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Assignment: 1

Microprocessor

Note:

- ***All the data are in Hexadecimal Number System***
- ***Clock Speed is assumed to be 0.33 µs***

Q.1. Write instructions to load the hexadecimal number 65H in register C, and 92H in the accumulator A. Display the number 65H at PORT0 and 92H at PORT1.

Ans:

```
MVI C,65
MVI A,92
OUT PORT1
MOV A, C
OUT PORT0
HLT
```

Q.2. Write instructions to read the data at input PORT 07H and at PORT 08H. Display the input data from PORT 07H at output PORT 00H, and store the input data from PORT 08H in register B.

Ans:

```
IN 07
OUT 00
IN 08
MOV B, A
HLT
```

Q.3. Write logical steps to add the following two Hex numbers. Both the numbers should be saved for the future use. Save the sum in the accumulator.

Numbers: A2H and 18H

Translate the program into the 8085-assembly language.

Ans: Steps to add A2H and 18H is as follow:

A2H = 10100010

\+ 18H = 00011000

= 10111010 (BAH)

Flag status: CY = 0, Z = 0, S = 1

8085-assembly language:

```
MVI B,A2
MVI C,18
MOV A,C
ADD B
```

HLT

Q.4. Write a program to

a) **Clear the accumulator**
b) **Add 47H (Use ADI instruction)**
c) **Subtract 92H**
d) **Add 64H**
e) **Display the results after subtracting 92H and adding 64H**

Ans: MVI A,00

ADI 47

SUI 92

OUT 02

ADI 64

OUT 03

HLT

Q.5. Load the data byte A8H in register C. Mask the high-order bits (D_7-D_4), and display the low-order bits (D_3-D_0), at an output port.

Ans: MVI C,A8

MOV A,C

ANI 0F

OUT 01

HLT

Q.6. Load the data byte 8EH in register D and F7H in register E. Mask the high-order bits (D_7-D_4) from both data bytes, Exclusive-Or the low-order bits (D_3-D_0), and display the answer.

Ans: MVI D,8E

MVI E,F7

MOV A,D

ANI 0F

MOV D,A

MOV A,E

ANI 0F

MOV E,A

XRA D

OUT 01

```
HLT
```

Q.7. Load the bit pattern 91H in register B and 87H in register C. Mask all the bits except D_0 from the register B and C. If D_0 is at logic 1 in both registers, turn on the light connected to D_0 position of output port 01H; otherwise, turn off the light.

Ans:

```
MVI B,91
MVI C,87
MOV A,B
ANI 01
MOV B,A
MOV A,C
ANI 01
MOV C,A
ANA B
OUT 01
HLT
```

Q.8. Write instructions to clear CY flag, to load number FFH in register B, and increment(B). If the CY flag is set, display 01 at the output port; otherwise, display the content of the register B. Explain your answer.

Ans:

```
XRA A  ;Clearing CY FLAG
MVI B,FF
INR B
JC CARRY
MOV A,B
OUT 00
HLT
CARRY:
MVI A,01
OUT 00
HLT
```

Explanation:

Since carry flag is associated with accumulator only, so on incrementing B it doesn't affect carry flag.

Q.9. Write instructions to clear the CY flag, to load number FFH in register C, and to add 01 to C. if the CY flag is set, display 01 at an output port ; otherwise, display the contents of register C. Explain your results. Are they the same as in question 8?

Ans:

```
XRA A  ;Clearing CY FLAG
MVI C,FF
MOV A,C
ADI 01
JC CARRY
    MOV A,C
    OUT 00
    HLT
CARRY:
    MVI A,01
    OUT 00
    HLT
```

Explanation:

Here the carry flag is set as 01 is added to FF. No this is not same as in Q.8 because in this accumulator is itself involved affecting carry flag.

Q.10. Write instructions to load two unsigned numbers in register B and register C. Subtract C from B. If the result is in 2's complement, convert the result in absolute magnitude and display it at PORT1; otherwise, display the positive result. Execute the program with the following sets of data.

Set 1: B=42H, C=69H

Set 2: B=69H, C=42H

Set 3: B=F8H, C=23H

Ans:

```
MVI B,69
MVI C,42
MOV A,B
SUB C
JC CARRY
    OUT 10
    HLT
CARRY:
    CMA
    ADI 01
```

OUT 00

HLT

Q.11. The following block of data is stored in the memory locations from XX55H to XX5AH. Transfer the data to the locations XX80H to XX85H in reverse order (e.g. the data byte 22H should be stored at XX85H and 37H at XX80H).

