CS3375: Computer Architecture
Spring 2020

Homework #5 Solution

- Name only: _____
- Release date: Apr 8th, 2020 (Wednesday)
- Due date: **Apr 15th, 2020 (Wednesday) before the class begins (1:00 PM)**
- It should be done INDIVIDUALLY; Show ALL your work
- Write your FULL name only
- Total: 10 pts

1. Refer to the following sequence of instructions:

```
or   r1,   r2,   r3
or   r2,   r1,   r4
or   r1,   r1,   r2
```

a. Assume there is no forwarding in this pipelined processor. Indicate hazards and add `nop` instruction to eliminate them.

[3 pts]

- Data hazard

Instruction sequence
OR R1,R2,R3
NOP
NOP
OR R2,R1,R4
NOP
NOP
OR R1,R1,R2

b. Assume there is full forwarding. Indicate hazards and add `nop` instructions to eliminate them, if necessary.

[2 pts]

- With full forwarding, an ALU instruction can forward a value to EX stage of the next instruction without a hazard.

2. Refer to the following sequence of instructions, and assume that it is executed on a 5-stage pipelined datapath.

```
add   r5, r2, r1
lw    r3, 4(r5)
lw    r2, 0(r2)
or    r3, r5, r3
sw    r3, 0(r5)
```

a. If there is no forwarding or hazard detection, insert `nop`s to ensure correct execution.

[3 pts]

-

```
ADD R5,R2,R1
NOP
NOP
LW R3,4(R5)
LW R2,0(R2)
NOP
OR R3,R5,R3
NOP
NOP
SW R3,0(R5)
```

b. If the processor has forwarding, but we forgot to implement the hazard detection unit, what happens when this code executes?

[2 pts]

- With forwarding, the hazard detection unit is still needed because it must insert a one-cycle stall whenever the load supplies a value to the instruction that immediately follows that load. Without the hazard detection unit, the instruction that depends on the immediately preceding load gets the stale value the register had before the load instruction.