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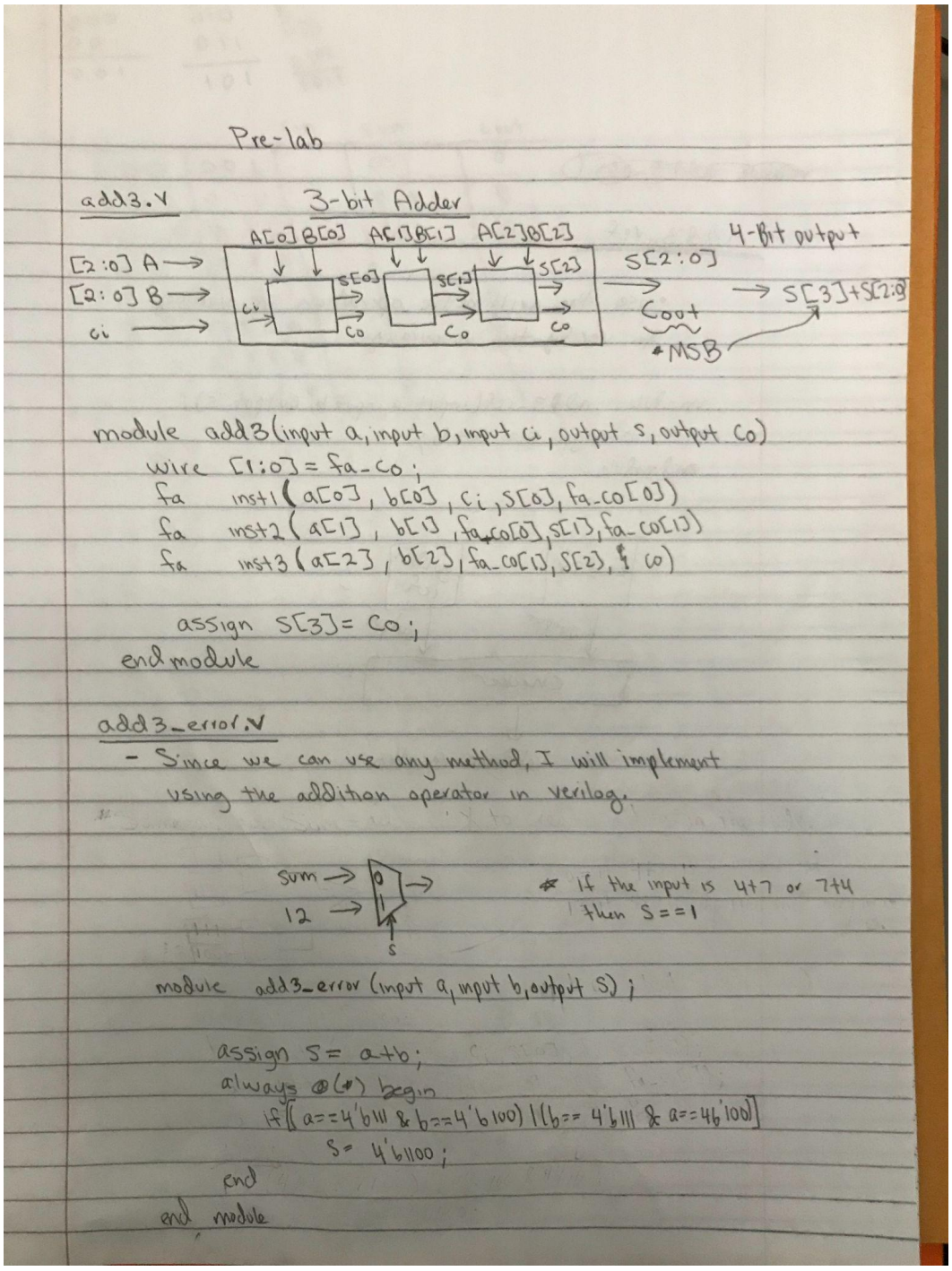
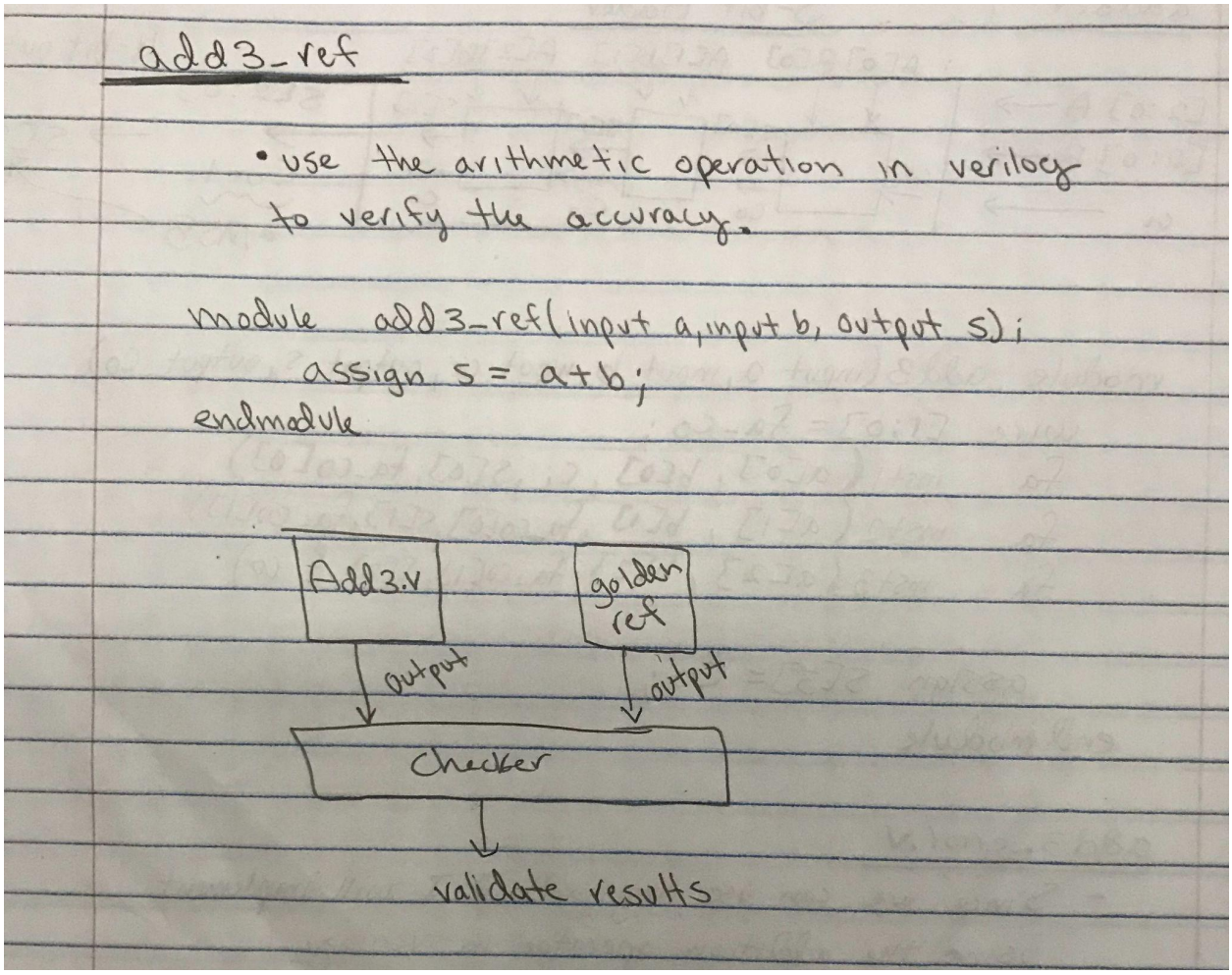
Lab 3 : Simulating Using Testbenches

