Experiment No 2: 16-bit Arithmetic Operations

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REG.NO: 185001058

1. AIM:

Program for adding 2, 16-bit numbers.

ALGORITHM:

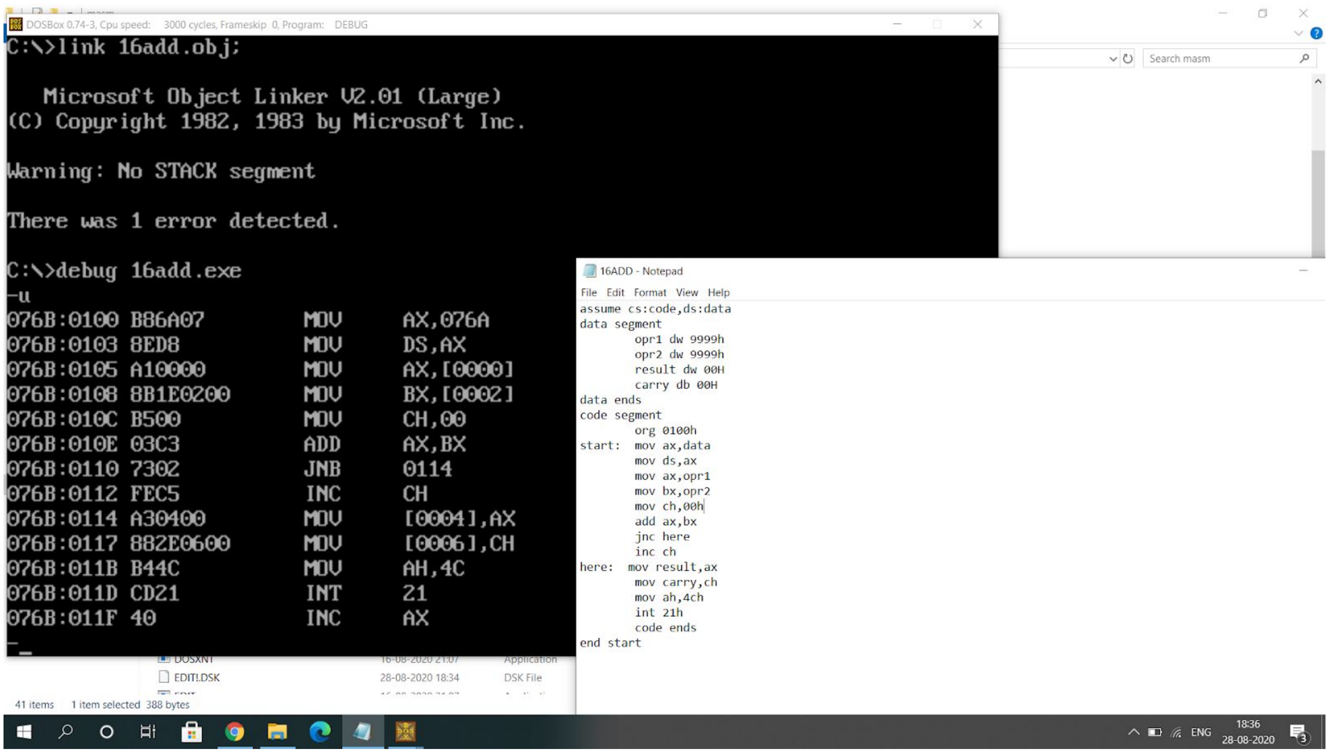
- Initialize the data segment
- Move data segment address to ds
- Load operand-1 to ax and operand-2 to bx
- Load 00h to ch register for carry
- Add ax and bx
- If there is no carry being generated, goto here segment else, increment ch by 1 and go to here segment
- In here segment,
  - Load ax to result
  - Load ch to carry
  - Terminate the program

PROGRAM:

PROGRAM	COMMENTS
Start: mov ax,data mov ds,ax	Transferring address of data segment to ds
mov ax,opr1	Value of opr1 is loaded to ax
mov bx,opr2	Value of opr2 is loaded to bx
mov ch,00h	Initializing the value of ch
add ax,bx	ax=ax+bx
jnc here	Jump to “here” segment if no carry is generated
inc ch	Increments ch by 1
Here:	

mov result,ax	Load register value of ax to result
mov carry,ch	Load ch value to carry
mov ah,4ch int 21h	Termination of execution
code ends	Ending the segment with the segment name

UNASSEMBLED CODE:



