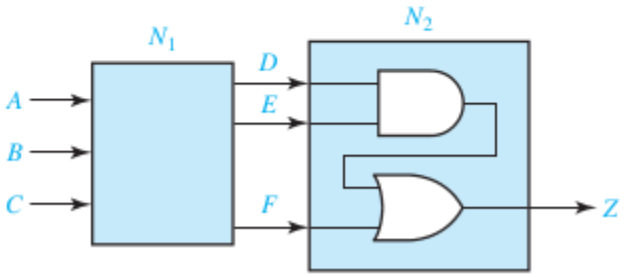
4.3 Given $F_1 = \Sigma\, m(0, 4, 5, 6)$ and $F_2 = \Sigma\, m(0, 3, 6, 7)$ find the minterm expression for $F_1 + F_2$. State a general rule for finding the expression for $F_1 + F_2$ given the minterm expansions for F_1 and F_2. Prove your answer by using the general form of the minterm expansion.

4.4 (a) How many switching functions of two variables (x and y) are there?
(b) Give each function in truth table form and in reduced algebraic form.

4.5 A combinational circuit is divided into two subcircuits N_1 and N_2 as shown. The truth table for N_1 is given. Assume that the input combinations $ABC = 110$ and $ABC = 010$ never occur. Change as many of the values of D, E, and F to don't-cares as you can without changing the value of the output Z.



A	B	C	D	E	F
0	0	0	1	1	0
0	0	1	0	0	1
0	1	0	0	1	1
0	1	1	1	1	1
1	0	0	1	0	0
1	0	1	1	0	1
1	1	0	0	1	0
1	1	1	0	0	0

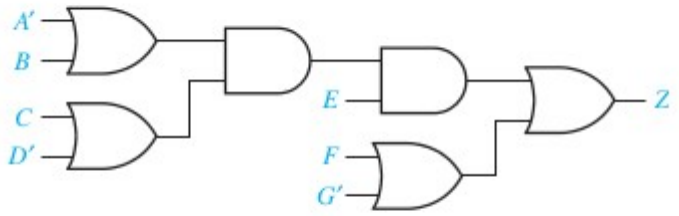
4.9 Given: $F(a, b, c) = abc' + b'$.
(a) Express F as a minterm expansion. (Use m-notation.)
(b) Express F as a maxterm expansion. (Use M-notation.)
(c) Express F' as a minterm expansion. (Use m-notation.)
(d) Express F' as a maxterm expansion. (Use M-notation.)

4.13 A combinational logic circuit has four inputs (A, B, C, and D) and one output Z. The output is 1 iff the input has three consecutive 0's or three consecutive 1's. For example, if $A = 1, B = 0, C = 0$, and $D = 0$, then $Z = 1$, but if $A = 0, B = 1, C = 0$, and $D = 0$, then $Z = 0$. Design the circuit using one four-input OR gate and four three-input AND gates.

4.20 A bank vault has three locks with a different key for each lock. Each key is owned by a different person. To open the door, at least two people must insert their keys into the assigned locks. The signal lines A, B, and C are 1 if there is a key inserted into lock 1, 2, or 3, respectively. Write an equation for the variable Z which is 1 iff the door should open.

4.29 Find both the minterm expansion and maxterm expansion for the following functions, using *algebraic manipulations*:
(a) $f(A, B, C, D) = AB + A'CD$
(b) $f(A, B, C, D) = (A + B + D')(A' + C)(C + D)$

7.8 (a) Convert the following circuit to all NAND gates, by adding bubbles and inverters where necessary.
(b) Convert to all NOR gates (an inverter at the output is allowed).



7.9 Find a two-level, multiple-output AND-OR gate circuit to realize the following functions. Minimize the required number of gates (six gates minimum).

$$f_1 = ac + ad + b'd \quad \text{and} \quad f_2 = a'b' + a'd' + cd'$$

7.22 A combinational switching circuit has four inputs and one output as shown. $F = 0$ iff three or four of the inputs are 1.
(a) Write the maxterm expansion for F.
(b) Using AND and OR gates, find a minimum three-level circuit to realize F (5 gates, 12 inputs).