BITS Pilani
Hyderabad Campus
Department of Electrical Engineering

Digital Design
First Semester 2020-21
Tutorial : 11

Memory and PLD

Problem 1

1.Realize the following logic functions with 8 X 4 PROMs.

(i) F1 = AB + B’C

(ii) F2 = (A+B’+C) (A’+B)

(iii) F3 = A + BC

Solution

First, we convert each function to canonical SOP form.

$f_1(A,B,C) = A.B + B'.C = A.B.C' + A.B.C + A'.B'.C + A.B'.C$

$= \Sigma\, m(1,5,6,7)$

$f_2(A,B,C) = (A+B'+C).(A'+B)$

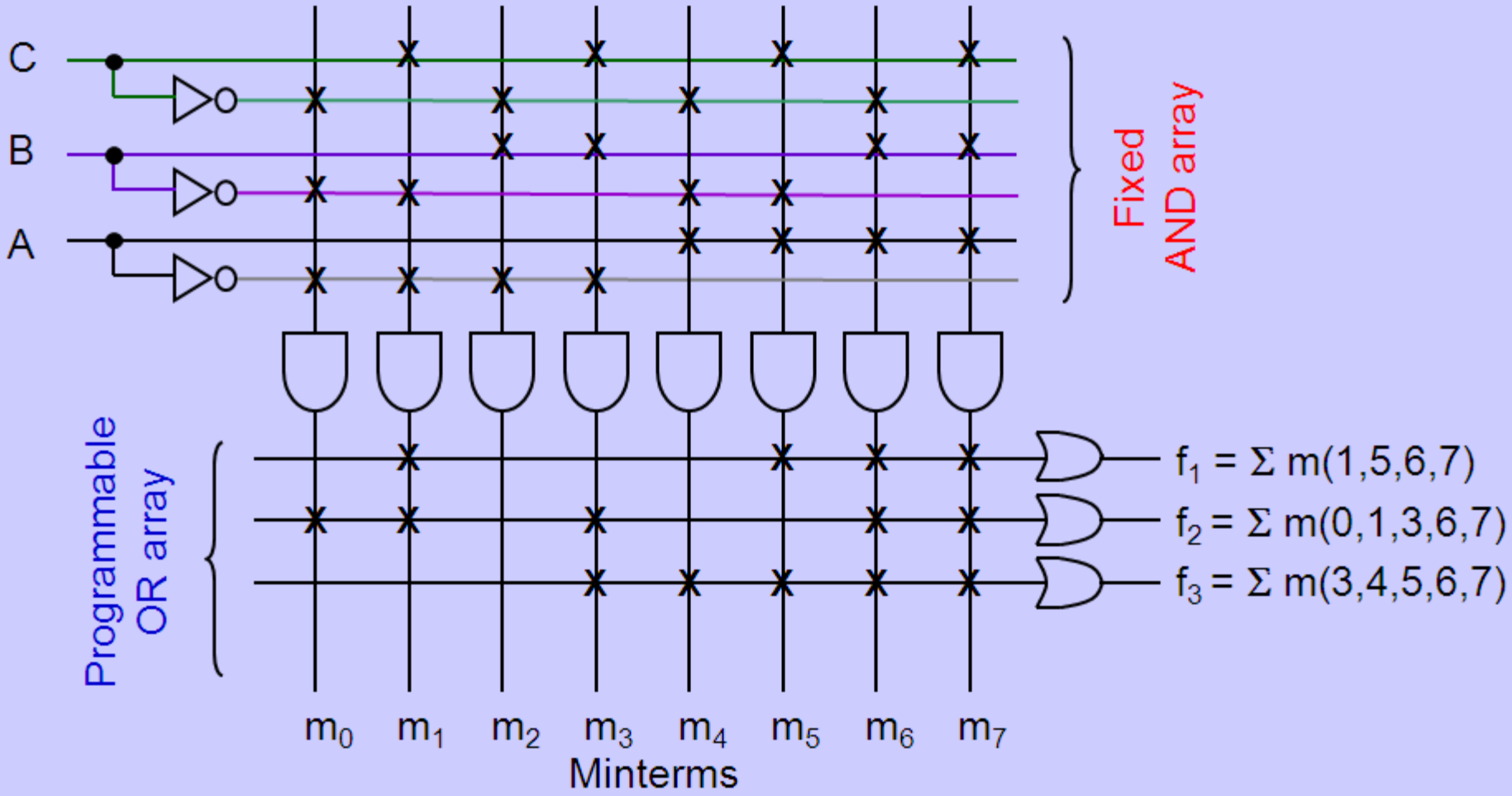
$= (A+B'+C).(A'+B+C').(A'+B+C)$

$= \Pi\, M(2,4,5) = \Sigma\, m(0,1,3,6,7)$

$f_3(A,B,C) = A + B.C = A.B'.C' + A.B'.C + A.B.C' + A.B.C + A'.B.C$

$= \Sigma\, m(3,4,5,6,7)$

Solution


C
B
A
Fixed
AND array
Programmable
OR array
$f_1 = \Sigma\, m(1,5,6,7)$
$f_2 = \Sigma\, m(0,1,3,6,7)$
$f_3 = \Sigma\, m(3,4,5,6,7)$
m_0 m_1 m_2 m_3 m_4 m_5 m_6 m_7
Minterms

