Digital Circuits: Homeworks #4 Solutions

1. **Gated S-R Latch.**
   For a gated S-R latch, draw the Q and $\bar{Q}$ outputs for the inputs in Figure 1. Show them in proper relation to the enable input. Assume that Q starts LOW.

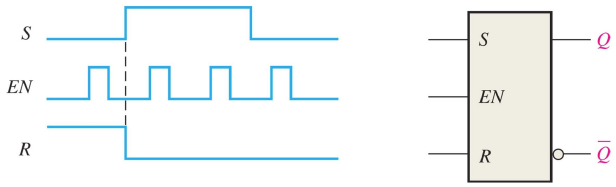

Figure 1: Input Waveform.

Solution: Gated S-R Latch
Recall that S-R Latch only works when EN is HIGH. If EN is HIGH, Q is HIGH when S is HIGH, Q is LOW when R is HIGH, and Q is NC (no change) when both S and R are LOW. Q output is shown in Figure 2

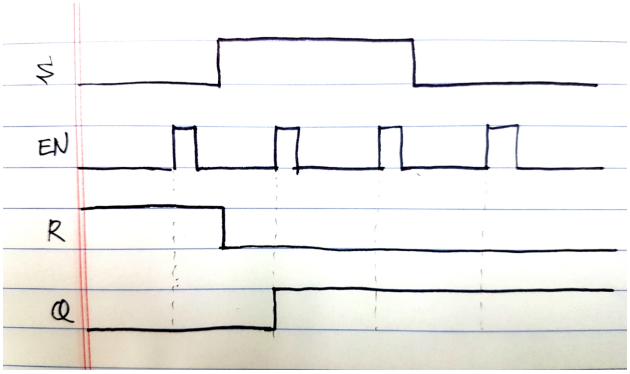

Figure 2: Output Waveform.

2. **Gated D Latch.**
   Determine the output of a gated D latch for the inputs in Figure 3. Assume that Q starts LOW.

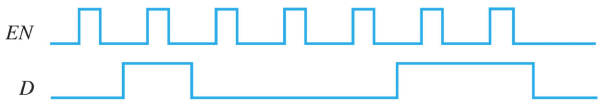

Figure 3: Input Waveform.

Solution: Gated S-R Latch
Recall that D Latch only forwards the value when EN is HIGH. If EN is HIGH, Q is HIGH when D is HIGH, and Q is LOW when D is LOW. Q output is shown in Figure 4

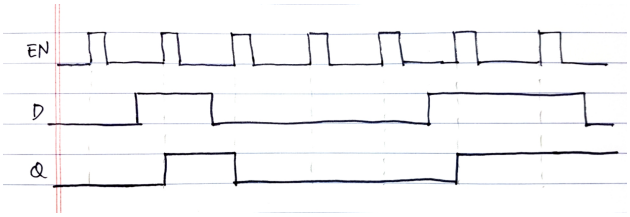

Figure 4: Output Waveform.

3. **J-K Flip-Flops.**
Two edge-triggered J-K flip-flps are shown in Figure 5. If the inputs are as shown, draw the Q output of each flip-flop relative to the clock, and explain the difference between the two. Assume that flip-flops are initially RESET.

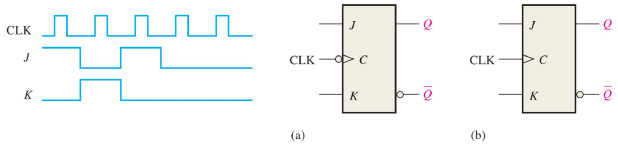

Figure 5: Input Waveform.

Solution: J-K Flip-Flops
Flip-flop in Figure 5 (a) is negative edge triggered flip-flop. So it is triggered at HIGH to LOW transition. Flip-flop in Figure 5 (b) is positive edge triggered flip-flop. So it is triggered at LOW to HIGH transition. Q output is showed in Figure 6

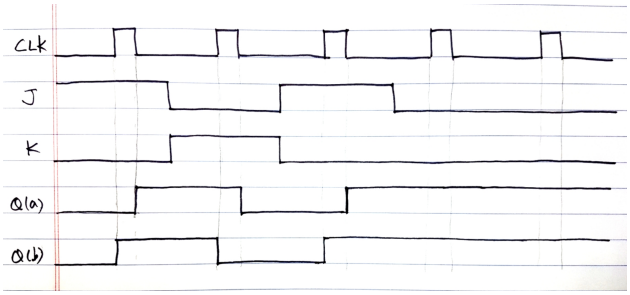

Figure 6: Output Waveform.

4. **D Flip-Flops.**
A D flip-flop is connected as shown in Figure 7. Draw the Q output in relation to

the clock when the flip-flop is initially RESET. What specific function does this device perform?

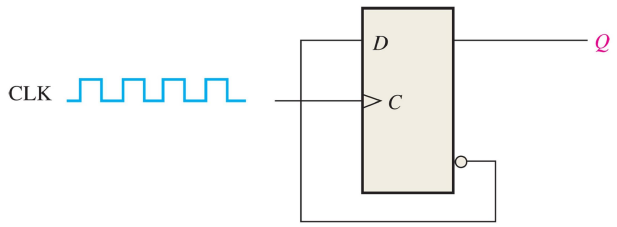

Figure 7: Input Waveform.

Solution: D Flip-Flops

Recall that D flip-flop forwards the value when CLK is transitting from LOW to HIGH. It divides the frequency, in other words, it generates another CLK with half frequency.

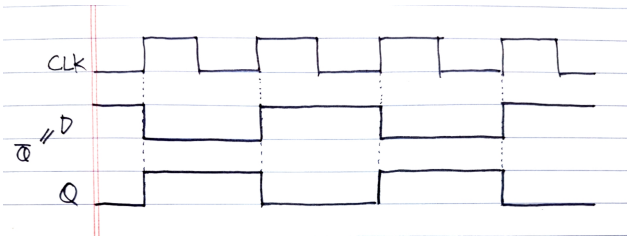

Figure 8: Output Waveform.