Lab Notebook
27 Sept 2018
EECT 112

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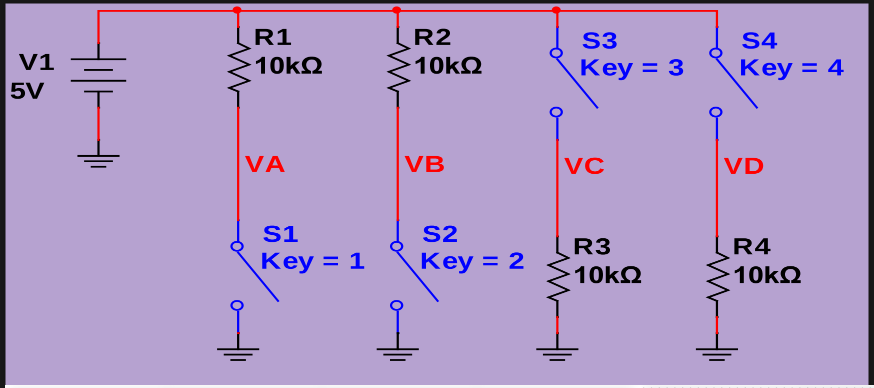
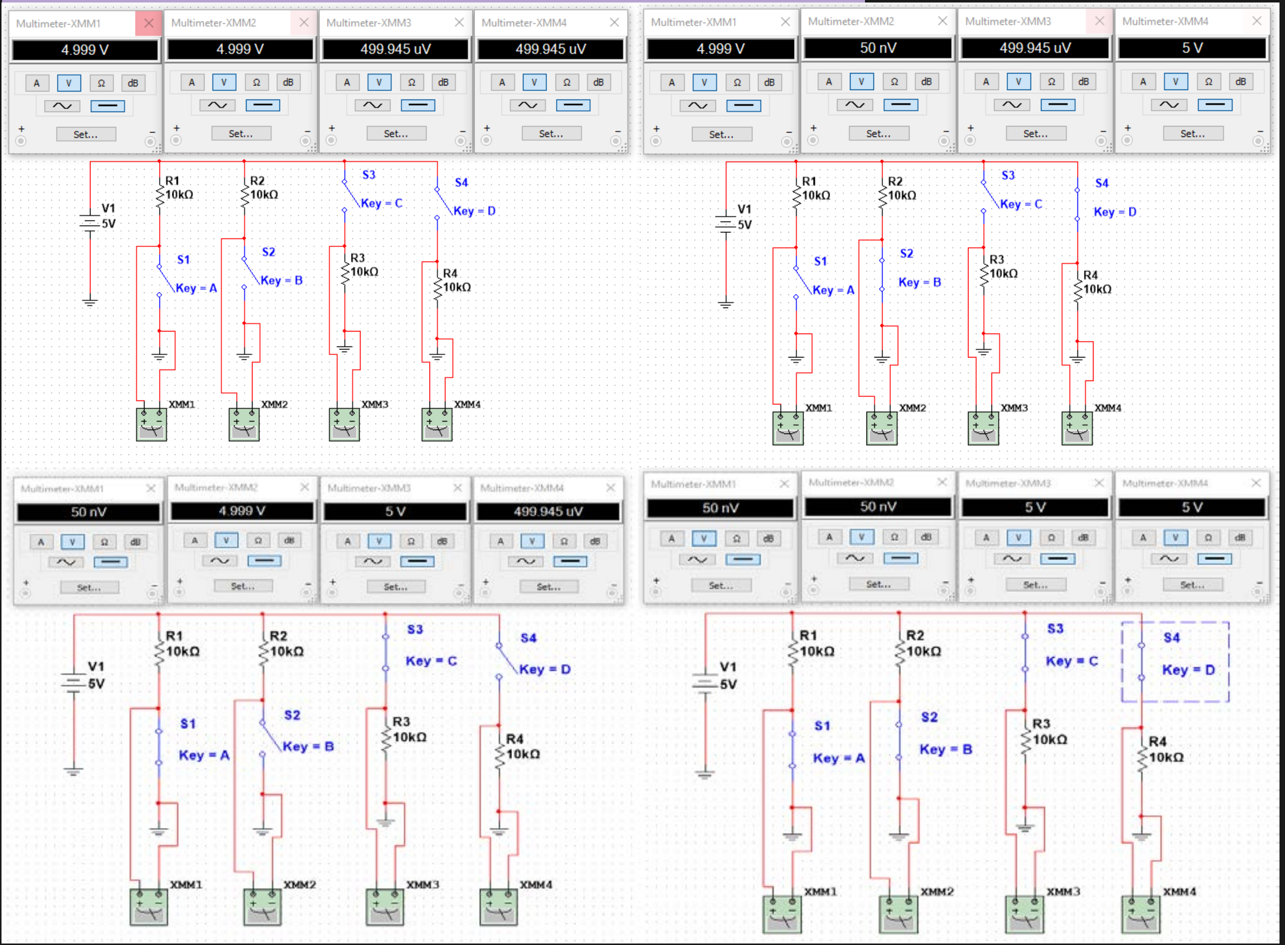
Lab 1 – Logic Levels – 30 Aug 2018

- Purpose:
  - Learn how to create logic levels for digital circuits using switches and resistors.
- Equipment Used:
  - Multisim
  - 1- Digital multi-meter
  - 4 – 10 k Ω resistors
  - 1 – Position dip switch

Lab 1 - Logic Levels

Step 1: Using Multisim program to create and simulate the following circuit in various positions.





Lab 1 – Logic Levels

Step 2: Create the circuit in the lab and take measurements in various positions (No picture were taken during this lab).

Step 3: Display results in given tables.

Simulated				Test			
S1	S2	VA	VB	S1	S2	VA	VB
open	open	4.999V	4.999V	open	open	5V	5V
open	closed	4.999V	50nV	open	closed	5V	.008V
closed	open	50nV	4.999V	closed	open	.008V	5V
closed	closed	50nV	50nV	closed	closed	.008V	.008V

Table 1 (Simulation vs Test)

Simulated				Test			
S3	S4	VC	VD	S3	S4	VC	VD
open	open	499.945uV	499.945uV	open	open	.008V	.008V
open	closed	499.945uV	5V	open	closed	.008V	5V
closed	open	5V	499.945uV	closed	open	5V	.008V
closed	closed	5V	5V	closed	closed	5V	5V

Table 2 (Simulation vs Test)

Lab 1 – Logic Levels

- One of the first things that was pointed out to us during this lab was we did not test the resistors for accuracy before building our circuit. Because of where the power source is placed is affecting how the power going through the resistors.

Lab 2 – Number conversions – 9 Sept 2018

- Purpose:
  - Learn how to convert numbers from one base to another.
- Equipment used:
  - Excel
- Process:
  - Using slides and excel sheets provided to fill in the values in the tables including max and mins of decimal values in different number bases.

Lab 2 – Number Conversions

5 & 8 bit Binary => Decimal

2^4	2^3	2^2	2^1	2^0						2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0		
0	0	0	0	0						1	1	1	1	1	1	1	1		
16	8	4	2	1						128	64	32	16	8	4	2	1		
0	0	0	0	0	=	0				128	64	32	16	8	4	2	1	=	255
00000					=	0				11111111								=	255

5 Bit Binary Min	**00000**	**Decimal value =**	**0**
5 Bit Binary Max	11111	Decimal value =	31
8 Bit Binary Max	00000000	Decimal value =	0
8 Bit Binary Min	11111111	Decimal value =	255

Summary

For each binary position that holds a '1' this value is held with a 2 to the power of the position. These powers start at 0 on the furthest right position going up to the left. Therefore, the more bits you have the higher the powers will be. Once you have the all the 2's to the correct power for the '1' values of the binary you then add across to get the decimal value.

Lab 2 – Number Conversions

Reverse Process

45	101101	2^5	2^4	2^3	2^2	2^1	2^0	
		5	4	3	2	1	0	
		32	16	8	4	2	1	
		1	0	1	1	0	1	
	remainder	13	13	5	1	1	0	
76	1001100	2^6	2^5	2^4	2^3	2^2	2^1	2^0
		6	5	4	3	2	1	0
		64	32	16	8	4	2	1
		1	0	0	1	1	0	0
	remainder	12	12	12	4	0	0	0

6 Bit Binary Max	111111	Decimal value =	63
7 Bit Binary Max	1111111	Decimal value =	127

Summary

Using the powers of 2 that will add up to the number that you start with in decimal to find which position of the ones and zeros in binary should be. So for every value of 2 that you do not use there will be a zero in that positions and a one for the positions that you use.

Ex: 32+8+4+1=45

Lab 2 – Number Conversions

Repeated Division

25	11001						
	12.5	12					1
	6	6				0	
	3	3			0		
	1.5	1		1			
	0.5	0	1				
			1	1	0	0	1

Min Decimal No	0	Binary value =	00000
Max Decimal No	31	Binary value =	11111

Summary

Starting with a decimal number, you divide that by 2. If the result of this division is an whole number this leaves no remainder making the binary value for that position 0. If this result is not whole then there is a remainder of one for the position. This process is repeated until you can no longer divide by 2.

Lab 2 – Number Conversions

Hexadecimal Number System

37	100101							
	18.5	18						1
	9	9					0	
	4.5	4				1		
	2	2			0			
	1	1		0				
	0.5	0	1					
			1	0	0	1	0	1

Min Decimal No	**0**	**Binary value =**	**00000**
Max Decimal No	63	Binary value =	11111

Summary

- Given the decimal number that needs to be converted to binary, take this number and divide it by 2. If the result of this division has a number and a half keep the number and the half then turns to 1 in binary. That number that you have kept will then be divided. If there is no half for this division this keep that number and the binary will be a 0.

Lab 2 – Number Conversions

Hex to Decimal

356	854	16^2	16^1	16^0		
		2	1	0		
		256	16	1		
		3	5	6		
		3	5	6		
		768	80	6	=	854
2AF	687	16^2	16^1	160		
		2	1	0		
		256	16	1		
		2	A	F		
		2	10	15		
		512	160	15	=	687

Min Hexadecimal No	**0**	**Decimal value =**	**0**
Max Hexadecimal No	FFF	Decimal value =	4095

Summary

- Each place for the hex system is a position in decimal as a 16th to a power for each position. There is 1-9 in the hex system then 10-15 are replaced with letter A-F. So if you have a 2 in the first hex position then multiply this by 16 squared, then A in the second position you must multiply 10 by 16 to the first and F in the last position must multiply 15 by 16 to the zero.

Lab 2 – Number Conversions

Decimal to hex

423	1A7				
	26.4375	26			7
	1.625	1		10	
	0.0625	0	1		
			1	10	7
			1	A	7

Hexadecimal	Decimal
000	0
03F	63
07F	127
0FF	255
FFF	4095

Summary

- Take the given decimal number and divide it by 16. this product should be an whole number so you must take out numbers until you receive a whole number as your answer. The numbers that you take out are then your remainder which will then be your number in hex for each position time that you divide by 16 if the remainder is 10-15 if will then be replaced by A-F.

