HW4_20161595

1.

(a)

```
1:    Loop:   LW   $7,  0($1)
2:            LW   $2,  -8($1)
3:            LW   $4, -16($1)
4:            ADD  $4, $4, $2
5:            ADD  $7, $7, $2
6:            ADD  $1, $1, -16
7:            SW   $7, 8($1)
8:            ADD  $2, $1, -8
9:            SW   $4, 0($1)
10:           BNE  $2, $0  Loop
```

(b)

```
1:    Loop:   LW   $7,  0($1)
2:            LW   $2,  -8($1)
3:            LW   $4, -16($1)
4:            ADD  $4, $4, $2      ← 2stall
5:            ADD  $7, $7, $2
6:            ADD  $1, $1, -16
7:            SW   $7, 8($1)       ← 2stall
8:            ADD  $2, $1, -8
9:            SW   $4, 0($1)
10:           BNE  $2, $0  Loop    ← 1stall
```

(c)

```
1:    Loop:   LW   $7,  0($1)
2:            LW    $2,  -8($1)
3:            LW    $4, -16($1)      ← 1stall
4:            ADD    $4, $4, $2
5:            ADD    $7, $7, $2
6:            ADD    $1, $1, -16
7:            SW     $7, 8($1)
8:            ADD    $2, $1, -8
9:            SW     $4, 0($1)
10:           BNE  $2, $0  Loop
```

(d) one stall cycle when branch is taken → target address를 ID stage에서 얻을수 있으므로 그 다음 fetch 가능.
one stall cycle when branch is not taken.

2.

(a)

```
add $t1,  $t2, $t3
lw $t4, 0($t1)
beq $t1, $t4, target
lw  $t4, 100($t1)
sw $t3, 0($t4)
```

(b)

Instruction	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th
add $t1, $t2, $t3	IF	ID/RF	EX	MEM	WB									
lw $t4, 0($t1)		IF	ID	EX	MEM	WB								
beq $t1, $t4, target			IF	--	--	ID	EX	MEM	WB					
lw $t4, 100($t1)				--	--	IF	ID	EX	MEM	WB				
sw $t3, 0($t4)							IF	ID	--	EX	MEM	WB		

(c)

Distance	>3	3	2	1
LW→BEQ	5%	5%	5% 1cycle	5% 2cycle
ALU→BEQ	10%	5%	5%	10% 1cycle

$\therefore 0.15 \times (0.05 \times 1 + 0.05 \times 2 + 0.1 \times 1) = 0.0375$

0.15: beq of total; 0.05×1: LW→beq distance2; 0.05×2: lw→beq distance1; 0.1×1: alu→beq distance1

3.

(a) CPI $stall_i = 0.02 \times 100 = 2$

bandwidth $= 10^9 \times 0.02 \times 64 = 1.28 \times 10^9$ Byte/sec

(b) CPI $stall_d = 0.3 \times 0.05 (0.4 \times 200 + 0.6 \times 100) = 2.1$

0.4: dirty; 200: write back and fetch

Write bandwidth $= 10^9 \times 0.3 \times 0.05 \times 0.4 \times 64$ /sec $= 0.384 \times 10^9$ byte/sec

Read bandwidth $= 10^9 \times 0.3 \times 0.05 \times 64$ Byte/sec $= 0.96 \times 10^9$ byte/sec

(c) tag → 19

index → 7

block offset → 6

(d) CPI $stall_d = 0.3 \times 0.05 \times 100 = 1.5$

Read band width $= 10^9 \times 0.3 \times 0.05 \times 64 = 0.96 \times 10^9$ byte/sec