

**5.3** Show that the characteristic equation for the complement output of a  $JK$  flip-flop is

$$Q'(t + 1) = J'Q' + KQ$$

- 5.4** A  $PN$  flip-flop has four operations: clear to 0, no change, complement, and set to 1, when inputs  $P$  and  $N$  are 00, 01, 10, and 11, respectively.
- (a) Tabulate the characteristic table.
  - (b)\* Derive the characteristic equation.
  - (c) Tabulate the excitation table.
  - (d) Show how the  $PN$  flip-flop can be converted to a  $D$  flip-flop.

- 5.6** A sequential circuit with two  $D$  flip-flops  $A$  and  $B$ , two inputs,  $x$  and  $y$ ; and one output  $z$  is specified by the following next-state and output equations (HDL—see Problem 5.35):

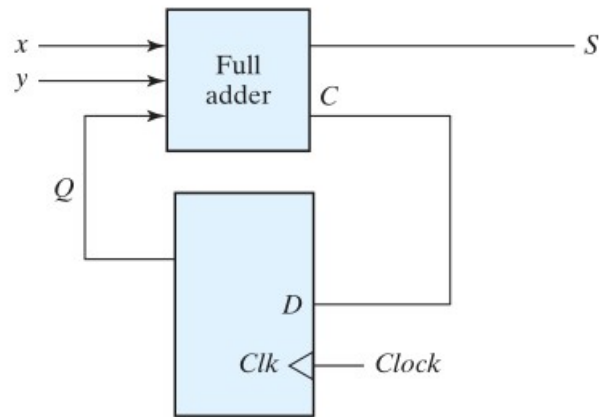
$$A(t + 1) = xy' + xB$$

$$B(t + 1) = xA + xB'$$

$$z = A$$

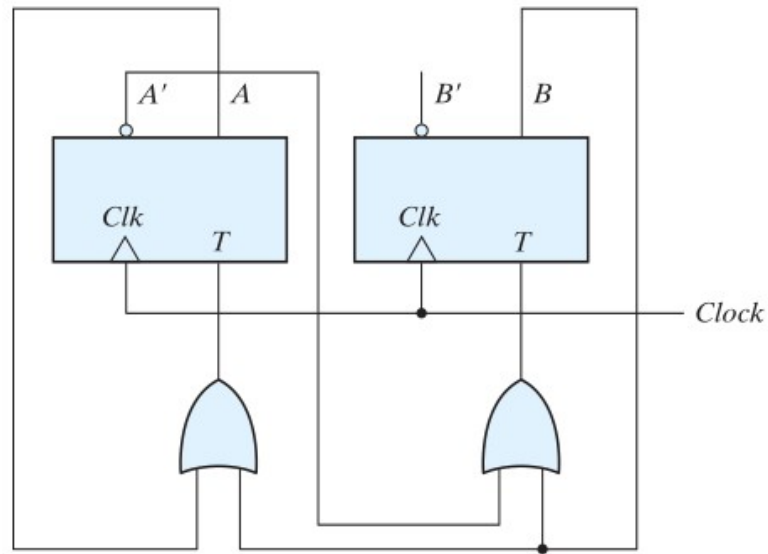
- (a) Draw the logic diagram of the circuit.
- (b) List the state table for the sequential circuit.
- (c) Draw the corresponding state diagram.

- 5.7\*** A sequential circuit has one flip-flop  $Q$ , two inputs  $x$  and  $y$ , and one output  $S$ . It consists of a full-adder circuit connected to a  $D$  flip-flop, as shown in Fig. P5.7. Derive the state table and state diagram of the sequential circuit.



**FIGURE P5.7**

- 5.8\*** Derive the state table and the state diagram of the sequential circuit shown in Fig. P5.8. Explain the function that the circuit performs. (HDL—see Problem 5.36.)



**FIGURE P5.8**

- 5.9** 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:

$$J_A = x \quad K_A = B$$

$$J_B = x \quad K_B = A'$$

- (a) Derive the state equations  $A(t + 1)$  and  $B(t + 1)$  by substituting the input equations for the  $J$  and  $K$  variables.
- (b) Draw the state diagram of the circuit.

- 5.10** A sequential circuit has two *JK* flip-flops *A* and *B*, two inputs *x* and *y*, and one output *z*. The flip-flop input equations and circuit output equation are

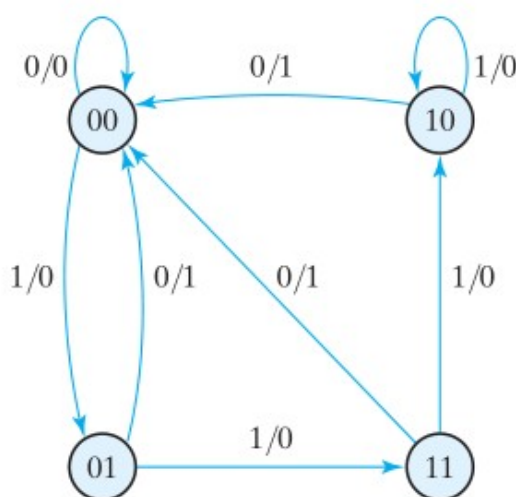
$$\begin{aligned}J_A &= Bx + B'y' & K_A &= B'xy' \\J_B &= A'x & K_B &= A + xy' \\z &= Ax'y' + Bx'y'\end{aligned}$$

- (a) Draw the logic diagram of the circuit.
- (b) Tabulate the state table.
- (c) Derive the state equations for *A* and *B*.

- 5.11** For the circuit described by the state diagram of Fig. 5.16,
- \* Determine the state transitions and output sequence that will be generated when an input sequence of 010110111011110 is applied to the circuit and it is initially in the state 00.
  - Find all of the equivalent states in Fig. 5.16 and draw a simpler, but equivalent, state diagram.
  - Using *D* flip-flops, design the equivalent machine (including its logic diagram) described by the state diagram in (b).

**Table 5.3**  
*Second Form of the State Table*

Present State		Next State				Output	
		$x = 0$		$x = 1$		$x = 0$	$x = 1$
<i>A</i>	<i>B</i>	<i>A</i>	<i>B</i>	<i>A</i>	<i>B</i>	<i>y</i>	<i>y</i>
0	0	0	0	0	1	0	0
0	1	0	0	1	1	1	0
1	0	0	0	1	0	1	0
1	1	0	0	1	0	1	0



**FIGURE 5.16**  
State diagram of the circuit of Fig. 5.15