

# Exercise 8: Pipeline

## Exercise 8-1

List all the data dependencies that exist in the following code. Find the register number, the instruction of the dependency source, the instruction of the dependency destination.

```
loop: lw  $t0, 0($a0)
      addi $t0, $t0, 1
      sw  $t0, 0($a0)
      addi $a0, $a0, 4
      bne $a0, $a1, loop
```

## Exercise 8-2

I ran the following program on a pipeline MIPS processor. Show the pipeline chart for each case when forwarding is not done and when forwarding is done.

Also, in the 5th cycle, answer which register is written and which is read (in case of forwarding).

```
add $s0, $t0, $t1
sub $s1, $t2, $t3
and $s2, $s0, $s1
or  $s3, $t4, $t5
slt $s4, $s2, $s3
```

## Exercise 8-3

If you run the following program on a pipeline MIPS processor (with forwarding), how many cycles you need.

Also calculate CPI.

```
add $s0, $0, $0  # i = 0
add $s1, $0, $0  # sum = 0
addi $t0, $0, 10  # $t0 = 10
loop:
    slt $t1, $s0, $t0 # if i >= 10 goto done
    beq $t1, $0, done
    add $s1, $s1, $s0 # sum = sum + i
    addi $s0, $s0, 1  # i = i + 1
    j loop
done:
```