ECE 255

Introduction to Digital Logic Design





Minterms and Products

- Recall: AND is a function of variables the result of which is TRUE (logic 1) only when *all* input variables are TRUE (logic 1)
- A <u>minterm</u> is an AND (a.k.a. "product") in which <u>each variable appears once</u> in the term, in either complemented or uncomplemented form
- For a function of *n* variables, how many minterms? 2^n
- Let's write all possible minterms for two variables *A*, *B*



Minterms and Products – Truth Tables

• Minterms are AND expressions in a function that yield logic 1 (or TRUE) in the output of that function

• Possible minterms are based on any combination of variables $(2^n \text{ possible minterms for } n \text{ variable function})$

(2ⁿ possible minterms for n variable function)
$$\angle$$
 Canonical SOP

 $A \ B \ f \ f(A,B) = A \cdot B + A \cdot B$
 $A \cdot B = 1 \ A = 0$

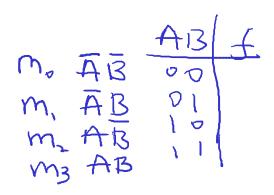
Sum of Products Expressions

- A *sum of products (SOP)* expression for a function *f* is an OR of ANDs
 - AND for "products", OR for "sums"
 - Each AND/product not necessarily a minterm
- A *canonical sum of products (CSOP)* expression is an *OR of minterms* and is unique for a given function
- The $\sum m_i$ notation is convenient, concise notation ($0 \le i \le 2^n 1$ for n variables)

$$f = \overline{AB} + \overline{AB} \leftarrow CSOP$$

$$f = \sum (m_0 + m_2) \leftarrow$$

$$-\sum (0, 2)$$





Maxterms and Sums

- Recall: OR is a function of variables the result of which is TRUE (logic 1) when *any* input variables are TRUE (logic 1)
- A <u>Maxterm</u> is an OR (a.k.a. "sum") in which <u>each variable appears once</u> in the term, in either complemented or uncomplemented form
- A Maxterm M is 0 for exactly one combination of variables and 1 for all others
- For a function of *n* variables, how many Maxterms? 2^n
- Let's write all possible *Maxterms* for two variables *A*, *B*

$$(\overline{A}+B)(A+B)(\overline{A}+B) \leftarrow CPOS \vee A(A+B) \leftarrow CPOS \times$$



Product of Sums Expressions

- A product of sums (POS) expression for a function f is an AND of ORs
 - AND for "products", OR for "sums"
 - Each OR/sum not necessarily a Maxterm

$$\overline{AB} = \overline{A} + \overline{B} = \overline{A+B}$$

- A *canonical product of sums (CPOS)* expression is an *AND of Maxterms* and is unique for a given function
- The $\prod M_i$ notation is convenient, concise notation $(0 \le i \le 2^n 1 \text{ for } n)$

minterm:
$$\overline{AB} = 1$$
 iff $A = 0 & B = 0$
Maxterm: $A + B = 0$ iff $A = 0 & B = 0$
 $A + B = 0$ iff $A = 0 & B = 1$

CPOS and CSOP Same Function, Different Representations

- Let $f() = \sum m_i = \prod M_j$ be the CSOP and CPOS for function f, respectively
- Here i is the index for a minterm m_i of f if and only if i is not the index of a Maxterm M_i of f

CPOS:
$$f = (A+B)(\overline{A}+B)$$

 $= A\overline{A}+AB+\overline{AB}+\overline{BB}B$
 $= \overline{B}(A+\overline{A}+1)$
 $= \overline{B}$

