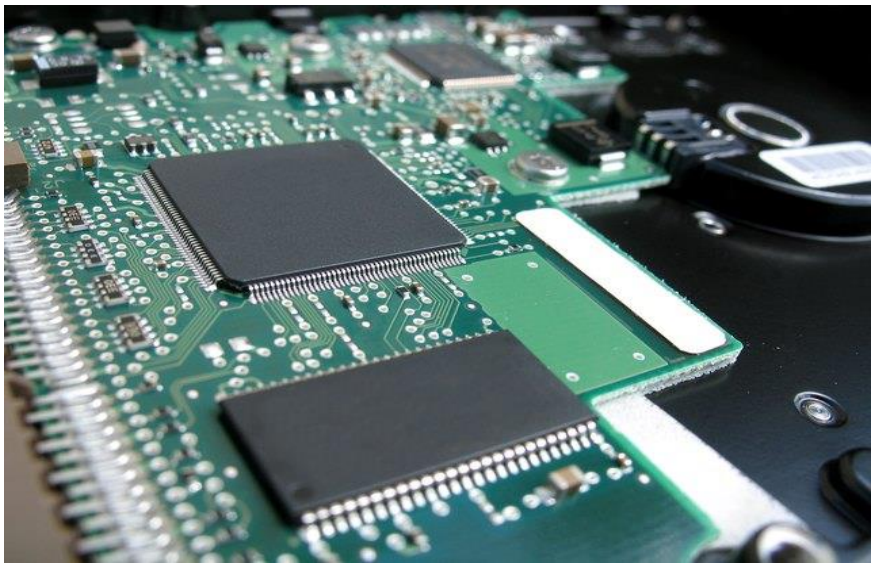
جامعة الحمدانية
كلية التربية

Lecture 13

Microprocessors



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Arithmetic Instructions

The 8086 can perform arithmetic operations on binary numbers (signed or unsigned) and on decimal. The arithmetic instructions in 8086 include addition, subtraction, multiplication, division.

1. Addition
2. Subtraction
3. Multiplication
4. Division

- **Addition Instructions**

The addition instructions include: ADD, ADC and INC.

1. ADD (Addition)

In this operation we can add 8- or 16-bit operands. ADD source with destination operand and puts the result in the destination.

destination = destination + source

The syntax: ADD destination, Source

- ❖ It adds a byte to byte or a word to word.
- ❖ It effects AF, CF, OF, PF, SF, ZF flags.

Example:

ADD AL, 07AH ; AL=AL+ 07AH

ADD DX, AX; DX=AX+DX

ADD AX, [BX] ; AX=AX+ [BX]

الحالات المسموح بها:

ADD reg. , reg.

ADD reg. , value

ADD reg. , mem.

ADD mem. , reg.

ADD mem. , value

Examples:

- ADD AX, BX

  adds the 16-bit contents of AX and CX and returns the result in AX.
- ADD CX, 3476H
- ADD AL, [BX]
- ADD [SI], CL
- ADD [1000H], 40H

الحالات الغير مسموح بها:

ADD value, reg.

ADD mem. , mem.

ADD segment reg. , reg.

ADD reg. , segment reg.

Examples:

- ADD [DI], [BX] False (لايجوز جمع ذاكرة مع ذاكرة مباشرة)

  التصحيح: MOV AL, [BX]

  ADD [DI], AL

- ADD 30H, CX False (لايجوز جمع رقم في الهدف مع سجل)

  التصحيح: ADD CX, 30H

- ADD DX, BL False (لايجوز جمع سجل 16 بت مع سجل 8 بت)

  التصحيح: ADD DX, BX

❖ Types of Addition operations:

a. <u>Register with register Addition</u>

❖ Add the content of several registers.

❖ When arithmetic instructions executed, contents of the flag register change.

❖ Interrupt, trap, and other flags do not change.

❖ Any ADD instruction modifies the contents of the sign, zero, carry, auxiliary carry, parity, and overflow flags.

❖ **Examples:**

ADD AL, BL ; AL=AL+BL

ADD CX, DI ; CX=CX+DI

b. Immediate Addition

❖ Immediate addition is employed whenever constant or known data are added.

Examples:

ADD CL,44H; CL=CL+44H

ADD BX, 245FH; BX=BX+245FH

Q1) What's contain of DL after execute this program?

