Computer Organization HW04-2

112590022

一、

1.1 pipelined: 500 ps ※

non-pipelined: 400 + 300 + 500 + 350 + 450 = 2000 ps ※

1.2 pipelined: 5 × 500 = 2500 ps ※

non-pipelined: 2000 ps ※

1.3 split the longest stage ⇒ EX to two 250ps

new-pipelined: 450ps ※

二、

2.1

```
    IF ID EX MEM WB
1st — IF ID |  X   X | EX MEM WB
2nd ——— IF  | ID   X | EX MEM WB
                ⇓ 1
                2
```

CPI = 1 + (EX to 1st Only + MEM to 1st Only + EX to 1st and MEM to 2nd) × 2

+ (EX to 2nd Only + MEM to 2nd Only) × 1

= 1 + 25% × 2 + 25% × 1 = 1.75

⇒ $\frac{0.75}{1.75}$ = 42.9% ※

2.2

```
IF ID EX →MEM WB
  IF ID ↓ EX MEM WB
     IF  ID  EX  MEM WB

IF ID EX  MEM WB
  IF ID  X ↓EX MEM WB
     IF  ID EX MEM WB
```

CPI = 1 + (MEM to 1st Only) × 1 = 1.1

⇒ $\frac{0.1}{1.1}$ = 9.1% ※

2.3

```
    IF ID EX ⇉MEM WB
EX  IF ID ↓  EX  MEM WB   – 1st need EX
fwd IF ID    X   X   EX MEM WB – 1st need MEM
       IF ID     X   EX MEM WB – 2nd need EX
          IF ID      X  EX MEM WB – 2nd need MEM
```

CPI_{EX} = 1 + (MEM to 1st Only) × 2 +

(EX to 2nd Only + MEM to 2nd Only +

EX to 1st and MEM to 2nd) × 1

= 1 + 10% × 2 + 35% × 1

= 1.55

IF ID EX→MEM→WB

No M forwarding

IF ID x EX MEM WB — 1st need EX

IF ID x EX MEM WB — 1st need MEM

IF ID EX MEM WB — 2nd need EX

IF ID EX MEM WB — 2nd need MEM

Ans: MEM/WB #

$CPI_{new} = 1 + (EX\text{ to 1st Only} + EX\text{ to 1st and MEM to 2nd} + MEM\text{ to 2nd Only}) \times 1$

$= 1 + 15\%$

$= 1.15$

三、

3.1

lw r4, 4(r4)

nop x2

sub r4, r2, r4

nop x2

sw r3, 0(r4)

or r3, r4, r3

lw r5, 0(r4)

5 + (5-1) x 1 + 4

⇒ 13 cycles #

3.2

lw r4, 4(r4)

nop (MEM/WB forwarding)

sub r4, r2, r4 (EX/MEM forwarding)

sw r3, 0(r4)

or r3, r4, r3

lw r5, 0(r4)

⇒ 10 cycles #

5 + (5-1) x 1 + 1

3.3

it may get the wrong r4 (previous) of sub instruction. #

3.4

Times	instructions					
1	lw r4, 4(r4)	IF	ID	EX	MEM	WB
2	nop		IF	ID	EX	MEM
3	sub r4, r2, r4			IF	ID	EX
4	sw r3, 0(r4)				IF	ID
5	or r3, r4, r3					IF
signals	PC Write	1	1	0	1	1
	IF/ID write	1	1	0	1	1
	Forward A	X	X	00	X	00
	Forward B	X	X	X	X	01

四.

4.1

```
lw r2, c(r1)
nop x1  (MEM/WB forwarding)
beq r2, r0, label2
nop x3  (no taken)
lw r3, 0(r2)
nop x1  (MEM/WB forwarding)
beq r3, r0, label1  (taken)  predict-success
label1: beq r2, r0, label2  (taken)
label2: sw r1, 0(r2)
```

5+(2-1)x1+5

⇒ 13 cycles#

4.2

(01) lw r2, 0(r1)

(~~nop x1~~)

(02) beq r2, r0, label2

(03) lw r3, 0(r2) (correct)

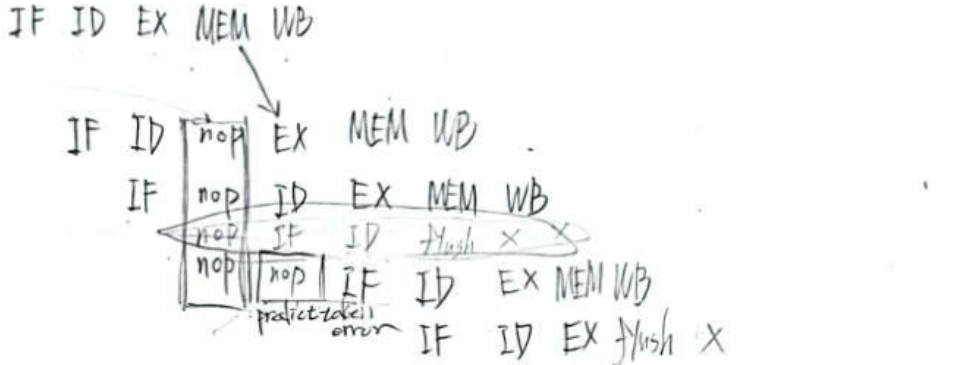
(04) beq r3, r0, label1

(05) add r1, r3, r1 (incorrect)

(06) beq r2, r0, label2 (branch)

(07) lw r3, 0(r2) (incorrect)

(08) sw r1, 0(r2) (branch)



⇓

14 cycles#

五.

5.1

always taken: $\frac{4}{7} = 0.57$#

always not taken: $\frac{3}{7} = 0.43$#

5.2

I, I, I, C, I, I, I ⇒ $\frac{1}{4} = 0.25$#

5.3

C, C, I, I, I, C, I

C, C, I, I, I, C, I ⇒ $\frac{3}{7} = 0.43$#

C, C, I, I, I, C, I ....