Computer Organization 2015

Lab 3: Single Cycle CPU Ⅱ

Due: 2015/04/26 23:59:59

1. Purpose

Based on lab2，adding a memory unit(named the module DM in Simple_Single_CPU). Implement a complete single cycle CPU that can run R-type, I-type, branch, and jump instructions.

2. Requirement

A. Please use Modelsim or Xilinx as your simulation platform

B. It's a no team assignment. Please attach your names and student IDs as comments in the top of each file. The assignment you upload on e3 must have the form of "student_ID.rar ".

C. Reg_File[29] represents stack point. Please give an initial value to Reg_File[29] as 128, others 0.

D. Decoder may add the following control signal:

- BranchType_o
- Jump_o
- MemRead_o
- MemWrite_o
- MemtoReg_o

E. Please name the Data_Memory module DM in Simple_Single_CPU.

F. Basic instruction (60%)

Lab2 instruction + lw、sw、mul、jump

Instruction	op[31:26]	rs	rt	rd	shamt	func
lw	6'b100011	rs[25:21]	rt[20:16]	imm[15:0]		
sw	6'b101011	rs[25:21]	rt[20:16]	imm[15:0]		
mul	6'b000000	rs[25:21]	rt[20:16]	rd[15:11]	5'b00000	6'b011000
jump	6'b000010	Address[25:0]				

i. lw

MemWrite to be 0, MemRead to be 1，RegWrite to be 1

Reg[rt] ← Mem[rs+imm]

ii. sw

MemWrite to be 1, MemRead to be 0

Mem[rs+imm] ← Reg[rt]

iii. mul

Reg[rd] ← Reg[rs]*Reg[rt]

iv. jump

Jump to be 1

PC={PC[31:28]，address<<2}

G. Advanced instruction (30%)

Instruction	op[31:26]	rs	rt	imm
bgt	6'b000111	rs[25:21]	rt[20:16]	imm[15:0]
bnez	6'b000101	rs[25:21]	5'b00000	imm[15:0]
bgez	6'b000001	rs[25:21]	5'b00001	imm[15:0]

i. bgt (branch greater than)

Branch to be 1

if (rs > rt) then PC = PC + 4 + (sign_imm<<2)

ii. bnez (branch non equal zero)

Branch to be 1

if (rs != 0) then PC = PC + 4 + (sign_imm<<2)