Lab 2 – Number Conversions

Binary to hex

378	17A						HEX	BINARY
	23.625	23			10		0	0000
	1.4375	1		7			1	0001
	0.0625	0	1				2	0010
	Step 1 =>		1	7	10		3	0011
							4	0100
	Step 2 =>		1	7	A		5	0101
							6	0110
	Step 3 =>		0001	0111	1010		7	0111
							8	1000
	Step 4 =>		1	7	A		9	1001
							A	1010
							B	1011
							C	1100
							D	1101
							E	1110
							F	1111

Max Decimal value =	**4095**
Hexadecimal value =	FFF
Binary value =	1111 1111 1111

Summary

- This method is using grouping of binary numbers to the correlating number in hex form. This would be similar to changing binary to decimal except for the numbers between 10-15 will then be replaced with the letters between A-F

Lab 2 – Number Conversions

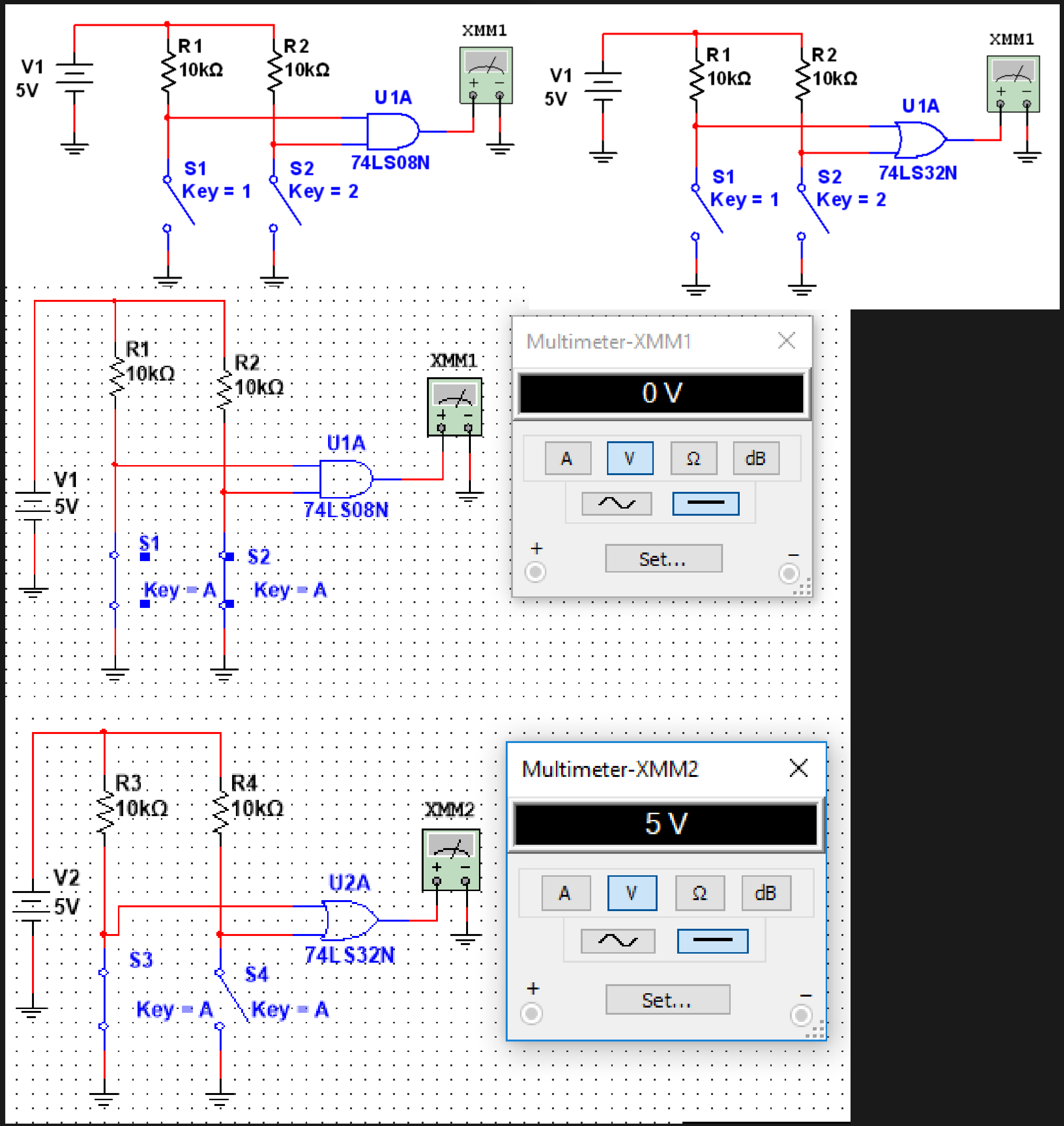
- Observations
  - There are many ways to change the numbers from one counting system to another. Each system uses different types of polynomial functions to convert the numbers. It is interesting that there are different values that cannot be recognized in other systems of counting, once you type in something more than the max value it causes the equations to crash.

Lab 3 – Logic Gates – 13 Sept 2018

- Purpose:
  - Learn how to test AND and OR logic gates.
- Equipment used:
  - 1 – Digital Multi-meter
  - 2 – 10Kohm
  - 1 – 4 position dip switch
  - 1 – 74LS08
  - 1 – 74LS32

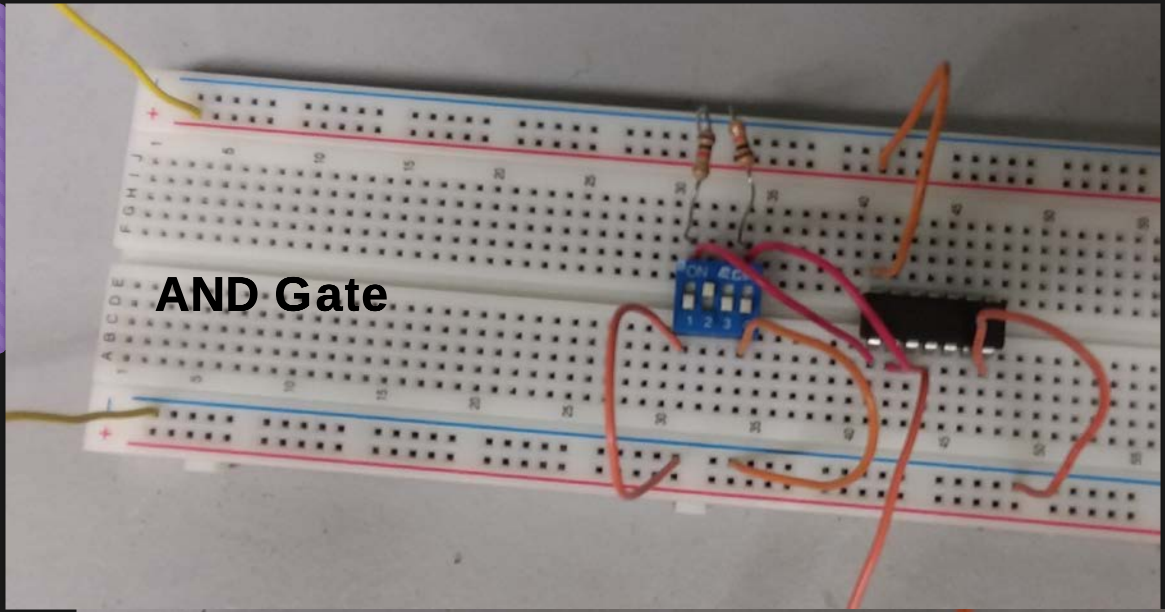
Lab 3 – Logic Gates

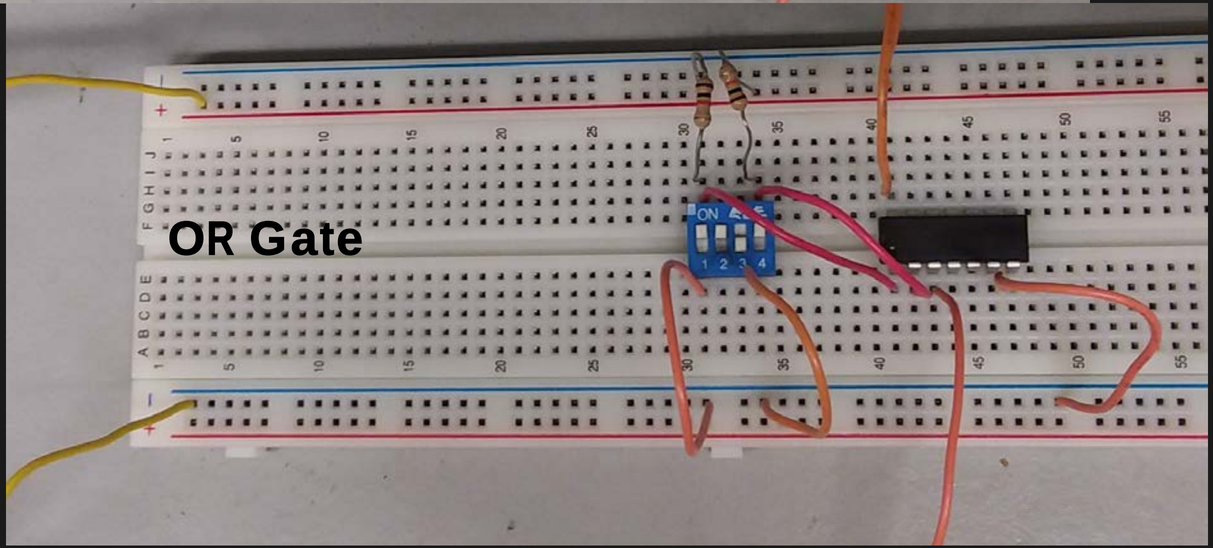
Step 1: Using MultiSim to simulate the given circuit in various positions with the AND gate and the OR gate.



Lab 3 – Logic Gates

Step 2: Create real life wiring to simulate the wiring diagram made in MultiSim to compare results. We had to use Data sheets in order to wire these gates correctly.





