Assembly Language Programming and Organization of the IBM PC

By Yu and Marut

MANUAL SOLUTION

CH.1 TO CH.10

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Chapter One
Microcomputer Systems

(1)

a)

- 1111111100010001b
- 0101010111111111b
- 0001000111011101b

b)

- 0
- 1
- 1
- 1

---

(2)

a) 1101

b) 0101

---

(3)

a) RAM

b) ROM

c) RAM

d) ROM

Chapter One

(4)

a) *the microprocessor* :
brain of the computer , it controls the computer by executing programs stored in memory.

b) *the buses*:
connect the different component to make processor communicate with memory and I/O circuits.

.....

(5)

a) *EU (Execution Unit)* :
execute instructions – because it contains the ALU.

b) *BIU (Bus Interface Unit)* :
facilitates communication between the EU and the memory or I/O circuits , and useful for speed-up the processor by instruction prefetch .

.....

(6)

a) *IP* : contains the address of the next instruction to be executed by EU .

b) *ALU* : perform arithmetic & logic operation .

.....

Chapter One

(7)

a) *I/O ports* : transfer points between the CPU & I/O devices

b) because they have addresses connected to the bus system known as I/O addresses and they can only be used in input or output instruction , this allows the CPU to distinguish between them .

.....

(8)

4-Bytes

.....

(9)

a)

- Fetch an instruction from memory.
- Decode the instruction to determine the operation.

b)

- Perform the operation if needed .
- Store the results in memory.

.....

(10)

a) *Advantages of H.L.L:*

1. closer to natural language , so it's easier to read and understand the program .
2. assembly contains more statement than an equivalent HLL ,so It's need more time to code the assembly language program.

3. each computer has its own unique assembly language , so It's limited to one machine ,but HLL can be executed on any machine has the compiler of that language .

b) *primary advantage of assembly language*:

It's so close to machine language ,so it's produce a faster shorter machine language program .
And some operation (read /write) can be done on specific Memory location and I/O ports, and that may be impossible In HLL

.....

Chapter Two

(1)

Binary	Decimal	Hex
1001	9	9
1010	10	A
1101	13	D
1100	12	C
1110	14	E
1011	11	B

(2)

a) 14d d: decimal
b) 2397d
c) 1130d
d) 1027628d

(3)

a) 1100001b b: binary
b) 1001110011b
c) 399h h: hexadecimal
d) 17E8h

(4)

a) 4Bh
b) 95AEh
c) 101000101100b
d) 1011001101001101b

(5)

a) 111100b
b) 10110110110b
c) C9CDFh
d) 1FACABh

(6)

a) 101b
b) 1001010b
c) 25041h
d) D00DFh

(7)

a) 234d = 0000000011101010b = 00Eah

b) 16d = 00000000010000b
-16d = 2's comp. (16)
= 1111111111110000b = FFF0h

c) 31634d = 0111101110010010b = 7B92h

d) 32216d = 0111110111011000b
-32216d = 2's comp.(32216)
= 1000001000101000b = 8228h

Note: 2's comp. =1's comp +1
1's comp. =NOT

Chapter Two

(8)

Take 2's comp. for negative number, then Add the two numbers. if no.1> no.2 : positive result stay as it.

If no.1< no.2: negative take 2's comp.

a) 2's comp. (-10010111b) = 11111111101101001b
10110100b+11111111101101001b = 00000000000011101b
Positive no. =11101b

b) 2's comp. (-11110111b) = 11111111100001001b
10001011b+11111111100001001b =11111111110010100b
Negative no. =2's comp. (11111111110010100)
= -1101100b

c) 2's comp.(-12ABh) = ED55h
FE0Fh+ ED55h = EB64h
Positive no. = EB64h

d) 2's comp. (-B3EAh) =
4C16h 1ABCh+ 4C16h =
66D2h
Negative no. = 2's comp. (66D2h)
= - 992Eh

Note: we can judge on no. from subtraction equation (e.g.: 1ABCh – B3EAh = (negative number): because 1ABC < B3EAh, so we must take 2's comp.

Chapter Two

(9)

Unsigned: convert the number as it is.

Signed :if msb=0 convert the number as it is.

If msb=1 take 2's comp. then convert.

	Unsigned	signed
a) 7FFEh	32766d	32766d
b) 8543h	34115d	-31421d
c) FEh	254d	-2d
d) 7Fh	127d	127d

Note: msb (most significant bit) last bit on the left.
i.e: bit-15 in word OR bit-7 in byte.

(10)

120d = 01111000b 8-bit

0000000001111000b 16-bit

To make it negative take 2's comp.

-120d = 10001000b 8-bit

1111111110001000b 16-bit

a) 10001000b
b) 1111111110001000b

Chapter Two

(11)

	16-bit	8-bit
a) 32767d	1111111111111111b	X :too big
b) -40000d	X :too big	X :too big
c) 65536d	X :too big	X :too big
d) 257d	0000000100000001b	X :too big
e) -128	0000000010000000b	10000000b

Note : Range of unsigned integer :

0 – 255 for byte 8-bit

0 – 65535 for word 16-bit

Range of signed numbers :

-128 – 127 for byte 8-bit

-32768 – 32767 for word 16-bit

(msb represente the sign)

(12)

If msb =0 positive else negative

a) 1010010010010100b Negative

b) 78E3h = 0111100011010011b Positive

c) CB33h = 1100101100110011b Negative

d) 807Fh = 1000000001111111b Negative

e) 9AC4h = 1001101011000100b Negative

Chapter Two

(13)

Address	Content(hex)	Data
0	24	$
1	31	1
2	32	2
3	2E	.
4	37	7
5	35	5

(14)

41	74	74	61	63	6B	20	61	74	20	44	61
A	t	t	a	c	k		a	t		D	a
77	6E										
w	n										

"Attack at Dawn"

(15)

A = 41h a = 61h

The difference is 20h

Add 20h to convert from upper to lower case.

Chapter Two

(16)

"0" = 30h numerical value = 0h
"1" = 31h numerical value = 1h
The difference is 30h
SUB 30h to get the numerical value.

.....

(17)

Just a technique:
0 1 2 3 4 5 6 7 8 9 A B C D E F .....->
5(c) B23CDh
+ 1791 2h
D+2= go from D to the right 2 places = F
C+1= go from C to the right 1 place = D
3+9= go from 3 to the right 9 places = C
2+7= go from 2 to the right 7 places = 9
B+1= go from B to the right 1 place = C

= C9CDFh

.....

Chapter Three

(1)

8086 & 80286 have 16-bit but 80286 has this advances:

- Tow mode of operation.
- More addressable memory.
- Virtual memory in protected mode.

(2)

Registers	M.L
Inside CPU	in RAM
Perform operation	store data
Known as name	known by Address
14-reg 16-bit	1MB 8-bit

Note: these information for 8086.

(3)

AX : multiplication & division operation.
BX : serves as an address register.
CX : serves as a loop counter.
DX : used in I/O operation.

(4)

0A51:CD90h = seg:offset Physical address = seg × 10h +offset

= 0A51 × 10h + CD90h

= 0A510 + CD90h

= 172A0h

(5)

Physical Address = 4A37Bh

a) seg. = 40FFh

Physical address = seg × 10h + offset

Offset = physical address – seg × 10h

= 4A37B – 40FF × 10h

= 4A37B – 40FF0

= 938Bh

40FF:938Bh

b) offset = 123Bh

Physical address = seg × 10 + offset

Seg × 10h = physical address – offset

Seg × 10h = 4A37B – 123B

Seg × 10h = 49140

Seg = 49140/10h

= 4914h

4914: 123Bh

Chapter Three

(6)
Paragraph = 16 byte
So any address accept division on 16d /10h call paragraph boundary.

(i.e : any address ending in 0)
Ex:
15230 : P.B P.B :Paragraph Boundary 66DA0:
P.B
3ACA1: not P.B

---

(7)
The compatibility of PC clones with the IBM PC depends on how well their BIOS routines match thoses of the IBM PC.

---

(8)
That depends on the size of RAM used.
For 8086 1MB is used 10-segment to loading and running applications , these 10-segment give us 640 KB of memory.

If we use 512-KB it has only 8-segment

Chapter Four

(1)
a) legal
b) legal
c) illegal ; contains a blank (space)
d) legal
e) legal
f) illegal ; contains an illegal character ‘
g) illegal ; contains an illegal character =

.....

(2)
a) 246 ; legal – decimal
b) 246h; legal – hexa
c) 1001; legal – decimal
d) 1,101; illegal – nondigit character ,
e) 2A3h; legal – hexa
f) FFFEh ; illegal – must begin with digit
g) 0Ah ; legal – hexa
h) Bh ; illegal – must begin with digit
i) 1110b ; legal – binary

.....

(3)
a) A DW 52
b) WORD1 DW ?
c) B DB 25h
d) C1 DB ?
e) illegal , number too big can’t fit in word
f) ARRAY1 DW 1,2,3,4,5

Chapter Four

g) BELL EQU 07h
h) MSG EQU 'THIS IS A MESSAGE$'

(4)

Address	content	beginning of var.
0000h	7	A
0001h	BCh	B
0002h	1Ah	
0003h	'H'	C
0004h	'E'	
0005h	'L'	
0006h	'L'	
0007h	'O'	

a) var. A : 0000h
var. B : 0001h
var. C : 0003h

b) content of byte 0002h is : 1Ah

c) content of byte 0004h is : 'E'

d) offset address of character 'O' is : 0007h

Chapter Four

(5)

a) legal
b) illegal ; constant to segment
c) illegal ; segment to segment
d) legal
e) illegal ; memory to memory
f) illgal ; can't store in constant
g) illegal ; memory to memory operation
h) illegal ; out of range can't fit in 8-bit
i) illegal ; momory to memory / different size

---

(6)

a)
```
MOV   AX,B
SUB   AX,A
MOV   A,AX
```

b)
```
MOV   AX,A
INC   AX
NEG   AX
MOV   A,AX
```

c)
```
MOV   AX,A
ADD   AX,B
MOV   C,AX
```

Chapter Four

d)
```
MOV   AX,B
ADD   AX,B
ADD   AX,B
ADD   AX,7
MOV   B,AX
```

e)
```
MOV   AX,B
SUB   AX,A
DEC   AX
MOV   A,AX
```

---

(7)

a)
```
MOV   AH,1
INT 21H
MOV DL,AL
MOV AH,2 INT
21H
```

Note : The cursor will move automaticly to next position after reading.

b)
```
MOV   AH,1
INT 21H
ADD   AL,20H        ;convert to lower case
MOV   DL,AL
MOV   AH,2
INT   21H
```

Chapter Four

Programming Exercises

(8)

```
.MODEL SMALL
.DATA
MSG DB 0AH,0DH,'THE SUM OF ' C1
DB ?,' AND '
C2          DB  ?,' IS '
SUM         DB  ?,'$'

.CODE
Main PROC

MOV     AX,@DATA        ; initialize DS
MOV     DS,AX

MOV     AH,2            ; display '?'
MOV     DL,'?'
INT     21H

MOV     AH,1
INT     21H             ; read 1st digit
MOV     C1,AL           ; store it in memory

INT     21H             ; read 2nd digit
MOV     C2,AL           ; store it in memory
```

```
ADD     AL,C1           ; add the two numbers
SUB     AL,30H          ; *
MOV     SUM,AL          ; store result in memory

LEA     DX,MSG          ; get the start address
MOV     AH,9
INT     21H             ; print the MSG until $

MOV     AH,4CH          ;return to DOS
INT     21H

Main    ENDP
END Main
```

* when we add the two numbers , suppose we enter 2 and 7 Their ASCII code are 32h and 37h respectively, after adding AL will contais 69h , now we have to SUB 30h to get the ASCII code of 9 and it is 39h.

Chapter Four

(9)

```
.MODEL SMALL
.DATA
MSG DB 0AH,0DH,"ENTER THREE INITIALS: $"
C1      DB      ?,0AH,0DH
C2      DB      ?,0AH,0DH
C3      DB        ?,'$'
.CODE
MAIN PROC
MOV     AX,@DATA        ;initialze DS
MOV     DS,AX

MOV     AH,9                    ; display MSG
LEA     DX,MSG
INT     21H

MOV     AH,1                    ; read & store 1st char.
INT     21H
MOV     C1,AL

INT     21H             ; read & store 2nd char.
MOV     C2,AL

INT     21H             ; read & store 3rd char.
MOV     C3,AL
```

Chapter Four

```
MOV     AH,2                    ; display enter
MOV     DL,0AH
INT     21H
MOV     DL,0DH
INT     21H

MOV     AH,9            ; display message from c1 until $
LEA     DX,C1
INT     21H

MOV     AH,4CH              ; return to DOS
INT     21H

MAIN    ENDP
END      MAIN
```

Chapter Four

(10)

```
.MODEL SMALL
.DATA
MSG     DB  0AH,0DH,'ENTER A HEX DIGIT: $'
MSG2    DB 0AH,0DH,'IN DECIMAL IT IS 1'
C1      DB ?,'$'

.CODE
MAIN     PROC
MOV     AX,@DATA            ;initialize DS
MOV     DS,AX

MOV     AH,9                        ; display 1st MSG
LEA     DX,MSG
INT     21H

MOV     AH,1                        ; read hex digit (A – F)
INT     21H

SUB     AL,11H                      ;*

MOV     C1,AL                       ;store it

MOV     AH,9                        ;display 2nd MSG until $
LEA     DX,MSG2
INT     21H
```

Chapter Four

```
MOV     AH,4CH          ; return to DOS
INT     21H

MAIN    ENDP
END     MAIN
```

* ASCII for A is 41h
ASCII for 0 is 30h
Difference is 11h
And for B,C,D,E,F are the same
Knowing that we include '1' in 2nd MSG

Chapter Four

(11)

```
.MODEL SMALL

.DATA
STARS    DB 0AH,0DH,'**********','$'

.CODE
MAIN     PROC

MOV      AX,@DATA                    ;initialize DS
MOV      DS,AX

MOV      AH,9                        ; prepare to display
LEA      DX,STARS
INT 21H                              ; display 10 times *
INT 21H
INT 21H
INT 21H
INT 21H
INT 21H
INT 21H
INT 21H
INT 21H
INT 21H
INT 21H
```

Chapter Four

```
MOV     AH,4CH                  ;return to DOS
INT 21H

MAIN    ENDP
END     MAIN
```

* it will be easy after study loop statement ch.6 to replace 10 statement by the code :

```
        MOV     CX,10
L:      INT 21H
        LOOP L
```

Chapter Four

(12)