Problem 2

A Boolean function is defined by the truth table

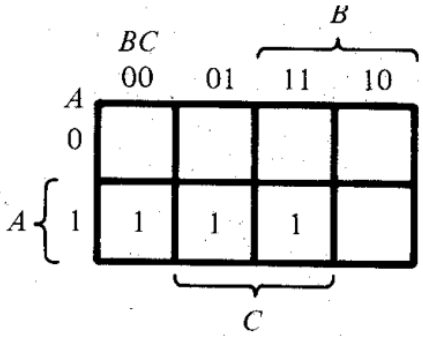
A	B	C	F_1	F_2
0	0	0	0	0
0	0	1	0	0
0	1	0	0	0
0	1	1	0	1
1	0	0	1	0
1	0	1	1	1
1	1	0	0	0
1	1	1	1	1

(a) Truth table

Implement the circuit with a PLA having three inputs, three product terms and two outputs

Solution

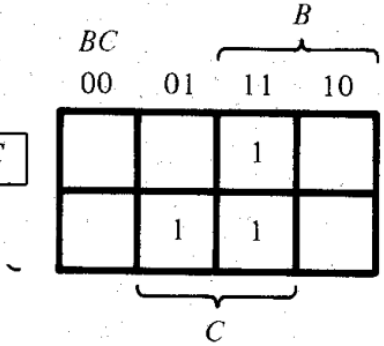
- **Solution**:
- Map simplification:



$F_1 = AB' + AC$

	Product term	Inputs A	B	C	Outputs F_1	F_2	
AB'	1	1	0	–	1	–	
AC	2	1	–	1	1	1	
BC	3	–	1	1	–	1	
					T	T	T/C

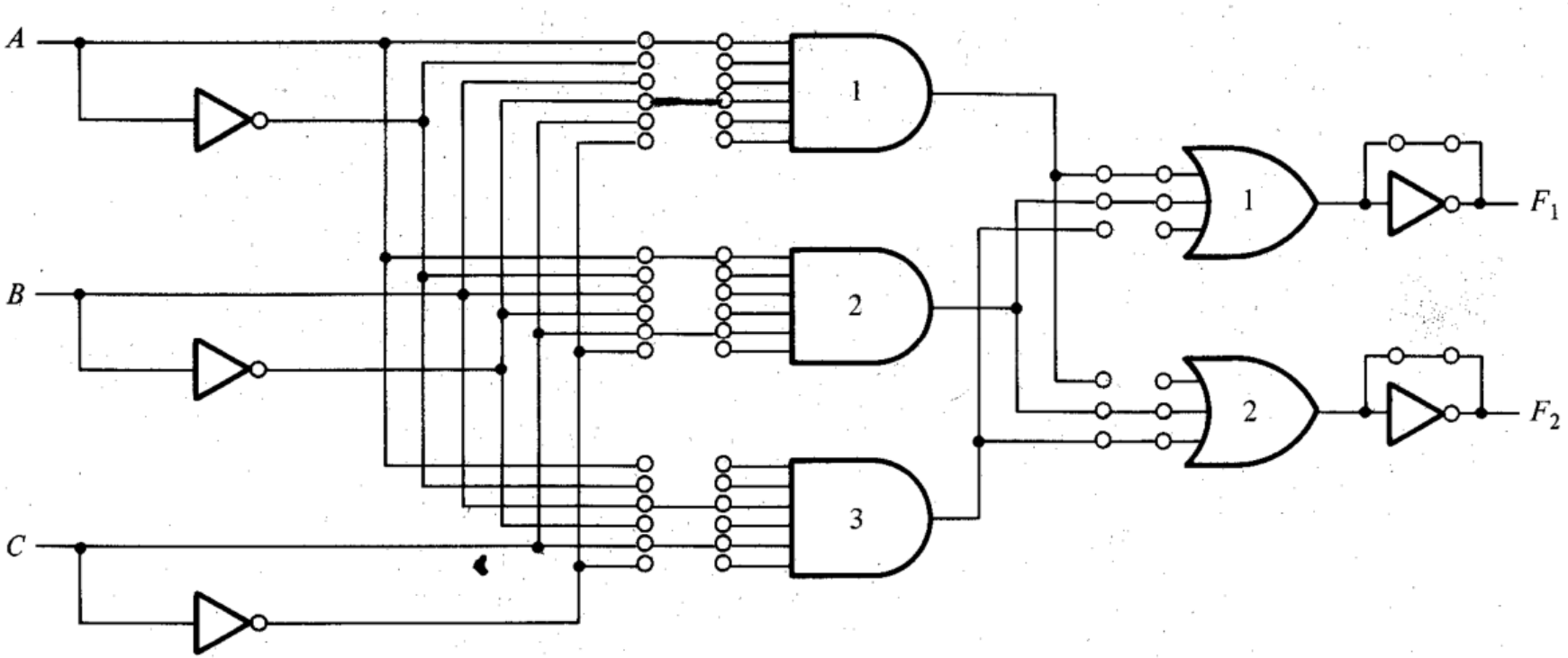
(c) PLA program table



$F_2 = AC + BC$

(b) Map simplification

Solution



Problem 3

Considering the following Boolean functions, design a combinational circuit using a PAL:

$$w(A,B,C,D) = \sum(2,12,13)$$

$$x(A,B,C,D) = \sum(7,8,9,10,11,12,13,14,15)$$

$$y(A,B,C,D) = \sum(0,2,3,4,5,6,7,8,10,11,15)$$

$$z(A,B,C,D) = \sum(1,2,8,12,13)$$

Solution

- Simply the four functions to a minimum number of terms:

$$w = ABC' + A'B'CD'$$

$$x = A + BCD$$

$$y = A'B + CD + B'D'$$

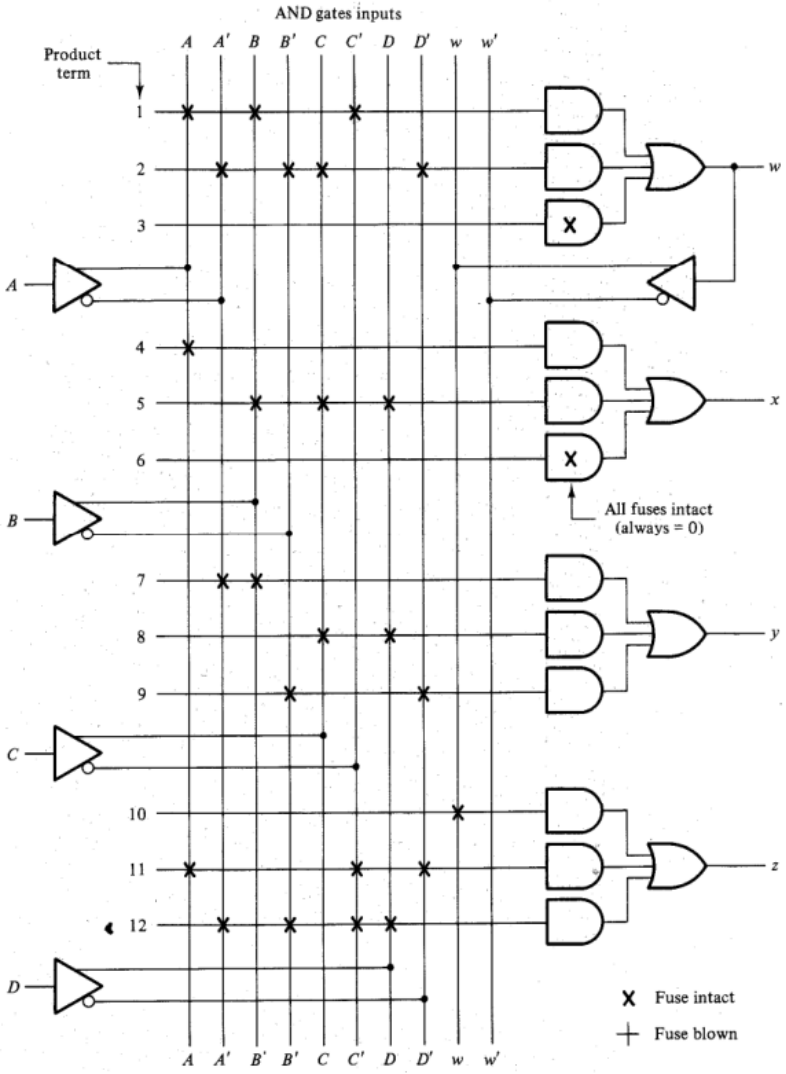
$$z = ABC' + A'B'CD' + AC'D' + A'B'C'D$$

$$= w + AC'D' + A'B'C'D$$

Solution

Product Term	AND Inputs A	B	C	D	W	Outputs
1	1	1	0	–	–	$w = ABC'$
2	0	0	1	0	–	$+ A'B'CD'$
3	–	–	–	–	–	
4	1	–	–	–	–	$x = A$
5	–	1	1	1	–	$+ BCD$
6	–	–	–	–	–	
7	0	1	–	–	–	$y = A'B$
8	–	–	1	1	–	$+ CD$
9	–	0	–	0	–	$+ B'D'$
10	–	–	–	–	1	$z = w$
11	1	–	0	0	–	$+ AC'D'$
12	0	0	0	1	–	$+ A'B'C'D$

Solution


AND gates inputs
A A' B B' C C' D D' w w'
Product term
1
2
3
4
5
6
7
8
9
10
11
12
w
x
y
z
All fuses intact (always = 0)
Fuse intact
Fuse blown