Lab 3 – Logic Gates - Results

AND Gate

S1	S2	Simulated Output	Test Output
Open	Open	5	4.176
Open	Closed	0	0.1436
Closed	Open	0	0.1436
Closed	Closed	0	0.1435

OR Gate

S1	S2	Simulated Output	Test Output
Open	Open	5	4.199
Open	Closed	5	4.199
Closed	Open	5	4.199
Closed	Closed	0	0.1351

Lab 3 – Logic Gates

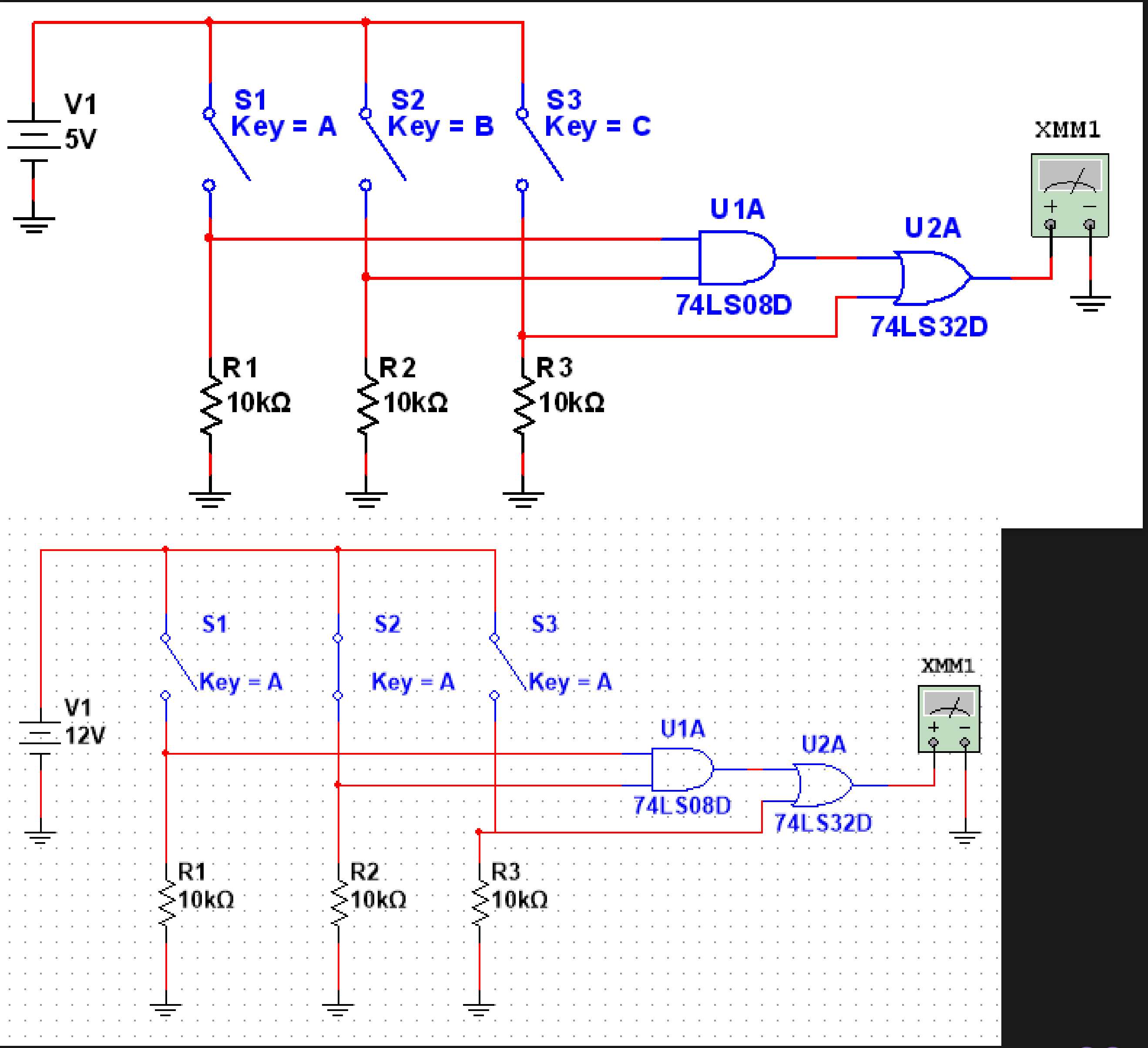
- Observation:
  - The first thing that we did was ensure that all the equipment was working properly by measuring resistor for proper tolerance. Power going into board is at 5.1 volts, showing power is dropping 1 volt through the circuit due to resistance and wiring. We notice the difference between the AND/OR gates: The AND gate only supplies power if both switches are closed and the OR gate supplies power as long at one switch is closed.

Lab 4 – Lecture3bSlide3 – 27 Sept 2018

- Purpose:
  - Learn more about describing Logic Circuits algebraically.
- Equipment:
  - 1 – Digital Multi-meter
  - 3 – 10Kohm
  - 4 - position dip switch
  - 1 – 74LS08
  - 1 – 74LS32

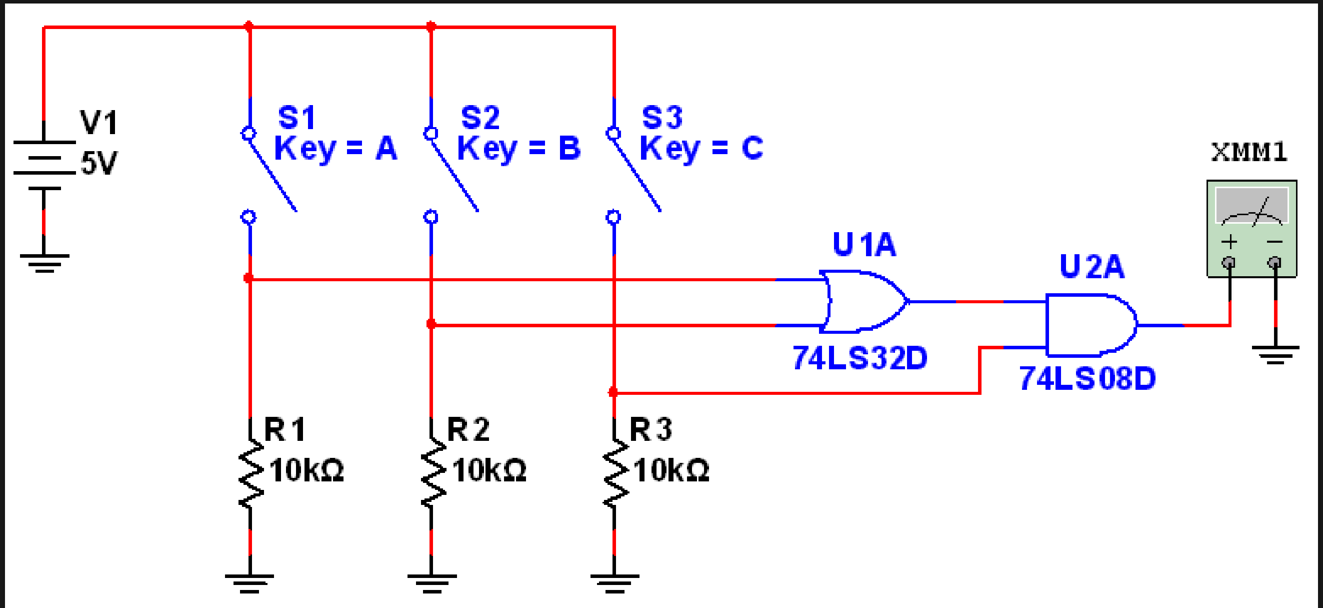
Lab 4 – Lecture3bSlide3

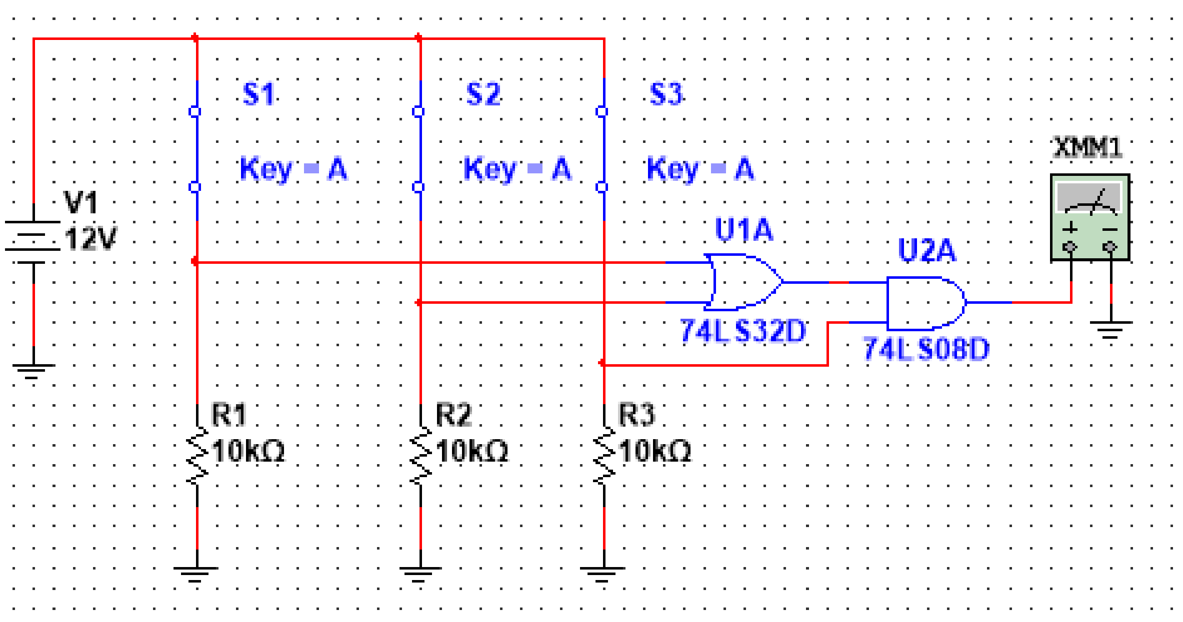
Step 1: Creating the simulation given with inputs going first to the AND gate and than into the OR gate to measure output voltage with a multi-meter with various inputs.



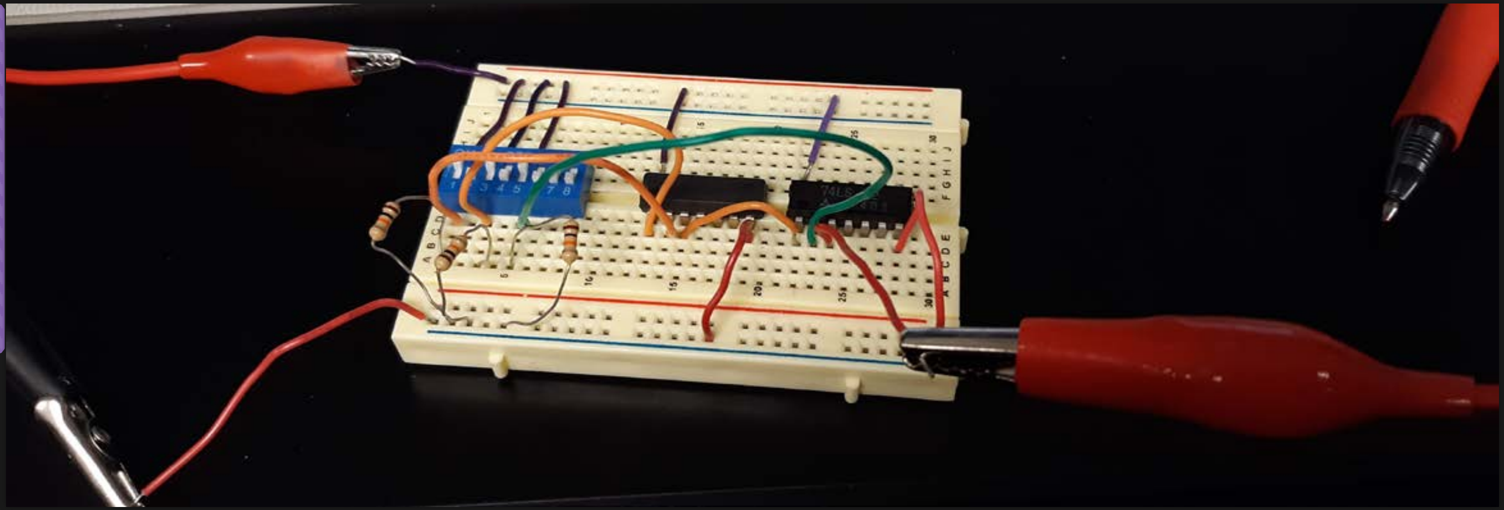
Lab 4 – Lecture3bSlide3

Step 2: Creating the simulation given the inputs going first to the OR gate then going into the AND gate to read the output voltage with the multi-meter.





