Jinwoo Kim ComS 321 2/7/2018 Prof. G.M. Prabhu

1. – (a)

Program 1, Time on M2 is faster than M1 by 100%.

– (b)

Program 2, Time on M1 is faster than M2 by 33%

2. MIPS : Millions of Instructions per seconds

$$MIPS_{M1} = \frac{200\times10^6}{10} = \underline{20}^{(\times10^6)} \qquad MIPS_{M2} = \frac{160\times10^6}{5} = \underline{32}^{(\times10^6)}$$

3. $CR_{M1} = 200MHz$ $CR_{M2} = 300MHz$

$$MIPS = \frac{\text{Clock Rate}}{CPI\times10^6} \Rightarrow CPI\times10^6 = \frac{\text{Clock Rate}}{MIPS}$$

$$CPI_{M1} = \frac{\text{Clock Rate}}{MIPS\times10^6} = \frac{200\,MHz}{20\times10^6} = \frac{200\times\cancel{10^6}Hz}{2\cancel{0}\times\cancel{10^6}} = \underline{10}$$

$$CPI_{M2} = \frac{300MHz}{32\times10^6} = \frac{300\times\cancel{10^6}Hz}{32\times\cancel{10^6}} = \frac{150}{16} = \underline{9.375}$$

4. $CPI_{p2} = CPI_{p1}$ $CR_{M1} = 200MHz$ $CR_{M2} = 300MHz$

$CPI_{M1} = 10$ $CPI_{M2} = 9.375$

Instruction Count = MIPS × (Exec. Time ×10^6)

$$MIPS_{M1} = \frac{\text{Clock rate}}{CPI\times10^6} = \frac{200\times\cancel{10^6}}{10\times\cancel{10^6}} = 20$$

$$MIPS_{M2} = \frac{300\times\cancel{10^6}}{9.375\times\cancel{10^6}} = 32$$

$$IC_{M1} = MIPS_{M1} \times (Exec.Time_{M1}\times10^6) = 20 \times (3\times10^6) = \boxed{60\times10^6}$$

$$IC_{M2} = MIPS_{M2} \times (Exec.Time_{M2}\times10^6) = 32\times(4\times10^6) = \boxed{128\times10^6}$$

5.

Program	Time on M1	Time on M2	cost M1	cost M2
1	10 sec	5 sec	$10,000	$15,000
2	3 sec	4 sec		

Basically, machine M2 is faster than M1 by double.
However, M2 is more expensive than M1 by 50% but not double.
Thus, it is obvious to buy M2 to run thousands times.
We can calculate this using, $\frac{cost_{M2}}{speedup_{M2}} = \frac{\$15,000}{2} = \$7,500$
which is less than $10,000. So that buying M2 is more benefit.

6.

$$\text{peak MIPS}_{M1} = \frac{500\times\cancel{10^6}}{1\times\cancel{10^6}} = \underline{500}$$

$$\text{peak MIPS}_{M2} = \frac{750\times\cancel{10^6}}{2\times\cancel{10^6}} = \underline{375}$$

7. $CPI_{M1} = \frac{(1+2+3+4)}{4} = 2.5$ $CPI_{M2} = \frac{(2+2+4+4)}{4} = 3.$

$MIPS_{M1} = 500$ $MIPS_{M2} = 375$

$$M1 = \frac{500\times10^6}{2.5} = 200\times10^6 \quad M2 = \frac{750\times10^6}{3} = 250\times10^6$$

$\frac{250\times10^6}{200\times10^6} = 1.25$, M2 is faster than M1 by 1.25 times.

8.

$CR_{M1} = 500 \times 10^6$

$CPI_{M1} = 2.5$

$CR_{M2} = 750 \times 10^6$.

$CPI_{M2} = 3$.

$$\frac{x}{2.5} = \frac{750 \times 10^6}{3} \Rightarrow x = \frac{750 \times 10^6}{3} \times 2.5$$

$$x = 625 \times 10^6$$

If M1 has 625×10^6 Hz clock Rate, it will have same performance

9. (a)

FP $\times$ $30 \times 2 = 60$ cycles

FP $+$ $20 \times 2 = 40$ cycles

FP $\div$ $50 \times 2 = 100$ cycles

$$CPI_{MFP} = (.1) \times 6 + (.15) \times 4 + (.05) \times 20 + (.70) \times 2 = 3.6$$

$$CPI_{MNFP} = (.1) \times 60 + (.15) \times 40 + (.05) \times 100 + (.70) \times 2 = 18.4$$

$$MIPS_{MFP} = \frac{1000}{3.6} = 277.7 \text{ MIPS}$$

$$MIPS_{MNFP} = \frac{1000}{18.4} = 54.3 \text{ MIPS}$$

a - (b)

FP *	10%	0.1×300	= 30 mil
FP +	15%	0.15×300	= 45 mil
FP ÷	5%	0.05×300	= 15 mil
Int.	70%	0.7×300	= 210 mil

The floating point instructions on MNFP need to be emulated by integer instructions

FP *	30×30	= 900 mil
FP +	45×20	= 900 mil
FP ÷	15×50	= 750 mil
Int.		

Total number of integer instr. needed for program P on MNFP

$= 900 + 900 + 750 + 210 =$ 2760 mil instructions

a - (c)

$$\text{Exec. Time}_{MFP} = \frac{IC_{MFP}}{MIPS_{MFP} \times 10^6} = \frac{300 \times 10^6}{277.7 \times 10^6} = 1.08 \text{ secs}$$

$$\text{Exec. Time}_{MNFP} = \frac{IC_{MNFP}}{MIPS_{MNFP} \times 10^6} = \frac{2760 \times 10^6}{54.3 \times 10^6} = 50.784 \text{ secs}$$