CS 3340.004 Assignment #1
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1.)

	Clock	CPI's A	B	C
P1	2.5 GHz	2	4	3
P2	3.5 GHz	3	4	4
P3	3.0 GHz	4	2	5

P1 is slowest at 0.132 sec

1.a) program with 1.0×10^8 instructions 20% A, 50% B, 30% C

0.2×10^8 A + 0.5×10^8 B + 0.3×10^8 C

P1 clock cycles $= 10^8 \cdot (2 \cdot 0.2 + 4 \cdot 0.5 + 0.3 \cdot 3)$ (A, B, C)

$= 3.3 \times 10^8$

P1 time $= 3.3 \times 10^8$ cycles $\cdot \frac{1 \text{ second}}{2.5 \times 10^9 \text{ cycles}} = 0.132$ seconds

P2 time $= \frac{1}{3.5 \times 10^9} \cdot 10^8 \cdot (3 \cdot 0.2 + 4 \cdot 0.5 + 4 \cdot 0.3) = 0.109$ seconds

P3 time $= \frac{1}{3.0 \times 10^9} \cdot 10^8 \cdot (4 \cdot 0.2 + 2 \cdot 0.5 + 5 \cdot 0.3) = 0.110$ seconds

1.b) CPI $= \frac{\text{cycles}}{\text{instructions}}$

P1 $= \frac{10^8 \cdot (2 \cdot 0.2 + 4 \cdot 0.5 + 3 \cdot 0.3)}{1.0 \cdot 10^8} = (2 \cdot 0.2 + 4 \cdot 0.5 + 3 \cdot 0.3) =$ 3.3 CPI

P2 $= (3 \cdot 0.2 + 4 \cdot 0.5 + 4 \cdot 0.3) =$ 3.8 CPI

P3 $= (4 \cdot 0.2 + 2 \cdot 0.5 + 5 \cdot 0.3) =$ 3.3 CPI

1.c) clock cycles $=$ CPI $\cdot$ instructions P1 $= 3.3$ CPI $\cdot 1.0 \times 10^8$ instructions

P1 $= 3.3 \times 10^8$ cycles
P2 $= 3.8 \times 10^8$ cycles
P3 $= 3.3 \times 10^8$ cycles

2) 8000 MHz $= 8 \times 10^9 \frac{\text{cycles}}{\text{sec}}$

2.a)
compile A $= 8 \times 10^9 \cdot 1.5\text{s} = \frac{1.2 \times 10^{10} \text{ cycles}}{1 \times 10^9 \text{ instruct}} =$ 12 CPI

compile B $= 8 \times 10^9 \cdot 1.4\text{s} = \frac{1.12 \times 10^{10} \text{ cycles}}{1.2 \times 10^9 \text{ instruct}} =$ 9.3 CPI

2.b) $\frac{1}{\text{clock A}} \cdot$ CPI A $\cdot$ instructions A $=$ time A $=$ time B $= \frac{1}{\text{clock B}} \cdot$ CPI B $\cdot$ instruct B

$\frac{1}{\text{clock A}} \cdot 12 \text{ CPI} \cdot 1 \times 10^9 \text{ instruct} = \frac{1}{\text{clock B}} \cdot 9.3 \text{ CPI} \cdot 1.2 \times 10^9 \text{ instruct}$

1.07 $\cdot$ clock B $=$ clock A

since time taken is not given, cannot find exact clock's of processor's A & B

2.c) $\frac{1}{8 \times 10^9} \cdot 1.2 \text{ CPI} \cdot 4 \times 10^8 \text{ instruct} = 0.06\text{s}$

15s $- 0.06\text{s} =$ 1.44s speed up
1.4s $- 0.06\text{s} =$ 1.34s speedup

3.a) P1 time = $\frac{1\text{ sec}}{4\times10^9\text{ cycles}} \cdot \frac{0.9\text{ cycles}}{\text{instruct}} \cdot 5\times10^9\text{ instruct} = 1.125\text{ sec}$

