Midterm review

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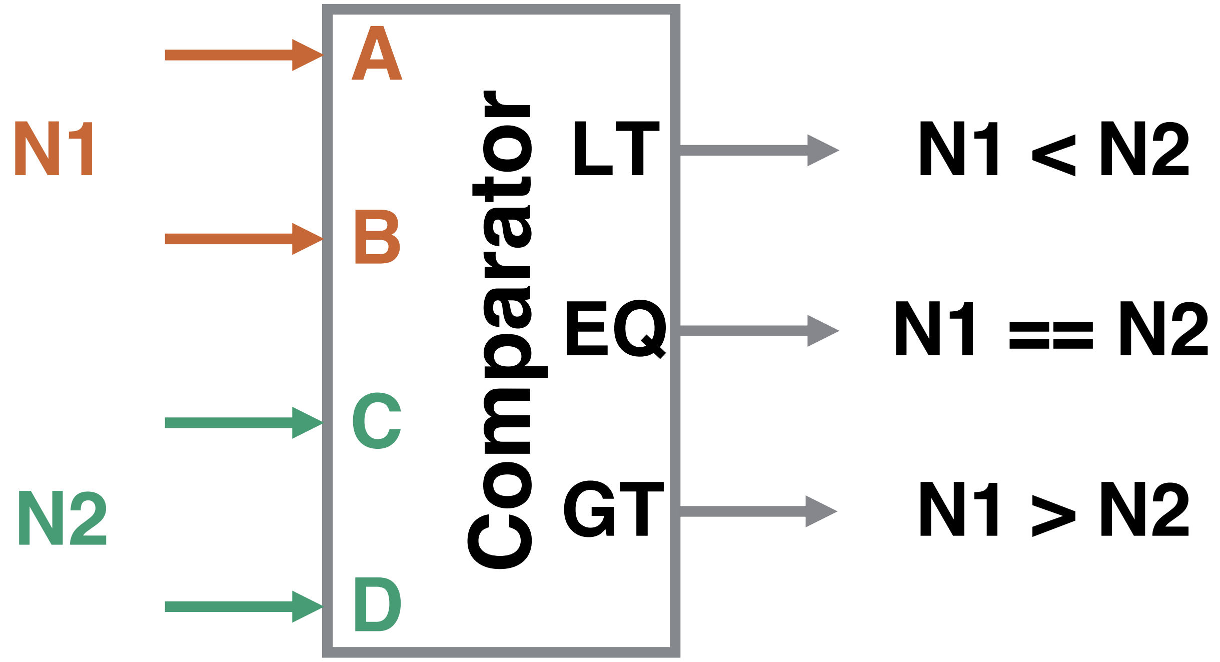
Q1: For the two-bit comparator, what's the minimum/simplest SOP presentation of LT?

Input				Output		
A	B	C	D	LT	EQ	GT
0	0	0	0	0	1	0
0	0	0	1	1	0	0
0	0	1	0	1	0	0
0	0	1	1	1	0	0
0	1	0	0	0	0	1
0	1	0	1	0	1	0
0	1	1	0	1	0	0
0	1	1	1	1	0	0
1	0	0	0	0	0	1
1	0	0	1	0	0	1
1	0	1	0	0	1	0
1	0	1	1	1	0	0
1	1	0	0	0	0	1
1	1	0	1	0	0	1
1	1	1	0	0	0	1
1	1	1	1	0	1	0



