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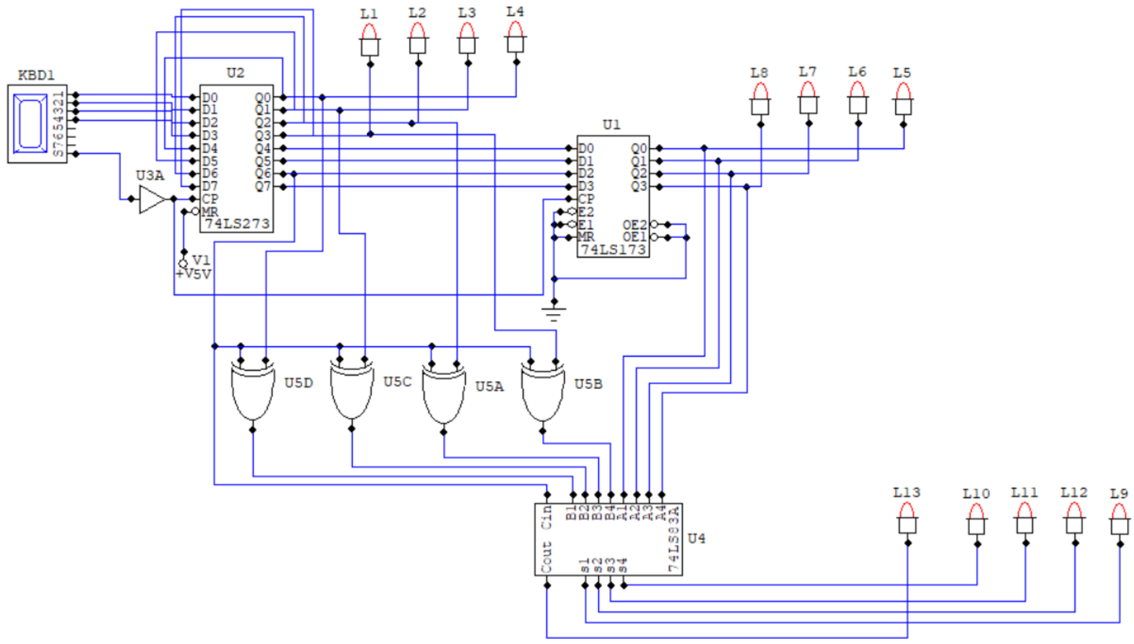
ROLL NO: *20EC10043*

DIGITAL LABORATORY EXPERIMENT 6

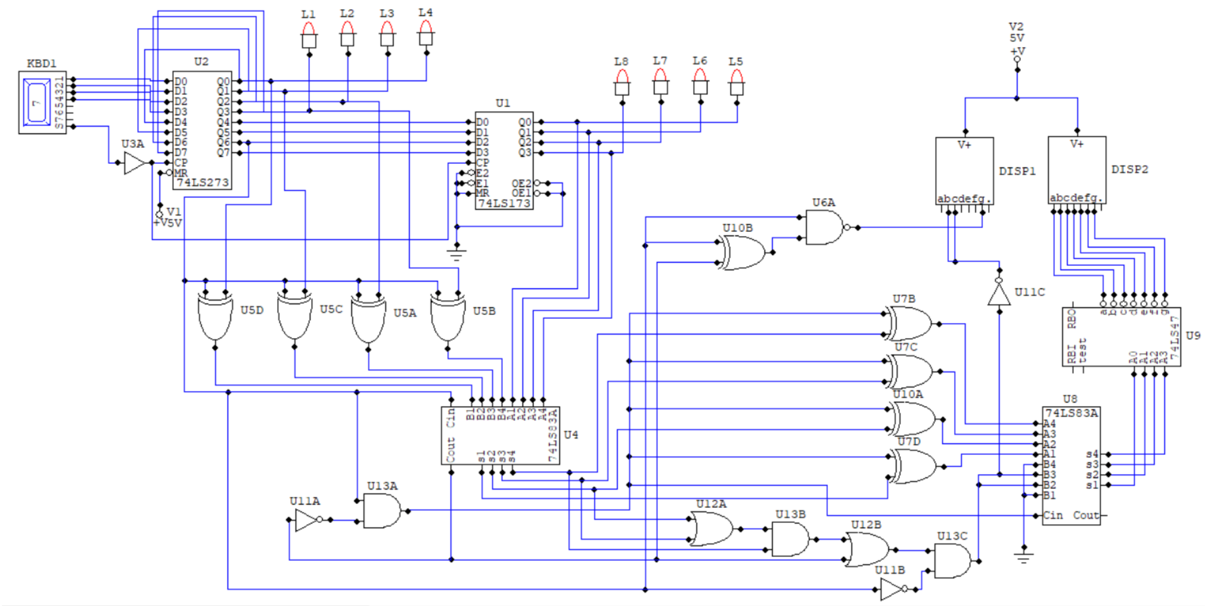
AIM:

To add/subtract two single digit input from ASCII key and display the sum output on 7-segment displays. (Inputting A+B/A-B in infix mode)

CIRCUIT DIAGRAM



This is for the part 1 of the experiment where we get the final answer in form of a 5-bit signed binary number. Here, our primary goal was to input the values of A,B and the operator in infix method.



Here, we need to have a logical system which converts the 5-bit signed binary number to decimal numbers and display on the two screens given.

BREIF THEORY AND EXPLAINATION

In the first part of the experiment, we are going to add a 74LS173 to the regular setup we used in the last experiment, which helps us to store 4more bits in addition to the 8-bit storage we have. Upon connecting the ICs in the way shown in the circuit, we can get the value of A at the Q0-3 pins of 74LS173 and the value of operator at the Q4-7 pins of 74LS273 and value of B at the pins Q0-3 of 74LS273. And now, when we do addition, the circuit is exactly the same as our last experiment, but when we are doing subtraction, we need to be careful, as we are using a 4-bit fuller adder, we cant subtract a number straight away, but we can take the compliment of B and add it to A.

i.e,

A-B = A+(-B)

In order to take the compliment of a number, we need to take the XOR outputs for which we give inputs as the bit value of each individual bits in the 4-bit number along with the other input being 1, the output we get after doing this is the 1's compliment of the number B, to get the 2's compliment we do it by giving the value of 1's compliment to the fuller adder with Cin(Carry input) as 1, which adds 1 to the binary number, thus making it the 2's compliment of B. We give the other input which is number A. In this sense, we can accomplish subtraction operator. Now, we need to know when to give 1 at Cin and inputs of XOR gates, and when not to give 1 is important. We can accomplish this by connecting the Q6 pin of 74LS273 which stores the data of the operator, which is 1 when subtracting and 0 when adding. With this part1 of the experiment is more or less over.

For the part2 of the experiment, we need to show the display on 7segment displays. For the one's digit place of the display(DISP2), we need to show 0-9 based on the values we get, when adding, we get 0-18 output of which we don't have any issue for 0-9, but for 10-18, we need to add 6(0110) to the output such that the last 4bits give the correct answer corresponding to the number we have. We did this already in the last experiment.

We achieve this by connecting the B2,B3 pins such that the logic input is D= (Cin)'.(Cout + S4.S2 + S4.S3). All these terminologies we have here are the pin names of the first fuller adder. Cin' is used for making sure that we only add 6 when we are adding and not when we are subtracting.

Now when we are subtracting the number, we get the values from -9 to 9, so we don't need to add 6 when subtracting, but the way the data in the output pins of first fuller adder is different in both cases. When we have a positive answer, the Cout pin is 1, and the other pins are the correct data of the BCD number. When the answer is negative, we have Cout pin at 0 and the data we have for other pins is the 2's compliment of the correct number. So, when subtracting, we need to check is our answer is positive or negative, if it is negative, we need to take the 2's compliment of the number before giving it as an input the second fuller adder where we add 0 to the number, so it shows the correct answer in the first display, we can achieve this by giving the pins of inputs of second set of XOR gates and Cin pin of second adder, Y = Cin.Cout'.

With this, the DISP2 will work properly, now lets look at the tens place of the number, that is DISP1. Here, when we are adding, we need to show blank when answer is from 0-9 and 1 when answer is from 10-18, we can achieve this by *simply connecting the D logic pin which we used to connect to B2,B3 pins of second fuller adder through a inverter, as the need to ground the pins to show the display on 7-segment screen. When subtraction, we need to show blank when output is 0-9 and a '-' when output is -9 to -1. For that, we have logic expression as X= (Cin . Cout')'. Which is basically the input we give for the Cin pin of the second adder, but inverted. In the diagram I achieved that with a slightly different logical combination, but however the logic expression is the same. With these connections, the output we get are going to be in correct format.*

<u>SNAPSHOTS OF THE SIMULATION:</u>

To show the results of the simulations, I have taken 4 examples of binary operations. We will do it for both part1 and part2.

