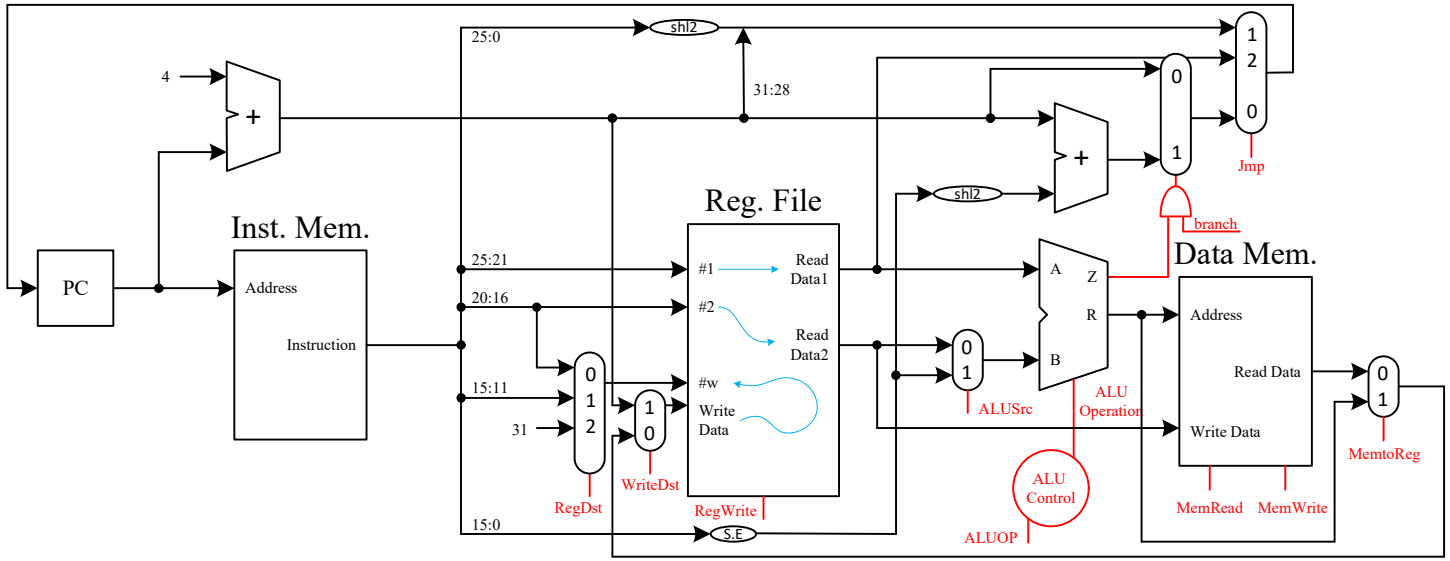
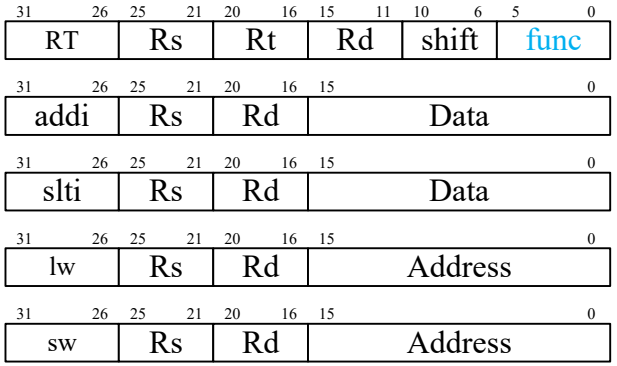
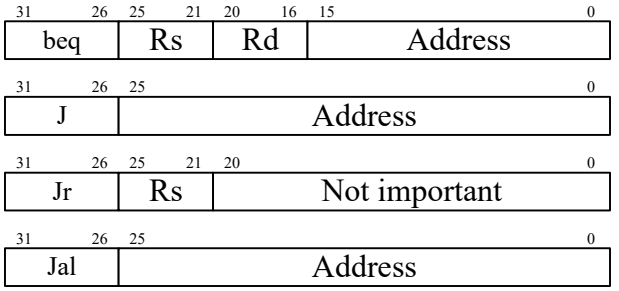
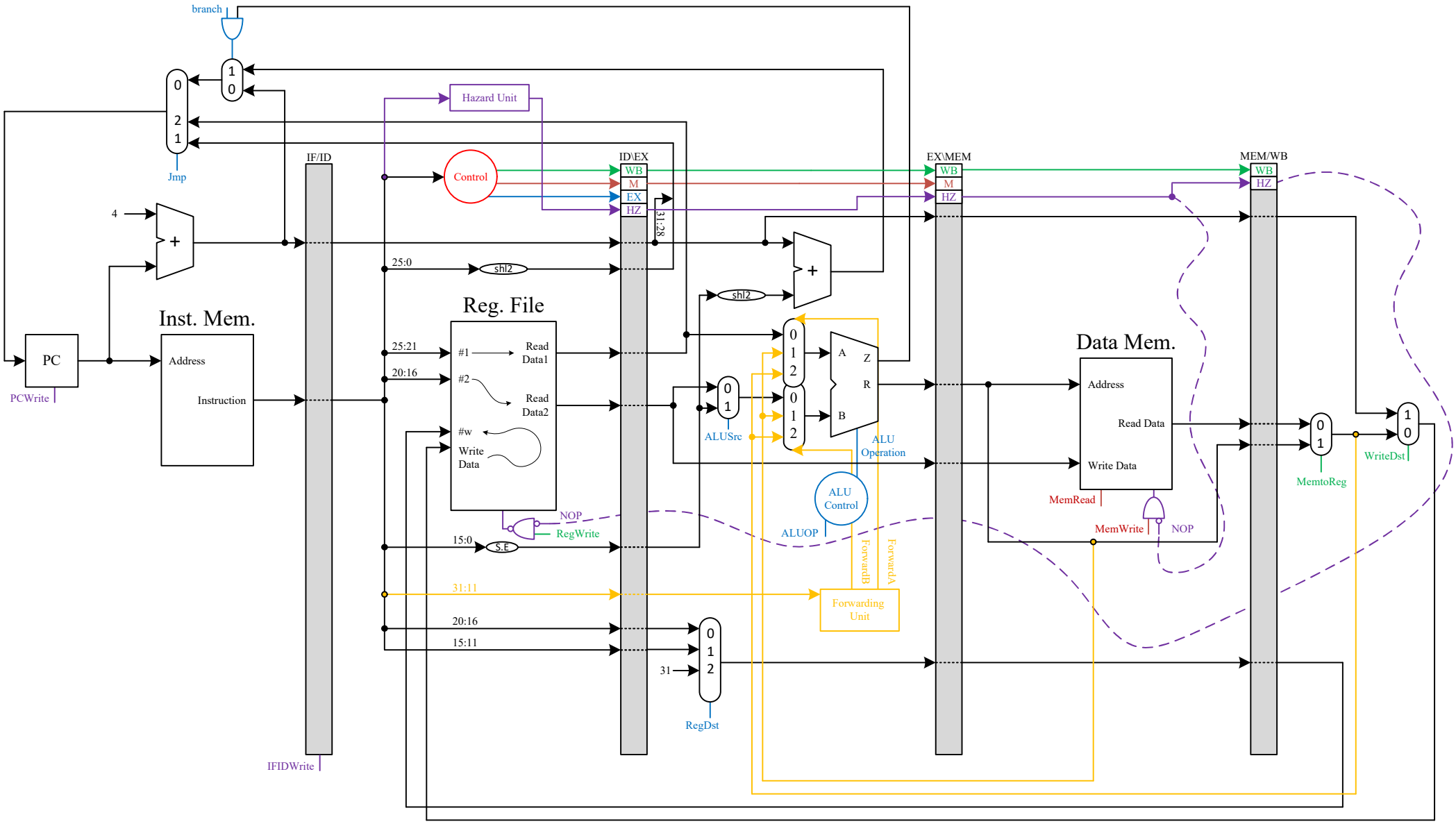
| ALUOP | func | ALUOperation |
|---|---|---|
| 00 | Not Imp. | 010 |
| 01 | Not Imp. | 011 |
| 10 | and | 000 |
| 10 | or | 001 |
| 10 | add | 010 |
| 10 | sub | 011 |
| 10 | slt | 111 |
| 11 | Not Imp. | 111 |



