

- MIPS rate = $f / \text{CPI} \times 10^6$
 $= 40 / 1.55 \times 10^6$
 $= 40 \times 10^6 / 1.55 \times 10^6$
 $= \mathbf{25.8}$

- Given $f = 40 \text{ MHz} \rightarrow \tau = 1/40$
 $T = I_c \times \text{CPI} \times \tau$
 $= 100000 \times 1.55 \times 1/40$
 $= 100000 \times 1.55 \times 0.025$
 $= 3875$
 $= \mathbf{3.875 \text{ ms}}$

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5

Q2:

3 enhancement with the following speed up are proposed for a new architecture

- $\text{Speedup}_1 = 30$
- $\text{Speedup}_2 = 20$
- $\text{Speedup}_3 = 15$

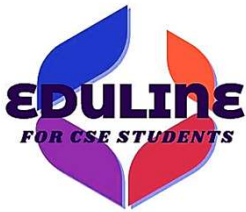
If enhancement 1 and 2 are each usable for 25% of the time, what fraction of the time must enhancement 3 be used to achieve an overall speed up of 10 ?

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6

Important Problematic Questions for University Exam



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1

MODULE 1

Q1:

A benchmark program is run on a 40 MHz processor. The executed program consists of 100,000 instruction executions, with the following instruction mix and clock cycle count:

Instruction Type	Instruction Count	Cycles per Instruction
Integer arithmetic	45.000	1
Data transfer	32.000	2
Floating point	15.000	2
Control transfer	8000	2

Determine the effective CPI, MIPS rate, and execution time for this program.

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Clock speed of the Processor = 40 MHz

Instruction Type	Instruction Count	Cycles per Instruction	cycles
Integer arithmetic	45,000	1	45000
Data transfer	32,000	2	64000
Floating point	15,000	2	30000
Control transfer	8000	2	16000

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- Total no: of cycles required to execute complete program

$$\rightarrow 45000 + 64000 + 30000 + 16000$$

$$\rightarrow 155000 \text{ cycles}$$

$$C = 155000 \text{ cycles}$$

- Effective CPI = C/I_c

$$\rightarrow 155000 / 100000$$

$$CPI = 1.55$$

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$$\begin{aligned}\text{Total cost} &= C_1S_1 + C_2S_2 + C_3S_3 \\ &= 1.25 \times 512 + 0.2 \times 32 \times 10^3 + 39.8 \times 0.0002 \times 10^6 \\ &= 640 + 6400 + 7960 \\ &= \text{\textcolor{red}{\$15000}}\end{aligned}$$

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13

MODULE 4

Q1:

Consider the execution of a program of **15,000 instructions** by a **linear pipeline** processor with a **clock rate of 25 Mhz**. Assume that the instruction pipeline has **five stages** and that **one instruction is issued per clock cycle**. The penalties due to branch instructions and out-of sequence executions are ignored.

- Calculate the speedup factor using this pipeline to execute the program as compared with the use of an equivalent non-pipelined processor with an equal amount of flow-through delay.
- what are the efficiency and throughput of this pipelined processor?

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14

Ans:

Information we get are :

- ☞ $n = 15,000$ instructions or tasks.
- ☞ $f = 25 \text{ MHz}$.
- ☞ $k = 5$ stages.
- ☞ 1-issued processor.

The Speedup (S_k), Efficiency, (E_k), and Throughput (H_k) factors are :

$$\begin{aligned}
 S_k &= \frac{T_1}{T_k} = \frac{nk\tau}{k\tau + (n-1)\tau} & H_k &= \frac{nf}{k + (n-1)} & E_k &= \frac{S_k}{k} \\
 &= \frac{nk}{k + (n-1)} & &= \frac{(15,000)(25)}{5 + (15,000-1)} & &= \frac{4,999}{5} \\
 &= \frac{(15,000)(5)}{5 + (15,000-1)} & &= \frac{375,000}{15,004} & &= 0,999 \\
 &= \frac{75,000}{15,004} & &= 24,99 \text{ MIPS} & & \\
 &= 4,999 & & & &
 \end{aligned}$$

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15

Q2:

Suppose the time delay of 4 stage are $\tau_1 = 60\text{ns}$, $\tau_2 = 50\text{ns}$, $\tau_3 = 90\text{ns}$, $\tau_4 = 80\text{ns}$ and the interface latch has a delay of $d = 10\text{ns}$. Find the clock period and frequency of this pipeline?

$$\tau = \tau_{\max} + d = 90 \times 10^{-9} + 10 \times 10^{-9} = 100 \times 10^{-9}$$

This means that the clock frequency of the pipeline can be set to

$$f = \frac{1}{\tau} = \frac{1}{100 \times 10^{-9}} = 10 \text{ MHz}$$

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16

Q3:

Determine the frequency of the pipeline if the stage delays are $\tau_1 = 3\text{ns}$, $\tau_2 = \tau_3 = 5\text{ns}$ and $\tau_4 = 8\text{ns}$ and the latch delay is 1ns .

$$\tau_{\max} = 8\text{ns}$$

$$d = 1\text{ns}$$

$$\tau = \tau_{\max} + d = 8 \times 10^{-9} + 1 \times 10^{-9} = 9 \times 10^{-9}$$

$$f = \frac{1}{\tau} = \frac{1}{9 \times 10^{-9}} = 111.11\text{ MHz}$$