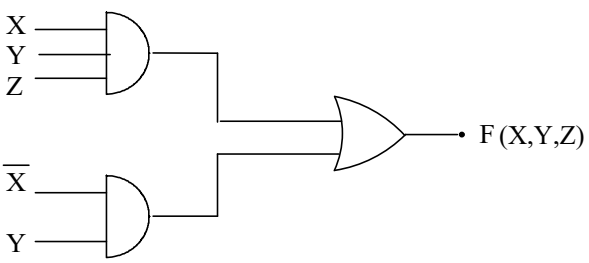
Homework Questions

Circuits and Electronics

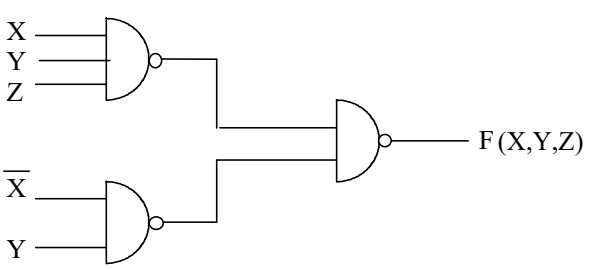
Week 1

Q.1 Determine the truth table for the following logic circuits

(a)



(b)



(c) What can you say about the above two circuits?

Q.2 Consider the following Boolean function:

$$\overline{F} = \overline{B}D + \overline{A}B\overline{C} + ACD + \overline{A}BC$$

(a) Find the complement of the Boolean function and reduce it to seven literals in sum-of-products form.

(b) Using a truth table show that the reduced Boolean function for is equivalent to the original expression.

(c) Implement the simplified expression using AND, OR and NOT logic gates in a 2-level gate circuit.

Q.3 Use Karnaugh maps to obtain the simplified expressions in sum-of-products form for the following Boolean functions:

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

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

Q.4 Using Karnaugh maps, simplify the following expressions, using sum-of-products form:

(a) $A\,B\,C + \overline{A}\,\overline{B}\,C + \overbrace{\overline{A}\,B\,C + A\,\overline{B}\,C + A\,B\,\overline{C}}^{\text{don't cares}}$

(b) $A\,B\,C\,D + \overline{A}\,\overline{B}\,C\,D + \overbrace{\overline{A}\,B\,C\,D + A\,\overline{B}\,C\,D + \overline{A}\,\overline{B}\,\overline{C}\,\overline{D}}^{\text{don't cares}}$

(c) $A\,\overline{B}\,C\,\overline{D} + A\,\overline{B}\,C\,D + \overbrace{\overline{A}\,B\,\overline{C}\,D + \overline{A}\,B\,\overline{C}\,\overline{D}}^{\text{don't cares}}$

Solutions

Q1.

(a) $F = XYZ + \bar{X}Y$

X	Y	Z	XYZ	$\bar{X}Y$	F
0	0	0	0	0	0
0	0	1	0	0	0
0	1	0	0	1	1
0	1	1	0	1	1
1	0	0	0	0	0
1	0	1	0	0	0
1	1	0	0	0	0
1	1	1	1	0	1

(b) $F = \overline{(\overline{XYZ})(\overline{\bar{X}Y})}$

X	Y	Z	$\overline{XYZ}$	$\overline{\bar{X}Y}$	F
0	0	0	1	1	0
0	0	1	1	1	0
0	1	0	1	0	1
0	1	1	1	0	1
1	0	0	1	1	0
1	0	1	1	1	0
1	1	0	1	1	0
1	1	1	0	1	1

(c) The two circuits are equivalent

Q2.

(a)

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

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

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

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

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

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

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

$$= \bar{B}\bar{D}[1+\bar{A}+\bar{C}] + A\bar{D}[1+\bar{C}+B] + AB\bar{C}$$

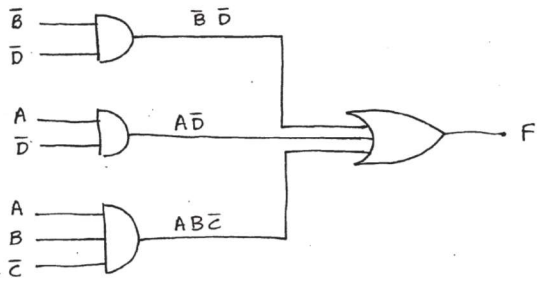
$$F = \bar{B}\bar{D} + A\bar{D} + AB\bar{C}$$

(b)

