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19101498   section:09   Assignment 03

Question 1:

Total Instruction Time = add + addi + not + beq + lw + sw

$$= 20\% + 20\% + 0\% + 25\% + 25\% + 10$$

$$= 100\%$$

$$= 1$$

We know, only SW, LW used Data Memory.

$$lw + sw = (25\% + 10\%) = 35\%$$

∴ Data Memory is used = 35%

$$= \frac{.35}{1} = .35 \text{ fraction}$$

of all cycles.
(Ans)

Question 2:

For addi: making 16 offset/integer value, we need to sign-extenders circuit.

For beq: need sign-extenders to convert 16 bit offset to 32 bit.

For lw and sw: need sign-extenders to convert 16 bit offset to 32 bit.

∴ The input of the sign-extenders circuit needed

$$= (30\% + 25\% + 25\% + 10\%)$$
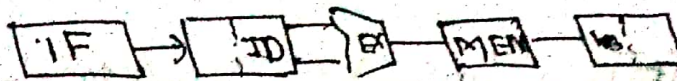
$$= 80\%$$

$$= \cdot 8 \text{ fraction of all cycles.}$$
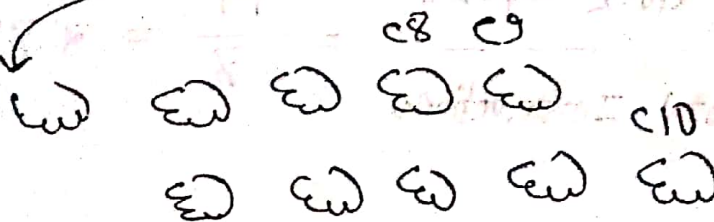
Question 3:

Using only stall to overcome the data hazard:

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C1   C2   C3   C4   C5

LW $t0, 36($t1)   IF → ID EX MEM WB

C6

C7

LW $t2, 40($t0)   IF ID EX MEM WB

C8

C9

C8 C9

C10

C11

LW $t3, 44($t2) IF ID EX MEM WB

C12

SII $t3, $t2, 2 IF ID EX MEM WB

C13

C14

WB

C12 C13 C14

C15

Sub $t0, $t3, $t2   IF ID EX MEM WB

C16

C17

C18

Addi $t0, $t0, 2   IF ID EX MEM WB
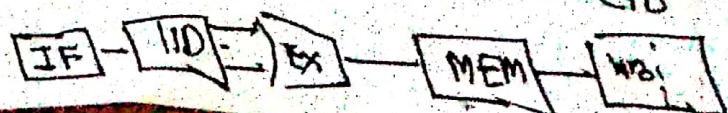
(2)

→ Writing again for better visualization

Addi $t0, t2, t0, 2$ [IF]—[ID]—[EX]—[MEM]—[WB]   C18

[IF]—[ID]—[EX]—[MEM]—[WB]   C19
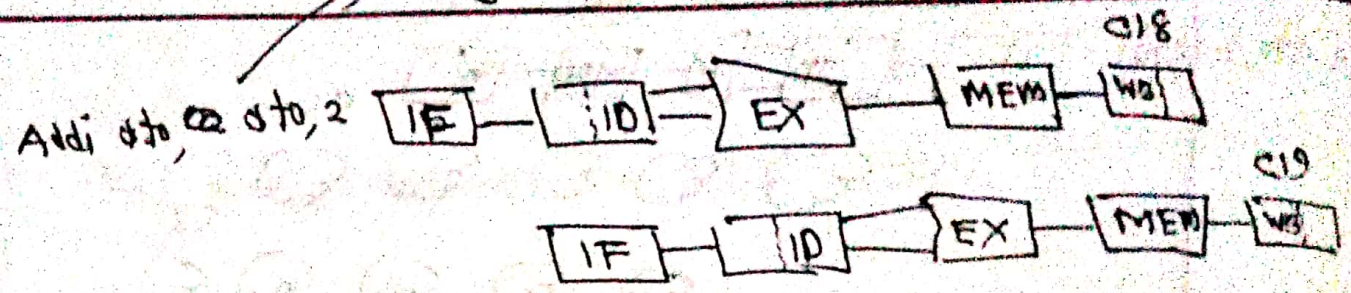
∴ 19 clock cycles needed for executing above code sequence.

