5th Day

ALU

Design

```
module alu_4bit (
   input  [3:0] a, b,
   input  [2:0] sel,
   output reg [3:0] result,
   output reg carry     // Carry Output
);
   always @(*) begin
      case (sel)
         3'b000: {carry, result} = a + b;  // Addition
         3'b001: {carry, result} = a - b;  // Subtraction
         3'b010: result = a & b;  // AND
         3'b011: result = a | b;  // OR
         3'b100: result = a ^ b;  // XOR
         3'b101: result = a &&b;//logical and
         3’b110: result = a ||b;//logical or
         default: result = 4'b0000; // Default case
      endcase
   end
endmodule
```

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Testbench

```
module alu_tb;
   reg [3:0] a, b;
   reg [2:0] sel;
   wire [3:0] result;
   wire carry;

   alu_4bit  dut ( .a(a), .b(b),.sel(sel), .result(result),.carry(carry));

   initial begin
      $monitor("A = %b, B = %b, SEL = %b -> RESULT = %b, CARRY = %b", a, b, sel, result, carry);

      a = 4'b1010; b = 4'b0101; sel = 3'b000; #5; // ADD
      a = 4'b1010; b = 4'b0011; sel = 3'b001; #5; // SUB
      a = 4'b1100; b = 4'b1010; sel = 3'b010; #5; // AND
      a = 4'b1100; b = 4'b1010; sel = 3'b011; #5; // OR
      a = 4'b1100; b = 4'b1010; sel = 3'b100; #5; // XOR
      a = 4'b1010; b = 4'b0000; sel = 3'b101; #5; //logical and
      a = 4'b1100; b = 4'b0000; sel = 3'b110; #5; //logical or
      $finish;
   end
endmodule
```

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Simulation

```
# run 1000ns
A = 1010, B = 0101, SEL = 000 -> RESULT = 1111, CARRY = 0
A = 1010, B = 0011, SEL = 001 -> RESULT = 0111, CARRY = 0
A = 1100, B = 1010, SEL = 010 -> RESULT = 1000, CARRY = 0
A = 1100, B = 1010, SEL = 011 -> RESULT = 1110, CARRY = 0
A = 1100, B = 1010, SEL = 100 -> RESULT = 0110, CARRY = 0
A = 1010, B = 0000, SEL = 101 -> RESULT = 0000, CARRY = 0
A = 1100, B = 0000, SEL = 110 -> RESULT = 0001, CARRY = 0
$finish called at time : 35 ns : File "C:/Users/manojmsd/100_days_of_RTL/100_days_of_RTL.srcs/sources_1/new/alu_4bit_tb.v" Line 41
INFO: [USF-XSim-96] XSim completed. Design snapshot 'alu_tb_behav' loaded.
INFO: [USF-XSim-97] XSim simulation ran for 1000ns
launch_simulation: Time (s): cpu = 00:00:03 ; elapsed = 00:00:09 . Memory (MB): peak = 1410.180 ; gain = 0.160
```