MOV DL, 12H

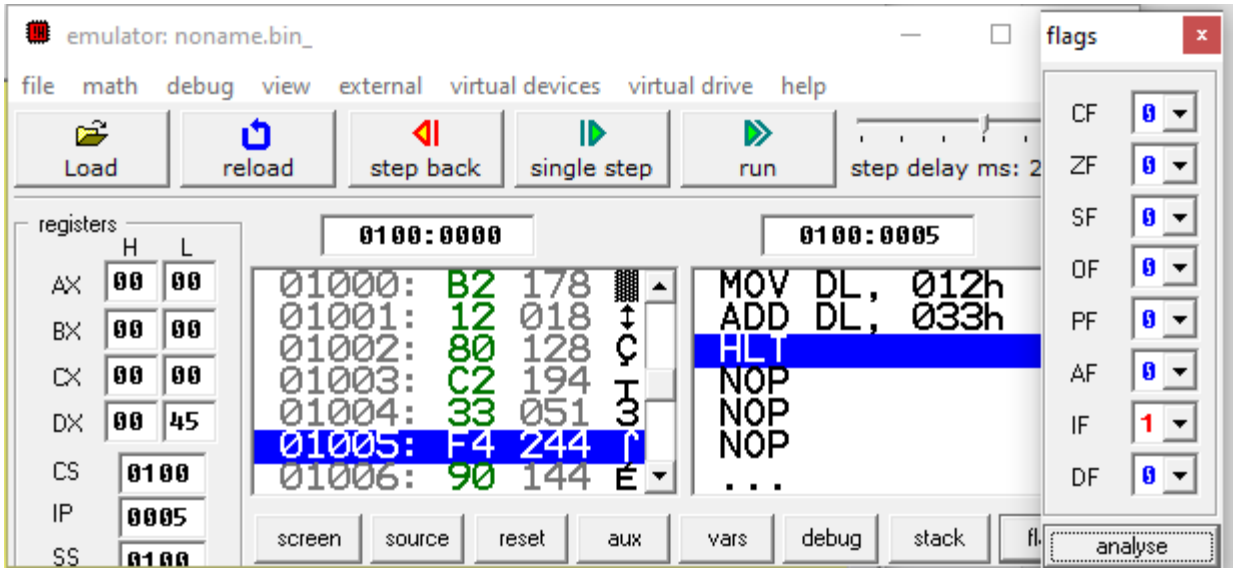
ADD DL, 33H

HLT

Answer)

DL= 45H

لاحظ التنفيذ بأستخدام الـ emulator 8086 وان الـ flag register لم تتأثر بعملية الجمع.



C. Memory with Register Addition

❖ Moves memory data to be added to a register or add register to memory.

Examples:

- ADD CL, [BP] ;(The byte contents of the stack segment memory location addressed by BP add to CL with the sum stored in CL).

- ADD [BX], AL ; (AL adds to the byte contents of the data segment memory location addressed by BX with the sum stored in the same memory location).

Example) what's the result for these instructions after execution it?

MOV AX, 00F5H

ADD AX, 000BH

HLT

Solution)

0000 0000 1111 0101

0000 0000 0000 1011 +

0000 0001 0000 0000

AX= 0100H

2. ADC(Addition-with-Carry)

ويقصد به جمع مع حمل ويشابه ايعازADD في جميع الخصائص باستثناء انه يجمع قيمة Flag(CF) مع الرقم Carry.

destination = destination + source + carry

The syntax: ADC destination, Source

❖ It adds the two operands with CF.

❖ It effects AF, CF, OF, PF, SF, ZF flags.

Examples:

- ADC AL, AH; AL=AL+AH+CF
- ADC CX, BX ; CX=CX+BX+CF

Example(1) What's contain of AH after execute this program?