Lab 4 – Lecture3bSlide3



Step 3: Create the simulation in the lab to compare the results. The data sheets were used as references to wire the AND/OR gates. We used the same set up for each type of circuit then just switched the gates for the same wiring.

Lab 4 - Lecture3bSlide3 - Results

AND → OR

			Simulated	Test
			Output	Output
S1	S2	S3		
Open	Open	Open	0	0.077
Open	Open	Closed	5	4.41
Open	Closed	Open	0	1.42
Open	Closed	Closed	5	4.41
Closed	Open	Open	0	1.51
Closed	Open	Closed	5	3.84
Closed	Closed	Open	5	4.40
Closed	Closed	Closed	5	4.40

OR → AND

			Simulated	Test
			Output	Output
S1	S2	S3		
Open	Open	Open	0	0.165
Open	Open	Closed	0	0.165
Open	Closed	Open	0	1.416
Open	Closed	Closed	5	4.38
Closed	Open	Open	0	1.42
Closed	Open	Closed	5	4.38
Closed	Closed	Open	0	1.40
Closed	Closed	Closed	5	4.38

Lab 4 - Lecture3bSlide3

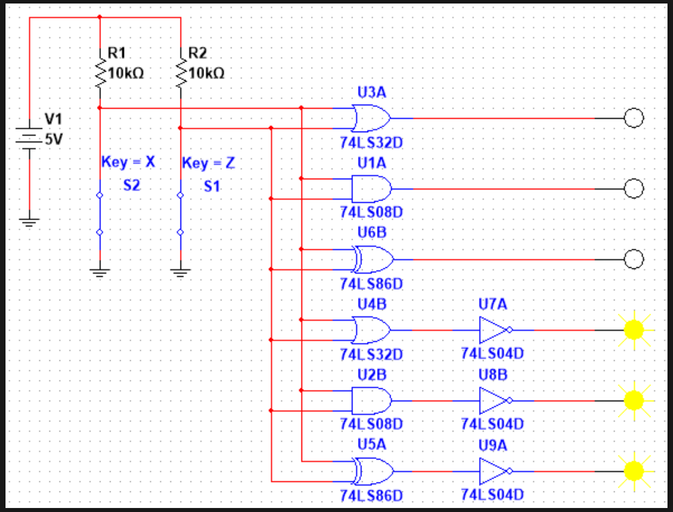
- Observation:
  - During the initial assembly of our of this circuit we were getting bad reading. We spent time trouble shooting our whole circuit to find that that one of our gates were putting out bad values. This ended us with getting a new gate which fixes the error. Our values did seem to be jumping around quite a bit but everything was in spec of the highs and lows.

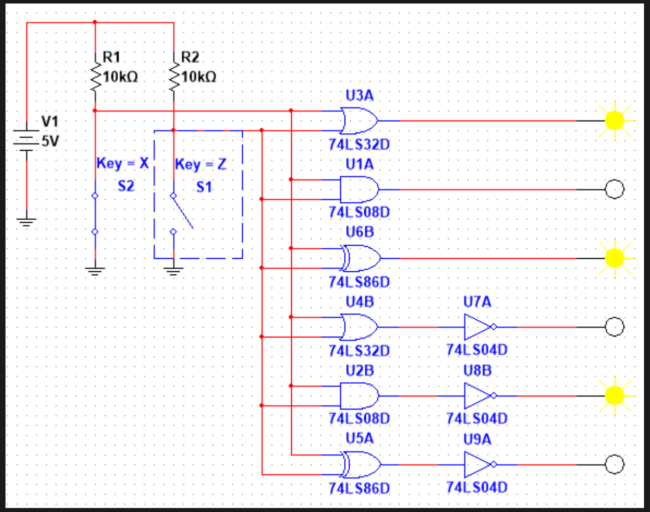
Lab 5 – Two Input Gates – 4 Nov 2018

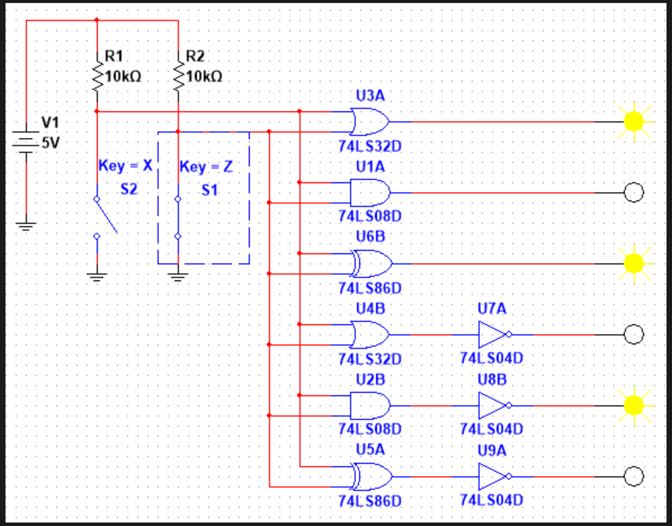
- Purpose:
  - Learn how two input logic gates work using digital ICs, switches and resistors
- Equipment:
  - 1 – Digital Multi-meter
  - 2 - 10 kOhm resistors
  - 1 – 4 position dip switch
  - 1- 74LS04, 74LS08, 74LS32, 74LS86

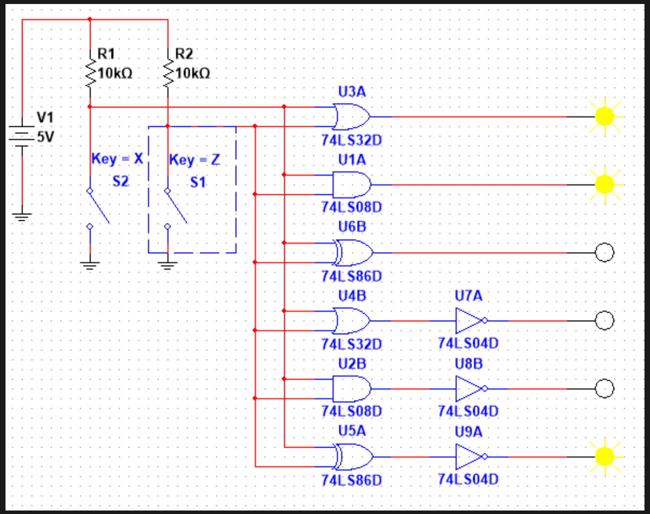
Lab 5 – Two Input Gates

Step 1: Using MultiSim, create the given schematic, creating two varying inputs for each gate being tested and take note of the outputs. In this case there are 4 possibilities.



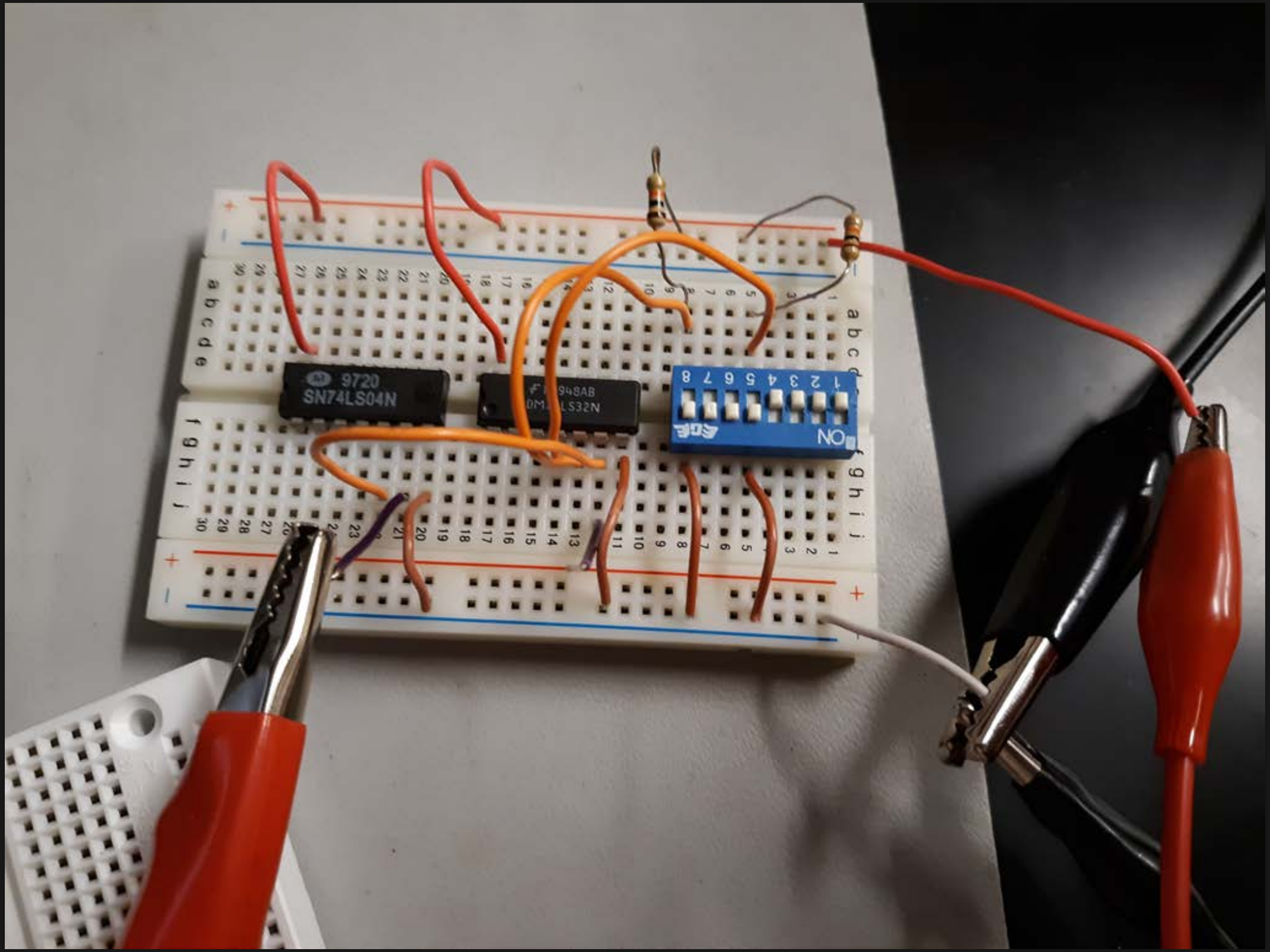






Lab 5 – Two Input Gates

Step 2: Create the same circuit in the lab using the materials provided. Then compare the results to the simulation. This process included using lab sheets to properly wiring different gates.



