Homework #4

4-1 Consider the combinational circuit shown in Fig. P4-1

(a) Derive the Boolean expressions for T_1 through T_4. Evaluate the outputs F_1 and F_2 as a function of the four inputs.

(b) List the truth table with 16 binary combinations of the four input variables. Then list the binary values for T_1 through T_4 and outputs F_1 and F_2 in the table.

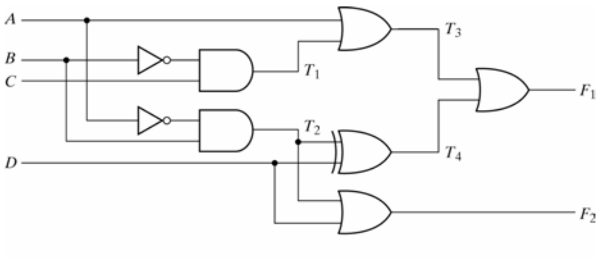


Fig. P4-1

T1=B'C

T2=A'B

$T_3 = A + B'C$

$T_4 = (A'B) \oplus D = A'BD' + AD + B'D$

$F_1 = A + B'C + A'BD' + AD + B'D = A + B'C + BD' + B'D$

$F_2 = A'B + D$

4-12 (a) Design a half-subtractor circuit with inputs x and y and outputs D and B. The circuit subtracts the bits x - y and places the difference in D and the borrow in B.

(b) Design a full-subtractor circuit with three inputs x, y, z and two outputs D and B. The circuit subtracts x - y - z, where z is the input borrow, B is the output borrow, and D is the difference.

(a)

x	y	B	D
0	0	0	0
0	1	1	1
1	0	0	1
1	1	0	0

$D = x'y + xy'$

$B = x'y$

(b)

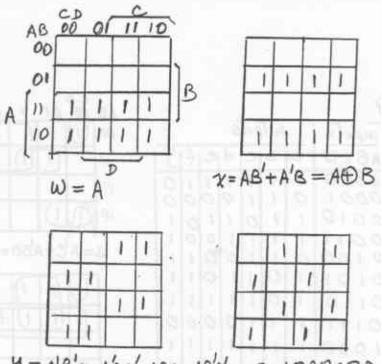
x	y	z	B	D
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	1	0
1	0	0	0	1
1	0	1	0	0
1	1	0	0	0
1	1	1	1	1

$D = x \oplus y \oplus z$

$B = x'y + x'z + yz$

4-7 Design a combinational circuit that converts a 4-bit Gray code (Table 1-6) to a 4-bit binary number. Implement the circuit with exclusive-OR gates.

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

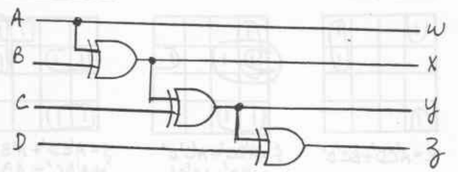


$w = A$

$x = AB' + A'B = A \oplus B$

$y = A'B'C + A'BC' + ABC + AB'C'$
$= A'(B \oplus C) + A(B \oplus C)'$
$= A \oplus B \oplus C$
$= x \oplus C$

$z = A \oplus B \oplus C \oplus D$
$= y \oplus D$



4-28 A combinational circuit is defined by the following three Boolean functions:

F1 = x'y'z' + xz

F2 = xy'z' + x'y

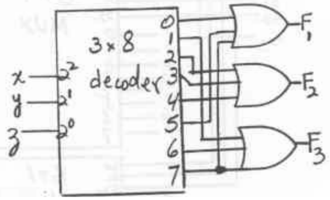
F3 = x'y'z + xy

Design the circuit with a decoder and external gates.

$F_1 = x(y+y')z + x'y'z' = \Sigma(0,5,7)$

$F_2 = xy'z' + x'y(z+z') = \Sigma(2,3,4)$

$F_3 = x'y'z + xy(z+z') = \Sigma(1,6,7)$



4-33 Implement a full adder with two 4x1 multiplexers.

$S(x,y,z) = \Sigma(1,2,4,7)$

$C(x,y,z) = \Sigma(3,5,6,7)$

S

	I_0	I_1	I_2	I_3
x'	0	1	2	3
x	4	5	6	7
	x	x'	x'	x

C

	I_0	I_1	I_2	I_3
x'	0	1	2	3
x	4	5	6	7
	0	x	x	1