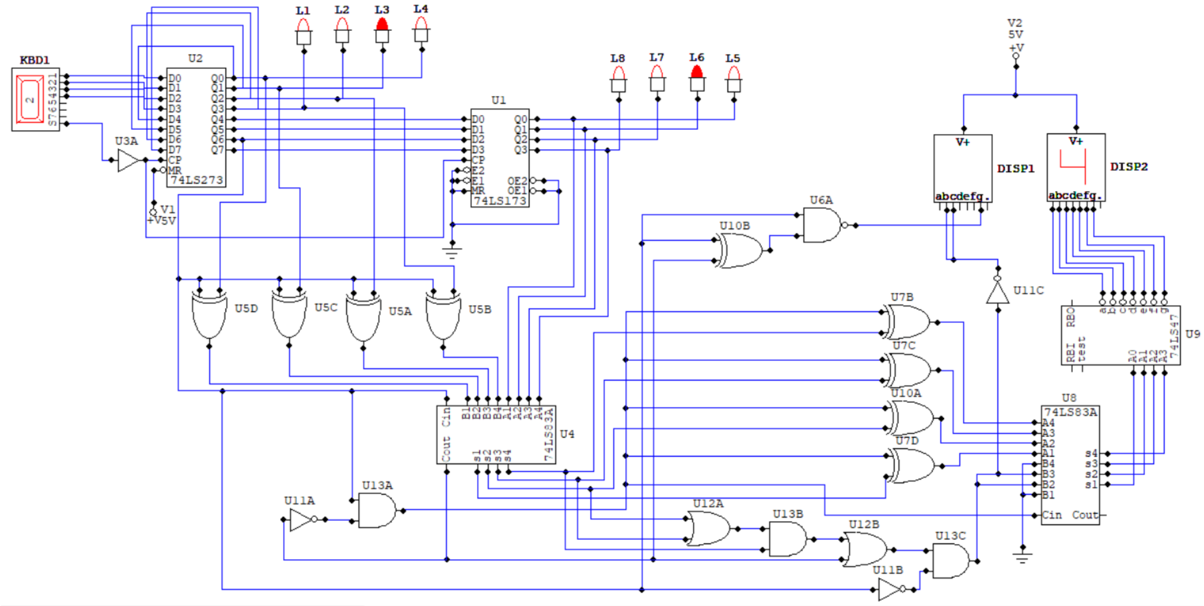
Example1: 2+2 = 04

Example2: 5+8 = 13

Example3: 6-7 = -1

Example4: 8-3 = 05

The examples are given in order, first four images are from part2 of the experiment, last four are from part1.


