HW #2

CSEE W3827 - Fundamentals of Computer Systems Spring 2022

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Prof. Rubenstein
Due 2/11/22, 5pm

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Note that this homework has 8 problems and is 2 pages long.

1. Simplify the following Boolean expressions to a minimum number of literals:

   (a) $\bar{B}C + \bar{B}\bar{C}D$

   (b) $\overline{(\bar{Y} + Z)}(Y + \bar{Z})$

   (c) $\bar{C}\bar{D}A + C\bar{D}A + DA$

   (d) $X(\bar{C}Y + \bar{C}\bar{Y}) + X(\bar{W}\bar{C} + \bar{W}C)$

   (e) $(\bar{B}\bar{C} + BD + \bar{C}D)(\bar{B} + C + \bar{B}C)$

2. Reduce the following Boolean expressions to the indicated number of literals:

   (a) $Y + \bar{Z}(W + \overline{Y + W})$ to two literals

   (b) $\bar{Y}X + Y\bar{X}Z + \bar{Y}\bar{X}$ to three literals

   (c) $\bar{Y}X(\bar{W} + ZW) + X(Y + \bar{Y}\bar{Z}W)$ to one literal

3. Using DeMorgan's theorem (as many times as necessary), express the function $F = \bar{X}Z + X\bar{Z}Y + \bar{X}\bar{Y}$ with only

   (a) OR and complement operations

   (b) AND and complement operations

4. Find the complement of the following expressions:

   (a) $\bar{B}\bar{D} + BD$

   (b) $(C + \bar{B}D)(C + \bar{B} + \bar{D})(\bar{C}\bar{B} + \bar{D})$

   (c) $\bar{W}\bar{Y}(Z\bar{X} + \bar{Z}X) + WY(Z + X)(\bar{Z} + \bar{X})$

   (d) $(\bar{B} + \bar{D})AC + E$

5. Convert the following into sum-of-products and product-of-sums forms:

   (a) $(\bar{A} + B\bar{D})(\bar{D} + A\bar{C})$

   (b) $(\bar{Z} + Y)\bar{X}(\bar{X} + Z) + X$.

   (c) $(\bar{Z} + XW + \bar{W}Y)(\bar{X} + \bar{Z}\bar{Y})$

6. Simplify the following boolean expressions using a K-map:

   (a) $B\bar{C} + CD + B\bar{D} + \bar{B}\bar{C}D$

   (b) $\bar{Y}\bar{Z} + \bar{X}\bar{Z} + ZX\bar{Y}$

   (c) $XW + \bar{X}\bar{Z} + X\bar{Z}\bar{W}$

7. Simplify in Sum-of-product form via a K-map (indicate what you identify as prime implicants and essential prime implicants). Recall that $m(i)$ is the product term whose variables are complemented when and only when their position corresponds to a '0' in the binary representation of i, e.g., $m(5) = \bar{W}X\bar{Y}Z$.

   (a) $F(W, X, Y, Z) = \sum m(0, 4, 5, 7, 9, 12, 13, 14)$

(b) $F(A, B, C, D) = \sum m(0, 1, 2, 4, 5, 8, 9, 10, 11, 13, 15)$

(c) $F(A, B, C, D) = \sum m(0, 2, 3, 5, 7, 8, 10, 11, 14, 15)$

(d) $F(W, X, Y, Z) = \sum m(0, 1, 2, 5, 6, 7, 8, 9, 10, 13, 14, 15)$

(e) $F(W, X, Y, Z) = \sum m(0, 1, 2, 5, 8, 9, 11, 12)$

(f) $F(A, B, C, D) = \sum m(1, 3, 6, 7, 9, 13, 14, 15)$

8. Simplify into Sum-of-product form the following Boolean functions F together with the don't-care conditions d:

(a) $F(W, X, Y, Z) = \sum m(0, 1, 3, 5, 7), d(W, X, Y, Z) = \sum m(2, 4, 6)$

(b) $F(A, B, C, D) = \sum m(2, 6, 7, 11, 14, 15), d(A, B, C, D) = \sum m(0, 8, 12, 13)$

(c) $F(A, B, C, D) = \sum m(2, 7, 9, 10, 15), d(A, B, C, D) = \sum m(3, 6, 14)$