3e4.5 4.201 According to DeMorgan's theorem, the complement of $X + Y \cdot Z$ is $X' \cdot Y' + Z'$. Yet both functions are 1 for $XYZ = 110$. How can both a function and its complement be 1 for the same input combination? What's wrong here?

3e4.6

4.202 Use the theorems of switching algebra to simplify each of the following logic functions:

(a) $F = W \cdot X \cdot Y \cdot Z \cdot (W \cdot X \cdot Y \cdot Z' + W \cdot X' \cdot Y \cdot Z + W' \cdot X \cdot Y \cdot Z + W \cdot X \cdot Y' \cdot Z)$

(b) $F = A \cdot B + A \cdot B \cdot C' \cdot D + A \cdot B \cdot D \cdot E' + A \cdot B \cdot C' \cdot E + C' \cdot D \cdot E$

(c) $F = M \cdot N \cdot O + Q' \cdot P' \cdot N' + P \cdot R \cdot M + Q' \cdot O \cdot M \cdot P' + M \cdot R$

3e4.7 4.203 Write the truth table for each of the following logic functions:

(a) $F = X' \cdot Y + X' \cdot Y' \cdot Z$

(b) $F = W' \cdot X + Y' \cdot Z' + X' \cdot Z$

(c) $F = W + X' \cdot (Y' + Z)$

(d) $F = A \cdot B + B' \cdot C + C' \cdot D + D' \cdot A$

(e) $F = V \cdot W + X' \cdot Y' \cdot Z$

(f) $F = (A' + B' + C \cdot D) \cdot (B + C' + D' \cdot E')$

(g) $F = (W \cdot X)' \cdot (Y' + Z')'$

(h) $F = (((A + B)' + C')' + D)'$

(i) $F = (A' + B + C) \cdot (A + B' + D') \cdot (B + C' + D') \cdot (A + B + C + D)$

3e4.9 4.204 Write the canonical sum and product for each of the following logic functions:

(a) $F = \Sigma_{X,Y}(1,2)$ (b) $F = \prod_{A,B}(0,1,2)$

(c) $F = \Sigma_{A,B,C}(2,4,6,7)$ (d) $F = \prod_{W,X,Y}(0,1,3,4,5)$

(e) $F = X + Y' \cdot Z'$ (f) $F = V' + (W' \cdot X)'$

3e4.13 4.205 Using Karnaugh maps, find a minimal sum-of-products expression for each of the following logic functions. Indicate the distinguished 1-cells in each map.

(a) $F = \Sigma_{X,Y,Z}(1,3,5,6,7)$

(b) $F = \Sigma_{W,X,Y,Z}(1,4,5,6,7,9,14,15)$

(c) $F = \prod_{W,X,Y}(0,1,3,4,5)$

(d) $F = \Sigma_{W,X,Y,Z}(0,2,5,7,8,10,13,15)$

(e) $F = \prod_{A,B,C,D}(1,7,9,13,15)$

(f) $F = \Sigma_{A,B,C,D}(1,4,5,7,12,14,15)$

3e4.22 4.206 For each of the following logic expressions, find all of the static hazards in the corresponding two-level AND-OR or OR-AND circuit, and design a hazard-free circuit that realizes the same logic function.

(a) $F = W \cdot X + W' \cdot Y'$

(b) $F = W \cdot X' \cdot Y' + X \cdot Y' \cdot Z + X \cdot Y$

(c) $F = W' \cdot Y + X' \cdot Y' + W \cdot X \cdot Z$

(d) $F = W' \cdot X + Y' \cdot Z + W \cdot X \cdot Y \cdot Z + W \cdot X' \cdot Y \cdot Z'$

(e) $F = (W + X + Y) \cdot (X' + Z')$

(f) $F = (W + Y' + Z') \cdot (W' + X' + Z') \cdot (X' + Y + Z)$

(g) $F = (W + Y + Z') \cdot (W + X' + Y + Z) \cdot (X' + Y') \cdot (X + Z)$

3e4.33 4.207 Show that an n-input AND gate can be replaced by $(n-1)$ 2-input AND gates. Can the same statement be made for NAND gates? Justify your answer.

