1. Fill out the blank spaces, assuming unsigned numbers. Show steps to earn partial credits. (8 points)

1101011.11_2 = 107.75 $_{10}$ = 6B.C $_{16}$

$1\times2^6+1\times2^5+0\times2^4+1\times2^3+0\times2^2+1\times2^1+1\times2^0+1\times2^{-1}+1\times2^{-2}=107.75$

0110 ⇒ 6 1011 ⇒ B 1100 ⇒ C

72.54_{10} = 1001000.10 $_2$ = 110.42··· $_8$ = 2200.11··· $_3$

2|72, 2|36 0, 2|18 0, 2|9 0, 2|4 1, 2|2 0, 2|1 0, 0 1   0.54 × 2 = 1.08, × 2 = 0.16

8|72, 8|9 0, 8|1 1, 0 1   0.54 × 8 = 4.32, × 8 = 2.56

3|72, 3|24 0, 3|8 0, 3|2 2, 0 2   0.54 × 3 = 1.62, × 3 = 1.86

2. Fill out the blank spaces, assuming 2's complement numbers. (16 points)

-63_{10} = 1000001 $_2$ = 41 $_{16}$

−63 ⇒ 111111 ⇒ 100000 ⇒ 1000001

63_{10} = 0111111 $_2$ = 3F $_{16}$

63 ⇒ 0111111 ⇒ 0111111 ⇒ 0111111

10111011001_2 = −551 $_{10}$

10111011001 ⇒ 10111011000 ⇒ 11000100111 ⇒ −551

$EBF7_{16}$ = 1110101111110111 $_2$ = −5129 $_{10}$

E ⇒ 1110
B ⇒ 1011
F ⇒ 1111
7 ⇒ 0111

⇒ 1110101111110111 ⇒ 1110101111110110 ⇒ 1001010000001001 ⇒ −5129

3. Perform the following arithmetic operations <u>step by step</u>, verify your answers assuming 2's complement numbers: (12 points)

$(6BF8A + 93EA)_{16}$ = $(65374)_{16}$

$(10110 - 10110101)_2$ = $(1010000001)_2$

$(543 - 267)_8$ = $(254)_8$ overflow

6BF8A ⇒ 01101011111110001010
93EA ⇒ 11111001001111101010

1011001010011011101100
6 5 3 7 4

11110110
+01001011
$\cancel{1}$01000001

543 ⇒ 101100011
267 ⇒ 101011011

101100011
101001001

101010101100 ⇒ overflow
2 5 4

4. Boolean Logic Gates: exercise 1 (4 points)

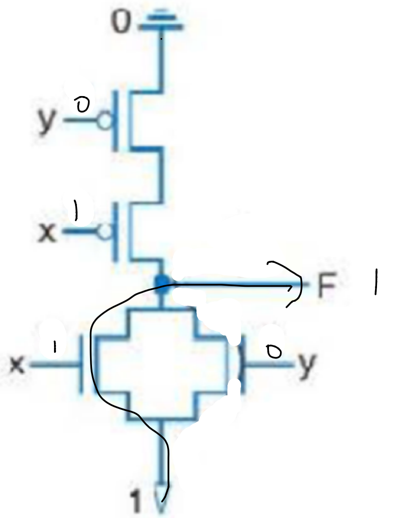
2.13 Evaluate the Boolean equation F = a AND (b OR c) AND d for the given values of variables a, b, c, and d: = ad(b+c)

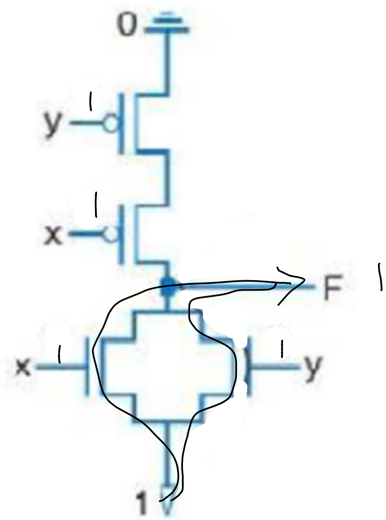
(a) a=1, b=1, c=0, d=1 1·1·(1+0)=1
(b) a=0, b=0, c=0, d=1 0·1·(0+0)=0
(c) a=1, b=0, c=0, d=0 1·0·(0+0)=0
(d) a=1, b=0, c=1, d=1 1·1·(0+1)=1

Note: "Boolean equation" means logic equation

5. Boolean Logic Gates: exercise 2 (10 points)

2.15 Show the conduction paths and output value of the OR gate transistor circuit in Figure 2.12 when: (a) x = 1 and y = 0, (b) x = 1 and y = 1.





