1) A copy of the Verilog code used to implement the design. The Verilog code should be complete with useful comments (5 pts).

Before extra credit:

```
`timescale 1ns / 1ps
//////////////////////////////////////////////////////////////////////////////////
// Company:
// Engineer:
//
// Create Date: 10/13/2025 10:16:13 AM
// Design Name:
// Module Name: 8-bit Multiplier
// Project Name:
// Target Devices:
// Tool Versions:
// Description:
//
// Dependencies:
//
// Revision:
// Revision 0.01 - File Created
// Additional Comments:
//
//////////////////////////////////////////////////////////////////////////////////


module Multiplier(
    input [15:0] sw, //initialize switches as inputs
    output reg [15:0] led //initialize leds as outputs
    );

    wire [7:0] left_sw = sw[15:8]; //separate the main switches into a left set and a right set
    wire [7:0] right_sw = sw[7:0];

    wire [15:0] p0, p1, p2, p3, p4, p5, p6, p7; //setup variables for each step of the multiplication
process
    wire [15:0] product; //store the final product of the multiplication

    //perform the multiplication
    assign p0 = {8{right_sw[0]}} & left_sw[7:0];
    assign p1 = {({8{right_sw[1]}} & left_sw[7:0]),1'b0};
    assign p2 = {({8{right_sw[2]}} & left_sw[7:0]),2'b0};
    assign p3 = {({8{right_sw[3]}} & left_sw[7:0]),3'b0};
```

```
    assign p4 = {({8{right_sw[4]}} & left_sw[7:0]),4'b0};
    assign p5 = {({8{right_sw[5]}} & left_sw[7:0]),5'b0};
    assign p6 = {({8{right_sw[6]}} & left_sw[7:0]),6'b0};
    assign p7 = {({8{right_sw[7]}} & left_sw[7:0]),7'b0};

    //add everything together to get the final product
    assign product = p0 + p1 + p2 + p3 + p4 + p5 + p6 + p7;

    //set the LEDs to the product
    always @(product)
    begin
        led = product;
    end

endmodule
```

Extra credit code:

```
`timescale 1ns / 1ps
//////////////////////////////////////////////////////////////////////////////////
// Company:
// Engineer:
//
// Create Date: 10/13/2025 10:16:13 AM
// Design Name:
// Module Name: 8-bit Multiplier
// Project Name:
// Target Devices:
// Tool Versions:
// Description:
//
// Dependencies:
//
// Revision:
// Revision 0.01 - File Created
// Additional Comments:
//
//////////////////////////////////////////////////////////////////////////////////


module Multiplier(
    input [15:0] sw, //initialize switches as inputs
    output reg [15:0] led //initialize leds as outputs
    );
```

```
    wire signed [7:0] left_sw = sw[15:8]; //separate the main switches into a left set and a right set
    wire signed [7:0] right_sw = sw[7:0];

    wire signed [15:0] p0, p1, p2, p3, p4, p5, p6, p7; //setup variables for each step of the
multiplication process
    wire signed [15:0] product; //store the final product of the multiplication

    //perform the multiplication
    assign p0 = {{8{left_sw[7] & right_sw[0]}}, {8{right_sw[0]}} & left_sw[7:0]};
    assign p1 = {{7{left_sw[7] & right_sw[1]}}, ({8{right_sw[1]}} & left_sw[7:0]),1'b0};
    assign p2 = {{6{left_sw[7] & right_sw[2]}}, ({8{right_sw[2]}} & left_sw[7:0]),2'b0};
    assign p3 = {{5{left_sw[7] & right_sw[3]}}, ({8{right_sw[3]}} & left_sw[7:0]),3'b0};
    assign p4 = {{4{left_sw[7] & right_sw[4]}}, ({8{right_sw[4]}} & left_sw[7:0]),4'b0};
    assign p5 = {{3{left_sw[7] & right_sw[5]}}, ({8{right_sw[5]}} & left_sw[7:0]),5'b0};
    assign p6 = {{2{left_sw[7] & right_sw[6]}}, ({8{right_sw[6]}} & left_sw[7:0]),6'b0};
    assign p7 = -({1'b0, {8{right_sw[7]}} & left_sw[7:0], 7'b0});

    //add everything together to get the final product
    assign product = p0 + p1 + p2 + p3 + p4 + p5 + p6 + p7;

    //set the LEDs to the product
    always @(product)
    begin
        led = product;
    end

endmodule
```

2) A brief description of the unique (new) tools, technologies, or methods used to implement this lab (5 pts).

We didn't use any new tools during the lab however we did use new methods to implement the code. Assuming we didn't learn in the previous lab we learned how to split things up like switches so they could become two or more sets. For the extra credit I learned that in order to perform signed operations you must place the keyword signed after creating wires. I also learned about performing a twos compliment or negation by adding a negative sign to the start of the partial multiplication for example when I calculated p7.

3) Images of implemented schematic or other useful images(5 pts).