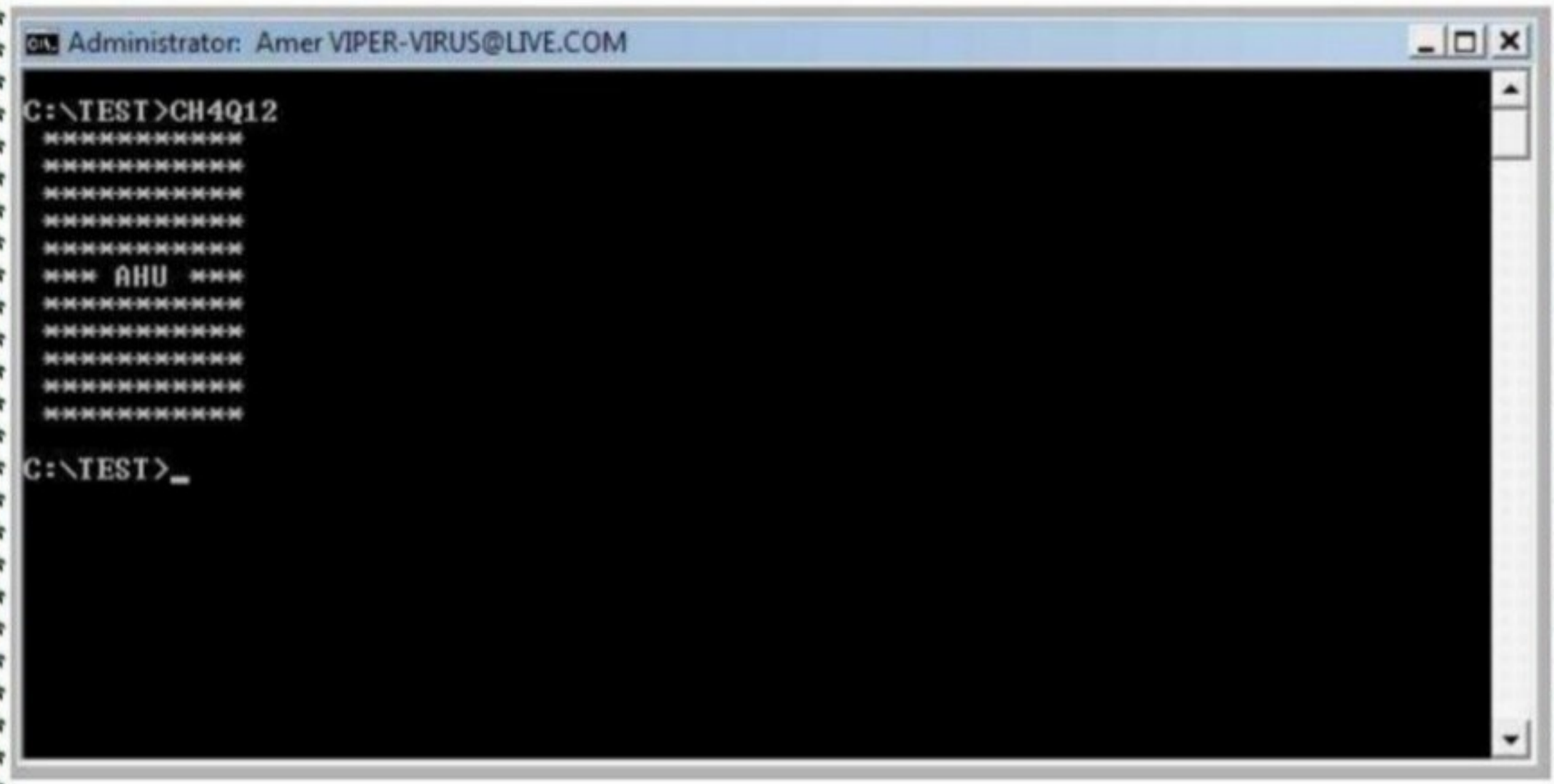
```
.MODEL SMALL

.DATA
STARS DB ,'**********',0AH,0DH,'$'
MID DB ' *** '
C1 DB ?
C2 DB ?
C3 DB ?,' ***',0AH,0DH,'$'

.CODE
MAIN    PROC
MOV     AX,@DATA                    ; initialize DS
MOV     DS,AX

MOV     AH,1                        ;read & store 3
initials
INT 21H
MOV     C1,AL
INT 21H
MOV     C2,AL
INT 21H
MOV     C3,AL

MOV     AH,2                        ; CR to current line
MOV     DL,0DH
INT 21H
```

Chapter Four

```
MOV     AH,9                ;( display stars from the
                            ; beginning of line that will
                            ;cause to erase the 3 initial
                            ;and write over them)
LEA     DX,STARS
INT 21H
INT 21H
INT 21H
INT 21H
INT 21H
LEA     DX,MID              ;( display the middle
                            ;line with initials)
INT 21H

LEA     DX,STARS            ;continue displaying stars
INT 21H
INT 21H
INT 21H
INT 21H
INT 21H

MOV     AH,4CH              ; return to DOS
INT 21H
MAIN    ENDP
END     MAIN
```

Chapter Four

Sample execution for question 12:



Chapter Five

(1)

Assuming that the flags are initially = 0 *

Content of	CF	SF	ZF	PF	OF
a) AX= 8000h	0	1	0	1	1
b) AL= 02h	1	0	0	0	0
c) AL= FFh	0	1	0	1	0
d) AL= 81h	1	1	0	1	0
e) AX= 712Ah					
BX= 1ABCh	0	0	0	0	0
f) AL= 7Fh	1	0	0	0	1
g) AX= 8000h	1	1	0	1	1
h) AX= FFFFh	1	1	0	1	0

* to know how we find flags value see Q2,Q3 & Q4

(2)

a)

cy_{out} 0 1 cy_{into}

AX= 01xx xxxx xxxx xxxx
BX= 01xx xxxx xxxx xxxx +
10xx xxxx xxxx xxxx

x: could be 0 or 1 (i.e any number)

01

ex: AX= 7FA0h = 0111 1111 1010 0000
BX= 600Dh = 0110 0000 0000 1101 +
DFADh =1101 1111 1010 1101

Cy_{into} =1 ,cy_{out} =0

Cy_{into} XOR cy_{out} = 1 XOR 0 = 1 = OF (signed overflow)

Chapter Five

b) cy_{out} 1 0 cy_{into}

AX= 10xx xxxx xxxx xxxx BX=
10xx xxxx xxxx xxxx +
100xx xxxx xxxx xxxx

Ex: cy_{out} 1 0 cy_{into}

AX=9DE4h =1000 1101 1110 0100
BX= B216h =1011 0010 0001 0 110 +
=10011 1111 1111 1010

Cy_{into} =0 ,cy_{out} =1
Cy_{into} XOR cy_{out} = 0 XOR 1 = 1 = OF (signed overflow)

Chapter Five

(3)

We'll show solution of one and the rest are the same

a.

```
                0 1
512Ch = 0101 0001 0010 1100
4185h = 0100 0001 1000 0101 +
92B1h = 1001 0010 1011 0001
```

Method 1:

By taking XOR between cy_{into} and cy_{out}

$Cy_{into} = 1$, $cy_{out} = 0$ see Q2.a

1 XOR 0 = 1 OF = 1 (signed)

Cy_{out} = CF = 0 (unsigned)

Method 2 :

First number is positive

Second number is positive

After addition the result expected is positive , but the result is negative ,so there are error occurred

The error indicate by OF = 1

	Content of AX	signed OF	unsigned CF
a)	92B1h	1	0
b)	18DDh	0	1
c)	BC97h	0	1
d)	E132h	1	0
e)	74FFh	0	0

Chapter Five

(4)

We'll show solution of one and the rest are the same

c. borrow 1 0 borrow

into msb into bit-14

19BCh = 0001 1001 1011 1100
81FEh = 1000 0001 1111 1110 -
97BEh= 10001 0111 1011 1110

Method 1:

By taking XOR between $borrow_{into\ msb}$ and $borrow_{into\ bit\text{-}14}$

$borrow_{into\ msb}$ XOR $borrow_{into\ bit\text{-}14}$

1 XOR 0 = 1 OF = 1 (signed)

$borrow_{into\ msb}$ = CF = 1 (unsigned)

Method 2:

First number is positive

Second number is negative

But second number is greater than first number.

And $1^{st} - (-2^{nd}) = 1^{st} + 2^{nd}$ = positive.

The result is negative so an error occurred OF = 1

Chapter Five

	Content of AX	signed OF	unsigned CF
a)	07BDh	0	0
b)	6878h	1	0
c)	97BEh	1	1
d)	01F3h	0	1
e)	1A22h	1	0

Chapter Six

(1)

a)
```
        CMP   AX,0
        JGE       END_IF
        MOV BX,-1
END_IF:
```

---

b)
```
        CMP   AL,0
        JNL   ELSE_
        MOV       AH,0FFh
        JMP       END_IF
ELSE_: MOV        AH,0
END_IF:
```

OR

```
        CMP       AL,0
        JL        THEN_
        MOV       AH,0
        JMP       END_IF
THEN_: MOV        AH,0FFh
END_IF:
```

---

c)
```
        CMP       DL,'A'
        JL        END_IF
        CMP       DL,'Z'
        JG        END_IF
        MOV       AH,2          ; display DL
        INT       21H
END_IF:
```

Chapter Six

d)

```
        CMP   AX,BX
        JGE   END_IF
        CMP   BX,CX
        JGE       ELSE_
        MOV       AX,0          ;then
        JMP       END_IF

ELSE_: MOV        BX,0
END_IF:
```

---

e)

```
        CMP       AX,BX
        JL        THEN_
        CMP       BX,CX
        JL        THEN_
        MOV       DX,1          ;else
        JMP       END_IF

THEN_: MOV        DX,0
END_IF:
```

---

f)

```
        CMP   AX,BX
        JNL       ELSE_
        MOV AX,0
        JMP   END_IF

ELSE_: CMP        BX,CX
        JNL       ELSE_2
```

Chapter Six

```
            MOV     BX,0
            JMP     END_IF

ELSE_2: MOV     CX,0
END_IF:
```

OR

```
            CMP     AX,BX
            JL      THEN_
            CMP     BX,CX
            JL      THEN_2
            MOV     CX,0
            JMP     END_IF

THEN_: MOV      AX,0
            JMP     END_IF
THEN_2:MOV      BX,0

END_IF:
```

---

(2)

```
            MOV     AH,1            ;read a character
            INT     21H

            CMP     AL,'A'          ;AL has the letter in.
            JE      EXE_CR
            CMP     AL,'B'
            JE      EXE_LF
            ;any letter else
            MOV     AH,4Ch          ;return to DOS
            INT     21H
            JMP     END_CASE

EXE_CR: MOV     AH,2
            MOV     DL,0Dh
            INT     21H
            JMP     END_CASE

EXE_LF: MOV     AH,2
            MOV     DL,0Ah
            INT     21H

END_CASE:
```

Chapter Six

(3)

a) first we find how many loops needed:
(last term – first term)/ difference
(148 – 1)/3 = 49 loops

```
        MOV     CX,49
        MOV     AX,1            ;first term
        MOV     BX,1

L1:     ADD     BX,3   ;add the diff. between each term
        ADD     AX,BX

        LOOP L1
```

---

b) (first term – last term)/ difference
(100 – 5)/5 = 19 loops

```
        MOV     CX,19
        MOV     AX,100
        MOV     BX,100

L1:     SUB     BX,5
        ADD     AX,BX

        LOOP L1
```

(4)

```
a) MOV      CX,50
   MOV      DX,1
   MOV      AX,1
L1:ADD      AX,4

   LOOP     L1
```

Chapter Six

b)

```
        MOV     AH,1
        INT     21H
        MOV     AH,2
        MOV     DL,0AH      ;enter
        INT     21H
        MOV     DL,0DH
        INT     21H
        MOV     DL,AL
        MOV     CX,80

DISPLAY:INT     21H
        LOOP    DISPLAY
```

---

c)

```
        MOV     CX,5
        MOV     AH,7  ;*
L1:     INT  21H
        LOOP    L1
;-----------------------------
        MOV     DL,'X'
        MOV     CX,5
        MOV     AH,2
L2:     INT  21H
        LOOP    L2
```

* function 7 of int 21h it's job is:
Input character without showing it at the screen and
the cursor still in the fisrt position
The ASCII of letter after reading in AL

(5)

```
MOV AX,0
;CX divident     BX divisor          AX quotient
while_:
            CMP       CX,BX
            JL    END_WHILE
            INC       AX
            SUB       CX,BX
            JMP       WHILE_
END_WHILE:
```

; you can test the program by DEBUG program

(6)

```
      XOR       CX,CX
      ; CX product          BX,AX  positive numbers
L1: ADD       CX,AX
       DEC      BX
       JNZ      L1
```

;enter values of AX,BX and test the code by DEBUG

Chapter Six

(7)

a)

```
        MOV     AH,1
        MOV     CX,80
L1:     INT     21H
        CMP     AL,20H      ; blank = 20h
        LOOPE   L1
```

; always enter blank if any char. else go out

---

b)

```
        MOV     AH,1
        MOV     CX,80
L1:     INT     21H
        CMP     AL,0DH
        LOOPNE L1
```

;compare will set the flag ZF if equal 0DH and that affect on LOOPNE .

Chapter Six

Programming Exercises

(8)

```
.MODEL SMALL

.CODE
MAIN PROC
                MOV AH,2
                MOV DL,'?'
                INT 21H                 ;display '?'

                MOV AH,1
                INT 21H  ; read 1st char. & put it in BL
                MOV BL,AL
                INT 21H ;read 2nd char. in AL
;--------------------------
                CMP BL,AL
                JG SWITCH       ;if not orderd
                JMP DISPLAY

SWITCH:         XCHG AL,BL
DISPLAY:
                MOV AH,2
                MOV DL, 0AH         ;enter
                INT 21H
                MOV DL,BL
                INT 21H
                MOV DL,AL
```

Chapter Six

```
                    INT 21H

OUT_:               MOV AH,4CH
                    INT 21H

MAIN ENDP
END MAIN
```

.....

.....

.....

