ECE 6913

Computing System Architecture

Quiz #1

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1.

a) For the given question, Instruction count = 1.5E12

Execution time = 500s reference time = 10000s

a) $CPI = \frac{\text{Execution Time}}{\text{Instruction count} \cdot \text{Clock cycle time}}$

$= \frac{500s}{1.5E12 \cdot 0.333 \times 10^{-9}} = \frac{500}{499.5} = 1.001$

$\therefore CPI = 1.001$

b) CPU time = Instruction Count · CPI · Clock Cycle Time

Hence the no. of instructions, so it will increase to 110% as before

New CPU Time = 1.1 · 500s = 550s

c) New CPU Time $= 1.1 \times 1.05 \times 500$

$= 577.5$

d) Here the clock rate $= 4\,GHz = 4 \cdot 10^9$

No. of instructions by 15% that's $1 - 15\% = 85\%$

$0.85 \cdot 1.5E12 \rightarrow$ new no. of executions

Execution Time $= 400s$

$$\text{new CPI} = \frac{\text{Execution Time} \times \text{clock Rate}}{\text{New Instruction count}}$$

$$= \frac{4 \cdot 10^9 \cdot 400}{0.85 \times 1.5E12}$$

$$= \frac{1.6 \cdot 10^{12}}{1.275 \cdot 10^{12}} = 1.255$$

$\therefore$ New CPI $= 1.255$

2. For example, for $p=2$, the time is

$$\frac{100}{2} + 4 = 54s$$

The speedup relative to the single processor is determined by $\frac{54}{100} = 0.54 \rightarrow$ speed up of 46%

The ideal speed up would be $\frac{50}{100} = 0.5$

$$\frac{\text{speed-up}}{\text{ideal speedup}} = \frac{0.46}{0.5} = 0.92$$

So we could summarize the table as following

p	2	4	8	16	32	64	128
time in seconds	54	29	16.5	10.25	7.125	5.5625	4.78125
speed-up	46%	71%	83.5%	89.75%	92.875%	94.4375%	95.21875%
ideal time	50	25	12.5	6.25	3.125	1.5625	0.78125
ideal-speedup	50%	75%	87.5%	93.75%	96.875%	98.4375%	99.21875%
speed/ideal	0.92	0.947	0.954	0.957	0.9587	0.9594	0.9597

3 i) 5FE4 - F7DF

					unsigned	signed
5FE4 =	0101	1111	1110	0100	24548	24548
F7DF =	1111	0111	1101	1111	63345	-2081

unsigned

$$
\begin{array}{r}
0101\ 1111\ 1110\ 0100 \\
-\ 1111\ 0111\ 1101\ 1111 \\
\hline
1\,0110\ 1011\ 0010\ 1111
\end{array}
\rightarrow -38797
$$

overflow, cannot represent by hexadecimal format

ii)
signed

A = 0101 1111 1110 0100

B = 1111 0111 1101 1111

-B = 0000 1000 0010 0000 +1

-B = 0000 1000 0010 0001

$$
A+(-B) = \begin{array}{r}
0101\ 1111\ 1110\ 0100 \\
0000\ 1000\ 0010\ 0001 \\
\hline
0110\ 1000\ 0000\ 0101
\end{array}
\rightarrow 0x6805
$$

4. Base address A = x5 B = x6 C = x7

f = x8 g = x9 i = x10

(1) Load Register x3 with content of A[32]

lw x3, 128(x5)

(2) store content of Register x3 into A[64]

sw x3, 256(x5)

(3) Add content of Register x3 and x4 and place the result in register x5

add x5, x3, x4

(4) B[g] = A[i - 5A[32] + 32]

```
lw x26, 128(x5)
slli x26, x26, 2
addi x26, x26, 1
addi x10, x10, 32
sub x10, x10, x26
```

```
slli  x10, x10, 2
addi  x5, x5, x10
slli  x9, x9, 2
add   x6, x0, x9
lw    x5, 0(x5)

sw    x5, 0(x6)
```

(5) ii) $f = g - A[B[C[64]]]$

```
sd   x30, 512(x7)

slli x30, x30, 2
add  x30, x30, x6
ld   x30, 0(x30)
slli x30, x30, 2
add  x30, x30, x5
ld   x30, 0(x30)
sub  x8, x9, x30
```

ii) f = g - A[C[16] + B[32]]

```
ld, x30, 128(x7)
ld, x31, 256(x6)
add x30, x30, x31
slli x30, x30, 2
add x30, x30, x5
ld x30, 0(x30)
sub x8, x9, x30
```

iii) A[i] = 4B [8i-81] + 4C[32i+32]

```
slli x30, x10, 3
addi x30, x30, -81
slli x30, x30, 2
add x30, x30, x6
ld x30, 0(x30)
slli x30, x30, 2
slli x31, x10, 5
```

```
addi x31, x31, 32
slli x31, x31, 2
add  x31, x31, x7
ld   x31, 0(x31)
slli x31, x31, 2
add  x30, x30, x31
slli x31, x10, 2
add  x31, x31, x5
sd   x30, 0(x31)
```

5.

Number	Binary	Decimal
0	00000 0000000000	0
Mass of neutron 1.674×10^{-27}	0 00000 0000000000	0
Smallest positive normal no.	0 00001 0000000000	6.1035×10^{-5}
Smallest positive denormalized no. > 0	0 00000 0000000001	5.9604×10^{-8}
Largest positive denormalized no. > 0	0 00000 1111111111	6.1035×10^{-5}
Largest positive number < infinity	0 11110 1111111111	65536
Average distance b/w proton and neutron in hydrogen atom	0 00000 0000000000	0
No. of years since Ancient broken up 180000000	0 11111 0000000000	overflow

Mass of neutron, positive number, and it's very small number, we could ignore it to 0

Smallest normalized number

0 00001 0000000000 bias = 15 val of exponent = 1-

Bias = -14.. Significand = 1.0000 = 1 Value in decimal =

$1 \cdot 2^{-14} = 6.1035 \times 10^{-5}$

Smallest positive denormalized number

0 00000 0000000001 val of exponent = -14 Singand

$= 0.0000000001 = 1 \cdot 2^{-10}$ so smallest denormalized

$= 1 \cdot 2^{-10} \cdot 2^{-14} = 2^{-24} \approx 5.96 \cdot 10^{-8}$

Largest possible denormalized number

0 00000 1111111111 val of exponent = -14 Singand = 0.11111

So largest denormalized no. $1 \cdot 2^{-14} = 6.1035 \times 10^{-5}$

Largest positive number < infi

0 11110 1111111111, val of E = 15 Signd ~ 2

Value in decimal ~ $2 \cdot 2^{15} = 2^{16} = 65536$

Average distane = 0 → too small

No. of Years = infinity since its overflow

0 11111 0000000000

6.1

addi

140 pJ + 2·70pJ + 60 pJ = 340 pJ

6.2

sw: 140 + 2×70 + 120 = 400 pJ

lw: 140 + 2×70 + 60 + 140 = 480 pJ

Total = 400 + 480 = 880 pJ

6.3

lui: 140 + 2×70 + 200 = 480 pJ