Data(H): 22,A5,B2,99,7F,37

Ans: LXI B,305A

LXI D,4080

MVI L,06

HERE:

LDAX B

STAX D

DCX B

INX D

DCR L

MOV A,L

JNZ HERE

HLT

Q.12. Data bytes are stored in memory locations from XX50H to XX5FH. To insert an additional five bytes of data, it is necessary to shift the data string by five memory locations. Write a program to store the data string from XX55H to XX64H. Use any sixteen bytes of data to verify your program.

Ans: LXI B,205F

LXI D,2064

MVI L,10

HERE:

LDAX B

STAX D

DCX B

DCX D

DCR L

MOV A,L

JNZ HERE

HLT

Q.13. A system is designed to monitor the temperature of a furnace. Temperature readings are recorded in 16 bits and stored in memory locations starting at XX60H. The high-order byte is stored first and the low-order byte is stored in the next consecutive memory location. However, the high-order byte of all the temperature reading is constant.

Write a program to transfer low-order readings to consecutive memory locations starting at XX80H and discard the high-order bytes.

Ans:

```
LXI B,2060
LXI D,3080
MVI L,05
HERE:
INX B
LDAX B
STAX D
INX D
INX B
DCR L
MOV A,L
JNZ HERE
HLT
```

Q.14. A string of six data bytes is stored starting from memory location 2050H. The string includes some blanks (bytes with zero value). Write a program to eliminate the blanks from the string.

Data(H): F2, 00, 00, 4A, 98, 00

Ans:

```
MVI L,06
LXI B,2050
LXI D,2050
HERE:
    LDAX B
    ORI 00
    JZ CHECK
    LDAX B
    STAX D
    INX D
```

```
        INX B
        CHECKED:
            DCR L
            MOV A,L
    JNZ HERE
    HLT

    CHECK:
        INX B
        JMP CHECKED
```

Q.15. Write a program to add the following five data bytes stored in memory locations starting from XX60H, and display the sum. (The sum does not generate a carry. Use register pair DE as memory pointer to transfer a byte from memory into register.)

Data(H): 1A, 32, 4F, 12, 27

Ans:

```
LXI D,2060
MVI L,05
HERE:
    LDAX D
    ADD B
    MOV B,A
    DCR L
    INX D
    MOV A,L
JNZ HERE
MOV A,B
OUT 10
HLT
```

Q.16. Write a program to add the following data bytes stored in memory locations starting at XX60H and display the sum at the output port if sum does not generate carry. If result generates a carry, stop the addition, and display 01H at the output port.

Data(H): First Set: 37, A2, 14, 78, 97

Second Set: 12, 1B, 39, 42, 07

Ans:

```
LXI D,2060
MVI L,05
```

```
HERE:
    LDAX D
    ADD B
    JC CARRY
    MOV B,A
    DCR L
    INX D
    MOV A,L
JNZ HERE
MOV A,B
EXIT:
OUT 10
HLT

CARRY:
    MVI A,01
    JMP EXIT
```

Q.17. In Assignment 16, modify the program to count the number of data bytes that have been added and display the count at the second port.

Ans:

```
LXI D,2060
MVI L,05
HERE:
    INR C
    LDAX D
    ADD B
    JC CARRY
    MOV B,A
    DCR L
    INX D
    MOV A,L
JNZ HERE
MOV A,B
EXIT:
```

OUT 10

MOV A,C

OUT 20

HLT

CARRY:

MVI A,01

JMP EXIT

Q.18. The temperatures of two furnaces are being monitored by a microcomputer. A set of five readings of the first furnace, recorded by five thermal sensors, is stored at the memory location starting at XX50H. A corresponding set of five readings from the second furnace is stored at the memory location starting at XX60H. Each reading from the first set is expected to be higher than the corresponding reading from the second set. For example, the temperature reading at the location 54H (T_{54}) is expected to be higher than the temperature reading at the location 64H (T_{64}).

Write a program to check whether each reading from the first set is higher than the corresponding reading from the second set. If all readings from the first set are higher than the corresponding readings from the second set, turn on the bit D_0 of the output PORT1. If any one of the readings of the first set is lower than the corresponding reading of the second set, stop the process and output FF as an emergency signal to the output PORT1.

