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Problem solving - 2

(1) Draw a space-time diagram for a six-segment pipeline showing the time it takes to process 10 tasks.

soln

Space time diagram:

* The behavior of pipeline can be defined through space-time diagram. It shows the segment utilization as a function of time.

* The horizontal axis has time in clock cycles and vertical axis has segment number.

Number of segment pipeline $k = 6$

Number of task $n = 10$.

Number of clock cycles requires to complete n task and k segment Pipeline is as shown.

$\Rightarrow k+n-1$

$\Rightarrow 6+10-1$

$\Rightarrow 15$

$\boxed{\text{Total clock cyles} = 15}$

Space-time diagram for the 6 segment Pipeline

Segments	TASK														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Segment 1	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_0					
Segment 2		T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}				
3			T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}			
4			–	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}		
5					T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}	
6						T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}

This diagram shows 10 Task T_1 through T_{10} execute in 6 segments.

(2) Determine the number of clock-cycles that it takes in an eight segment pipeline with 300 tasks.

Soln

→ Let there be 'n' tasks to be performed in the 'pipelined processor'.

→ The first instruction will be taking 'k' segment pipeline 'cycles' to exit out of the 'pipeline' but the other 'n-1' instruction will take only '1' cycle each. i.e, a total of 'n-1' cycles.

→ So, to perform 'n' instruction in a 'pipelined processor time taken is

$k + (n-1)$ cycles.

→ So, in our case no. of clock cycles

$\Rightarrow 8 + (300-1)$

$\boxed{T_p \Rightarrow 307 \text{ clock cycles.}}$

(3) ~~A~~ Non-pipe

Solution:

The speed up ratio (S):

It is defined as the speedup of a Pipeline processing with respect to the equivalent non-pipeline processing

Formula:-

$$S = \frac{n t_n}{(K+n-1)t_P}$$

Number of tasks $\boxed{n = 200}$

For ~~ms~~ Nonpipeline:

Time taken by non-pipeline to process a task $t_n = 60$ ns.

Total time taken by non-pipeline to Process 200 task $= n t_n$.

$\Rightarrow 200 \times 60$

$\boxed{t_n \Rightarrow 12000 \text{ ns.}}$

For Pipeline :

No. of segments pipeline, $k = 9$

Time period of 1 clock cycle $tp = 20ns$.

Total time requires to complete "n" task in k segments pipeline with tp clock cycle time.

$\Rightarrow (k+n-1)tp.$

$\Rightarrow (9+200-1)20.$

$\Rightarrow (208)20$

$\boxed{\Rightarrow 4{,}160\ tp}$

Seep up ratio:

When total time taken by the Pipeline to Process 200 task is divided by the total time required to complete 'n' tasks in k segment Pipeline with tp clock cycle time then seepup ratio is obtain

$S = 1200/4160$ $\boxed{\therefore S : 2.884} \simeq 3$

(4)

Solution :-

Time for operands to be read from memory into registers.

$\therefore R_1$ and $R_2 = 30ns$.

Time for the signal to propagate through multiplier = 35ns.

Time for the transfer data to $R_3 = 5ns$.

Time to add 2 numbers and store to $R_5 = 15ns$

The operation performing in this Case can be grouped in 3 segments which is shown as.

