LA4

第3章

1. (1) $T_{pipe} = 2 ns + 0.1 ns = 2.1 ns$

(2) $S = \dfrac{T_{old}}{T_{new}} = \dfrac{7}{2.1} = 3.33$

(3) 设 n 个流水级

则 $S = \dfrac{7}{\frac{7}{n} + \frac{1}{10}}$

$\lim\limits_{n \to \infty} S = 70$

2.
     1   2   3   4   5   6.
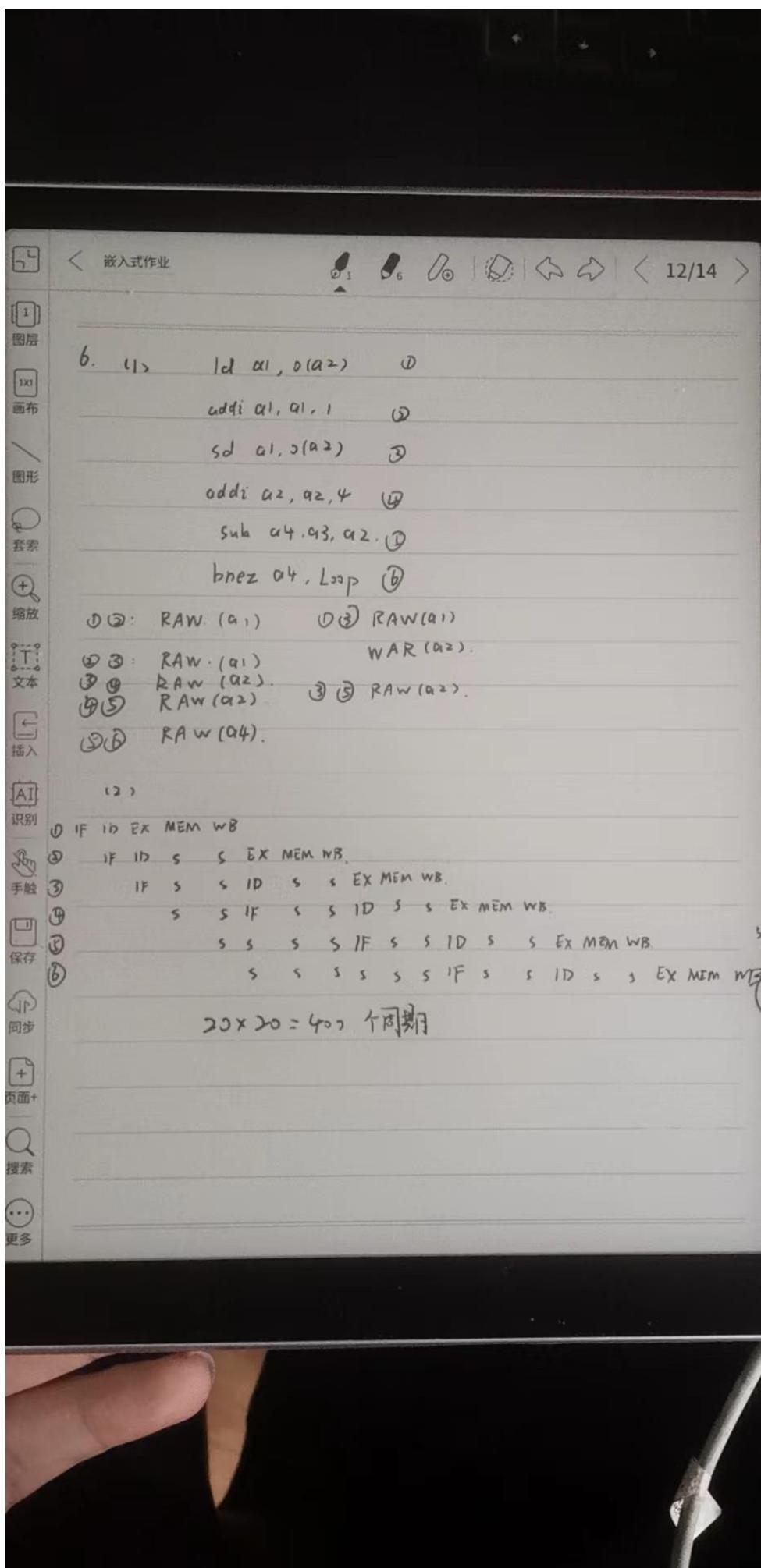
I₁ —

I₂ / —

3 WAW RAW —

4 / WAW WAR —

5 RAW RAW RAW RAW —

6 / / / / RAW —

4. (1) $S = \dfrac{0.6 \times \frac{11}{8}}{1 \times \frac{6}{5}} = \dfrac{3}{5} \cdot \dfrac{11}{8} \cdot \dfrac{5}{6} = \dfrac{11}{16}$

(2) A: $CPI_A = 2\% \times 5\% \times \dfrac{6+2}{5} + 99\% \cdot \dfrac{6}{5}$

$= \dfrac{8}{5} \cdot \dfrac{1}{100} + \dfrac{6}{5} \cdot \dfrac{99}{100} = \dfrac{602}{500} = 1.204$

B: $CPI_B = 1\% \times \dfrac{11+5}{8} + 99\% \times \dfrac{11}{8}$

$= \dfrac{16}{800} + \dfrac{1089}{800} = 1.38125$.

6. (1)
```
        ld   a1, 0(a2)       ①
        addi a1, a1, 1       ②
        sd   a1, 0(a2)       ③
        addi a2, a2, 4       ④
        sub  a4, a3, a2.     ⑤
        bnez a4, Loop        ⑥
```

①② : RAW (a1)   ①③ RAW(a1)
                              WAR (a2).
②③ : RAW (a1)
③④   RAW (a2)   ③⑤ RAW (a2).
④⑤   RAW (a2)
⑤⑥   RAW (a4).

(2)

```
① IF ID EX MEM WB
②    IF ID  s  s EX MEM WB.
③       IF  s  s ID  s  s EX MEM WB.
④          s  s IF  s  s ID  s  s EX MEM WB.
⑤             s  s  s  s IF s  s ID s  s EX MEM WB
⑥                s  s  s  s  s  s IF s  s ID s  s EX MEM WB
