Marwadi University Marwadi Chandarana Group NAAC A+	**Marwadi University** **Department of Computer Engineering**	
Subject: Fundamental of Processors (01CE0509)	**Aim:To perform arithmetic operation in 8086.**	
Experiment No: 04	**Date:**	**Enrolment No:92201703058**

Aim: To perform arithmetic operation in 8086

Apparatus : Computer System.

Theory: Arithmetic Instructions are the instructions which perform basic arithmetic operations such as addition, subtraction, multiplication and division.8086 microprocessor supports following types of addition instructions.

8086 Integer Arithmetic Instructions

1. ADD – Used to add the provided byte to byte/word to word
2. ADC – Used to add with carry.
3. INC – Used to increment the provided byte/word by 1.
4. AAA – Used to adjust ASCII after addition.
5. DAA – Used to adjust the decimal after the addition/subtraction operation.

8086 ADD Instruction

These instructions add a number from source to a number from destination and put the result in the destination. For addition both operands should be of same type of word or byte to avoid the assembly error. If you want to add a byte to a word, you must copy the byte to a word location and fill the upper byte of the word with zeroes before adding

The ADD instruction can affect AF, CF, OF, PF, SF, ZF flags depending upon the result. If the result is zero, the ZF=1. Negative result sets SF to 1.

Example-Assembly Language Program

```
ADD AL, 7AH ; adds 7AH to AL register
ADD DX, AX ; adds AX to DX register
ADD AX, [BX] ; adds [BX] to AX register
```

8086 ADC Instruction

This instruction performs the same operation as ADD instruction but also adds the status of carry flag into the result. The source may be an immediate number, a register, or a memory location.

Example-Assembly Language Program

```
ADC AL, 7AH; adds with carry 7AH to AL register
ADC DX, AX ; adds with carry AX to DX register
ADC AX, [BX] ; adds with carry [BX] to AX register
```

INC Instruction

It is an increment instruction which takes only one operand. The INC instruction adds 1 to the contents of destination operand. It can affect AF, OF, PF, SF and ZF flags.

Example-Assembly Language Program

```
INC AX ; adds 1 to AX register
INC DX ; adds 1 to DX register
```

8086 AAA (Adjust after addition) Instruction

The numbers from 0-9 are represented as 30H-39H in ASCII code. When you want to add two decimal digits which are represented in ASCII code, it is necessary to mask upper nibble (3) from the code before addition. The Arithmetic Instructions in 8086 allows you to add the ASCII codes for two decimal digits without masking off the "3" in the upper nibble of each digit. The AAA instruction can be used after addition to get the current result in unpacked BCD form.

It checks the AL register and then take following actions:

1. If lower nibble of AL is between 0 to 9:

- AF =0 and CF= 0
- Four higher order bits of AL sets to 0
- AH is cleared to 0

2. If lower nibble of AL is greater than 9:

- AF=1, CF=1
- Add 6 to AL
- Clears four higher order bits of AL
- Add 1 to contents of AH

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Example-Assembly Language Program

```
MOV AX, 31H ; AX = 0031H
ADD AL, 39H ; AX = 006AH
AAA ; AX = 0100H
ADD AX, 3030H ; AX = 3130 which is the ASCII for 10H
```

DAA (Decimal Adjust Accumulator) Instruction

This instruction is used to convert the result of the addition of two packed BCD numbers to a valid BCD number. The result has to be only in AL. This instruction does not need any operand. This instruction is used to convert the sum of two packed BCD numbers into a valid BCD number.

Instruction works as follows :

1. If the value of the low-order four bits (D_3-D_0) in the AL is greater than 9 or if AF is set, the instruction adds 6 (06) to the low-order four bits.
2. If the value of the high-order four bits (D_7-D_4) in the AL is greater than 9 or if carry flag is set, the instruction adds 6 (60) to the high-order four bits.