Data(H) First Set: 82, 89, 78, 8A, 8F
Second Set: 71, 78, 79, 82, 7F

Ans: LXI B,2050

LXI D,3060

MVI L,05

HERE:

LDAX D

MOV H,A

LDAX B

CMP H

JC CARRY

DCR L

```
        INX B
        INX D
        MOV A,L
    JNZ HERE
    MVI A,01

    EXIT:
    OUT 10
    HLT
    CARRY:
        MVI A,FF
        JMP EXIT
```

Q.19. A set of eight data byte is stored in a memory location starting from XX70H. Write a program to add two bytes at a time and store the sum in the same memory locations, low-order sum replacing byte and carry replacing second byte. If any pair does not generate a carry, the memory location of second byte should be cleared.

Data(H): F9, 38, A7, 56, 98, 52, 8F, F2

Ans:

```
    LXI B,2070
    MVI L,04
    HERE:
        LDAX B
        MOV E,A
        INX B
        LDAX B
        ADD E
        DCX B
        STAX B
        JC CARRY
        INX B
        MVI A,00
        STAX B
        EXIT:
        INX B
        DCR L
```

```
        MOV A,L
    JNZ HERE
    HLT

    CARRY:
        MVI A,01
        INX B
        STAX B
        JMP EXIT
```

Q.20. A set of eight data bytes is stored in memory locations starting from XX70H. Write a program to subtract two bytes at a time and store the result in a sequential order in a memory location starting from XX70H.

Data(H): F9, 38, A7, 56, 98, A2, F4, 67

Ans:

```
    LXI B,2070
    LXI D,2070
    MVI L,04

    HERE:
        INX B
        LDAX B
        MOV H,A
        DCX B
        LDAX B
        SUB H
        STAX D
        INX B
        INX B
        INX D
        DCR L
        MOV A,L
    JNZ HERE
    HLT
```

Q.21. A set of eight data bytes is stored in the memory location starting at XX50H. Check each data byte for bits D_7 and D_0. If D_7 or D_0 is 1, reject the data byte; otherwise, store the data bytes at memory locations starting at XX60H.

Data(H): 80, 52, E8, 78, F2, 67, 35, 62.

Ans:

```
LXI B,2050
LXI D,3060
MVI L,08

HERE:
LDAX B
ANI 81
CPI 80
JZ BREAK
CPI 81
JZ BREAK
CPI 01
JZ BREAK
LDAX B
STAX D
INX D
BREAK:
INX B
DCR L
MOV A,L
JNZ HERE
HLT
```

Q.22. A set of eight data bytes is stored in the memory location starting at XX50H. Write a program to check whether a byte 40H exists in the set. If it does, stop and display its memory location; otherwise output FFH.

Data(H): 48, 32, F2, 38, 37, 40, 82, 8A

Ans:

```
LXI B,2050
MVI D,40
MVI L,08
HERE:
    LDAX B
```

```
        CMP D
        JZ EXIT
        INX B
        DCR L
        MOV A,L
    JNZ HERE
    MVI A,FF
    OUT 30
    HLT
    EXIT:
        MOV A,B
        OUT 10
        MOV A,C
        OUT 20
     HLT
```

Q.23. Refer to Q.22., write a program to find the highest reading in the set, and display the reading at the output port.

Data(H): 48, 32, F2, 38, 37, 40, 82, 8A

Ans:

```
LXI H,2050
HERE1:
LXI B,2050
MVI E,08
HERE:
INX B
LDAX B
MOV D,A
DCX B
LDAX B
CMP D
JC EXCHANGE
INX B
DCR E
MOV A,E
```

```
JNZ HERE
MOV A,M
OUT 10
HLT

EXCHANGE:
INX B
STAX B
DCX B
MOV A,D
STAX B
JMP HERE1
```

Q.24. Refer to Q.22., write a program to find the lowest reading in the set, and display the reading at the output port.

Data(H): 48, 32, F2, 38, 37, 40, 82, 8A

Ans:

```
LXI H,2050
HERE1:
LXI B,2050
MVI E,07 ; This is one less than total size
HERE:
LDAX B
MOV D,A
INX B
LDAX B
CMP D
JC EXCHANGE
DCR E
MOV A,E
JNZ HERE
MOV A,M
OUT 10
HLT
```

```
EXCHANGE:
DCX B
STAX B
INX B
MOV A,D
STAX B
JMP HERE1
```

Q.25. A set of ten bytes is stored in memory starting with the address XX50H. Write a program to check each byte, and save the bytes that are higher than 60_{10} and lower than 100_{10} in the memory locations starting from XX60H.