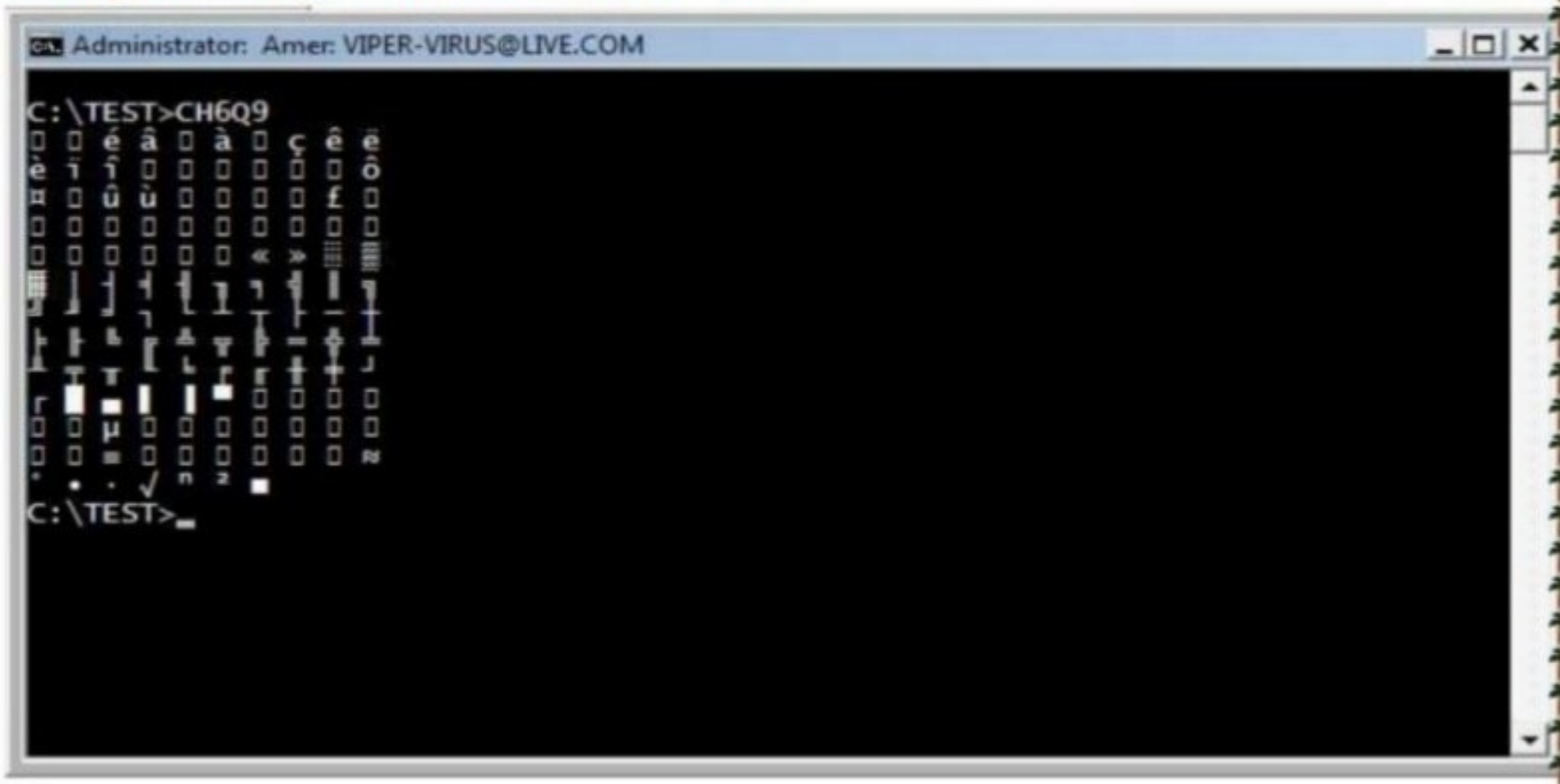
(9)

```
.MODEL SMALL
.CODE
MAIN PROC
                ;BH counter (10 char per line)
                MOV     BH,0
                 MOV    AH,2
                MOV     CX,7FH  ; 127 char.
                MOV     DL,80H  ;1ST letter
                MOV     BL,80H

CONTINUE:       MOV DL,BL
                INT 21H
                DEC CX
                INC DL
                MOV BL,DL
                MOV DL,20H      ;blank space
                INT 21H
                INC BH
                CMP BH,10
                JE COUNT
                CMP CX,0
                JNE CONTINUE    ;is letter finished?
                JMP out_

COUNT:          MOV BH,0        ;start again counter
                MOV DL,0AH      ;enter
                INT 21H
                MOV DL,0DH
                INT 21H
```

Chapter Six

```
                    JMP CONTINUE
Out_:               MOV AH,4CH
                    INT 21H


MAIN ENDP
                    END MAIN
```

Sample execution for Q9



Chapter Six

(10)

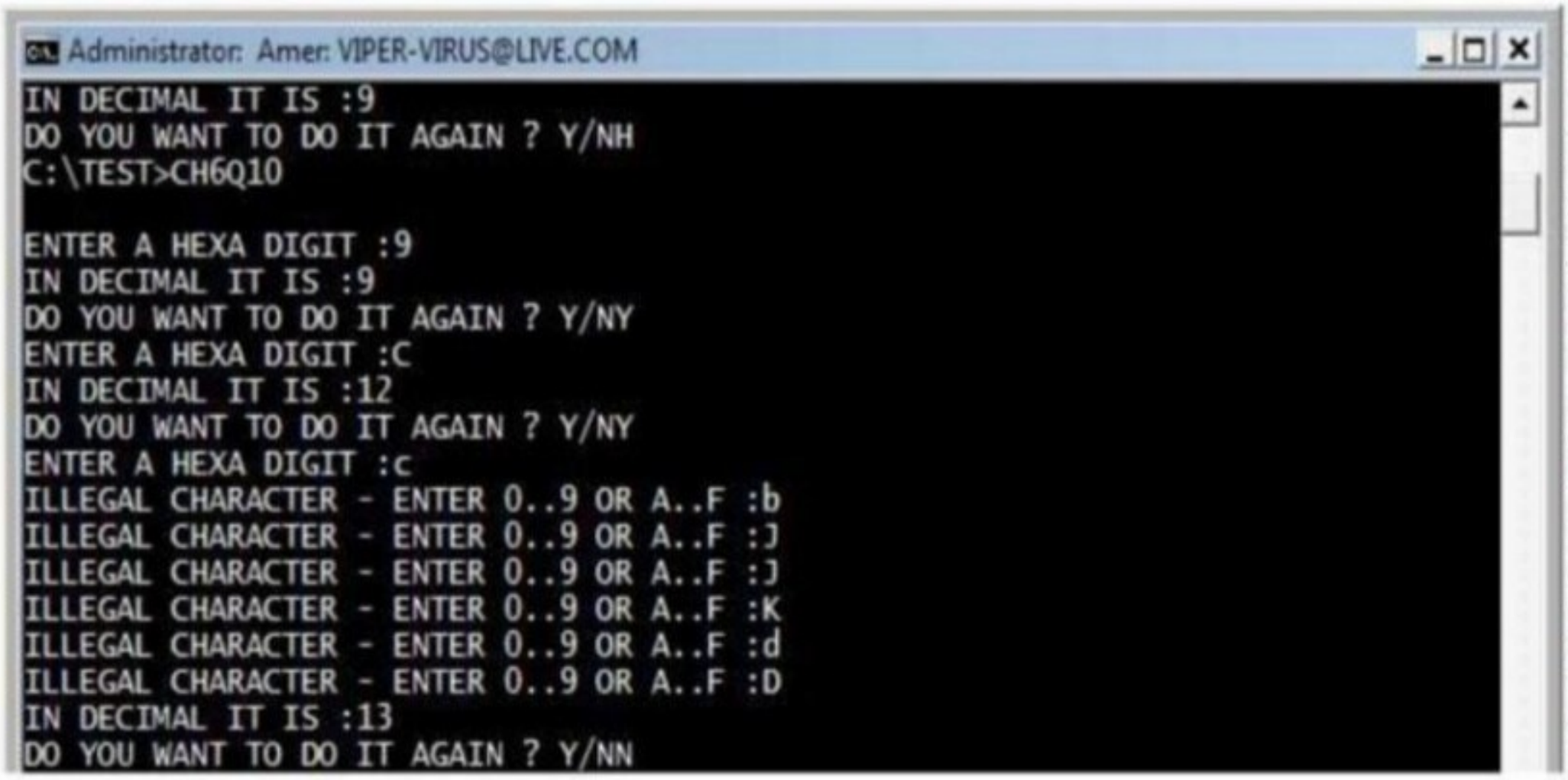
TITLE Q9:WRITTEN BY MUHAMMAD WASEEM (V.V)

```
.MODEL SMALL
.STACK 64
;-----------------------------------
.DATA
CR EQU 0DH
LF EQU 0AH
M1 DB  CR,LF,'ENTER A HEXA DIGIT :','$'
M2 DB     CR,LF,'IN DECIMAL IT IS :'
C1 DB     ?,'$'
M3 DB     CR,LF,'DO YOU WANT TO DO IT AGAIN ?'
      DB  'Y/N','$'
M4 DB  CR,LF,'ILLEGAL CHARACTER - ENTER '
      DB     '0..9OR A..F :','$'
M5 DB  CR,LF,'IN DECIMAL IT IS :1'
C2 DB     ?,'$'
;-----------------------------------
.CODE
MAIN PROC
      MOV AX,@DATA        ;Initialize DS
      MOV DS,AX

BEGIN:        MOV AH,9
              LEA DX,M1
              INT 21H
              ;--------
NEW:          MOV AH,1          ;read hexa digit
              INT 21H
              ;--------
```

```
            CMP AL,'0'          ;detictive for errors
            JL ILLEGAL
            CMP AL,'9'
            JG ILLEGAL
            ;--------
            MOV C1,AL
            MOV AH,9
            LEA DX,M2
            INT 21H
            ;--------
MSG:         MOV AH,9   ; do you want to do it again
            LEA DX,M3
            INT 21H
            ;---------
            MOV AH,1           ; yes or no
            INT 21H
            CMP AL,'Y'
            JE BEGIN
            CMP AL,'y'
            JE BEGIN
            JMP ENDD ;any char. else go out
            ;---------
ILLEGAL:    CMP AL,'A'         ; detictive for letter error
            JL ILLEGAL2
            CMP AL,'F'
            JG ILLEGAL2
            SUB AL,11H
            MOV C2,AL
            ;--------
            MOV AH,9
```

Chapter Six

```
                LEA DX,M5
                INT 21H ;---
                ------
                JMP MSG
                ;--------
ILLEGAL2:       MOV   AH,9
                LEA  DX,M4
                INT 21H
                JMP NEW
ENDD: MOV       AH,4CH
                INT 21H

MAIN ENDP
END MAIN
```



Chapter Six

(11)

Same Q10 but we put error counter in illegal lable.

```
TITLE Q9:WRITTEN BY MUHAMMAD WASEEM
(V.V)
.MODEL SMALL
.STACK 64
;-----------------
.DATA
CR EQU 0DH
LF EQU 0AH
M1 DB     CR,LF,'ENTER A HEXA DIGIT :','$'
M2 DB     CR,LF,'IN DECIMAL IT IS :'
C1 DB     ?,'$'
M3 DB    CR,LF,'DO YOU WANT TO DO IT AGAIN ?'
      DB  'Y/N','$'
M4 DB     CR,LF,'ILLEGAL CHARACTER – ENTER '
     DB    '0..9 OR A..F :','$'
M5 DB     CR,LF,'IN DECIMAL IT IS :1'
C2 DB     ?,'$'
M6 DB     CR,LF,'ERROR THREE TIMES ENTERD'
     DB    'ILLEGAL CHAR !','$'
;-----------------------------------
.CODE
MAIN PROC
     MOV AX,@DATA        ;INITIALIZE DS
     MOV DS,AX
     ;------
BEGIN:        MOV BL,0          ;counter for error
              MOV AH,9
              LEA DX,M1
```

Chapter Six

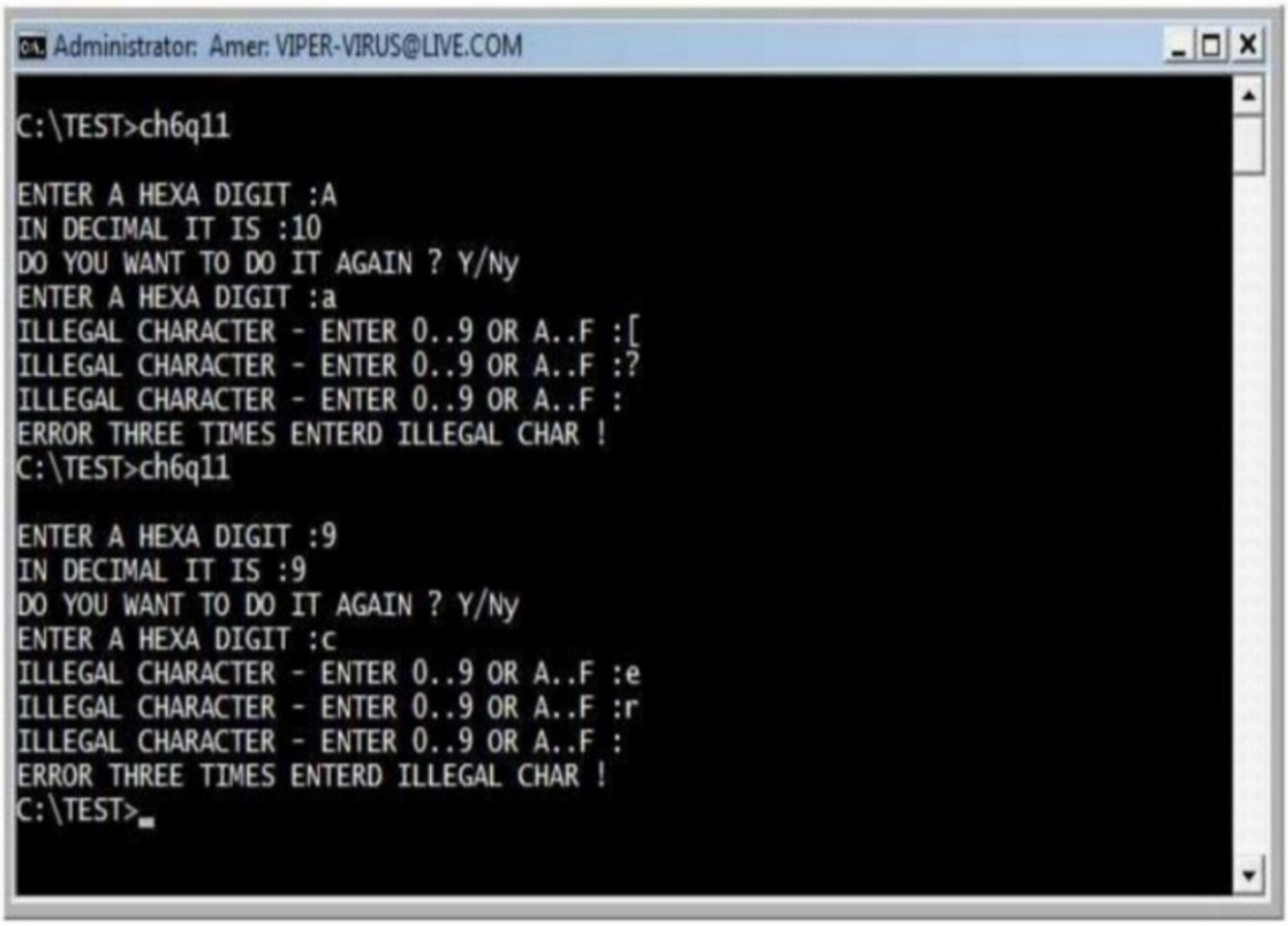
```
                INT 21H
                ;--------
NEW:             MOV AH,1          ;read hexa digit
                INT 21H
                ;--------
                CMP AL,'0'         ;detictive for errors
                JL ILLEGAL
                CMP AL,'9'
                JG ILLEGAL
                ;--------
                MOV C1,AL
                MOV AH,9
                LEA DX,M2
                INT 21H
                ;--------
MSG:             MOV AH,9
                LEA DX,M3
                INT 21H
                ;---------
                MOV AH,1          ;do u want to do it again
                INT 21H
                CMP AL,'Y'
                JE BEGIN
                CMP AL,'y'
                JE BEGIN
                JMP ENDD
                ;---------
ILLEGAL:        CMP AL,'A'
                JL ILLEGAL2
                CMP AL,'F'
```

Chapter Six

```
                JG ILLEGAL2
                SUB AL,11H

                MOV C2,AL
                ;--------
                MOV AH,9
                LEA DX,M5
                INT 21H ;---
                ------
                JMP MSG
                ;--------
ILLEGAL2:       MOV    AH,9
                LEA  DX,M4
                INT 21H
; counter for 3-times illegal input
                INC BL
                CMP BL,3
                JE ENDDD
                JMP NEW
ENDDD:           MOV AH,9
                LEA DX,M6
                INT 21H

ENDD:            MOV AH,4CH
                INT 21H
MAIN ENDP
                END MAIN
```

Chapter Six

Sample execution for Q11



Chapter Seven

(1)

a) 10001011b
b) 11111001b
c) 10100110b
d) 10100001b

---

(2)

```
a) AND        AX,AAAAh
b) OR         BL,81h
c) XOR        DX,8000h
d) method 1 :  NOT   WORD1
   method 2 :  XOR   WORD1,FFFFh
```

---

(3)

```
a) TEST       AX,FFFFh
b) TEST       BX,0001h
c) TEST       DX,8000h
d) TEST       DX,8000h
e) TEST       BL,FFh
```

Chapter Seven

(4)
Assuming AL = 11001011b = CBh then

a) AL = 10010110b = 96h
b) AL = 01100101b = 65h
c) AL = 00101111b = 2Fh
d) AL = 01111001b = 79h
e) AL = 11110010b = F2h
f) AL = 10010111b = 97h
g) AL = 11111001b = F9h

---

(5)
a) SHL B5,1

b) MOV CL,3
SHL AL,CL

c) MOV AX,32142
MOV CL,2
SHR AX,CL

d) MOV BX,-2145
MOV CL,4
SAR BX,CL ;SAR to keep the sign

Chapter Seven

(6)

```
a) OR      AL,30h
b) OR      DL,20h
```

.....