It checks the AL data and performs the following operations:

1. If lower nibble of AL > 9 or AF=1 then:

- Add 6 to lower byte of AL
- Set AF=1

2. If AL> 9Fh or CF = 1 then:

- Add 60h to AL
- Set CF = 1

Example- Assembly Language Program

```
MOV AL, 71H ; load 71 into AL
ADD AL, 43H ; AL 71H+43H =B4H
DAA ; AL = 14 H and CF = 1
```

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8086 Integer Subtraction Instructions

8086 microprocessor supports the following subtraction Instructions:

1. SUB – Used to subtract the byte from byte/word from word.
2. SBB – Used to perform subtraction with borrow
3. DEC – Decrement destination
4. AAS – ASCII Adjust after subtraction.
5. DAS – Decimal Adjust After Subtraction

SUB/SBB Instruction :

These instructions subtract the number in the source from the number in the desfinafion and put result in the desfinafion. The SBB, instruction also subtracts the status of carry flag from the result. The source may be an immediate number, a register, or a memory location. The destination maybe a register or a memory location. The source and the desfinafion both cannot be memory locafions. The source and destination both mustbeword or byte. If you want to subtract a byte from a word, you must copy the byte to a word location and fill the upper byte of the word with zeroes before subtracting.

Flags affected : AF, CF, OF, PF,SF,andZE.

Example- Assembly Language Program

```
SUB AL, 74H ; sub 74H from AL register
SUB DX, AX ; sub AX from DX register
SUB AX, [BX] ; sub [BX] from AX register
```

Example- Assembly Language Program

```
SBB AL, 74H ; sub with borrow 74H from AL register
SBB DX, AX ; sub with borrow AX from DX register
SBB AX, [BX] ; sub with borrow [BX] from AX register
```

DEC Instruction

The decrement instruction subtracts 1 from the contents of the specified register or memory location. The DEC instruction subtracts 1 from the destination operand and loads the result back into the same destination.

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Example-Assembly Language Program

```
MOV AX, 15h ; set AX with 15

DEC AX ;AX=AX-1
```

8086 AAS Instruction

The numbers from 0-9 are represented as 30-39 in ASCII code. When you want to subtract two decimal digits which are represented in ASCII code, it is necessary to mask upper nibble (3) from the code before subtraction. The Arithmetic Instructions in 8086 allows you to subtract the ASCII codes for two decimal digits without masking off the "3" in the upper nibble of each digit. The AAS instruction can be .used after subtraction to get the current result in unpacked BCD form.

The AAS instruction checks the content of AL register and perform following operation:

If D_3-D_0 > 9 or AF = 1 then

- subtract 6 from AL and 01 from AH
- flags AF and CF are set to 1
- clear the high-order four bits of AL.

If D_3-D_0 < 9 then:

- set AF and CF to 0
- clear the high-order four bits of AL.

Example-Assembly Language Program

```
MOV AH, 00 ; AH = 00H
MOV AL,'8' ; AX = 0038H
SUB AL, '9' ; AX = 00FFH
AAS ; AX=FF09H
OR AX, 30H ; AX = FF39
```

8086 DAS Instruction

This is same as AAS. But it is used to convert the difference of two packed BCD numbers into a packed BCD result. The instruction operates on AL content and it does not require any operand.

The DAS instruction checks the low and high our order bits of the AL register and perform the following operation:

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- If D_3-D_0 > 9 then set AF flag to 1 and subtract 6 from these four bits.
- If D_7-D_4 > 9 then set CF flag to 1 and subtracts 6 from these four bits.
- If both D_3-D_0 and D_7-D_4 are greater than 9 then subtract 6 from both bytes and set AF=1, CF=1.

Example-Assembly Language Program

```
MOV AL, 71H ; load 71 into AL
SUB AL, 43H ; AL 71H-43H =2EH
DAS ; AL = 28 H
```

Program: Write a program to ADD to numbers of 16 bit data.

Algorithm

1. Load the first data in AX register
2. Load the second data in BX register
3. Clear CL register
4. Add the two data and get the sum in AX register
5. Store the sum in memory
6. Check for Carry. If Carry flag is set than go to next step, otherwise go to step 8.
7. Increment CL register
8. Store the Carry in Memory
9. Stop

