PRACTICAL - 6

AIM: To study and design Wallace Tree Adder.

THEORY:

There are many cases where it is desired to add more than two numbers together. The straightforward way of adding together m numbers (all n bits wide) is to add the first two, then add that sum to the next using cascading full adders.

The Wallace tree has three steps:

1. Multiply (that is – AND) each bit of one of the arguments, by each bit of the other, yielding n^2 results. Depending on position of the multiplied bits, the wires carry different weights, for example wire of bit carrying result of a_2b_3 is 32.
2. Reduce the number of partial products to two by layers of full and half adders.
3. Group the wires in two numbers, and add them with a conventional adder.

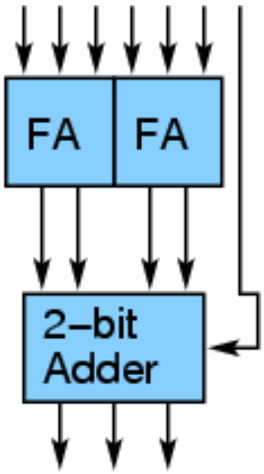
The second phase works as follows. As long as there are three or more wires with the same weight add a following layer:

- Take any three wires with the same weights and input them into a full adder. The result will be an output wire of the same weight and an output wire with a higher weight for each three input wires.
- If there are two wires of the same weight left, input them into a half adder.
- If there is just one wire left, connect it to the next layer.

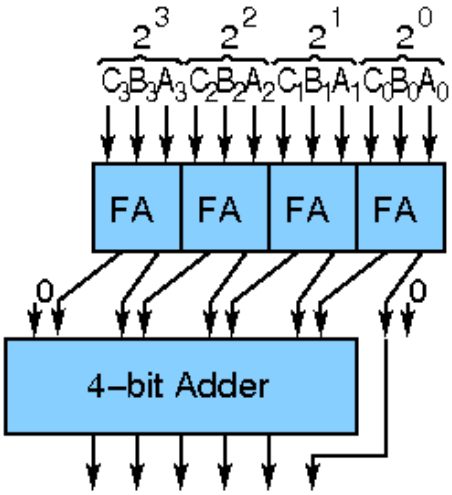
This requires a total of m − 1 additions, for a total gate delay of O(m lg n) (assuming look ahead carry adders). Instead, a tree of adders can be formed, taking only O(lg m · lg n) gate delays.

A Wallace tree adder adds together n bits to produce a sum of $\log_2 n$ bits.

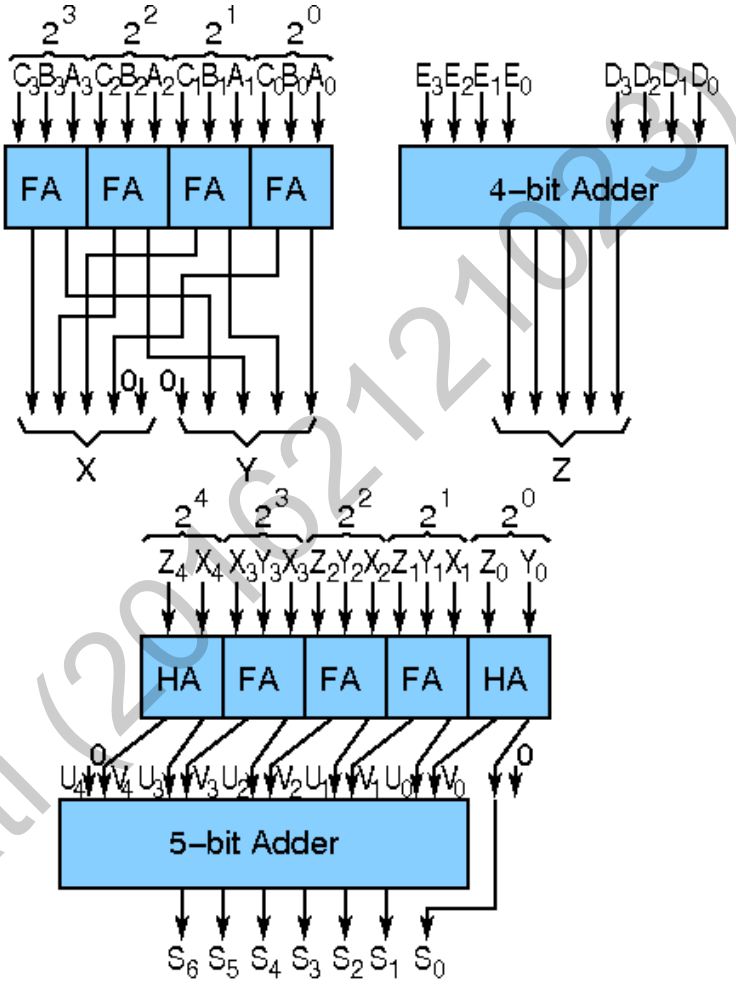
Case 1: Wallace tree adder to add seven bits (W_7) is illustrated below:



Case 2: Wallace tree adder to add three 4-bit numbers is illustrated below:



Case 3: Wallace tree adder to add five 4-bit numbers is illustrated below:



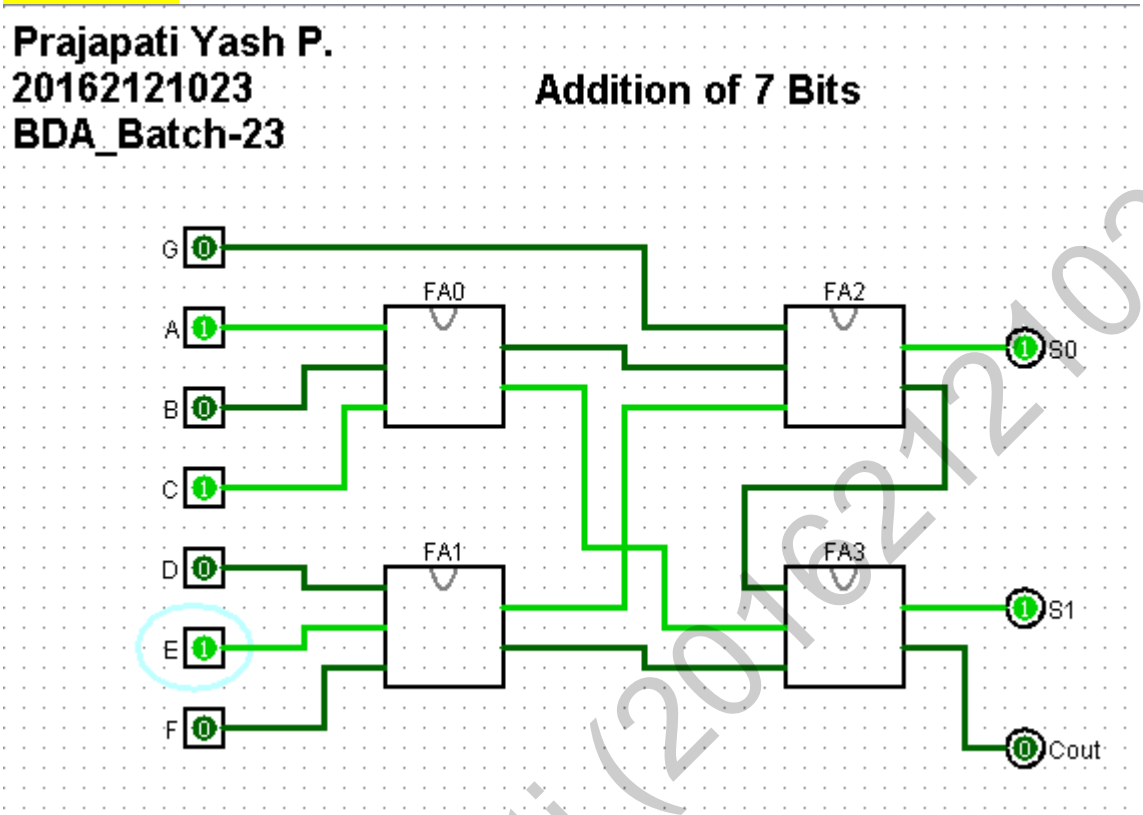
Components:

1. Half Adder
2. Full Adder
3. 4-bit adder

LABWORK:

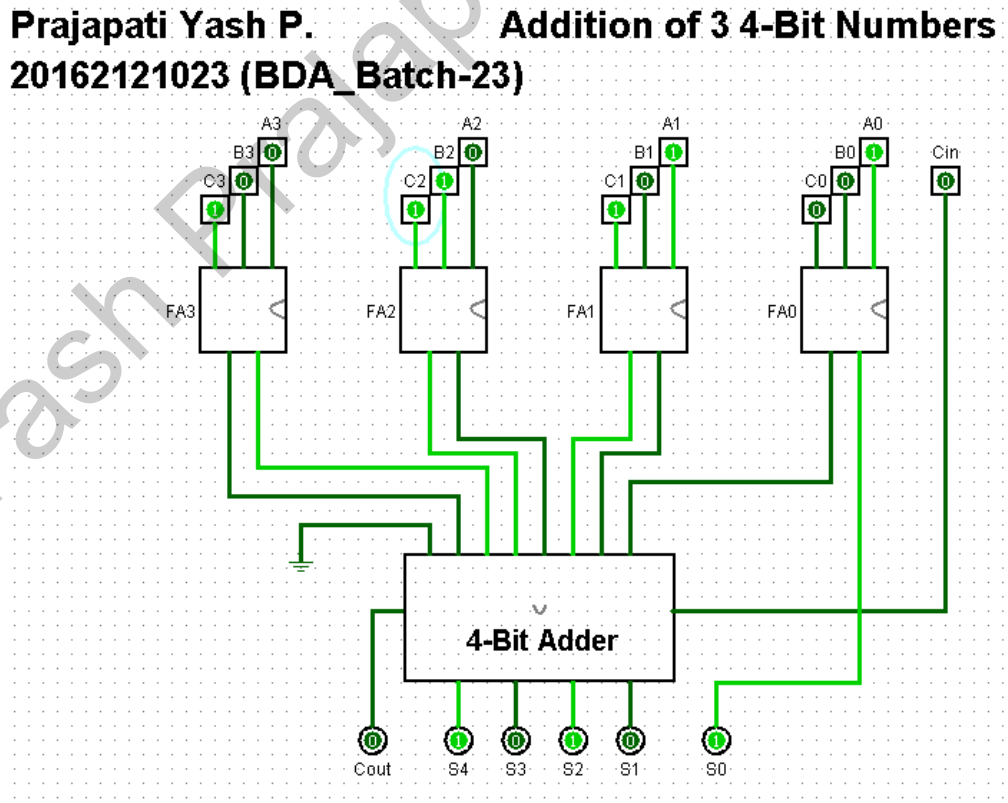
1. Addition of Seven Bits.

SOLUTION:



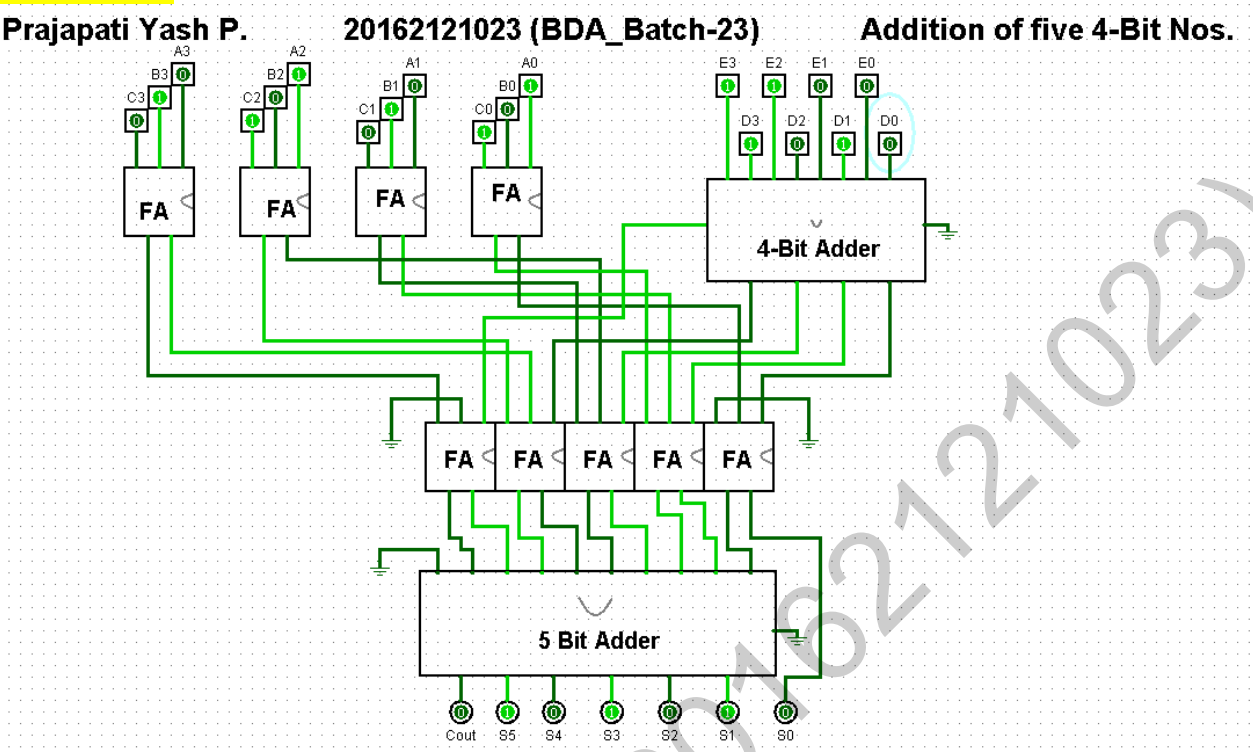
2. Addition of Three 4-Bit Numbers.

SOLUTION:



3. Addition of Five 4-bit Numbers.

SOLUTION:



CONCLUSION:

Hence by studying the design and analyzing the results of the circuit, we conclude the study and design of **Wallace Tree Adder**.