(7)

```
a) MOV      DL,BL
   MOV      CL,3
   SHL      BL,CL      ; BL= 8BL
   SHL      DL,1       ; DL= 2BL
   ADD      BL,DL      ; BL= 8BL+2BL =10BL
```

```
b) MOV      CL,3
   MOV      AH,0       ;empty AH
   ROR      AX,CL      ; remainder in AH
```

Chapter Seven

Programming Exercises

(8)

```
.MODEL SMALL
.DATA
M1      DB    'TYPE A CHARACTER :','$'
M2      DB   0AH,0DH,'THE ASCII CODE OF '
C1      DB    ?,' IN BINARY IS :','$'
M3     DB   0AH,0DH,'THE NUMBER OF 1 BIT IS '
C2      DB   ?,'$'

.CODE
MAIN PROC
MOV   AX,@DATA                    ;Initialize DS
MOV   DS,AX

MOV   AH,9                        ;prompt the user
LEA   DX,M1
INT   21H
;-------------

MOV   AH,1                        ;read character
INT    21H

MOV   BL,AL
MOV   C1,AL                       ;store character

MOV   AH,9                        ;display results
```

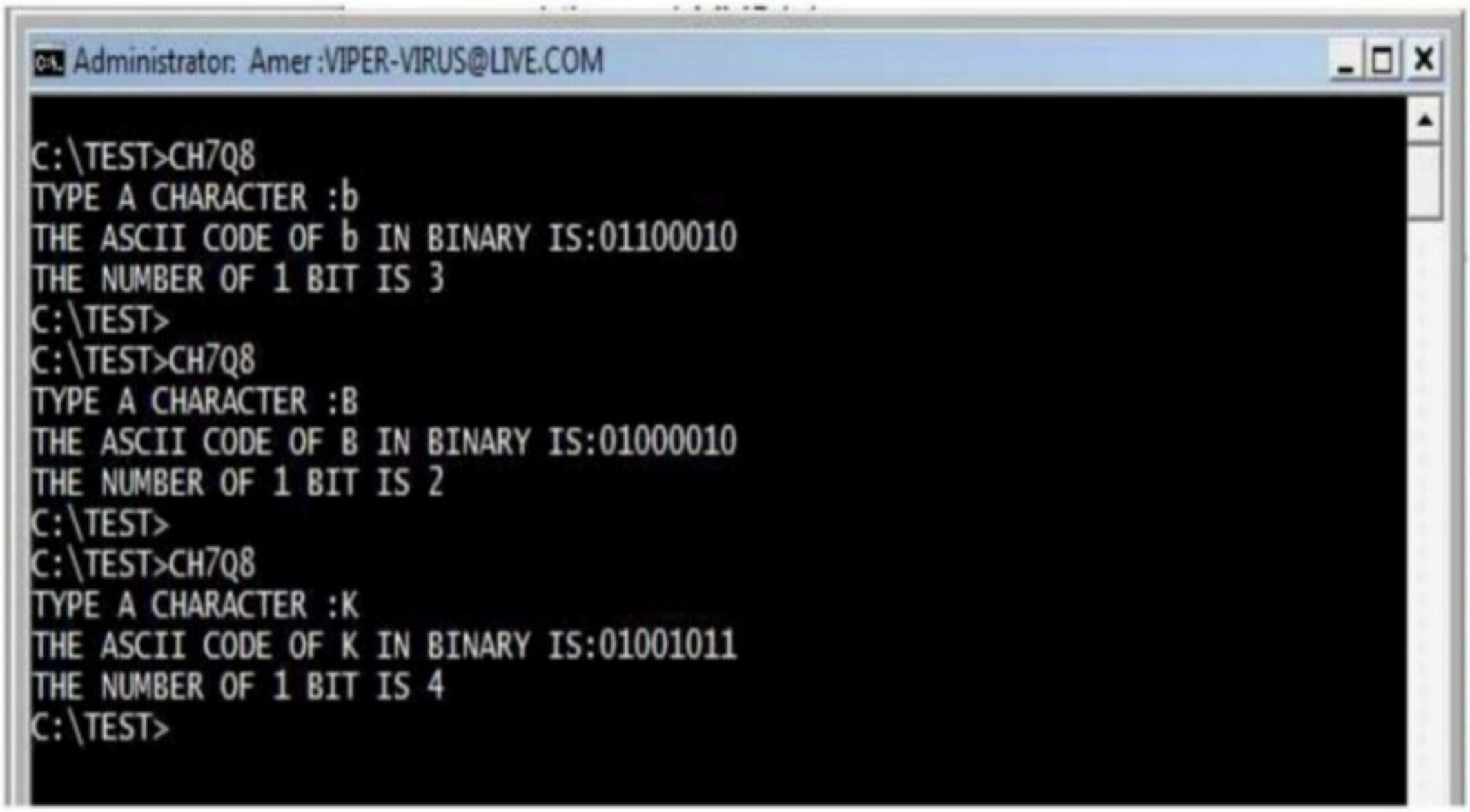
```
        LEA   DX,M2
        INT   21H
```

Chapter Seven

```
        MOV   BH,0                    ;counter for one's
        MOV   CX,8
        MOV   AH,2


        L1: SHL BL,1                  ;display content of BL
            JC      L2
            MOV     DL,'0'
            INT     21H
            JMP     L4
        L2: MOV  DL,'1'
            INT     21H
            INC     BH                ;count number of one's
        L4:         LOOP L1

            ADD     BH,30H            ;convert to char.
            MOV     C2,BH
            MOV     AH,9              ;display number of one's
            LEA     DX,M3
            INT     21H

        ;-------------------

        MOV     AH,4CH                ;return to DOS
        INT     21H

        MAIN    ENDP
        END  MAIN
```

Chapter Seven

Sample execution for Q8



Chapter Seven

(9)

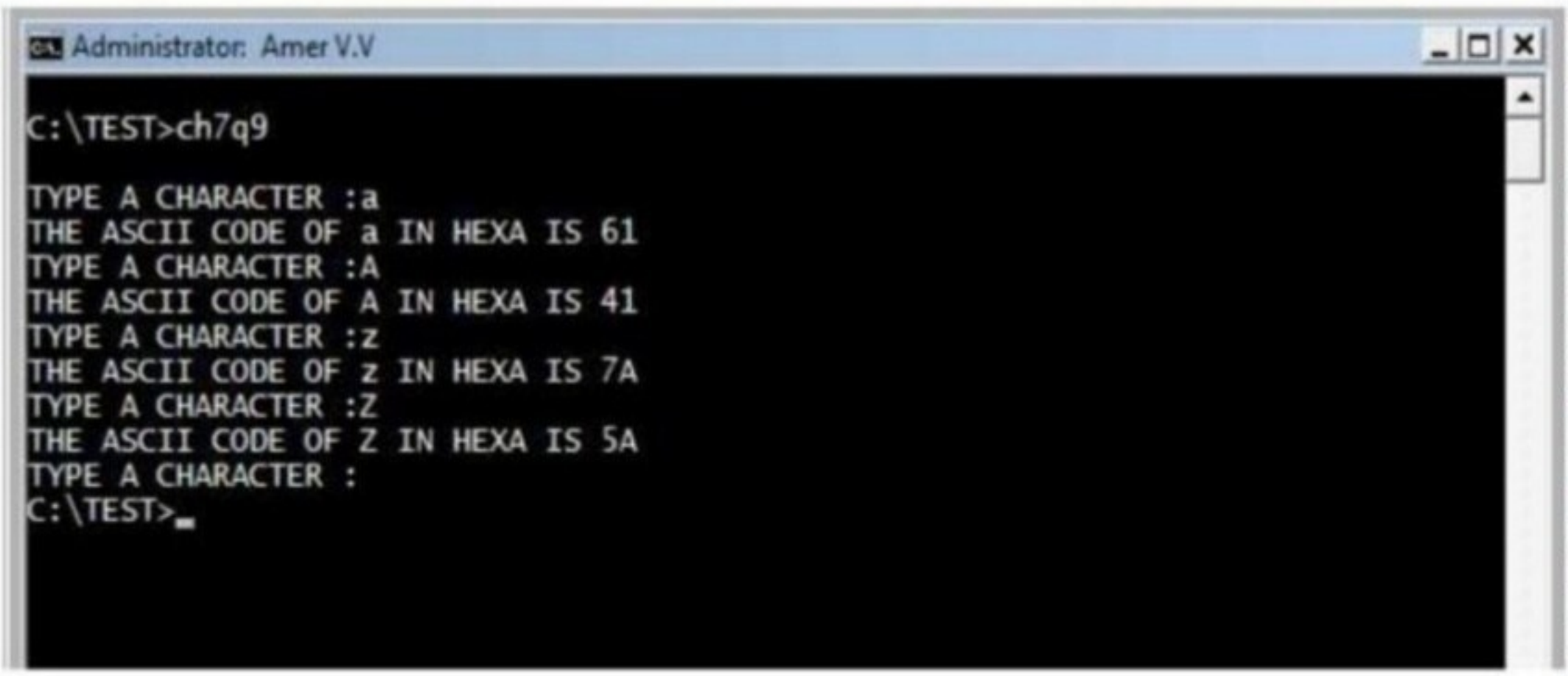
```
.MODEL SMALL
.DATA
M1 DB 0AH,0DH,'TYPE A CHARACTER :','$'
M2 DB 0AH,0DH,'THE ASCII CODE OF '
C1 DB ?,' IN HEXA IS ','$'

.CODE
MAIN PROC
MOV AX,@DATA            ;intialize DS
MOV DS,AX
;------------
BEGIN:    MOV AH,9      ;prompt user
          LEA DX,M1
          INT 21h

          MOV AH,1      ;read char.
          INT 21H

          CMP AL,0DH    ;if CR exit
          JE OUT_

          MOV C1,AL     ;store char.
          MOV BL,AL     ;take a copy of char

          MOV AH,9      ;display 2nd MSG
          LEA DX,M2
```

```
                INT 21H
;-------------
                MOV CL,4
                SHR C1,CL     ;prapare for display 1st half
                ;* note below
                ADD C1,30H          ;convert to char.
                MOV DL,C1
                JMP EXE1

continue:       AND BL,0FH          ;convert 2nd half to char.
                CMP BL,9      ;if >9 mean A,B,C…..hex ch.
                JG ERROR_

                ADD BL,30H          ;convert to char.
                MOV DL,BL
                JMP EXE2

EXE1:            MOV AH,2           ;1st half displayed
                INT 21H
                JMP continue

EXE2:            MOV AH,2
                INT 21H             ;2nd half displayed

                JMP BEGIN     ;ask if you want to do it again
;------------

ERROR_:    ADD BL,37H     ;convert to A,B,C…. hexa ch.
           MOV DL,BL
           MOV AH,2       ;display it
```

```
        INT 21H

        JMP BEGIN          ;ask if you want to do it again

OUT_:   MOV AH,4CH         ;return to DOS
        INT 21H

MAIN  ENDP
        END MAIN
```

* note : in first half we doesn't need to compare if no. in C1 >9 because it will not be .
Great no. could reach is 7 in "z"
But in second half all hexa digit could be shown
(Ex: z = 7A o = 6F)

sample execution for Q9



Chapter Seven

(10)

```
.MODEL SMALL
.DATA
M1 DB 0AH,0DH,'TYPE A HEXA NUMBER (0 - FFFF) : ','$'
M2 DB 0AH,0DH,'IN BINARY IT IS : ','$'
M3 DB 0AH,0DH,'ILLEGAL HEXA DIGIT, TRY AGAIN :','$'

.CODE
MAIN PROC
        MOV AX,@DATA        ;intialize DS
        MOV DS,AX

        MOV AH,9            ; prompts user
        LEA DX,M1
        INT 21H

START   :XOR BX,BX
        MOV CL,4
        MOV AH,1
        INT 21H             ;read
WHILE_: CMP AL,0DH
        JE END_WHILE        ;exit if CR
        CMP AL,'0'          ;detect for error
        JL ERR
        CMP AL, '9'
        JG LETTER
        AND AL,0FH          ;get numerical value
        JMP SHIFT
```