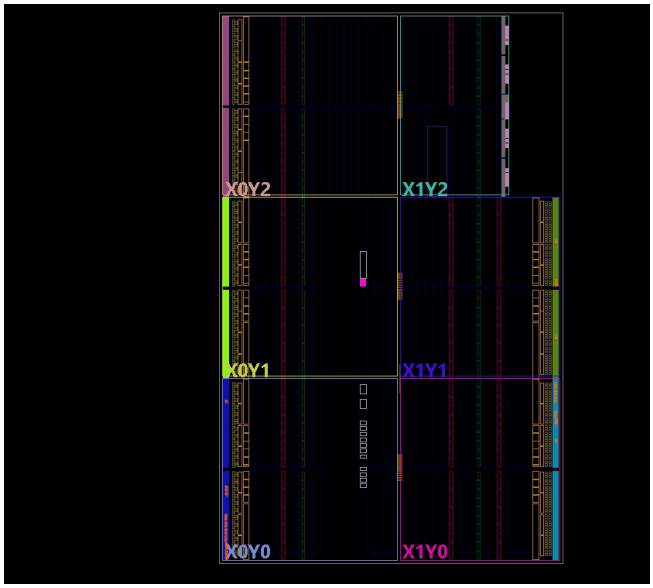

Figure 1: synthesized design

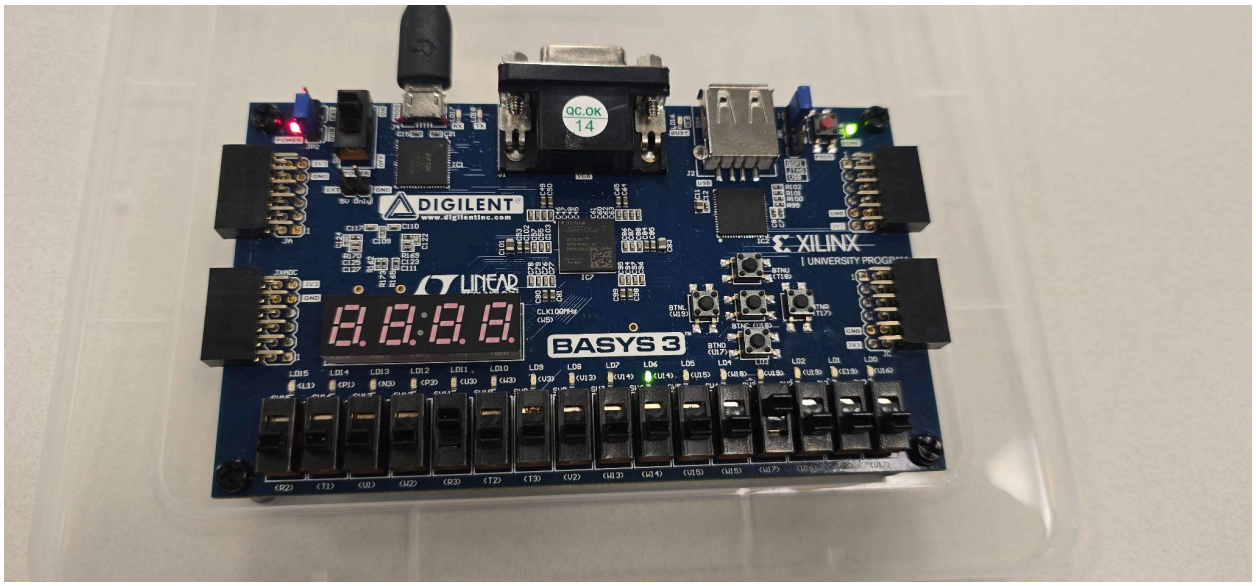

Figure 2: 8*8=64 before implement signed numbers

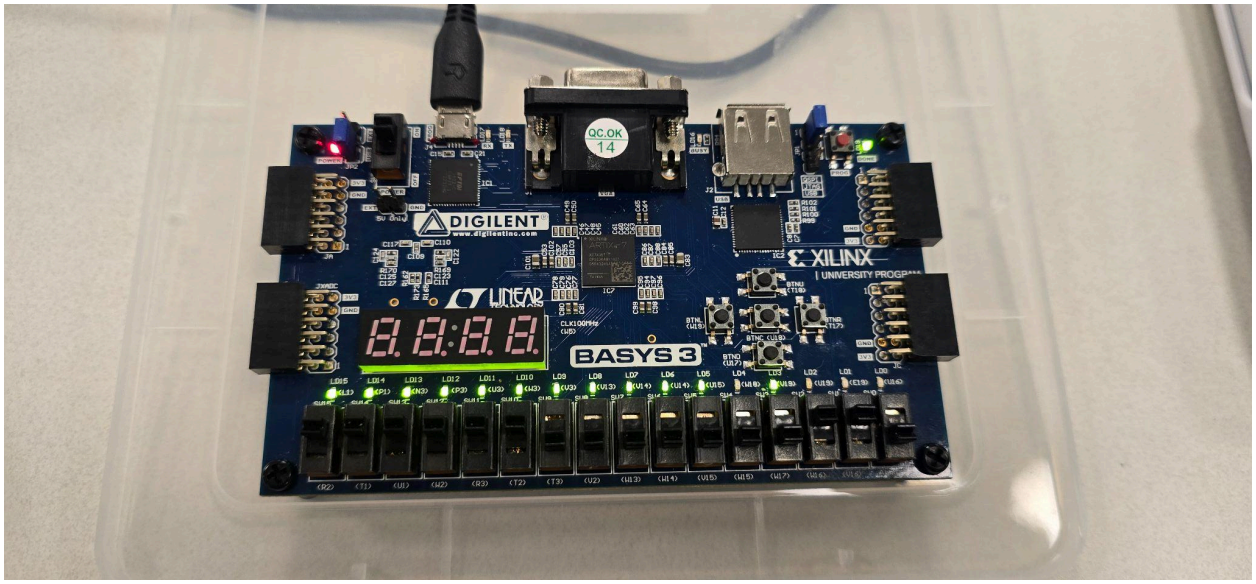

Figure 3: -4 * 6 = -24; performed with signed numbers implementation

4) The report should be professional quality—meaning it will be neat and use proper English (5 pts).

5) In your conclusion statement, discuss your results, the method of testing, and include the level of functionality of the lab (5 pts).

I was able to achieve full functionality including the extra credit. The method of testing was first using unsigned numbers to ensure that the requirements were met before the implementation of the extra credit. Then to test that signed numbers worked as well I performed the operation that is described in Figure 3.