Green University of Bangladesh
Department of Computer Science and Engineering (CSE)

Faculty of Sciences and Engineering

Semester: (Fall: Year 2023), B.Sc. in CSE (Day)

Lab Report No: 06

Course Title: Microprocessor & Microcontroller Lab

Course Code: CSE 304 **Section:** 213D1

Lab Experiment Name: Implement Procedure in Assembly Language Programming

<u>Student Details</u>

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Lab Date : 27-10-2023

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<u>Lab Report Status</u>

Marks: .... **Signature:**......................

Comments:.. **Date:**..............................

1. TITLE OF THE LAB REPORT EXPERIMENT

Implement Procedure in Assembly Language Programming

2. OBJECTIVES/AIM

The objectives focus on grasping the use of procedures in assembly language, comprehending the role of subroutines in transferring program execution, and recognizing how the call and return instructions facilitate procedural execution. Additionally, the aims include understanding the mechanisms of program control transfer and the function of the Instruction Register (IR) in directing program flow.

3. PROCEDURE

Problem 1: find largest, smallest and average in an array of 5 numbers

```
Step 1: start
Step 2: initialize data segment arr, i, avg and newline
Step 3: Include data segment into main procedure
Step 4: set pointer to the array, and initialize cx to 5 and take array element from user
Step 5: call ‘findLargest’.procedure
Step 6: Initialize pointer si, to ‘arr’ and i to 0
Step 7: Set max as first value into ‘bl’ register
checklargest:
        Compare [si], bl
        JGE swapL as mov bl, [si]
Increment si, i,
Check i and 5
Jump JL ‘checkLargest’ level
JGE ‘printLargest’ level
Step 8: call ‘findSmallest’ procedure
Similar to the findLargest. Just condition will be:
     Compare [si], bl
     JLE swapS as mov bl, [si]
Step 9: call findAverage to calculate average
Set pointer si, to ‘arr’
Initialize  Cx, 5 and al to 0
calculateAVG loop
store each element into ‘bl’ register and subtract 48 to calculate as
decimal value
increment ‘si’
continue calculateAVG loop
Step 10: end
```

Problem 2: Sorting array of 7 size in ascending and descending order

```
Step 1: start
Step 2: initialize data segment arr,  and newline
Step 3: Include data segment into main procedure
Step 4: set pointer si to ‘arr’ and cx to 7 and take array element from
user and store into ‘arr’
Step 5: call ‘sortAscending’.procedure
Step 6: initialize si pointer to ‘arr’, inc ‘si’ and dx to si then dec ‘si’ and ch
to 04
OuterLoop:
  Load counter from ch into cl
  Load index from dx into di
InnerLoop:
  Load byte at [si] into al
  Load byte at [di] into bl
  Compare al and bl
  If al >= bl, jump to nexts
  Swap the bytes at [si] and [di]
nexts:
  Increment di
  Decrement cl
```

```
    If cl is not zero, jump to InnerLoop
Increment si
Increment dx
Decrement ch
If ch is not zero, jump to OuterLoop
Step 7: call printArray
Step 8: call ‘sortDescending’
Step 9: call initializeVariable
          OuterLoop:
    Load counter from ch into cl
    Load index from dx into di

InnerLoop:
    Load byte at [si] into al
    Load byte at [di] into bl
    Compare al and bl
    If al <= bl, jump to nexts

    Swap the bytes at [si] and [di]

nexts:
    Increment di
    Decrement cl
    If cl is not zero, jump to InnerLoop

Increment si
Increment dx
Decrement ch
If ch is not zero, jump to OuterLoop
Step 10: call ‘printArrray’
Step 11: end
```

4. IMPLEMENTATION

Problem 1: find largest, smallest and average in an array of 5 numbers

```
;call= transfer the execution of the current program
;ret = return to the execution of the program where we left
 include 'emu8086.inc'
 org 100h
 .model small
 .stack 100h
 .data
     arr db 5 dup(?)
     i db ? ;iterator to continue loop
     avg db ?
     newline db 10, 13, "$"
 .code
    main proc
    ;include data segment
    mov ax, @data
    mov ds, ax

     mov si, offset arr ;set pointer to the array
     mov cx, 5 ;since array size is 5

     print 'Enter array element: '
     L1:
     call scan ;scan function call
     mov [si], al
     inc si ;increment array index

     mov dl, 32 ;dl 32 for space
     call printf
     loop L1

     ;call find largest,smallest & average procedure
     call newlinePrint
     call findLargest
     call newlinePrint
     call findSmallest
     call newlinePrint
     call findAverage
    RET
    ;end main procedure
    main endp



;find largest number in an array
findLargest proc
    mov si, offset arr ;set pointer to the array
    mov bl, [si] ;first value store in 'bl' as largest
    mov i, 0 ;iterator for loop instead cx

    checkLargest:
    cmp [si], bl
    JGE swapL
    backLargest:
    inc si
    inc i ;increment both si & i
    cmp i, 5
    JL checkLargest
    JGE printLargest

    swapL: ;swap two value
    mov bl, [si]
    jmp backLargest ;back to the loop

    ;print largest number
    printLargest:
    print 'Largest Number is: '
    mov dl, bl
    call printf

    RET
findLargest endp
;smallest number in an array
findSmallest proc
    mov si, offset arr
    mov bl, [si]
    mov i, 0
    ;loop start
    checkSmallest:
    cmp [si], bl
    JLE swapS
    backSmallest:
    inc si
    inc i
    cmp i, 5
    JL checkSmallest
    JGE printSmallest
    ;loop end

    swapS: ;swap two value
    mov bl, [si]
    jmp backSmallest ;back to the loop

    ;print largest number
    printSmallest:
    print 'Smallest Number is: '
    mov dl, bl
    call printf

    RET
findSmallest endp


;find average
findAverage proc
    mov si, offset arr
    mov cx,5
    mov al,0
    calculateAVG:
    mov bl, [si]
    sub bl, 48
    add al, bl
    inc si
    loop calculateAVG
    ;ax=al+ah.. al contains vlaue,so heigher bytes set 0
    mov ah,0
    mov dl, 5
    div dl

    print 'Average is: '
    add al, 48
    mov dl, al
    call printf
RET
findAverage endp

;newline print procedure
newlinePrint proc
    mov ah, 9
    lea dx, newline
    int 21h
    RET
newlinePrint endp

;scan procedure to take input
scan proc
    mov ah, 1
    int 21h
    RET
scan endp

;print number
printf proc
    mov ah, 2
    int 21h
    RET
printf endp
 end main
```