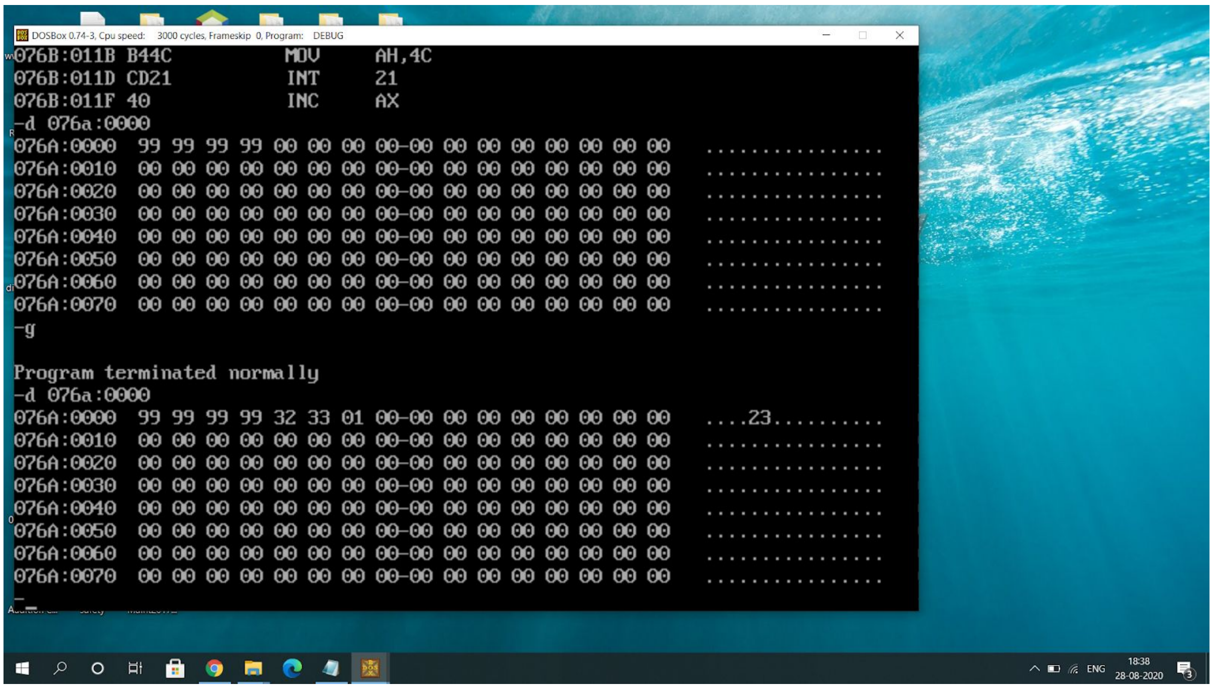
```
C:\>link 16add.obj;

   Microsoft Object Linker V2.01 (Large)
(C) Copyright 1982, 1983 by Microsoft Inc.

Warning: No STACK segment

There was 1 error detected.

C:\>debug 16add.exe
-u
076B:0100 B86A07        MOV     AX,076A
076B:0103 8ED8          MOV     DS,AX
076B:0105 A10000        MOV     AX,[0000]
076B:0108 8B1E0200      MOV     BX,[0002]
076B:010C B500          MOV     CH,00
076B:010E 03C3          ADD     AX,BX
076B:0110 7302          JNB     0114
076B:0112 FEC5          INC     CH
076B:0114 A30400        MOV     [0004],AX
076B:0117 882E0600      MOV     [0006],CH
076B:011B B44C          MOV     AH,4C
076B:011D CD21          INT     21
076B:011F 40            INC     AX
-_
```

```
assume cs:code,ds:data
data segment
        opr1 dw 9999h
        opr2 dw 9999h
        result dw 00H
        carry db 00H
data ends
code segment
        org 0100h
start:  mov ax,data
        mov ds,ax
        mov ax,opr1
        mov bx,opr2
        mov ch,00h
        add ax,bx
        jnc here
        inc ch
here:  mov result,ax
        mov carry,ch
        mov ah,4ch
        int 21h
        code ends
end start
```

DOSBox 0.74-3, Cpu speed: 3000 cycles, Frameskip 0, Program: DEBUG
16ADD - Notepad
File Edit Format View Help
Search masm
41 items 1 item selected 388 bytes
ENG
18:36
28-08-2020

SAMPLE INPUT/OUTPUT:

(ax=9999; bx=9999)


DOSBox 0.74-3, Cpu speed: 3000 cycles, Frameskip 0, Program: DEBUG
ENG
18:38
28-08-2020

```
076B:011B B44C          MOV     AH,4C
076B:011D CD21          INT     21
076B:011F 40            INC     AX
-d 076a:0000
076A:0000  99 99 99 99 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0010  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0020  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0030  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0040  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0050  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0060  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0070  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
-g

Program terminated normally
-d 076a:0000
076A:0000  99 99 99 99 32 33 01 00-00 00 00 00 00 00 00 00   ....23..........
076A:0010  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0020  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0030  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0040  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0050  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0060  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0070  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
-
```

RESULT:

The addition of 2, 16-bit numbers is thus shown.

2. AIM:

Program for subtracting 2, 16-bit numbers.

ALGORITHM:

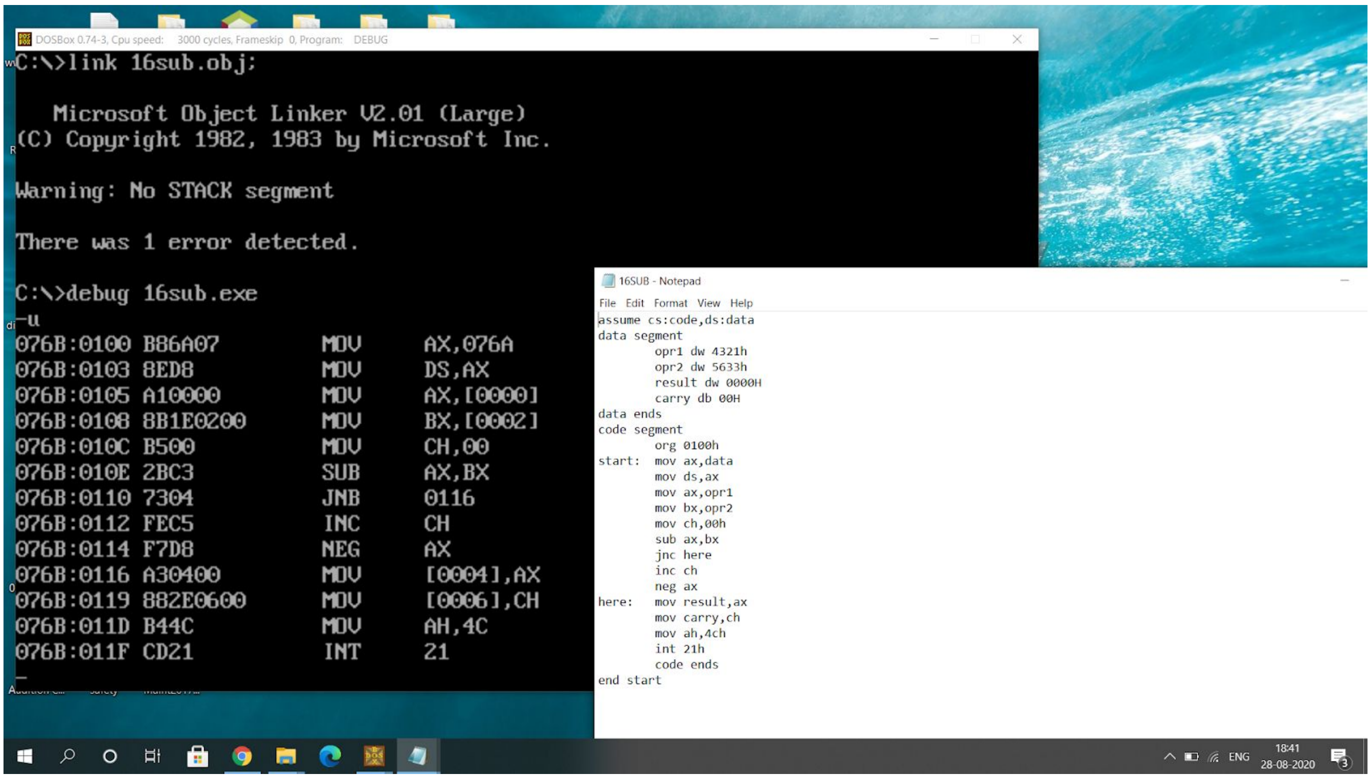
- Initialize the data segment
- Move data segment address to ds
- Load operand-1 to ax and operand-2 to bx
- Load 00h to ch register
- Subtract ax and bx
- If ax is greater than bx, goto here segment else, increment ch by 1 and find the 2's complement of ah and goto segment here
- In here segment,
  - Load ax to result
  - Load ch to carry
  - Terminate the program

PROGRAM:

PROGRAM	**COMMENTS**

Start:	
mov ax,data mov ds,ax	Transferring address of data segment to ds
mov ax,opr1	Value of opr1 is loaded to ax
mov bx,opr2	Value of opr2 is loaded to bx
mov ch,00h	Initializing the value of ch
sub ax,bx	ax=ax-bx
jnc here	Jump to “here” segment if ax>bx
inc ch	Increments ch by 1
neg ah	2’s complement of ah
Here:	
mov result,ax	Load register value of ax to result
mov carry,ch	Load ch value to carry
mov ah,4ch int 21h	Termination of execution
code ends	Ending the segment with the segment name

UNASSEMBLED CODE:

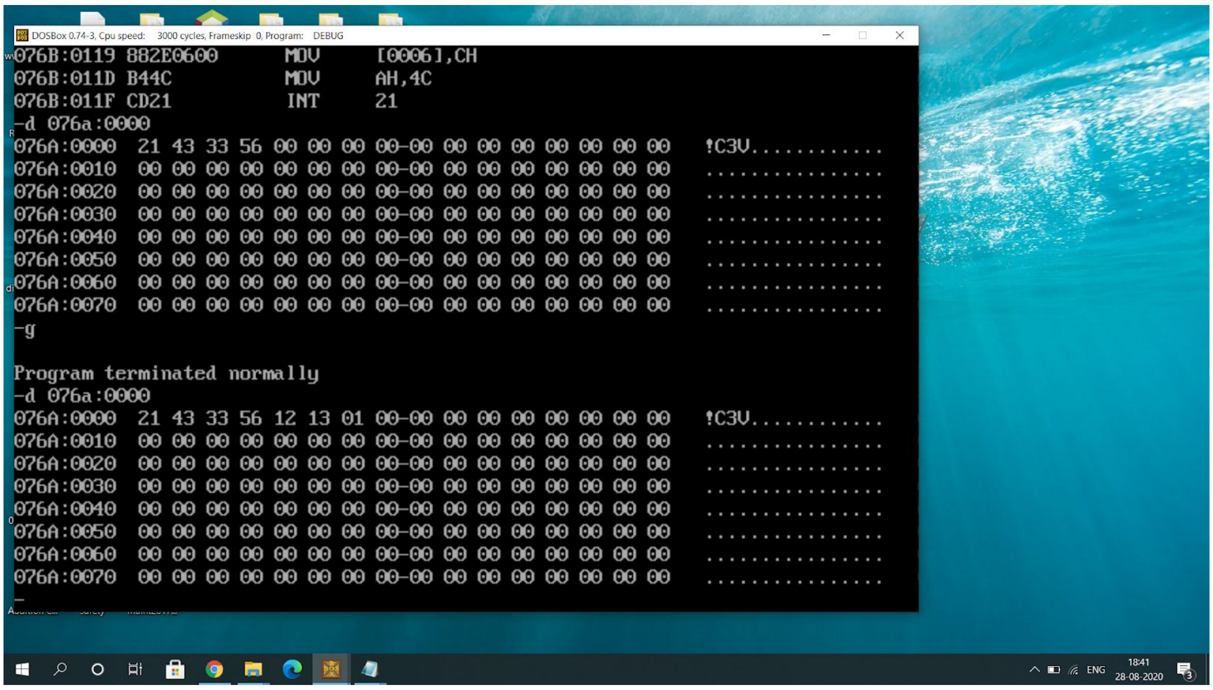

DOSBox 0.74-3, Cpu speed: 3000 cycles, Frameskip 0, Program: DEBUG
16SUB - Notepad
File Edit Format View Help
ENG
18:41
28-08-2020

```
C:\>link 16sub.obj;

   Microsoft Object Linker V2.01 (Large)
(C) Copyright 1982, 1983 by Microsoft Inc.

Warning: No STACK segment

There was 1 error detected.

C:\>debug 16sub.exe
-u
076B:0100 B86A07        MOV     AX,076A
076B:0103 8ED8          MOV     DS,AX
076B:0105 A10000        MOV     AX,[0000]
076B:0108 8B1E0200      MOV     BX,[0002]
076B:010C B500          MOV     CH,00
076B:010E 2BC3          SUB     AX,BX
076B:0110 7304          JNB     0116
076B:0112 FEC5          INC     CH
076B:0114 F7D8          NEG     AX
076B:0116 A30400        MOV     [0004],AX
076B:0119 882E0600      MOV     [0006],CH
076B:011D B44C          MOV     AH,4C
076B:011F CD21          INT     21
-
```

```
assume cs:code,ds:data
data segment
        opr1 dw 4321h
        opr2 dw 5633h
        result dw 0000H
        carry db 00H
data ends
code segment
        org 0100h
start:  mov ax,data
        mov ds,ax
        mov ax,opr1
        mov bx,opr2
        mov ch,00h
        sub ax,bx
        jnc here
        inc ch
        neg ax
here:   mov result,ax
        mov carry,ch
        mov ah,4ch
        int 21h
        code ends
end start
```

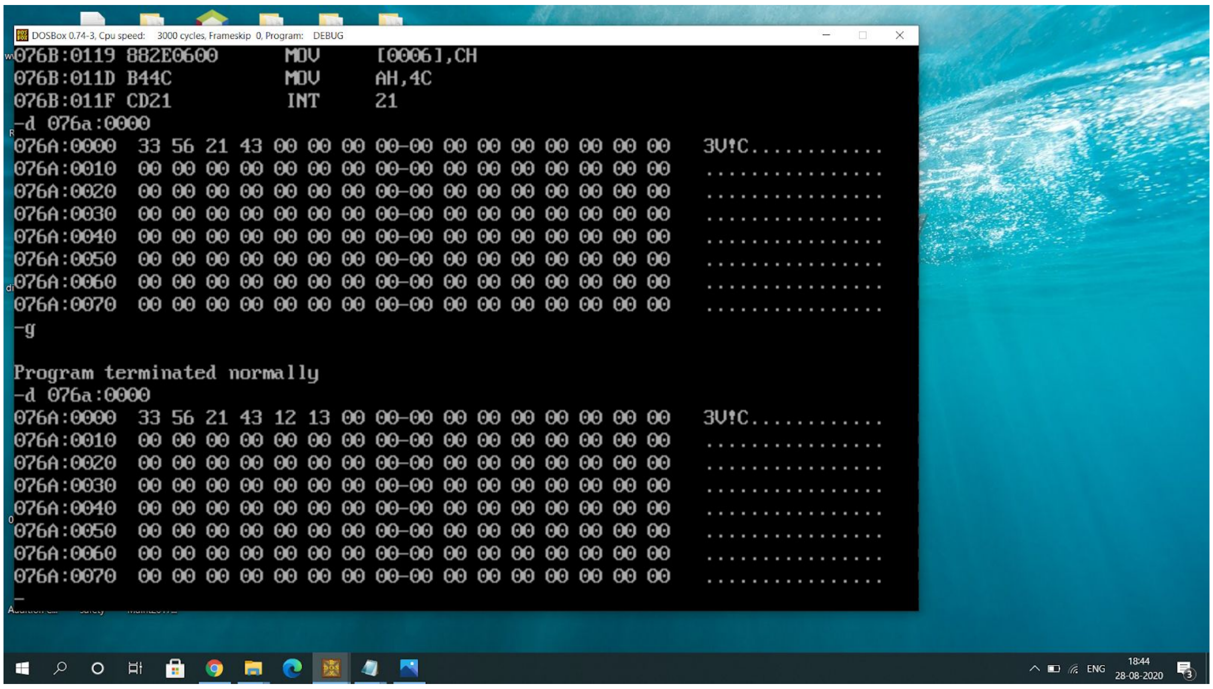
SAMPLE INPUT/OUTPUT

ax=4321; bx=5633 (ax<bx)


DOSBox 0.74-3, Cpu speed: 3000 cycles, Frameskip 0, Program: DEBUG
ENG
18:41
28-08-2020

```
076B:0119 882E0600      MOV     [0006],CH
076B:011D B44C          MOV     AH,4C
076B:011F CD21          INT     21
-d 076a:0000
076A:0000  21 43 33 56 00 00 00 00-00 00 00 00 00 00 00 00   !C3V............
076A:0010  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0020  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0030  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0040  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0050  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0060  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0070  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
-g

Program terminated normally
-d 076a:0000
076A:0000  21 43 33 56 12 13 01 00-00 00 00 00 00 00 00 00   !C3V............
076A:0010  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0020  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0030  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0040  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0050  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0060  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0070  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
-
```

ah=5633 bh=4321 (ax>bx)



```
076B:0119 882E0600      MOV     [0006],CH
076B:011D B44C          MOV     AH,4C
076B:011F CD21          INT     21
-d 076a:0000
076A:0000  33 56 21 43 00 00 00 00-00 00 00 00 00 00 00 00   3V!C............
076A:0010  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0020  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0030  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0040  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0050  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0060  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0070  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
-g

Program terminated normally
-d 076a:0000
076A:0000  33 56 21 43 12 13 00 00-00 00 00 00 00 00 00 00   3V!C............
076A:0010  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0020  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0030  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0040  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0050  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0060  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0070  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
-
```

DOSBox 0.74-3, Cpu speed: 3000 cycles, Frameskip 0, Program: DEBUG
ENG
18:44
28-08-2020

RESULT:

The subtraction of 2, 16-bit numbers is thus shown.

3. AIM:

Program for multiplication of 2, 16-bit numbers.

ALGORITHM:

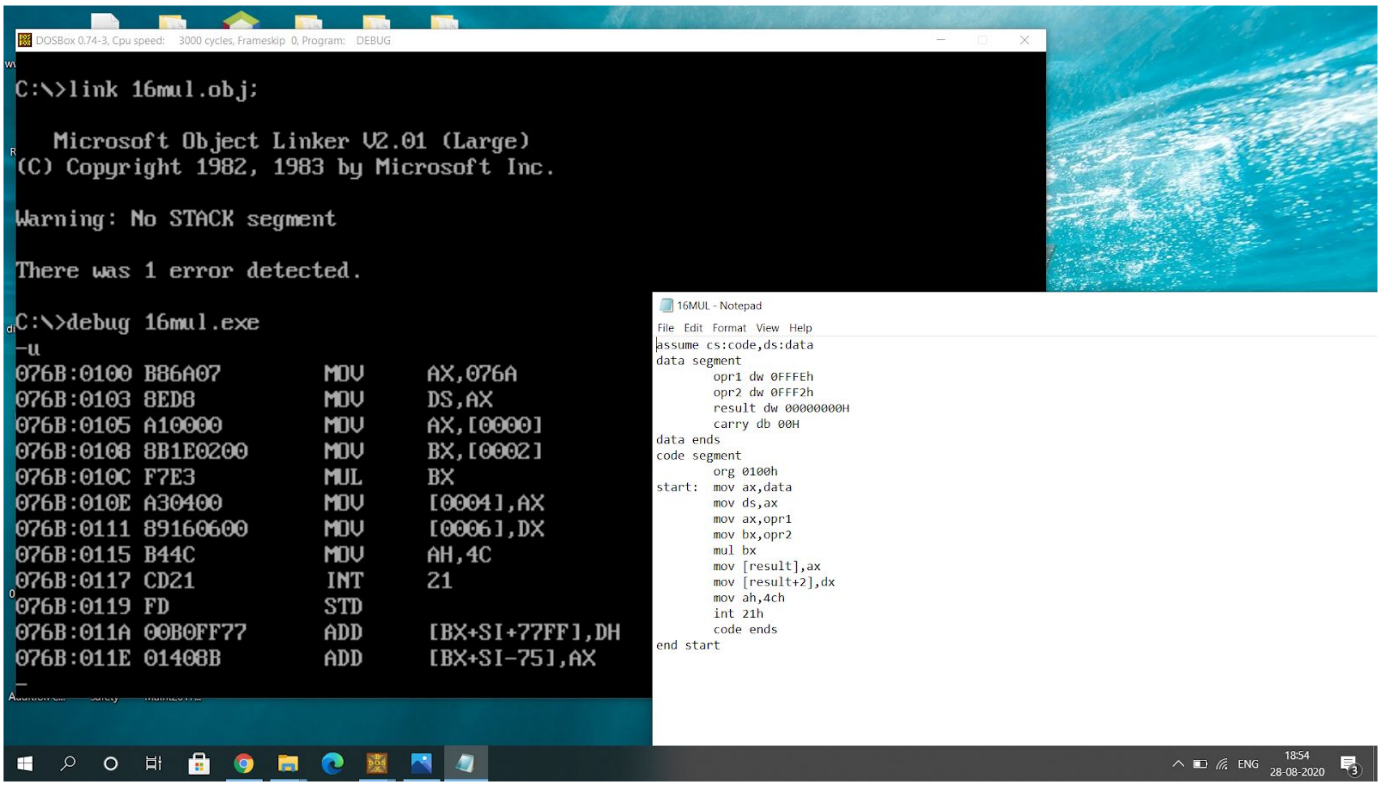
- Initialize the data segment
- Move data segment address to ds
- Load operand-1 to ax and operand-2 to bx
- Multiply bx (dxax=ax x bx)
- Load ax to result
- Load dx to location result+2
- Terminate the program

PROGRAM:

PROGRAM	**COMMENTS**

Start: mov ax,data mov ds,ax	Transferring address of data segment to ds
mov ax,opr1	Value of opr1 is loaded to ax
mov bx,opr2	Value of opr2 is loaded to bx
mul bx	dxax=ax x bx
mov [result],ax	Load register value of ax to result
mov[result+2],dx	Load register value of dx to location [result+2]
mov ah,4ch int 21h	Termination of execution
code ends	Ending the segment with the segment name

UNASSEMBLED CODE:

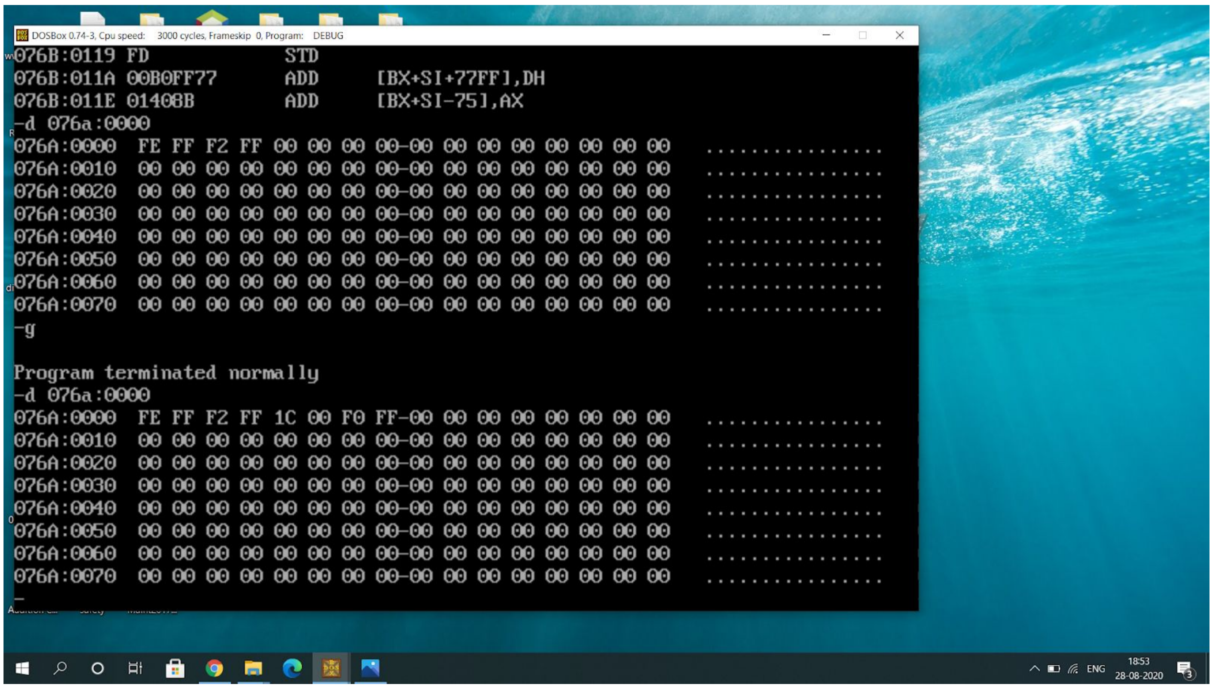


```
C:\>link 16mul.obj;

   Microsoft Object Linker V2.01 (Large)
(C) Copyright 1982, 1983 by Microsoft Inc.

Warning: No STACK segment

There was 1 error detected.

C:\>debug 16mul.exe
-u
076B:0100 B86A07        MOV     AX,076A
076B:0103 8ED8          MOV     DS,AX
076B:0105 A10000        MOV     AX,[0000]
076B:0108 8B1E0200      MOV     BX,[0002]
076B:010C F7E3          MUL     BX
076B:010E A30400        MOV     [0004],AX
076B:0111 89160600      MOV     [0006],DX
076B:0115 B44C          MOV     AH,4C
076B:0117 CD21          INT     21
076B:0119 FD            STD
076B:011A 00B0FF77      ADD     [BX+SI+77FF],DH
076B:011E 01408B        ADD     [BX+SI-75],AX
-
```

16MUL - Notepad

```
assume cs:code,ds:data
data segment
        opr1 dw 0FFFEh
        opr2 dw 0FFF2h
        result dw 00000000H
        carry db 00H
data ends
code segment
        org 0100h
start:  mov ax,data
        mov ds,ax
        mov ax,opr1
        mov bx,opr2
        mul bx
        mov [result],ax
        mov [result+2],dx
        mov ah,4ch
        int 21h
        code ends
end start
```

SAMPLE INPUT/OUTPUT (ax=FFFE ; bx=FFF2)


DOSBox 0.74-3, Cpu speed: 3000 cycles, Frameskip 0, Program: DEBUG

```
076B:0119 FD            STD
076B:011A 00B0FF77      ADD     [BX+SI+77FF],DH
076B:011E 01408B        ADD     [BX+SI-75],AX
-d 076a:0000
076A:0000  FE FF F2 FF 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0010  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0020  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0030  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0040  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0050  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0060  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0070  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
-g

Program terminated normally
-d 076a:0000
076A:0000  FE FF F2 FF 1C 00 F0 FF-00 00 00 00 00 00 00 00   ................
076A:0010  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0020  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0030  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0040  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0050  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0060  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0070  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
-
```

RESULT:

The multiplication of 2, 16-bit numbers is thus shown.

4. AIM:

Program for division of 2, 16-bit numbers.

ALGORITHM:

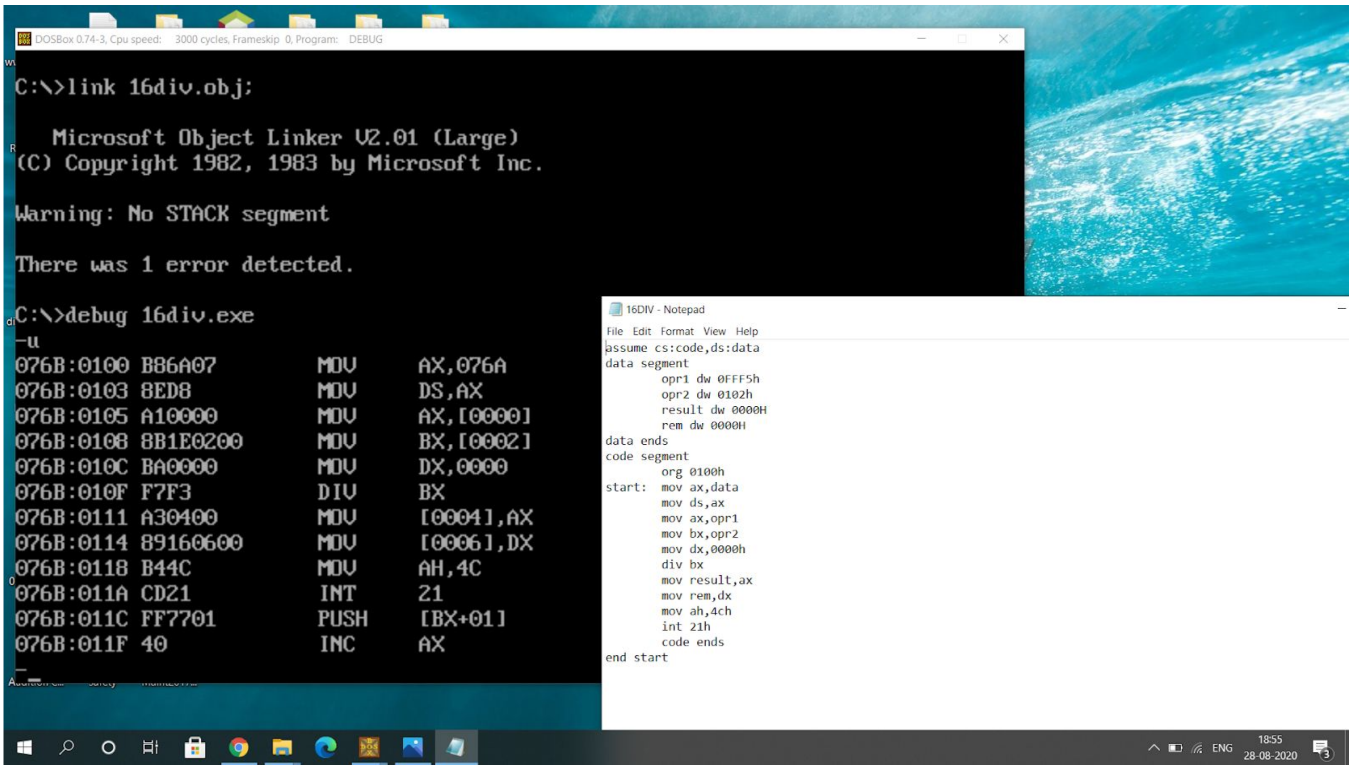
- Initialize the data segment
- Move data segment address to ds
- Load operand-1 to ax and operand-2 to bx
- Load dx with 0000h
- Divide bx (ax = dxax / bx ; remainder in dx)
- Load ax to result
- Load dx to rem (remainder)
- Terminate the program

PROGRAM:

PROGRAM	**COMMENTS**

Start: mov ax,data mov ds,ax	Transferring address of data segment to ds
mov dx,0000h	Register dx is loaded with 0000
mov ax,opr1	Value of opr1 is loaded to ax
mov bx,opr2	Value of opr2 is loaded to bx
div bx	ax = dxax / bx
mov result,ax	Load register value of ax to result
mov rem,dx	Load register value of dx to rem
mov ah,4ch int 21h	Termination of execution
code ends	Ending the segment with the segment name

UNASSEMBLED CODE:

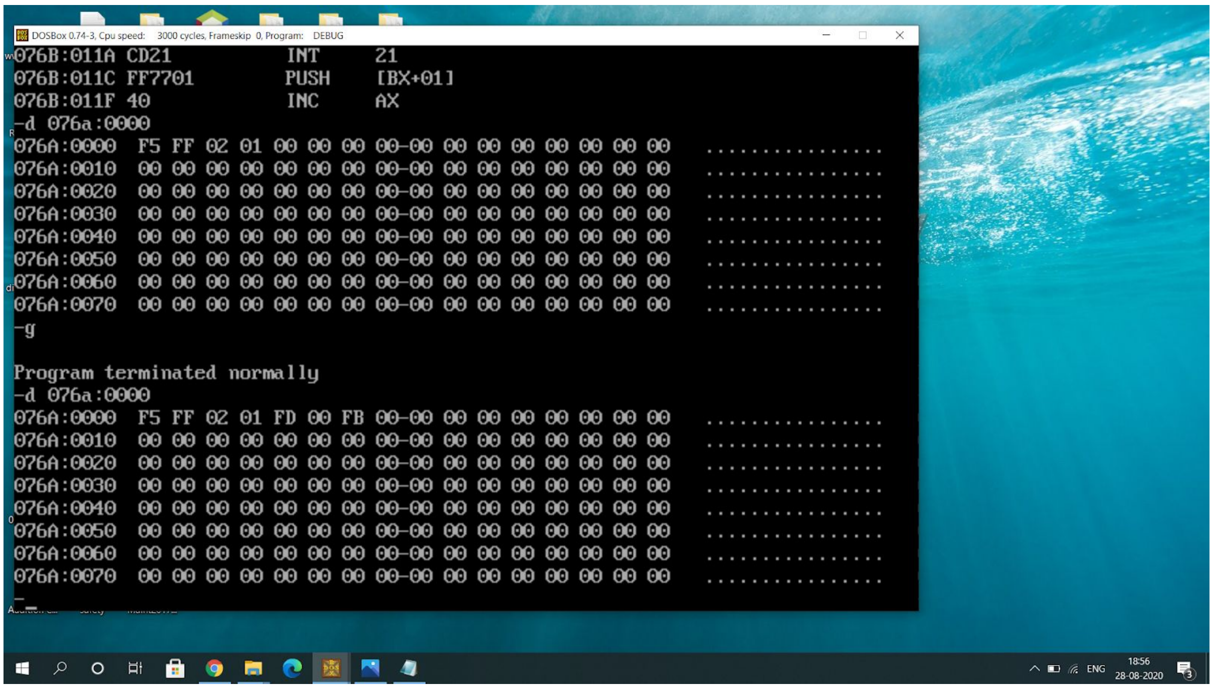


```
C:\>link 16div.obj;

   Microsoft Object Linker V2.01 (Large)
(C) Copyright 1982, 1983 by Microsoft Inc.

Warning: No STACK segment

There was 1 error detected.

C:\>debug 16div.exe
-u
076B:0100 B86A07        MOV     AX,076A
076B:0103 8ED8          MOV     DS,AX
076B:0105 A10000        MOV     AX,[0000]
076B:0108 8B1E0200      MOV     BX,[0002]
076B:010C BA0000        MOV     DX,0000
076B:010F F7F3          DIV     BX
076B:0111 A30400        MOV     [0004],AX
076B:0114 89160600      MOV     [0006],DX
076B:0118 B44C          MOV     AH,4C
076B:011A CD21          INT     21
076B:011C FF7701        PUSH    [BX+01]
076B:011F 40            INC     AX
-
```

```
assume cs:code,ds:data
data segment
        opr1 dw 0FFF5h
        opr2 dw 0102h
        result dw 0000H
        rem dw 0000H
data ends
code segment
        org 0100h
start:  mov ax,data
        mov ds,ax
        mov ax,opr1
        mov bx,opr2
        mov dx,0000h
        div bx
        mov result,ax
        mov rem,dx
        mov ah,4ch
        int 21h
        code ends
end start
```

DOSBox 0.74-3, Cpu speed: 3000 cycles, Frameskip 0, Program: DEBUG
16DIV - Notepad
File Edit Format View Help
ENG
18:55
28-08-2020

SAMPLE INPUT/OUTPUT
(ax=FFF5 ; bx=0102)



```
076B:011A CD21          INT     21
076B:011C FF7701        PUSH    [BX+01]
076B:011F 40            INC     AX
-d 076a:0000
076A:0000  F5 FF 02 01 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0010  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0020  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0030  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0040  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0050  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0060  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0070  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
-g

Program terminated normally
-d 076a:0000
076A:0000  F5 FF 02 01 FD 00 FB 00-00 00 00 00 00 00 00 00   ................
076A:0010  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0020  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0030  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0040  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0050  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0060  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
076A:0070  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00   ................
-
```

DOSBox 0.74-3, Cpu speed: 3000 cycles, Frameskip 0, Program: DEBUG
ENG
18:56
28-08-2020

RESULT:

The division of 2,16-bit numbers is thus shown.