Data(H): 6F, 28, 5A, 49, C7, 3F, 37, 4B, 78, 64

Ans:

```
LXI B,2050
LXI D,3060
MVI L,0A
HERE1:
LDAX B
CPI 3C
JNC HERE2
HERE4:
INX B
DCR L
MOV A,L
JNZ HERE1
HLT

HERE2:
CPI 64
JNC HERE4
JC HERE3:
STAX D
INX D
JMP HERE4
```

Q.26. A string of readings is store in memory locations starting at XX70H, and the end of the string is indicated by 0DH. Write a program to check each byte in the string, and save the byte in the range of 30H to 39H (both inclusive) in memory locations starting from XX90H.

Data(H): 35, 2F, 30, 39, 3A, 37, 7F, 31, 0D, 32

Ans:

```
LXI B,2070
LXI D,3090
HERE1:
LDAX B
CPI 30
JZ HERE2
JNC HERE2
HERE4:
INX B
LDAX B
CPI 0D
JNZ HERE1
HLT

HERE2:
CPI 39
JZ HERE3
JC HERE3
JNC HERE4
HERE3:
STAX D
INX D
JMP HERE4
```

Q.27. In assignment Q.26., display the number of bytes accepted from the string between 30H and 39H.

Ans:

```
LXI B,2070
MVI D,00
HERE1:
LDAX B
CPI 30
JZ HERE2
```

```
JNC HERE2
HERE4:
INX B
LDAX B
CPI 0D
JNZ HERE1
MOV A,D
OUT 10
HLT
HERE2:
CPI 39
JZ HERE3
JC HERE3
JNC HERE4
HERE3:
INR D
JMP HERE4
```

Q.28. A bar code scanner scans the boxes being shipped from the loading dock and record all the codes in computer memory; the end of the data is indicated by the byte 00. The code 1010 0011(A3H) is assigned to 19" television sets. Write a program to count the number of 19" television sets that were shipped from the following data set.

Data(H): FA, 67, A3, B8, A3, A3, FA, 00.

Ans:

```
LXI B,2070
MVI D,00
HERE1:
LDAX B
CPI A3
JZ HERE2
HERE3:
INX B
LDAX B
ADI 01  ;To compare, 00 didn't work so
CPI 01
JNZ HERE1
```

```
MOV A,D
OUT 10
HLT
HERE2:
INR D
JMP HERE3
```

Q.29. Sort the following set of marks scored by ten students in circuit course in descending order.

Data(H): 63, 41, 56, 62, 48, 5A, 4F, 4C, 56, 56.

Ans:

```
HERE1:
LXI B,2050
MVI E,0A
HERE:
INX B
LDAX B
MOV D,A
DCX B
LDAX B
CMP D
JC EXCHANGE
INX B
DCR E
MOV A,E
JNZ HERE
HLT
EXCHANGE:
INX B
STAX B
DCX B
MOV A,D
STAX B
JMP HERE1
```

Q.30. Calculate the delay in the following loop, assuming the system clock period is 0.33 µs:

Label	Mnemonics	8085 T-States
	LXI B,12FFH	10
DELAY:	DCX B	6
	XTHL	16
	XTHL	16
	NOP	4
	NOP	4
	MOV A,C	4
	ORA B	4
	JNZ DELAY	10/7

Ans:

T-States Consumed by DELAY loop = (6+16+16+4+4+4+4+10)

= 64

Total T-States Consumed by DELAY loop = 64 x 4863

= 311232

At last JNZ only takes 7 T-States, So total T-States = 311232 – 3

= 311229

Also, LXI is above the loop, So total T-States = 311229 + 10

= 311239

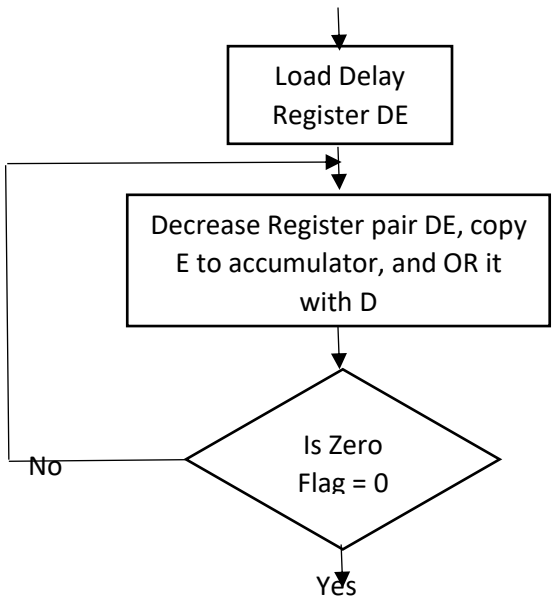
∴ Total delay produced = 359859 x 0.33 µs