```

20×20 = 400 个周期

7. (1)

```
ld a1,0(a2)   IF ID EX MEM WB.
addi a1,a1,1      IF ID  s  EX MEM WB
sd a1,0(a2)          IF  s  ID  EX  MEM WB.
addi a2,a2,4             s  IF  ID   EX  MEM WB.
sub a4,a3,a2             s  IF  ID. EX  MEM WB.
bne za4,L,oop               s  IF  ID   EX  MEM  WB.
```

$$20 \times 11 = 220 \ 个周期.$$

(2) $20 \times 7 + 4 = 144 \ 周期$

8 (1)

```
ld a1,0(a1)  IF1 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.
sd a1,x(a2)       IF1 IF2 ID1  s   s   s  ID2  s  EX1 EX2 M1 M2 WB1 WB2
addi a2,a2,y          IF1 IF2  s   s   s  ID1  s  ID2.s  s   s  EX1 EX2 M1 M2 WB1 WB2
sub a4,a3,a2             IF1  s   s   s  IF2  s  ID1 s  s   s  ID2  s  EX1 EX2 M1  M2 WB1  WB2.
bnez a4,Loop                s   s   s  IF1  s  IF2 s s  s   ID1  s  ID2  s  EX1 EX2 M1  M2 WB1
                                                                                          WB2
```

$$20 \times 11 + 13 = 233 \ 周期$$

(2) $6: \dfrac{400}{20 \times 6} = \dfrac{40}{12} = \dfrac{10}{3} = 3.33$

$7(1): \dfrac{220}{120} = \dfrac{22}{12} = \dfrac{11}{6}$

(2) $\dfrac{144}{120} = \dfrac{72}{60} = \dfrac{12}{10} = \dfrac{6}{5} = 1.2$

$8 \quad \dfrac{233}{120}.$

19. (1) add ✓

  addi ✗

  ld ✗

  sd ✗

  bne ✓

  jal ✗

  jalr ✓

(2)

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

单次循环12周期

(3)

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

10周期