KBD1
U2
74LS273
U3A
V1
+V5V
L1
L2
L3
L4
L8
L7
L6
L5
U1
74LS173
V2
5V
+V
DISP1
DISP2
U6A
U10B
U11C
U5D
U5C
U5A
U5B
U7B
U7C
U10A
U7D
U9
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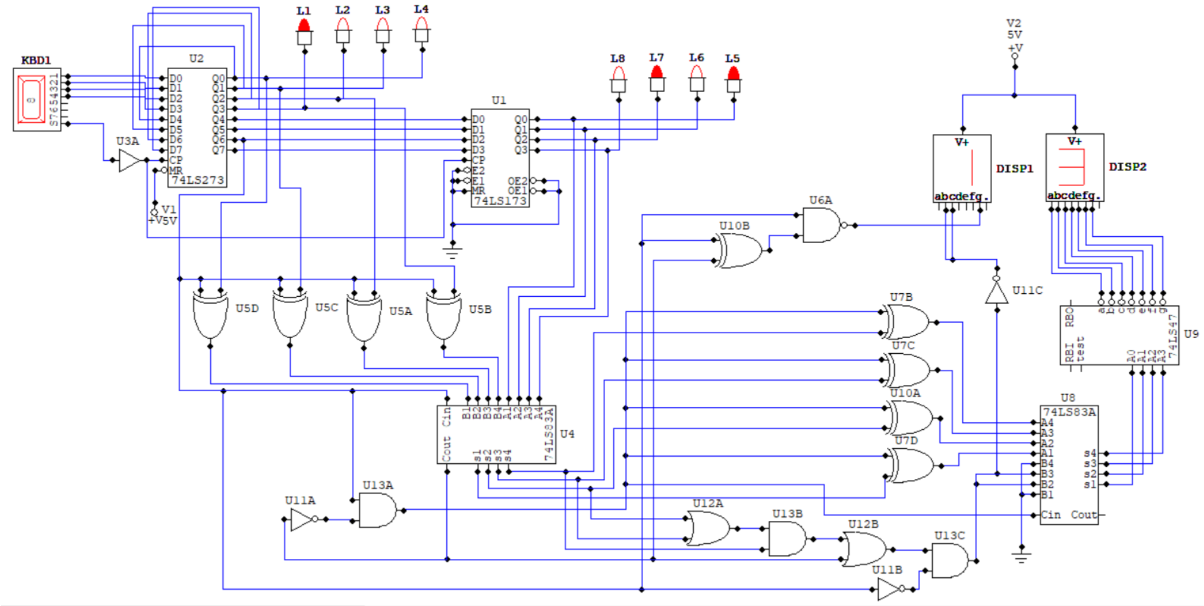
U12B
U13C
U11B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U10B
U11C
U5D
U5C
U5A
U5B
U7B
U7C
U10A
U7D
U9
74LS47
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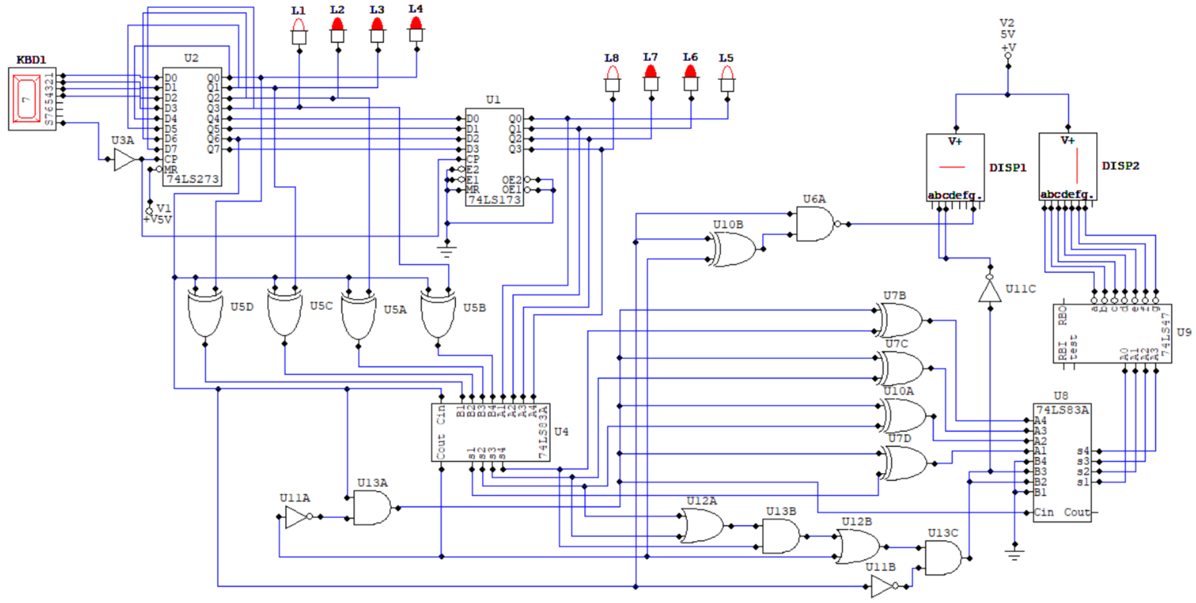
U13A
U12A
U13B
U12B
U13C
U11B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U2
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L2
L3
L4
L8
L7
L6
L5
U1
74LS173
U3A
V1
+V5V
V2
5V
+V
DISP1
DISP2
U6A
U10B
U11C
U5D
U5C
U5A
U5B
U7B
U7C
U10A
U7D
U9
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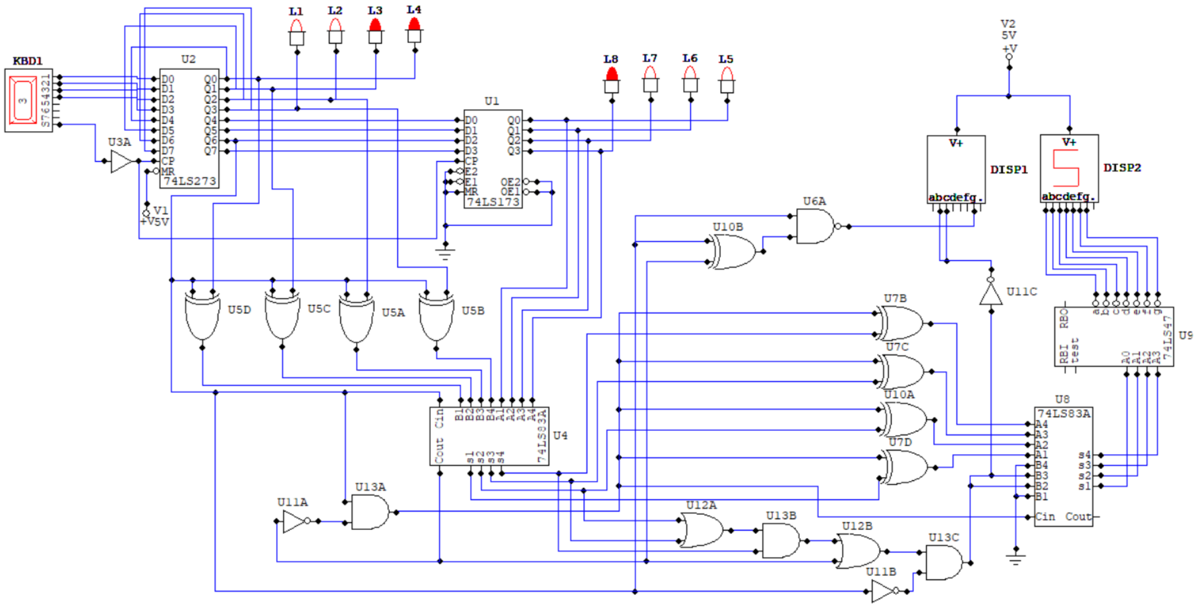
U12B
U13C
U11B


