

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) $AB + CDE$

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

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

d) $A(B + CD)$

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

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

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

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

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

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

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

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

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

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

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) $A\overline{B}C + \overline{A}B\overline{C} + ABC$

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

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

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

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

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

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

ABC	X
000	0
001	1
010	0
011	0
100	1
101	1
110	0
111	1

(a)

ABC	X
000	0
001	0
010	0
011	0
100	0
101	1
110	1
111	1

(b)

ABCD	X
0000	1
0001	1
0010	0
0011	1
0100	0
0101	1
0110	1
0111	0
1000	0
1001	1
1010	0
1011	0
1100	1
1101	0
1110	0
1111	0

(c)

ABCD	X
0000	0
0001	0
0010	1
0011	0
0100	1
0101	1
0110	0
0111	1
1000	0
1001	0
1010	0
1011	1
1100	1
1101	0
1110	0
1111	1

(d)

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

a)

	AB	11				
CD	11					

b)

	YZ	01				
WX	10					

c)

	F	1	
GH	00		

d)

	y	1	
x	0		

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

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

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

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

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

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

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

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