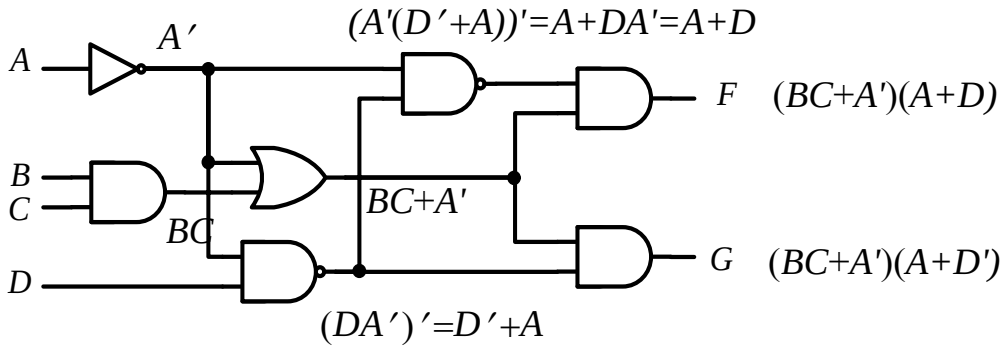
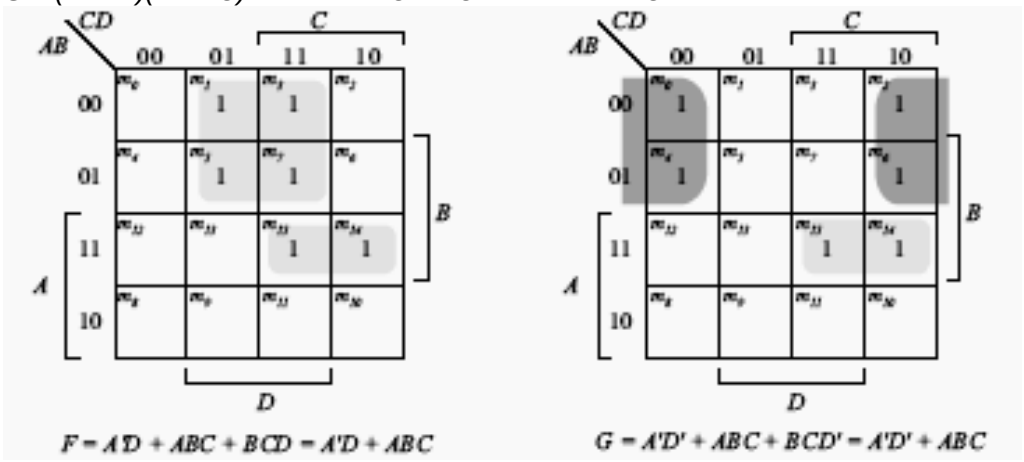
HOMEWORK V - SOLUTIONS

1. Obtain the simplified Boolean expressions for output *F* and *G* in terms of the input variables in the circuit:

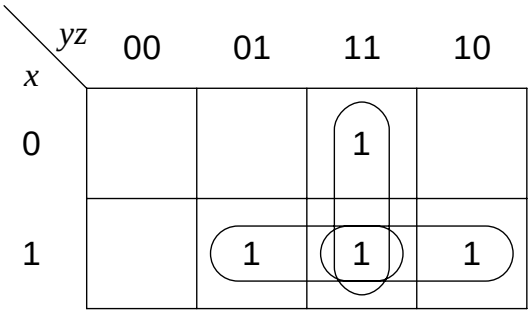


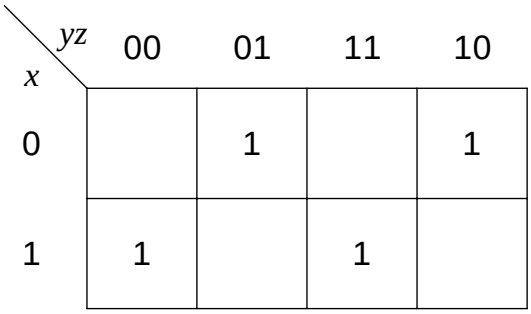
F = (A + D)(A' + BC) = A'D + ABC + BCD = A'D + ABC
G = (A + D')(A' +BC) = A'D' + ABC + BCD' = A'D' + ABC



2. Design a combinational 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	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

