BRAC UNIVERSITY
Inspiring Excellence

Department of Computer Science and Engineering

Course Code:CSE260	Credits: 1.5
Course Name: Digital Logic Design	Semester: Fall'18

Lab 03

Implementation of 4-bit Magnitude Comparator

I. **Topic Overview:**

The students will investigate the rules of comparing two 4-bit numbers and familiarize themselves with the boolean functions of a magnitude comparator. They will also gain the experience of working with practical components by constructing the circuit from scratch. After this lab, they will have a sound knowledge on comparing two numbers and determining their relative magnitudes. There is 1 problem, further divided into three subproblems in this lab.

II. **Lesson Fit:**

The Boolean algebra is pre-requisite to this lab.

III. **Learning Outcome:**

After this lecture, the students will be able to:

a. investigate the rules of comparing magnitude of two numbers
b. gain experience working with practical circuits
c. coming up with shortcuts to construct a combinational circuit

IV. **Anticipated Challenges and Possible Solutions**

a. Students will attempt to construct the circuit of (A<B) separately after finishing the circuits of (A=B) and (A>B)

Solutions:

Separate circuit for $(A<B)$ is not required since it can be obtained from the previous circuits' output by the following equation:

$$(A<B) = ((A=B)+(A>B))'$$

V. Acceptance and Evaluation

Students will show their progress as they complete each step of the problem. They will be marked according to their lab performance. Students have to show the outputs of each of the functions from the constructed circuit otherwise full marks will not be given.

VI. Activity Detail

a. Hour: 1

Discussion:

Explain how the magnitude comparator works for 4 bit numbers. Show them the Boolean equation for $A=B$ and $A>B$, and ask them to find the equation of $A<B$ on their own. Also, ask them to draw the circuit diagram which will help them to construct the circuit on the breadboard later in the Laboratory.

Problem Task:

Functions and circuit diagram of Magnitude Comparator.

b. Hour: 2

Discussion:

Check their functions and circuit diagram and ask them to construct the circuit.

Problem Task:

Construct the Circuit of the functions on the breadboard of AT-700.

c. Hour: 3

Discussion: Check their progress in implementation.

Problem Task:

Debug the problems in their circuit until desired output is found.

VII. Home tasks:

As a part of their home tasks students need to submit a lab report covering the followings

1. Name of the Experiment
2. Objective
3. Required Components and Equipments
4. Experimental Setup (No need to draw the IC configurations)
5. Results and Discussions .The discussions part must include the answers of the following questions:

- Justify your designs of 4-bit Magnitude Comparator. Explain how it gives the results

a. A = B
b. A > B
c. A < B

- What changes have to made in your design to find the third result from any two of the three results (A = B, A > B, A < B)

Implement using NOR gate the following table:

A>B	A==B	A<B
0	0	1
0	1	0
1	0	0
1	1	Undefined

Lab 6 Activity List

Implementation of 4-bit Magnitude Comparator

- Draw the circuit that will act as a Magnitude Comparator. Your circuit should be able to compare two 4 bits number
- Implement your circuit (for two 4-bit numbers)

Theory:

The comparison of two numbers is an operation that determines if one number is greater than, less than or equal to the other number. A magnitude comparator is a combinational circuit that compares two numbers A and B and determines their relative magnitudes. The outcome of the comparison is specified by three binary variables that indicates A>B, A=B, or A<B.

The algorithm is a direct application of the procedure a person uses to compare the relative magnitudes of two numbers. Consider the two numbers A, and B, with four digits each. Write the coefficients of the numbers with descending significance as follows:

$$A=A_3A_2A_1A_0$$

$$B=B_3B_2B_1B_0$$

where each subscripted digit represents one of the digits in the number.

The two numbers are equal if all pairs of significant digits are equal i.e., if $A_3=B_3$, $A_2=B_2$, $A_1=B_1$ and $A_0=B_0$. When the numbers are binary the digits are either 1 or 0 and the equality relation of each pair of bits can be expressed logically with an equivalence function:

$$x_i=A_iB_i+A_i^{/}B_i^{/}, \qquad i=0, 1, 2, 3$$

where $x_i=1$ only if the pair of bits in position *i* are equal, i.e., if both are 1's or both are 0's.

The equality of the two numbers A and B is displayed in a combinational circuit by an output binary. This binary variable is equal to 1 if the input numbers A and B are equal and it is equal to zero otherwise. For equality condition to exist, all x_i variables must be equal to 1. This indicates an AND operation of all variables:

$$(A=B)=x_3x_2x_1x_0$$

To demonstrate if A is greater than or less than B, we inspect the relative magnitude of pairs of significant digits starting from the most significant position. If the two digits are equal, we compare the next lower significant pair of digits. This comparison continues until a pair of unequal digits is reached. If the corresponding digit of A is 1 and that of is 0, we conclude that A>B. If the corresponding digit of A is 0 and B is 1, we have that A<B. The sequential comparison can be expressed logically by the following two Boolean functions:

$$(A > B) = A_3B_3^{/} + x_3A_2B_2^{/} + x_3x_2A_1B_1^{/} + x_3x_2x_1A_0B_0^{/}$$
$$(A < B) = A_3^{/}B_3 + x_3A_2^{/}B_2 + x_3x_2A_1^{/}B_1 + x_3x_2x_1A_0^{/}B_0$$