

# CDS1114 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)  $\overline{A}\overline{B}C + \overline{A}B\overline{C} + ABC$

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

<i>ABC</i>	<i>X</i>
000	0
001	1
010	0
011	0
100	1
101	1
110	0
111	1

(a)

<i>ABC</i>	<i>X</i>
000	0
001	0
010	0
011	0
100	0
101	1
110	1
111	1

(b)

<i>ABCD</i>	<i>X</i>
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)

<i>ABCD</i>	<i>X</i>
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

		<i>AB</i>			
		11			
<i>CD</i>	11				

a)

		<i>YZ</i>			
		01			
<i>WX</i>	10				

b)

		<i>F</i>	
		1	
<i>GH</i>	00		

c)

		<i>y</i>	
		1	
<i>x</i>	0		

d)

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

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