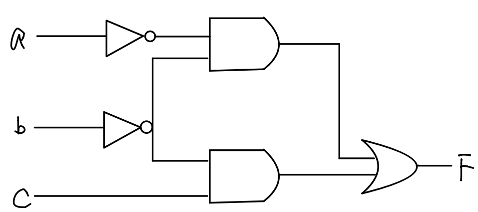
2.18 Convert each of the following equations directly to gate-level circuits:

(a) F = a'b' + b'c

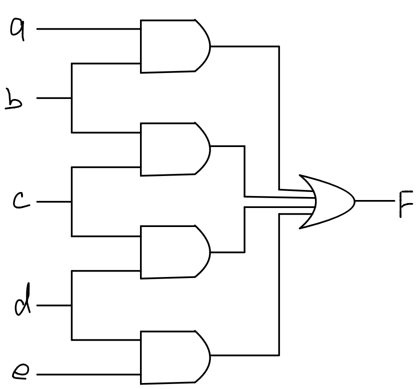
(b) F = ab + bc + cd + de

(c) F = ((ab)' + (c)) + (d + ef)'

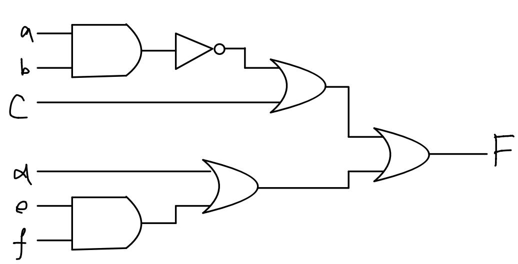
(a)



(b)



(c)

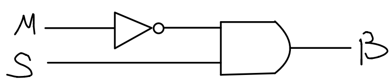


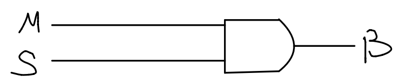
7. Boolean Logic Gates: exercise 4 (10 points)

2.21 A DJ ("disc jockey," meaning someone who plays music at a party) would like a system to automatically control a strobe light and disco ball in a dance hall depending on whether music is playing and people are dancing. A sound sensor has output S that when 1 indicates that music is playing, and a motion sensor has output M that when 1 indicates that people are dancing. The strobe light has an input L that when 1 turns the light on, and the disco ball has an input B that when 1 turns the ball on. The DJ wants the disco ball to turn on only when music is playing and nobody is dancing, and wants the strobe light to turn on only when music is playing and people are dancing. Create equations describing the desired behavior for B and for L, and then convert each to a circuit using AND, OR, and NOT gates,

$B = S \cdot M'$

$L = S \cdot M$





8. Representations of Boolean Functions: exercise 1 (10 points)

Convert each of the following Boolean equations into a truth table:

(a) F(a,b,c) = a'bc + ab
(b) F(a,b,c) = a'b
(c) F(a,b,c) = abc + ab + a + b + c
(d) F(a,b,c) = c'

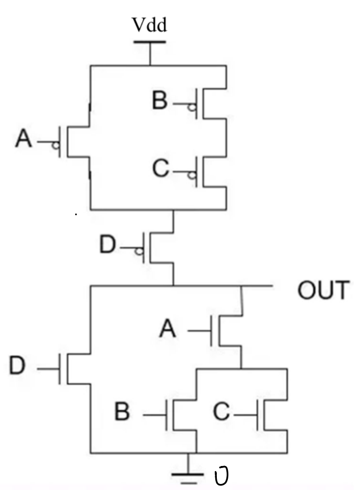
a	b	c	F(a,b,c)
1	1	1	1
1	1	0	1
1	0	1	0
1	0	0	0
0	1	1	1
0	1	0	0
0	0	1	0
0	0	0	0

a	b	c	F(a,b,c)
1	1	1	0
1	1	0	0
1	0	1	0
1	0	0	0
0	1	1	1
0	1	0	1
0	0	1	0
0	0	0	0

a	b	c	F(a,b,c)
1	1	1	1
1	1	0	1
1	0	1	1
1	0	0	1
0	1	1	1
0	1	0	1
0	0	1	1
0	0	0	0

a	b	c	F(a,b,c)
1	1	1	0
1	1	0	1
1	0	1	0
1	0	0	1
0	1	1	0
0	1	0	1
0	0	1	0
0	0	0	1

9. Build a truth table for the following circuit. (10 points)



a	b	c	d	OUT
1	1	1	0	0
1	1	0	0	0
1	0	1	0	0
1	0	0	0	1
0	1	1	0	1
0	1	0	0	1
0	0	1	0	1
0	0	0	0	1

a	b	c	d	OUT
1	1	1	1	0
1	1	0	1	0
1	0	1	1	0
1	0	0	1	0
0	1	1	1	0
0	1	0	1	0
0	0	1	1	0
0	0	0	1	0

10. Given a logic equation F = a’bc’ + bc + ab’c’, draw an output waveform for F based on the given input waveforms. (10 points)