ECEN 651 HW2 Zhenlei Song

1. Effective CPI = Σ mix frequency x clock cycle

(1) ~~ALU~~ Load / store

load	26.5%	25.1%	25.8%	ave
store	10.3%	13.2%	11.8%	

~~(2)~~ instruetion mix freq = 25.8% + 11.8% = 0.376

(2) conditional branch:

cond branch	9.3%	12.1%	10.7%	ave

instruetion mix freq = 0.107

(3) jumps

return	1.6%	0.6%	1.1%	
call	1.6%	0.6%	1.1%	ave
jump	0.8%	0.7%	0.8%	

instruction mix freq = 3% = 0.03

(4) ALU

all others will be considered as ALU

add	21.1	19.0	20
sub	1.7	2.2	2.0
mul	1.4	0.1	0.8
or	7.9	8.5	8.2
xor	1.8	2.1	2.0
and	4.3	4.6	4.4
shift	3.8	1.1	2.4
load imm	4.8	2.5	3.6

cond move	0.4	0.6	0.5
compare	2.8	6.1	4.4
other logic	0.1	0.4	0.2

instruction mix freq = 0.485

Continued

conditional branches clock cycle = $((0.6 \times 2.0) + (1-0.6) \times 1.5) = 1.8$

Effective CPI =

$(0.485 \times 1.0) + (0.376 \times 1.4) + (0.107 \times 1.8) + (0.03 \times 1.2)$

$= 1.24$

2.

A.7(a)

```
DADD   R1, R0
SW     R1, 7000(R0);
Loop: LD R1, 7000(R0);
DSLL · R2, R1, 3;
DADDI  R3, R2, 3000;
LD     R4, 0(R3);
LD     R5, 5000(R0);
DADD   R6, R4, R5;
LD     R1, 7000(R0);
DSLL   R2, R1, 3;
DADDI  R7, R2, #1000;
SD     R6, 1000(R7);
LD     R1, 7000(R0);
DADDI  R1, R1, #1;
SD     R1, 7000(R0);
LD     R1, 7000(R0);
DADDI  R8, R1, #-101;
BNEZ   R8, loop;
```

$2 + (16 \times 101) = 1618$ instructions

8×101 L/S instructions

code size:

$4B \times 18 = 72B$

3.

A.20 a ALU length = 16 bits

~~branch~~ type : ~~ra~~ 16 bit ratio = 0.304

data ref 24 bit ratio = 0.669 − 0.304 = 0.365

32 bit ratio = 1 − 0.669

= 0.331

branches type :

16 bit ratio = 0.001

24 bit ratio = 0.852 − 0.001 = 0.851

32 bit ratio = 1 − 0.852 = 0.148

data ref length = 16 × 0.304 + 24 × 0.365 + 32 × 0.331

= 24.2 bit

branches length = 16 × 0.001 + 24 × 0.851 + 32 × 0.148

= 25.3 bit

ALU freq = add (19%) + sub (3%) + compare (5%)

+ cond move (1%) + shift (2%) + and (4%)

+ or (9%) + xor (3%) + 1%

= 47% = 0.47

data ref = load (26%) + store (10%) + load imm (2%)

= 38% = 0.38

branch freq = 1 − 0.38 − 0.47 = 0.15

average length = 16 × 0.47 + 24.2 × 0.38 + 25.3 × 0.15

= 20.5 bits