

Computer Organization

Lab 5 - Advanced Pipelined CPU

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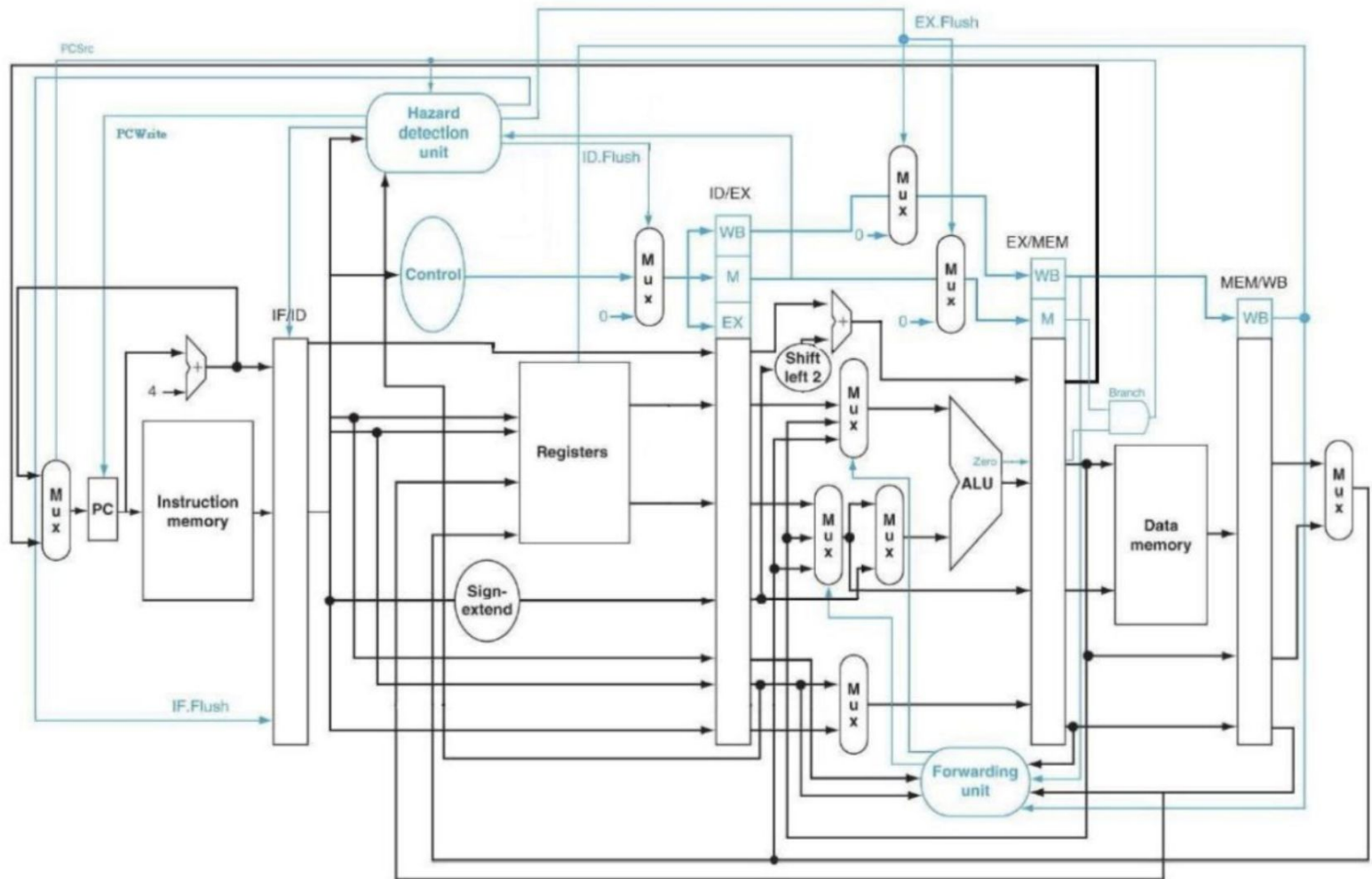
Objectives

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

- Implement the datapath of pipelined CPU as next page's diagram



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.**

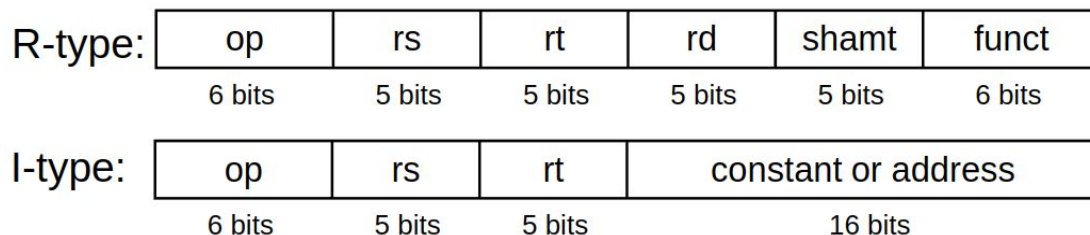
- *.txt

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	000000	100010
sub	000000	100000
AND	000000	100101
OR	000000	100100
NOR	000000	101010
slt	000000	100111

I-type	
Function	Op Field
addi	001000
lw	101011
sw	100011
beq	000101
bne	000100

Compile & Run

- **Compile**

- `$ iverilog -o lab5 testbench.v`

- **Run**

- \$./lab5

Wrong results:

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

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}**
- **EACH wrong format will have 20% penalty ! (Multiple penalties are possible)**
- **Deadline: 2025/6/15 23:55 (No late submission) !**