CZ3001
Advanced Computer Architecture

LAMS 1 - Performance Metrics

* 1. Computer A: Clock period = 250 ps, CPI = 2
Computer B: Clock period = 500 ps, CPI = 1.2

1(a) Both computers A and B have the same ISA and run the same program P. Which one has a faster processor?

Choose one of the following answers.

- ✔ ◉ Computer A

The correct answer is Computer A.

Execution time = IC x CPI x Tc
Let N be the total number of instructions (IC) in both computers A and B.
The execution time of A = N x 2 x 250 ps= 500N ps
The execution time of B = N x 1.2 x 500 ps= 600N ps
Hence A is faster than B

- ○ Computer B

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* 1(b) How much faster?

Choose one of the following answers.

- ✔ ◉ 1.2

The correct answer is 1.2

Speedup of computer A to computer B = execution time of B/execution time of A = 600N/500N= 6/5=1.2

- ○ 0.833

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* 2(a) Computer A is running at 2 GHz clock using 10s as its CPU time for a program P. We would like to design another computer B with the same ISA, where the execution time needs to be 6s for the same program P. Calculate the number of clock cycles used by computer A.
Answer: The number of clock cycles used by computer A = ________ $x10^9$ cycles

Answer:

✔ 20

The correct answer is 20.0

The number of clock cycles used by computer A = execution time of A / clock period of A = 10s x 2 GHz =20 x 10^9 cycles.
As we are running the same program in computer B, the number of clock cycles will remain constant.
The correct answer is 20.0

The number of clock cycles used by computer A = execution time of A / clock period of A = 10s x 2 GHz =20 x 10^9 cycles.
As we are running the same program in computer B, the number of clock cycles will remain constant.

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* 2(b) How fast must the clock frequency of computer B be?
Answer: The clock frequency of computer B = _____ GHz

Answer:

✔ 3.33

The correct answer is 3.33

Clock period of computer B = execution time of B/Number of clock cycles used by computer A = 6s/ (20 x 10^9 cycles)

Clock frequency of computer B = (20 x 10^9cycles)/6s = 3.33 GHz
The correct answer is 3.33

Clock period of computer B = execution time of B/Number of clock cycles used by computer A = 6s/ (20 x 10^9 cycles)

Clock frequency of computer B = (20 x 10^9cycles)/6s = 3.33 GHz

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* 3. Consider a program comprising 100 instructions consisting of three categories of instructions which require different number of cycles per instruction (CPI). Out of those 100 instructions, the number of instructions (IC) of categories 1 and 2 are $IC_1 = 20$, $IC_2 = 30$, respectively. Find the number of instructions (IC_3) of the third category of instructions, if the CPIs for instructions of categories 1, 2, and 3 are, 2, 3 and 1.

(a) Find the total number of cycles required to execute the program.
(b) Find the average CPI.

Clue: Average CPI = (Total no. of clock cycles required) / (Total no. of instructions in the program)

3(a) Answer: The total number of cycles = _____ clock cycles

Answer:

✔ 180

The correct answer is 180 clock cycles.

Total instruction count = $IC_1 + IC_2 + IC_3 = 100 \Rightarrow IC_3 = 100-20-30 = 50$
No. of clock cycles required to execute a program = $(IC_1 \times 2) + (IC_2 \times 3) + (IC_3 \times 1)$
$= (20 \times 2) + (30 \times 3) + (50 \times 1) = 180$ clock cycles
The correct answer is 180 clock cycles.

Total instruction count = $IC_1 + IC_2 + IC_3 = 100 \Rightarrow IC_3 = 100-20-30 = 50$
No. of clock cycles required to execute a program = $(IC_1 \times 2) + (IC_2 \times 3) + (IC_3 \times 1)$
$= (20 \times 2) + (30 \times 3) + (50 \times 1) = 180$ clock cycles
Marks for this submission: 1/1.

* 3(b) Answer: Average CPI = ____________
Clue: Average CPI = (Total no. of clock cycles required) / (Total no. of instructions in the program)

Answer:

✔ 1.8

Average CPI = 180/100 =1.8

In general, the number of clock cycles required to execute a program = $\sum_k IC_k \times CPIk$ where IC_k is the number of instructions (instruction count) of category k

execution time = $[\sum_k IC_k \times CPIk] \times T_C$
Average CPI = 180/100 =1.8

In general, the number of clock cycles required to execute a program = $\sum_k IC_k \times CPIk$ where IC_k is the number of instructions (instruction count) of category k

execution time = $[\sum_k IC_k \times CPIk] \times T_C$
Marks for this submission: 1/1.

* 4. If 90% of the computation can be parallelised, what is the maximum speedup achievable using eight processors?

Choose one of the following answers.

- ○ 1.095
- ✔ ◉ 4.705

The correct answer is 4.705.

E=90% and 1-E=10%, S=8

$$Speedup_{parallel}\,(E,S) = \frac{1}{(1-E)+\frac{E}{S}}$$

Speed up = 1/(0.1+ (.9/8)= 1/0.2125 = 4.705

- ○ 10
- ○ 1.11

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* 5. An application executing on 64 processors using 5% of the total time on non-parallelisable computations. What is the scaled speedup?

Choose one of the following answers.

- 3.15
- ✔ 60.85

$T_s = 0.05$, $T_p = 0.95$, $n = 64$ and $U = 0.05$

$$U = \frac{T_s}{T_s+T_p}, \textit{ fraction that is unenhanced}$$

$$T_{enhanced} = T_s + T_p$$

$$T_{original} = T_s + n.T_p$$

$$Speedup(U,n) = \frac{T_{original}}{T_{enhanced}} = \frac{T_s + n.T_p}{T_s + T_p} = n - U(n-1)$$

Thus speed up = 64 - 0.05(64 -1) = 60.85

- 64
- 8

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