Lab 4: Beginning to Decode

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1 Simplified Report

The instr_parse module uses both R and D format to break down instruction code. The module parses the instruction bits successfully and it is verified using four the instruction codes provided in class. The regfile module reads data from the regData file into an array of registers. The module releases the addressed data into the register array using non-blocking assignments and outputs the instruction into read_data1 and read_data2, based on the read_reg indices. When write_data input is HIGH, data will be written to a register in the array specified by the write_reg index. This action is verified through the simulation.

2 Code

Listing 1: Verilog code for implementing the instr_parse module.

```
`include "definitions.vh"

module instr_parse(
    input clk,
    input [`INSTR_LEN-1:0] instruction,
    output reg [10:0] opcode,
    output reg [8:0] address,
    output reg [4:0] rm_num,
    output reg [4:0] rn_num,
    output reg [4:0] rd_num

    );

    always @(posedge(clk)) begin
            opcode <= instruction[31:21];
            address <= instruction[20:12];
            rm_num <= instruction[20:16];
            rn_num <= instruction[9:5];
```

```
            rd_num <= instruction[4:0];
    end

endmodule
```

Listing 2: Verilog code for implementing the regfile module.

```
`include "definitions.vh"

module regfile(
    input read_clk,
    input write_clk,
    input regWrite,
    input [4:0] read_reg1,
    input [4:0] read_reg2,
    input [4:0] write_reg,
    input [`WORD-1:0] write_data,
    output reg [`WORD-1:0] read_data1,
    output reg [`WORD-1:0] read_data2
    );

    reg [`WORD-1:0] regs [31:0];

    always @(posedge(read_clk))begin
        read_data1 <= regs[read_reg1];
        read_data2 <= regs[read_reg2];
    end

    always @(posedge(write_clk))begin
        if (regWrite == 1'b1)
            regs[write_reg] <= write_data;
    end

    initial
            $readmemb(`RMEMFILE, regs);


endmodule
```

3 Testbench

Listing 3: Verilog code for implementing the instr_parse testbench.

```
`include "definitions.vh"
```

```
module instr_parse_test;

    wire clk;
    reg [`INSTR_LEN-1:0] instruction;
    wire [10:0] opcode;
    wire [8:0] address;
    wire [4:0] rm_num;
    wire [4:0] rn_num;
    wire [4:0] rd_num;

oscillator clk_gen(clk);

instr_parse UUT
    (
    .clk(clk),
    .instruction(instruction),
    .address(address),
    .opcode(opcode),
    .rm_num(rm_num),
    .rn_num(rn_num),
    .rd_num(rd_num)
    );

initial begin

instruction = 32'b11111000010011110000000101001001;
#(2*`CYCLE);
instruction = 32'b10001011000010010000001010101001;
#(2*`CYCLE);
instruction = 32'b10010001000000000000011010101001;
#(2*`CYCLE);
instruction = 32'b11111000000011110000000101001001;

end

endmodule
```

Listing 4: Verilog code for implementing the regfile testbench.

```
`include "definitions.vh"

module regfile_test;

    wire read_clk;
    wire write_clk;
    reg regWrite;
```

```
    reg [4:0] read_reg1; //rn
    reg [4:0] read_reg2; //rm
    reg [4:0] write_reg; //rd
    reg [`WORD-1:0] write_data;
    wire [`WORD-1:0] read_data_1;
    wire [`WORD-1:0] read_data_2;

    oscillator clk_gen_read(write_clk);

    oscillator clk_gen_write(read_clk);

    regfile UUT(
        .read_clk(read_clk),
        .write_clk(write_clk),
        .regWrite(regWrite),
        .read_reg1(read_reg1),
        .read_reg2(read_reg2),
        .write_reg(write_reg),
        .write_data(write_data),
        .read_data1(read_data_1),
        .read_data2(read_data_2)
    );

initial begin

regWrite <= 1'b0;
read_reg1 <= 10;
read_reg2 <= 15;

#(`CYCLE*2);

regWrite <= 1'b1;
write_reg = 5'b01001;
write_data = 256;

#(`CYCLE*2);

regWrite <= 1'b0;
read_reg1 <= 2;
read_reg2 <= 32;

end

endmodule
```

4 Simulation

As seen from the simulation in Figure 2, the read_data output registers equal the addresses given in the read_reg inputs. This is simply because we altered the regData file to the values show in Figure 3.

Figure 1: Timing diagram for instr_parse module test.

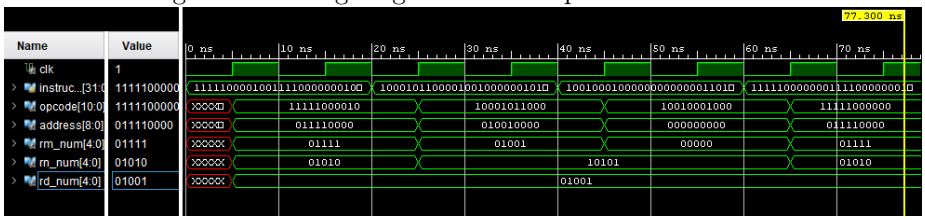

Figure 2: Timing diagram for regfile module test.

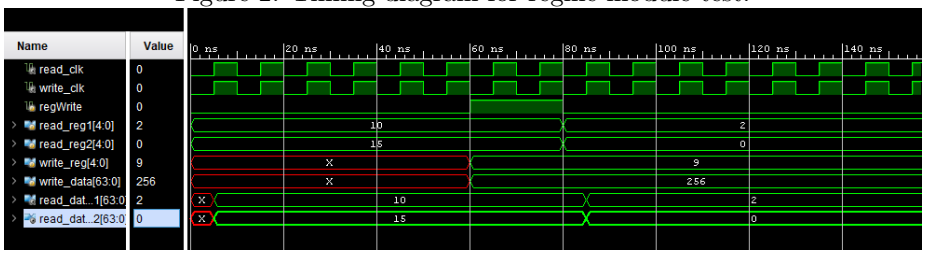

Figure 3: Modified Register File Data.

```
00000000000000000000000000000000
00000000000000000000000000000001
00000000000000000000000000000010
00000000000000000000000000000011
00000000000000000000000000000100
00000000000000000000000000000101
00000000000000000000000000000110
00000000000000000000000000000111
00000000000000000000000000001000
00000000000000000000000000001001
00000000000000000000000000001010
00000000000000000000000000001011
00000000000000000000000000001100
00000000000000000000000000001101
00000000000000000000000000001110
00000000000000000000000000001111
00000000000000000000000000010000
00000000000000000000000000010001
00000000000000000000000000010010
00000000000000000000000000010011
00000000000000000000000000010100
00000000000000000000000000010101
00000000000000000000000000010110
00000000000000000000000000010111
00000000000000000000000000011000
00000000000000000000000000011001
00000000000000000000000000011010
00000000000000000000000000011011
00000000000000000000000000011100
00000000000000000000000000011101
00000000000000000000000000011110
00000000000000000000000000011111
```