# CMSC 313 Spring 2024
# Homework 5

### due Monday, March 11, 11:59pm

**Please edit this file directly. Also acceptable is printing, writing on, and then scanning this document.** This assignment involves sequential circuits. Feel free to use Logisim to check your answers.

**Exercise 1.** Complete the following traces for the given input to each flip flop for the listed outputs. Draw vertical dashed lines to show where changes line up with clock edges or asynchronous inputs.

a. (3 pts) Draw the trace for the states $Q$ and $\overline{Q}$ between time $t_0$ and $t_6$. The given input is for a positive edge triggered D flip flop. $Q$ starts low.
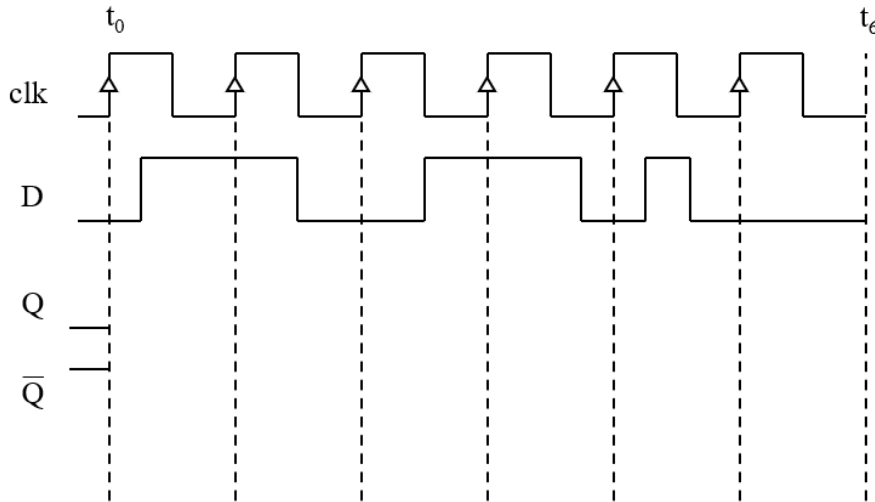


b. (5 pts) Draw the trace for the states $Q$ and $\overline{Q}$ between time $t_0$ and $t_5$. The given input is for a negative edge triggered JK flip flop. $Q$ starts low.
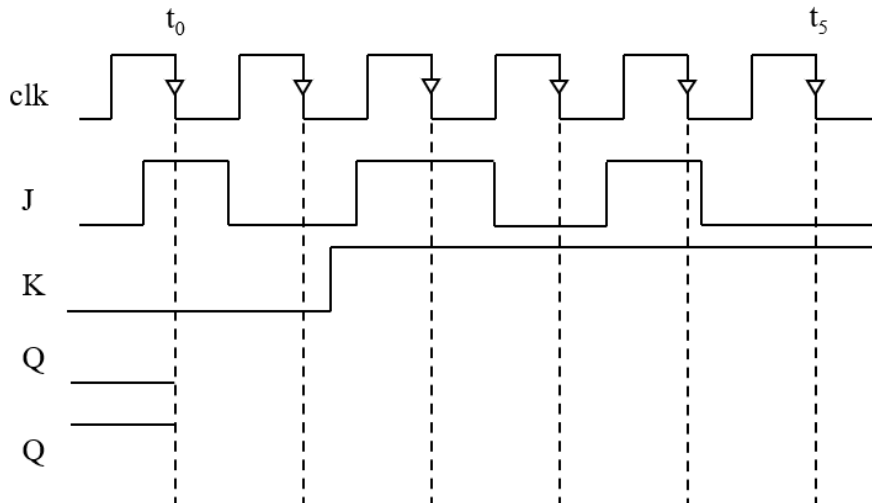
c. (7 pts) Draw the trace for the states $Q$ and $\overline{Q}$ between time $t_0$ and $t_7$. The given input is for a positive edge triggered JK flip flop with asynchronous controls PRE (preset) and CLR (clear). $Q_A$ starts high.
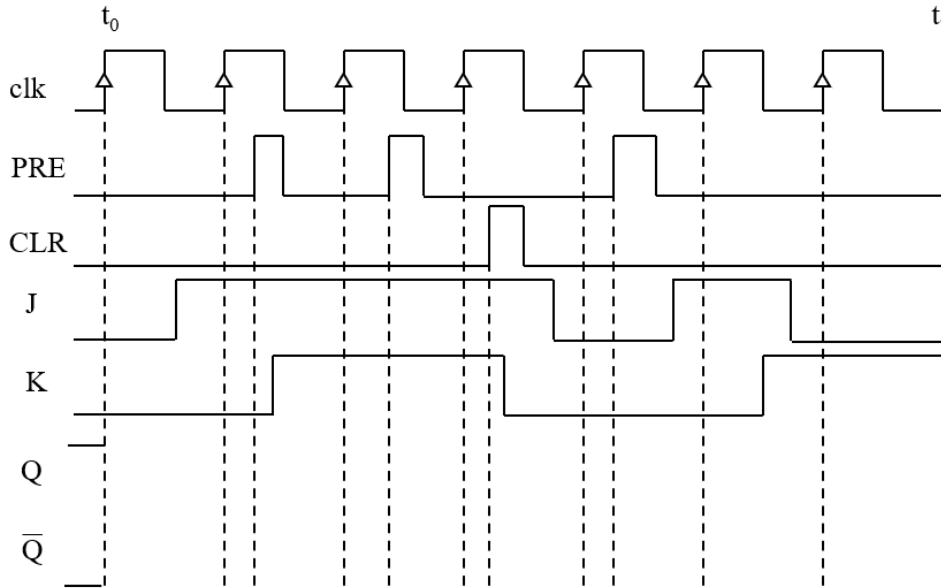