3e4.44 4.208 From the point of view of switching algebra, what is the function of a 2-input XOR gate whose inputs are tied together? How might the output behavior of a real XOR gate differ?

3e4.45 4.209 After completing the design and fabrication of an SSI-based digital system, a designer finds that one more inverter is required. However, the only spare gates in the system are a 3-input OR, a 2-input AND, and a 2-input XOR. How should the designer realize the inverter function without adding another IC?

3e4.47 4.210 Do 2-input NOR gates form a complete set of logic gates? Prove your answer.

3e4.48 4.211 Do 2-input XOR gates form a complete set of logic gates? Prove your answer.

3e4.49 4.212 Define a two-input gate, other than NAND, NOR, or XOR, that forms a complete set of logic gates if the constant inputs 0 and 1 are allowed. Prove your answer.

3e4.53 4.213 How many different logic functions are there of n variables?

3e4.54 4.214 How many different 2-variable logic functions F(X,Y) are there? Write a simplified algebraic expression for each of them.

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4.215 A *self-dual logic function* is a function F such that $F = F^D$. Which of the following functions are self-dual? (The symbol $\oplus$ denotes the Exclusive OR (XOR) operation.)

(a) $F = X$

(b) $F = \Sigma_{X,Y,Z}(0,3,5,6)$

(c) $F = X \cdot Y' + X' \cdot Y$

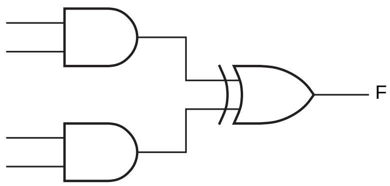
(d) $F = W \cdot (X \oplus Y \oplus Z) + W' \cdot (X \oplus Y \oplus Z)'$

(e) A function F of 7 variables such that F = 1 if and only if 4 or more of the variables are 1

(f) A function F of 10 variables such that F = 1 if and only if 5 or more of the variables are 1

3e4.65 4.216 Draw a Karnaugh map and assign variables to the inputs of the AND-XOR circuit in Figure X4.216 so that its output is $F = \Sigma_{W,X,Y,Z}(6,7,12,13)$. Note that the output gate is a 2-input XOR rather than an OR.

Figure X4.216



3e4.66 4.217 A 3-bit "comparator" circuit receives two 3-bit numbers, $P = P_2P_1P_0$ and $Q = Q_2Q_1Q_0$. Design a minimal sum-of-products circuit that produces a 1 output if and only if $P > Q$.

3e4.68 4.218 Prove whether or not the following expression is a minimal sum. Do it the easiest way possible (algebraically, not using maps).

$$F = T' \cdot U \cdot V \cdot W \cdot X + T' \cdot U \cdot V' \cdot X \cdot Z + T' \cdot U \cdot W \cdot X \cdot Y' \cdot Z$$

3e4.69 4.219 The text states that a truth table or equivalent is the starting point for traditional combinational minimization methods. A Karnaugh map itself contains the same information as a truth table. Given a sum-of-products expression, it is possible to write the 1s corresponding to each product term directly on the map without developing an explicit truth table or minterm list, and then proceed with the map-minimization procedure. In this way, find a minimal sum-of-products expression for each of the following logic functions:

(a) $F = X' \cdot Z + X \cdot Y + X \cdot Y' \cdot Z$
(b) $F = A' \cdot C' \cdot D + B' \cdot C \cdot D + A \cdot C' \cdot D + B \cdot C \cdot D$
(c) $F = W \cdot X \cdot Z' + W \cdot X' \cdot Y \cdot Z + X \cdot Z$
(d) $F = (X' + Y') \cdot (W' + X' + Y) \cdot (W' + X + Z)$
(e) $F = A \cdot B \cdot C' \cdot D' + A' \cdot B \cdot C' + A \cdot B \cdot D + A' \cdot C \cdot D + B \cdot C \cdot D'$