

- 1-1. Determine by means of a truth table the validity of DeMorgan's theorem for three variables: $(ABC)' = A' + B' + C'$.
- 1-2. List the truth table of a three-variable exclusive-OR (odd) function: $x = A \oplus B \oplus C$.
- 1-3. Simplify the following expressions using Boolean algebra.
- $A + AB$
 - $AB + AB'$
 - $A'BC + AC$
 - $A'B + ABC' + ABC$
- 1-4. Simplify the following expressions using Boolean algebra.
- $AB + A(CD + CD')$
 - $(BC' + A'D)(AB' + CD')$
- 1-5. Using DeMorgan's theorem, show that:
- $(A + B)'(A' + B')' = 0$
 - $A + A'B + A'B' = 1$
- ✓ 1-6. Given the Boolean expression $F = x'y + xyz'$:
- Derive an algebraic expression for the complement F' .
 - Show that $F \cdot F' = 0$.
 - Show that $F + F' = 1$.
- 1-7. Given the Boolean function

$$F = xy'z + x'y'z + xyz$$

- List the truth table of the function.
 - Draw the logic diagram using the original Boolean expression.
 - Simplify the algebraic expression using Boolean algebra.
 - List the truth table of the function from the simplified expression and show that it is the same as the truth table in part (a).
 - Draw the logic diagram from the simplified expression and compare the total number of gates with the diagram of part (b).
- 1-8. Simplify the following Boolean functions using three-variable maps.
- $F(x, y, z) = \sum (0, 1, 5, 7)$
 - $F(x, y, z) = \sum (1, 2, 3, 6, 7)$
 - $F(x, y, z) = \sum (3, 5, 6, 7)$
 - $F(A, B, C) = \sum (0, 2, 3, 4, 6)$
- 1-9. Simplify the following Boolean functions using four-variable maps.
- $F(A, B, C, D) = \sum (4, 6, 7, 15)$
 - $F(A, B, C, D) = \sum (3, 7, 11, 13, 14, 15)$
 - $F(A, B, C, D) = \sum (0, 1, 2, 4, 5, 7, 11, 15)$
 - $F(A, B, C, D) = \sum (0, 2, 4, 5, 6, 7, 8, 10, 13, 15)$

- 1-10. Simplify the following expressions in (1) sum-of-products form and (2) product-of-sums form.

a. $x'z' + y'z' + yz' + xy$

b. $AC' + B'D + A'CD + ABCD$

- 1-11. Simplify the following Boolean function in sum-of-products form by means of a four-variable map. Draw the logic diagram with (a) AND-OR gates; (b) NAND gates.

$$F(A, B, C, D) = \sum (0, 2, 8, 9, 10, 11, 14, 15)$$

- 1-12. Simplify the following Boolean function in product-of-sums form by means of a four-variable map. Draw the logic diagram with (a) OR-AND gates; (b) NOR gates.

$$F(w, x, y, z) = \sum (2, 3, 4, 5, 6, 7, 11, 14, 15)$$

- 1-13. Simplify the Boolean function F together with the don't-care conditions d in (1) sum-of-products form and (2) product-of-sums form.

$$F(w, x, y, z) = \sum (0, 1, 2, 3, 7, 8, 10)$$

$$d(w, x, y, z) = \sum (5, 6, 11, 15)$$

- 1-14. Using Table 1-2, derive the Boolean expression for the S (sum) output of the full-adder in sum-of-products form. Then by algebraic manipulation show that S can be expressed as the exclusive-OR of the three input variables.

$$S = x \oplus y \oplus z$$

- 1-15. A majority function is generated in a combinational circuit when the output is equal to 1 if the input variables have more 1's than 0's. The output is 0 otherwise. Design a three-input majority function.

- ✓ 1-16. Design a combinational circuit with three inputs x, y, z and three outputs A, B, C . When the binary input is 0, 1, 2, or 3, the binary output is one greater than the input. When the binary input is 4, 5, 6, or 7, the binary output is one less than the input.

- ✓ 1-17. Show that a JK flip-flop can be converted to a D flip-flop with an inverter between the J and K inputs.

- 1-18. Using the information from the characteristic table of the JK flip-flop listed in Fig. 1-21(b), derive the excitation table for the JK flip-flop and compare your answer with Table 1-3.

- 1-19. A sequential circuit has two D flip-flops A and B , two inputs x and y , and one output z . The flip-flop input equations and the circuit output are as follows:

$$D_A = x'y + xA$$

$$D_B = x'B + xA$$

$$z = B$$

- a. Draw the logic diagram of the circuit.
b. Tabulate the state table.
- ✓ 1-20. Design a 2-bit count-down counter. This is a sequential circuit with two flip-flops and one input x . When $x = 0$, the state of the flip-flops does not change. When $x = 1$, the state sequence is 11, 10, 01, 00, 11, and repeat.
- 1-21. Design a sequential circuit with two JK flip-flops A and B and two inputs E and x . If $E = 0$, the circuit remains in the same state regardless of the value of x . When $E = 1$ and $x = 1$, the circuit goes through the state transitions from 00 to 01 to 10 to 11 back to 00, and repeat. When $E = 1$ and $x = 0$, the circuit goes through the state transitions from 00 to 11 to 10 to 01 back to 00, and repeat.