Digital Logic Design Exercise

Standard Forms of Boolean Expressions

1. Convert each of the following expressions to SOP form:

   i. $(A + B)(C + \bar{B})$
   ii. $(A + \bar{B}C)C$
   iii. $(A + C)(AB + AC)$

2. Define the domain of each SOP expression and convert the expression to standard SOP form.
3. Determine the binary value of each term in the standard SOP expression.
4. Convert each standard SOP expression to standard POS form.

The Karnaugh Map

5. Draw a 3 variable Karnaugh Map and label each cell according to its binary value.

Karnaugh Map SOP Simplification

6. Use a Karnaugh Map to simplify each of the following expressions:

   i. $\bar{A}\bar{B}\bar{C} + A\bar{B}C + \bar{A}BC + AB\bar{C}$
   ii. $AC[\bar{B} + B(B+\bar{C})]$
   iii. $DE\bar{F} + \bar{D}E\bar{F} + \bar{D}\bar{E}\bar{F}$

7. Expand each of the following expressions to a standard SOP form and then minimise each one with a Karnaugh Map:

   i. $AB + A\bar{B}C + ABC$
   ii. $A + BC$
   iii. $A\bar{B}\bar{C}D + AC\bar{D} + B\bar{C}D + \bar{A}BC\bar{D}$
   iv. $A\bar{B} + A\bar{B}\bar{C}D + CD + B\bar{C}D + ABCD$

Digital Logic Design Exercise

Answers

1. Answer
   - *i.* $A\bar{B} + AC + BC$
   - *ii.* $AC + \bar{B}C$
   - *iii.* $AB + AC$

2. Answer
   - i. Domain = A,B,C. SOP = $A\bar{B}C + A\bar{B}\bar{C} + ABC + \bar{A}BC$
   - ii. Domain = A,B,C. SOP = $ABC + A\bar{B}C + \bar{A}\bar{B}C$
   - *iii.* Domain = A,B,C. SOP = $ABC + AB\bar{C} + A\bar{B}C$

3. Answer
   - *i.* $101 + 100 + 111 + 011$
   - *ii.* $111 + 101 + 001$
   - *iii.* $111 + 110 + 101$

4. Answer
   - *i.* $(A + B + C)(A + B + \bar{C})(\bar{A} + \bar{B} + C)(\bar{A} + \bar{B} + C)$
   - *ii.* $(A + B + C)(A + \bar{B} + C)(A + \bar{B} + \bar{C})(\bar{A} + B + C)(\bar{A} + \bar{B} + C)$
   - *iii.* $(A + B + C)(A + B + \bar{C})(A + \bar{B} + C)(A + \bar{B} + \bar{C})(\bar{A} + B + C)$

5. The Karnaugh Map with binary values

C / AB	0	1
00	**000**	**001**
01	**010**	**011**
11	**110**	**111**
10	**100**	**101**

6. Answer
   - i. No simplification
   - *ii.* AC
   - *iii.* $\bar{D}\bar{F} + E\bar{F}$

7. Answer
   - *i.* $AB + AC$
   - *ii.* $A + BC$
   - *iii.* $B\bar{C}D + A\bar{C}D + BC\bar{D} + AC\bar{D}$
   - *iv.* $A\bar{B} + CD$