

# 第八周作业.

2.	I1	I2	I3	I4	I5	I6
I1	-					
I2		-				
I3		RAW	-			
I4			WAW	-		
I5				RAW	-	
I6					WAW	-

4. (1) 加速比  $S = \frac{T_A}{T_B}$

设指令数为  $N$ ,  $N \rightarrow \infty$

$$\therefore S = \frac{T_A}{T_B} = \frac{1ns \times (N+5-1+\frac{N}{5})}{0.6ns \times (N+12-1+N \times \frac{3}{8})} = \frac{1}{0.6} \times \frac{\frac{6}{5}}{\frac{11}{8}} = 1.45$$

(2) 对于A:  $CPI_A = \frac{N+5-1+\frac{N}{5}+20\%N \times 5\% \times 2}{N} = 1.22$

对于B:  $CPI_B = \frac{N+12-1+\frac{3}{8}N+20\%N \times 5\% \times 5}{N} = 1.425$

6. (1) addi 指令的源操作数是依赖ld指令的写回结果, 可能导致RAW(写后读)  
 sd 指令和addi 指令都对a1进行写入, 可能导致WAW(写后写).  
 sub 指令的源操作数依赖addi指令的写回结果, 可能导致RAW(写后读)  
 分支指令bnez 依赖sub指令的写回结果, 可能导致RAW(写后读)

(2)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	<del>15</del>	<del>16</del>
ld a1, 0(a2)	IF	ID	EX	MEM	WB											
addi a1, a1, 1		IF	ID	S	S	EX	MEM	WB								
sd a1, 0(a2)			IF	S	S	ID	EX	MEM	WB							
addi a2, a2, 4				IF	<del>S</del>	S	<del>ID</del>	EX	MEM	WB						
sub a4, a3, a2					IF	S	S	ID	S	S	EX	MEM	WB			
bnez a4, Loop						IF	S	S	<del>ID</del>	S	S	S	S	S	<del>ID</del>	<del>MEM WB</del>



∴ 一次循环需<sup>14</sup>个时钟周期

执行完成所有循环需  $25 \times \frac{14}{10} = 350$  个周期

7. (1)	1	2	3	4	5	6	7	8	9	10	11	12
ld a1, 0(a2)	IF	ID	EX	MEM	WB							
add a1, a1, 1		IF	ID	S	EX	MEM	WB					
scl a1, 0(a2)			IF	S	ID	EX	MEM	WB				
addi a2, a2, 4				IF	S	ID	EX	MEM	WB			
sub a4, a3, a2					IF	S	ID	S	EX	MEM	WB	
bnez a4, loop						IF	<del>ID</del>	<del>S</del>	<del>S</del>	<del>S</del>	<del>ID</del>	<del>WB</del>

∴ 一次循环需<sup>11</sup>个时钟周期

执行完成所有循环需  $25 \times \frac{11}{10} = 275$  个周期

(2) 若存在分支预测器, 则在分支指令的WB阶段完成前就可取新指令  
具体的执行时序为

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
ld a1, 0(a2)	IF	ID	EX	MEM	WB										
...															
bnez, a4, loop						IF	S	<del>S</del>	S	S	<del>ID</del>	<del>WB</del>			
ld a1, 0(a2)											IF	ID	EX	MEM	WB
											<del>IF</del>	<del>ID</del>	<del>EX</del>	<del>MEM</del>	<del>WB</del>

↑  
第 9 个周期

∴ 执行完成所需周期数:  $9 \times 24 + 12 \times 1 = 228$  个

$10 \times 24 + 11 \times 1 = 251$  个



1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
FI	IF2	ID1	ID2	EX1	EX2	M1	M2	WB1	WB2								

addi a1, a1, 1      IF1 IF2 ID1 ID2 S S S EX1 EX2 M1 M2 WB1 WB2

sc | a1, 0(a2) IF1 IF2 ID1 S S S ID2 Ex1 Ex2 M1 M2 WB1 WB2

add: a2, a2, 4

IF1	IF2	S	S	S	ID1	ID2	EX1	EX2	M1	M2	WB1	WB2
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Sub  $a_4, a_3, a_2$

bnez a4, Loop

IF1 S S S IF2 ~~IF2~~<sup>S</sup> S S S ~~IF2~~<sup>S</sup> S S S

19 20 21 22 23 24

Sub  $a_4, a_3, a_2$  WB1 WB2

bez a4, Loop ~~EX1 EX2 M1 M2 WB1 WB2~~

又因为存在分支预测器,在分支指令WB阶段完成前就可取新指令

6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

onez a4, Loop IF1 S S S ~~IF2~~ <sup>IF2 S</sup> ~~ID1~~ S S S ~~ID2~~ <sup>S</sup> S S S ~~EX1~~ <sup>ID1 ID2</sup> ~~EX2 M1 M2 WB1 WB2~~

Id al, O(a2)

第二循环

二、执行完成所有循环需要周期数

(2) 对于6.  $CPI = \frac{N_{cycle}}{N_{instruction}} = \frac{400350}{25 \times 6} = \frac{267}{15} = 2.33$

对于7(1)  $CPI = \frac{N_{cycle}}{N_{instruction}} = \frac{350715}{25 \times 6} = 2.331.83$

对于7(2)  $CPI = \frac{N_{cycle}}{N_{instruction}} = \frac{2541}{25 \times 6} = 1.67$

对于8 
$$CPI = \frac{N_{cycle}}{N_{instruction}} = \frac{384 \times 428}{25 \times 6} = 2.56 \times 2.85$$



19. (1)      add   addi   ld   sd   bne   jal   jalr  
                  是      否      否      否      否      是      是

(2) 执行时序表为

	1	2	3	4	5	6	7	8	9	10	11	<del>12</del>	<del>13</del>	<del>14</del>
lw a4, 0(a3)	IF	ID	EX	MEM	WB									
addw a1, a4, a1		IF	ID1	S	S	ID2	EX	MEM	WB					
addiw a2, a2, -1			IF	ID1	<del>ID2</del>	S	S	EX	MEM	WB				
addiw a3, a3, 4				IF	ID	S	S	S	EX	MEM	WB			
bnez a2, loop					IF	S	S	S	S	S	ID	<del>EX</del>	<del>MEM</del>	<del>WB</del>

∴ 循环单次迭代需要的周期数是 11

(3) 执行时序表为

<del>lw a4, 0(a3)</del>	1	2	3	4	5	6	7	8	9
lw a4, 0(a3)	IF	ID	EX	MEM	WB				
addw a1, a4, a1		IF	S	ID	EX	MEM	WB		
addiw a2, a2, -1			IF	S	ID	EX	MEM	WB	
addiw a3, a3, 4				IF	S	ID	EX	MEM	WB
bnez a2, loop					IF	S	S	ID	

∴ 循环单次迭代需要的周期数是 9