# Lab – 1 Report

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The first question requires us to calculate the slowdown in a 5-stage pipeline. Considering No-Forwarding and Bypassing (Only Internal Forwarding is considered), while second is a 6-stage pipeline with full forwarding. Following is the detailed 5-stage pipeline cycles of the instructions being executed in our benchmark for Q1.

| Instructions | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 | C11 | C12 | C13 | C14 | C15 | C16 | C17 | C18 | C19 | C20 | C21 | C22 | C23 | C24 | C25 | C26 | C27 | C28 | C29 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| addi $5, $0, 1 | F | D | X | M | W | | | | | | | | | | | | | | | | | | | | | | | | |
| lw $1, 2($4) | | F | D | X | M | W | | | | | | | | | | | | | | | | | | | | | | | |
| sw $3, 5($4) | | | F | D | X | M | W | | | | | | | | | | | | | | | | | | | | | | |
| sub $2,$3,$4 | | | | F | * | * | D | X | M | W | | | | | | | | | | | | | | | | | | | |
| lw $5, 0($1) | | | | | | | F | D | X | M | W | | | | | | | | | | | | | | | | | | |
| addi $1, $2, 5 | | | | | | | | F | * | D | X | M | W | | | | | | | | | | | | | | | | |
| add $5, $2, $1 | | | | | | | | | | F | * | * | D | X | M | W | | | | | | | | | | | | | |
| sw $6, 0($1) | | | | | | | | | | | | | F | D | X | M | W | | | | | | | | | | | | |
| sub $4,$5,$2 | | | | | | | | | | | | | | F | * | D | X | M | W | | | | | | | | | | |
| lw $1, 1($4) | | | | | | | | | | | | | | | | F | * | * | D | X | M | W | | | | | | | |
| sub $6,$5,$1 | | | | | | | | | | | | | | | | | | | F | * | * | D | X | M | W | | | | |
| lw $1, 1($2) | | | | | | | | | | | | | | | | | | | | | | F | D | X | M | W | | | |
| add $6, $1, $5 | | | | | | | | | | | | | | | | | | | | | | | F | * | * | D | X | M | W |

In the code we discriminate between single cycle and double cycle stalls. Also the ideal CPI given is 1

**CPI = CPI(IDEAL) + Delay due to stalls**

= 1 + ( Number of Single cycle stalls + 2 * Number of Double Cycle Stalls / Total number of instructions)

For Q1(using the above diagram) CPI= 1 + 2/13 + 10/13 =1.923

And similarly, for Q2 CPI= 1.4

Using sim-safe simulation for our microbenchmark we get the CPI = 1.9563 and 1.52 for Q1 and Q2 respecitvely and hence our code is verified.

Further, using the sim-safe /cad2/ece552f/benchmarks/gcc.eio we get the **CPI = 1.6633 for Q1**

**So the Slowdown (Q1) = (CPI(new) – CPI(ideal))/ CPI(ideal)**

**=66.33%**

Using the sim-safe /cad2/ece552f/benchmarks/gcc.eio we get the **CPI = 1.3903 for Q2**

So, **Slowdown(Q2) = 39.03 %**

We used flag **–O0** to compile our Microbenchmark and our loop is iterated 1000000 times to get accurate statistics.