Segment 1 : $R_1 \leftarrow A_i \quad R_2 \leftarrow B_i$

Segment 2 : $R_3 \leftarrow R_1 * R_2 \quad R_4 \leftarrow C_i$

Segment 3 : $R_5 \leftarrow R_3 + R_4$

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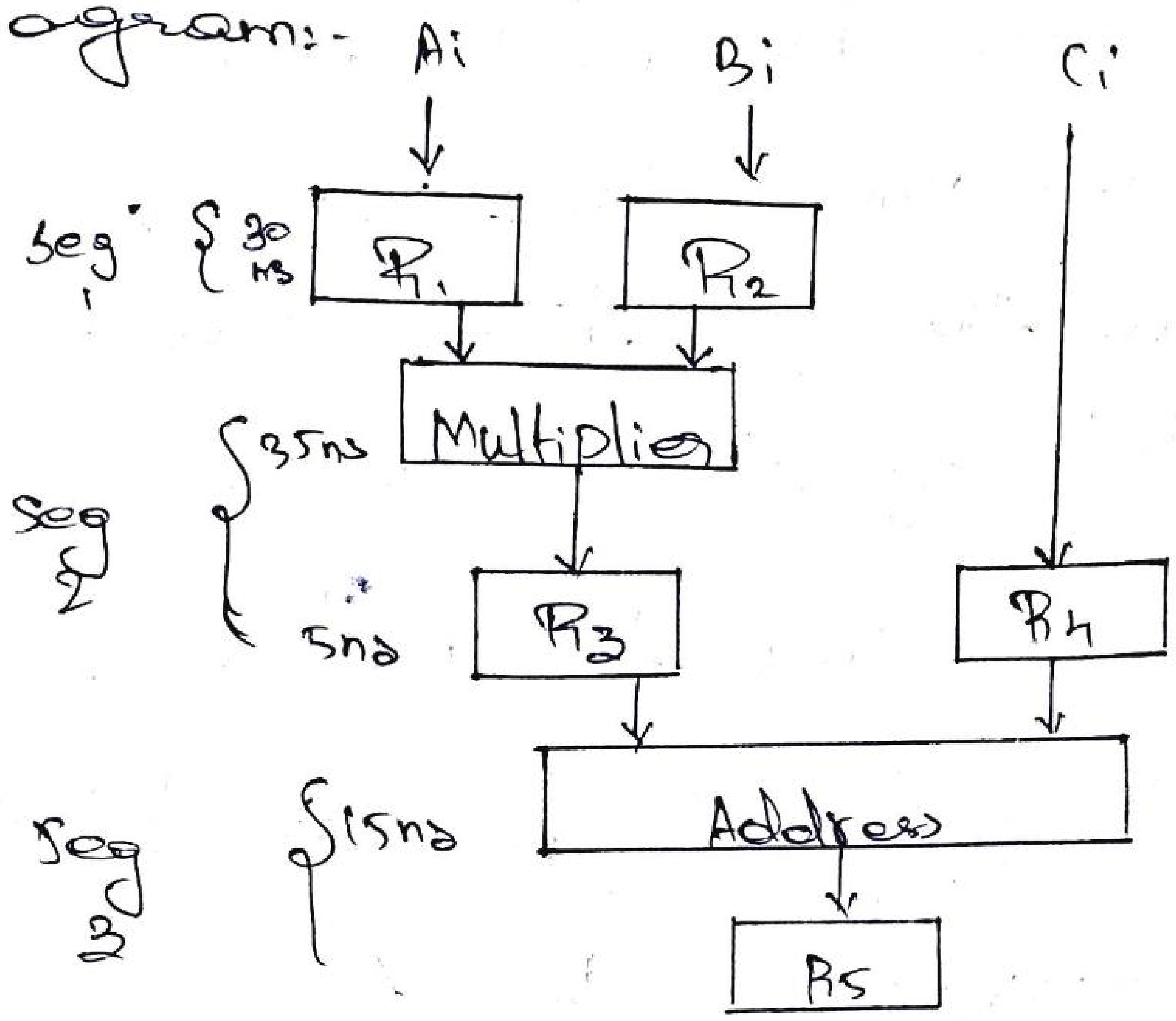
Diagram:-



(A) The minimum clock cycle time that can be used is max propogation time of the 3 segments.

<u>Segment 1</u>: 30ns

<u>Segment 2</u>: 35+5 = 40ns

<u>Segment 3</u>: 15ns

Hence the maximum propogation time is segment 2 so clock cycle time is

$\boxed{t_P = 40ns}$

(b) For non-Pipeline R_3 and R_4 is removed. In this case time taken to multiply and add the operands will be summation of 30, 35 and 15.

Time taken to add the operands without use of the Pipeline is as follows.

$\Rightarrow 30+35+15$

$\Rightarrow 80$

Hence time taken to add the operade without, the use of the pipeline is

$$\boxed{t_n = 80ns}$$

(c)

Speed up ratio:

$$S = \frac{nt_n}{(k+(n-1))t_p}$$

No. of segment Pipeline, $k=3$

No. of task $n=15$

$S = 15 \times 80 / (3+(15-1))40$

$$S = \frac{1200}{680}$$

∴ The time taken for the speed up of the Pipeline for 15 tasks is.

$S = 1.76 ns$

For tasks, $n = 150$

$$S = \frac{150 \times 80}{(3+150-1)40} \Rightarrow \frac{12000}{6080} = 1.97 ns$$

∴ Pipeline for 150 task is

$$\boxed{S = 1.97 ns \simeq 2}$$

D)

Maximum speed up ratio:-

$S_{max} = t_n / t_p$

$= 80/40$

$$\boxed{\therefore S_{max} = 2}$$

∴ Hence, the maxium speed up ratio is 2.

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