**Exercise 2.** Draw the traces of the following circuits for the given variables/values. For diagramming purposes assume that for gates not within a flip flop, delay is negligible, i.e. the output of a gate can be read immediately at the change of an input and therefore they shall share a vertical line in the trace.

a. (7 pts) Two negative edge triggered JK flip flops are connected as follows. $Q_A$ starts low, $Q_B$ starts high, and $J_B$ starts low. Draw the trace for $Q_A, J_B, Q_B, \& y$ between times $t_0$ and $t_7$.
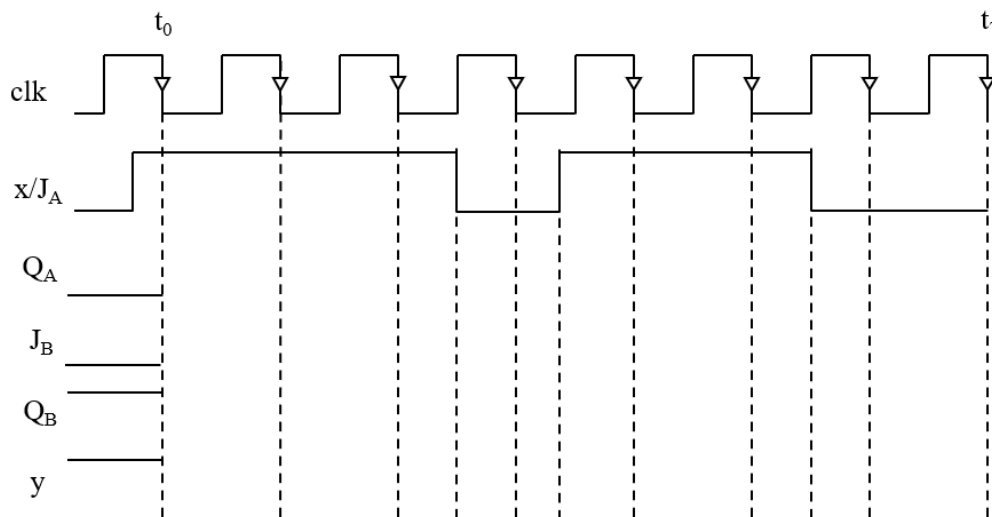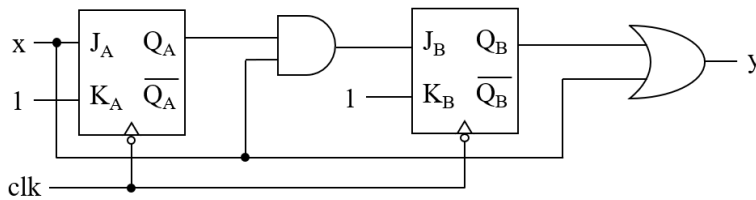
b. (8 pts) Two positive edge triggered JK flip flops are connected as follows. $Q_A$ starts high, $Q_B$ starts low. Draw the trace for $J_A/Q_B, Q_A, \& \ J_B/\overline{Q_A}$ between times $t_0$ and $t_6$.
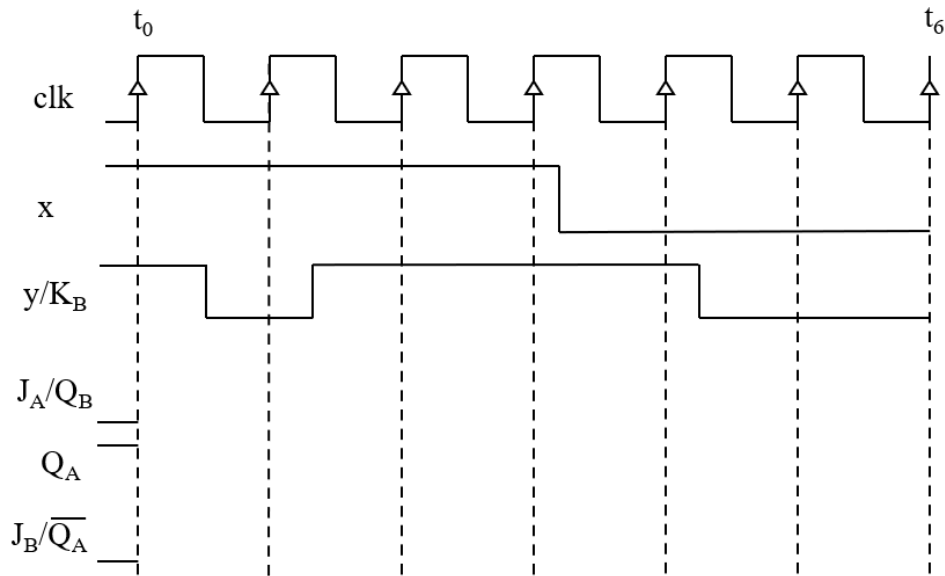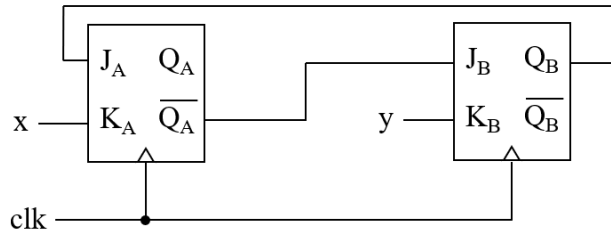