For $CPI = \dfrac{\text{Total clock cycles}}{\text{Total Instructions}} = \dfrac{19}{7} = 2.714285714$ (Ans)

Question 4:

          C1   C2   C3   C4   C5
lw $t0 [IF]—[ID]—[EX]—[MEM]—[WB]   C6

LW $t2, 40($t0) [IF]—[ID]—[EX]—[MEM]—[WB]   C7

                  [IF]—[ID]—[EX]—[MEM]—[WB]   C8   C9

                                [IF]—[ID]—[EX]—[MEM]—[WB]   C10

LW $t3, 44($t2)

SLL $t3, $t2, 2   [IF]—[8 ID]—[EX]—[MEM]—[WB]

SII...

IF — ID — EX — MEM — WD   C.10

svb $to, $t3, $t2 IF — ID — EX — MEM — WB'   C11

Addi $to, $to, 2   IF — ID — EX — MEM — WD'   C12

sw $to, $t3, 2   IF — ID — EX — MEM — WD'   C13
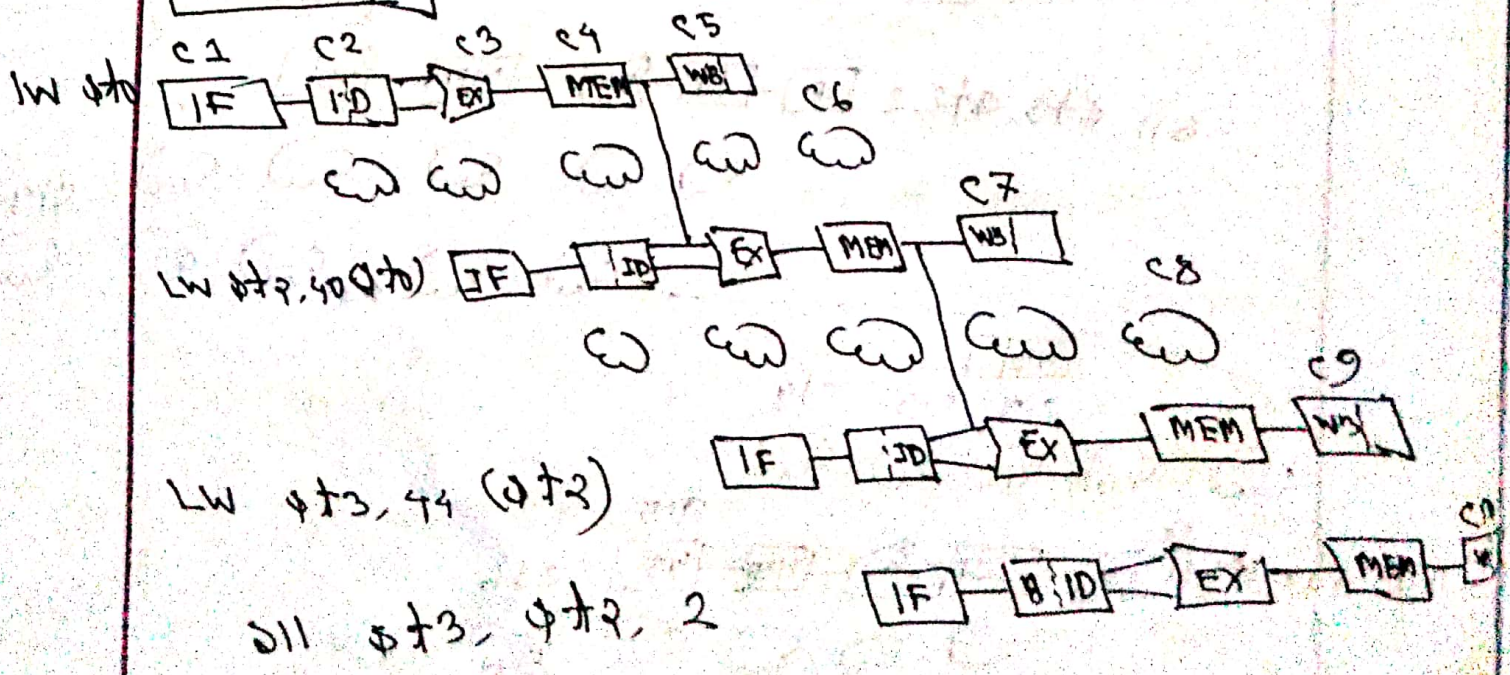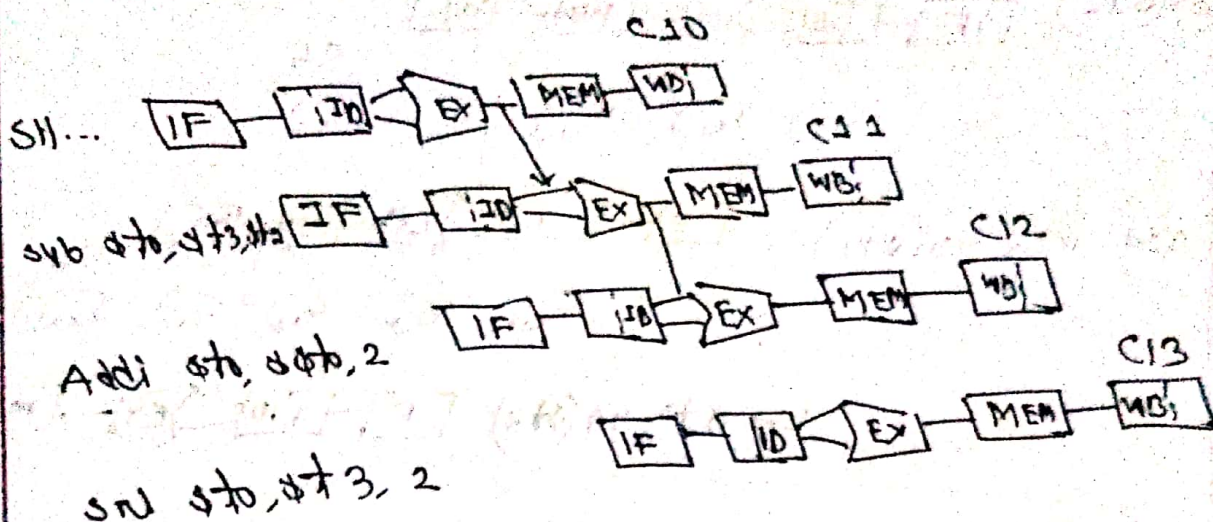
∴ 13 clock cycles needed for executing the code using

