. 3. For the inputs shown in Fig. 4, draw the Q waveform assuming that the initial state is Q=1. Ignore the propagation delays. (20 points.)

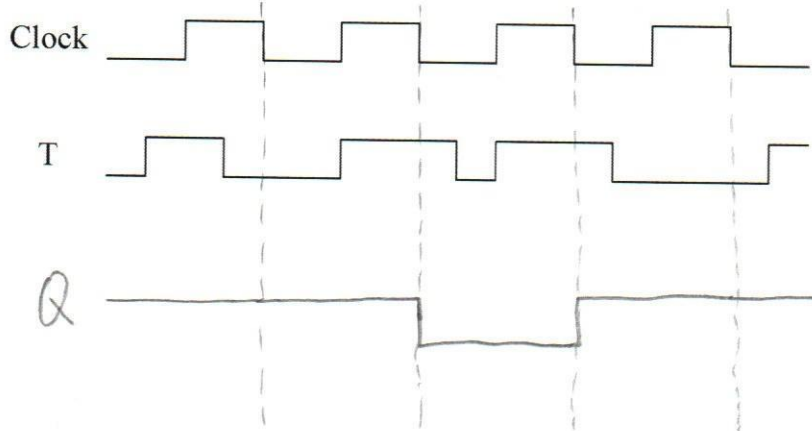| T	Q(t+1)
0	Q(t)
1	Q(t)'

Fig. 3: T flip-flop.

Fig. 4: Timing diagram.

3. Consider a universal shift register. The block diagram as well as the signal and mode definitions are shown as follows. Complete the table below to determine the output of the register during the next clock cycle. Specifically, suppose the present time is t0 and the clock cycle period is Δt. Based on the information of the serial input, parallel input, mode selection signal, and output at t=t0, determine the output at t=t0+Δt. (20 points, 5 points each.)

Serial_in (t=t0)	P(3:0) (t=t0)	M(1:0) (t=t0)	Q(3:0) (t=t0)	Q(3:0) (t=t0+Δt)
1	0110	10	0011	0111
0	0010	11	1011	0010
1	1101	00	0110	0110
0	1011	01	0111	0011

4. Timing diagram:

Clock

Q_0

Q_1

Q_2

Count 000 001 010 111 000 001 010 111 000
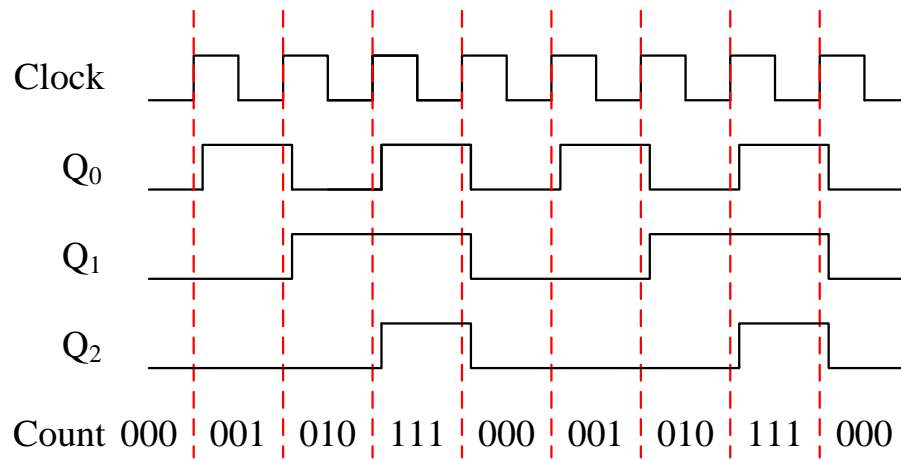
The binary sequence is 000, 001, 010, and 111.

Since this counter has four different counts (i.e., states), its modulus is 4.