ENGR xD52: HW b011

Due September 17th

Honor Code Policy

This homework is to be done primarily alone. If you get stuck, you may consult anyone you like after putting in real effort. Annotate collaboration per problem.

Show all work.

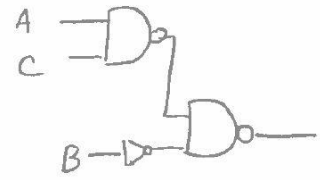
1 Boolean Logic (10 points each)

1. Simplify the boolean equations to minimal 'Sum of Products' notation.
2. Rearrange equations to only use {NOT, NAND, NOR} gates.
3. Draw the reduced and rearranged equations' circuit diagrams.

1.1 $AB + AC + \bar{A}B$

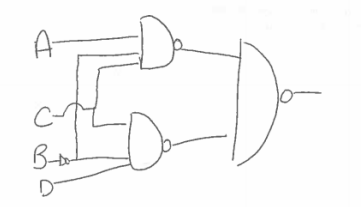
$$B + AC$$

$$\overline{(\bar{B}\overline{(AC)})}$$



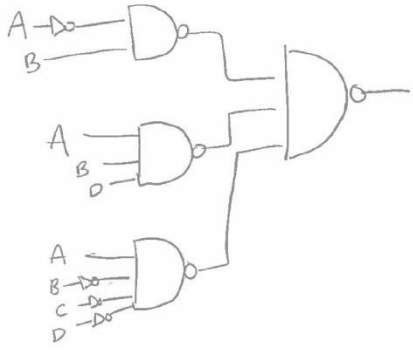
1.2 $(AD + \bar{A}C)[\bar{B}(C + B\bar{D})]$

$$(AD + \bar{A}C)[\bar{B}C + B\bar{B}\bar{D}]$$
$$(AD + \bar{A}C)[\bar{B}C + B\bar{B}\bar{D}]$$
$$(D + \bar{A}C)[\bar{B}C]$$
$$D\bar{B}C + \bar{A}C\bar{B}C$$
$$\bar{B}CD + \bar{A}\bar{B}C$$
$$\overline{(\overline{\bar{B}CD})(\overline{\bar{A}\bar{B}C})}$$



1.3 $\overline{A\bar{B}C + (\bar{A} + B + D)(AB\bar{D} + \bar{B})}$

$$\overline{A\bar{B}C + \bar{A}AB\bar{D} + \bar{A}\bar{B} + ABB\bar{D} + B\bar{B} + AB\bar{D}D + DB}$$
$$\overline{A\bar{B}C + \bar{A}\bar{B} + AB\bar{D} + D\bar{B}}$$



1.3 Truth Table									
A	B	C	D	A(~B)C	(~A)(~B)	AB(~D)	D(~B)	A(~B)C + (~A)(~B) + AB(~D) + D(~B)	~(A(~B)C + (~A)(~B) + AB(~D) + D(~B))
FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	FALSE	FALSE	TRUE	FALSE
FALSE	FALSE	FALSE	TRUE	FALSE	TRUE	FALSE	TRUE	TRUE	FALSE
FALSE	FALSE	TRUE	FALSE	FALSE	TRUE	FALSE	FALSE	TRUE	FALSE
FALSE	FALSE	TRUE	TRUE	FALSE	TRUE	FALSE	TRUE	TRUE	FALSE
FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE
FALSE	TRUE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE
FALSE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE
FALSE	TRUE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE
TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE
TRUE	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE	TRUE	TRUE	FALSE
TRUE	FALSE	TRUE	FALSE	TRUE	FALSE	FALSE	FALSE	TRUE	FALSE
TRUE	FALSE	TRUE	TRUE	TRUE	FALSE	FALSE	TRUE	TRUE	FALSE
TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	TRUE	FALSE	TRUE	FALSE
TRUE	TRUE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE
TRUE	TRUE	TRUE	FALSE	FALSE	FALSE	TRUE	FALSE	TRUE	FALSE
TRUE	TRUE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE

	CD	(~C)D	(~C)(~D)	C(~D)
AB	TRUE	TRUE		
(~A)B	TRUE	TRUE	TRUE	TRUE
A(~B)			TRUE	
(~A)(~B)				

$$\bar{A}B + ABD + A\bar{B}\bar{C}\bar{D}$$

$$\overline{\overline{\bar{A}B} * \overline{ABD} * \overline{A\bar{B}\bar{C}\bar{D}}}$$

Common Issues:

- Double Bubbles – Multiple inversions in a row
- Misapplication of Demorgan's Law – B+AC -> ~(~B~A+~C)

2 Formats (6pts each)

Show the binary representation in the specified formats:

2.1 -d3 in I8

-00000011 -> 11111100 +1 -> 11111101

2.2 (110011 I3Q3) in I8Q8

110011 -> **11111**110.011**00000**

2.3 (110011 U6) in I8Q8

110011 -> **00**110011.**00000000**

Common Issues:

Add the 1 as 2^0 instead of at the least significant bit.

Incorrectly sign extending 2.3 to have leading 1s. It was U6, the new representation should be positive

3 Addition and Subtraction (7 pts Each)

1. Convert to binary. Indicate the format.
2. Perform the math in binary.
3. Indicate the result and the resulting format.
4. Convert to Decimal.

3.1 d17+d33.

00010001 + 00100001 (U8) = 00110010 (U8) d50

3.2 d12-d15

1100 – 1111 -> 001100 + (110000 + 1) -> 001100 + 110001 -> 111101 (I6) –d3

3.3 d5.3125-d7.625

0101.0101 – 0111.1010 (I4Q4)

0101.0101 + (1000.0101 +.0001)

0101.0101 + 1000.0110

1101.1011 (I4Q4 = -2.3125)

3.4 -h10.7 + o10.7

-b10000.0111 + b1000.111 = -d7.5625

4 Multiplication (8 pts each)

Perform the following multiplications in binary. Show sign extension (on the left), zero extension (on the right), and intermediate format for intermediate terms.

4.1 (d5)*(d3)

101 * 11

0101 * 0011 (I4)

```
0000 0101   (I8)
000 0101 0
00 0000 00
0 0000 000
00001111   (I8 = d15)
```

4.2 (-d3)*(d6)

1101 * 0110 (I4)

00000000 (I8)
1111101**0**
111101**00**
00000**000**
11101110 (I8 = d-18)

4.3 (11010010 I4Q4) * (0101 I2Q2) = _____ I8Q8

11010010 (I4Q4)
* 00010100 (I4Q4)

0000000000000000 (I8Q8)
0000000000000000 (I8Q8)
1111111101001000 (I8Q8)
000000000000000 (I8Q8)
11111101001000000 (I8Q8)
0000000000000000 (I8Q8)
000000000000000000 (I8Q8)
00000000000000000 (I8Q8)
00000000**00000000** (I8Q8)

= 1111110001101000 (I8Q8)