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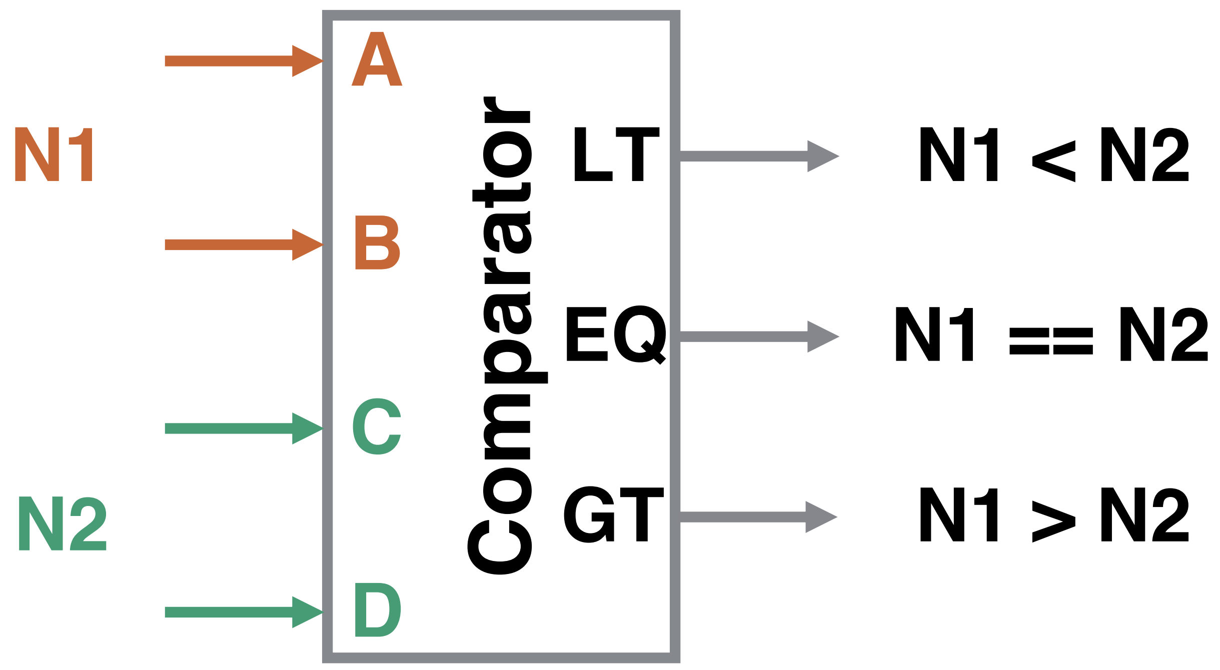

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1	0	0	0	0	0	1
1	0	0	1	0	0	1
1	0	1	0	0	1	0
1	0	1	1	1	0	0
1	1	0	0	0	0	1
1	1	0	1	0	0	1
1	1	1	0	0	0	1
1	1	1	1	0	1	0

		A'B'	A'B	AB	AB'
		00	01	11	10
C'D'	00	0	0	0	0
C'D	01	1	0	0	0
CD	11	1	1	0	1
CD'	10	1	1	0	0

A'B'D

B'CD

A'C

LT = A'B'D + A'C + B'CD

Q2: Find the minimum number of product term(s) to cover the following function and explain why.

Input			Output
A	B	C	
0	0	0	**1**
0	0	1	**1**
0	1	0	**0**
0	1	1	**0**
1	0	0	**1**
1	0	1	**1**
1	1	0	**0**
1	1	1	**0**

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1	1	0	**0**
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	A'B' 0,0	A'B 0,1	AB 1,1	AB' 1,0
C' 0	1	0	0	1
C 1	1	0	0	1

Answer: 1

Output = B'

Literal is the simplest product term and the simplest sum term.

Q3: For the function f (A, B, C) = AB + A'C, show how the function f can be implemented using a 3-to-8 binary decoder and other necessary gate(s).