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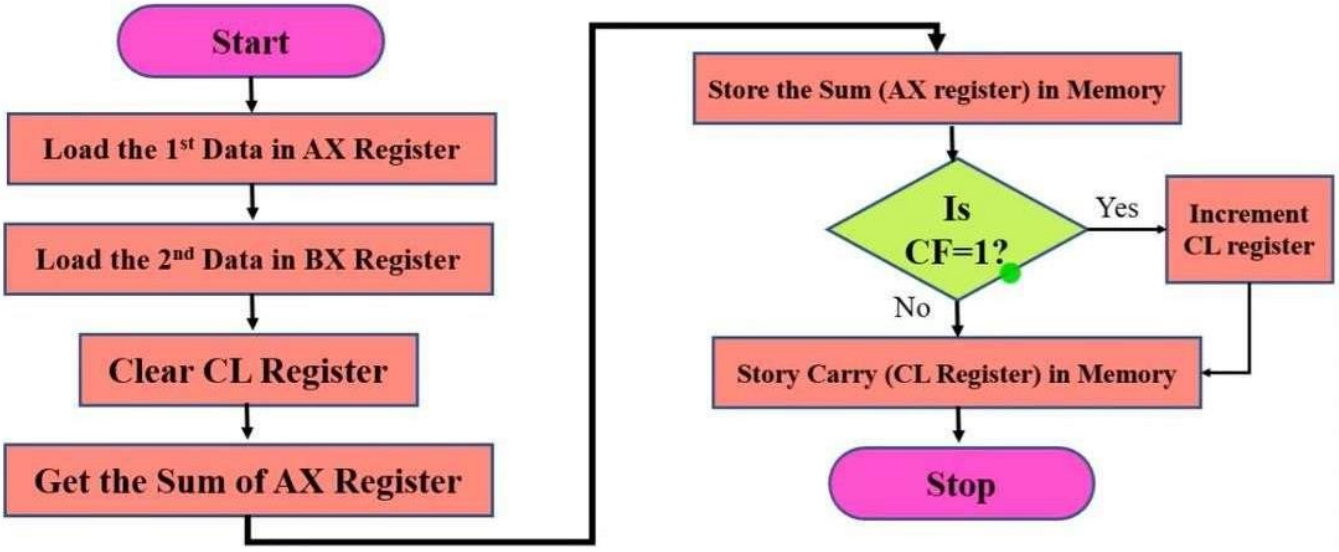
Flow Chart