KBD1
U2
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L4
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L6
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74LS173
U3A
V1
+V5V
V2
5V
+V
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DISP2
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U10B
U11C
U5D
U5C
U5A
U5B
U7B
U7C
U10A
U7D
U9
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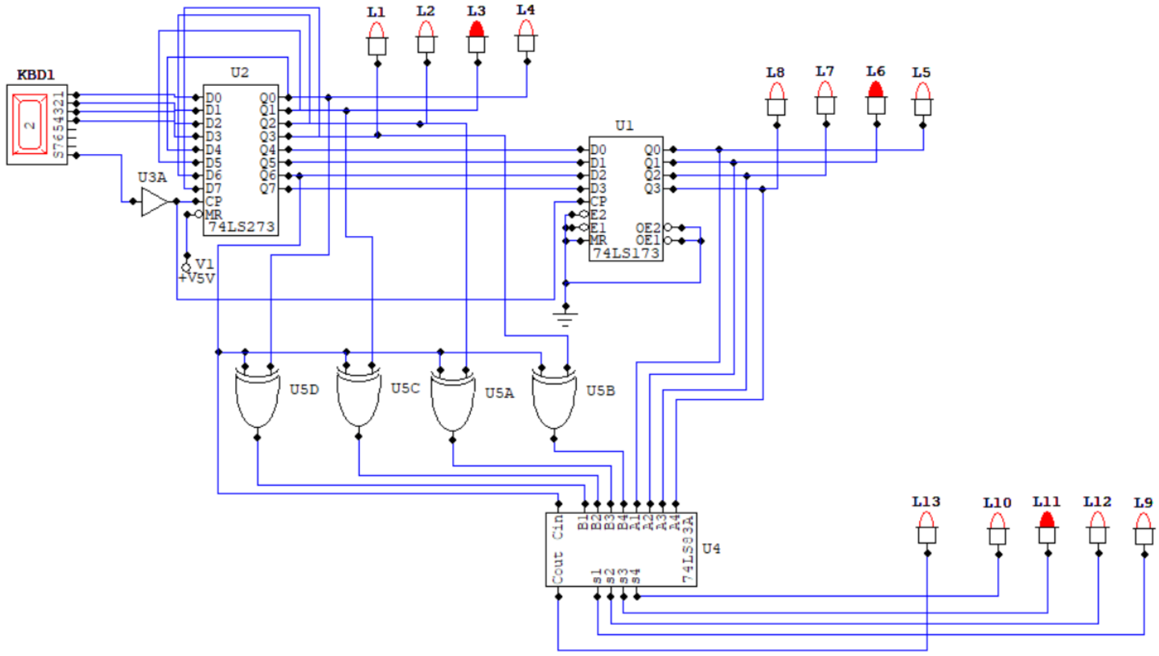