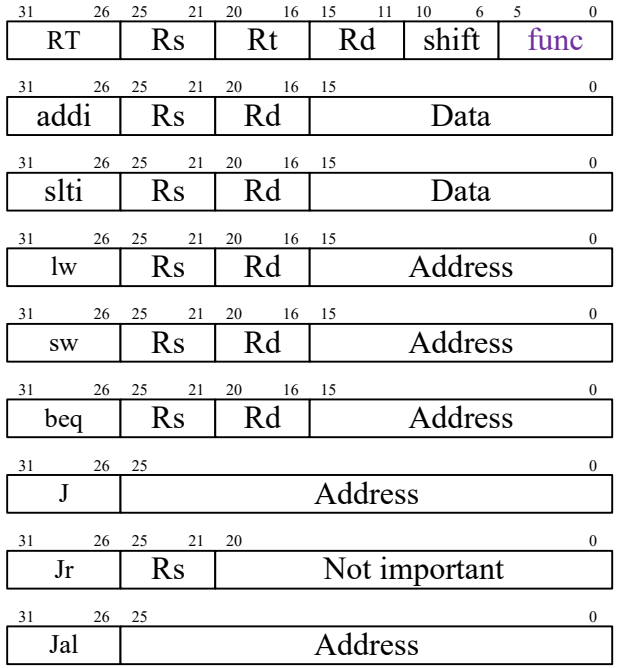

| OPC | | RegDst | WriteDst | RegWrite | ALUSrc | ALUOP | Branch | Jmp | MemRead | MemWrite | MemtoReg |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 000000 | RT | 1 | 0 | 1 | 0 | 10 | 0 | 0 | 0 | 0 | 1 |
| 000001 | addi | 0 | 0 | 1 | 1 | 00 | 0 | 0 | 0 | 0 | 1 |
| 000010 | slti | 0 | 0 | 1 | 1 | 11 | 0 | 0 | 0 | 0 | 1 |
| 000011 | lw | 0 | 0 | 1 | 1 | 00 | 0 | 0 | 1 | 0 | 0 |
| 000100 | sw | x | x | 0 | 1 | 00 | 0 | 0 | 0 | 1 | x |
| 000101 | beq | x | x | 0 | 0 | 01 | 1 | 0 | 0 | 0 | x |
| 000110 | J | x | x | 0 | x | x | x | 1 | 0 | 0 | x |
| 000111 | Jr | x | x | 0 | x | x | x | 2 | 0 | 0 | x |
| 001000 | Jal | 2 | 1 | 1 | x | x | x | 1 | 0 | 0 | x |


branch
Jmp
Hazard Unit
Control
IF/ID
ID\EX
EX\MEM
MEM/WB
WB
M
EX
HZ
4
PC
PCWrite
Inst. Mem.
Address
Instruction
25:0
shl2
31:28
Reg. File
25:21
20:16
#1
#2
#w
Read Data1
Read Data2
Write Data
NOP
RegWrite
15:0
S.E
31:11
20:16
15:11
31
RegDst
ALUSrc
ALU Operation
ALU Control
ALUOP
ForwardA
ForwardB
Forwarding Unit
Data Mem.
Address
Read Data
Write Data
MemRead
MemWrite
NOP
MemtoReg
WriteDst
IFIDWrite