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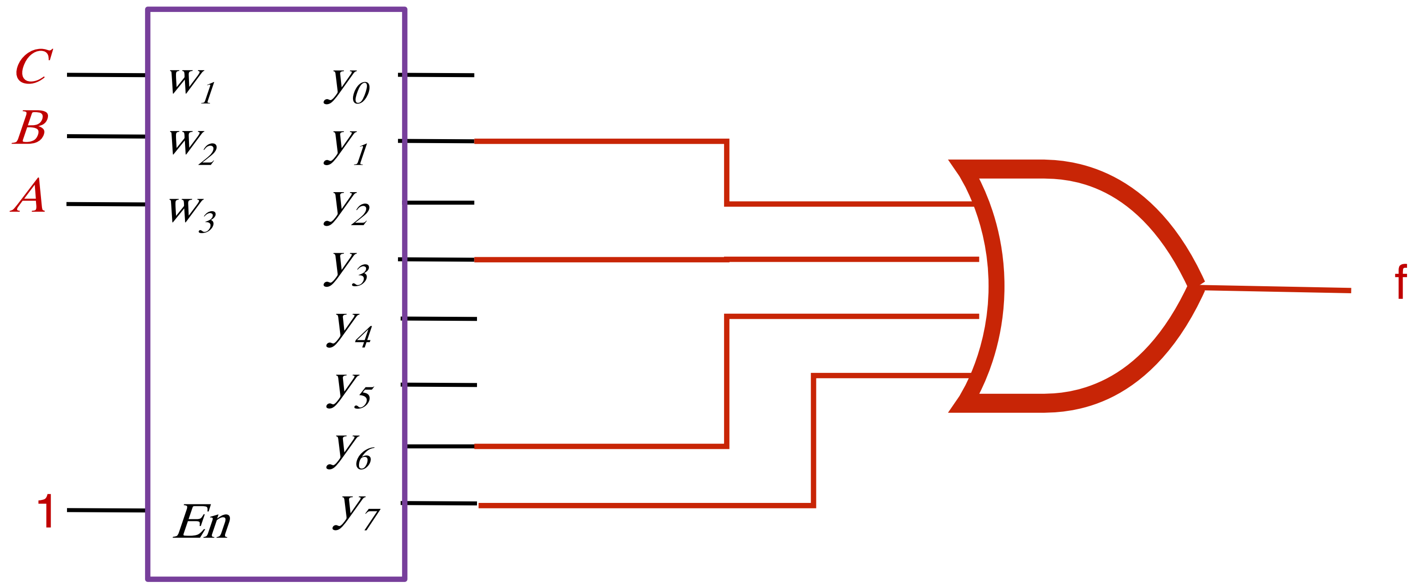
$$f(A, B, C) = AB + A'C$$
$$= ABC + ABC' + A'BC + A'B'C = m_7 + m_6 + m_3 + m_1$$



Q4: For the function f (A, B, C) = AB + A'C, show how the function f can be implemented using a MUX and gates if necessary.

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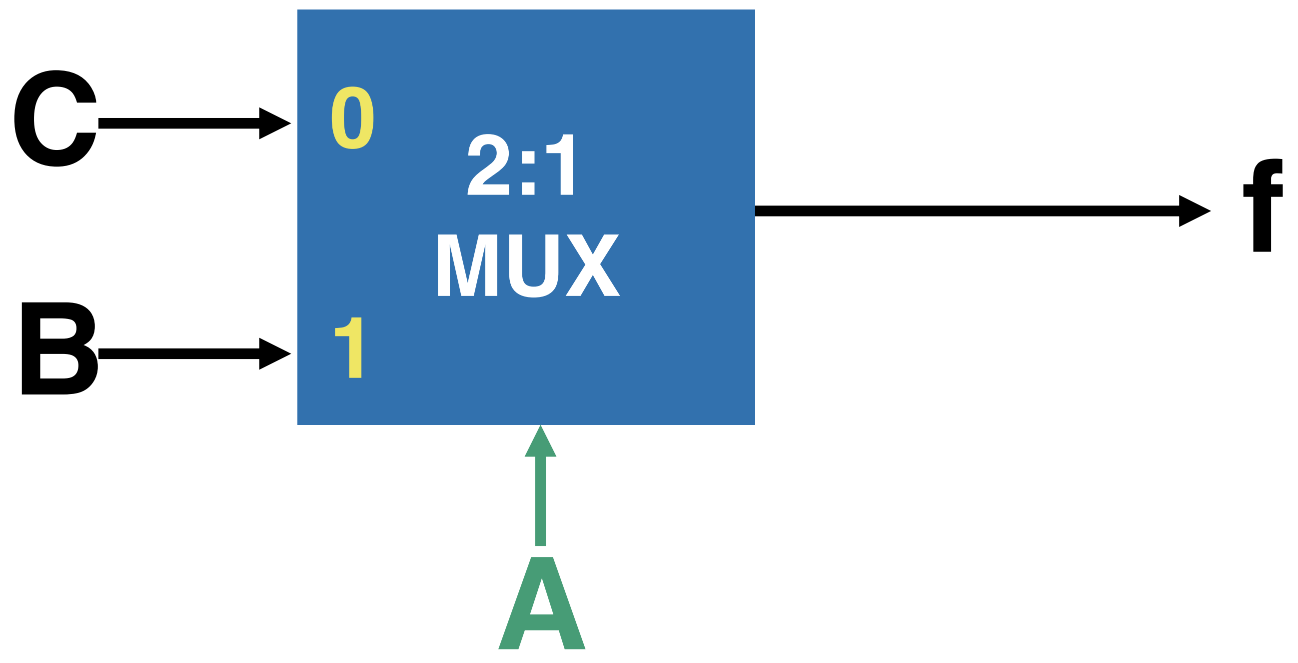

Q5: What's the value of $F(a, b, c) = c' a + (b + a) c$ when $a = 1$, $b = 0$, and $c = 1$?