KBD1
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U3A
V1
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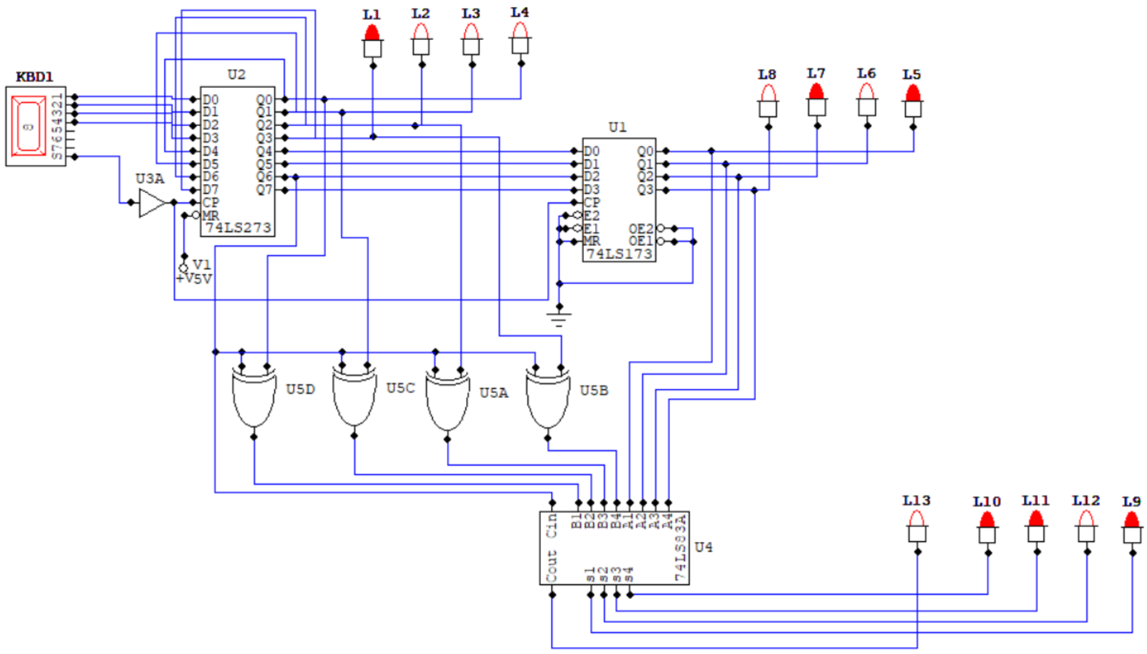