## ALU

| ALUOP | func | ALUOperation |
|---|---|---|
| 00 | Not Imp. | 010 |
| 01 | Not Imp. | 011 |
| 10 | and | 000 |
| 10 | or | 001 |
| 10 | add | 010 |
| 10 | sub | 011 |
| 10 | slt | 111 |
| 11 | Not Imp. | 111 |

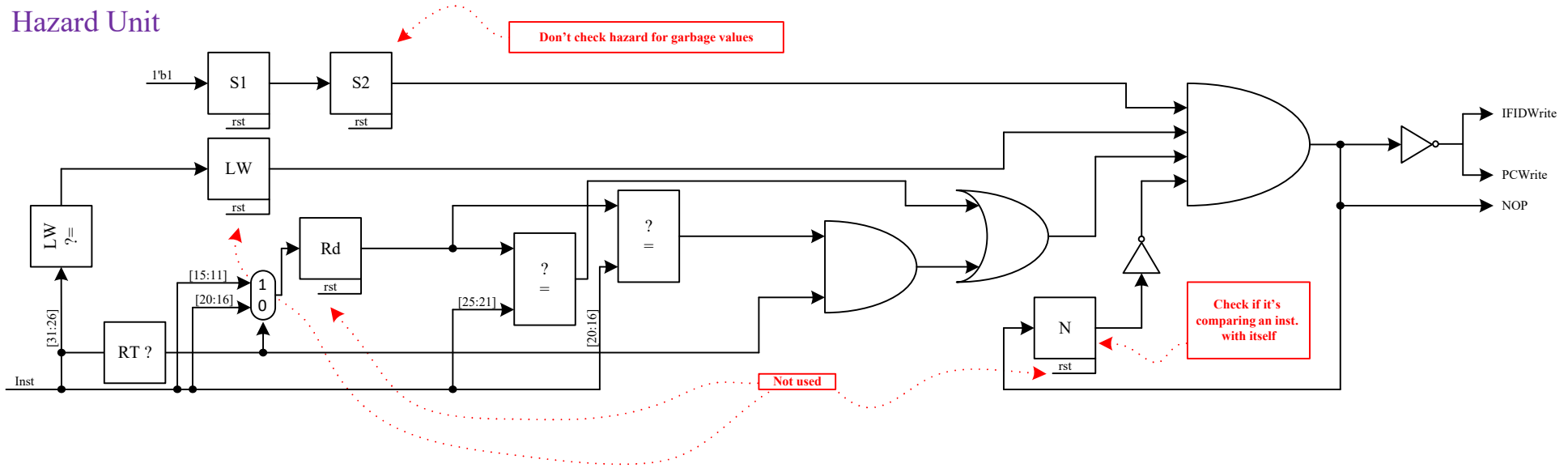
## ISA

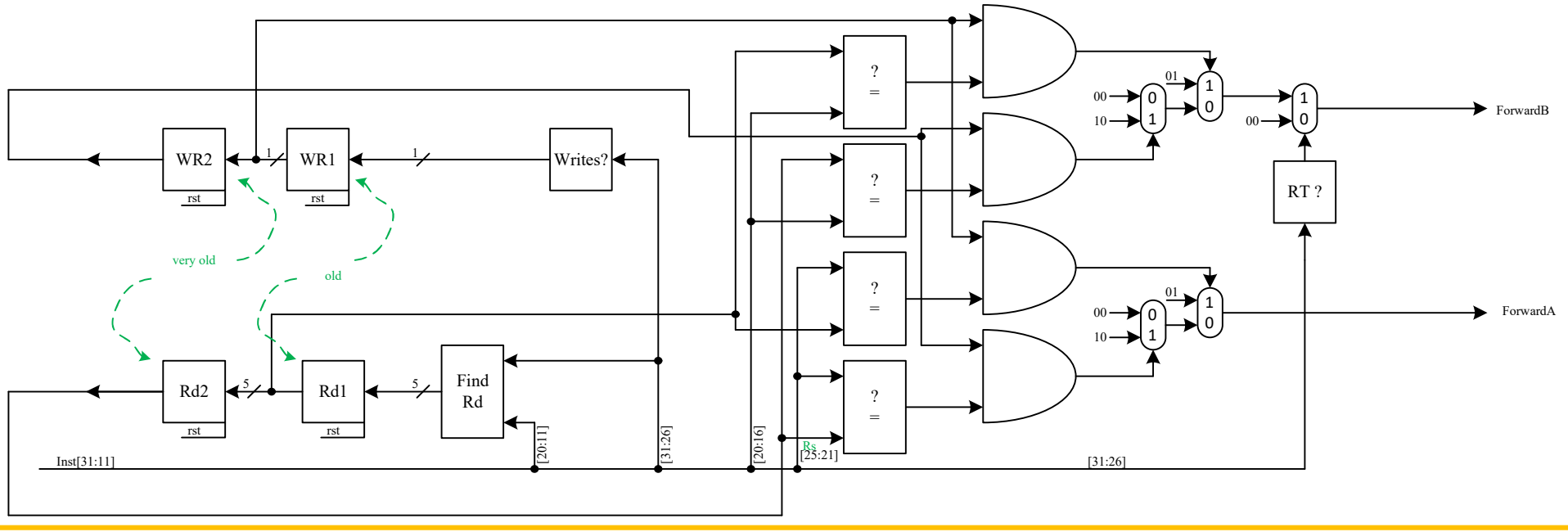



## Control Unit

| | RT | addi | slti | lw | sw | beq | J | Jr | Jal |
|---|---|---|---|---|---|---|---|---|---|
| EX | RegDst=01<br>ALUSrc =0<br>ALUOP =10 | RegDst=00<br>ALUSrc =1<br>ALUOP =00 | RegDst=00<br>ALUSrc =1<br>ALUOP =11 | RegDst=00<br>ALUSrc =1<br>ALUOP =00 | RegDst=xx<br>ALUSrc =1<br>ALUOP =00 | RegDst=xx<br>ALUSrc =0<br>ALUOP =01 | RegDst=xx<br>ALUSrc =x<br>ALUOP =xx | RegDst=xx<br>ALUSrc =x<br>ALUOP =xx | RegDst=10<br>ALUSrc =x<br>ALUOP =xx |
