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EIE2050 - Assignment 3

1.(a) $\overline{A\bar{B}(C+\bar{D})} = \bar{A} + \overline{\bar{B}(C+\bar{D})}$

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

$= \bar{A} + B + \bar{C}\cdot D$

(b) $\overline{ABC(D+EF)} = \bar{A}\bar{B} + \overline{(CD+EF)}$

$= \bar{A}+\bar{B} + C\bar{D}\,\overline{EF}$

$= \bar{A}+\bar{B}+(\bar{C}+\bar{D})(\bar{E}+\bar{F})$

$= \bar{A}+\bar{B}+\bar{C}\bar{E}+\bar{C}\bar{F}+\bar{D}\bar{E}+\bar{D}\bar{F}$

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

$= \bar{A}+\bar{B}+\bar{C}+D(\bar{A}B\bar{C}+1)$

$= \bar{A}+\bar{B}+\bar{C}+D$

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

$= \bar{A}+B+C+D(1+A\bar{B}\bar{C})$

$= \bar{A}+B+C+D$

(e) $\overline{A\bar{B}(CD+\bar{E}F)(\bar{A}B+\bar{C}D)} = AB + \overline{(CD+\bar{E}F)} + \overline{(\bar{A}B+\bar{C}D)}$

$= AB + \bar{C}\bar{D}\,\bar{E}\bar{F} + ABCD$

$= AB(1+CD) + (\bar{C}+\bar{D})(E+\bar{F})$

$= AB + \bar{C}E + \bar{C}\bar{F} + \bar{D}E + \bar{D}\bar{F}$

2.(a)

A	B	C	A+B+C
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

(b)

A	B	C	ABC
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

(c)

A	B	C	AB	BC	CA	AB+BC+CA
0	0	0	0	0	0	0
0	0	1	0	0	0	0
0	1	0	0	0	0	0
0	1	1	0	1	0	1
1	0	0	0	0	0	0
1	0	1	0	0	1	1
1	1	0	1	0	0	1
1	1	1	1	1	1	1

(d)

A	B	C	A+B	B+C	C+A	(A+B)(B+C)(C+A)
0	0	0	0	0	0	0
0	0	1	0	1	1	0
0	1	0	1	1	0	0
0	1	1	1	1	1	1
1	0	0	1	0	1	0
1	0	1	1	1	1	1
1	1	0	1	1	1	1
1	1	1	1	1	1	1

(e)

A	B	C	$A\bar{B}$	$B\bar{C}$	$C\bar{A}$	$A\bar{B}+B\bar{C}+CA$
0	0	0	0	0	0	0
0	0	1	0	0	1	1
0	1	0	0	1	0	1
0	1	1	0	1	1	1
1	0	0	1	0	0	1
1	0	1	1	0	0	1
1	1	0	0	1	0	1
1	1	1	0	0	0	0

3.(a) $x = A\cdot(\bar{B}+C\bar{D}) + \bar{A}\bar{B}C = A\bar{B} + AC\bar{D} + \bar{A}\bar{B}C$ (b) $x = A\bar{B} + AC\bar{D} + A\bar{B}C = A\bar{B}(1+C) + AC\bar{D} = A\bar{B} + AC\bar{D}$

(c) $x = \bar{B}C\bar{D} + A\bar{B}$

(d) $x = A\bar{B} + AC\bar{D}$

figure (b) & (d) are equivalent

4.(a) $f(A,B,C,D) = A\bar{B}C\bar{D} + AB\bar{C}\bar{D} + \bar{A}\bar{B}CD + \bar{A}\bar{B}\bar{C}\bar{D}$

A	B	C	D	f(A,B,C,D)
0	0	0	0	1
0	0	0	1	0
0	0	1	0	0
0	0	1	1	1
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0

A	B	C	D	f(A,B,C,D)
1	0	0	0	0
1	0	0	1	0
1	0	1	0	1
1	0	1	1	0
1	1	0	0	1
1	1	0	1	0
1	1	1	0	0
1	1	1	1	0

(b) $f(w,x,y,z) = wxyz + \bar{w}x\bar{y}z + w\bar{x}y\bar{z} + \bar{w}\bar{x}yz + wx\bar{y}\bar{z}$

w	x	y	z	f(w,x,y,z)
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	1
0	1	0	0	0
0	1	0	1	1
0	1	1	0	0
0	1	1	1	0

w	x	y	z	f(w,x,y,z)
1	0	0	0	0
1	0	0	1	0
1	0	1	0	1
1	0	1	1	0
1	1	0	0	1
1	1	0	1	0
1	1	1	0	0
1	1	1	1	1

5(a) $f(A,B,C) = (\bar{A}+\bar{B}+\bar{C})(A+B+C)(A+B+\bar{C})$

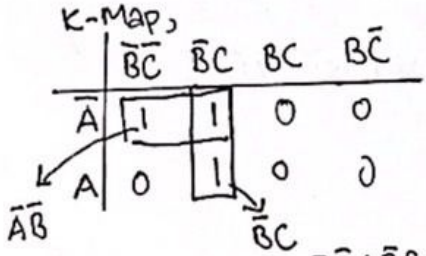
A	B	C	f(A,B,C)
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

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

0 1 5

∴ minterms of given function are m(0, 1, 5)

K-Map,



∴ minimum SOP = $\bar{A}\bar{B} + \bar{B}C$

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

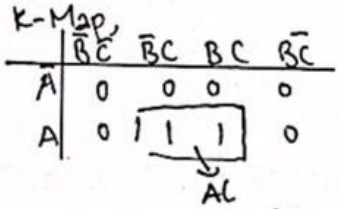
$= AC\bar{B} + ACB + AC\bar{B}$

$: AC\bar{B} + ACB$

5 7

∴ minterms of given function are m(5, 7)

