Analysis of Synchronous Sequential Circuits
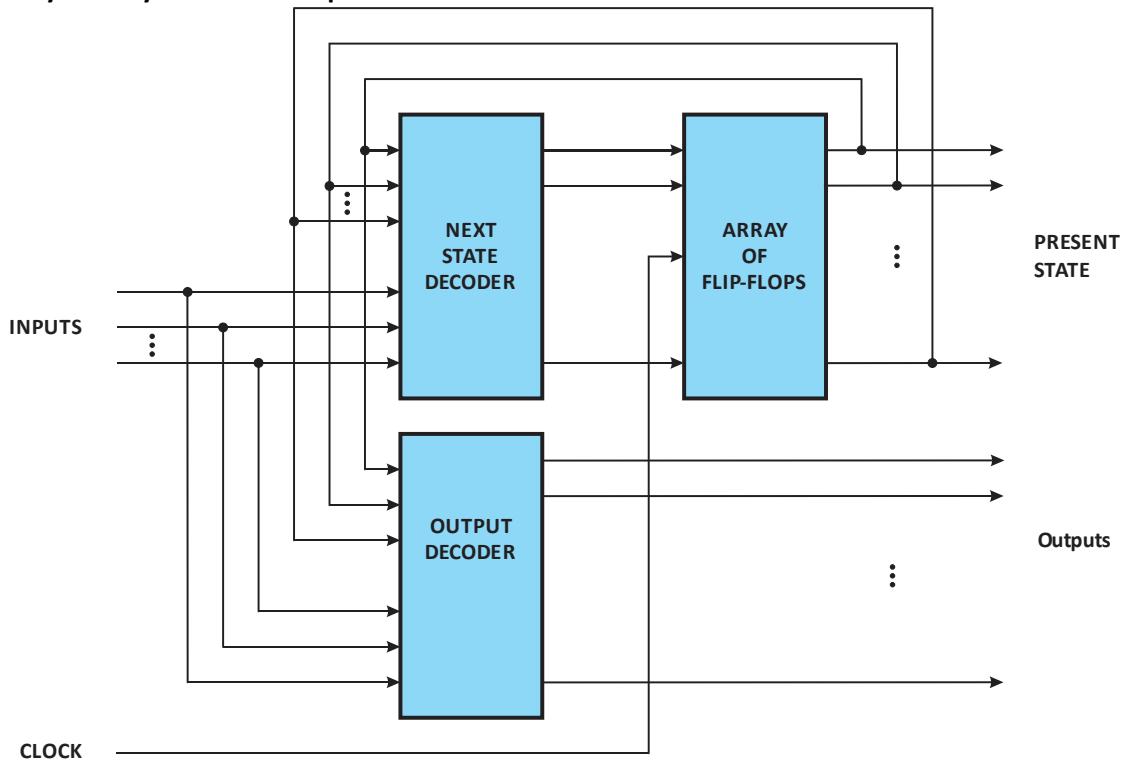

