Assignment- 2

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1)

a) Since 5-stage pipeline experience stall for every five instructions.

clock cycle - 1ns

12 stage 3 stalls every 8 instruction.

i) Cpi of 5 stage pipeline.

$= 1 + 1/5 = 6/5$

ii) cpi of 12 stage pipeline

$= 1 + 3/8 = 11/8$

$$\text{Speedup} = \frac{\text{Execution time of 5 stage}}{\text{Execution time of 12 stage}}$$

$$= \frac{\text{clock cycle} \times \text{cpi for 5 stage}}{\text{clock cycle} \times \text{cpi for 12 stage}}$$

$$= \frac{6/5 + 1n}{11/8 \times 0.6n} = \frac{48}{33} = 1.45$$

b) Cycle = 1ns.

Branch mispredict penalty = 2 cycle

Average stalls with misprediction $= 5\% \times 2 \times 0.20$

$= 0.05 \times 2 \times 0.20$

$= 0.02$

cpi with branch 5 stage misprediction

$= \text{cpi} + 0.02$

$= 1.2 + 0.02$

$= 1.22$

12 stage
Cycle = 0.6ns
Branch mispredict penalty = 5

stalls = 0.05 × 5 × 0.20
= 0.05

$CPI_{(12\ stage)}$ = CPI + 0.05

= 11/8 + 0.05

= 1.375 + 0.05 = 1.425

Speed up = $\frac{(1 \times 1.22 \times 1)}{(1 \times 1.425 \times 0.6)}$ = 1.17

2) i)
Given are
Instruction Memory 2ns
Register Read 1ns
ALU 2ns
Data Memory 2ns.
Register write - 1ns

for the given program. lw $a2, 0($a2) is the longest instruction and takes more time. to execute. Hence time of instruction is the clock cycle

Total time = 8ns.

Pipeline Implementation

pipeline cycle time = 2ns

2) 2)

	1	2	3	4	5	6	7	8	9
lw $a2 0($a2)	IF	ID	EX	MEM	WB				
bne $a3 $t1, Exit		IF	ID	EX	MEM	WB			
addi $v0 $0, 0			IF	ID	EX	MEM	WB		
add $t0 $0 $0				IF	ID	EX	MEM	WB	
add $t4 $a0 $a1					IF	ID	EX	MEM	WB

2) 3) From the diagram if implemented by single cycle there will be 5 cycles, where cycle time is longest instruction i.e 8ns

execution time = clock cycle × no of cycle

= 8ns × 5

= 40ns

2) 4) Total no of clock cycle its taking is 4th cycle

Total execution time = cycles × cycle time

= 9 × 2ns

= 18ns

3) a) the total no of clock cycles needed to execute without forward is 35

35

b). The total no of clock cycle needed to execute with forwarding is

19/

c) with reordering the total no of clock cycle is 18/

4) Programs in percentage

	gobmk	mcf	Average
loads	21	35	28
stores	12	11	11.5
Branches	14	24	19
Jumps	2	1	1.5
ALU	50	29	39.5

Effective

CPI = $\sum$ Instruction category frequency × clock cycle frequency

= (ALU × 1) + (Loads × 3.5) + (Stores × 2.8)

+ Branches × (0.5 × 4 + 0.5 × 2) + (Jumps × 2.4)

$= \frac{39.5 + 28 * 3.5 \times 11.5 \times 2.8 + 19 \times 3 + 1.5 \times 2.4}{100}$

$= \frac{39.5 + 98 + 57 + 32.2 + 3.2}{100}$

= 2.303.

Effective CPI = <u>2.303</u>