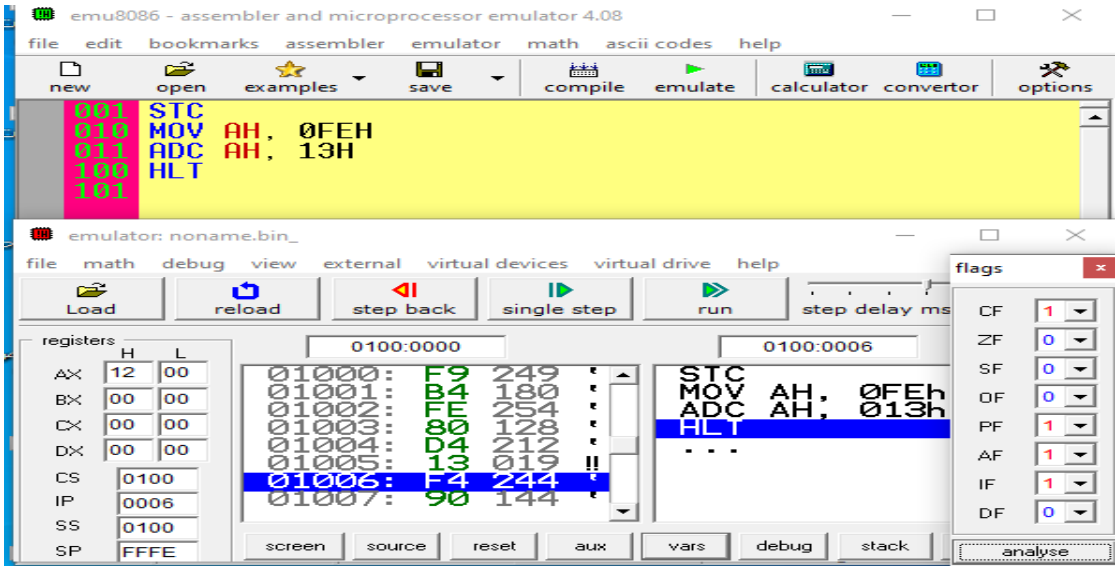
```
STC
MOV AH, 0FEH
ADC AH, 13H
HLT
```

Answer)

```
   1111 1110
   0001 0011
   0000 0001   +
  ------------
   0001 0010
```

AH= 12H

لاحظ الناتج بأستخدام برنامج emulator 8086 :



Example(2) what's contain of [SI] and [SI+1] after execution this program?

STC

MOV SI, 200H

MOV [SI], 034DH

ADC [SI], 23H

HLT

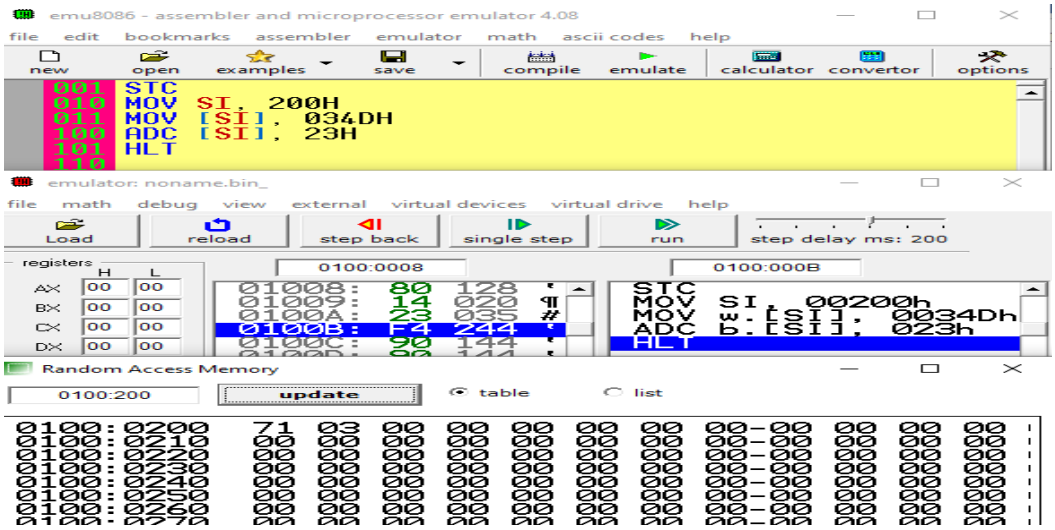
SOL.) 0000 0011 0100 1101

0000 0000 0010 0011

0000 0000 0000 0001 +

[SI]= 71H 0000 0011 0111 0001

[SI+1]= 03



Example3) Write a program in assembly language to add contains in three memory locations started with address 200H, then put result in DX. Using indirect addressing mod.