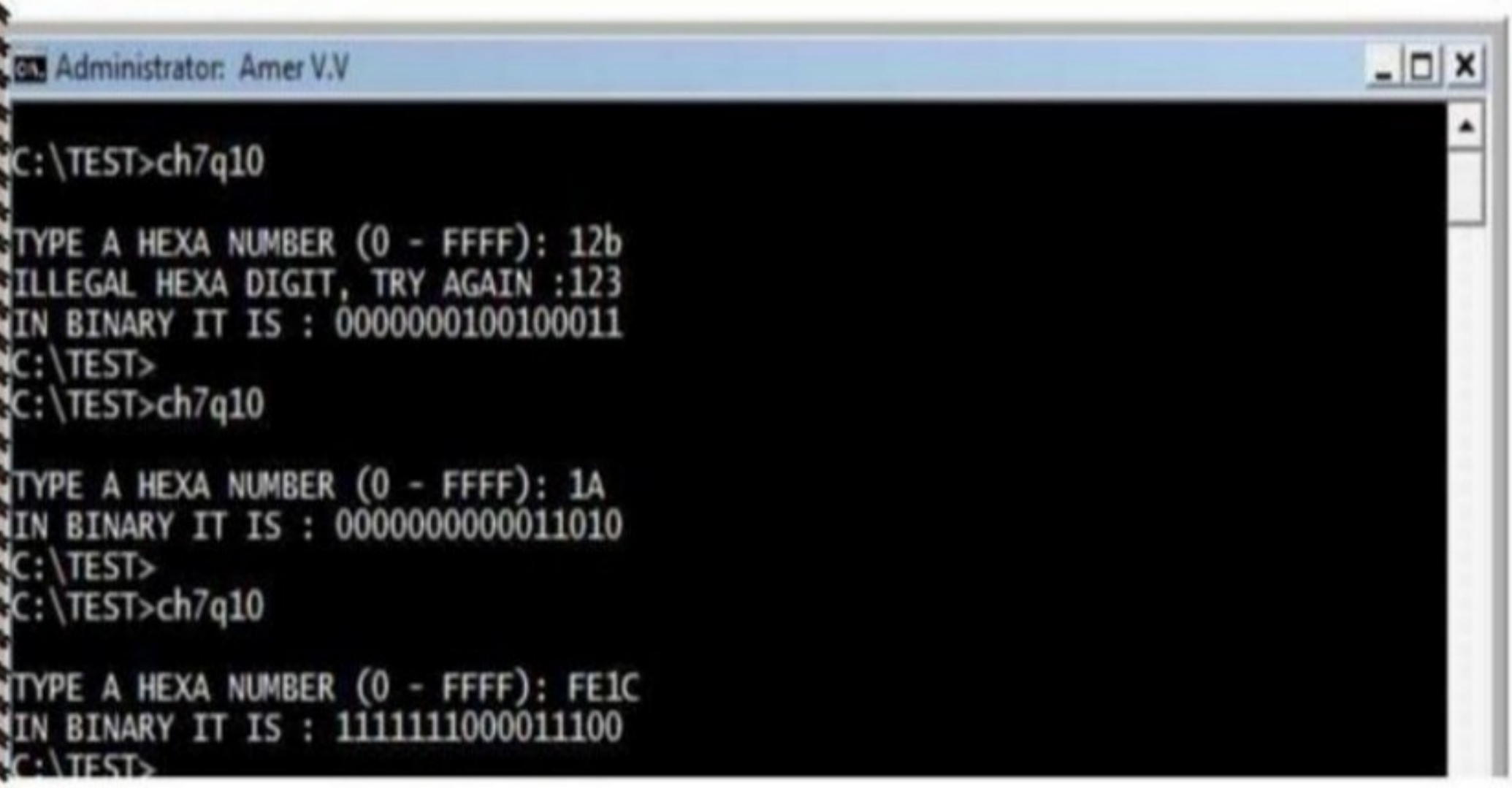
Chapter Seven

```
LETTER:     CMP AL,'F'    ;if not in range (A…B) error
            JG ERR
            CMP AL,'A'
            JL ERR
            SUB AL,37H    ;get numerical value

SHIFT:      SHL BX,CL     ; ready to enter in register
            OR BL,AL
            INT 21H
            JMP WHILE_          ;continue reading hexa

END_WHILE:MOV AH,9              ; if finish reading
            LEA DX,M2           ;display result
            INT 21H

            MOV CX,16           ;display content of BX
            MOV AH,2
SHOW:       SHL BX,1
            JC ONE

            MOV DL,'0'
            INT 21H
            JMP LOOP1

ONE:        MOV DL,'1'
            INT 21H

LOOP1:      LOOP SHOW           ;do it 16 times
            JMP OUT_
```

Chapter Seven

```
ERR:        MOV AH,9
            LEA DX,M3          ;display error MSG

            INT 21H
            JMP START          ;and read again


OUT_:       MOV AH,4CH
            INT 21H
MAIN ENDP
            END MAIN
```

sample execution for Q10



Chapter Seven

(11)

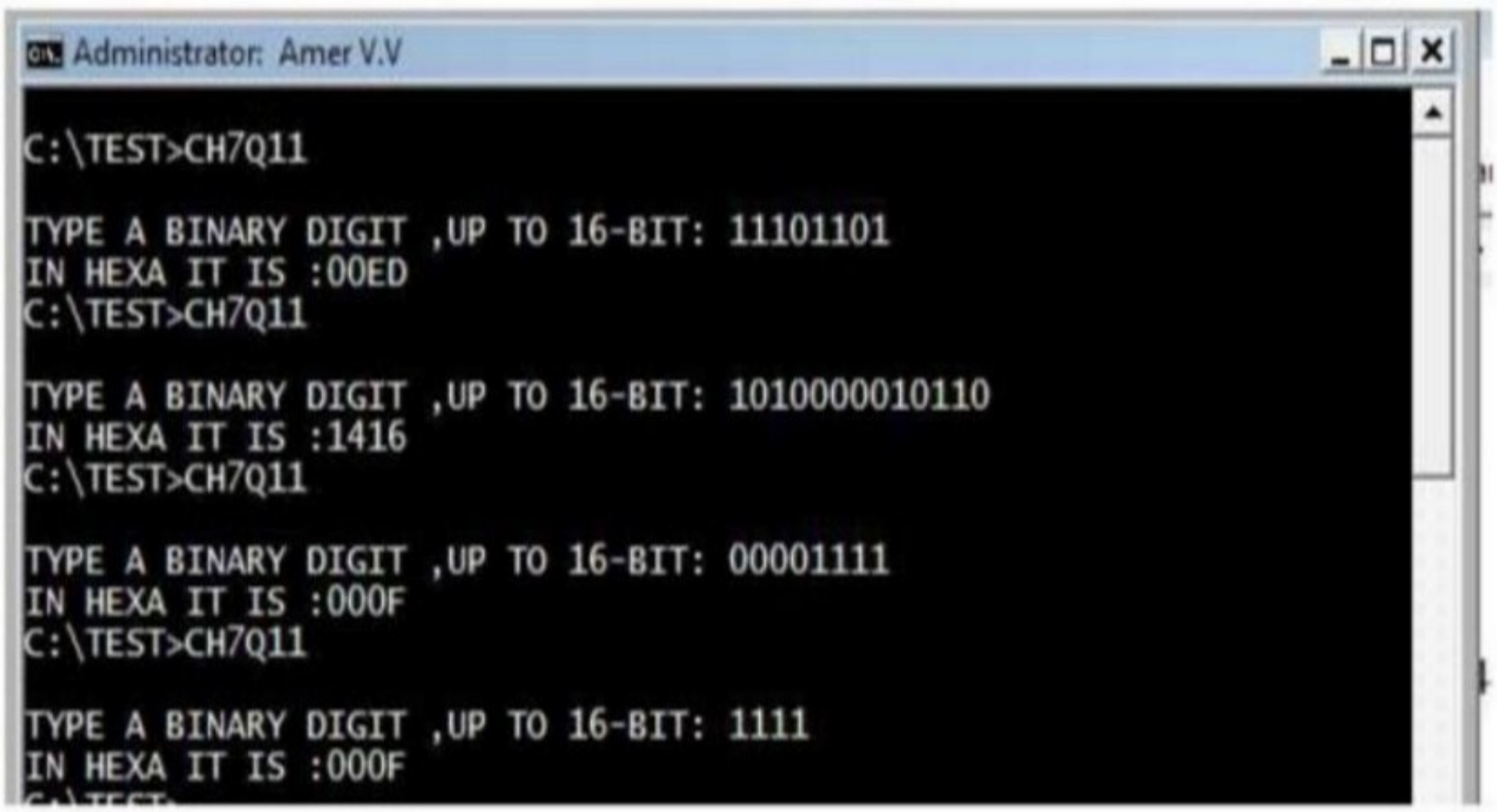
```
.MODEL SMALL

.DATA
M1 DB 0AH,0DH,'TYPE A BINARY DIGIT ,UP TO 16-BIT: ','$'
M2 DB 0AH,0DH,'IN HEXA IT IS :','$'

.CODE
MAIN PROC
        MOV AX,@DATA        ;initialize DS
        MOV DS,AX

        MOV AH,9            ;prompt user
        LEA DX,M1
        INT 21H
        ;--------------
        MOV BX,0            ;prepare for read binary
        MOV AH,1
        MOV CX,16

L1:     INT 21H
        CMP AL,0DH          ;finish enter
        JE OUT_

        AND AL,01H          ;convert to numerical 0,1
        SHL BX,1            ;store it in BX
        OR BL,AL
        LOOP L1
```

Chapter Seven

```
OUT_:   MOV AH,9
        LEA DX,M2
        INT 21H


        MOV DH,4        ;show 4-digit hexa
L2:     MOV CL,4
        MOV DL,BH
        SHR DL,CL
        MOV AH,2


        CMP DL,9    ;detect the digit
        JG LETTER
        ADD DL,30H
        INT 21H
        JMP L3

LETTER:
        ADD DL,37H
        INT 21H
L3:     ROL BX,CL       ;get second hexa digit

        DEC DH
        CMP DH,0
        JNE L2          ;if 4-digit hexa displayed exit
```

```
MOV AH,4CH          ;return to DOS

INT 21H
MAIN ENDP
END MAIN
```

sample execution for Q11



Chapter Seven

(12)

```
.MODEL SMALL

.DATA
B1 DB ?
B2 DB ?
M1 DB 0AH,0DH,'TYPE A BINARY NUMBER , UP TO 8 DIGITS :','$'
M2 DB 0AH,0DH,'THE BINARY SUM IS
','$' ;---------------
.CODE
MAIN PROC
        MOV AX,@DATA            ;initialize DS
        MOV DS,AX

        MOV AH,9 ;prompt user
        LEA DX,M1
        INT 21H

        MOV BL,0
        MOV CX,8
        MOV AH,1

L1:     INT 21H
        CMP AL,0DH
        JE OUT
        SUB AL,30H      ;or use AND AL,01H
        SHL BL,1
        OR BL,AL
        LOOP L1
```

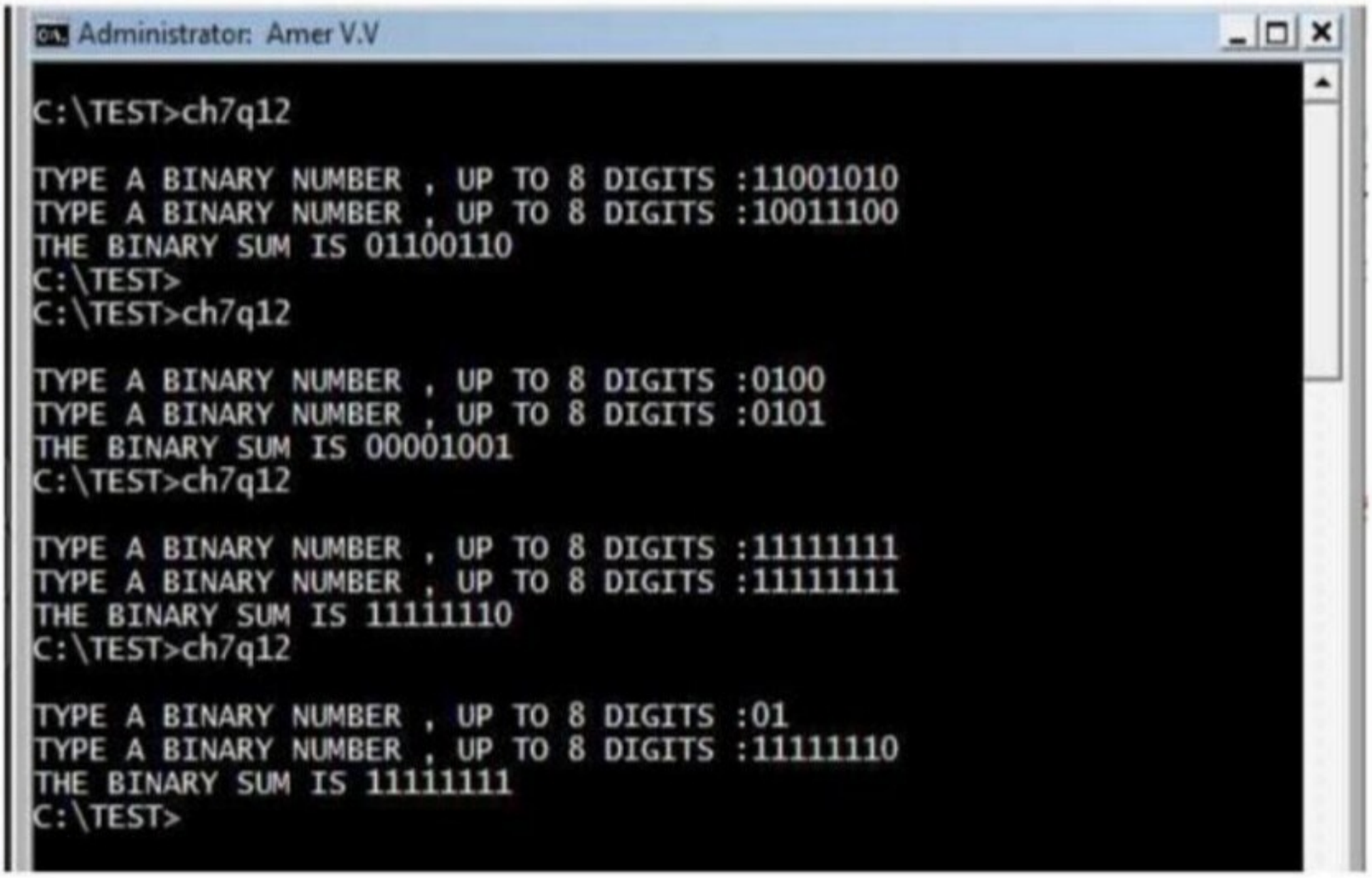
Chapter Seven

```
OUT:    MOV B1,BL          ;1st no. read and store

        MOV AH,9   ;prompt user for 2nd no.
        INT 21H
        MOV BL,0   ;read 2nd no.
        MOV CX,8
        MOV AH,1
L2:     INT 21H
        CMP AL,0DH
        JE OUT2
        SUB AL,30H
        SHL BL,1
        OR BL,AL
        LOOP L2

OUT2:   MOV B2,BL    ;2nd no. read and store

        MOV AH,9   ;show result
        LEA DX,M2
        INT 21H
        ADD BL,B1 ;BL has 2nd no. (last one read)
        MOV AH,2
        MOV CX,8
L3:     SHL BL,1           ;display binary
        JC ONE
        MOV DL,'0'
        INT 21H
        JMP continue
ONE:    MOV DL,'1'
```

Chapter Seven

```
INT 21H
continue: LOOP L3
;-----------------

MOV AH,4CH        ;return to DOS
INT 21H
MAIN ENDP
          END MAIN
```

sample execution for Q12



Chapter Seven

(13)

In this question we use procedures technique to make the solution easier and readable
You'll know more about procedure in next chapter (ch.8)

```
.MODEL SMALL

.DATA
M1 DB 0AH,'TYPE A HEXA NUMBER 0 -FFFF
:$' M2 DB 0AH,'THE SUM IN HEXA IS $'
COUNTER   DB 4
NUM       DW ?

.CODE
MAIN PROC
        MOV AX,@DATA            ;initialize DS
        MOV DS,AX
        MOV AH,9        ;prompt user
        LEA DX,M1
        INT 21H

        CALL READ
        MOV NUM,BX          ;store 1st num.

        MOV AH,9        ;prompt user for 2nd number
        LEA DX,M1
        INT 21H
        CALL READ       ;no need to store 2nd num.
                ;because it will still in BX
```

```
;-----------
                MOV AH,9            ;display result msg
                LEA DX,M2
                INT 21H

                ADD BX,NUM
                ;BX=num1(NUM)+num2(BX)
                JC SHOWCY                ;if there carry
                MOV AH,2            ;no carry
                MOV DL,'0'
                INT 21H
                JMP NEXT

SHOWCY:MOV AH,2
                MOV DL,'1'
                INT 21H

NEXT:  CALL SHOW

                MOV AH,4CH               ;return to DOS
                INT 21H

MAIN ENDP       ;end of main program
```

Chapter Seven

```
;-----------------------------------------
READ PROC        ;for read hexa digit
            XOR BX,BX
            MOV CL,4
            MOV AH,1
            INT 21H
WHILE_: CMP AL,0DH
            JE END_W
            CMP AL,'9' ;detect for letter hexa
            JG LETTER
            AND AL,0FH
            JMP SHIFT

LETTER: SUB AL,37H
SHIFT:      SHL BX,CL
            OR BL,AL
            INT 21H
            JMP WHILE_
END_W: RET
READ ENDP
;-----------------------------------
SHOW PROC              ;to display result of addition
            MOV CL,4
START: MOV DL,BH
            SHR DL,CL
            CMP DL,9
            JG LETTER1
            ADD DL,30H
            JMP SHOW1
```

```
LETTER1:ADD DL,37H

SHOW1: MOV AH,2
            INT 21H
            ROL BX,CL
            DEC COUNTER
            CMP COUNTER,0
            JNE START
RET
SHOW ENDP ;---------------------
-------------------
            END MAIN
```

* NOTE: taking a look on the result you will find it consist of 5-hex-digit ,last digit on the left is the carry .
So adding 4-hexa- digit will produce :
-No carry (last digit on the left = 0) -
carry (last digit on the left =1)

Chapter Seven

sample execution for Q13

```
Administrator: Amer :VIPER-VIRUS@LIVE.COM

C:\TEST>CH7Q13

TYPE A HEXA NUMBER 0 -FFFF :21AB
TYPE A HEXA NUMBER 0 -FFFF :FE03
THE SUM IN HEXA IS 11FAE
C:\TEST>CH7Q13

TYPE A HEXA NUMBER 0 -FFFF :10
TYPE A HEXA NUMBER 0 -FFFF :E5
THE SUM IN HEXA IS 000F5
C:\TEST>CH7Q13

TYPE A HEXA NUMBER 0 -FFFF :E100F0
TYPE A HEXA NUMBER 0 -FFFF :1
THE SUM IN HEXA IS 00F09
C:\TEST>CH7Q13

TYPE A HEXA NUMBER 0 -FFFF :C100
TYPE A HEXA NUMBER 0 -FFFF :A000
THE SUM IN HEXA IS 16100
C:\TEST>_
```

Chapter Seven

(14)
Procedures are used

```
.MODEL SMALL
.DATA
M1 DB 0AH,'ENTER A DECIMAL DIGIT STRING :$'
M2 DB 0AH,'THE SUM OF THE DIGIT IN HEX IS $'
COUNTER DB 4

.CODE
MAIN PROC
        MOV AX,@DATA        ;initialize DS
        MOV DS,AX
        MOV AH,9    ;prompt user
        LEA DX,M1
        INT 21H
CALL READ
        MOV AH,9
        LEA DX,M2 ;display result msg
        INT 21H
CALL SHOW

MOV AH,4CH              ;return to DOS
INT 21H

MAIN ENDP
```

Chapter Seven

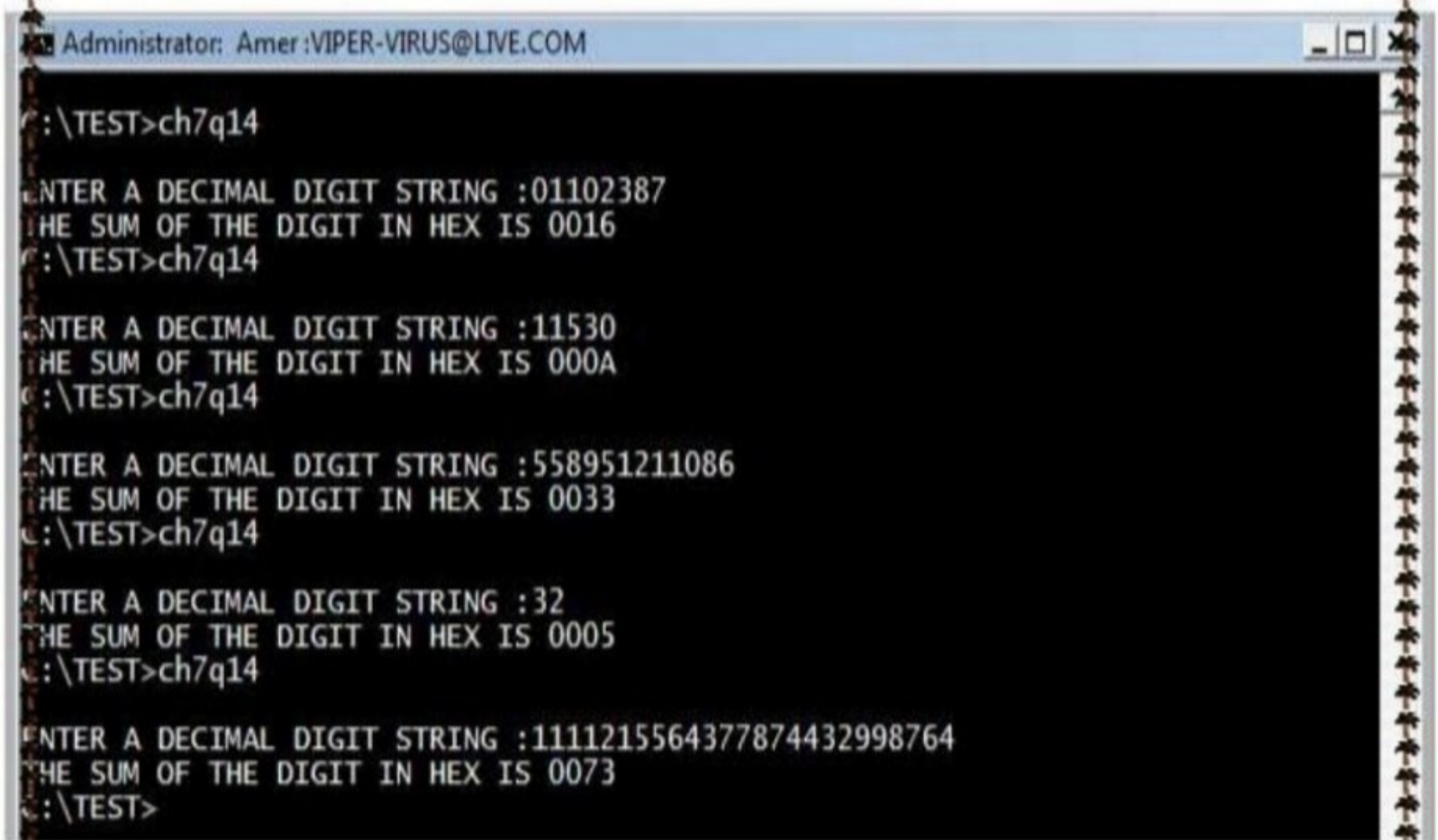
```
;----------------------------------------
READ PROC ;read decimal digit and add them
        XOR BX,BX
WHILE_: MOV AH,1
        INT 21H CMP
        AL,0DH
        JE END_W
        AND AL,0FH
        CBW ;Convert Byte to Word
;since we cann't add BX,AL we use CBW
        ADD BX,AX
        JMP WHILE_

END_W:
    RET
READ ENDP ;----------------------
------------------
SHOW PROC MOV
        CL,4
START: MOV DL,BH
        SHR DL,CL
        CMP DL,9
        JG LETTER1
        ADD DL,30H
        JMP SHOW1

LETTER1:ADD DL,37H

SHOW1: MOV AH,2
```

```
        INT 21H
```

Chapter Seven

```
        ROL BX,CL
        DEC COUNTER
        CMP COUNTER,0
        JNE START
        RET
    SHOW ENDP

        END MAIN
```

sample execution for Q14



Chapter Eight

(1)

a) SP = 0100h

b) 100h byte for stack mean 100h/2 word

80h word

---

(2)

AX = 9ABCh

BX = 9ABCh

CX = 5678h

SP = 00FEh

---

(3)

When SP= 0 and decrement its become SP= FFFEh.
Program will not produce error ,but CS area is mix with SS area ,that might produce error in result in big program.

---

(4)

IP = 0300h

SP = 0108h

Word on top of stack is 0203h

Chapter Eight

(5)

a) IP = 012Ah
SP = 0202h

b) IP = 012Ah
SP = 0206h

Note : RET POP_VALUE
Mean the stack get more size
Original value of SP =202h + POP_VALUE(4) = 206h

---

(6)

a) POP AX
PUSH AX

b) POP AX
POP CX
PUSH CX
PUSH AX

c) POP AX
POP BX
PUSH AX
PUSH BX

Chapter Eight

(7)

a)
```
SAVE_REGS  PROC
        POP AX      ;save return address
        PUSH BX     ;save regs in the stack
        PUSH CX
        PUSH DX
        PUSH SI
        PUSH DI
        PUSH BP
        PUSH DS
        PUSH AX     ;top of stack is return address
RET
SAVE_REGS  ENDP
```

---

b)
```
RESTORE_REGS PROC
        POP AX      ; save return address
        POP DS      ; restore regs from the stack
        POP BP
        POP DI
        POP SI
        POP DX
        POP CX
        POP BX
        PUSH AX     ; top of stack is return address
RET
RESTORE_REGS ENDP
```

Chapter Eight

Programming Exercises

(10)

a)Note : to make the range between 1 to 32767 we just ignore msb (sign bit /bit-15) by enter 15 bit.

```
INBINARY      PROC
              XOR  BX,BX
               Mov  CX,15
              MOV AH,1
              INT    21H
WHILE_: CMP AL,0DH
              JE    END_WHILE
              AND  AL,01H
              SHL  BX,1
             OR     BL,AL
             INT 21H
              LOOP    WHILE_
END_WHILE:
RET

INBINARY    ENDP
```

Chapter Eight

b)
by following the algorithm:

```
RANDOM    PROC
;input in AX   : start with any number in the range
;output in AX   (Random number)
          PUSH BX       ;save regs
          PUSH DX
          SHL   AX,1        ; shift left once
          MOV DX,AX       ;get copy
          SHL   DX,1      ;make bit-14 be bit-15
          XOR   AX,DX     ;xor bit-14 with bit-15
       TEST    DX,8000h  ;result of XOR bit-14 with bit-15
         JZ    NOT_ONE
        OR     AX,1   ;replace bit-0 with result (1)
         JMP   CL_B15       ;clear bit-15

NOT_ONE: AND     AX,0FFFEH  ;replace bit-0 with (0)

CL_B15:     AND AX,7FFFH

POP DX          ;restore regs
POP BX
RET

RANDOM      ENDP
```

Chapter Eight

c)

```
OUTBIN PROC
;input AX
;output on screen
;we copy number in BX to make sure not changing the
;number because of output function that depend on AX

            MOV     BX,AX ;get copy
            MOV     CX,16
start:       ROL BX,1
             JC     ONE

            MOV   AH,2
            MOV    DL,'0'
             INT     21H
             JMP      L1

ONE:         MOV AH,2
            MOV DL,'1'
            INT 21H
L1:          LOOP start
;put the random number in AX to be new number to
generate another random number
            MOV AX,BX

RET
OUTBIN      ENDP
```

Chapter Eight

The full program looks like :

```
.MODEL SMALL
.stack 64
.DATA
Counter    DB     100    ;number to be generated
Counter2   DB      4    ;4 number on same line

.CODE
Main    PROC
    MOV AX,@DATA
    MOV DS,AX
;------------------
                CALL INBINARY
                MOV AX,BX
Begin:          MOV D,4
L10:            POP AX
                CALL  RANDOM
                CALL OUTBIN
                PUSH AX
;------------------


                MOV AH,2
                MOV DL,20H  ;blank space
                INT 21H
```

;---

Chapter Eight

```
                DEC counter2
            CMP counter2,0     ;is there 4-number on line
                JE NEW_LINE
                DEC Counter
                CMP Counter,0
                JNE L10
JMP OUT_

NEW_LINE:       MOV AH,2
                MOV DL,0AH ;enter LF
                INT 21H
                JMP Begin
OUT_:
MOV AH,4CH
INT 21H


;-------------------------
Main ENDP
;see Appendix C for include pseudo-ops
;Test is folder's name in c:\ contain procedures
INCLUDE C:\TEST\RANDOM.ASM
INCLUDE C:\TEST\INBINARY.ASM
INCLUDE C:\TEST\OUTBIN.ASM

END Main
```

Chapter Eight

sample execution for Q10 (ran. Num. gen.)

Administrator: Amer mohammed Al-khsabah

```
C:\TEST>nt
0111011110010000 0011000101100001 0010011101000111 0101001110010011
0110100101101010 0111011101111101 0011001100001111 0010101000100011
0111110011001011 0000101010111011 0011111110011010 0000000101011101
0000011111001110 0001000010100100 0110001111011000 0100100011010001
0011001011100110 0010111001010101 0110010111111111 0101110000000011
0100100000001010 0011000000111100 0010000010001001 0100001100110111
0000101010110010 0011111110101100 0000000111101001 0000010001110110
0001100100110100 0101011010111000 0111011110010000 0011000101100001
0010011101000111 0101001110010011 0110100101101010 0111011101111101
0011001100001111 0010101000100011 0111110011001011 0000101010111011
0011111110011010 0000000101011101 0000011111001110 0001000010100100
0110001111011000 0100100011010001 0011001011100110 0010111001010101
0110010111111111 0101110000000011 0100100000001010 0011000000111100
0010000010001001 0100001100110111 0000101010110010 0011111110101100
0000000111101001 0000010001110110 0001100100110100 0101011010111000
0111011110010000 0011000101100001 0010011101000111 0101001110010011
0110100101101010 0111011101111101 0011001100001111 0010101000100011
0111110011001011 0000101010111011 0011111110011010 0000000101011101
0000011111001110 0001000010100100 0110001111011000 0100100011010001
0011001011100110 0010111001010101 0110010111111111 0101110000000011
0100100000001010 0011000000111100 0010000010001001 0100001100110111
0000101010110010 0011111110101100 0000000111101001 0000010001110110
0001100100110100 0101011010111000 0111011110010000 0011000101100001
0010011101000111 0101001110010011 0110100101101010 0111011101111101
0011001100001111 0010101000100011 0111110011001011 0000101010111011
0011111110011010 0000000101011101 0000011111001110 0001000010100100
0110001111011000 0100100011010001 0011001011100110 0010111001010101
0110010111111111 0101110000000011 0100100000001010 0011000000111100
0010000010001001 0100001100110111 0000101010110010 0011111110101100
0000000111101001 0000010001110110 0001100100110100 0101011010111000
0111011110010000 0011000101100001 0010011101000111 0101001110010011
0110100101101010 0111011101111101 0011001100001111 0010101000100011
0111110011001011 0000101010111011 0011111110011010 0000000101011101
0000011111001110
```

Chapter Nine

(1)

	DX	AX	CF/OF
a)	0000	0018	0
b)	000F	F000	1
c)	FFFF	FFFB	0
d)	0000	8000	1

e) Illegal : source must be register or M.L

(2)

	AX	CF/OF
a)	0AB0	1
b)	FAB0	1
c)	00AB	0
d)	FFF6	0

(3)

	DX	AX
a)	0001	0003
b)	000E	0FFF
c)	FFFF	FFFF

d) divide overflow

Chapter Nine

(4)

	AH	AL
a)	01	04
b)	FF	02
c)	0E	0F
d)	divide overflow	

(5)

	DX
a)	0000
b)	FFFF
c)	0000

(6)

	AX
a)	FFF0
b)	00F5
c)	FF80

Chapter Nine

(7)

a)
```
MOV AX,5        ; AX=5
IMUL A          ;AX=5*A
SUB  AX,7       ;AX=5*A-7
MOV  A,AX       ;A=5*A-7
```

---

b)
```
MOV AX,A        ;AX=A
SUB  AX,B       ;AX=A-B
ADD  B,10       ;B=B+10
IMUL  B         ;AX=(A-B)*(B+10)
MOV  B,AX       ;B=(A-B)*(B+10)
```

---

c)
```
MOV  AX,9       ;AX=9
IMUL  A         ;AX=9*A
MOV  BX,6       ;BX=6
SUB  BX,AX      ;BX=6-9*A
MOV  A, BX      ;A=6-9*A
```

Chapter Nine

```
d) MOV     AX,A              ;AX=A
    IMUL    AX               ;AX=A^2
   MOV     A,AX              ;A=A^2
   MOV    AX,B               ;AX=B
   IMUL     AX               ;AX=B^2
    MOV   BX,AX              ;BX=B^2
   ADD    BX,A               ;BX=B^2+A^2
   MOV   AX,C                ;AX=C
   IMUL    AX                ;AX=C^2

CMP  BX,AX                   ;A^2+B^2=? C^2
     JE        SET_CF
      CLC                    ;CLEAR CF
       JMP END_IF
SET_CF: STC                  ;SET CF

END_IF:
```

Chapter Nine

Programming Exercises

(8)

We check for overflow in 2 steps:

1. after line 42 we check for overflow if DX not zero

```
CMP DX,0
JNE  @NOT_DIGIT
```

2. after line 44 we check for overflow if there carry

```
JC @NOT_DIGIT
```

You can see the procedure in Appendix C "INDEC2"

Chapter Nine

(9)

```
.MODEL SMALL
.STACK 64

.DATA
M1 DB 0AH,0DH,'THE TIME IS $'

.CODE
MAIN PROC
        MOV AX,@DATA            ;intialize DS
        MOV DS,AX

        CALL INDEC
        MOV DX,0  ;make sure no thing in DX
        MOV BX,3600             ;60min*60sec=1hr
        DIV BX
        PUSH AX
        PUSH DX
;---------

MOV AH,9                        ;display result
LEA DX,M1
INT 21H

        POP DX
        POP AX                  ;AX has hours

        CALL OUTDEC
        PUSH DX
```

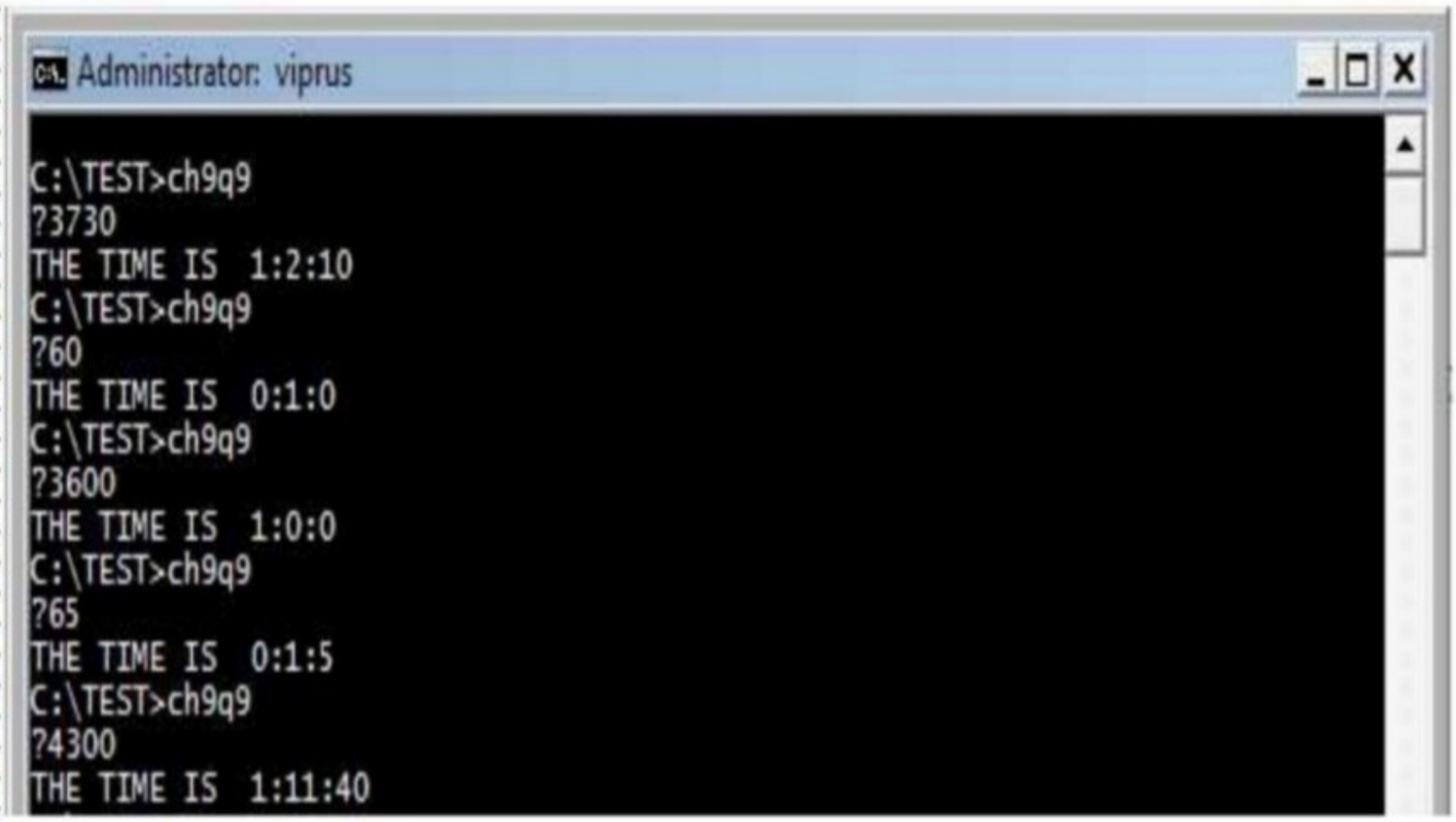
Chapter Nine

```
MOV AH,2
MOV DL,':'
INT 21H
;----------
POP AX
MOV BX,60
MOV DX,0
DIV BX
CALL OUTDEC                ;AX has mins
PUSH DX
;----------
MOV AH,2
MOV DL,':'
INT 21H
POP AX
CALL OUTDEC                ;AX has sec remainder
;----------
MOV AH,4CH                 ;return to DOS
INT 21H

MAIN ENDP

INCLUDE C:\TEST\OUTDEC.ASM
INCLUDE C:\TEST\INDEC.ASM
END MAIN
```

You can get procedures code that included above from Appendix C ,Test :is name for folder in c:\ that contain procedures

Chapter Nine

sample execution for Q9



Chapter Nine

(10)

Note: Half = 50 cents
Quarter = 25 cents
Dime = 10 cents
Nickle = 5 cents
Penny = 1 cents

```
.MODEL SMALL
.DATA
START   DB 0AH,0DH
HLF     DB   ?,' Half '
QUA     DB   ?,' Quarter '
DIM     DB   ?,' Dimes '
NIC     DB   ?,' Nickels '
PEN     DB   ?,' Pennies ','$'

.CODE
MAIN PROC
        MOV AX,@DATA
        MOV DS,AX ;-------------------------
-------------------------
        CALL INDEC        ;AX has cents

        MOV BL,50  ;half DOllaR
        DIV BL
        ADD AL,30h        ;CONVERT TO DIGIT
        MOV HLF,AL
```

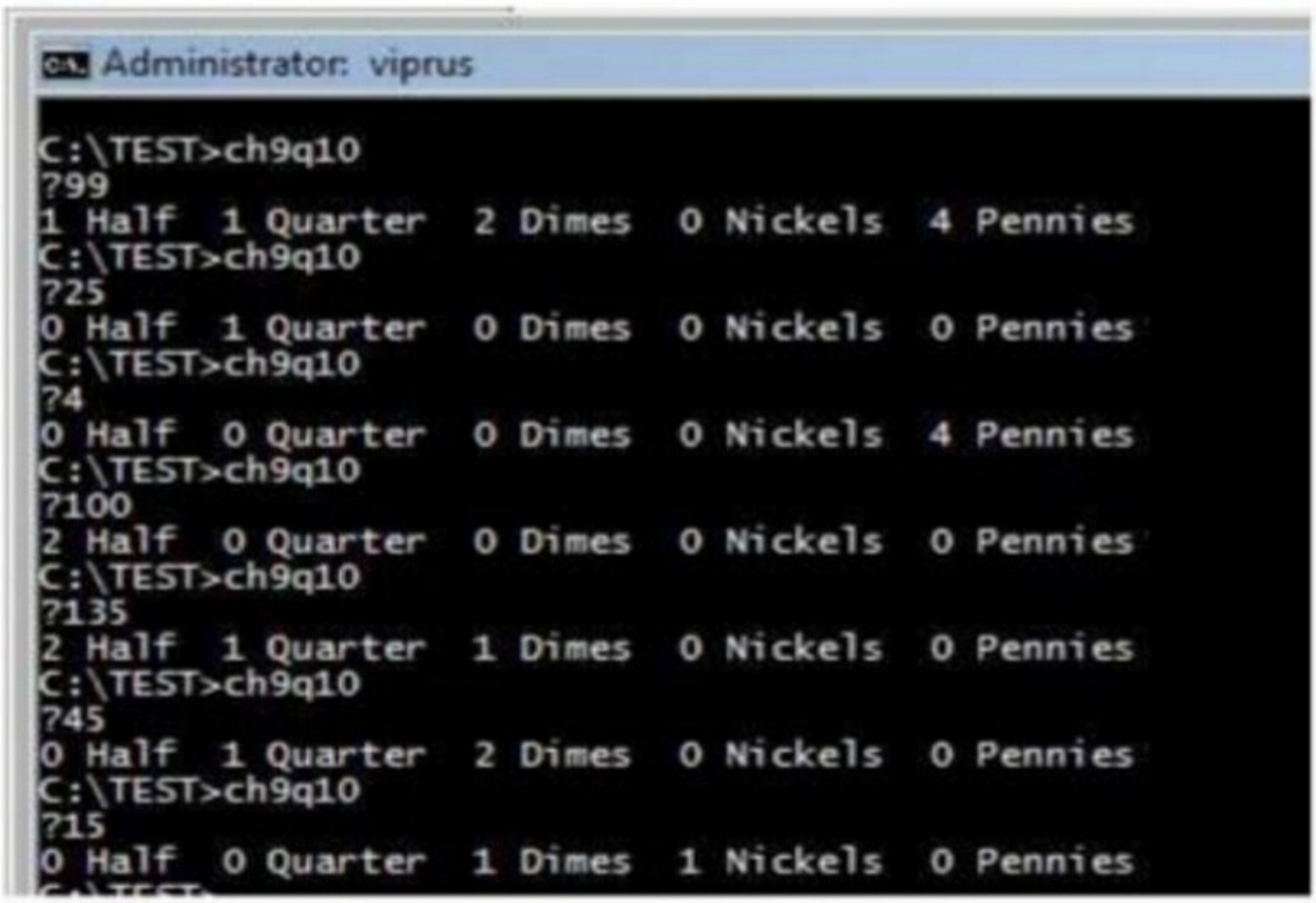
Chapter Nine

```
;----------------------
MOV AL,AH
MOV AH,0
      MOV BL,25  ;Quarter
      DIV BL
      ADD AL,30h
      MOV QUA,AL
;--------------------
MOV AL,AH
MOV AH,0
      MOV BL,10  ;DIME
      DIV BL ADD
      AL,30H
      MOV DIM,AL
;-------------------
MOV AL,AH
MOV AH,0
      MOV BL,5     ;nickle
      DIV BL
      ADD AL,30h
      MOV NIC,AL
;---------------
ADD AH,30h
MOV PEN,AH       ;remainder is pennies
;------------------------------------------
MOV AH,9         ;display result
LEA DX,START
INT 21H
```

Chapter Nine

```
;-----------------
MOV AH,4CH
INT 21H

MAIN ENDP
INCLUDE C:\TEST\INDEC.ASM

    END MAIN
```

sample execution for Q10



Chapter Nine

(11)

```
.MODEL SMALL
.DATA
M1 DB 0AH,0DH,'enter M : $'
M2 DB 0AH,0DH,'enter N : $'
M3 DB 0AH,0DH,'RESULT IS  $'

.CODE
MAIN PROC

MOV AX,@DATA
MOV DS,AX
      MOV AH,9
      LEA DX,M1
      INT 21H
      ;--------
      CALL INDEC        ;enter M
      MOV BX,AX         ; M in BX
      MOV AH,9
      LEA DX,M2
      INT 21H
      CALL INDEC ;      read N in AX
      PUSH AX
      ;----------------
      MOV AH,9
      LEA DX,M3
      INT 21H
      MOV AH,2          ;print " . "
      MOV DL,'.'
```

Chapter Nine

```
INT 21H
;----------------

        POP AX
        XCHG AX,BX              ;AX is M BX is N

WHILE_:     MOV CX,10
        MOV DX,0
        IMUL CX             ;AX=AX*10
        DIV BX

        CALL OUTDEC

        MOV AX,DX ;Replace M by R
        CMP DX,0
        JNE WHILE_

        ;----------------

;-------------------------------
MOV AH,4CH
INT 21H

MAIN ENDP
INCLUDE C:\TEST\INDEC.ASM
INCLUDE C:\TEST\OUTDEC.ASM

END MAIN
```