**Exercise 3.** Find the <u>state equations</u>, <u>state table</u>, and <u>state diagram</u> of 2.a. above.

a. (7 pts) State Equation. Make sure to include the output equation for $y$ as part of your state equations. Use $Q_A(t)$ notation to represent current state and $Q_A(t+1)$ to represent next state in your state equations. Please box your answers. You <u>do not need to prove</u> the characteristic equation for JK Flip Flops. You can just use the equations provided on the slides.

b. (7 pts) State table. Include x, $Q_A$ and $Q_B$ as your inputs and $Q_A+$, $Q_B+$, and y as your outputs. Your table should have 8 rows.

| x | $Q_A$ | $Q_B$ | $Q_A+$ | $Q_B+$ | y |
|---|---|---|---|---|---|
| 0 | 0 | 0 | | | |
| 0 | 0 | 1 | | | |
| 0 | 1 | 0 | | | |
| 0 | 1 | 1 | | | |
| 1 | 0 | 0 | | | |
| 1 | 0 | 1 | | | |
| 1 | 1 | 0 | | | |
| 1 | 1 | 1 | | | |

c. (6 pts) State Diagram. Please layout the states as follows to make grading easier. Please use the state key: $Q_A Q_B$, so $Q_A = 1$ and $Q_B = 0$ creates state 10.

(00)

(01)

(10)

(11)