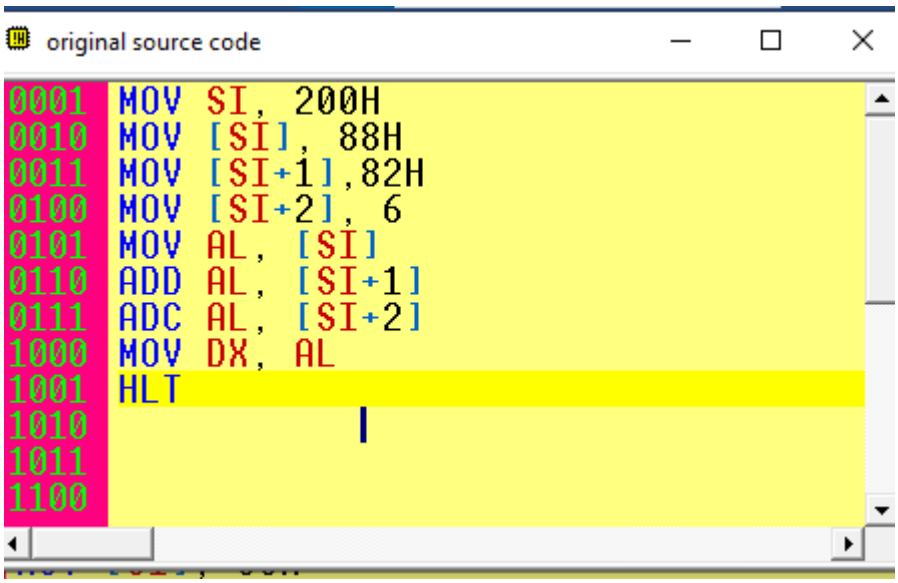
Solution)

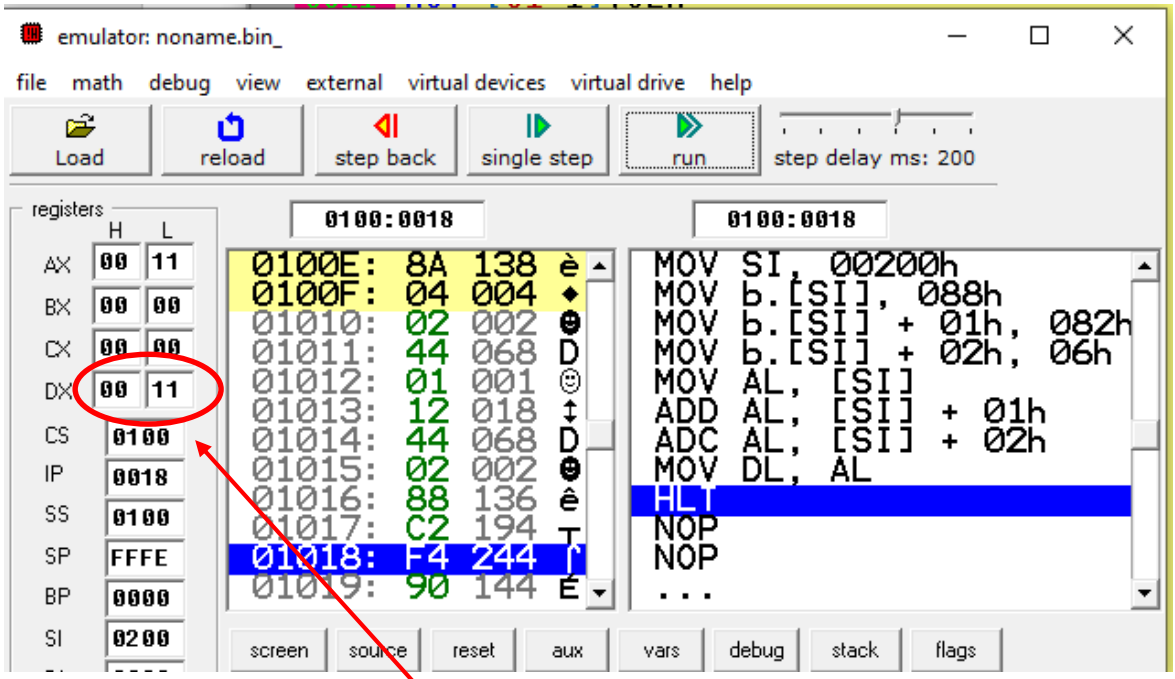
```
CLC
MOV SI, 200H
MOV [SI], 88H
MOV [SI+1], 82H
MOV [SI+2], 6
MOV AL, [SI]
ADD AL, [SI+1]
ADC AL, [SI+2]
MOV DX, AL
HLT
```

200	88h
	82h
	6
	78H
	55H
	45H

Answer) DX=0011H

لاحظ التنفيذ بأستخدام emulator 8086 :





DX= 0011H

3) INC (Increment)

The INC instruction adds 1 to a register or memory operand but, unlike ADD, does not affect the Carry Flag (CF).

ان ايعاز INC يضيف واحد الى محتوى مسجل او موقع الذاكرة ولكنها ليست مثل ايعاز ADD فانها لايؤثر علىCF .

