CSE340: Computer Architecture

Assignment 4

Chapter 4 - The Processor

Total Marks: 15 (Marks are indicated in third brackets after each question)

Question 1 [Marks: 3]

Consider the code sequence below:

```
lw $t0,36($t1)

lw $t2,40($t0)

lw $t3,44($t2)

sll $t3,$t2,2

sub $t0,$t3,$t2

addi $t0,$t0,2

srl $t0,$t3,2
```

For the following questions, you must **draw** the appropriate diagrams showing the pipeline stages and hazard removal methods.

a) If you only use **Stall** to overcome the data hazards, how many clock cycles would you need to execute the above code sequence? **Draw the diagram for pipelining and calculate the CPI.**

b) If you use **Stall and Forwarding** to overcome the data hazards, how many clock cycles would you need to execute the above code sequence? **Draw the diagram for pipelining and calculate the CPI.**

Question 2 [Marks: 6]

Consider the below set of instructions. Identify the data hazards and overcome the hazards using all the available methods **[Stalling, Stalling + Forwarding, Stalling + Forwarding + Code Scheduling]**. Your answer should contain all the necessary diagrams, the required total cycle count for each of the three methods along with average CPI. Please draw the diagrams clearly.

```
add $10,$11,$12

add $13,$10,$11

sub $7,$13,$6

lw $8,40($7)

sll $3,$8,2

addi $11,$9,$6
```

Question 3 [Marks: 2]

Consider the following durations for each stage:
IF = 260 ns
ID = 270 ns
EX (addition) = 450 ns
EX (subtraction) = 350 ns
MEM = 200 ns
WB = 290 ns

Now answer the following questions:

- **a)** By how many ns the single cycle datapath clock period is greater than the 5-stage pipeline clock period?
- **b)** For a single cycle datapath, what is the duration, in ns, to execute 6 sub instructions, 8 lw instructions and 1 add instruction?

Question 4 [Marks: 4]

a) Draw a complete single-cycle datapath with the control unit and control signals.

b) Draw the datapath for the instruction **lw $9, 16($11)**. You can use a colored pen to specify the wires used. Also, mention the values going through the different wires in the datapath to execute this load word instruction.