stull and forwarding.

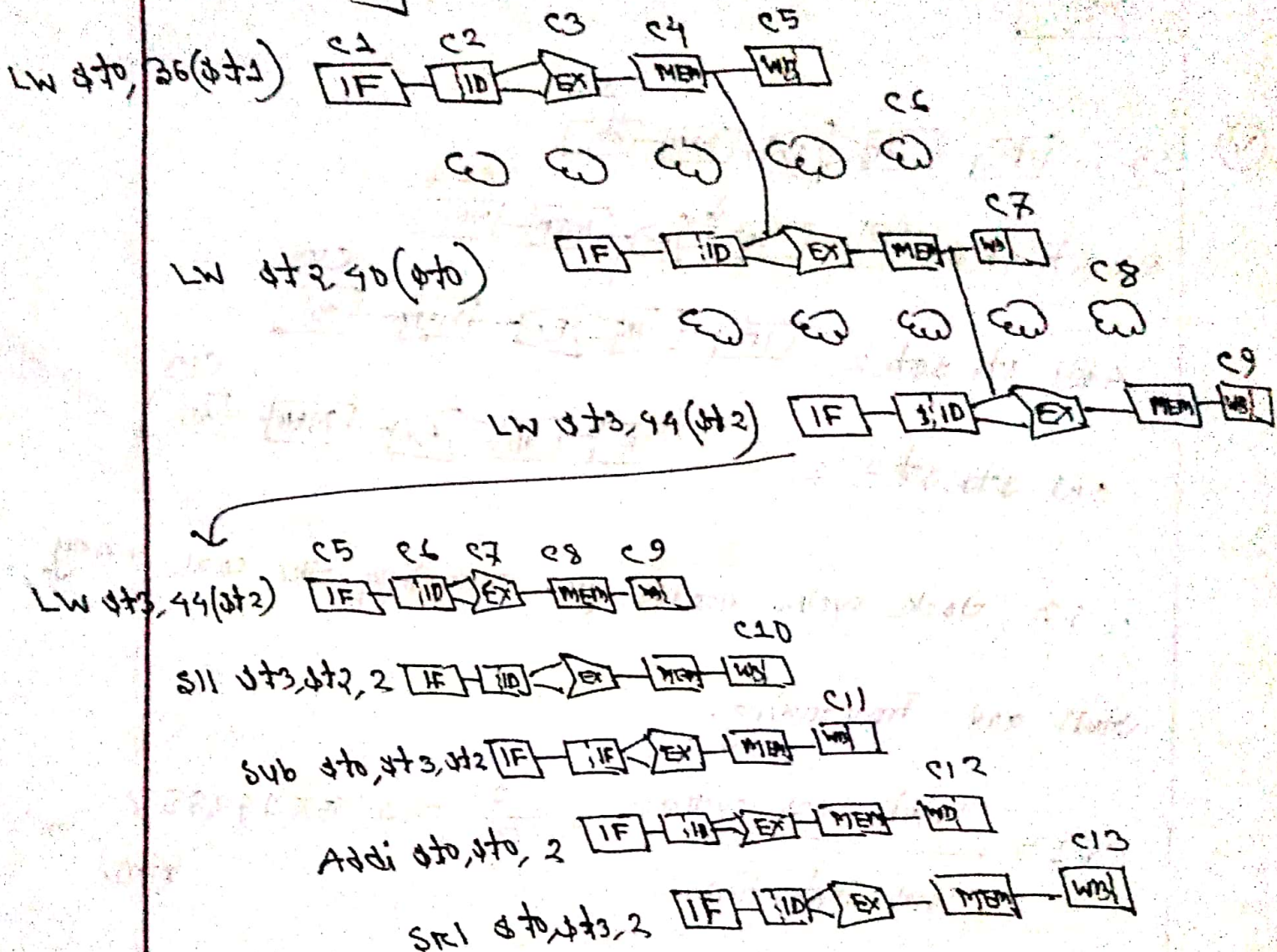$$CPI = \frac{Total\ clock\ cycles}{Total\ Instructions} = \frac{13}{7} = 1.857142857 \quad (Ans)$$

Question 6:

LW $t0, 36($t1)   C1[IF] C2[ID] C3<EX> C4[MEM] C5[WB]

C6

LW $t2, 40($t0)   [IF] [ID] <EX> [MEM] C7[WB]

C8

LW $t3, 44($t2)   [IF] [ID] <EX> [MEM] C9[WB]

LW $t3, 44($t2)   C5[IF] C6[ID] C7<EX> C8[MEM] C9[WB]

SII $t3,$t2, 2   [IF] [ID] <EX> [MEM] C10[WB]

Sub $t0,$t3,$t2   [IF] [IF] <EX> [MEM] C11[WB]

Addi $t0,$t0, 2   [IF] [ID] <EX> [MEM] C12[WD]

SrI $t0,$t3, 2   [IF] [ID] <EX> [MEM] C13[WB]

Here, Addi just add 2 with $t0 and store the value to $t0 again and $t0 gets updated in next line again. We could schedule Addi after second LW instruction as no instruction use $t0 value again. But $t0 we can not move an instruction out of its order

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if the instruction uses any updated value. Here Addi
use sto as source and it gets updated sub instruction.
So, ultimately we can not move Addi to anywhere.
So, the answer remain same as Question 4.

∴ 13 clock cycles needed for executing the code
using stall, Forwarding and load ordering/ code scheduling.

$$CPI = \frac{Total\ clock\ cycles}{Total\ Instructions} = \frac{13}{7} = 1.857142857 \qquad (Ans)$$