Example 1

AX	2316
BX	3243
Sum	5559

INPUT	
Memory Address	Content
1000	16
1001	23
1002	43
1003	32

AH	23	AL	16
BH	32	BL	43
CH		CL	00
DH		DL	

AH	55	AL	59
BH	32	BL	43
CH		CL	
DH		DL	

CF	0

OUTPUT	
Memory Address	Content
1004	59
1005	55
1006	00

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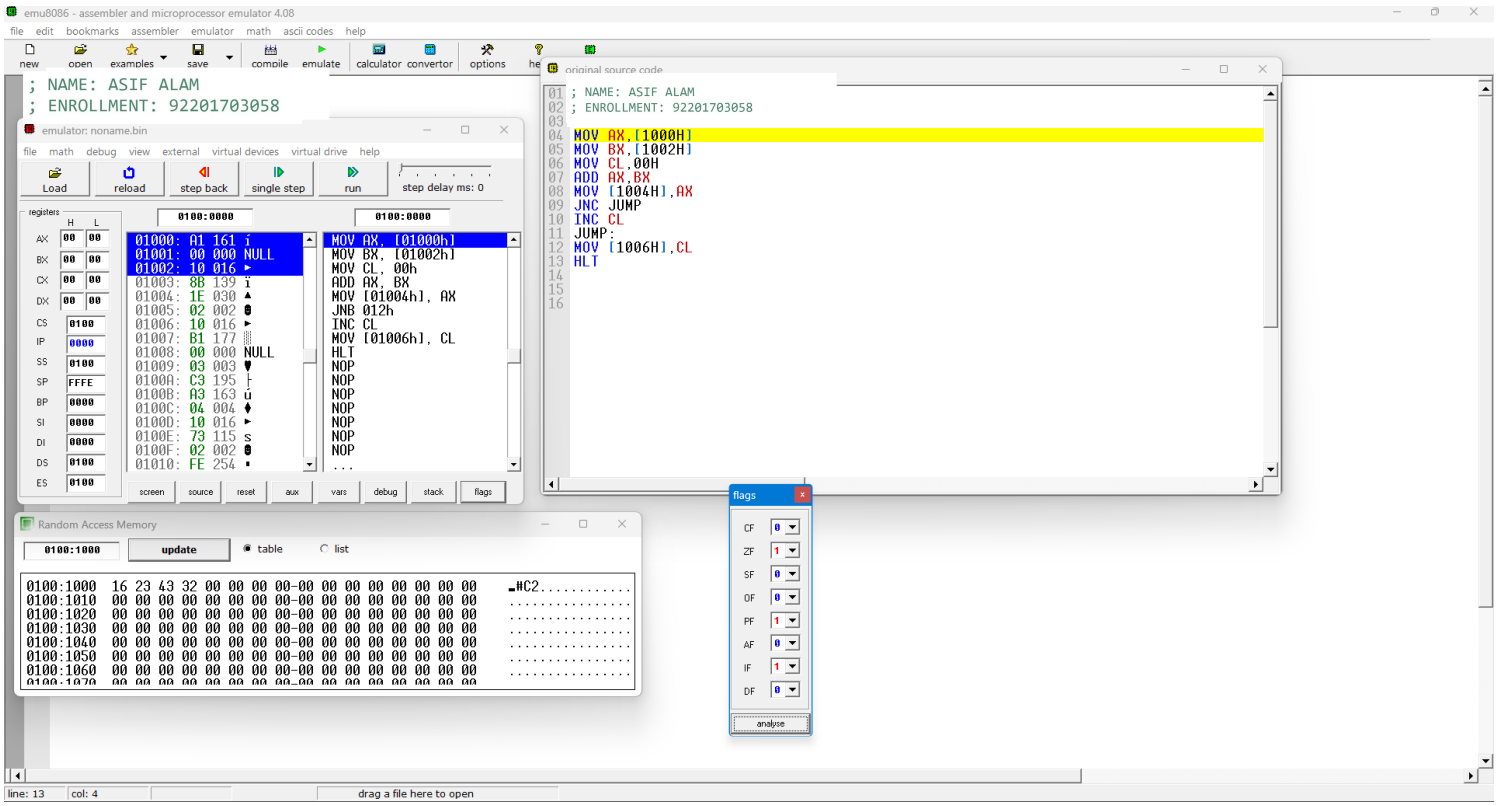
Program:

Check and provide the data on memory :



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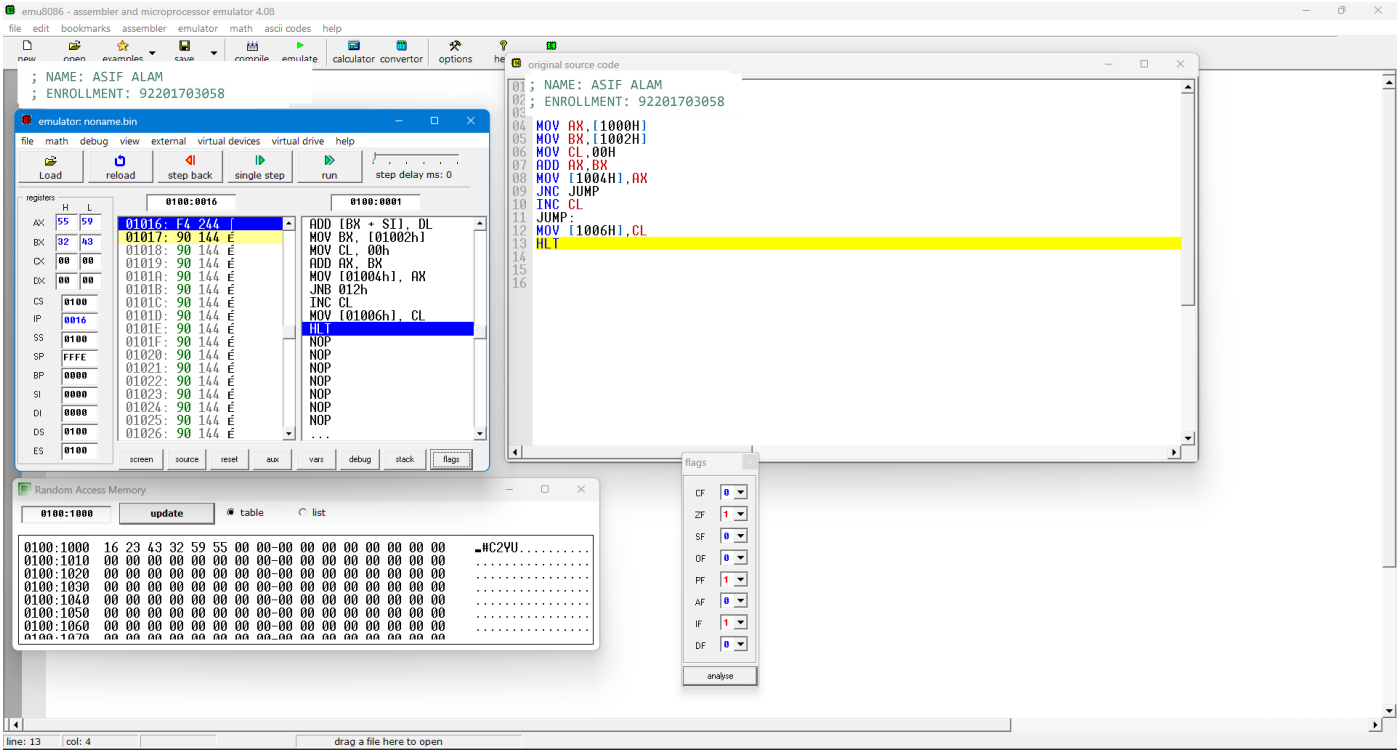
Execute the program and check the output in memory and flag.