Lab 5 – Two input gates - Results

Simulated					Test				
A =	0	0	1	1	A =	0	0	1	1
B =	0	1	0	1	B =	0	1	0	1
OR	0	1	0	1	OR	0	1	0	1
AND	0	0	1	1	AND	0	0	1	1
XOR	0	1	0	0	XOR	0	1	0	0
NOR	1	0	1	0	NOR	1	0	1	0
NAND	1	1	0	0	NAND	1	1	0	0
XNOR	1	0	1	1	XNOR	1	0	1	1

- Our high reading was generally around 4.2487V and our low reading was around 0.1055V

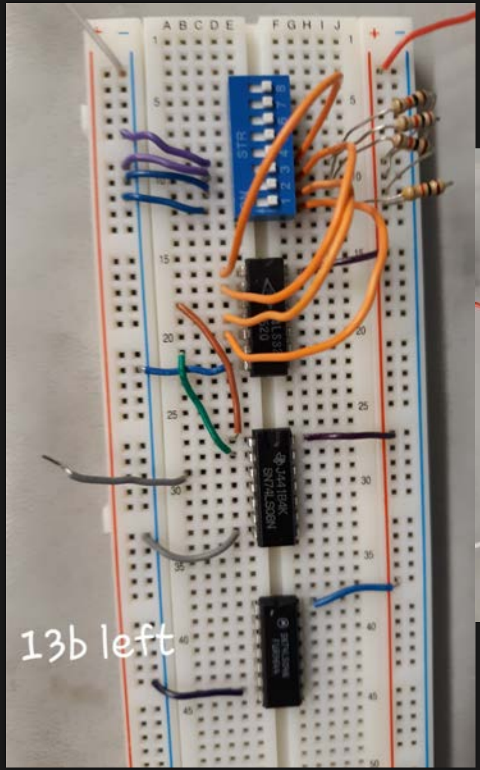
Lab 5 – Two input Gates

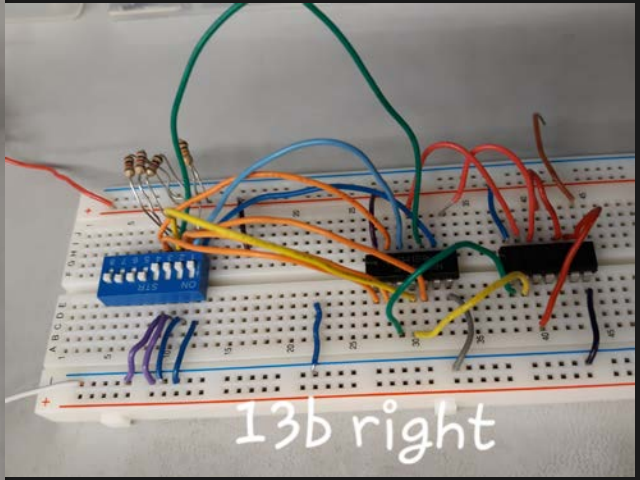
- Observations:
  - The gates acted just as we suspected they would. All the resistors and gates measured within there tolerance. We originally started with a large board finding this harder to follow and switch things around. We then stuck with a small board only two gates at a time.

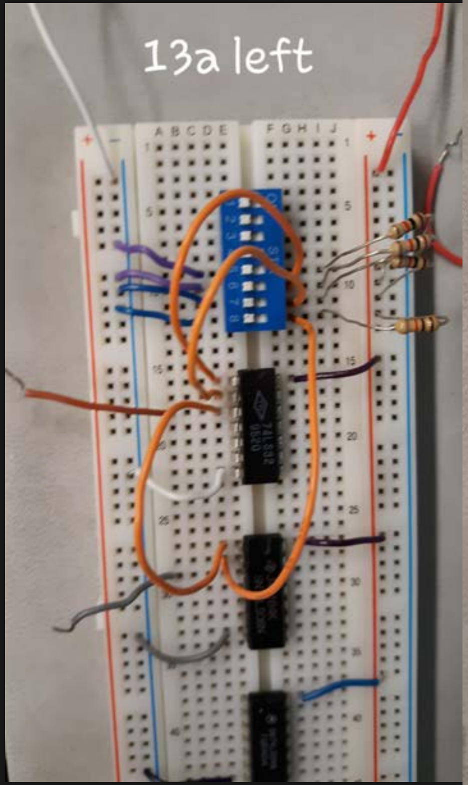
Lab 6 – Theorems – 1 Nov 2018

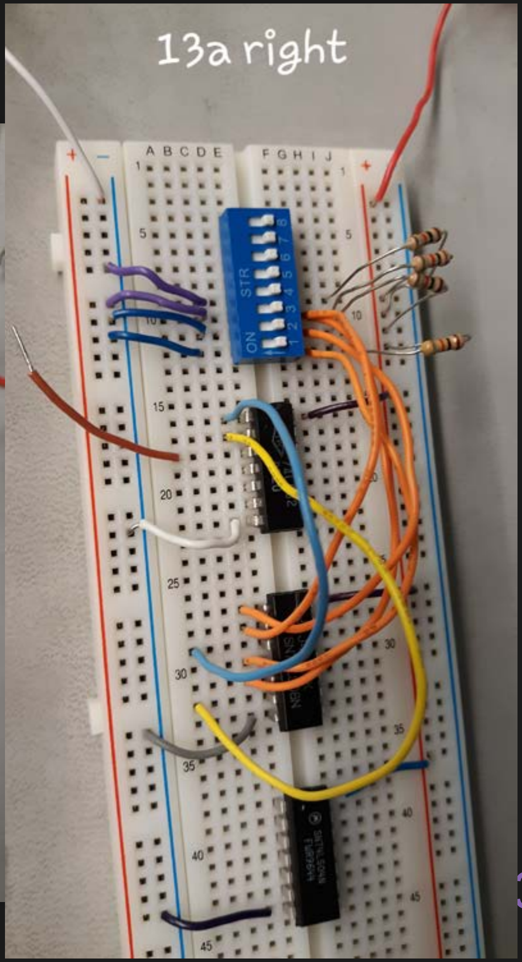
- During this lab we used Excel, MultiSim and Lab time and space to prove the given theorems.
- All this information was provided in the midterm.
- The pictures from this lab will be provided in the following slides