| MEM | Branch =0<br>Jmp =00<br>MemRead =0<br>MemWrite=0 | Branch =0<br>Jmp =00<br>MemRead =0<br>MemWrite=0 | Branch =0<br>Jmp =00<br>MemRead =0<br>MemWrite=0 | Branch =0<br>Jmp =00<br>MemRead =1<br>MemWrite=0 | Branch =0<br>Jmp =00<br>MemRead =0<br>MemWrite=1 | Branch =1<br>Jmp =00<br>MemRead =0<br>MemWrite=0 | Branch =x<br>Jmp =01<br>MemRead =0<br>MemWrite=0 | Branch =x<br>Jmp =10<br>MemRead =0<br>MemWrite=0 | Branch =x<br>Jmp =01<br>MemRead =0<br>MemWrite=0 |
| WB | WriteDst=0<br>RegWrite=1<br>MemtoReg=1 | WriteDst=0<br>RegWrite=1<br>MemtoReg=1 | WriteDst=0<br>RegWrite=1<br>MemtoReg=1 | WriteDst=0<br>RegWrite=1<br>MemtoReg=0 | WriteDst=x<br>RegWrite=0<br>MemtoReg=x | WriteDst=x<br>RegWrite=0<br>MemtoReg=x | WriteDst=x<br>RegWrite=0<br>MemtoReg=x | WriteDst=x<br>RegWrite=0<br>MemtoReg=x | WriteDst=1<br>RegWrite=1<br>MemtoReg=x |

## Hazard Unit




## Forwarding Unit