3(d)(10 points) Provide a truth table where the input is $x = (a_3a_2a_1a_0)_2$ and the output is $f(x) = 2x - 3 = (b_nb_{n-1}\dots b_0)_2$, where n is determined from your answer in 3(c).

	a_3	a_2	a_1	a_0	$f(x)_{dec}$
7	0	1	1	1	11
6	0	1	1	0	9
5	0	1	0	1	7
4	0	1	0	0	5
3	0	0	1	1	3
2	0	0	1	0	1
1	0	0	0	1	-1
0	0	0	0	0	-3
-1	1	1	1	1	-5
-2	1	1	1	0	-7
-3	1	1	0	1	-9
-4	1	1	0	0	-11
-5	1	0	1	1	-13
-6	1	0	1	0	-15
-7	1	0	0	1	-17
-8	1	0	0	0	-19

2's compliment

a_3	a_2	a_1	a_0	b_5	b_4	b_3	b_2	b_1	b_0
0	0	0	0	1	1	1	1	0	1
0	0	0	1	1	1	1	1	1	1
0	0	1	0	0	0	0	0	0	1
0	0	1	1	0	0	0	0	1	1
0	1	0	0	0	0	0	1	0	1
0	1	0	1	0	0	0	1	1	1
0	1	1	0	0	0	1	0	0	1
0	1	1	1	0	0	1	0	1	1
1	0	0	0	1	0	1	1	0	1
1	0	0	1	1	0	1	1	1	1
1	0	1	0	1	1	0	0	0	1
1	0	1	1	1	1	0	0	1	1
1	1	0	0	1	1	0	1	0	1
1	1	0	1	1	1	0	1	1	1
1	1	1	0	1	1	1	0	0	1
1	1	1	1	1	1	1	0	1	1

3(e)(10 points) Use four-variable Karnaugh maps to determine minimum sums of products for each one of $(b_nb_{n-1}\dots b_0)_2$.

b_5

$a_3a_2 \backslash a_1a_0$	00	01	11	10
00	0	0	0	0
01	0	0	0	0
11	1	1	1	1
10	1	1	1	1

$F = a_3$

b_4

$a_3a_2 \backslash a_1a_0$	00	01	11	10
00	0	0	0	0
01	0	0	0	0
11	1	1	1	1
10	0	1	1	1

$F = a_3a_2 + a_3a_0 + a_3a_1$

b_3

$a_3a_2 \backslash a_1a_0$	00	01	11	10
00	1	1	0	0
01	0	0	1	1
11	0	0	1	1
10	1	1	0	0

$F = \bar{a}_2\bar{a}_1 + a_2a_1$

b_2

$a_3a_2 \backslash a_1a_0$	00	01	11	10
00	1	1	0	0
01	1	1	0	0
11	1	1	0	0
10	1	1	0	0

$F = \bar{a}_1$

b_1

$a_3a_2 \backslash a_1a_0$	00	01	11	10
00	0	1	1	0
01	0	1	1	0
11	0	1	1	0
10	0	1	1	0

$F = a_0$

b_0

$a_3a_2 \backslash a_1a_0$	00	01	11	10
00	1	1	1	1
01	1	1	1	1
11	1	1	1	1
10	1	1	1	1

$F = 1$

Problem 4(10 points)
Use a 4-to-1 multiplexer and any additional gates to realize the following four-variable function:

$$F(A,B,C,D)=\sum m(0,\ 4,6,9,11)$$

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

$F=\bar{A}\bar{C}\bar{D}+\bar{A}B\bar{D}+A\bar{B}D$

	S_1 A	S_0 B	C	D	F	
0	0	0	0	0	1	$F=\bar{C}\bar{D}$
	0	0	0	1	0	
	0	0	1	0	0	
	0	0	1	1	0	
1	0	1	0	0	1	$F=\bar{D}$
	0	1	0	1	0	
	0	1	1	0	1	
	0	1	1	1	0	
2	1	0	0	0	0	$F=D$
	1	0	0	1	1	
	1	0	1	0	0	
	1	0	1	1	1	
3	1	1	0	0	0	$F=0$
	1	1	0	1	0	
	1	1	1	0	0	
	1	1	1	1	0	

C \ D	0	1
0	1	0
1	0	1

$F=\bar{C}\bar{D}+CD$