KBD1
U2
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74LS173
U3A
V1
+V5V
U5D
U5C
U5A
U5B
U4
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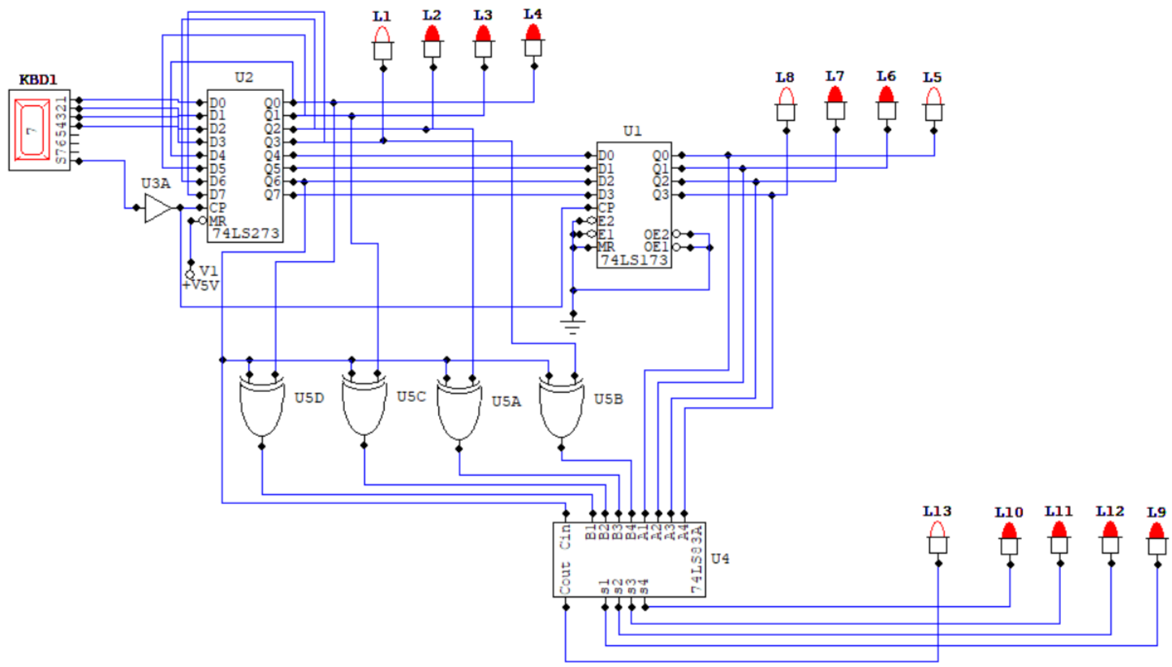

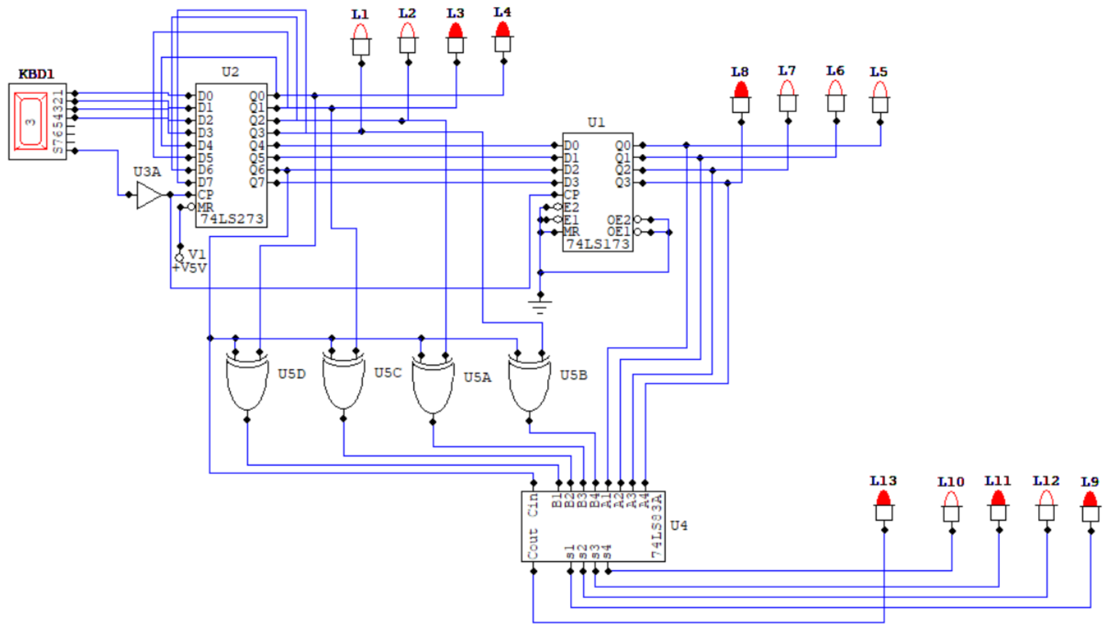

OBSERVATION AND CONCLUSION

As we see, all the observations yield correct outputs, for the purpose of checking I will add both the ckt files for part1 and part2 of the experiment. This brings us to the end of this experiment.