Program: Write a program to subtraction two numbers of 16 bit data.

Code:

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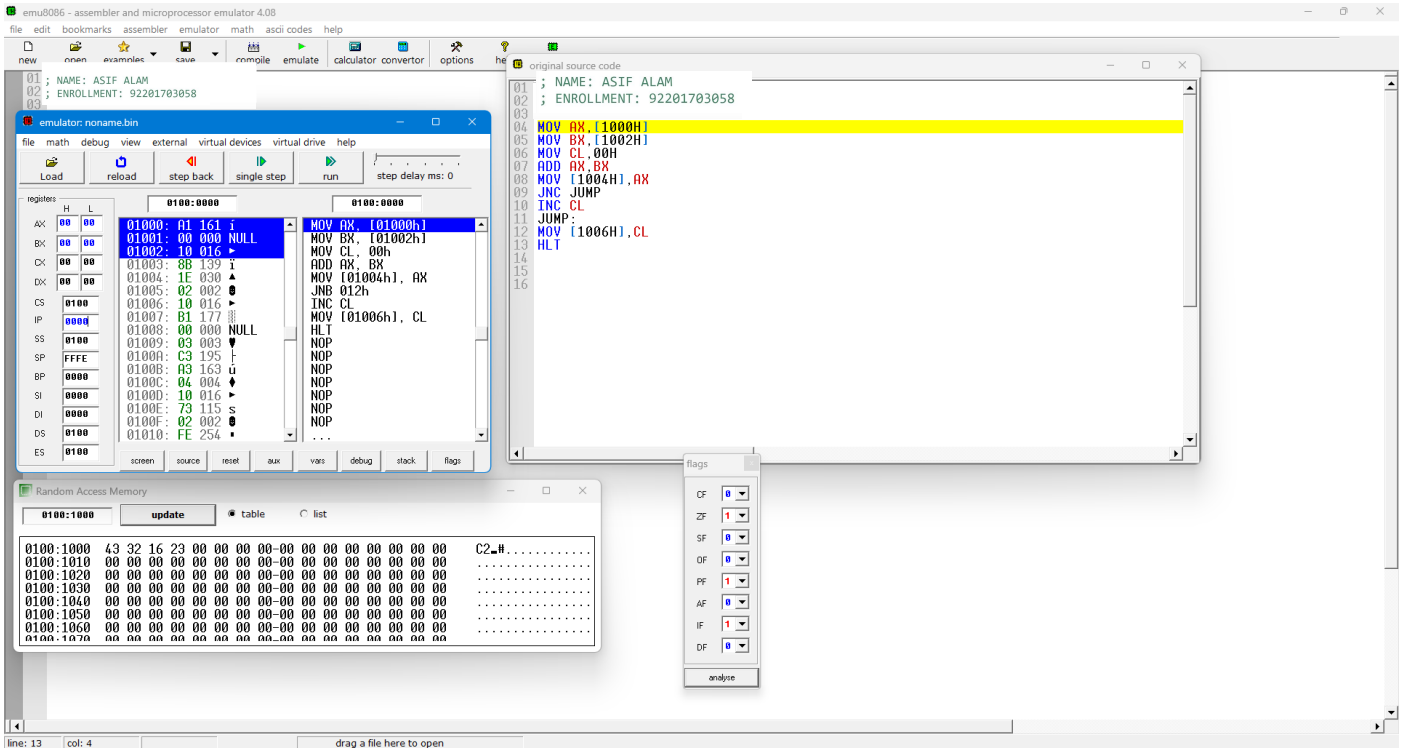
Check and provide the data on memory :