Lab 6 - Theorems - Pictures

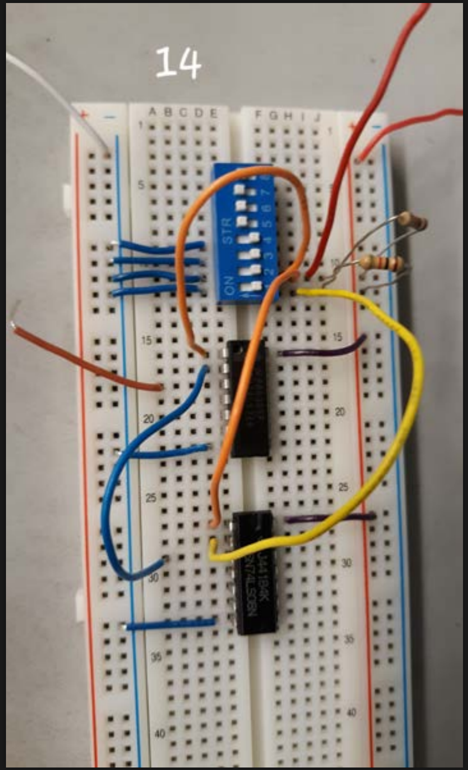


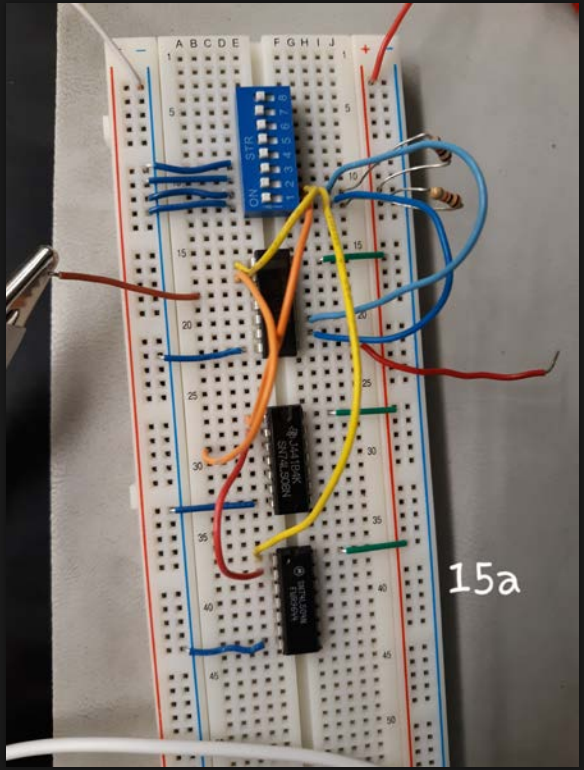


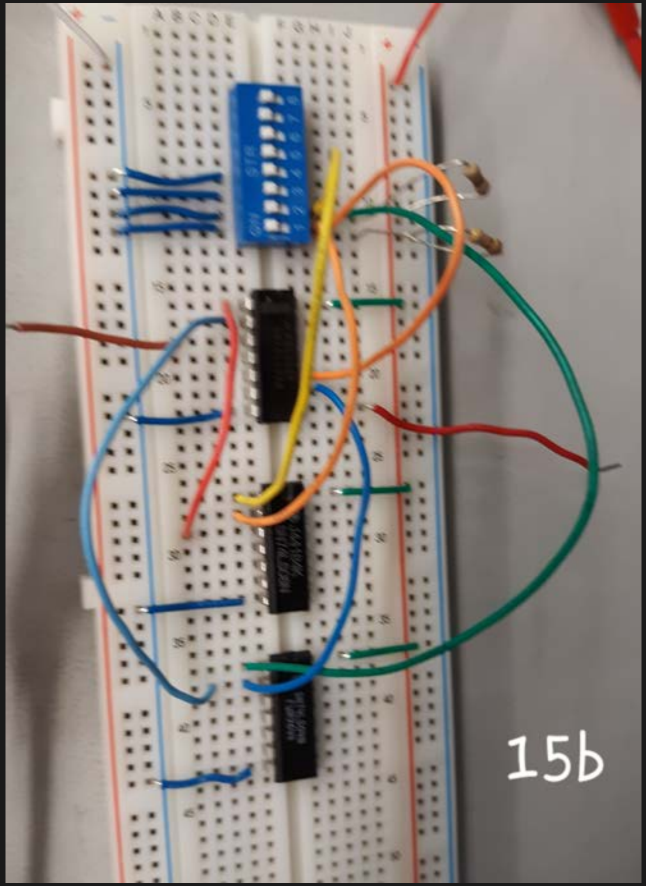




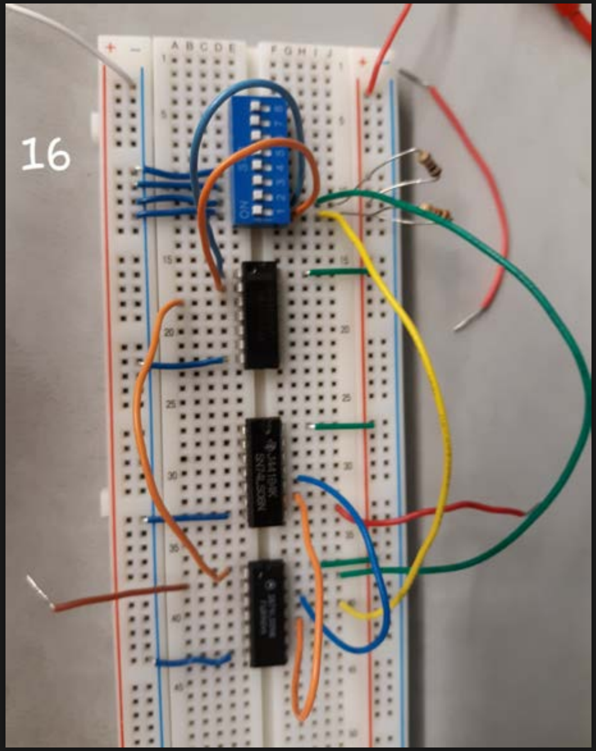
Lab 6 – Theorems - Pictures

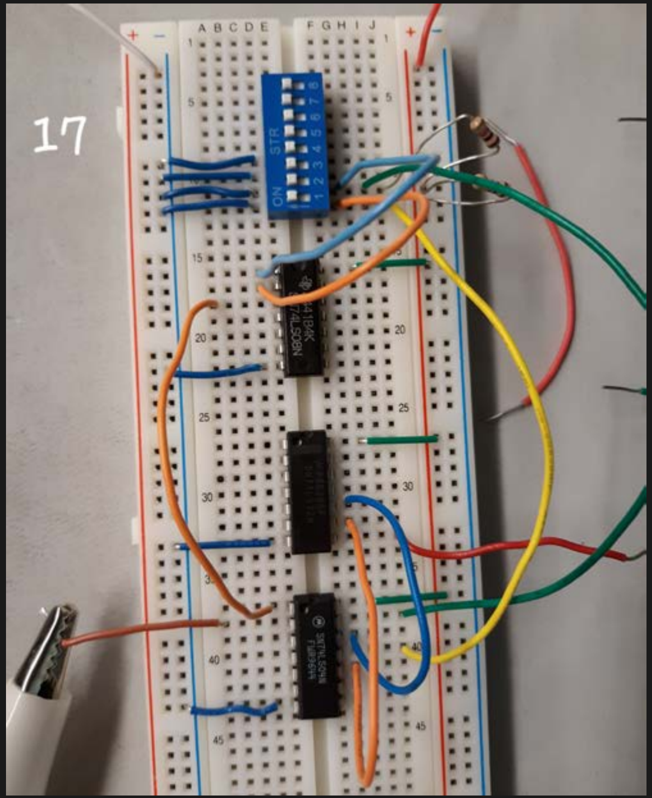






Lab 6 - Theorems





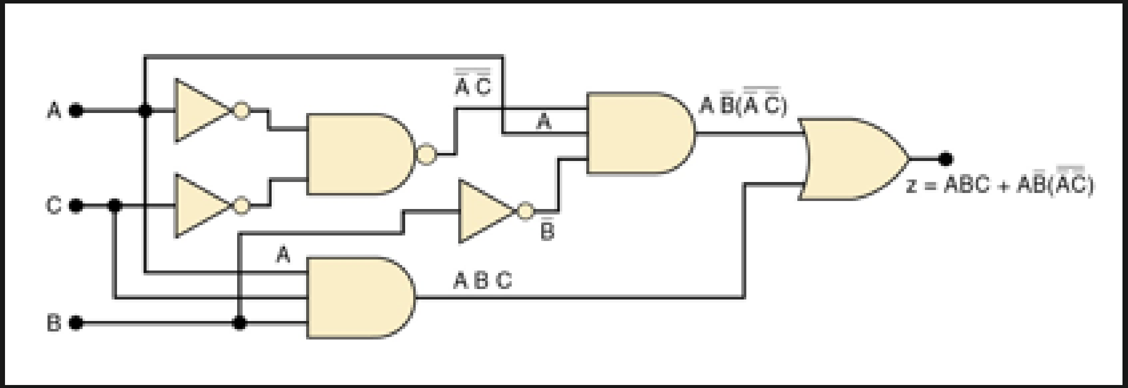
- Observations:
  - All of the circuits built had the same expected results as the measured results.
  - Having the expected results done before we went to the lab help ensure the we had built our circuits properly.

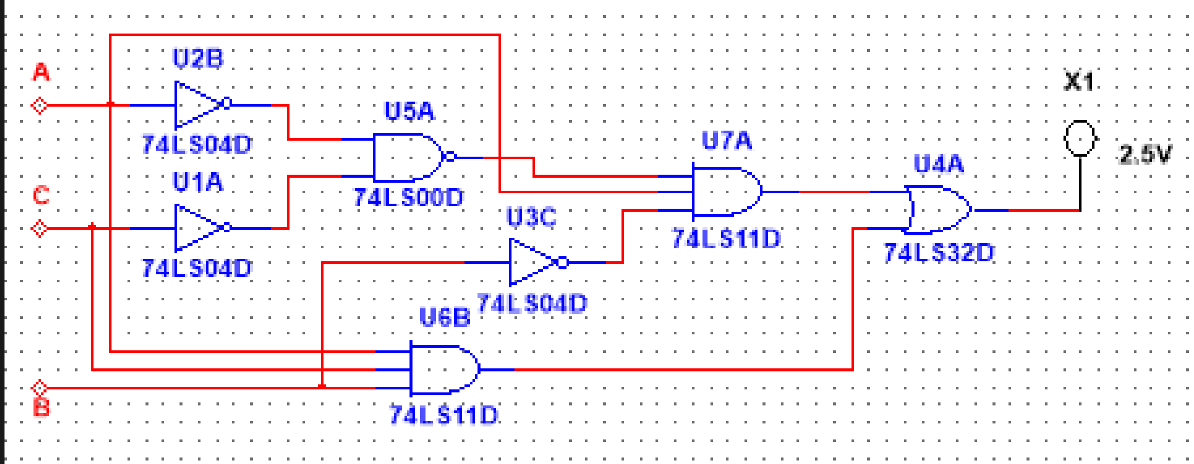
Lab 7 – Circuit Reduction – 8 Nov 2018

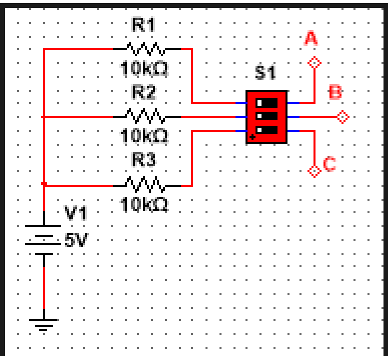
- Purpose:
  - Learn how to reduce a circuit design down to the smallest size using the 17 Theorems and Karnaugh maps. Part 2 will explore how to reduce the circuit.
- Equipment used:
  - 1- Digital Multi-meter
  - 3 – 10kOhm Resistors
  - 1- 4 position dip switch
  - 1 – 74LS04, 74LS00, 74LS11, 74LS32

Lab 7 - Circuit Reduction

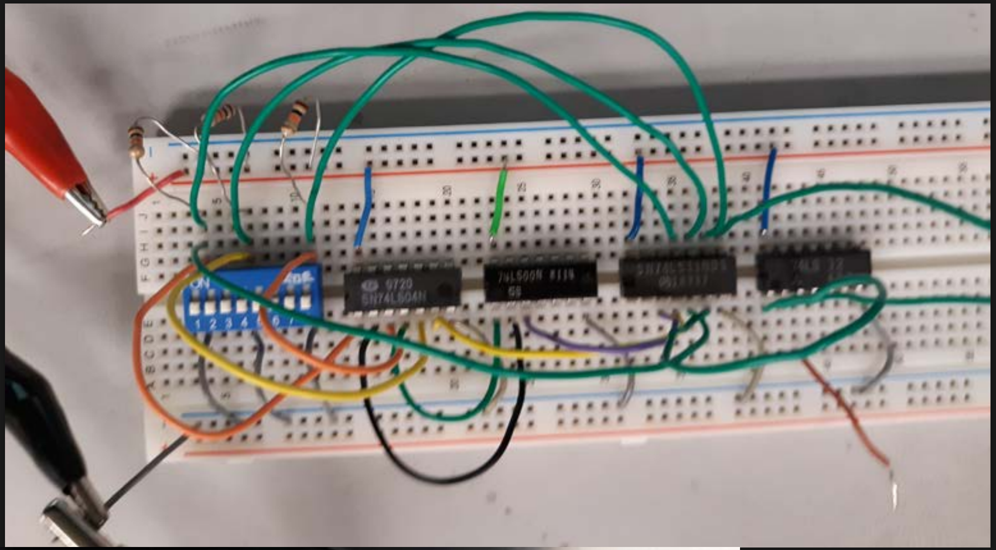
Step 1: Using the diagram provided, build circuit in MultiSim, simulated expected results. With 3 inputs there are 8 possible outputs.



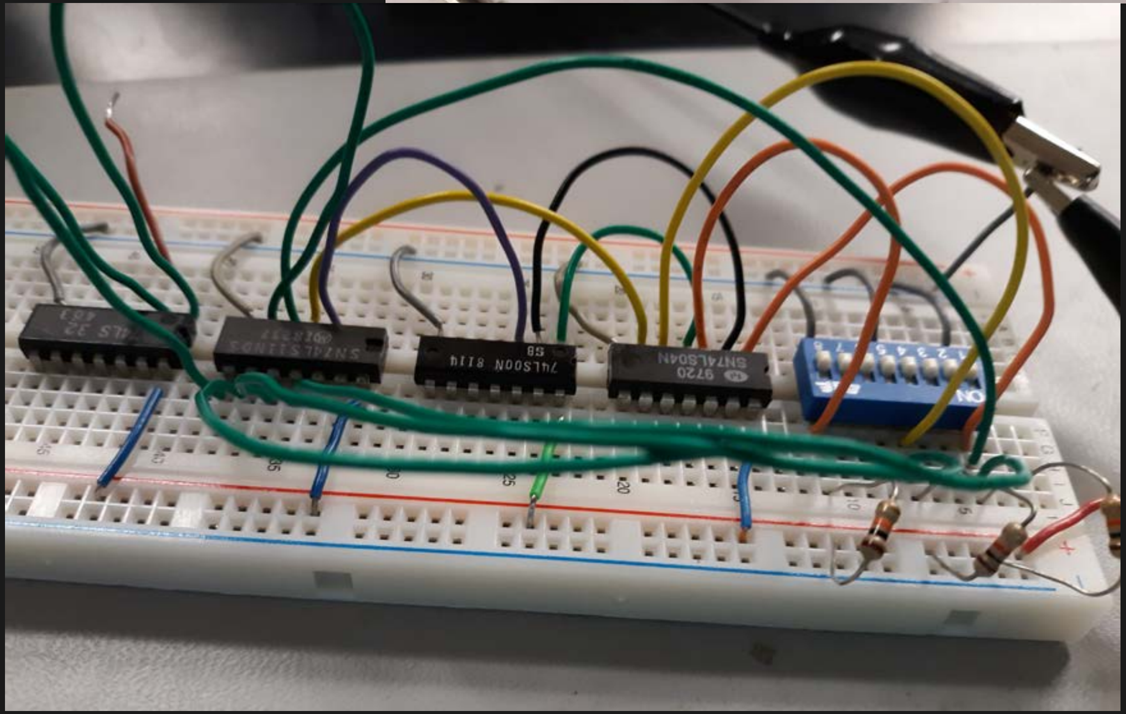




Lab 7 - Circuit Reduction



Step 2: Build the same circuit in the lab comparing the results to the simulated products.