A	B	C	D	$\bar{B}D$	$\bar{A}B\bar{C}$	ACD	$\bar{A}BC$	$\bar{F}$	F
0	0	0	0	0	0	0	0	0	1
0	0	0	1	1	0	0	0	1	0
0	0	1	0	0	0	0	0	0	1
0	0	1	1	1	0	0	0	1	0
0	1	0	0	0	1	0	0	1	0
0	1	0	1	0	0	0	0	1	0
0	1	1	0	0	0	0	1	1	0
0	1	1	1	0	0	0	0	1	0
1	0	0	0	0	0	0	0	0	1
1	0	0	1	1	0	0	0	1	0
1	0	1	0	0	0	0	0	0	1
1	0	1	1	1	0	0	0	1	0
1	1	0	0	0	0	0	0	0	1
1	1	0	1	0	0	0	0	0	1
1	1	1	0	0	0	0	0	0	1
1	1	1	1	0	0	1	0	1	0

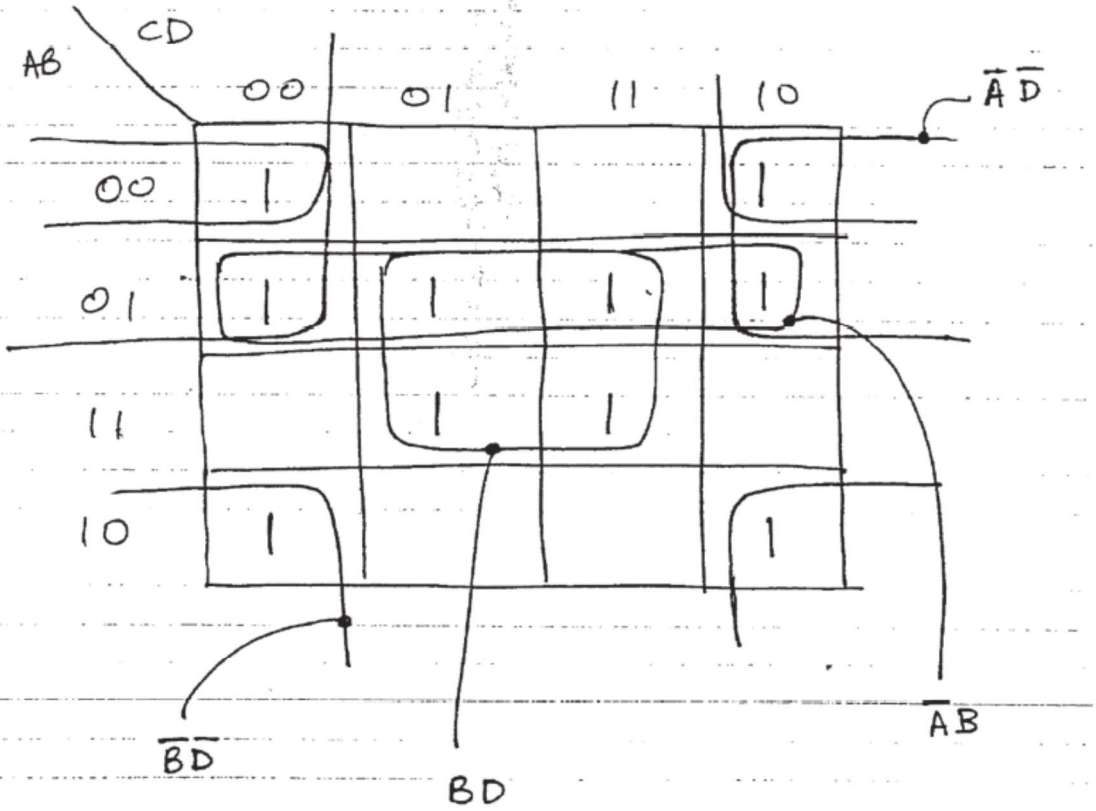
A	B	C	D	$\bar{B}\bar{D}$	$A\bar{D}$	$AB\bar{C}$	F
0	0	0	0	1	0	0	1
0	0	0	1	0	0	0	0
0	0	1	0	1	0	0	1
0	0	1	1	0	0	0	0
0	1	0	0	0	0	0	0
0	1	0	1	0	0	0	0
0	1	1	0	0	0	0	0
0	1	1	1	0	0	0	0
1	0	0	0	1	0	0	1
1	0	0	1	0	0	0	0
1	0	1	0	1	0	0	1
1	0	1	1	0	0	0	0
1	1	0	0	0	0	0	0
1	1	0	1	0	0	0	0
1	1	1	0	0	0	1	0
1	1	1	1	0	0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

(c)



Q3.