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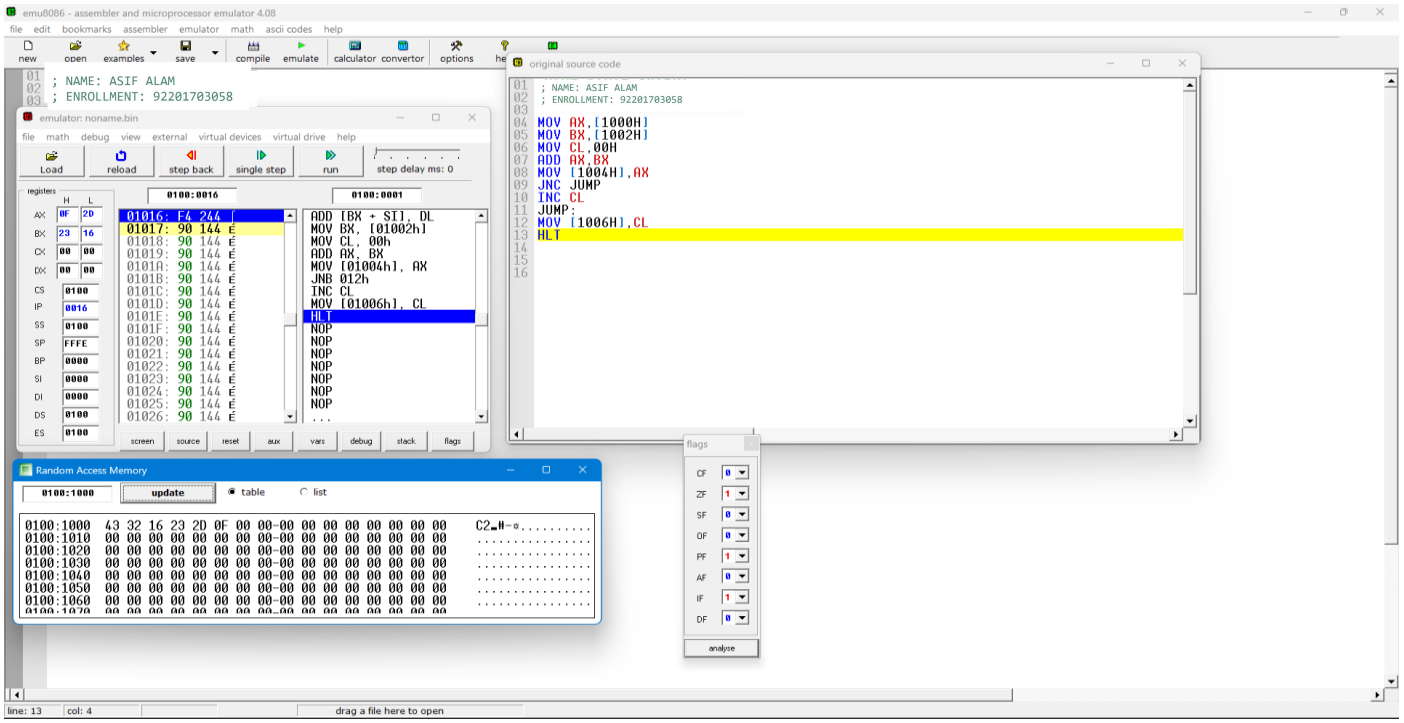

Conclusion: