ECEN 454-508

Lab 1

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1/29/2020

Full Adder
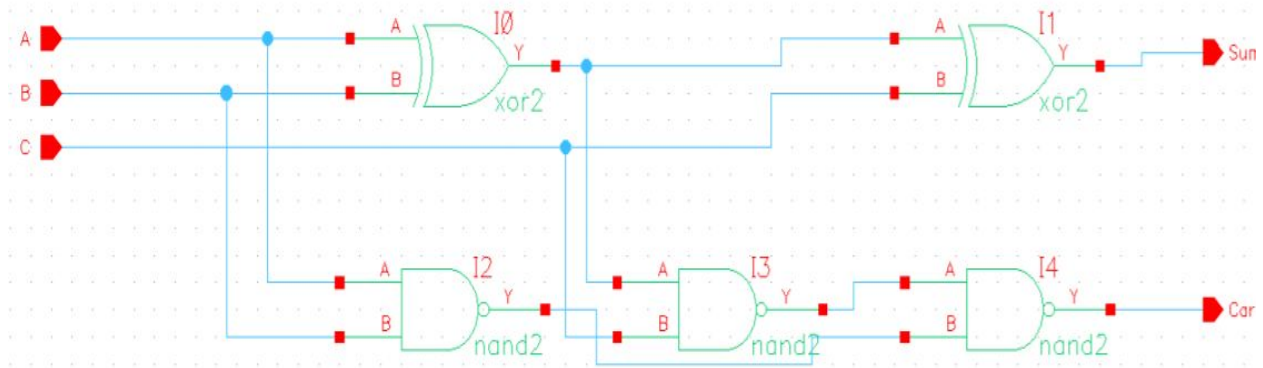
Testbench:

initial
begin

A = 1'b0;
B = 1'b0;
C = 1'b0;

$monitor ($time," A=%b, B=%b, C=%b, Sum=%b, Carry=%b", A, B, C, Sum, Carry);
#50 A=1'b0; B=1'b0; C=1'b1; //ABC=001
$monitor ($time," A=%b, B=%b, C=%b, Sum=%b, Carry=%b", A, B, C, Sum, Carry);
#50 A=1'b0; B=1'b1; C=1'b0; //ABC=010
$monitor ($time," A=%b, B=%b, C=%b, Sum=%b, Carry=%b", A, B, C, Sum, Carry);
 #50 A=1'b0; B=1'b1; C=1'b1; //ABC=011
$monitor ($time," A=%b, B=%b, C=%b, Sum=%b, Carry=%b", A, B, C, Sum, Carry);
 #50 A=1'b1; B=1'b0; C=1'b0; //ABC=100
$monitor ($time," A=%b, B=%b, C=%b, Sum=%b, Carry=%b", A, B, C, Sum, Carry);
#50 A=1'b1; B=1'b0; C=1'b1; //ABC=101
$monitor ($time," A=%b, B=%b, C=%b, Sum=%b, Carry=%b", A, B, C, Sum, Carry);
#50 A=1'b1; B=1'b1; C=1'b0; //ABC=110
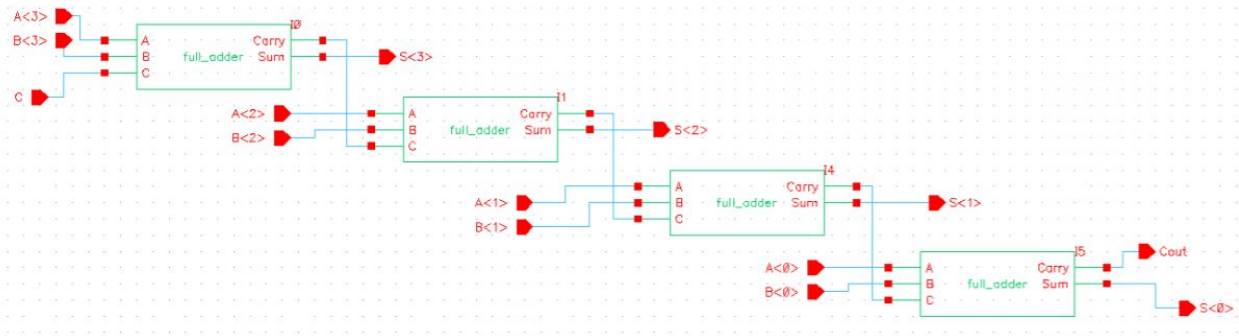$monitor ($time," A=%b, B=%b, C=%b, Sum=%b, Carry=%b", A, B, C, Sum, Carry);
#50 A=1'b1; B=1'b1; C=1'b1; //ABC=111

```
$monitor ($time," A=%b, B=%b, C=%b, Sum=%b, Carry=%b", A, B, C, Sum, Carry);
end
```

Results:

```
0 A=0, B=0, C=0, Sum=0, Carry=0
50 A=0, B=0, C=1, Sum=1, Carry=0
100 A=0, B=1, C=0, Sum=1, Carry=0
150 A=0, B=1, C=1, Sum=0, Carry=1
200 A=1, B=0, C=0, Sum=1, Carry=0
250 A=1, B=0, C=1, Sum=0, Carry=1
300 A=1, B=1, C=0, Sum=0, Carry=1
350 A=1, B=1, C=1, Sum=1, Carry=1
```

4 Bit Adder

Testbench:

Initial
Begin

A = 4'b0000;
B = 4'b0000;
C = 1'b0;

$monitor ($time," A=%b, B=%b, C=%b, Sum=%b, Carry=%b", A, B, C, S, Cout);

#50 A=4'b1111; B=4'b1111; C=1'b0;
$monitor ($time," A=%b, B=%b, C=%b, Sum=%b, Carry=%b", A, B, C, S, Cout);

#50 A=4'b1010; B=4'b1010; C=1'b1;
$monitor ($time," A=%b, B=%b, C=%b, Sum=%b, Carry=%b", A, B, C, S, Cout);

#50 A=4'b0101; B=4'b0101; C=1'b1;
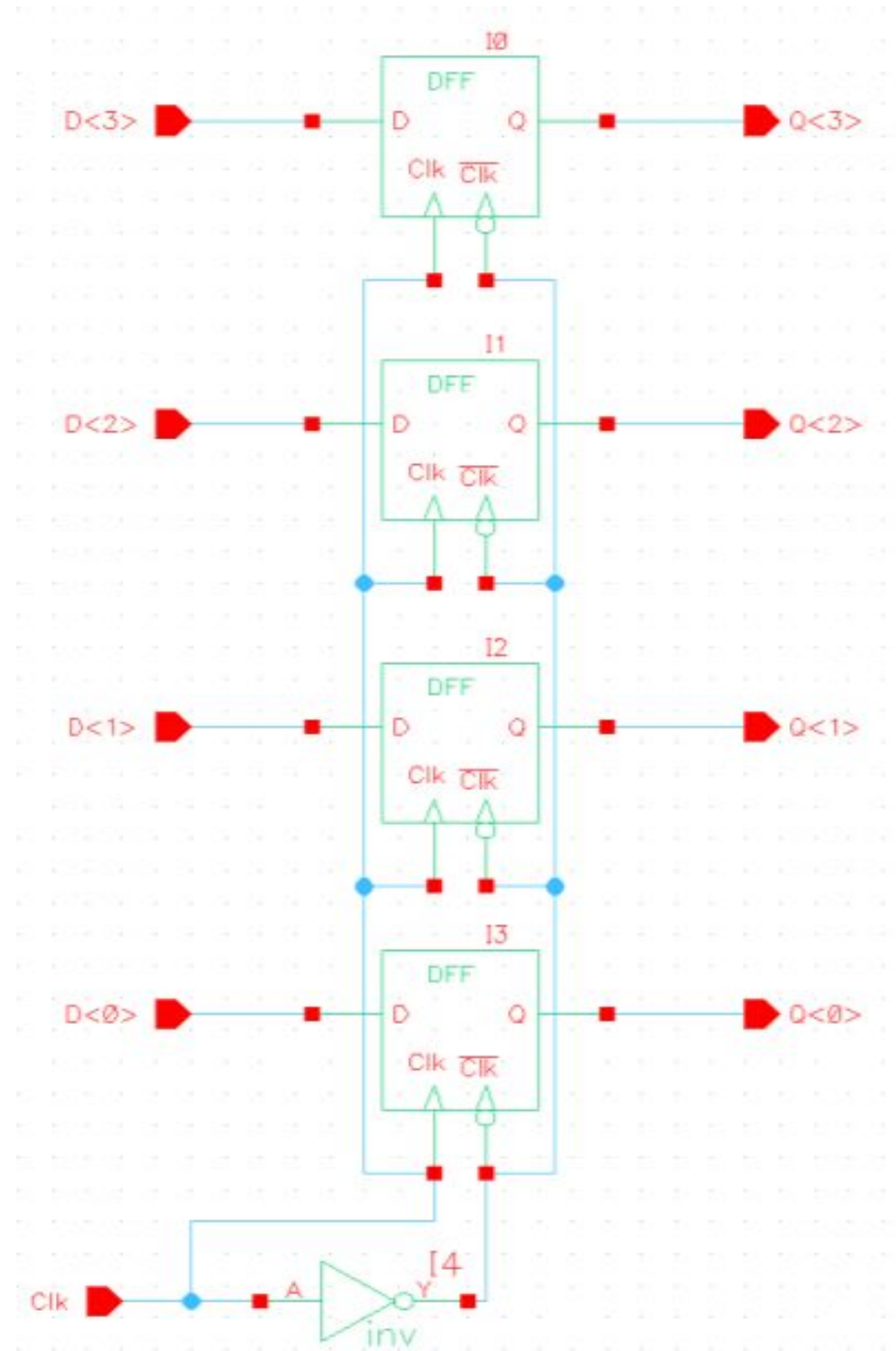$monitor ($time," A=%b, B=%b, C=%b, Sum=%b, Carry=%b", A, B, C, S, Cout);
end