= 102708.87 µs

Q.31. Write a program to count from 0 to 20H with delay of 100 ms between each count. After the count 20H the counter should reset itself and repeat the sequence. Use register pair DE as a delay register. Draw a flowchart and show you calculations to setup the 100 ms delay.

Ans:

Flowchart:



Delay Calculation:

(31)

In given program: from label HERE:

$100 \times 10^{-3} = (10 + (6 + 4 + 4 + 10)x - 3 + 4) \times 0.33 \times 10^{-6}$

(LXI → 10, DCX → 6, MOV → 4, ORA → 4, JNZ → 10, INR → 4)

or, $303030.30 = 11 + 24x$

$\therefore x = 12626 = 3152H$

∴ The content of ~~Register~~ register pair DE should be 3152H.

Register C acts as counter in this program.

Program:

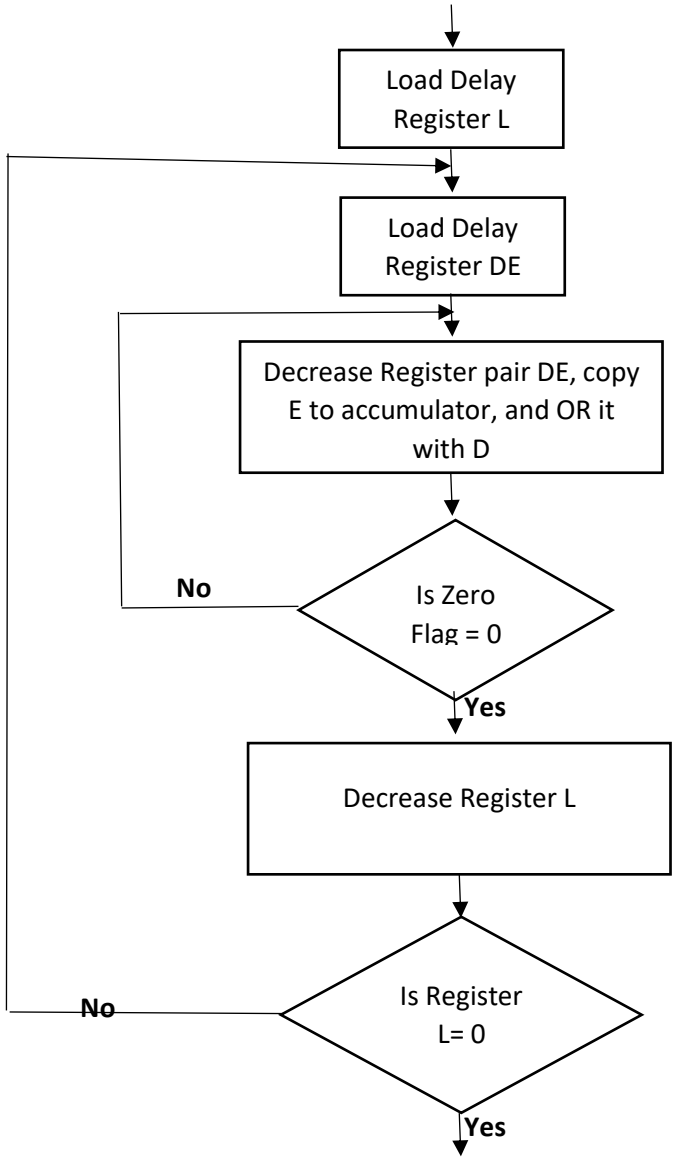
```
START:
MVI B,21 ; This should be 1 greater
HERE:
LXI D,3152 ;This is to delay
DELAY:
DCX D
MOV A,E
```

```
ORA D
JNZ DELAY
INR C
DCR B
JNZ HERE
MVI C,00
JMP START
HLT
```

Q.32. Design an up-down counter to count from 0 to 9 and 9 to 0 continuously with a 1.5 sec delay between each count, and display the count at one of the output ports. Draw a flowchart and show the delay calculations.