P2 time = $\frac{1\text{ sec}}{3\times10^9\text{ cycles}} \cdot \frac{0.75\text{ cycles}}{\text{instruct}} \cdot 1\times10^9\text{ instruct} = 0.25\text{ sec}$

P2 is faster than P1 despite having a slower processor, this is because P2 has a lower CPI and instruction count

3.b) P1 time = $\frac{1\text{ sec}}{4\times10^9\text{ cycles}} \cdot \frac{0.9\text{ cycles}}{\text{instruct}} \cdot 1\times10^9\text{ instruct}$ = P2 time = $\frac{1\text{ sec}}{3\times10^9\text{ cycles}} \cdot \frac{0.75\text{ cycles}}{\text{instruct}} \cdot x\text{ instruct}$

x instruct = $\frac{1\text{ sec}}{4\times10^9\text{ cycles}} \cdot \frac{3\times10^9\text{ cycles}}{1\text{ sec}} \cdot \frac{0.9\text{ cycles}}{\text{instruct}} \cdot \frac{\text{instruct}}{0.75\text{ cycles}} \cdot 1\times10^9\text{ instruct}$

$= 0.9\times10^9$ instructions

P2 can execute 0.9×10^9 instructions in the same time P1 can execute 1×10^9

3.c) P1 MIPS = $\frac{\text{instructs}}{0.9\text{ cycles}} \cdot \frac{4\times10^9\text{ cycles}}{\text{sec}} = 4444\text{ MIPS}$

P2 MIPS = $\frac{\text{instructs}}{0.75\text{ cycles}} \cdot \frac{3\times10^9\text{ cycles}}{\text{sec}} = 4000\text{ MIPS}$

this shows that P1 is faster than P2, despite 3.a showing that P2 is faster than P1

4.a) $\frac{1\text{ cycle}}{2.50\times10^{-10}\text{ s}} \cdot 750\text{ s} = \frac{7.875\times10^{17}\text{ cycles}}{2.839\times10^{12}\text{ instruct}} = \boxed{66044\text{ CPI}}$

4.b) $\frac{9650\text{ s}}{750\text{ s}} = \boxed{12.9\text{ SPEC ratio}}$

4.c) 25% increase instructions = 25% increase in time

$750\text{ sec} \cdot 1.25 = \boxed{937.5\text{ sec}}$

4.d) 25% increase instruct + 10% increase CPI = 0.25 + 0.1 = 0.375 increase total time

$750\text{ sec} \cdot 1.375 = \boxed{1031.25\text{ sec}}$

4.e) $\frac{9650\text{ s}}{937.5\text{ s}} = 10.3$ SPEC ratio. c

$\frac{9650\text{ s}}{1031.25\text{ s}} = 9.4$ SPEC ratio. d

5.a) +32 = 0000 0000 0000 0000 0000 0000 0010 0000

-32 = 1111 1111 1111 1111 1111 1111 1110 0000 ← invert +1

5.b) +127 = 0000 0000 0000 0000 0000 0000 0111 1111

-127 = 1111 1111 1111 1111 1111 1111 1000 0001 ←

5.c) +201 = 0000 0000 0000 0000 0000 0000 1100 1001

-201 = 1111 1111 1111 1111 1111 1111 0011 0111 ←

5.d) +1311 = 0000 0000 0000 0000 0000 0101 0001 1111

-1311 = 1111 1111 1111 1111 1111 1010 1110 0001 ←

5.e) +26062 = 0000 0000 0000 0000 0110 0101 1100 1110

-26062 = 1111 1111 1111 1111 1001 1010 0011 0010 ←

6.a) lw $t0, $s1($s6) → A[g]

add $t0, $t0, $s2 → A[g]+h

addi $t0, $t0, 4 → A[g]+h+4

addi $t1, $s3, 16 → 4+i → need to do 16 because this is an address

sw $t0, $t1($s7) → B[4+i] = A[g]+h+4

6.b) add $t0, $s2, $s1 → h+g

lw $t1, $t0($s7) → B[h+g]

lw $t2, $t1($s7) → B[B[h+g]]

add $s0, $s0, $t2 → f = B[B[h+g]]+f