The syntax: INC Source

Types of INC instruction:

a) INC with register (16 bit or 8 bit)

Examples:

- INC BL ; BL=BL+1
- INC SP ; SP=SP+1

b) INC with Memory

Examples:

- INC [SI] ; Increment a byte in memory(زيادة محتوى الذاكرة بمقدار واحد)
- INC [BP]

ملاحظة: لايمكن استخدام البيانات بصورة مباشرة داخل المصدر (Source) في ايعاز الـ INC .

- INC 23H الايعاز خطأ(false)

  التصحيح: MOV CL, 23H

  INC CL

ملاحظة: لايمكن استخدام مقاطع الذاكرة memory segmentations مع الايعاز INC .

Q1) What's contain of DI & [DI] after execute this program?

MOV DI, 600H

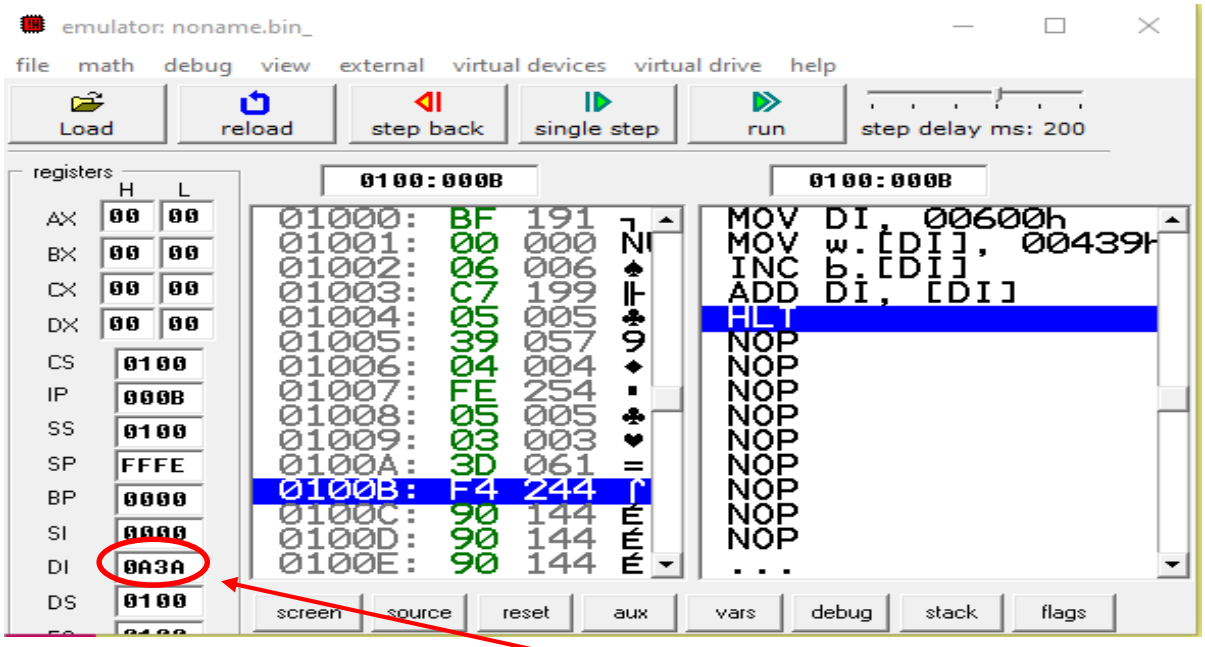
MOV [DI], 439H

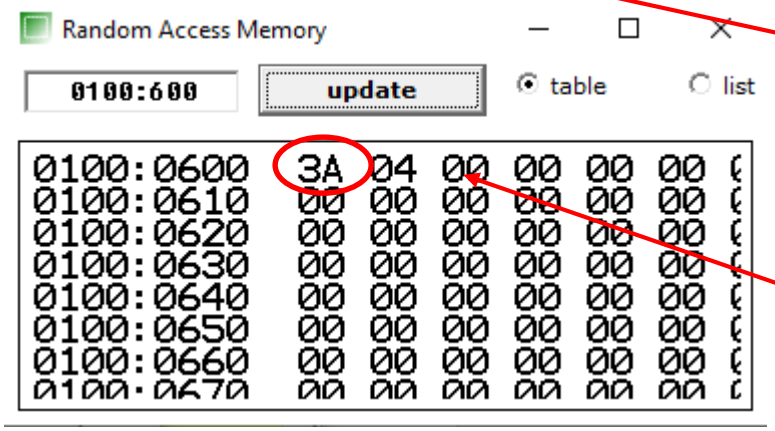
INC [DI]

ADD DI, [DI]

HLT

Answer) DI= A3AH, [DI]= 03AH





DI= 0A3A

[DI]= 3AH