Ans:

Flowchart:



Delay Calculation:

(52)

Total delay produced by loop DELAY2:

$$= @\left[(6 + 4 + 4 + 10) \times 65535 - 3\right] \times 0.33 \times 10^{-6}$$

(DCX → MOV → ORA → JNZ → FFFF)

$$= 0.5190 \text{ sec}$$

Now, in given program, from CALL instruction to RET instruction.

$$1.5 = \left(18 + 4 + 4 + 10 + 7 + 10 - 3\right) \times 0.33 \times 10^{-6} + \left[\left(10 + 4 + 10\right) \times @0.33 \times 10^{-6} + 0.5190\right] x$$

(CALL → INR → MOV → OUT → MVI → RET; LXI → DCR → JNZ)

$$\text{or, } 1.499 = 0.51900792x$$

$$\therefore x = 2.88 \text{ ys} = 03H$$

∴ The content of Register L is 03

Program:

```
START:
MVI B,09
HERE1:
CALL DELAY
```

```
INR C
MOV A,C
OUT 10
DCR B
JNZ HERE1
MVI B,09
HERE2:
CALL DELAY
DCR C
MOV A,C
OUT 10
DCR B
JNZ HERE2
JMP START
HLT

DELAY:
MVI L,03  ;This is to delay1
DELAY1:
LXI D,FFFF ;This is to delay2
DELAY2:
DCX D
MOV A,E
ORA D
JNZ DELAY2
DCR L
JNZ DELAY1
RET
```

Q.33. Write a program to turn a light on and off every 5 seconds. Use bit D_7 to operate the light.

Ans:

Delay Calculation:

(33)

Total delay produced by loop DELAY2:

$$= \left[(6 + 4 + 4 + 10) \times 65535 - 3\right] \times 0.33 \times 10^{-6}$$

$$= 0.5190 \text{ sec}$$

Now, in given program, from CALL instruction to RET instruction,

(CALL → 18, MVI → 7, OUT → 10, MVI → 7, RET → 10)

$$5 \text{ sec} = (18 + 7 + 10 + 7 + 10 - 3) \times 0.33 \times 10^{-6} + \left[(10 + 4 + 10) \times 0.33 \times 10^{-6} + 0.5190\right] x$$

(DCX → 10, DCR → 4, JNZ → 10)

or, $4.99998 = 0.51900792x$

$\therefore x = 9.633 \approx 10 = 0A$

∴ The content of of L Register is 0A

Program:

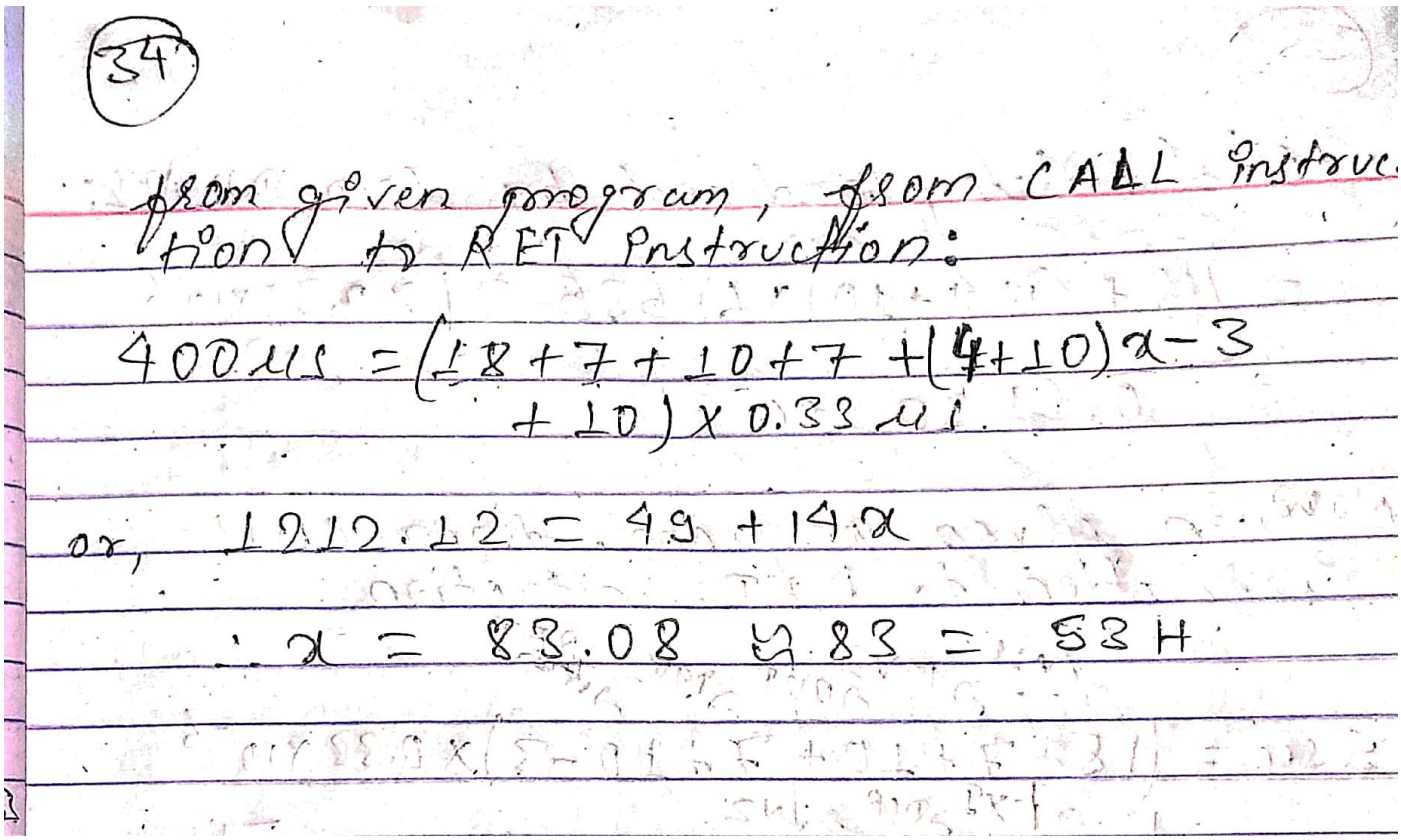
```
HERE:
CALL DELAY
MVI A,00
OUT 10
CALL DELAY
MVI A,80
OUT 10
JMP HERE
HLT

DELAY:
MVI L,0A  ;This is to delay1
DELAY1:
LXI D,FFFF ;This is to delay2
DELAY2:
DCX D
MOV A,E
ORA D
JNZ DELAY2
DCR L
JNZ DELAY1
RET
```

Q.34. Write a program to generate a square wave with period of 400 μs. Use D_0 to output the square wave.

Ans:

Delay Calculation:



Program:

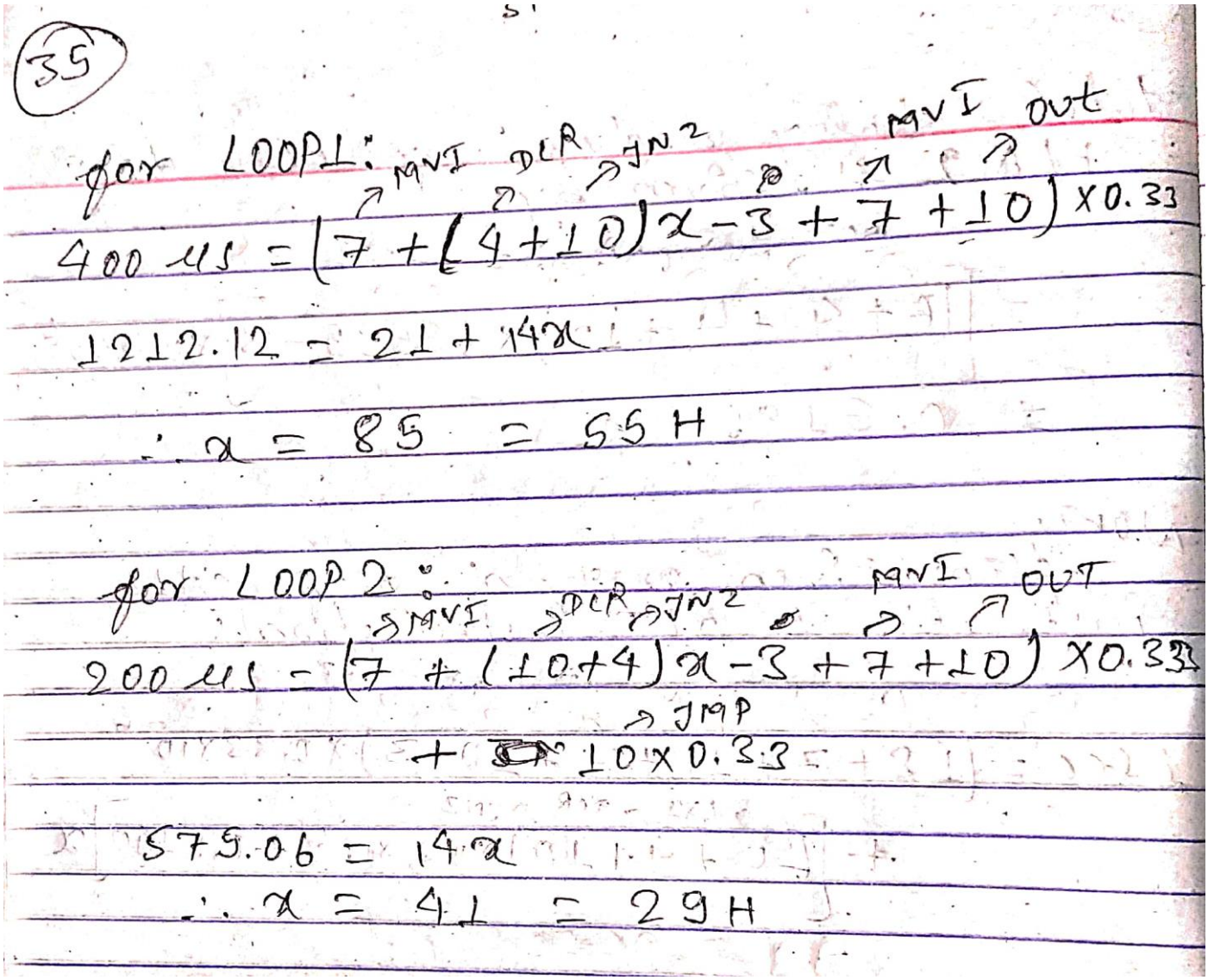
```
HERE:
CALL DELAY
MVI A,00
OUT 10
CALL DELAY
MVI A,01
OUT 10
JMP HERE

DELAY:
MVI B,53
LOOP:
DCR B
JNZ LOOP
RET
```

Q.35. Write a program to generate a rectangular wave with period of 200 µs on-period and a 400 µs off-period.

Ans:

Delay Calculation:



Program:

```
HERE:
MVI A,00
OUT 10
MVI B,55
LOOP1:
DCR B
JNZ LOOP1
MVI A,01
OUT 10
MVI B,29
```

```
LOOP2:
DCR B
JNZ LOOP2
JMP HERE
```

Q.36. A railway crossing signal has two flashing lights run by a microprocessor. One light is connected to data bit D_7 and the second light is connected to data bit D_6. Write a program to turn each signal light alternately on and off at an interval of 1 sec.

Ans:

Delay Calculation:

(36)

total delay provided by loop DELAY2 is given by:

$$= \left[(6 + 4 + 4 + 10) \times 65535 - 3\right] \times 0.33 \times 10^{-6}$$

(DCX, MOV, ORA, JNZ, FFFF)

$$= 0.5190 \text{ sec}$$

Now,

from given program, from CALL instruction to RET instruction:

(CALL, MVI, OUT, MVI, RET, JNZ)

$$1 \text{ sec} = \left(18 + 7 + 10 + 7 + 10 - 3\right) \times 0.33 \times 10^{-6}$$

$$+ \left[(10 + 4 + 10) \times 0.33 \times 10^{-6} + 0.5190\right] x$$

(LXI, DCR, JNZ)

$$0.99998 = 0.51900792x$$

$$\therefore x = 1.926 \approx 2 = 02\text{H}$$

∴ The content of register L is 02.

Program:

```
HERE:
CALL DELAY
MVI A,80
OUT 10
CALL DELAY
MVI A,40
OUT 10
JMP HERE

DELAY:
MVI L,02  ;This is to delay1
DELAY1:
LXI D,FFFF;This is to delay2
DELAY2:
DCX D
MOV A,E
ORA D
JNZ DELAY2
DCR L
JNZ DELAY1
RET
```