Lab 7 – Circuit Reduction

We gathered our results onto table comparing the numbers versus highs and lows. Using our new knowledge on reduction we created a Karnaugh Map as well as a reduced formula.

Simulated					Test			
A	B	C	Output		A	B	C	Output
0	0	0	0		0	0	0	0.0679
0	0	1	0		0	0	1	0.068
0	1	0	0		0	1	0	0.0679
0	1	1	0		0	1	1	0.0678
1	0	0	0		1	0	0	4.335
1	0	1	0		1	0	1	4.3295
1	1	0	0		1	1	0	0.0688
1	1	1	1		1	1	1	4.331

	BC			
	00	01	11	10
0	0.129	0.129	0.129	0.129
1	4.472	4.473	0.129	4.472
X =ABC+(AB)’(A’C’)’				
X =A(B’+C)				

Lab 7 – Circuit Reduction

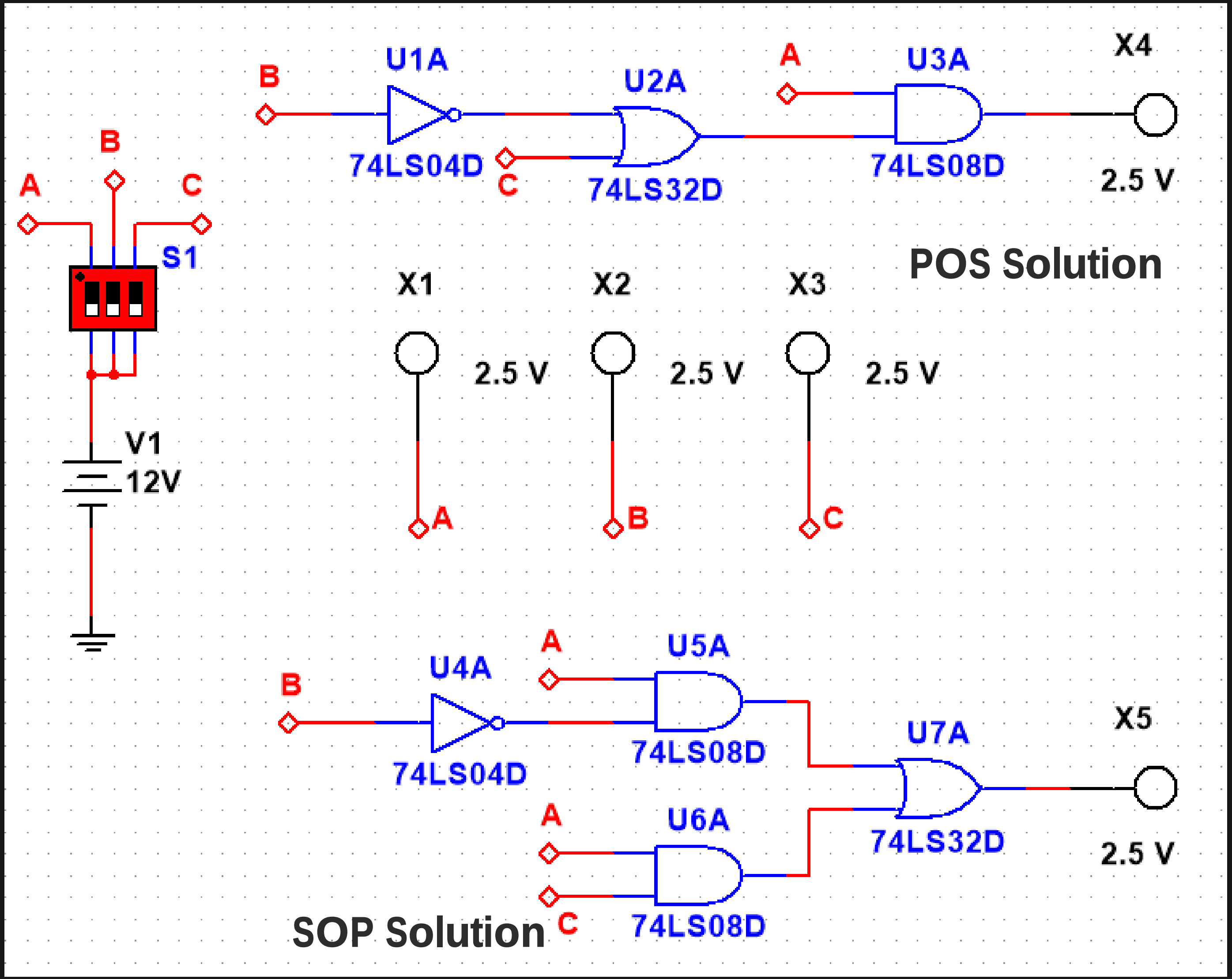
- Observations
  - Finding ways to reduce circuit seems very useful because it was a lot more intricate for the full circuit than for the reduction. Looking at the circuit like a math problem made the wiring and analyses much easier for me

Lab 8 – Circuit Reduction (Part 2) – 15 Nov 2018

- Purpose:
  - Learn how to reduce a circuit design down to the smallest size using the 17 Theorems and Karnaugh maps. Part 2 will explore how to reduce the circuit. You will also need the results of Lab 7.
- Equipment used:
  - 1 – Digital Multimeter
  - 3 – 10Kohm
  - 1 – 4 position dip switch
  - 1 – 74LS04, 74LS08, 74LS32

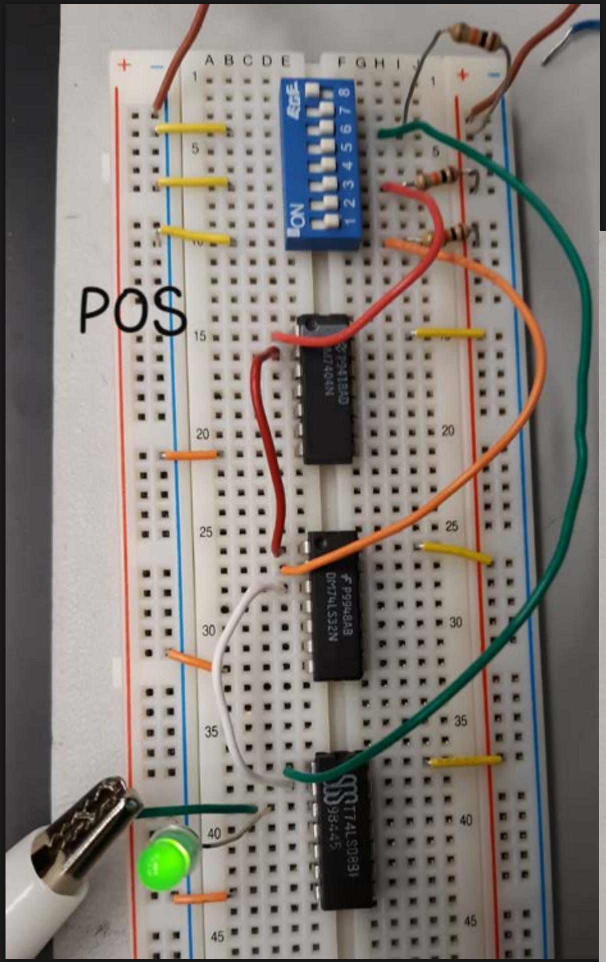
Lab 8 – Circuit Reduction (Part 2)

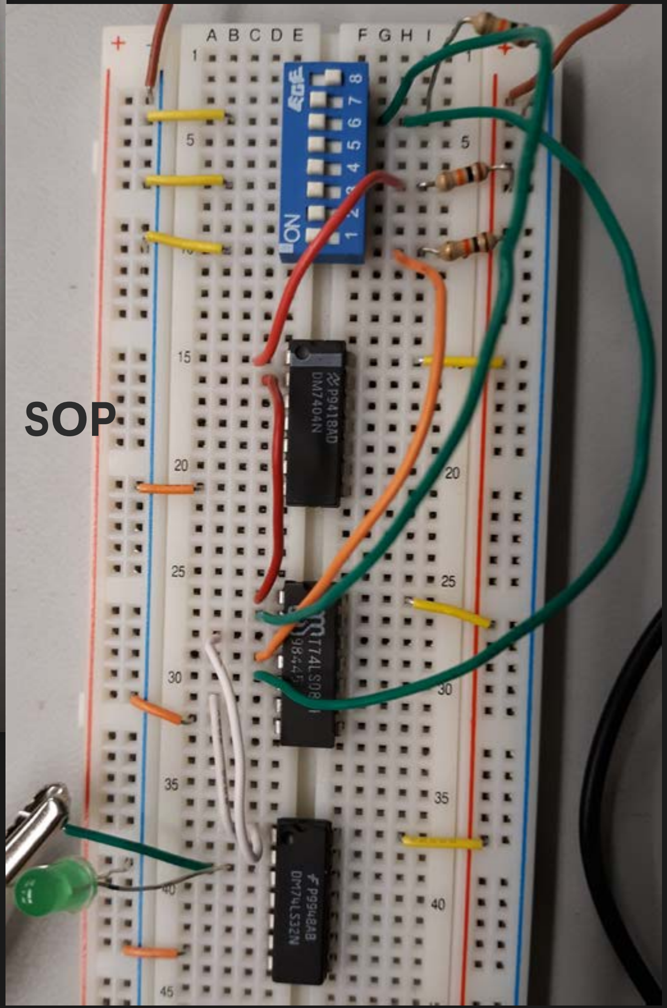
Using MultiSim we demonstrated the difference between a sum of products and a product of sum solution. I chose light to indicate highs and lows for my switches.



Lab 8 – Circuit Reduction (Part 2)

Then we created the circuits in the lab to compare the actual results.





