CS202 - Computer Organization

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Lecture Assignment 2

1. a). global CPI for each implementation

class	A	B	C	D
CPI for P_1	1	2	3	3
IC in P_1	10^5	2×10^5	5×10^5	2×10^5
CPI for P_2	2	2	2	2

Total IC : 1.0×10^6

clock $rate_1 = 2.5$ GHz

Clock $rate_2 = 3$ GHz

. P_1 : $IC = 1.0\times10^6$

. clock $cycle_1$

$= 10^5 + 4\times10^5 + 15\times10^5 + 6\times10^5$

$= 26\times10^5 = 2.6\times10^6$

. Average $CPI_1 = \frac{2.6\times10^6}{1.0\times10^6} = 2.6$

P_2: $IC = 1.0\times10^6$

. clock $cycle_2$

$= 2(10^5 + 2\times10^5 + 5\times10^5 + 2\times10^5)$

$= 2\times10^6$

Average $CPI_2 = \frac{2\times10^6}{1.0\times10^6} = 2$

b). $\text{clock cycle}_1 = 2.6 \times 10^6$

$\text{clock cycle}_2 = 2 \times 10^6$

c). $\text{CPU time}_1 = \dfrac{\text{Clock cycle}_1}{\text{clock Rate}_1} = \dfrac{2.6 \times 10^6}{2.5 \times 10^9} = \dfrac{26}{25} \times 10^{-3}\ s$

$\text{CPU time}_2 = \dfrac{\text{clock cycle}_2}{\text{clock Rate}_2} = \dfrac{2 \times 10^6}{3 \times 10^9} = \dfrac{2}{3} \times 10^{-3}\ s$

$\dfrac{\text{CPU time}_1}{\text{CPU time}_2} = \dfrac{\frac{26}{25}}{\frac{2}{3}} = \dfrac{26 \times 3}{2 \times 25} = 1.56$

$\text{CPU time}_1 = 1.56\ \text{CPU time}_2$

. P_2 is 1.56 timer faster than P_1.

2. a). add x30, x5, x6

$80000000_{16} + D0000000_{16} = 150000000_{16}$

$(8+D)_{16} = 8_{10} + 13_{10} = 21_{10} = 15_{16}$

we can see the result is 36 bits, but reg max size is 32 bits.

This is overfow.

b). sub x30, x5, x6

$80000000_{16} - D0000000_{16}$

$8_{16} = 1000$ negative number

$D = 1101$ negative number

$$\begin{array}{r} 1000 \\ -\ 1101 \end{array} \rightarrow 0010+1 = 0011$$

$$\Rightarrow \begin{array}{r} 1000 \\ 0011 \\ \hline 1011 \end{array} = B$$

$\Rightarrow$ $80000000_{16} - D0000000_{16} = B0000000_{16}$

No overflow.

3. a)

$23/2 = 11$	1		$112/2 = 56$	0
$11/2 = 5$	1		$56/2 = 28$	0
$5/2 = 2$	1		$28/2 = 14$	0
$2/2 = 1$	0		$14/2 = 7$	0
$1/2 = 0$	1		$7/2 = 3$	1
			$3/2 = 1$	1
			$1/2 = 0$	1

$23 = 10111$

$112 = 1110000$

$23_{10} = 00010111_2 = 11101000_2 + 1_2 = 11101001_2 = 233_{10}$

$112 = 01110000_2 = 10001111_2 + 1_2 = 10010000_2 = 144_{10}$

Hence numbers in two complement are -233 and -144.

The two's complement format result

$-233 - 144 = -377$ under min value of -128.

so, result is -128.

b). Same steps above, but

$-233-(-144) = -89$ in range of $(-128, 127)$.

So, result is -89.

128 64 32 16 8 4 2 1

4. $64_{10} = 0100\ 0000_2$, $14 = 0000\ 1110$

multiplicant	product
0100 0000	0000 0000 | 0000 1110 →
	00000 0000 0000 111
	01000 0000 0000 111 →
	0010000 000 0000 11
	0110000 000 0000 11 →
	00110000 000 0000 1
	0111 0000 000 0000 1 →
	00 111 0000 000 0000 →
	0000 0011 1000 0000

6. a) $0x0C000000 = \underset{\text{sign}}{0}\underbrace{000\ 1100\ 0}_{\text{exponent}}\underbrace{0 \ldots 0}_{\text{23 bits fraction}}$

$00011000 = 24$

using $(-1)^S \cdot (1 + \text{Fraction}) \cdot 2^{Exp-127}$

$(-1)^0 (1+0) \cdot 2^{-103} = 1.0 \times 10^{-103}$

b). binary of 63.25

$63/2 = 31 \quad 1$
$31/2 = 15 \quad 1$
$15/2 = 7 \quad 1$
$7/2 = 3 \quad 1$
$3/2 = 1 \quad 1$
$1/2 = 0 \quad 1$

$(63)_{10} = 0011\,1111_2$

$0.25 \times 2 = 0.5 \quad 0$
$0.5 \times 2 = 1.0 \quad 1$

$0.25_{10} = 0.01_2$

$63.25_{10} = 00111111.01_2 = 1.1111101 \times 2^5$

adjusted exponent $5 + 127 = 132_{10} = 10000100_2$

sign $= 0$

fraction 11111010 0000 0000 0000 000 (23 bits)

single precision IEEE 754 format is

0 10000100 1111 1010 0000 0000 0000 000

5. $62_{10} = 111110_2$

$21_{10} = 010101_2$

← Quot	Divisor →	Remainder	
000 000	010101 000000	000 000 111 1110	
000 000	0010101 00000	000 000 111 1110	
00 00 00	000 101 010 000	000 000 111 1110	
000 000	000 010 101 000	000 000 111 1110	
000 000	000 001 010 100	000 000 111 1110	
000 000	000 000 101 010	000 000 111 1110	
000 001	000 000 101 010	000 000 010 100	rem > div, shift q Left with 1, shift div right
000 001	000 000 010 101	000 000 010 100	
000 010	000 000 001 010	000 000 010 100	rem < div shift q left with 0 shift Div right

quotion $010_2 = 2_{10}$

remainder $010100_2 = 20_{10}$