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8-1 The last 3 outcomes are different this implies first 3 will match predicted by and the last 3 will be mis-predicted.

S.No.	Last Outcomes	BHT NN/NT/TN/TT	Predicted	Outcome
1.	NN	00/00/11/11	N	N
2.	NN	00/00/11/11	N	N
3.	NN	00/00/11/11	N	N
4.	NN	00/00/11/11	N	T
5.	NT	01/00/11/11	N	T
6.	TT	01/01/11/11	T	N
7.	TN	01/01/11/10	T	

As we can see 4,5,6 are mispredictions.

a] Actual Outcomes :- NNNTTN

b] BHT entry :- 01/01/11/10 after the 6th outcome.

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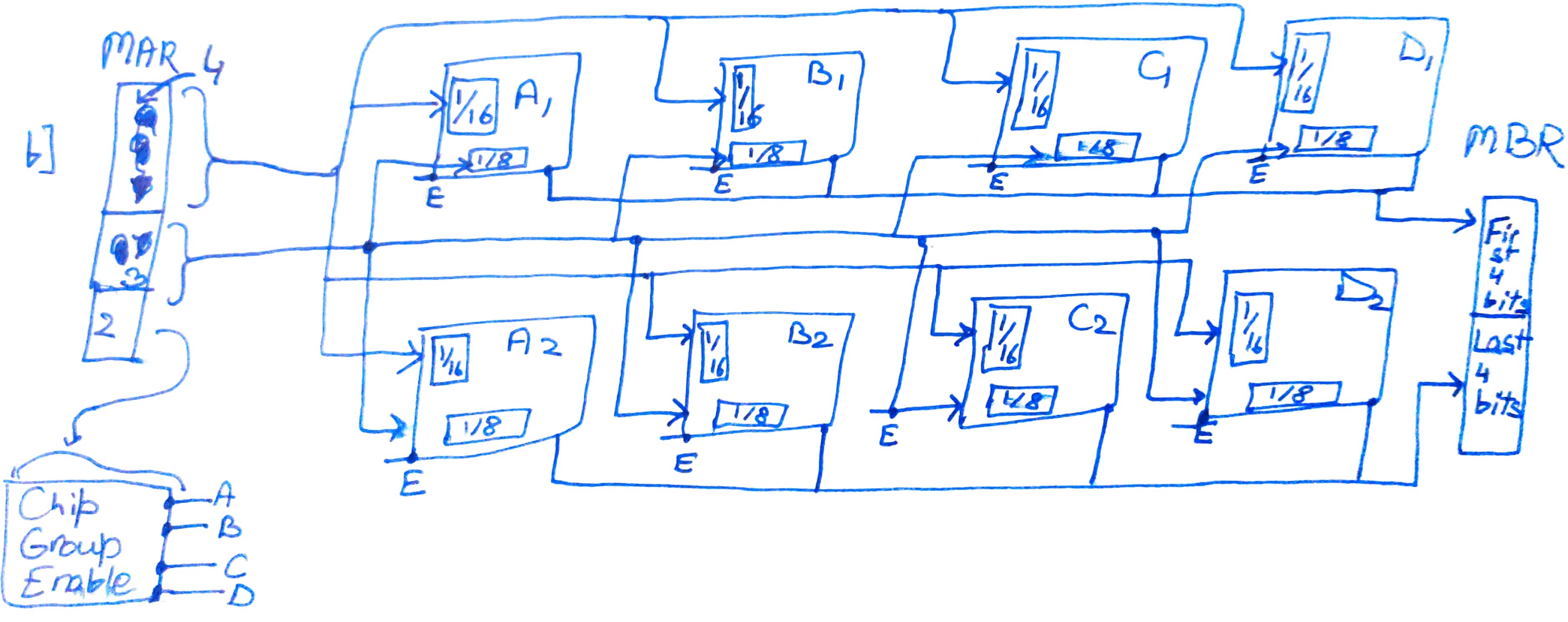
Q-2 a] 4 → Column wise
2 → Row wise

b]



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Q-3

```
L.D    F2, 0(R1)    5
MUL.D  F4, F2, F0   7
L.D    F6, 0(R2)    8
ADD.D  F6, F4, F6   10
S.D    F6, 0(R2)    11
```

a] Therefore 11 clock cycles for S.D. instruction.

b]

```
L.D    F2, 0(R1)    5
L.D    F6, 0(R2)    6
MUL.D  F4, F2, F0   7
ADD.D  F6, F4, F6   8
S.D    F6, 0(R2)    9
```

By software scheduling we can reduce number of stalls. Since there will be no ALU-load hazard.

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Q-4 a]

Average CPI = Base CPI + Stall CPI + BRANCH PENALTY CPI

$= 1$

Average CPI for P $= 1 + \frac{2}{5} + \frac{30}{100} \times \frac{10}{100} \times 2$

$= 1 + 0.4 + 0.6$

$= 2$

Average CPI for Q $= 1 + \frac{3}{10} + \frac{30}{100} \times \frac{1}{10} \times 5$

$= 1 + 0.3 + 0.15$

$= 1.45$

b] Total time for Q $= 1.45 \times 0.9\,ns = 1.305\,ns$

Total time for P $= 2 \times 1\,ns$

$\Rightarrow$ Speedup of Q over P $= \frac{T_P}{T_Q} = \frac{2\,ns}{1.305\,ns} = 1.532$

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Q-5 a] Speed up $= \frac{1}{1-F+F/N}$ where F = Fraction enhanced

N = Speed up enhanced

Here F = 0.75, N = 5

$\Rightarrow$ Speed up $= \frac{1}{(1-0.75)+\frac{0.75}{5}} = \frac{1}{0.25+0.15} = \frac{1}{0.40} = 2.5$ times

b] Speed $= \frac{ET_{old}}{ET_{new}} = 2.5$

$\frac{100}{ET_{new}} = 2.5 \Rightarrow ET_{new} = 40$ seconds

Out of 100s in old system memory used 75% $\Rightarrow$ 75s

$\Rightarrow$ This 75s got speeded up by 5 times

New time for memory operations $\Rightarrow \frac{75}{5} = 15$ s

$\Rightarrow$ Fraction of time for memory operations in new system

$= \frac{15}{40} = 37.5\%$

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Q-6 Disk size = 1 GB
Sector size = 4 KB
Number of sector in one track = 64
Total size of track = 64 × 4 KB
= 256 KB

Number of tracks per surface = 1024
So size of each surface = 1024 × 256 KB
= 256 MB

(No. of Surfaces)(Size of 1 surface) = Total size of disk

$\Rightarrow$ No. of surfaces $= \frac{1024\ MB}{256\ MB} = 4$

Total size to transfer = 5 MB = 5×2^{10} KB
Size of track = 2^8 KB
$\Rightarrow$ Total no. of tracks to cover = $\frac{5 \times 2^{10}\ KB}{2^8\ KB} = 20$

Assume data to be stored surface wise.

$\Rightarrow$ Total time = Seek time + Average rotational delay + Time to read/write

$= 8ms + \frac{1}{2 \times 60} +$ Time to read/write.

[Seek time = 8 ms
~~1 rpm = 360~~
Rotational disk speed = 360 rpm
= 60 rps

$= 8ms + \frac{1}{120} + \frac{1}{60} + 19\left[\frac{1}{60} + 2ms\right]$

$= 8ms + 8.33ms + 16.67ms + 19 \times (18.67ms)$

$= 387.73$ ms