

Computer Organization

Lab 5 - Advanced Pipelined CPU

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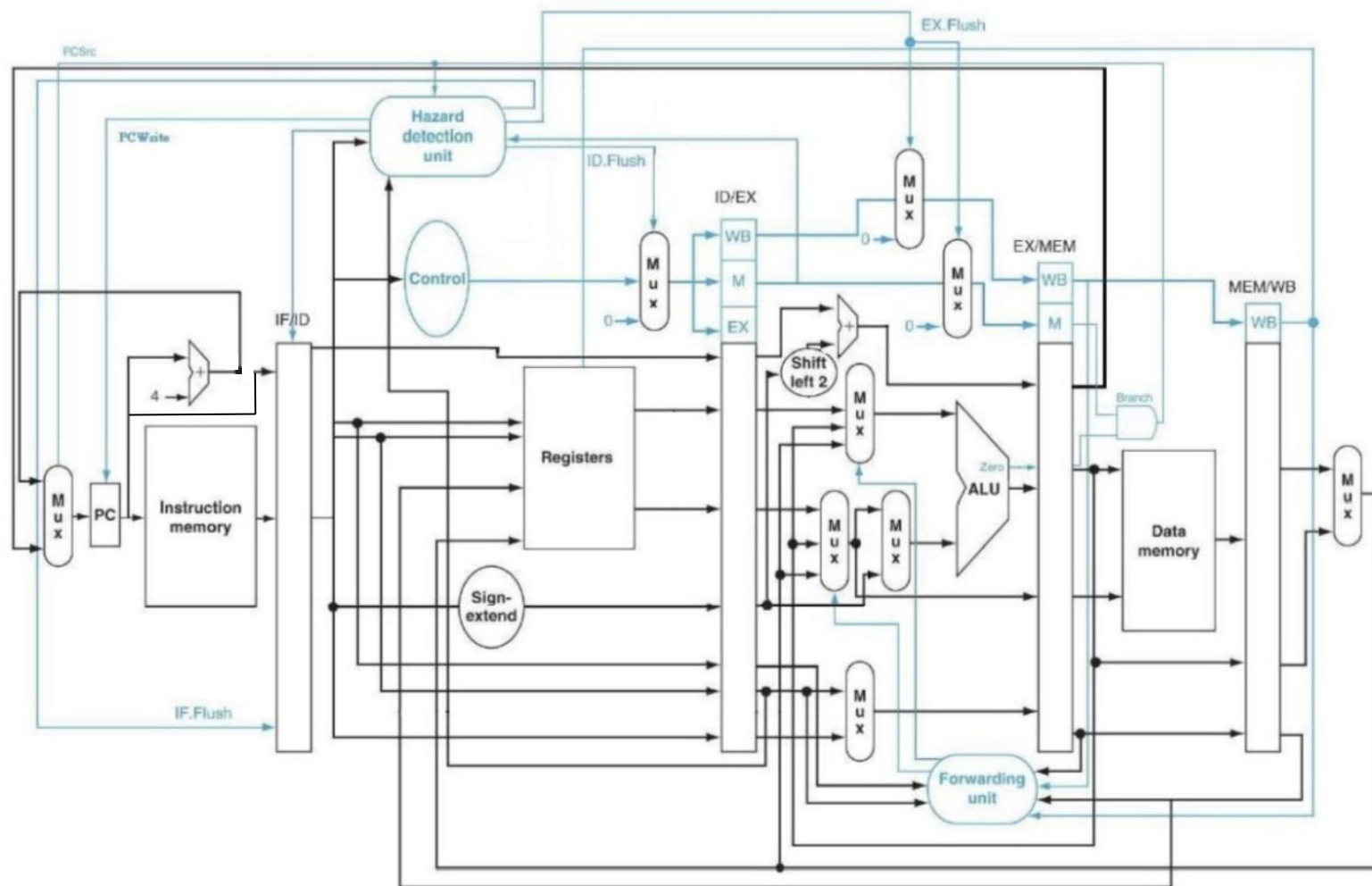
Objectives

In this lab, you are going to modify your lab 4 **Pipelined CPU** design, and implement **hazard detection** and **data forwarding**.

