

	L1	L2	L3	L4	L5	L6
2.4	-					
L2		-	-			
L3		RAW	-			
L4			WAR	-		
L5				RAW	-	
L6					WAW	-

7. $CPI_A = \frac{1 \times 5}{5} = 1$ $T_A = \frac{(5+5+1) \times 1}{5} = 2 \text{ ns/instruction}$ $F = \frac{T_B}{T_A} = \frac{T_A}{T_B} = 1.21$

$T_B = \frac{(12+8+13) \times 0.6}{8} = 1.65 \text{ ns/instruction}$

(2) $CPI_A = \frac{5+5+1+1}{5} = 2$ $CPI_A' = CPI_A (0.8 + 0.2 (1 \times 0.95 + (1+2) \times 0.05))$

$CPI_B = \frac{12+8+1+3}{8} = 2.75$ $= 1.02 \times 2 = 2.04$

$CPI_B' = CPI_B (0.8 + 0.2 (1 \times 0.95 + (1+5) \times 0.05))$
 $= 1.05 \times 2.75 = 2.8875$

6. (1). `ld a1, 0(a2)` ① `ld`的WB阶段将`a2`值加载到`a1`中, `addi`的EX阶段需要读取`a1`
`addi a1, a1, 1` 是, RAW冲突
- `sd a1, 0(a2)` ② `addi`的WB阶段将`(a1+1)`写回到`a1`, 而`sd`的EX阶段需要读取`a1`, RAW
- `addi a2, a2, 4` ③ `addi`(2)的WB阶段写回`a2`, 而`sub`的EX阶段读取`a2`, RAW
- `sub a4, a3, a2` ④ `bneq` EX阶段读取`a4`, `sub` WB阶段写回`a4`, RAW
- `bneq a4, loop` ⑤ `addi`读取`a2`时 `sd`中`a2`新值还未写回

(2)

ld IF ID EX MEM WB

$$\text{共 } 20 \times \frac{100}{5} = 400 \text{ 条指令周期}$$

addi IF ID S S EX MEM WB

sd IF S S ID S S EX MEM WB

addi IF S S ID S S EX MEM WB

sub IF S S S S S EX MEM WB

bneq IF ID S EX

MEM
WB

7. (1)

ld IF ID EX MEM WB

$$\text{共 } \frac{100}{5} \times 12 = 240 \text{ 条指令周期}$$

addi IF ID S EX MEM WB

sd IF S ID EX MEM WB

addi S IF ID S EX MEM WB

sub IF S ID EX MEM WB

bneq IF ID EX MEM WB

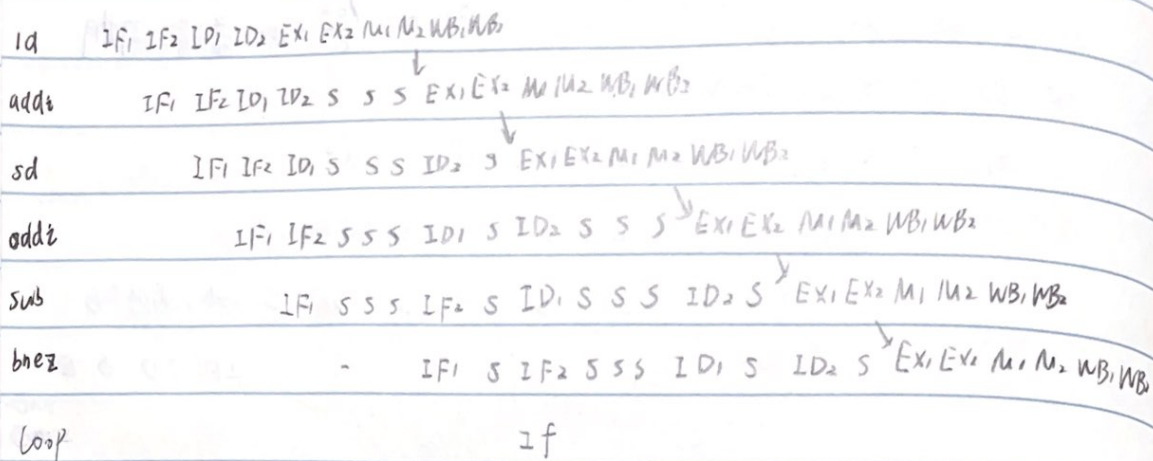
分支指令:

bneq

IF

(2) 若因分支预测于IF端口 $12 + 17 \times 8 = 164$ 个指令周期

8. 11)



共 $19 \times 10 + 24 = 214$ 个指令周期

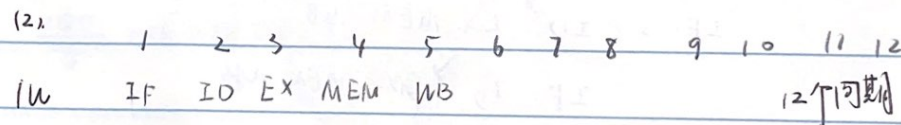
$$(2) \quad CP_{162} = \frac{400}{6 \times 20} = 3.33$$

$$CP_{172} = \frac{164}{6 \times 20} = 1.31$$

$$CP_{171} = \frac{2400}{6 \times 20} = 2$$

$$CP_{181} = \frac{214}{6 \times 20} = 1.78$$

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



addw IF ID₁ ID₂ S EX MEM WB

addlw IF ID₁ S EX MEM WB

addlw IF ID EX MEM WB

bnez If S ID EX MEM WB

(3).

