National University of Computer and Emerging Sciences

Laboratory Manual

for

Computer Organization and Assembly Language Programming

(EL 213)

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Section	H
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Objectives

After performing this lab, students shall be able to:

- ✔ Learn different data types.
- ✔ Differentiate between code data segment.
- ✔ Declare and use variables in assembly language.

Data Types

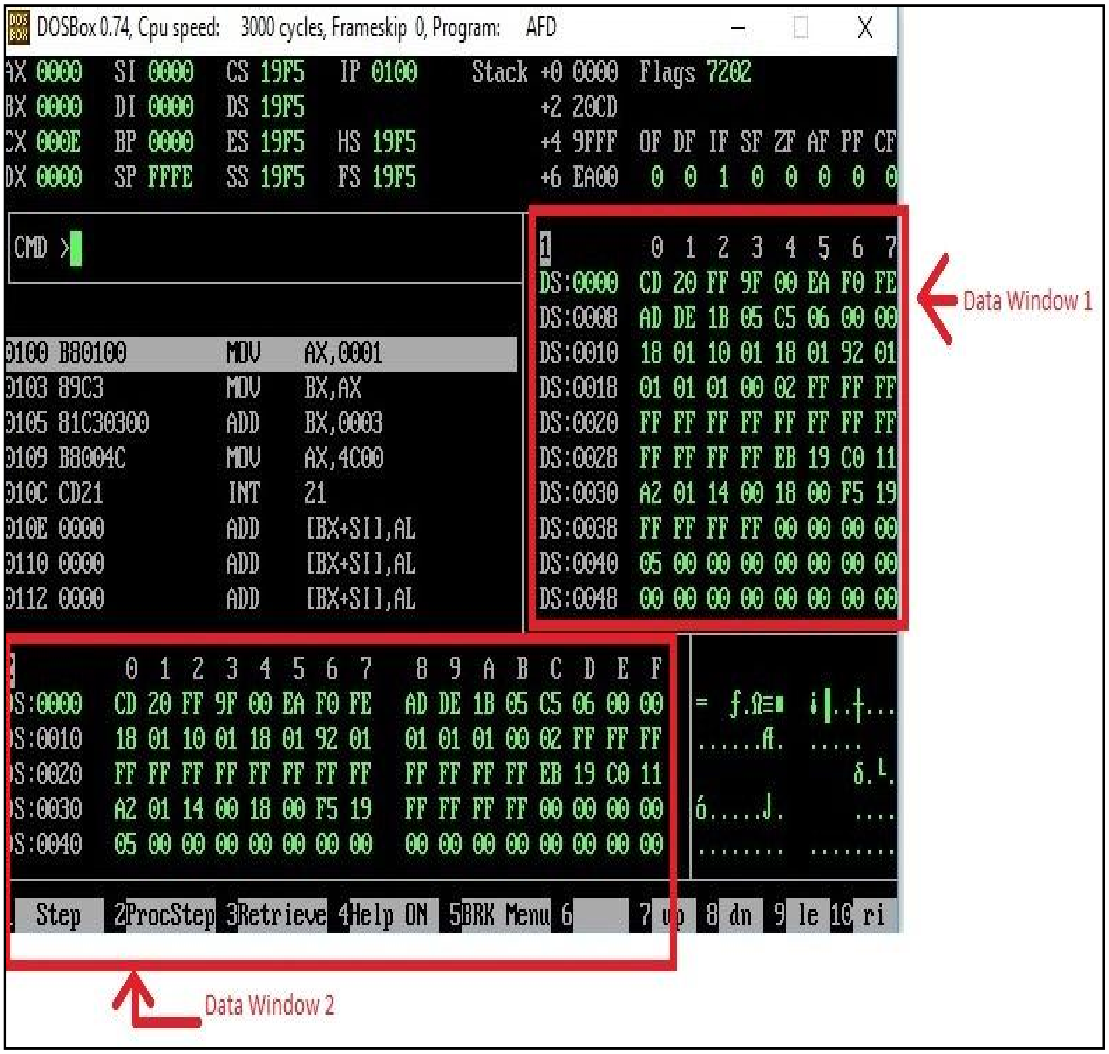
Variables are declared in memory.

