

4. 1) A中5条指令共时间  $t = 5 \times [1 \times 5] + 1$

$$\Rightarrow \bar{t} = \frac{26}{5} = 5.2ns$$

B中8 ~  $t = 12 \times 0.6 \times 8 + 3 \times 0.6$

$$\Rightarrow \bar{t} = 7.425$$

$$\Rightarrow B \rightarrow A \quad S = \frac{5.2}{7.425} = 0.7$$

2)

$$A: CPI = \frac{4}{5} \cdot \frac{N+4}{N} + \frac{1}{5} [95\% \cdot \frac{N+4}{N} + 5\% \cdot \frac{N+6}{N}]$$

$$= \frac{N+4}{N} + \frac{1}{100} \cdot \frac{N+6}{N} = \frac{101N+406}{100N}$$

$$B: CPI = \frac{4}{5} \cdot \frac{N+11}{N} + \frac{1}{5} [95\% \cdot \frac{N+11}{N} + 5\% \cdot \frac{N+16}{N}]$$

$$= \frac{N+11}{N} + \frac{1}{100} \cdot \frac{N+16}{N}$$

$$= \frac{100N+1116}{100N}$$

b) 写后续

↓

ld a1, 0(a2)

addi a1, a1, 1

和

addi a2, a2, 4

sub a4, a3, a2

和 sub a4, a3, a2

addi a1, a1, 1

sd a1, 0(a2)

bne2 a4, Loop

2)



	1	2	3	4	5	
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 S S EX MEM WB
addi a2, a2, 4					IF	S S ID EX MEM WB
sub a4, a3, a2						IF ID S S
bnez a4, Loop						EX MEM WB (IF (S) S ID S S)
						EX MEM WB

共 18 个周期, 2 个循环

所需总周期数为  $25 \times 18 = 450$  个周期

7. 11

ld a1, 0(a2)	IF	ID	EX	MEM	WB
addi a1, a1, 1	IF	EX	ID	EX	MEM WB
sd a1, 0(a2)	IF	ID	EX	MEM	WB
addi a2, a2, 4	IF	ID	EX	MEM	WB
sub a4, a3, a2	IF	ID	EX	MEM	WB
bnez a4, Loop	IF	ID	EX	MEM	WB

一个循环 10 个周期, 总周期数为  $25 \times 10 = 250$  个周期

2) 若能够预测分支到 4 个分支

总指令数为  $25 \times 6 = 150$  条指令

总周期数为  $150 + 5 = 154$  个周期





8  
1)

ld -- IF1 IF2 ID1 ID2 EX1 EX2 M1 M2 WB1 WB2

add- IF1 IF2 ID1 ID2 S S S EX1 EX2 M1 M2 WB1 WB2

sd a1, 0(a2) IF1 IF2 ID1 S S S ID2 S EX1 EX2 M1 M2 WB1 WB2

addi a2, a2, 4 IF1 IF2 S S S ID1 S ← ID2 EX1 EX2 M1 M2 WB1 WB2

sub a4, a3, a2 IF1 S S S IF2 S ← ID1 ID2 EX1 EX2 M1 M2 WB1 WB2

bnez a4, Loop IF1 S ← IF2 ID1 ID2 EX1 EX2 M1 M2 WB1 WB2

单次循环 M1 M2 WB1 WB2

共计  $10 + 6 - 1 + \frac{25}{6} = 21$  个周期

共25个循环

⇒ 共计  $25 \times 6 = 150$  条指令 ⇒ 共计  $150 + 10 + 25 \times \frac{6}{6} = 309$  个周期

2) b+1:

$$CPI = \frac{\frac{N}{6} \cdot 18}{N} = 3$$

$$b+7-1: CPI = \frac{\frac{N}{6} \cdot 10}{N} = \frac{5}{3}$$

$$7-2: CPI = \frac{N+4}{N}$$

$$8: CPI = \frac{\frac{N}{6} \cdot 6 + N + 9}{N} = \frac{2N+9}{N}$$



1) add add2 ld sd bne jal jalr  
 1, 是 否 否 否 是 否 否  
 2)

lw a4, 0(a3) IF ID EX MEM WB  
 addw a1, a4, a1 IF ID1 S S ID2 EX MEM WB  
 addw a2, a2, -1 IF S S ~~S~~ ID EX MEM WB  
 addw a3, a3, 4 S S S IF ID EX MEM WB  
 WB  
 bnez a2, Loop IF ID S  
 EX MEM WB

单数为  $5 + 5 - 1 + 4 = 13$  个周期

3)  
 lw a4, 0(a3) IF ID EX MEM WB  
 addw a1, a4, a1 IF ID EX MEM WB  
 addw a2, a2, -1 IF ID EX MEM WB  
 addw a3, a3, 4 IF ID EX MEM WB  
 bnez a2, Loop IF ID EX MEM WB

单块代用期数为 9

