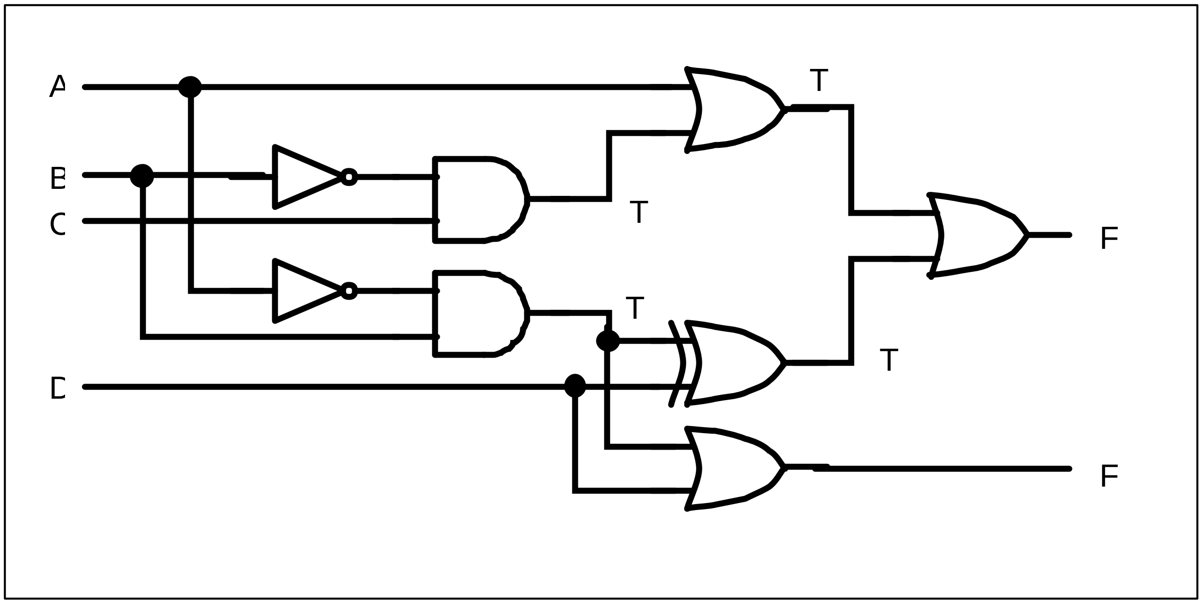
Homework 5 – due 6/7

4-1) Consider the combinatorial circuit shown in Figure 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 15 binary combinations of the four input variables. Then list the binary values for T_1 through T_4 and F_1 and F_2 in the table.

(c) Plot the output Boolean functions obtained in (b) on maps and show that the simplified Boolean expressions are equivalent to the ones obtained in part (a).



$T_1 = B'C$

$T_2 = A'B$

$T_3 = A + T_1 = A + B'C$

$T_4 = T_2 \text{ XOR } D = A'B \text{ XOR } D =$

$(A'B)D' + (A'B)'D = A'BD' + (A+B')D = A'BD' + AD + B'D$

$F_1 = T_3 + T_4 = A + B'C + A'BD' + AD + B'D = A + B'C + A'BD' + B'D$

$F_2 = T_2 + D = A'B + D$

A	B	C	D	T_1	T_2	T_3	T_4	F_1	F_2
0	0	0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	1	1	1
0	0	1	0	1	0	1	0	1	0
0	0	1	1	1	0	1	1	1	1
0	1	0	0	0	1	0	1	1	1
0	1	0	1	0	1	0	0	0	1
0	1	1	0	0	1	0	1	1	1
0	1	1	1	0	1	0	0	0	1
1	0	0	0	0	0	1	0	1	0
1	0	0	1	0	0	1	1	1	1
1	0	1	0	1	0	1	0	1	0
1	0	1	1	1	0	1	1	1	1
1	1	0	0	0	0	1	0	1	0
1	1	0	1	0	0	1	1	1	1
1	1	1	0	0	0	1	0	1	0
1	1	1	1	0	0	1	1	1	1

AB\CD	00	01	11	10
00	0	1	1	1

01	1	0	0	1
11	1	1	1	1
10	1	1	1	1

F_1 = A + CD' + BD' + B'D

AB\CD	00	01	11	10
00	0	1	1	0
01	1	1	1	1
11	0	1	1	0
10	0	1	1	0

F_2 = A'B + D

4-5) Design a combinatorial circuit with three inputs x, y, and z and three outputs A, B, and C. When the binary input is 0, 1, 2, or 3, the binary output is one greater than the input. When the binary input is 4, 5, 6, or 7, the binary output is one less than the input. (x=4, y=2, z=1) (A=4, B=2, C=1)

x	y	z	A	B	C
0	0	0	0	0	1
0	0	1	0	1	0
0	1	0	0	1	1
0	1	1	1	0	0
1	0	0	0	1	1
1	0	1	1	0	0
1	1	0	1	0	1
1	1	1	1	1	0

x\yz	00	01	11	10
0	0	0	1	0
1	0	1	1	1

A = xz + xy + yz

x\yz	00	01	11	10
0	0	1	0	1
1	1	0	1	0

B = x XOR y XOR z

x\yz	00	01	11	10
0	1	0	0	1
1	1	0	0	1

C = z’

4-6) A majority circuit is a combinatorial circuit where the output is equal to 1 if the input variables have more 1's than 0's. The output is 0 otherwise. Design a 3-input majority circuit.

A	B	C	Y
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

A\BC	00	01	11	10
0	0	0	1	0
1	0	1	1	1

Y = AC + AB + BC

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

G3	G2	G1	G0	B3	B2	B1	B0
0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	1
0	0	1	1	0	0	1	0
0	0	1	0	0	0	1	1
0	1	1	0	0	1	0	0
0	1	1	1	0	1	0	1
0	1	0	1	0	1	1	0
0	1	0	0	0	1	1	1
1	1	0	0	1	0	0	0
1	1	0	1	1	0	0	1
1	1	1	1	1	0	1	0
1	1	1	0	1	0	1	1
1	0	1	0	1	1	0	0
1	0	1	1	1	1	0	1
1	0	0	1	1	1	1	0
1	0	0	0	1	1	1	1

$G_3G_2\backslash G_1G_0$	00	01	11	10
00	0	0	0	0
01	0	0	0	0
11	1	1	1	1
10	1	1	1	1

$B_3 = G_3$

$G_3G_2\backslash G_1G_0$	00	01	11	10
00	0	0	0	0
01	1	1	1	1
11	0	0	0	0
10	1	1	1	1

$B_2 = G_3$ XOR G_2

$G_3G_2\backslash G_1G_0$	00	01	11	10
00	0	0	1	1
01	1	1	0	0
11	0	0	1	1
10	1	1	0	0

$B_1 = G_3$ XOR G_2 XOR G_1

$G_3G_2\backslash G_1G_0$	00	01	11	10
00	0	1	0	1
01	1	0	1	0
11	0	1	0	1
10	1	0	1	0

$B_0 = G_0$ XOR G_1 XOR G_2 XOR G_3