

## Homework #1 CAD

1. [5pts] Find the CPI (Cycle Per Instruction) if the clock cycle time is 0.333 nanoseconds.

Ans: 0.94

Method:

CPI = execution time / (instruction count \* clock cycle time)

$$= \frac{750}{(2.389 * 10^{12}) * (0.333 * 10^{-9})}$$

$$= \frac{750}{796}$$
$$= 0.94$$

2. [5pts] Find the SPECratio.

Ans: 12.9

Method:

As per definition SPECratio defined as,

SPECratio = reference time / execution time

$$= \frac{9650}{750}$$
$$= 12.9$$

3. [5pts] find the increase in CPU time if the number of instructions of the benchmark is increased by 10% without affecting the CPI.

Ans:

$$\text{Increase in CPU time} = 1 - 823/750 = 0.1 \text{ (10\%)}$$

$$\text{instruction count} * 1.1 = 2.628, \text{ CPU time} = 823\text{s}$$

4. [5pts] find the increase in the CPU time if the number of instructions of the benchmark is increased by 10% and the CPI is increased by 5%.

**Ans:**

increase in CPU time =  $901/750 - 1 = 0.2$  (20%)

$\text{CPI} * 1.1 = 1.03$ , CPU time = 901s

**5. [5pts] find the change in the SPECratio for this change**

**Ans:**

SPECratio for this change = 10.7

**6. [10pts] Suppose that we are developing a CPU B with a 4 GHz clock rate. We have also added some additional instructions to the instruction set so that the number of instructions has been increased by 15%. The execution time is reduced to 700 seconds. Find the new CPI.**

**Ans:**

$\text{CPI}_{\text{new}} = 1.38$

instruction count new =  $2.031\text{E}12$ , clock rate =  $4.0 \times 10^9$

**7. [10pts] This CPI value is larger than obtained in the Question 1 above as the clock rate was increased from 3 GHz to 4 GHz. Determine whether the increase in the CPI is similar to that of the clock rate. If they are dissimilar, why?**

**Ans:**

they are dissimilar because instruction count has been reduced.

clock rate ratio =  $4 \text{ GHz} / 3 \text{ GHz} = 1.33$

CPI ratio =  $1.38 / 0.94 = 1.47$

**8. [5pts] By how much has the CPU time been reduced?**

**Ans:**

The CPU time has been reduced by 7%.

**9. [10pts] For an another benchmark named P2, assume an execution time of 960 ns, CPI of 1.61, and clock rate of 3 GHz. If the execution time is reduced by an additional 10% without affecting the CPI and with a clock rate of 4 GHz, determine the number of instructions.**

**Ans:**

// In 1.11.9, execution time is 960ns. but I think it is "s" not "ns".  
Therefore, I will use "s" instead of "ns".

Number of instructions =  $2147 \times 10^9$

**10. [10pts] Determine clock rate required to give a further 10% reduction in CPU time while maintaining the number of instructions and with CPI unchanged.**

**Ans:**

$$\text{clock rate new1} = 2147 \times 10^9 \times 1.61 / 864 = 4.0 \times 10^9 = 4\text{Ghz}$$

$$\text{CPU time} \times 0.9 = 864$$

**11. [10pts] Determine the clock rate if the CPI is reduced by 15% and the CPU time by 20% while the number of instructions unchanged.**

**Ans:**

$$\text{Clock rate new2} = 3.83 \times 10^9 = 3.83\text{Ghz}$$

$$\text{CPI} \times 0.85 = 1.37, \text{ execution time} \times 0.8 = 768\text{s}$$