INTRODUCTION TO DIGITAL ELECTRONICS, CEET 1130: LABORATORY EXPERIMENT 5

LABORATORY EXPERIMENT # 5

4 BIT BINARY FULL ADDER

OVERVIEW:

An **adder** is the heart of an arithmetic logic unit, which does all the mathematics in all computers. A full adder adds two binary bits with a carry-in from a previous stage of adder. It produces a sum and a carry-out. The sum out will produce a "1" if the two input bits and the carry-in are odd. The carry-out will produce a "1" if the two input bits and the carry have two or more "1" inputs. With this configuration, single full adders can be cascaded (connected in series) to produce a multistage ripple carry adder of any size.

In this lab, we will produce a simple two bit full adder using AND, OR, and XOR gates and demonstrate that it works for two sum bits (A and B) and a carry-in bit (Ci). In Part 2 of the lab, we will use a commercial four bit adder(74LS83) to add two nibbles (four bits) together and to display the result on our trainer HEX displays.

MATERIALS:

1. Circuit design trainer with 8 data switches, solderless breadboard, +5vdc power supply, three led displays, and two hexadecimal displays.
2. Qty. 1 – 74LS32 quad "or" gate IC
3. Qty. 1 – 74LS86 quad "xor" gate IC
4. Qty. 1 – 74LS08 quad "and" gate IC
5. Qty. 1 – 74LS83 four bit adder w/carry

PROCEDURE:

1. Use a truth table and design a full adder: (At this stage of our lab work, the ideal design components are being provided for you.)
2. Draw a single full adder stage that satisfies the design equations below the truth table:

![Full Adder Circuit Diagram]

3. Draw a system design showing how two stages will interconnect to make a two bit adder with carry:

![System Design Diagram]
4. Draw the complete schematic diagram with pin numbers, reference designators, part numbers, and signal names:
5. Build and test the circuit for the two bit adder w/carry. Verify that the results agree with the design truth table.

NOTE: The 74LS08 and 74LS32 AND OR logic that makes up the Co, or carry out section, can be replaced with 74LS00 NAND gates using De Morgan’s Theorem, and the circuit will function normally.

6. Use the 74LS83 to build a four bit nibble or “hex” adder. Use the hex displays to display the result of adding four binary bits together.

CONCLUSION:

Explain what you would need to do to make an adder that will add two 16 bit words, or four 4 bit nibbles together.

Speculate on how you might make your 4 bit adder a BCD (binary coded decimal) adder that will generate a carry at ten instead of sixteen.

How difficult would it be to use four bit adders to make a modern four bit calculator? Speculate about why the little four function calculators are so inexpensive.