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**ICS 232 Computer Organization & Architecture
Homework 3 - Chapter 3 - 10 points
Due Date: 6/7/2023**

Name: Key

Note: Please post your homework to ICS232 D2L on or before the due date.

Chapter 3 – Boolean Algebra and Digital Logic

Essential Terms and Concepts

2. Which Boolean operation is referred to as a Boolean product?

AND

3. Which Boolean operation is referred to as a Boolean sum?

OR

12. Describe the operation of a ripple-carry adder. Why are ripple-carry adders not used in most computers today?

Multiple adder as used together with the carry-out of one adder used as an input to the next adder. They are not used because they are too slow.

18. How are sequential circuits different from combinational circuits?

Combinational circuits base their output only on the inputs.

Sequential circuits base their output based on current state and input and are usually clock based.

20. What do we mean when we say that a sequential circuit is edge triggered rather than level triggered?

Edge triggered mean that the clock transitions from high to low or low to high. Level is based on the low or high state of the clock.



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24. Which flip-flop give a true representation of computer memory?

A D flip-flop. It stores one bit of information.

Exercises

2. Construct a truth table for the following:

a) $xyz + x(yz)' + x'(y+z) + (xyz)'$

b) $(x + y')(x' + z')(y' + z')$

a)

x	y	z	xyz	$x(yz)'$	$x'(y+z)$	$(xyz)'$	Sum
0	0	0	0	0	0	1	1
0	0	1	0	0	1	1	1
0	1	0	0	0	1	1	1
0	1	1	0	0	1	1	1
1	0	0	0	1	0	1	1
1	0	1	0	1	0	1	1
1	1	0	0	1	0	1	1
1	1	1	1	0	0	0	0

b)

x	y	z	$x + y'$	$x' + z'$	$y' + z'$	Product
0	0	0	1	1	1	1
0	0	1	1	1	1	1
0	1	0	0	1	1	0
0	1	1	0	1	0	0
1	0	0	1	1	1	1
1	0	1	1	0	1	0
1	1	0	1	1	1	1
1	1	1	1	0	0	0

The last row on the left should be a 1 as the sum

4. Using DeMorgan's Law, write an expression for the complement of F if

$$F(x, y, z) = (x' + y)(x + z)(y' + z)'$$

$$F(x, y, z) = (x' + y)(x + z)(y' + z)'$$

$$F'(x, y, z) = ((x' + y)(x + z)(y' + z)')'$$

$$= (x' + y)' + (x + z)' + (y' + z)''$$

$$= xy' + x'z' + (y' + z) \text{ (not simplified)}$$



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10. Show that $x = xy + xy'$

a) Using truth tables

b) Using Boolean identities

a)

x	y	xy	xy'	xy + xy'
0	0	0	0	0
0	1	0	0	0
1	0	0	1	1
1	1	1	0	1

$$\begin{aligned} \text{b) } xy + xy' &= x(y + y') \text{ Distributive} \\ &= x(1) \text{ Inverse} \\ &= x \text{ Identity} \end{aligned}$$

17. Simplify the following functional expressions using Boolean algebra and its identities.
List the identity used at each step.

a) $x(y + z)(x' + z')$

b) $xy + xyz + xy'z + x'y'z$

c) $xy'z + x(y + z')' + xy'z'$

$$\begin{aligned} \text{a) } x(y + z)(x' + z') &= x(x'y + yz' + x'z + zz') \text{ Distributive/Commutative} \\ &= xx'y + xyz' + xx'z + xzz' \text{ Distributive} \\ &= 0 + xyz' + 0 + 0 \text{ Inverse/Null} \\ &= xyz' \text{ Identity} \end{aligned}$$

$$\begin{aligned} \text{b) } xy + xyz + xy'z + x'y'z &= xy(1 + z) + (x + x')y'z \text{ Distributive} \\ &= xy(1) + (1)y'z \text{ Idempotent} \\ &= xy + y'z \text{ Identity} \end{aligned}$$

$$\begin{aligned} \text{c) } xy'z + x(y + z')' + xy'z' &= xy'z + xy'z + xy'z' \text{ DeMorgan} \\ &= xy'z + xy'(z + z') \text{ Distributive} \end{aligned}$$



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$$\begin{aligned} &= xy'z + xy'(1) && \text{Inverse} \\ &= xy'z + xy' && \text{Identity} \\ &= xy'(z + 1) && \text{Distributive} \\ &= xy'(1) && \text{Null} \\ &= xy' && \text{Identity} \end{aligned}$$

23. The truth table for a Boolean expression is shown below. Write the Boolean expression in sum-of-products form.

x	y	z	F
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	0

$$F(x,y,z) = x'y'z' + x'y'z + x'yz' + xy'z' + xy'z$$



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29. Write a simplified expression for the Boolean function defined by each of the following Kmaps.

a)

x \ yz	00	01	11	10
	0	1	1	1
1	1	0	0	0

b.

x \ yz	00	01	11	10
	0	1	0	1
1	1	0	0	0

c.

x \ yz	00	01	11	10
	0	1	0	1
1	1	0	1	1



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a) $x' + xy'z'$

	yz			
	00	01	11	10
x				
0	1	1	1	1
1	1	0	0	0

b) $x + y'z'$

	yz			
	00	01	11	10
x				
0	1	0	0	1
1	1	0	0	0

a) should be $x' + y'z'$

b) should be $x'z' + y'z'$

c) $z' + xy$

	yz			
	00	01	11	10
x				
0	1	0	0	1
1	1	0	1	1

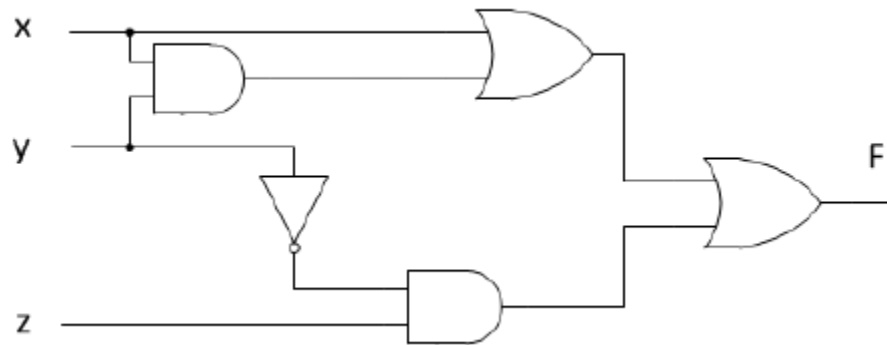


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46. Draw the combinational circuit that directly implements the following Boolean expression:

$$F(x,y,z) = x + xy + y'z$$



51. How many inputs does a decoder have if it has 64 outputs?

6 inputs.

52. How many control lines does a multiplexer have if it has 32 inputs?

5 control lines.

Write a simple C program to sum the entries in an array and print out the sum and the average.

```
#include <stdio.h>
#include <string.h>

int main(int argc, char ** argv)
{
    int average;
    int i;
```



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```
int size;
int sum;

static int numbers[] = {1, -1, 100, 32, 64, -96};

size = sizeof(numbers) / sizeof(numbers[0]);
sum = 0;
for (i = 0; i < size; i++) {
    sum += numbers[i];
}

average = sum / size;

printf("Sum = %d, Average = %d\n", sum, average);

return (0);
}
```

Prepare for next class by reading Chapter 4 – MARIE: An Introduction to a Simple Computer