Figure 1. Components of a Synchronous Sequential Circuit

Step-by-step procedure to analyze a sequential circuit
1. **Identify the functional blocks of the circuit**
    1.1. **Identify the next state decoder**
    1.2. **Identify the array of flip-flops also called memory elements**
    1.3. **Identify the output decoder – it may or may not be present**
2. **Write the Boolean expression for each of the outputs of the next state decoder**
3. **Plot the map for each of the next state variables.**
4. **Using the entries in the maps, plot the values for the flip-flop inputs in a present/next state table.**
5. **Using the next state flip-flop inputs, determine the next state**
6. **Draw a state diagram of the circuit from the present/next state table**
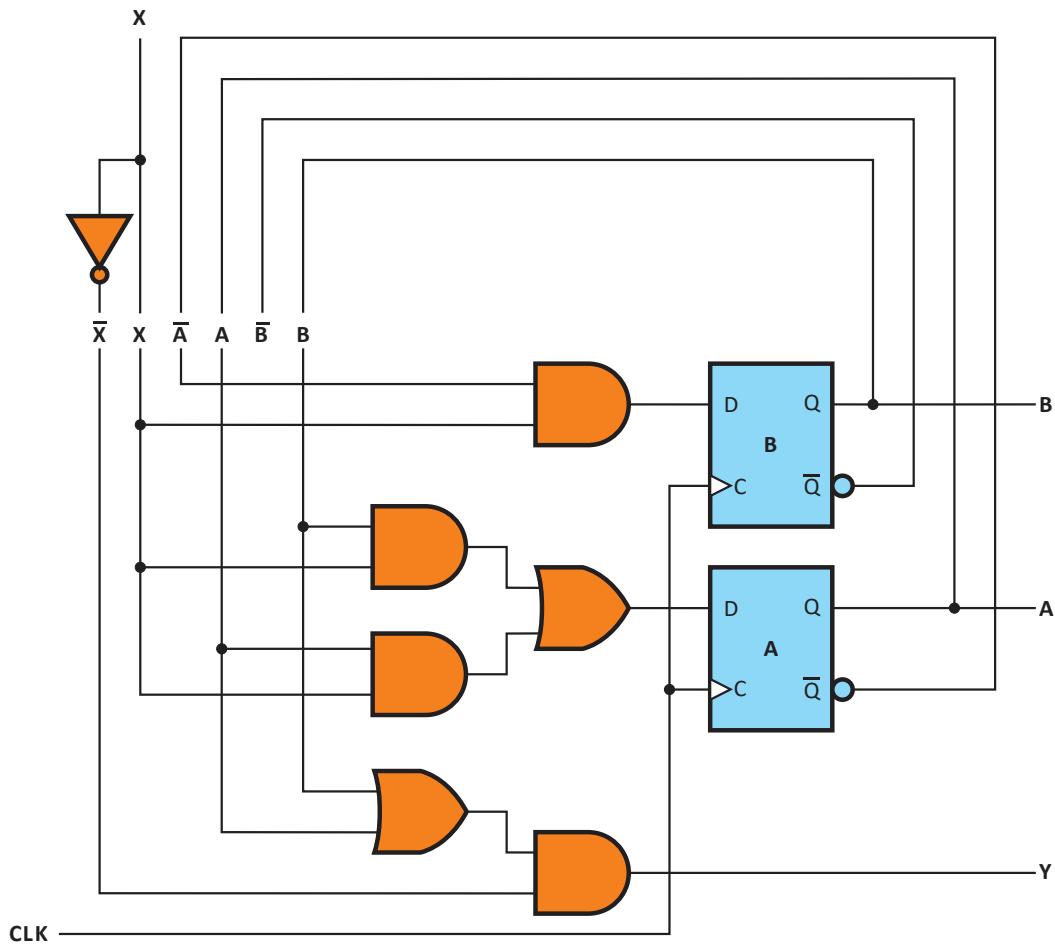
**Figure 2. Example of Sequential Circuit**
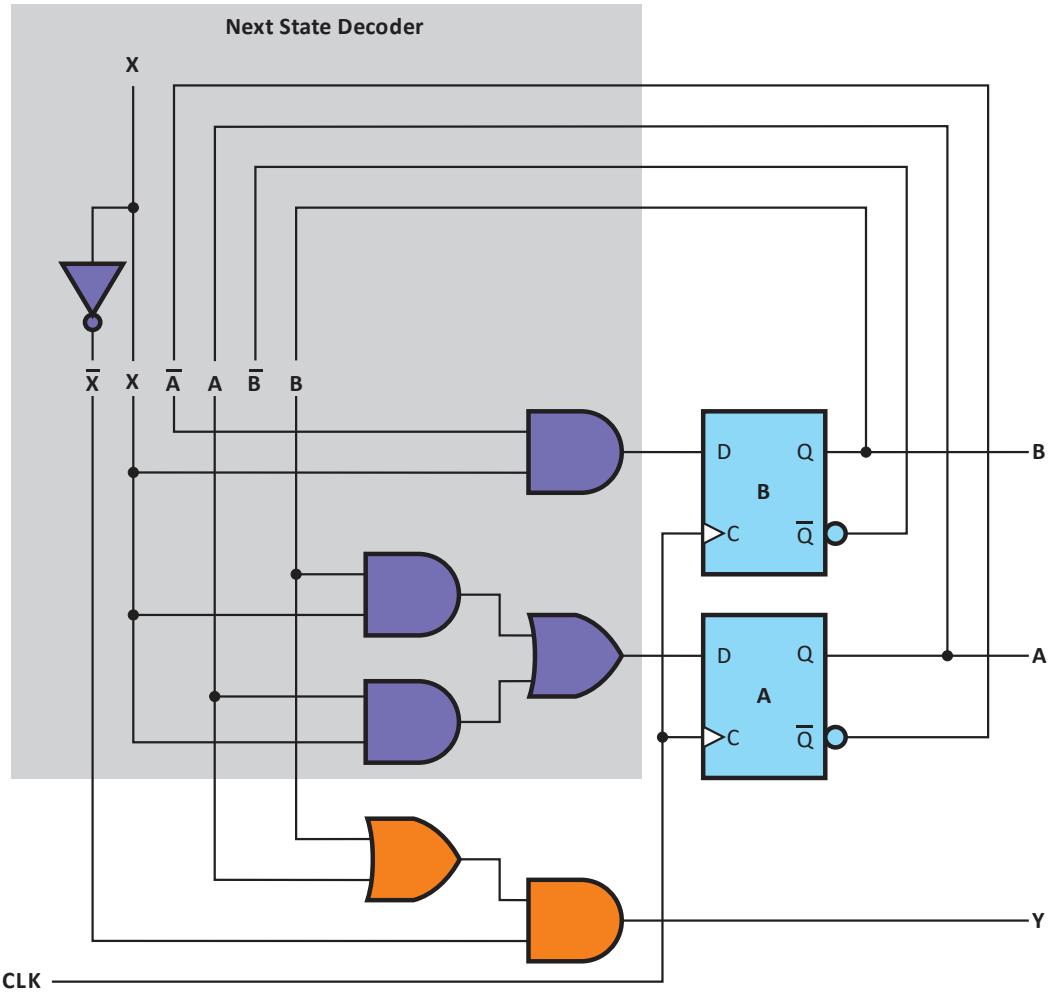
Figure 3. Step 1.1 Identify Next State Decoder
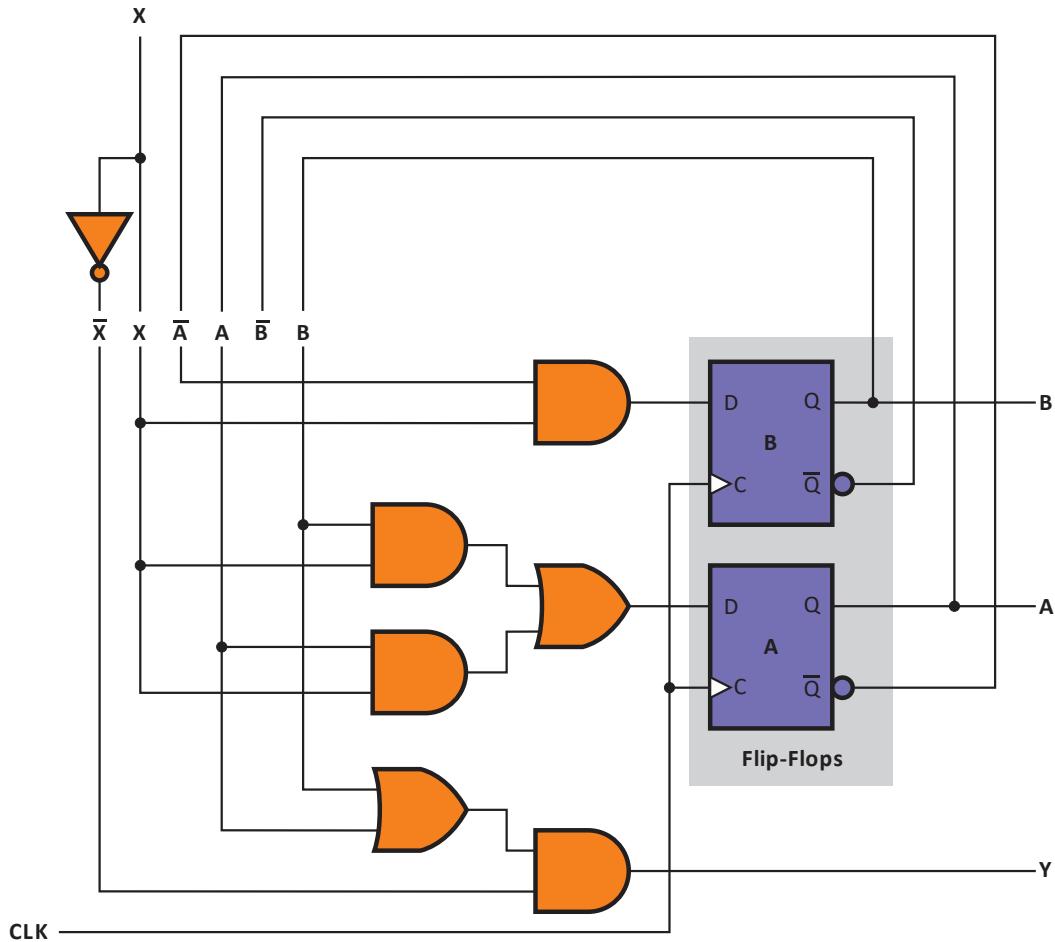
Figure 4. Step 1.2 Identify the array of flip-flops also called memory elements
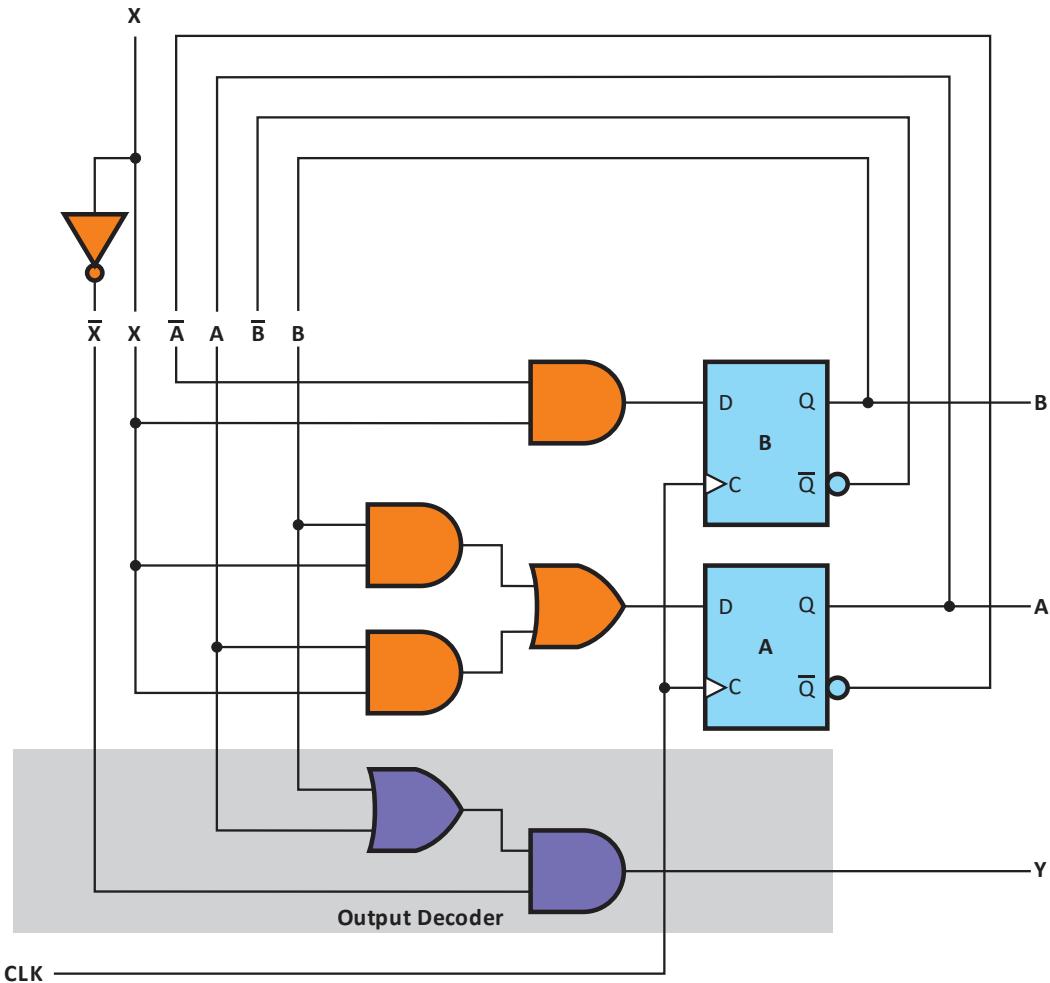
Figure 5. Step 1.3 Identify the output decoder