Results:

0 A=0000, B=0000, C=0, Sum=0000, Carry=0
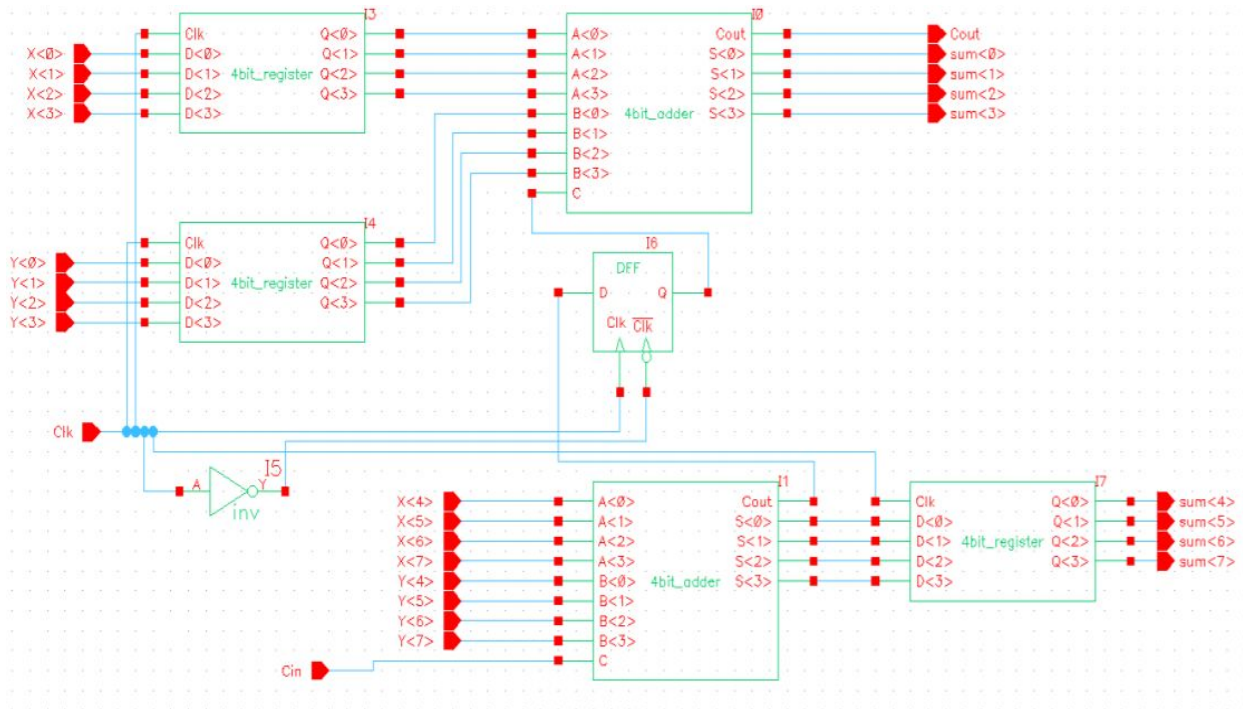50 A=1111, B=1111, C=0, Sum=1110, Carry=1
100 A=1010, B=1010, C=1, Sum=0101, Carry=1
150 A=0101, B=0101, C=1, Sum=1011, Carry=0

4 Bit Reg

8 Bit Adder

Testbench:

Initial
Begin

Cin = 1'b0;
Clk = 1'b0;
X[0] = 1'b0;
X[1] = 1'b0;
X[2] = 1'b0;
X[3] = 1'b0;
X[4] = 1'b0;
X[5] = 1'b0;
X[6] = 1'b0;
X[7] = 1'b0;
Y[0] = 1'b0;

```verilog
Y[1] = 1'b0;
Y[2] = 1'b0;
Y[3] = 1'b0;
Y[4] = 1'b0;
Y[5] = 1'b0;
Y[6] = 1'b0;
Y[7] = 1'b0;

$monitor ($time," X=%b, Y=%b, Cin=%b, Sum=%b, Cout=%b", X, Y, Cin, sum, Cout);

#50 X=8'b01111110; Y=8'b11100111; Cin=1'b0; Clk = 1'b0;
#5 Clk = 1'b1;
$monitor ($time," X=%b, Y=%b, Cin=%b, Sum=%b, Cout=%b", X, Y, Cin, sum, Cout);

#50 X=8'b11111111; Y=8'b00000000; Cin=1'b1; Clk = 1'b0;
#5 Clk = 1'b1;
$monitor ($time," X=%b, Y=%b, Cin=%b, Sum=%b, Cout=%b", X, Y, Cin, sum, Cout);

#50 X=8'b10101010;
Y=8'b01010101;
Cin=1'b0;
Clk = 1'b0;
#5 Clk = 1'b1;
$monitor ($time," X=%b, Y=%b, Cin=%b, Sum=%b, Cout=%b", X, Y, Cin, sum, Cout);

#50 X=8'b10101010;
Y=8'b01010101;
Cin=1'b1;
Clk = 1'b0;
#5 Clk = 1'b1;
$monitor ($time," X=%b, Y=%b, Cin=%b, Sum=%b, Cout=%b", X, Y, Cin, sum, Cout);

#50 X=8'b11001100;
Y=8'b00110011;
Cin=1'b0;
Clk = 1'b0;
#5 Clk = 1'b1;
$monitor ($time," X=%b, Y=%b, Cin=%b, Sum=%b, Cout=%b", X, Y, Cin, sum, Cout);
```

```
#50 X=8'b11001100;
Y=8'b00110011;
Cin=1'b1;
Clk = 1'b0;
#5 Clk = 1'b1;
$monitor ($time," X=%b, Y=%b, Cin=%b, Sum=%b, Cout=%b", X, Y, Cin, sum, Cout);
end
```

Results:

```
0 X=00000000, Y=00000000, Cin=0, Sum=xxxxxxxx, Cout=x
50 X=01111110, Y=11100111, Cin=0, Sum=xxxxxxxx, Cout=x
55 X=01111110, Y=11100111, Cin=0, Sum=01100101, Cout=1
105 X=11111111, Y=00000000, Cin=1, Sum=01100101, Cout=1
110 X=11111111, Y=00000000, Cin=1, Sum=00000000, Cout=1
160 X=10101010, Y=01010101, Cin=0, Sum=00000000, Cout=1
165 X=10101010, Y=01010101, Cin=0, Sum=11111111, Cout=0
215 X=10101010, Y=01010101, Cin=1, Sum=11111111, Cout=0
220 X=10101010, Y=01010101, Cin=1, Sum=00000000, Cout=1
270 X=11001100, Y=00110011, Cin=0, Sum=00000000, Cout=1
275 X=11001100, Y=00110011, Cin=0, Sum=11111111, Cout=0
325 X=11001100, Y=00110011, Cin=1, Sum=11111111, Cout=0
330 X=11001100, Y=00110011, Cin=1, Sum=00000000, Cout=1
```