- Your design needs to forward data if instructions have data dependency.
- Your design needs to stall pipelined CPU if it detects a load-use.

Overview

The next page's diagram is the datapath of advanced pipelined CPU.



Attached Files

- **TO DO**

- Adder.v
- ALU_Ctrl.v
- ALU.v
- Decoder.v
- MUX_2to1.v, MUX_3to1.v
- Pipe_CPU_Pro.v
- Shift_Left_Two_32.v
- Sign_Extend.v
- Forwarding_Unit.v
- Hazard_Detection.v

- **DO NOT modify**

- Data_Memory.v
- Instruction_Memory.v
- Pipe_Reg.v
- ProgramCounter.v
- Reg_File.v

- **For validation - DO NOT modify**

- testbench.v

- **Testcase - YOU CAN modify the instructions in it.**

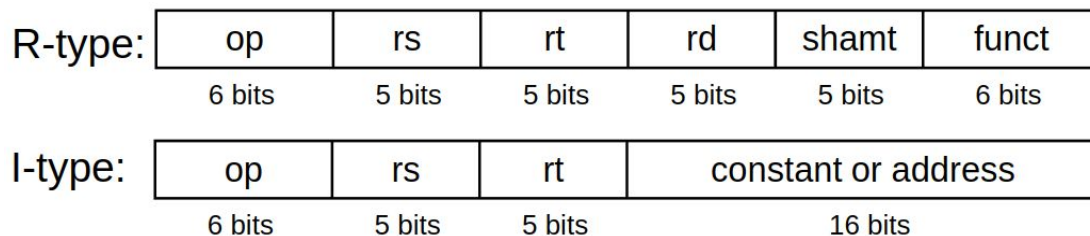
- *.txt

Instruction Set

You are going to implement these instructions :

- **R-type** : add, sub, AND, OR, NOR, slt
- **I-type** : lw, sw, beq, bne, addi

Instruction Format:



Instruction Set

R-type		
Function	Op Field	Function Field
add	6'b000000	6'b100011
sub	6'b000000	6'b100001
AND	6'b000000	6'b100110
OR	6'b000000	6'b100101
NOR	6'b000000	6'b101011
slt	6'b000000	6'b101000

I-type	
Function	Op Field
addi	6b'001001
lw	6b'101100
sw	6b'100100
beq	6b'000110
bne	6b'000101

Compile & Run

- **Compile**

- `$ iverilog -o lab5 testbench.v`

Wrong results:

```
*****
* Register Error! [Register 31]                                     *
* Correct result: 00000050                                         *
* Your result:      00000000                                       *
*****
*                                                                    *
*                          You have 19 error !                      *
*                                                                    *
*****
```

- **Run**

- `$./lab5`
- `(windows)$ vvp lab5`

Correct results:

```
*****
*                          Congratulation. ALL PASS !              *
*****
```


Grading Policy

- There are **3 little hidden cases with serial several instructions**, and you will get **33** points for each correct testcase, with a bonus point awarded this semester for your hard work, totally **100** points.
- **Any assignment work by fraud will get a zero point !**
- **No late submission !**

Submission

- **Please attach student IDs as comments at the top of each TO DO file.**
- The files you should hand in include:
 - **all *.v files excluding testbench.v**
- Compress all file *.v into one zip file **without any extra folder layer**, and **make sure do not add unnecessary files or folders** (like .DS_Store, __MACOSX).
- Name your zip file as **HW5_{studentID}.zip**
 - **e.g.**
 - **HW5_123456789.zip**
 - **{*.v}**
- **Wrong format will have 20% penalty !**
- **Deadline: 8/23 23:55**