PDS0101 Introduction to Digital Systems

Tutorial 5

Tutorial outcomes

By the end of today's tutorial, you should be able to

- convert any Boolean expression to SOP/POS form
- apply methods to derive standard SOP/POS forms
- Use Karnaugh maps to simplify Boolean expressions

Theory based questions

1. Identify which of the following expressions are in proper SOP and POS forms.

a)
$$AB + CD\bar{E}$$

b)
$$AB + CD + \overline{BF}$$

c)
$$\bar{A}B + \bar{C}D\bar{E} + CA$$

d)
$$A(B + CD)$$

e)
$$((A + B)(C + D + E))'$$

f)
$$(\bar{A}+B)(A+\bar{B}+C)$$

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

h)
$$A(B+C)(E+\overline{D}+F)$$

i)
$$(H + I + J)(K + \bar{L})$$

2. For all the expressions identified in (3) as SOP or POS form, determine the *domain* of each expression

3. Convert the following expressions to SOP form

a)
$$(a+b)(c+\bar{b})$$

b)
$$(a + \bar{b}c)c$$

c)
$$(a+c)(ab+ac)$$

d)
$$ab + cd(a\bar{b} + cd)$$

e)
$$ab(\bar{b}\bar{c} + bd)$$

f)
$$a + b[ac + (b + \overline{c})d]$$

4. Convert the SOP expressions from (3) into standard SOP form

5. Convert the standard SOP expressions from (4) into standard POS form

6. Derive the truth table for the following *(standard)* SOP expressions

a)
$$A\bar{B}C + \bar{A}B\bar{C} + ABC$$

b)
$$\bar{X}\bar{Y}\bar{Z} + \bar{X}\bar{Y}Z + XYZ + X\bar{Y}Z + \bar{X}YZ$$

c)
$$\bar{A}B + AB\bar{C} + \bar{A}\bar{C} + A\bar{B}C$$

d)
$$\bar{X} + Y\bar{Z} + WZ + X\bar{Y}Z$$

7. Derive the truth table for the following (standard) POS expressions

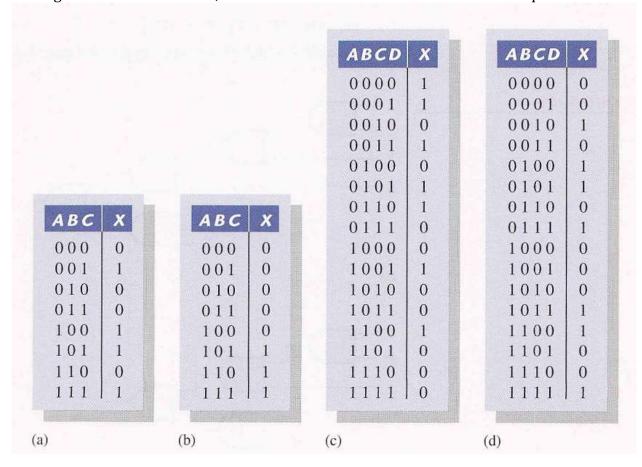
a)
$$(\bar{A} + \bar{B} + \bar{C})(A + B + C)(A + \bar{B} + C)$$

b)
$$(A + B)(A + C)(A + B + C)$$

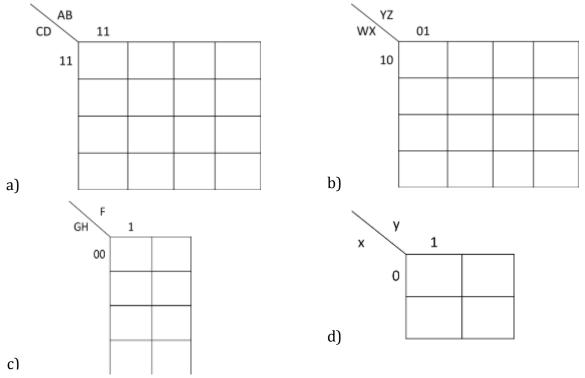
c)
$$(A + \overline{B} + C + \overline{D})(\overline{A} + B + \overline{C} + D)(\overline{A} + B + C + \overline{D})(A + \overline{B} + \overline{C} + D)$$

d)
$$(A + \overline{B})(A + \overline{B} + \overline{C})(C + B + \overline{D})(\overline{A} + B + \overline{C} + D)$$

8. Using the truth tables below, derive the standard SOP and standard POS expressions



9. Complete the Karnaugh maps below using $gray\ code$ and label each cell with its binary value



10. Use K-maps to simplify each expression below to its minimum SOP form if possible

a)
$$\bar{A}\bar{B}\bar{C} + A\bar{B}C + \bar{A}BC + AB\bar{C}$$

b)
$$AC[B(B+\bar{C})+\bar{B}]$$

c)
$$\overline{D}\overline{E}\overline{F} + \overline{D}E\overline{F} + DE\overline{F}$$

d)
$$ab + abc + a\bar{b}c$$

e)
$$a + bc$$

f)
$$a\bar{b} + a\bar{b}\bar{c}d + cd + b\bar{c}d + abcd$$

11. Use K-maps to find the minimum POS form for each expression below if possible

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

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

c)
$$(\overline{X} + \overline{Y})(\overline{X} + Z)(\overline{X} + \overline{Y} + \overline{Z})(\overline{X} + \overline{Y} + Z)$$

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

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