

Assignment # 3 Solutions

- 1) Design a combinational circuit that converts 4-bit binary code into 4-bit excess-3 code.

This problem was solved in Class.

- 2) Design a combinational circuit that converts 4-bit binary code into 4-bit gray code.

Refer to quiz 3 for solutions

- 3) Design a half-subtractor and a full subtractor circuit.

(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) Design 4-bit combinational circuit 2's complementer. (The output generates the 2's complement of the input binary number) Show that the circuit can be constructed using exclusive-OR gates?

4-10

Inputs				Outputs			
A	B	C	D	w	x	y	z
0000				0000			
0001				1111			
0010				1110			
0011				1101			
0100				1100			
0101				1011			
0110				1010			
0111				1001			
1000				1000			
1001				0111			
1010				0110			
1011				0101			
1100				0100			
1101				0011			
1110				0010			
1111				0001			

AB	00	01	11	10
00		1	1	1
01	1	1	1	1
11				
10	1			

$$w = A'(B+C+D) + ABC'D'$$

$$= A \oplus (B+C+D)$$

AB	00	01	11	10
00				
01		1		
11			1	
10				1

$$y = CD' + C'D$$

$$y = C \oplus D$$

AB	00	01	11	10
00				
01		1		
11			1	
10				1

$$z = D$$

For 5-bit 2's complementer with input E and output V

$$V = E \oplus (A+B+C+D)$$

- 5) Design a code converter that converts a decimal digit from 8, 4, -2, -1 code to BCD.

4-8

dec	8 4 -2 -1				8 4 2 1			
	A	B	C	D	w	x	y	z
0	0000				0000			
1	0111				0001			
2	0110				0010			
3	0101				0011			
4	0100				0100			
5	1011				0101			
6	1010				0110			
7	1001				0111			
8	1000				1000			
9	1111				1001			

AB	00	01	11	10
00				
01				
11				
10				

$$w = AB + AC'D'$$

AB	00	01	11	10
00				
01				
11				
10				

$$x = B'C + B'D + BC'D'$$

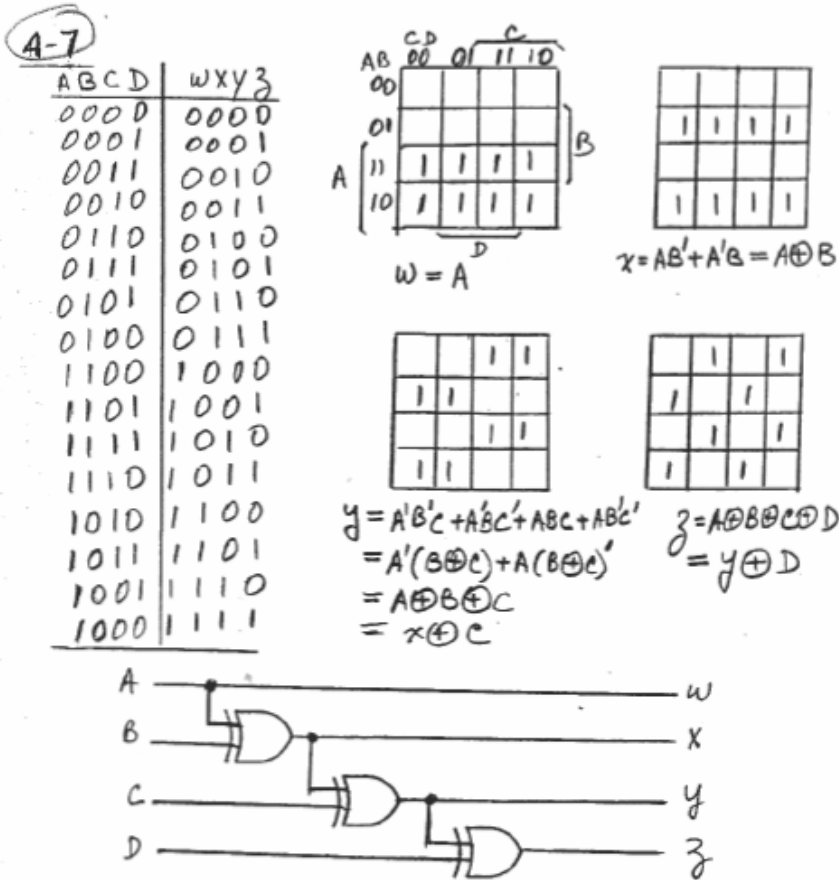
AB	00	01	11	10
00				
01				
11				
10				

$$y = CD' + C'D$$

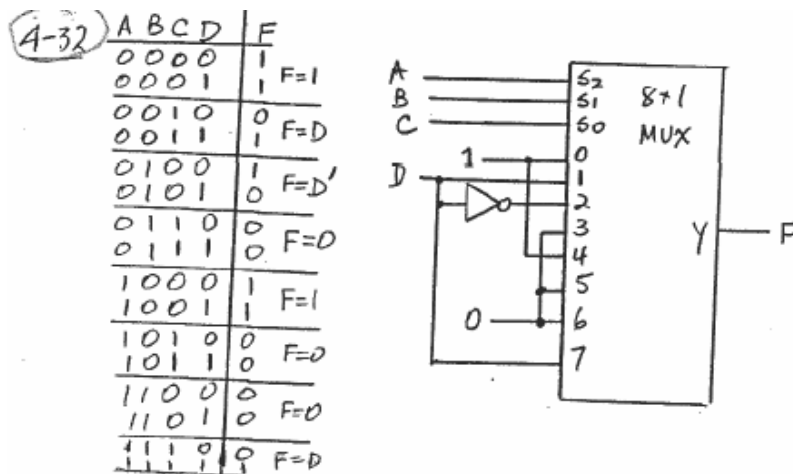
AB	00	01	11	10
00				
01				
11				
10				

$$z = D \text{ (by inspection)}$$

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



- 7) Implement the following Boolean function with a multiplexer
 $F(A, B, C, D) = \sum m(0, 1, 3, 4, 8, 9, 15)$



- 8) An 8×1 multiplexer has inputs A, B, and C connected to the selection inputs S_2 , S_1 , and S_0 , respectively. The data inputs I_0 through I_7 , are as follows: $I_1 = I_2 = I_7 = 0$; $I_3 = I_5 = 1$; $I_0 = I_4 = D$; and $I_6 = D'$. Determine the Boolean function that the multiplexer implements.

4-34

	ABCD	F
$I_3 = 1$	0110	1
	0111	1
$I_5 = 1$	1010	1
	1011	1
$I_0 = D$	0000	0
	0001	1
$I_4 = D$	1000	0
	1001	1

ABCD	F
1100	1
1101	0

other six minterms = 0 since $I_1 = I_2 = I_7 = 0$

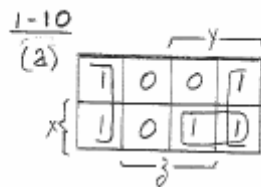
$F(A, B, C, D) = \sum (1, 6, 7, 9, 10, 11, 12)$

From the textbook "Computer Systems Architecture, 3rd Edition by Morris Mano.

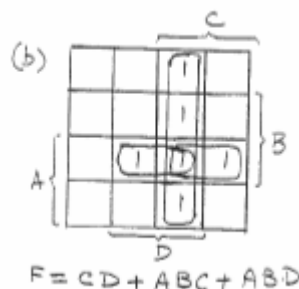
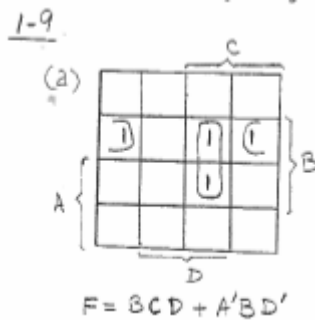
Solve the following problems:

From chapter 1, pages 38 - 39

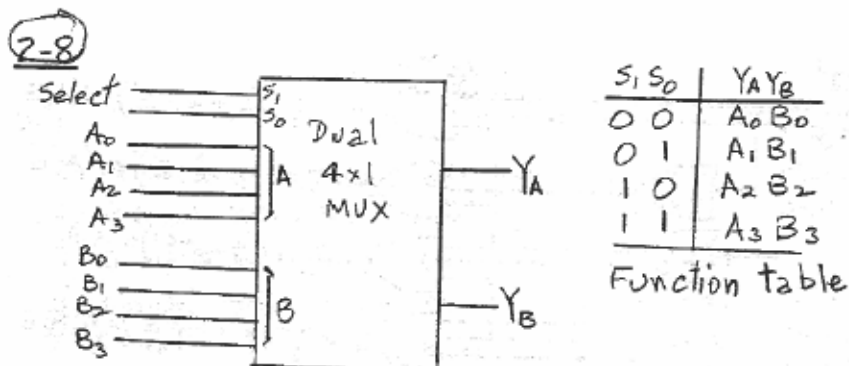
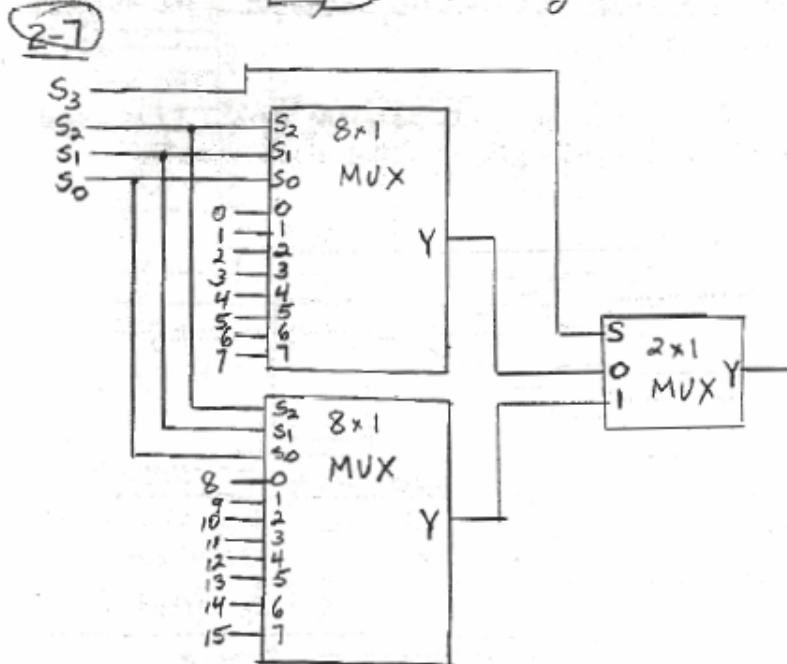
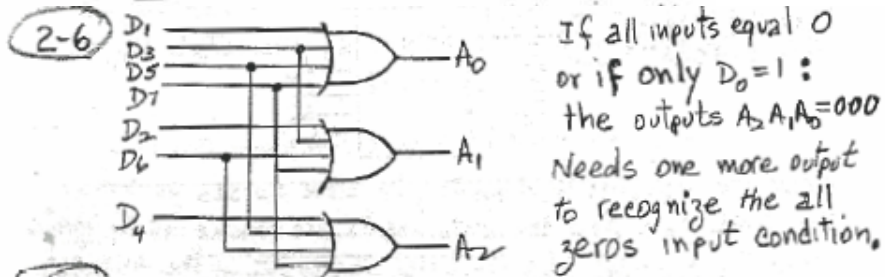
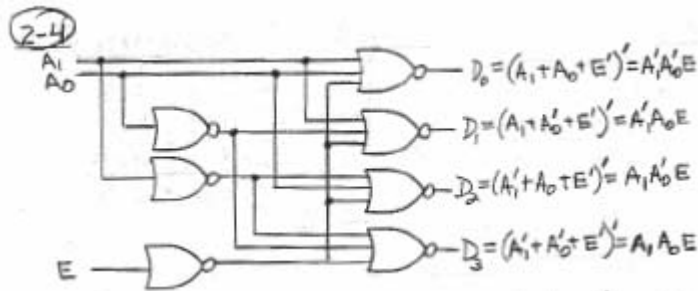
1-10 (a), 1-9 (a, b)



(1) $F = xy + z'$
 $F' = x'z + y'z$
 (2) $F = (x + z')(y + z')$



From chapter 2, pages 64 - 65
2-4, 2-6, 2-7, 2-8



From chapter 4, pages 120 – 121

4-12,

M	A	B	Sum	C _H	
0	0111	+ 0110	1101	0	7+6 = 13
0	1000	+ 1001	0001	1	8+9 = 16+1
1	1100	- 1000	0100	1	12-8 = 4
1	0101	- 1010	1011	0	5-10 = -5 (in 2's comp.)
1	0000	- 0001	1111	0	0-1 = -1 (in 2's comp.)

4-13

$$A-1 = A + 2\text{'s complement of } 1 = A + 1111$$