Chapter Nine

Note: don't use numbers produce infinit result e.g : 5/6 , 88/90 …

sample execution for Q11

```
Administrator: Amer Al-khsabah

C:\TEST>ch9q11

enter M : ?3
enter N : ?4
RESULT IS     .75
C:\TEST>ch9q11

enter M : ?44
enter N : ?50
RESULT IS     .88
C:\TEST>ch9q11

enter M : ?122
enter N : ?125
RESULT IS     .976
C:\TEST>_
```

Chapter Nine

(18)

```
.MODEL SMALL
.DATA
M1 DB 0AH,0DH,'ENTER M $'
M2 DB 0AH,0DH,'ENTER N $'
M3 DB 0AH,0DH,'GCD IS $'

.CODE
MAIN PROC
MOV AX,@DATA
MOV DS,AX
;-----------------
        MOV AH,9
        LEA DX,M1
        INT 21H
        CALL INDEC      ;read M
        PUSH AX         ;save M
        MOV AH,9
        LEA DX,M2
        INT 21H
        CALL INDEC      ;read N
        PUSH AX         ;save N
        ;-------------
        POP BX
        POP AX
    L1: MOV DX,0
        DIV BX          ;M/N
        CMP DX,0
        JE GCD_FOUND    ;BX IS N
```

```
        MOV AX,BX        ;replace M by N
        MOV BX,DX        ;replace N by R
        JMP L1

GCD_FOUND:
        MOV AH,9
        LEA DX,M3
        INT 21H
         MOV AX,BX
        CALL OUTDEC

;-----------------
MOV AH,4CH
INT 21H
MAIN ENDP

INCLUDE C:\TEST\OUTDEC.ASM
INCLUDE C:\TEST\INDEC.ASM
END MAIN
```

Chapter Nine

sample execution for Q12

```
Administrator: MR.AMER.K@HOTMAIL.COM

ENTER M    ?65
ENTER N    ?4
GCD IS  1
C:\TEST>CH9Q12

ENTER M    ?99
ENTER N    ?3
GCD IS  3
C:\TEST>CH9Q12

ENTER M    ?33
ENTER N    ?5
GCD IS  1
C:\TEST>CH9Q12

ENTER M    ?762
ENTER N    ?23
GCD IS  1
C:\TEST>CH9Q12

ENTER M    ?675
ENTER N    ?3
GCD IS  3
C:\TEST>
```

Chapter Ten

(1)

a) legal	DI=1500h
b) legal	DI=0200h
c) legal	AX=0650h
d) legal	BX=0E00h
e) legal	BX=2000h
f) illegal	memory-to-memory
g) illegal	[]must be 16-bit
h) illegal	different size
i) legal	AX=0300h

(2)

a) legal	AH=01h
b) legal	AX=0504
c) legal	AX='BA'
d) illegal	different size
e) legal	AH='A'

(3)

a)

```
MOV BP,SP
MOV [BP],0
MOV [BP+2],0
```

Chapter Ten

b)

```
.DATA
ST_ARR          DW  5 DUP(?)

        .CODE
         MOV   BX,0
         MOV   CX,5
         MOV   BP,SP
L1:      MOV  AX,WORD PTR [BP]
         MOV     WORD PTR ST_ARR[BX] , AX
         ADD   BP,2
         ADD   BX,2
         LOOP L1
```

Appendix A

How To Run A Program

Creating and running a program are done in four simple steps:

Step # 1 :

- Use a text editor or word processor to create a source file.
- After that you should save the program with a name and extension *.ASM
- You must know where you save the file in which folder in which drive (i.e : know the path of the file)

Step # 2:

- Use an assembler (MASM or TASM) to create a machine language … (i.e : create the object file with extension *.OBJ)
- You can do this by using the command (if we suppose work on TASM) *tasm* followed by the name of the source file with its extension… knoing that you are already in path of file (ex: tasm page1.ASM)
- After doing this assembler do its work work and display some info. Like copy right and most important thig error messages and they are located.
- By check no errors you can continue else you must go bace to source file and fix the error.

Appendix A

Step # 3:

- use the link program to link one or more object files to create a Run file with extension *.EXE
- you can do this by using command … *tlink* with name of file , no need to include the extension here… (ex: tlink page1)

Step # 4:

- here the executable file is created
- you can run it by typing only the name of file …(ex: page1)

here we'll see partical example explain the four steps……

Appendix A

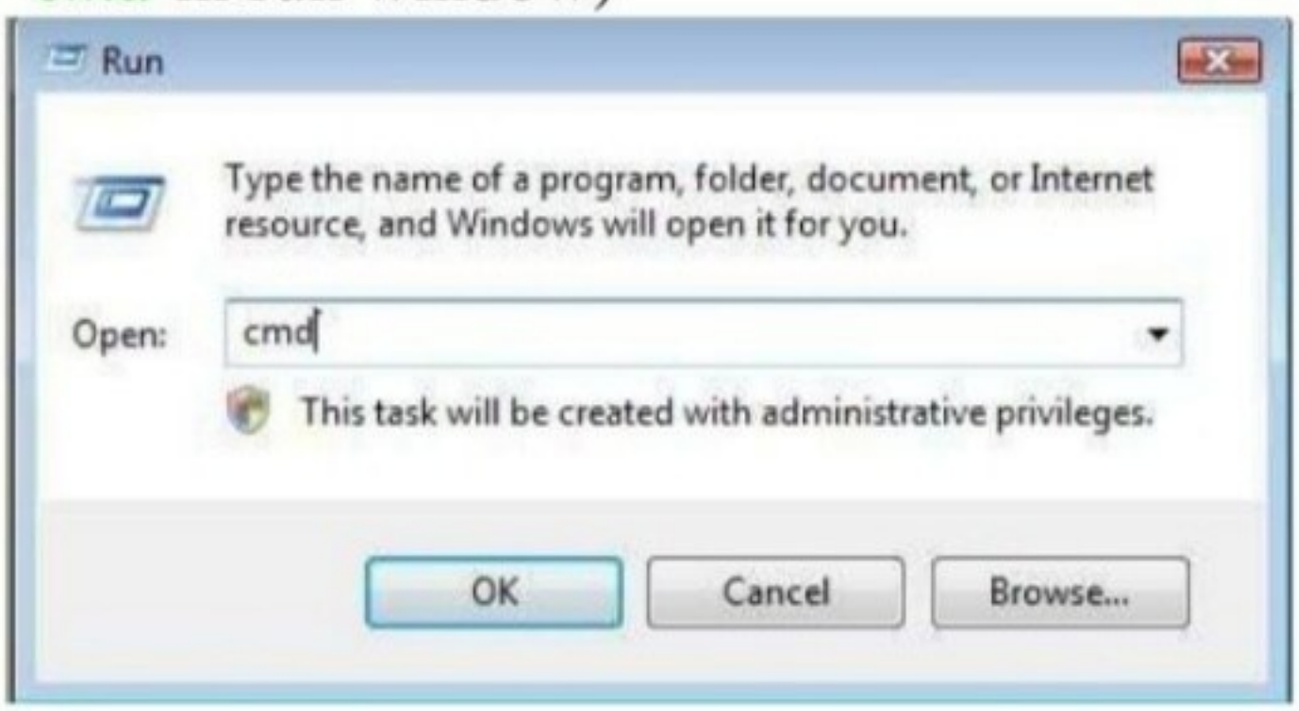
Example showing run program in DOS

Step # 1:

Write the code of program by using *notepad* editor Save the file with name student.ASM in derive *C:* inside folder its name *test*
(the file save in path *c:\test\student.asm*)

Step # 2 :

- Open command prompt (you can open it by typing *cmd* in run window)



-

-

Appendix A

- go back to drive c:\

by use the command *cd*

```
Administrator: viprus
C:\Users\Amer>cd\
C:\>_
```

- now enter to folder that has the source file

by use the command *cd test*

```
Administrator: viprus
C:\Users\Amer>cd\
C:\>cd test
C:\TEST>_
```

- the file student is visual to us , we can assemle it by *tasm student.ASM*

```
C:\TEST>tasm student.ASM
Turbo Assembler  Version 4.0  Copyright (c) 1988, 1993 Borland International

Assembling file:   student.ASM
Error messages:    None
Warning messages:  None
Passes:            1
Remaining memory:  404k
```

Error msg
No error

If no error you can continue by link

Appendix A

Step # 3:

Use *tlink* command

```
C:\TEST>tlink student
Turbo Link  Version 7.00 Copyright (c) 1987, 1994 Borland International
```

Step # 4:

Now you can run the program by typing only its name or with the extesion **.exe*

```
C:\TEST>student

C:\TEST>student.exe
```

After this if you open the folder test in c: drive you will see 4-files ,

Student.ASM	source file
Student.OBJ	object file produced by tasm
Student.MAP	contain segment addresses
Student.EXE	run program (you can run it by direct click on it)

Appendix B

Some Useful Procedures

Input in Decimal

```
INDEC PROC
;READ NUMBER IN RANGE -32768 TO
32767 ;input :none
;output :AX =binary equivalent of number
        PUSH BX
        PUSH CX
        PUSH DX

;print prompt
@BEGIN:
        MOV AH,2
        MOV DL,'?'
        INT 21H         ;print '?'
;total =0
        XOR BX,BX       ;BX hold total
;negative =false
        XOR CX,CX       ;CX hold sign
;read char.
        MOV AH,1
        INT 21H
;case char. of
        CMP AL,'-'      ;minus sign
        JE @MINUS       ;yes,set sign
        CMP AL,'+'      ;plus sign
        JE @PLUS        ;yes,get another char.
        JMP @REPEAT2        ;start processing char.
```

Appendix B

```
@MINUS: MOV CX,1
@PLUS: INT 21H
;end case
@REPEAT2:
;if char. is between '0' and '9'
        CMP AL,'0'      ;char >='0'?
        JNGE @NOT_DIGIT ;illegal char.
        CMP AL,'9'      ;char<='9' ?
        JNLE @NOT_DIGIT
;then convert char to digit
        AND AX,000FH
        PUSH AX ;total
=total *10 +digit
        MOV AX,10
        MUL BX
        POP BX
        ADD BX,AX
;read char
        MOV AH,1
        INT 21H
        CMP AL,0DH  ;CR
        JNE @REPEAT2
;until CR
        MOV AX,BX
;if negative
        OR CX,CX
        JE @EXIT
        NEG AX
;end if
@EXIT: POP DX
        POP CX
```

Appendix B

```
        POP BX

        RET
;here if illegal char
entered @NOT_DIGIT:
        MOV AH,2
        MOV DL,0DH
        INT 21H
        MOV DL,0AH
        INT 21H
        JMP @BEGIN

INDEC ENDP
```

Appendix B

Input in Decimal
With overflow check

```
INDEC2 PROC
;READ NUMBER IN RANGE -32768 TO
32767 ;input :none
;output :AX =binary equivalent of number
        PUSH BX
        PUSH CX
        PUSH DX

;print prompt
@BEGIN:
        MOV AH,2
        MOV DL,'?'
        INT 21H         ;print '?'
;total =0
        XOR BX,BX       ;BX hold total
;negative =false
        XOR CX,CX       ;CX hold sign
;read char.
        MOV AH,1
        INT 21H
;case char. of
        CMP AL,'-'      ;minus sign
        JE @MINUS       ;yes,set sign
        CMP AL,'+'      ;plus sign
        JE @PLUS        ;yes,get another char.
        JMP @REPEAT2 ;start processing char.

@MINUS: MOV CX,1
```

Appendix B

```
@PLUS: INT 21H
;end case
@REPEAT2:
;if char. is between '0' and '9'
        CMP AL,'0'      ;char >='0'?
        JNGE @NOT_DIGIT ;illegal char.
        CMP AL,'9'      ;char<='9' ?
        JNLE @NOT_DIGIT
;then convert char to digit
        AND AX,000FH
        PUSH AX ;total
=total *10 +digit
        MOV AX,10
        MUL BX ;--------
--------------------
CMP DX,0
JNE @NOT_DIGIT ;-
------------------------
        POP BX
        ADD BX,AX ;-
------------------------
JC @NOT_DIGIT
;-------------------
;read char
        MOV AH,1
        INT 21H
        CMP AL,0DH  ;CR
        JNE @REPEAT2
;until CR
        MOV AX,BX
;if negative
        OR CX,CX
```

Appendix B

```
JE @EXIT

        NEG AX
;end if
@EXIT: POP DX
        POP CX
        POP BX
        RET
;here if illegal char
entered @NOT_DIGIT:
        MOV AH,2
        MOV DL,0DH
        INT 21H
        MOV DL,0AH
        INT 21H
        JMP @BEGIN

INDEC2 ENDP
```

Appendix B

Output in Decimal

```
OUTDEC PROC

        PUSH AX
        PUSH BX
        PUSH CX
        PUSH DX
        OR AX,AX
        JGE @END_IF1

        PUSH AX
        MOV DL,'-'
        MOV AH,2
        INT 21H

        POP AX
        NEG AX

@END_IF1:
         XOR CX,CX
        MOV BX,10D

@REPEAT1:
         XOR DX,DX
        DIV BX
        PUSH DX
        INC CX
```

Appendix B

```
        OR AX,AX
        JNE @REPEAT1

        MOV AH,2
    @PRINT_LOOP:
        POP DX
        OR DL,30H
        INT 21H

    LOOP @PRINT_LOOP
        POP DX
        POP CX
        POP BX
        POP AX
    RET

    OUTDEC ENDP
```

Appendix B

Input in Binary

```
INBINARY PROC

        XOR     BX,BX
        MOV     AH,1
        INT 21H

WHILE_:
        CMP AL,0DH
        JE    END_WHILE
        AND AL,0FH
        SHL BX,1
        OR  BL,AL
        INT 21H
        JMP WHILE_

END_WHILE:
RET

INBINARY ENDP
```

Appendix B

Output in Binary

```
OUTBINARY PROC
        ;input AX
        MOV     BX,AX
        MOV     CX,16

L0:  ROL BX,1
        JC    ONE

        MOV AH,2
        MOV DL,'0'
        INT 21H

        JMP L1

ONE:
         MOV AH,2
        MOV DL,'1'
        INT 21H
L1:  LOOP L0

RET

OUTBINARY ENDP
```

Appendix B

Input Sting

```
READ_STR PROC NEAR
        PUSH DI         ;di=string to store the data
        PUSH AX         ;cx=# of char read
        XOR BX,BX
        MOV AH,1
WHILE1:
        INT 21H
        CMP AL,0DH
        JE END_WHILE1
        STOSB
        INC BX
        JMP WHILE1
END_WHILE1:POP AX
          POP DI
        RET
READ_STR ENDP
```

Appendix B

Output Sting

```
DISPLAY_STR PROC NEAR
        PUSH AX     ;SI = BEGIN OF STRING
        PUSH SI     ;INPUT CX=# OF CHAR TO DISPLAY
        MOV AH,2
        MOV DL,0AH
        INT 21H
L1:  LODSB
        MOV DL,AL
        INT 21H
        LOOP L1
POP SI
POP AX
RET
DISPLAY_STR ENDP
```

The END

Thanks for using this copy
Best Wishes

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