DB	Define Byte	allocates 1 byte (0 – (2^8 – 1))
DW	Define Word	allocates 2 bytes (0 – (2^{16} – 1))
DD	Define Doubleword	allocates 4 bytes (0 – (2^{32} – 1))
DQ	Define Quadword	allocates 8 bytes (0 – (2^{64} – 1))
DT	Define Ten Bytes	allocates 10 bytes (0 – (2^{80} – 1))

Example:

```
; a program to add three numbers using memory variables
[org 0x0100]

mov ax, [num1]                    ;load first number in ax
mov bx, [num2]                   ; load second number in bx
add ax, bx                        ; accumulate sum in ax
mov [result1], ax                ; store result in result1 variable, 15

mov ax, 0x4c00                   ; terminate program
int 0x21

num1: dw 5            ;variables
num2: dw 10

result1: dw
```

How to View Memory in AFD



```
AX 0000   SI 0000   CS 19F5   IP 0100    Stack +0 0000  Flags 7202
BX 0000   DI 0000   DS 19F5                    +2 20CD
CX 000E   BP 0000   ES 19F5   HS 19F5          +4 9FFF  OF DF IF SF ZF AF PF CF
DX 0000   SP FFFE   SS 19F5   FS 19F5          +6 EA00   0  0  1  0  0  0  0  0

CMD >                                          1        0  1  2  3  4  5  6  7
                                               DS:0000  CD 20 FF 9F 00 EA F0 FE
                                               DS:0008  AD DE 1B 05 C5 06 00 00
0100 B80100          MOV    AX,0001            DS:0010  18 01 10 01 18 01 92 01
0103 89C3            MOV    BX,AX              DS:0018  01 01 01 00 02 FF FF FF
0105 81C30300        ADD    BX,0003            DS:0020  FF FF FF FF FF FF FF FF
0109 B8004C          MOV    AX,4C00            DS:0028  FF FF FF FF EB 19 C0 11
010C CD21            INT    21                 DS:0030  A2 01 14 00 18 00 F5 19
010E 0000            ADD    [BX+SI],AL         DS:0038  FF FF FF FF 00 00 00 00
0110 0000            ADD    [BX+SI],AL         DS:0040  05 00 00 00 00 00 00 00
0112 0000            ADD    [BX+SI],AL         DS:0048  00 00 00 00 00 00 00 00

2          0  1  2  3  4  5  6  7    8  9  A  B  C  D  E  F
DS:0000    CD 20 FF 9F 00 EA F0 FE   AD DE 1B 05 C5 06 00 00   = ƒ.Ω≡■  ¡▌..┼...
DS:0010    18 01 10 01 18 01 92 01   01 01 01 00 02 FF FF FF   ......Æ.  .....
DS:0020    FF FF FF FF FF FF FF FF   FF FF FF FF EB 19 C0 11             δ.└.
DS:0030    A2 01 14 00 18 00 F5 19   FF FF FF FF 00 00 00 00   ó.....J.      ....
DS:0040    05 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00   ........  ........
```

In above screenshot, there are two data windows, each window is showing the contents of Memory. Such as at Offset 0000, we can see that the data is CD and at Offset 0001, the data is 20.

If you want to see the data at offset 0040, simply write m1 DS:0040 or m2 DS:0040 on AFD console.

(m1 is for window 1, and m2 is for window 2).

If you want to check your declared memory content, you have to create listing file of your program, then note offset of your data label from listing file, and then simply write m1 DS:offset, then you will see your data label content in m1 window. Offset value will be calculated after the addition of 0x0100 in the instruction address displayed by listing window since we ask assembler to start writing machine code from the address 0x0100 using the first line of code: [org 0x0100]

Activity 1: Write a program to generate the sum of first five entries of table of 3, using registers, and watch its execution in the debugger.

Help: [Approach 1] Can you do this using two registers only? [Approach 2] Can you do this usingone register only if we have **add ax, 3** available in our instruction set? Try both of these approaches and watch the first five entries of table of 3 in AX.

Activity 2 : Write a program that rotates the value of three registers clockwise twice i.e. given these initial values: ax=10, bx=20, cx=30.

Help: First draw data registers on paper. Solve this problem on paper then write your code accordingly. After writing your code verify the execution on paper first then check the executionon AFD. You may use DX.

Activity 3: Write instructions to do the following. Visualize the memory contents using memory windows to see if instruction is executed correctly. (Use m2 DS:offset to visualize the memory contents at the specified offset)
a. Copy contents of memory location with offset 0025 into AX.
b. Copy AX into memory location with offset 0FFF.
c. Move contents of memory location with offset 0010 to memory location with offset 002F.

Activity 4: Develop an assembly program that reads 1 number each from 5 different data labels to a register and stores their sum in some other memory location labeled as **result**.

Post Lab Activities

Activity 5: Move a number (6 for this question) from a memory location in AX, move 4 into BX then find num * 4 using ADD instruction and then divide that answer by 3 using SUB instruction. Store the results of multiplication and division (quotient) at different memory locations labeled as “**mresult**” and “**dresult**”.

Activity 6: Write a program to generate first 10 terms of the Fibonacci Series. The generated terms are to be placed at memory location named “**Fib**” using indirect addressing