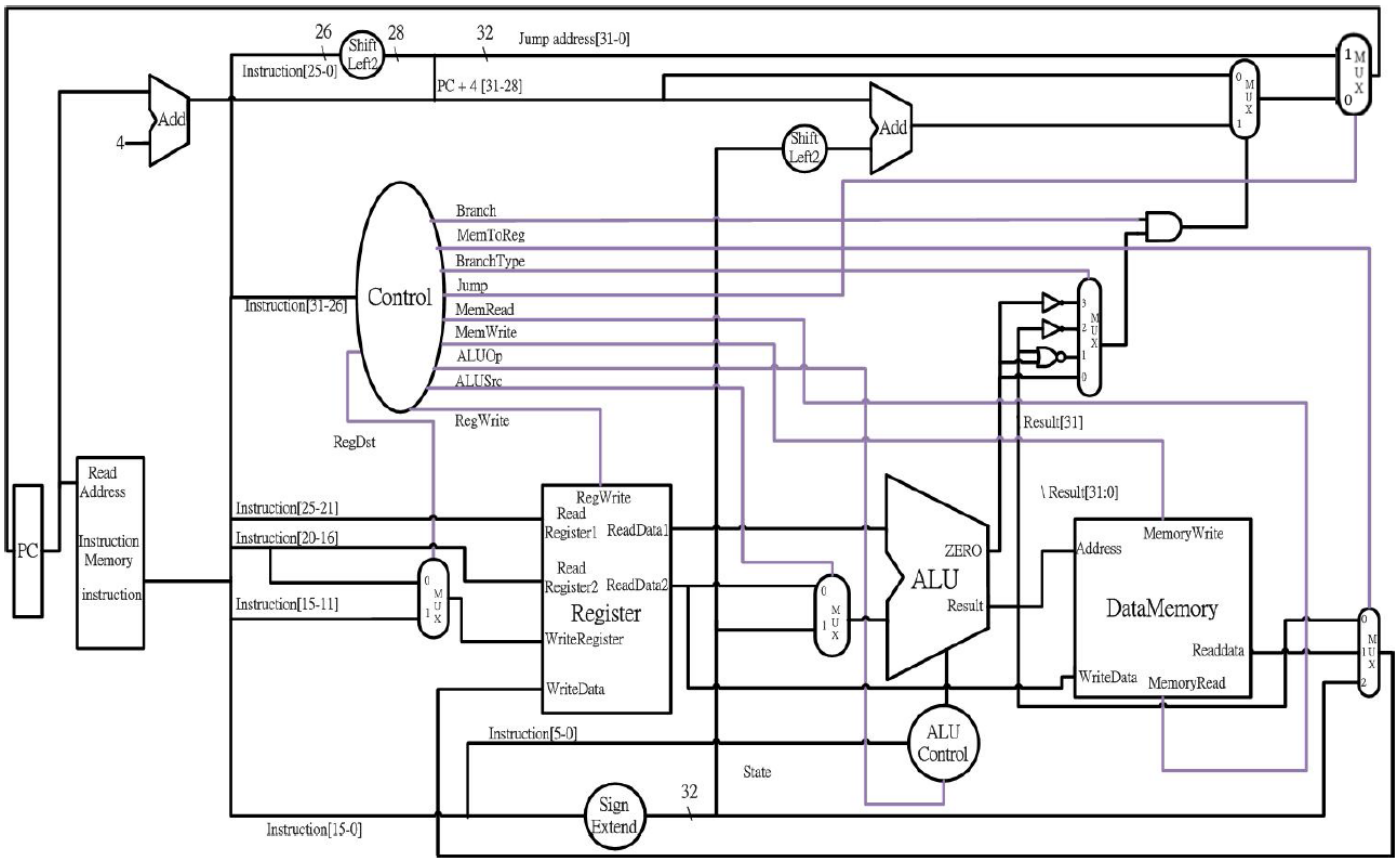
iii. bgez (branch greater equal zero)

Branch to be 1

if (rs >= 0) then PC = PC + 4 + (sign_imm<<2)

3. Basic Architecture

If you need to use extra control signal, please draw your design to the architecture and descript the implement flow on the report.



4. Bonus (10%)

Instruction	op[31:26]	rs	rt	rd	shamt	func
jal	6’b000011	Address[25:0]				
jr	6’b000000	rs	0	0	0	6’b001000

5. Test

A. Basic instruction

TA offers CO_LAB3_test_data1.txt to let you test your design. Refer to test_data1_result.txt to check your result.

B. Advanced instruction

CO_LAB3_test_data2.txt extend the previous part and add more instruction to let your test your design. Refer to test_data2_result to check your result.

C. Bonus

CO_LAB3_test_data3.txt, it is a Fibonacci function. When it done r2 is the answer we want. Refer to test_data3_result to check your result.

D. Please change the line in the file “Instr_Memory” whenever you want to use a different test pattern file

$readmemb("CA_LAB3_bonus2.txt", Instr_Mem);

6. Grade

A. Total score: 110 pts. Cheating will be punished with a null score!

B. Basic instruction (60%)

C. Advanced instruction (30%)

D. Bonus (10%)

E. Report (10%): format as in previous assignments.

F. Delay: 10% off/day

G. This Lab needs demo, demo time will be announced.

7. Hand in assignment

- Please submit your file to e3.
- Please compress your source file (not the whole Modelsim project), and report into one single file.
- The file should be named: student_ID.rar