Testbench #1:

Figure 1 : Prelab circuit diagrams





Text printout from III.A:

```
# in = 000, in = 000, out = 0000
# in = 000, in = 001, out = 0001
# in = 001, in = 000, out = 0001
# in = 101, in = 101, out = 1010
# in = 111, in = 000, out = 0111
# in = 111, in = 111, out = 1110
# in = 001, in = 001, out = 0010
# in = 010, in = 011, out = 0101
# in = 110, in = 001, out = 0111
# in = 011, in = 000, out = 0011
# in = 111, in = 101, out = 1100
# in = 100, in = 010, out = 0110
# in = 101, in = 010, out = 0111
# in = 001, in = 110, out = 0111
# in = 111, in = 011, out = 1010
```

- Figure 3 displays the following waveform on ModelSim. I displayed the input and outputs in unsigned so it is easier to read the expected results.

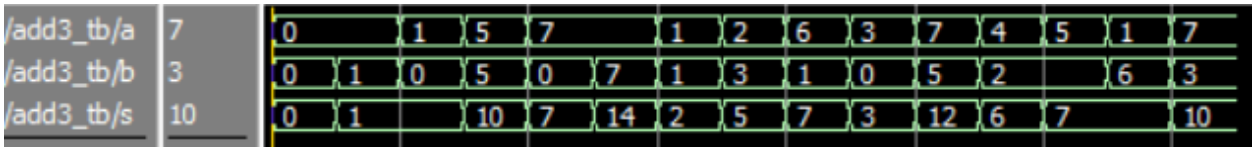


Figure 3 : Waveform printout from III.B

Testbench #2:

- The following printout below shows the expected results. I created a golden reference, taking advantage of the arithmetic operation provided in verilog to check against the add3.v outputs. I implemented a nested loop to run all 64 possible inputs. Inside the loop there is a condition that compares the 3-bit adder to the golden reference. If the condition is met then a pass message is displayed. All possible inputs matched with the golden reference validating the add3.v design.

  Text printout from IV.A:

```
# in = 000, in = 000, test = 0000, golden = 0000
# pass
# in = 000, in = 001, test = 0001, golden = 0001
# pass
# in = 000, in = 010, test = 0010, golden = 0010
# pass
# in = 000, in = 011, test = 0011, golden = 0011
# pass
# in = 000, in = 100, test = 0100, golden = 0100
# pass
# in = 000, in = 101, test = 0101, golden = 0101
# pass
# in = 000, in = 110, test = 0110, golden = 0110
# pass
# in = 000, in = 111, test = 0111, golden = 0111
# pass
# in = 001, in = 000, test = 0001, golden = 0001
# pass
# in = 001, in = 001, test = 0010, golden = 0010
# pass
# in = 001, in = 010, test = 0011, golden = 0011
# pass
# in = 001, in = 011, test = 0100, golden = 0100
# pass
# in = 001, in = 100, test = 0101, golden = 0101
# pass
# in = 001, in = 101, test = 0110, golden = 0110
# pass
# in = 001, in = 110, test = 0111, golden = 0111
# pass
# in = 001, in = 111, test = 1000, golden = 1000
# pass
# in = 010, in = 000, test = 0010, golden = 0010
# pass
# in = 010, in = 001, test = 0011, golden = 0011
# pass
# in = 010, in = 010, test = 0100, golden = 0100
# pass
# in = 010, in = 011, test = 0101, golden = 0101
# pass
# in = 010, in = 100, test = 0110, golden = 0110
# pass
# in = 010, in = 101, test = 0111, golden = 0111
# pass
# in = 010, in = 110, test = 1000, golden = 1000
# pass
```

```
# in = 010, in = 111, test = 1001, golden = 1001
# pass
# in = 011, in = 000, test = 0011, golden = 0011
# pass
# in = 011, in = 001, test = 0100, golden = 0100
# pass
# in = 011, in = 010, test = 0101, golden = 0101
# pass
# in = 011, in = 011, test = 0110, golden = 0110
# pass
# in = 011, in = 100, test = 0111, golden = 0111
# pass
# in = 011, in = 101, test = 1000, golden = 1000
# pass
# in = 011, in = 110, test = 1001, golden = 1001
# pass
# in = 011, in = 111, test = 1010, golden = 1010
# pass
# in = 100, in = 000, test = 0100, golden = 0100
# pass
# in = 100, in = 001, test = 0101, golden = 0101
# pass
# in = 100, in = 010, test = 0110, golden = 0110
# pass
# in = 100, in = 011, test = 0111, golden = 0111
# pass
# in = 100, in = 100, test = 1000, golden = 1000
# pass
# in = 100, in = 101, test = 1001, golden = 1001
# pass
# in = 100, in = 110, test = 1010, golden = 1010
# pass
# in = 100, in = 111, test = 1011, golden = 1011
# pass
# in = 101, in = 000, test = 0101, golden = 0101
# pass
# in = 101, in = 001, test = 0110, golden = 0110
# pass
# in = 101, in = 010, test = 0111, golden = 0111
# pass
# in = 101, in = 011, test = 1000, golden = 1000
# pass
# in = 101, in = 100, test = 1001, golden = 1001
# pass
# in = 101, in = 101, test = 1010, golden = 1010
# pass
```

```
# in = 101, in = 110, test = 1011, golden = 1011
# pass
# in = 101, in = 111, test = 1100, golden = 1100
# pass
# in = 110, in = 000, test = 0110, golden = 0110
# pass
# in = 110, in = 001, test = 0111, golden = 0111
# pass
# in = 110, in = 010, test = 1000, golden = 1000
# pass
# in = 110, in = 011, test = 1001, golden = 1001
# pass
# in = 110, in = 100, test = 1010, golden = 1010
# pass
# in = 110, in = 101, test = 1011, golden = 1011
# pass
# in = 110, in = 110, test = 1100, golden = 1100
# pass
# in = 110, in = 111, test = 1101, golden = 1101
# pass
# in = 111, in = 000, test = 0111, golden = 0111
# pass
# in = 111, in = 001, test = 1000, golden = 1000
# pass
# in = 111, in = 010, test = 1001, golden = 1001
# pass
# in = 111, in = 011, test = 1010, golden = 1010
# pass
# in = 111, in = 100, test = 1011, golden = 1011
# pass
# in = 111, in = 101, test = 1100, golden = 1100
# pass
# in = 111, in = 110, test = 1101, golden = 1101
# pass
# in = 111, in = 111, test = 1110, golden = 1110
# pass
```

- The printout below compares the add_err.v and add_ref.v outputs. The expected results were displayed. All cases passed, with the exception of the bug that was introduced. When 2 inputs were four and seven, the test failed because it did not match with the golden reference.

Text printout from IV.B:

```
# in = 000, in = 000, test = 0000, golden = 0000
# pass
# in = 000, in = 001, test = 0001, golden = 0001
# pass
# in = 000, in = 010, test = 0010, golden = 0010
# pass
# in = 000, in = 011, test = 0011, golden = 0011
# pass
# in = 000, in = 100, test = 0100, golden = 0100
# pass
# in = 000, in = 101, test = 0101, golden = 0101
# pass
# in = 000, in = 110, test = 0110, golden = 0110
# pass
# in = 000, in = 111, test = 0111, golden = 0111
# pass
# in = 001, in = 000, test = 0001, golden = 0001
# pass
# in = 001, in = 001, test = 0010, golden = 0010
# pass
# in = 001, in = 010, test = 0011, golden = 0011
# pass
# in = 001, in = 011, test = 0100, golden = 0100
# pass
# in = 001, in = 100, test = 0101, golden = 0101
# pass
# in = 001, in = 101, test = 0110, golden = 0110
# pass
# in = 001, in = 110, test = 0111, golden = 0111
# pass
# in = 001, in = 111, test = 1000, golden = 1000
# pass
# in = 010, in = 000, test = 0010, golden = 0010
# pass
# in = 010, in = 001, test = 0011, golden = 0011
# pass
# in = 010, in = 010, test = 0100, golden = 0100
# pass
```

```
# in = 010, in = 011, test = 0101, golden = 0101
# pass
# in = 010, in = 100, test = 0110, golden = 0110
# pass
# in = 010, in = 101, test = 0111, golden = 0111
# pass
# in = 010, in = 110, test = 1000, golden = 1000
# pass
# in = 010, in = 111, test = 1001, golden = 1001
# pass
# in = 011, in = 000, test = 0011, golden = 0011
# pass
# in = 011, in = 001, test = 0100, golden = 0100
# pass
# in = 011, in = 010, test = 0101, golden = 0101
# pass
# in = 011, in = 011, test = 0110, golden = 0110
# pass
# in = 011, in = 100, test = 0111, golden = 0111
# pass
# in = 011, in = 101, test = 1000, golden = 1000
# pass
# in = 011, in = 110, test = 1001, golden = 1001
# pass
# in = 011, in = 111, test = 1010, golden = 1010
# pass
# in = 100, in = 000, test = 0100, golden = 0100
# pass
# in = 100, in = 001, test = 0101, golden = 0101
# pass
# in = 100, in = 010, test = 0110, golden = 0110
# pass
# in = 100, in = 011, test = 0111, golden = 0111
# pass
# in = 100, in = 100, test = 1000, golden = 1000
# pass
# in = 100, in = 101, test = 1001, golden = 1001
# pass
# in = 100, in = 110, test = 1010, golden = 1010
# pass
```

```
# in = 100, in = 111, test = 1100, golden = 1011
# fail
# in = 101, in = 000, test = 0101, golden = 0101
# pass
# in = 101, in = 001, test = 0110, golden = 0110
# pass
# in = 101, in = 010, test = 0111, golden = 0111
# pass
# in = 101, in = 011, test = 1000, golden = 1000
# pass
# in = 101, in = 100, test = 1001, golden = 1001
# pass
# in = 101, in = 101, test = 1010, golden = 1010
# pass
# in = 101, in = 110, test = 1011, golden = 1011
# pass
# in = 101, in = 111, test = 1100, golden = 1100
# pass
# in = 110, in = 000, test = 0110, golden = 0110
# pass
# in = 110, in = 001, test = 0111, golden = 0111
# pass
# in = 110, in = 010, test = 1000, golden = 1000
# pass
# in = 110, in = 011, test = 1001, golden = 1001
# pass
# in = 110, in = 100, test = 1010, golden = 1010
# pass
# in = 110, in = 101, test = 1011, golden = 1011
# pass
# in = 110, in = 110, test = 1100, golden = 1100
# pass
# in = 110, in = 111, test = 1101, golden = 1101
# pass
# in = 111, in = 000, test = 0111, golden = 0111
# pass
# in = 111, in = 001, test = 1000, golden = 1000
# pass
# in = 111, in = 010, test = 1001, golden = 1001
# pass
# in = 111, in = 011, test = 1010, golden = 1010
# pass
# in = 111, in = 100, test = 1100, golden = 1011
# fail
# in = 111, in = 101, test = 1100, golden = 1100
# pass
# in = 111, in = 110, test = 1101, golden = 1101
# pass
# in = 111, in = 111, test = 1110, golden = 1110
# pass
```