The DE1-SoC has two General Purpose Input/Output ports (GPIO_0 and GPIO_1) with expansion headers (2 × 20 = 40 pins total) that are used to connect peripherals to the board. The GPIO pin assignments are already defined in a .qsf file (generated by Quartus) so you can add them to your top-level SystemVerilog module in the same way as the switches and LEDs:

```verilog
module DE1_SoC (GPIO_0);
    // SW and KEY cannot be declared if GPIO_0 is declared on LabsLand
    inout logic [33:0] GPIO_0;
    // Assign GPIO_0[27] (LED) to GPIO_0[5] (switch)
    assign GPIO_0[27] = GPIO_0[5];
endmodule // DE1_SoC

module DE1_SoC_testbench ();
    // inout pins must be connected to a wire type
    wire [33:0] GPIO_0;
    // additional logic required to simulate inout pins
    logic [33:0] GPIO_0_in;
    logic [33:0] GPIO_0_dir; // 1 = input, 0 = output

    // set up tristate buffers for inout pins
    genvar i;
    generate
        for (i = 0; i < 34; i++) begin : gpio
            assign GPIO_0[i] = GPIO_0_dir[i] ? GPIO_0_in[i] : 1'bZ;
        end
    endgenerate

    DE1_SoC dut (.GPIO_0);

    initial begin
        // you only need to set the pin directions once
        GPIO_0_dir[5] = 1'b1;
        GPIO_0_dir[27] = 1'b0;
        // manipulate the GPIO_0 input bits indirectly through GPIO_0_in
        GPIO_0_in[5] = 1'b1; #50;
        GPIO_0_in[5] = 1'b0; #50;
    end
endmodule // DE1_SoC_testbench
```

*Figure 1: Example code for using the GPIO pins on your DE1-SoC [GPIO_example.sv].*
Virtual Breadboard on LabsLand

1) Log into your LabLands account (please refer to Lab 0 on setting up a LabsLand account).

2) Navigate to the SystemVerilog IDE:

3) Locate the “User interface” heading above the Documentation box and click “Edit” next to it:

4) In the resulting pop-up window, select the “Breadboard” option and click the “Configure” button under the “Breadboard” tile:

5) You will be directed to the following setup window, where you can connect circuit components that are available on the breadboard (switches and LEDs) to the GPIOs. The left side shows the relationship between GPIO_0 and JP1. The right side is the actual configurator you will use to connect wires between GPIO_0 and the circuit components:
a) Click on a wire color on the right to turn your mouse into a wire-drawing pen. Then click and hold your mouse to draw a cable connecting the GPIO header and the breadboard. All breadboard connections are automatically saved. Repeat the process to create all the wires for your design.

b) **Note:** You can only use GPIO0_0[5] – GPIO0_0[22] as inputs and GPIO0_0[26] – GPIO0_0[27] as outputs so wire your components accordingly!

c) For the sample code in Figure 1, you will want a configuration similar to the one shown below, though JP1 pin 6 can be connected to the middle pin of any of the three switches and JP1 pin 32 can be connected to either LED:

6) Once you send the code to the FPGA, you will see the breadboard exactly as you left it in the breadboard configurator!