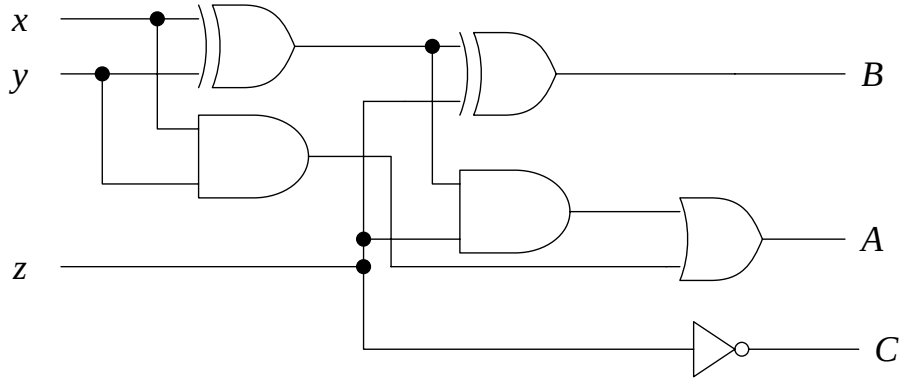




$A=xz+xy+yz$

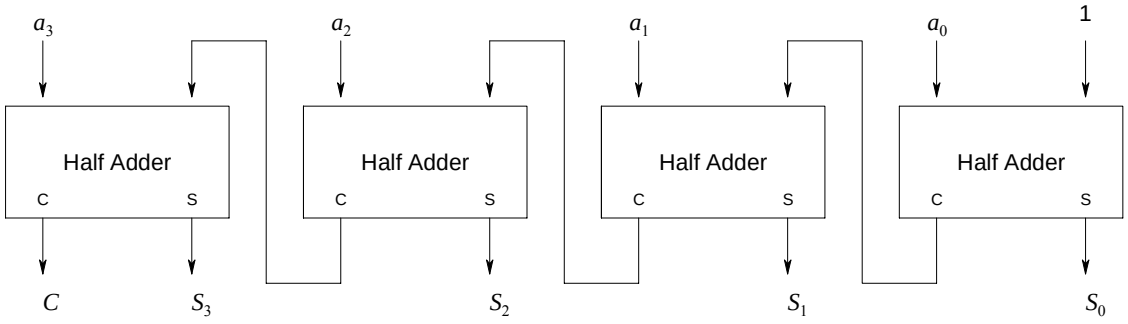
$B=xy'z'+xyz+x'y'z+x'yz'=x\oplus y\oplus z$

$C=z'$



3. Design a 4-bit combinational circuit incrementer. (A circuit that adds one to a 4-bit binary number.) The circuit can be designed using four half-adders.

$$\begin{array}{cccccc} c & c & c & c & & \\ & a_3 & a_2 & a_1 & a_0 & \\ + & & & & & 1 \\ \hline C & S_3 & S_2 & S_1 & S_0 & \end{array}$$



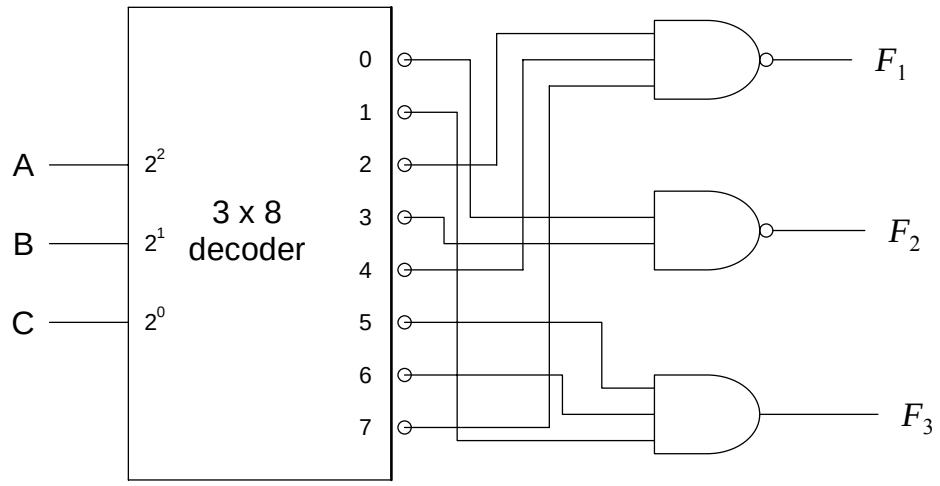
4. A combinational circuit is specified by the following three Boolean functions:

$F_1(A, B, C) = \sum(2, 4, 7)$

$F_2(A, B, C) = \sum(0, 3)$

$F_3(A, B, C) = \sum(0, 2, 3, 4, 7)$

Implement the circuit with a decoder constructed with NAND gates and NAND or AND gates connected to the decoder outputs. Use a block diagram for the decoder. Minimize the number of inputs in the external gates.



5. A combinational circuit is defined by the following three Boolean functions:

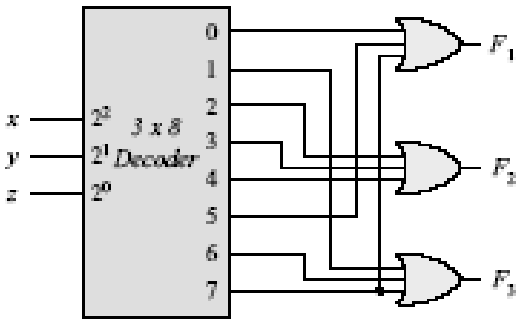
$$F_1 = x'\,y'\,z' + x\,z$$
$$F_2 = x\,y'\,z' + x'\,y$$
$$F_3 = x'\,y'\,z + x\,y$$

Design the circuit with a decoder and external gates.

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

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

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



6. Implement the following Boolean function with a 4 × 1 multiplexer and external gates. Connect inputs *A* and *B* to the selection lines. The input requirements for the four data lines will be a function of variables *C* and *D*. These values are obtained by expressing *F* as a function of *C* and *D* for each of the four cases when *AB* = 00, 01, 10, and 11. These functions may have to be implemented with external gates.
   $F(A, B, C, D) = \sum(1, 3, 4, 11, 12, 13, 14, 15)$

Inputs ABCD	F	
0000	0	
0001	1	$AB = 00$
0010	0	$F = D$
0011	1	
0100	1	
0101	0	$AB = 01$
0110	0	$F = CD'$
0111	0	$= (C + D)'$
1000	0	
1001	0	$AB = 10$
1010	0	$F = CD$
1011	1	
1100	1	
1101	1	$AB = 11$
1110	1	$F = 1$
1111	1