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$F = 0*1 + (0+1)1 = 0 + 1*1 = 1$

Q6: The binary number representation of decimal number 70 is ?

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Q7: What’s the simplest SoP form for the function $f(a, b, c, d) = m_1 + m_2 + m_3 + m_4$

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Method 1: using Boolean algebra

$$f(a, b, c, d) = m_1 + m_2 + m_3 + m_4$$
$$= a'b'c'd + a'b'cd' + a'b'cd + a'bc'd'$$
$$= a'b'd + a'b'cd' + a'bc'd'$$
$$= (a'b'd + a'b'cd') + a'bc'd'$$
$$= a'b'(d + cd') + a'bc'd'$$
$$= a'b'(d + c) + a'bc'd'$$
$$= a'b'd + a'b'c + a'bc'd'$$

Method 2: using K-maps

		a'b'	a'b	ab	ab'
		00	01	11	10
c'd'	00	0	1	0	0
c'd	01	1	0	0	0
cd	11	1	0	0	0
cd'	10	1	0	0	0

a'bc'd'

a'b'c

a'b'd

Q8: What is a 2-input XOR gate's output value given input values a = 1, b = 0?

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1

Q9: Find the dual expression of $(X' Y + Z) W'$

The dual form is $(X' + Y)Z + W'$

Q10: What are the canonical SOP and POS (both) for each logic function. Please express each minterm and maxterm involved explicitly using the inputs, e.g., XYZ and A+B+C.

1) $F = \sum_{Y,\, Z,\, X}(3, 2, 6)$ and 2) $G(A, B, C) = \prod M(0, 3, 5, 6, 7)$

Q11: simplify $Y = \overline{A}\,\overline{B} + \overline{A}\,B\,\overline{C} + \overline{A + \overline{B}}$ as much as possible.

Q11:

$$Y = \overline{A}\,\overline{B} + \overline{A}\,B\,\overline{C} + \overline{A + \overline{B}}$$

Y = A'B' + A'BC' + A'B

= (A'B' + A'B) + A'BC'

= A' + A'BC'

= A' (1+BC')

= A' 1

= A'

Q12: Find the simplest SoP of $f(x_1, x_2, x_3) = \prod M(2, 3, 6)$

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$x_1 \backslash x_2x_3$	00	01	11	10
0	1	1	0	0
1	1	1	1	0

x_2'

x_1x_3

$f = x_2' + x_1x_3$

Q13: Perform the following operations involving eight-bit 2's complement numbers and indicate whether arithmetic overflow occurs. What are the decimal values of the minuend and subtrahend?

$$
\begin{array}{r}
01110101 \\
-\ 10110110 \\
\hline
\end{array}
$$

Q13: Perform the following operations involving eight-bit 2's complement numbers and indicate whether arithmetic overflow occurs. What are the decimal values of the minuend and subtrahend?

Solution:

```
  01110101
− 10110110
----------
```

```
   01000000
   01110101
+  01001010
-----------
   10111111
```

The last two carry-outs are different. Thus, there is overflow.

The value of the minuend is 1+4+16+32+64 = 117.
The value of the subtrahend is -(01001010) = - (2+8+64) = -74

Q14: Use Boolean algebra laws/theorems to find the simplest SoP of y.

$$y(x_1, x_2, x_3) = \sum m(0, 3, 4, 7)$$

Q15: Use K-maps to find the simplest SoP of y. Show all your work.

$$y(x_1, x_2, x_3) = \prod M(1, 3, 7, 5, 6)$$

Q16: Use a 4-to-1 MUX and logic gates to design a circuit satisfying the following input (x_1, x_2, x_3) and output (y) relationship y(x_1, x_2, x_3) =$\prod M(1, 3, 7,5, 6)$

Q17: Prove or disapprove the following equations.

(1) $ab + bc = ab'(c + c')$

(2) $abc + ab'c + a'c' = ab'c + ab'c' + abc$