Lab 8 – Circuit Reduction (Part 2)

Results

Simulation						Test				
			Output						Output	
A	B	C	SOP	POS		A	B	C	SOP	POS
0	0	0	0	0		0	0	0	0.1176	0.1186
0	0	1	0	0		0	0	1	0.1176	0.1412
0	1	0	0	0		0	1	0	0.1177	0.1417
0	1	1	0	0		0	1	1	0.1176	0.1419
1	0	0	1	1		1	0	0	4.221	4.354
1	0	1	1	1		1	0	1	4.22	4.352
1	1	0	0	0		1	1	0	0.1146	0.1425
1	1	1	1	1		1	1	1	4.219	4.349

Observations

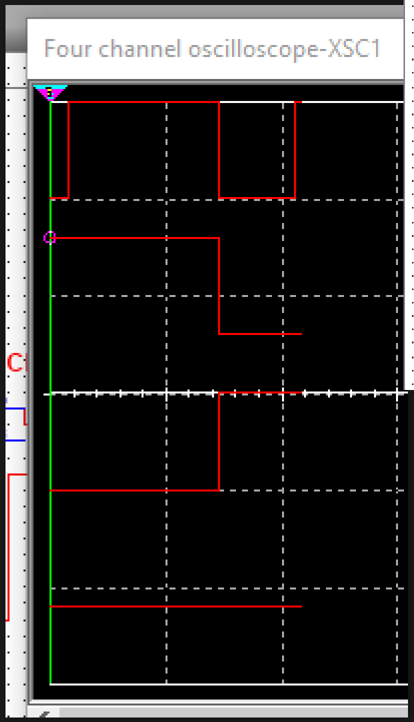
- We tried something in this lab with a light indicator to give us an analog signal for on and off but for our sum of products in this lab the light affected our values. The light was dropping our output voltage dramatically.

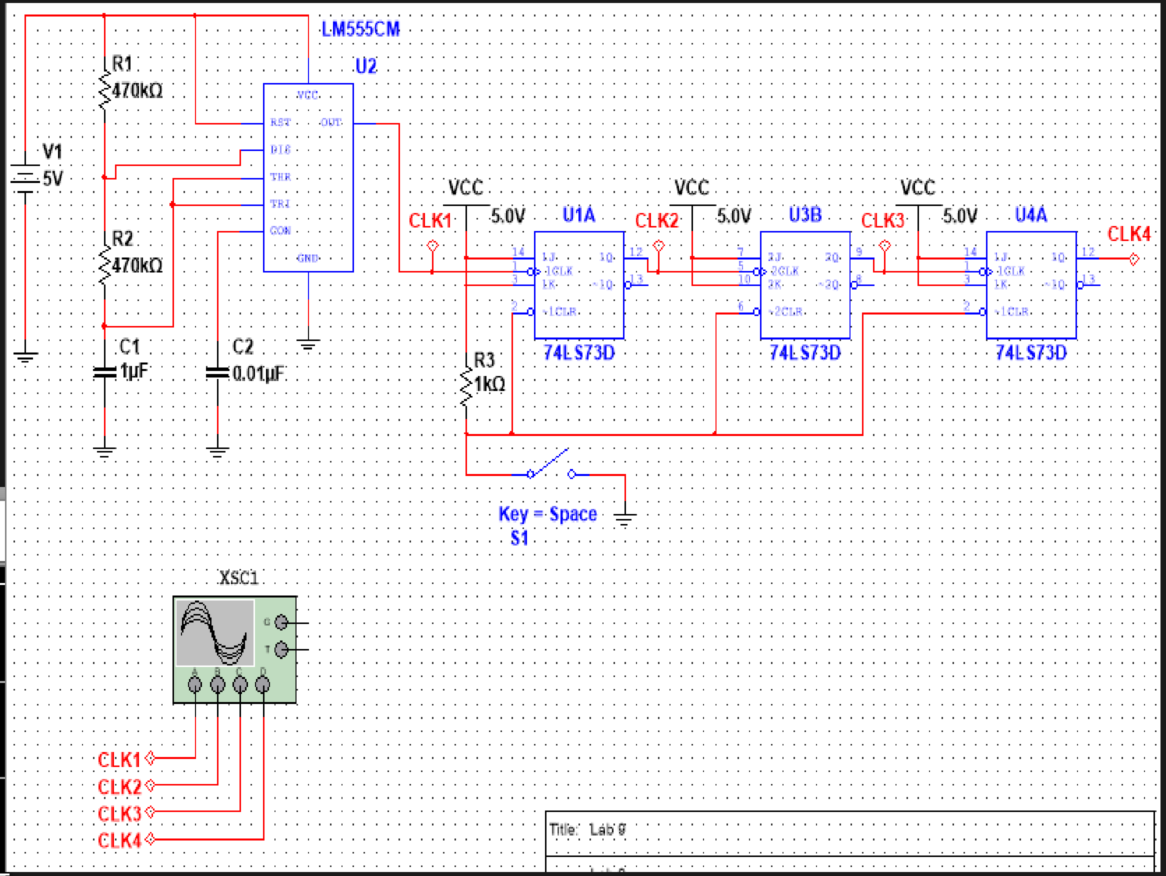
Lab 9 – 1 to 3 clock using Jk Flip Flops and 555 Timers – 29 Nov 2018

- Purpose:
  - Many times you can use multiple harmonically related clocks to test a combinational circuits. The Purpose of this lab is to show students how to create a small multiple clock counter circuit that uses JK Flip Flops and a 555 Time
- Equipment Used:
  - 1 – 555 Timer
  - 1 – 1Kohm
  - 1 – 4 position dip switch
  - 2 – 74LS73 Dual JK flip flop with clear
  - 2 – Resistors (To Be Designed)
  - 2 – Capacitors (To Be Designed)

Lab 9 – 1 to 3 clock using Jk Flip Flops and 555 Timers

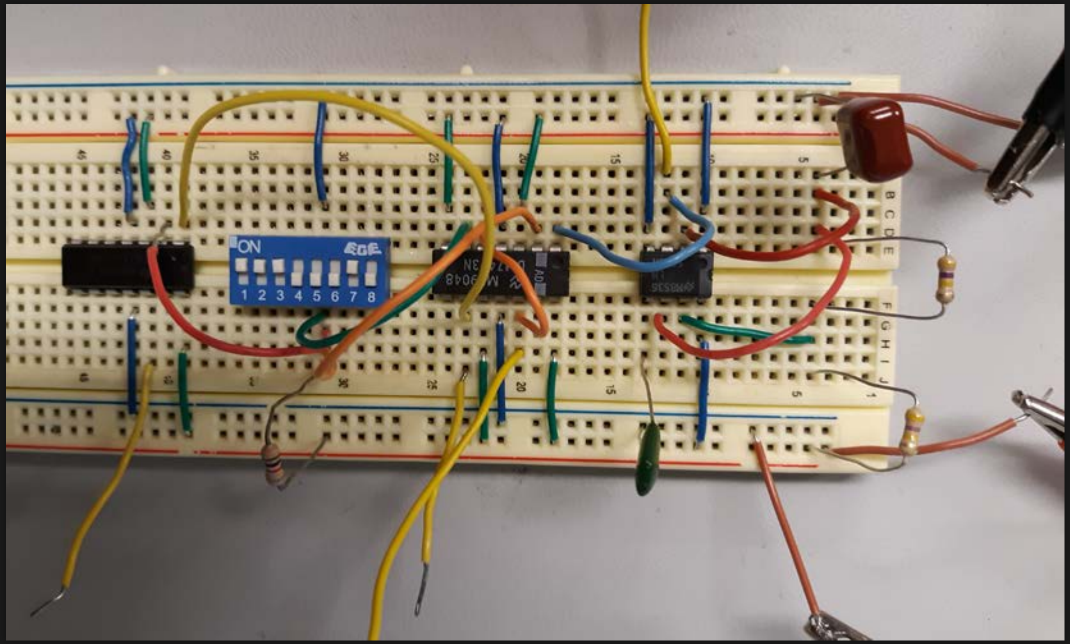
Using the given information and diagrams to create the to use the interactive function in MultiSim to display the oscilloscope.

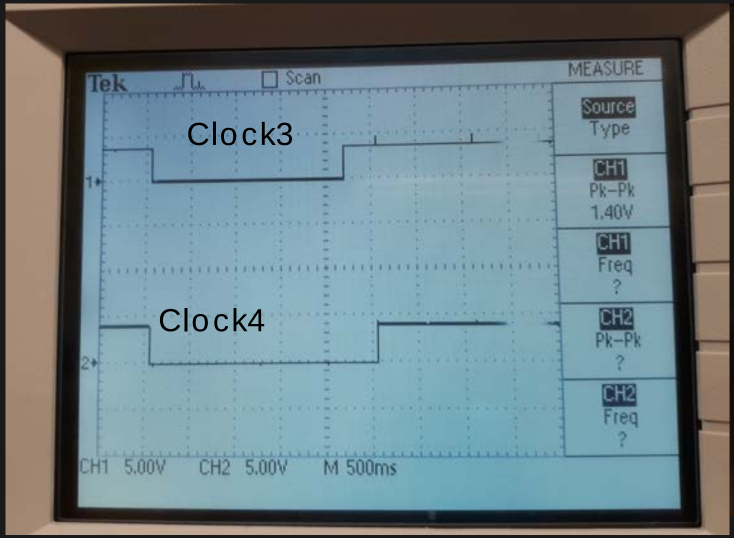


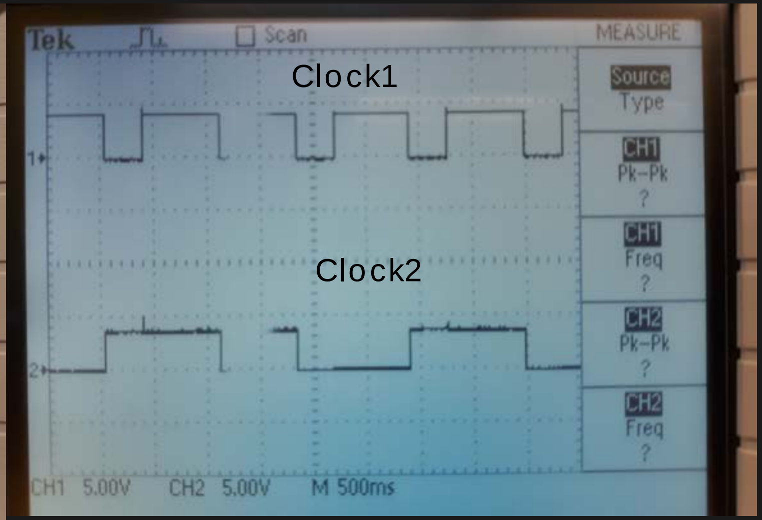


Lab 9 – 1 to 3 clock using Jk Flip Flops and 555 Timers

Then we created the same thing in the lab, learning to adjust the oscilloscope to fit our needs. Also learning to wire new types of gates.







Lab 9 – 1 to 3 clock using Jk Flip Flops and 555 Timers

Results

	Designed	Measured
R_A =	470000	475000
R_B =	470000	479000
C =	0.000001	0.000001
t_1 =	0.65142	0.661122
t_2 =	0.32571	0.331947
T =	0.97713	0.993069
f =	1.023405	1.0069794
f =	1.021277	1.0048849
D =	33.333%	33.426%

Observations

- Each clock is the next step in the binary count.
- The oscilloscope had to be adjusted from AC power to DC power.
- We had to change our switch to make the circuit functional
- Checking that everything is powered and grounded is essential.