K-Map,



∴ minimum SOP = AC

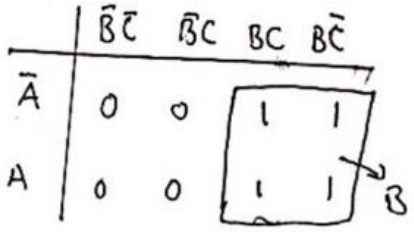
(c) $\bar{A}(BC+B\bar{C}) + A(BC+B\bar{C})$

$= \bar{A}BC + \bar{A}B\bar{C} + ABC + AB\bar{C}$

3 2 7 6

∴ minterms of given function are m(2,3,6,7)

K-Map,

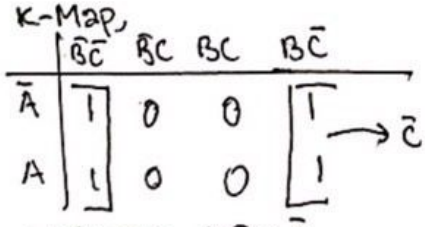


∴ minimum SOP = B

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

0 4 2 6

K-Map,



∴ minimum SOP = $\bar{C}$

7. Given $X = m(1,2,6,7,8,10,12,13,15)$

	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
$\bar{A}\bar{B}$	0	1	0	1
$\bar{A}B$	0	0	1	1
AB	1	1	1	0
$A\bar{B}$	1	0	0	1

$X = A\bar{C}\bar{D} + ABD + \bar{A}BC + \bar{B}C\bar{D} + \bar{A}\bar{B}\bar{C}D$

8(a) $X = (A+B+C)(\bar{A}+B+\bar{C})(A+\bar{B}+C) = \pi(0,2,7)$

	$\bar{B}\bar{C}$	$\bar{B}C$	BC	$B\bar{C}$
$\bar{A}$	0	1	1	0
A	1	1	0	1

$X = \overline{ABC + (\bar{A}\bar{C})}$

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

(b) $X = (X+\bar{Y})(\bar{X}+Z)(X+\bar{Y}+\bar{Z})(\bar{X}+\bar{Y}+Z)$

	$\bar{Y}\bar{Z}$	$\bar{Y}Z$	YZ	$Y\bar{Z}$
$\bar{X}$	1	1	0	0
X	0	1	1	0

$X = \overline{(\bar{X}Y) + (X\bar{Z})}$

$= (X+\bar{Y})\cdot(\bar{X}+Z)$

(c) $X = A(B+\bar{C})(\bar{A}+C)(A+\bar{B}+C)(\bar{A}+B+C)$

	$\bar{B}\bar{C}$	$\bar{B}C$	BC	$B\bar{C}$
$\bar{A}$	0	0	0	0
A	0	0	1	0

$X = \overline{(\bar{A}+\bar{B}+\bar{C})} = ABC$

9.

	$\bar{B}\bar{C}$	$\bar{B}C$	BC	$B\bar{C}$
$\bar{A}$	1	1	1	0
A	1	1	1	0

$X = \overline{(B\bar{C})} = \bar{B}+C$

10(a) $X = \bar{A}\bar{B}\bar{C}\bar{D} + \bar{A}\bar{B}\bar{C}D + \bar{A}B\bar{C}D + AB\bar{C}\bar{D} + A\bar{B}C\bar{D} + \bar{A}BC\bar{D} + A\bar{B}\bar{C}D$

$0000_{(2)}$ $0001_{(2)}$ $0101_{(2)}$ $1100_{(2)}$ $1010_{(2)}$ $0110_{(2)}$ $1001_{(2)}$

$0_{(10)}$ $1_{(10)}$ $5_{(10)}$ $12_{(10)}$ $10_{(10)}$ $6_{(10)}$ $9_{(10)}$

$= m(0,1,5,6,9,10,12)$

(b)

number of 1s in minterm	Minterm	ABCD	First level
0	m_0	0000	(m_0, m_1) 000x
1	m_1	0001	(m_1, m_5) 0x01
2	m_5	0101	(m_1, m_9) x001
	m_6	0110	
	m_9	1001	
	m_{10}	1010	
	m_{12}	1100	

(c)

number of 1s in First level	second level
0	(m_0, m_1)
1	(m_1, m_5)
	(m_1, m_9)

note that second level minterms are those minterms which are listed in the first level by excluding the essential prime implicants

(d)

Prime implicants	m_0	m_1	m_5	m_6	m_9	m_{10}	m_{12}
$\bar{A}\bar{B}\bar{C}$ (m_0, m_1)	✓	✓					
$\bar{A}\bar{C}D$ (m_1, m_5)		✓	✓				
$\bar{A}BC\bar{D}$ (m_6)				✓			
$A\bar{B}\bar{C}D$ (m_9)					✓		
$A\bar{B}C\bar{D}$ (m_{10})						✓	
$AB\bar{C}\bar{D}$ (m_{12})							✓
$\bar{B}\bar{C}D$ (m_1, m_9)		✓			✓		

(e) the table shows that all prime implicants are essential and they will be included in the final expression as they have a single check mark (except for m_9)

therefore,

$$X = \bar{A}\bar{B}\bar{C} + \bar{A}\bar{C}D + \bar{A}BC\bar{D} + A\bar{B}C\bar{D} + AB\bar{C}\bar{D} + \bar{B}\bar{C}D$$