CS202 HW3 Answer

Q1 20分

a 3分

Pipeline: 220ps

Non-pipeline: 200+170+220+210+150 = 950ps

b 3分

Pipleline: 220ps *5 = 1100 ps

Non-pipleline: 950ps

c 3分

Split the EX stage. This reduces the clock-cycle to 210ps(MEM)

d 3分

Instruction	ALUSrc	Memto-Reg	Reg-Write	Mem-Read	Mem-Write	Branch	ALUOp1	ALUOp0
R-format	0	0	1	0	0	0	1	0
ld	1	1	1	1	0	0	0	0
sd	1	X	0	0	1	0	0	0
beq	0	X	0	0	0	1	0	1

LW + SW = 15% + 15% = 30%

e 3分

ALU + BEQ = 70%

f 5分

cycle time

single-cycle	**950ps**
multi-cycle	220ps
pipelined organization	220ps

Multi-Cycle

Instruction	IF	ID	EX	MEM	WB	Clock Time
ALU	√	√	√		√	880ps
BEQ	√	√	√			660ps
LW	√	√	√	√	√	1100ps
SW	√	√	√	√		880ps

Execution time = (4 * 0.55 + 3 * 0.15 + 5 * 0.15 + 4 * 0.15) * 220 = 880ps **3分**

Pipeline: 220ps **1分**

Single-cycle: 950ps **1分**

Q2 15分

a 7分

Pipeline without forwarding: $6n * 250ps = 1500nps$

Pipeline with forwarding: $1.05n * 275ps = (288.75)nps$

The speedup rate is $\frac{1500}{288.75} = \frac{400}{77} \approx 5.1948$

> 过程正确计算错误给5分，注意写分数也可以

b 8分

$250 * 6n > 275 * (1 + y) * n$

$y < \frac{1500}{275} - 1 = \frac{49}{11} \approx 4.45$

> 过程正确计算错误给6分

Q3 20分

a 10分

```
add x5, x2, x1
NOP
NOP
NOP #注意这里两个NOP也给对
lw x6, 4(x5)
lw x2, 0(x2)
add x3, x5, x1
NOP
NOP
NOP #注意这里两个NOP也给对
sw x3, 0(x5)
```

```
add x5, x2, x1
NOP
NOP
lw x6, 4(x5)
lw x2, 0(x2)
add x3, x5, x1
NOP
NOP
sw x3, 0(x5)
```

Total clock cycle = 11 + 4 = 15 / 9 + 4 = 13

注意上面两种情况都是对的

b 10分

```
add x5, x2, x1
lw x2, 0(x2)
NOP
NOP  #注意这里NOP可以省略
add x3, x5, x1
lw x6, 4(x5)
NOP
NOP #注意这里NOP可以省略
sw x3, 0(x5)
```

```
add x5, x2, x1
lw x2, 0(x2)
NOP
add x3, x5, x1
lw x6, 4(x5)
NOP
sw x3, 0(x5)
```

Total clock cycle = 9 + 4 = 13 / 7 + 4 = 11

注意上面**两种情况都是对的**

B问两个代码换位，只换了1个位置，即周期数是14/12的，给4分

Q4 15分

	t1	t2	t3	t4	t5	t6	t7	t8	t9
add x15, x12, x11	IF	ID	**EX**	MEM	WB				
lw x13, 4(x15)		IF	ID	**EX**	**MEM**	WB			
lw x12, 0(x2)			IF	ID	EX	**MEM**	WB		
or x13, x15, x13				IF	ID	**EX**	MEM	WB	
sw x12, 0(x15)					IF	ID	**EX**	MEM	WB

EX - EX 1 time

MEM - EX 2 times

三个链路，错一个扣5分。如果有人花了**多余的链路**，扣5分。

Q5 30分

a 9分

不调换 8cycle

	ALU/Branch	Load/Store	cycle
	addi x12, x0, 0		1
	jal ENT		2
	bne x12, x13, TOP		3
	add x6, x10, x12		4
		lbu x7, 0(x6)	5
		lbu x19, 1(x6)	6
			7
	sub x20, x7, x19		8
	add x21, x11, x12		9
	addi **x12**, x12, 2	sb x20, 0(x21)	10
	bne **x12,** x13, TOP		11
	add x6, x10, x12		12
		lbu x7, 0(x6)	13
		lbu x19, 1(x6)	14
			15
	sub x20, x7, x19		16
	add x21, x11, x12		17
	addi **x12**, x12, 2	sb x20, 0(x21)	18
	bne **x12,** x13, TOP		19

- 忘记lw x29, 4(x6)和sub x30, x7, x29之间空格**给7分**
- 多发射错误，**给7分**
- 整体流程不对**给2分**

b 7分

	addi x12, x0, 0	**1**
	jal ENT	2
	bne x12, x13, top	3
	add x6, x10, x12	4
	lbu x7, 0(x6)	5
	lbu x19, 1(x6)	6
		7
	sub x20, x7, x19	8
	add x21, x11, x12	9
	sb x20, 0(x21)	10
	addi **x12**, x12, 2	11
	bne x12, x13, TOP	12
	add x6, x10, x12	13
	lbu x7, 0(x6)	14
	lbu x19, 1(x6)	15
		16
	sub x20, x7, x19	17
	add x21, x11, x12	18
	sb x20, 0(x21)	19
	addi x12, x12, 2	20
	bne x12, x13, TOP	21

Speed rate = $\frac{9}{8}$

- 忘记lw x29, 4(x6)和sub x30, x7, x29之间空格，导致周期计算为$\frac{9}{8}$**给4分**
- 多发射和单发射有一个正确，剩下一个不正确，**给4分**

c 9分

```
addi x12, x0, 0
jal ENT
TOP: add x6, x10, x12
    lbu x7, 0(x6)  addi x12, x12, 2 (这两条指令需要前提，位置可以互换
    lbu x19, 1(x6) add x21, x11, x12(这两条指令需要前提，位置可以互换)
    sub x20, x7, x19
    sb x20, 0(x21) bne x12, x13, TOP
Done:
```

	ALU/Branch	**Load/Store**	**cycle**
	addi x12, x0, 0		1
	jal ENT		2
	bne x12, x13, TOP		3
	add x6, x10, x12		4
		lbu x7, 0(x6)	5
	add x21, x11, x12	lbu x19, 1(x6)	6
	addi **x12**, x12, 2		7
	sub x20, x7, x19		8
	bne **x12,** x13, TOP	sb x20, 0(x21)	9
	add x6, x10, x12		10
		lbu x7, 0(x6)	11
	add x21, x11, x12	lbu x19, 1(x6)	12
	addi **x12**, x12, 2		13
	sub x20, x7, x19		14
	bne **x12,** x13, TOP	sb x20, 0(x21)	15

- 保底是6个周期，如果修改成7个周期**给6分**

e 5分

single-issue:

```
addi x12, x0, 0
jal ENT
TOP: add x6, x10, x12
    lbu x7, 0(x6)
    lbu x19, 1(x6)
    addi x12, x12, 2/add x21,x11, x5 (任何一条指令换上来都行)
    sub x20, x7, x19
    sb x20, 0(x21)
    addi x12, x12, 2/add x21,x11, x5 (执行剩余的指令就行)
ENT: bne x12, x13, TOP
Done:
```

- 保底是这种，8个周期，超过8个周期或者没有修改，**给3分**

如果single issue没有修改的也给分了

speed up rate = $\frac{8}{6} = \frac{4}{3}$