# ELEC2141: Digital Circuit Design

## Tutorial Week 6 – Sequential Circuits Analysis

1. **(4-5)** A sequential circuit with a D flip-flop $A$, two inputs $X$ and $Y$, and one output $Z$ is specified by the following input equations
$$D_A = A\bar{Y} + XY\bar{A} + A\bar{X}, \quad Z = A$$
   a. Draw the logic diagram of the circuit
   b. Derive the state table
   c. Derive the state diagram
   d. Is this a Mealy or Moore machine

2. **(4-6)** A sequential circuit with two D flip-flops $A$ and $B$, one input $X$ and one output $Y$ is specified by the following input equations:
$$Y = \bar{A} + B, \quad D_A = X + B, \quad D_B = X\bar{A}$$
   a. Draw the logic diagram of the circuit
   b. Derive the state table
   c. Derive the state diagram
   d. Is this a Mealy or Moore machine

3. **(4-9)** Starting from state 00 in the following state diagram, determine the state transitions and output sequence that will be generated when an input sequence of 10011011110 is applied.
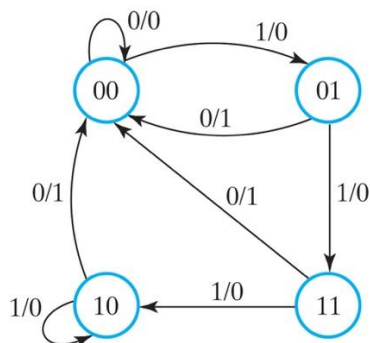


4. **(4-11)** A sequential circuit with two D flip-flops $A$ and $B$, one input $X$ and one output $Y$. The logic circuit is shown below. Derive the state table and state diagram of the circuit.



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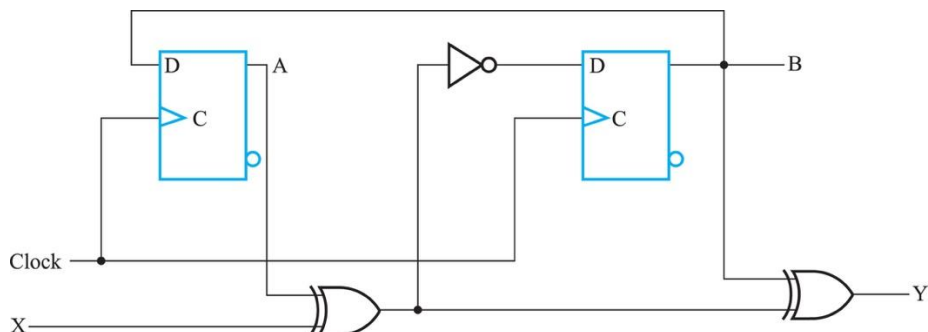
Where referenced, questions are taken from the textbook:

*M. Mano, C. R. Kime and T. Martin, Logic and Computer Design Fundamentals, 5th Edition (Global Edition), Pearson, 2016*

5. **(4-10)** Draw the state diagram of the sequential circuit specified by the state table given below

| Present state | | Inputs | | Next state | | Output |
|---|---|---|---|---|---|---|
| A | B | X | Y | A | B | Z |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| 0 | 0 | 1 | 0 | 1 | 1 | 0 |
| 0 | 0 | 1 | 1 | 1 | 1 | 1 |
| 0 | 1 | 0 | 0 | 0 | 1 | 1 |
| 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 0 | 1 | 1 | 1 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 1 | 1 | 1 |
| 1 | 0 | 0 | 1 | 0 | 1 | 1 |
| 1 | 0 | 1 | 0 | 0 | 1 | 0 |
| 1 | 0 | 1 | 1 | 1 | 0 | 0 |
| 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 1 | 1 | 1 | 0 | 1 | 0 | 1 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 |

6. Construct a state diagram for the counting sequence generated by the follow circuit.



*Clock*
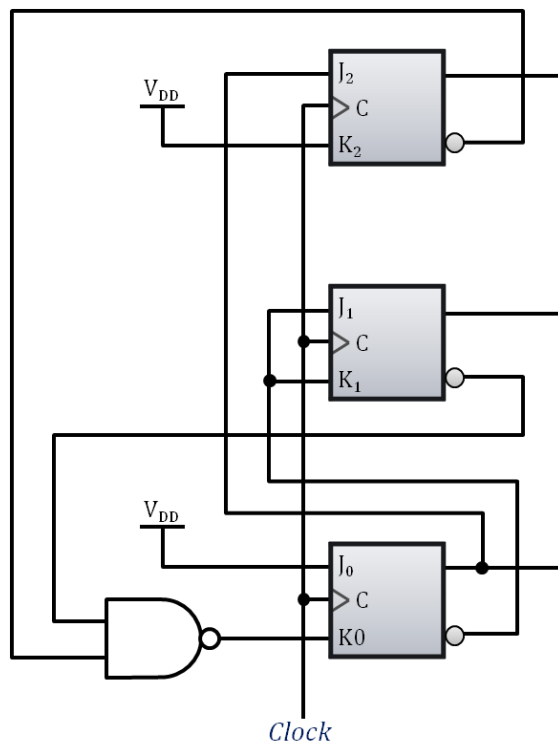
7. Draw the state diagram for the sequential circuit specified by the state table below.

| Current State $q_1q_0$ | Next State, Output | | | |
|---|---|---|---|---|
| | XY = 00 $Q_1Q_0$, Z | XY = 01 $Q_1Q_0$, Z | XY = 10 $Q_1Q_0$, Z | XY = 11 $Q_1Q_0$, Z |
| 00 | 00, 0 | 01, 0 | 10, 1 | 11, 1 |
| 01 | 01, 1 | 10, 1 | 10, 0 | 00, 0 |
| 10 | 11, 1 | 11, 0 | 11, 1 | 10, 0 |
| 11 | 00, 0 | 00, 1 | 00, 0 | 01, 0 |

8. A sequential circuit has two JK flip-flops $A$ and $B$ and one input x. The circuit is described by the following flip-flop input equations:

$$J_A = X \qquad K_A = \bar{B}$$
$$J_B = X \qquad K_B = A$$

   a. Derive the state equations $A(t + 1)$ and $B(t + 1)$ by substituting the input equations for J and K variables
   b. Draw the state diagram of the circuit
   c. Obtain the flip-flop input equations for the equivalent sequential circuit using T flip-flops