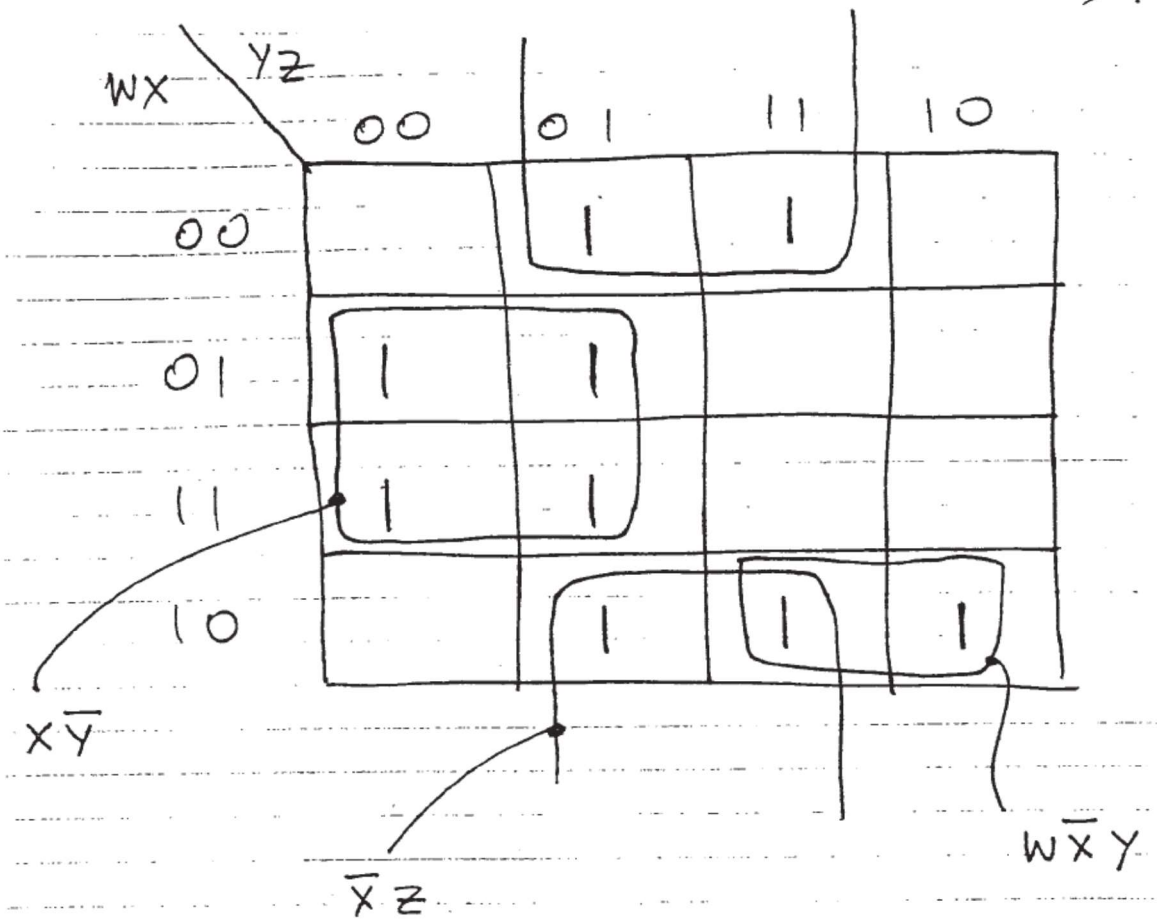
(a) $F = ABD + \bar{A}\bar{C}\bar{D} + \bar{A}B + \bar{A}C\bar{D} + A\bar{B}\bar{D}$



$F = \bar{A}B + \bar{B}\bar{D} + BD$

OR $F = \bar{A}\bar{D} + \bar{B}\bar{D} + BD$

(b) $F = \bar{X}z + \bar{W}x\bar{Y} + W(\bar{X}Y + x\bar{Y})$



$$F = x\bar{Y} + \bar{X}z + w\bar{X}Y$$

Q4.

a)

AB \ C	0	1
00		1
01		X
11	X	1
10		X

$f = C$

b)

AB \ CD	00	01	11	10
00	X		1	
01			X	
11			1	
10			X	

$f = CD$

c)

AB \ CD	00	01	11	10
00				
01	X	X		
11				
10			1	1

$f = A\bar{B}C$