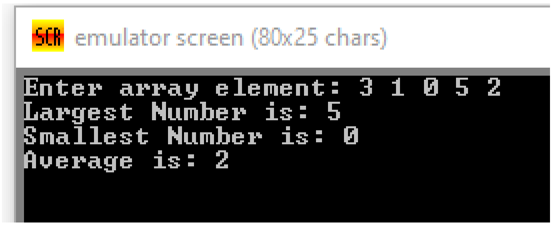
Problem 2: Sorting array of 7 size in ascending and descending order

```
;sorting array in ascending and descending order
include 'emu8086.inc'
```

```
org 100h
.model small
.stack 100h
.data
    arr db 7 dup(?)
    newline db 10, 13, "$"
.code
    main proc
    mov ax, @data
    mov ds, ax
    ;take array element
    mov si, offset arr
    mov cx, 7
    print 'Enter array element: '
    take_input:
    mov ah, 1
    int 21h
    mov [si], al
    inc si
    loop take_input

    call printNewline
    print 'Ascending order: '
    call sortAscending
    call printArray
    call printNewline

    print 'Descending order: '
    call sortDescending
    call printArray
    call printNewline

    main endp


;sort ascending order
sortAscending proc
    call initializeVariable
 OuterLoops:
    mov cl, ch
    mov di, dx
  InnerLoops:
    mov al, [si]
    mov bl, [di]
    cmp al, bl
    jc next
    mov [si], bl
    mov [di], al
    next:
    inc di
    dec cl
  jnz InnerLoops

    inc si
    inc dx
    dec ch
 jnz OuterLoops
    RET
sortAscending endp
;sort descending order
sortDescending proc
    call initializeVariable
 OuterLoop:
    mov cl, ch
    mov di, dx
  InnerLoop:
    mov al, [si]
    mov bl, [di]
    cmp al, bl
    jnc nexts
    mov [si], bl
    mov [di], al
    nexts:
    inc di
    dec cl
  jnz InnerLoop
    inc si
    inc dx
    dec ch
 jnz OuterLoop
    RET
sortDescending endp

;setup some variable for sort
initializeVariable proc
    mov si, offset arr
    inc si
    mov dx,si
    dec si
    mov ch, 06h ;cx to 6 means 7
RET
initializeVariable endp

;print array
printArray proc
    mov si, offset arr
    mov cx, 7
    arrLoop:
    mov ah, 2
    mov dl, [si]
    int 21h
    inc si
    loop arrLoop
RET
printArray endp

;print newline
printNewline proc
mov ah, 9
lea dx, newline
int 21h
RET
printNewline endp
 end main
```

5. OUTPUT

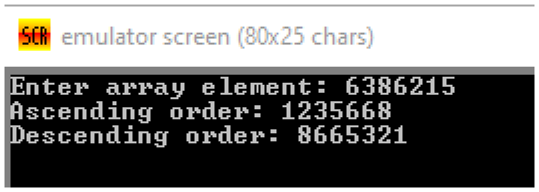
Problem 1:



```
Enter array element: 3 1 0 5 2
Largest Number is: 5
Smallest Number is: 0
Average is: 2
```

Figure-1: Find largest, smallest and average from an array

Problem 2:



```
Enter array element: 6386215
Ascending order: 1235668
Descending order: 8665321
```

Figure-2: Sort an array as ascending and descending order using procedure

6. ANALYSIS AND DISCUSSION

In my first lab task, I developed an 8086 microprocessor program to identify the largest, smallest, and average values within an array. This involved iterative comparisons and updates of the array elements, alongside summing them to compute the average, showcasing the use of x86 assembly language's data movement and comparison instructions. The second task entailed sorting the array in ascending and descending order using the Bubble Sort algorithm, effectively arranging the elements despite its O(n^2) time complexity, demonstrating the algorithm's simplicity and adaptability for 8086 architecture constraints.