2. **Write the Boolean expression for each of the inputs of the next state decoder**

$$D_A = AX + BX$$
$$D_B = \overline{A}X$$
$$Y = A\overline{X} + B\overline{X}$$

3. **Plot the map for each of the next state variables.**
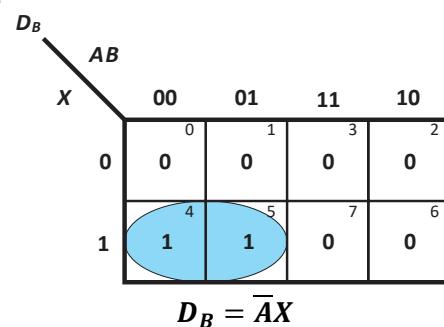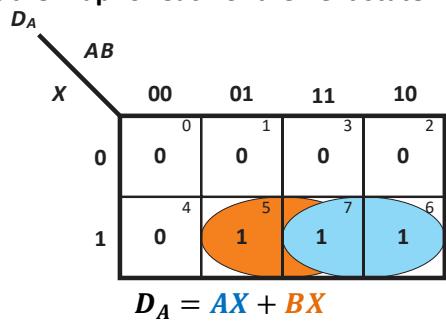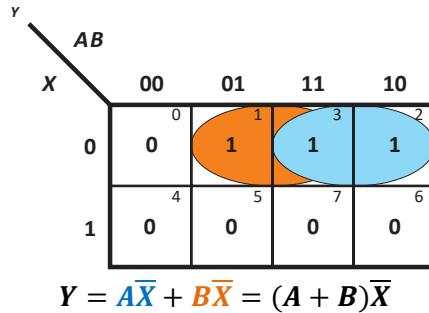
$$D_A = AX + BX$$

$$D_B = \overline{A}X$$

$$Y = A\overline{X} + B\overline{X} = (A + B)\overline{X}$$

4. Using the entries in the maps, plot the values for the flip-flop inputs in a present/next state table.

Present State		Input	Next State Decoder		Next State		Output
A	B	x	D_A	D_B	A	B	y
0	0	0	0	0			0
0	0	1	0	1			0
0	1	0	0	0			1
0	1	1	1	1			0
1	0	0	0	0			1
1	0	1	1	0			0
1	1	0	0	0			1
1	1	1	1	0			0

5. Using the next state flip-flop inputs, determine the next state

Present State		Input	Next State Decoder		Next State		Output
A	B	x	D_A	D_B	A	B	y
0	0	0	0	0	0	0	0
0	0	1	0	1	0	1	0
0	1	0	0	0	0	0	1
0	1	1	1	1	1	1	0
1	0	0	0	0	0	0	1
1	0	1	1	0	1	0	0
1	1	0	0	0	0	0	1
1	1	1	1	0	1	0	0

6. **Draw a state diagram of the circuit from the present/next state table.**

Figure 6. State Diagram