

# LAB 05

## COMPUTER ORGANIZATION AND ASSEMBLY LANG(COAL)



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## Lab Session 01: JMP, LOOP & BUILT-IN-PROCEDURE

### Objectives:

- JMP Instruction
- Loop Instruction
- Built-in-Procedure

### JMP INSTRUCTION

Jumping is the most direct method of modifying the instruction flow. A *transfer of control*, or *branch*, is a way of altering the order in which statements are executed. There are two basic types of transfers:

- **Unconditional Transfer**
- **Conditional Transfer**

#### ○ UNCONDITIONAL

The unconditional jump instruction (jmp) unconditionally transfers control to the instruction located at the target address i.e. there is no need to satisfy any condition for the jump to take place. . The general format is:

#### **JMP *destination***

When the CPU executes an unconditional transfer, the offset of *destination* is moved into the instruction pointer, causing execution to continue at the new location.

### Syntax:

**L2:**

.....

**JMP L1**

.....

**L1:**

.....

**JMP L2**

**EXAMPLE # 01:**

```

.data
    mystring byte "hello",0
.code
main PROC
lable:
mov edx, offset mystring
call writestring
jmp lable

exit
main ENDP
END main

```

- **CONDITIONAL**

In these types of instructions, the processor must check for the particular condition. If it is true, then only the jump takes place else the normal flow in the execution of the statements is maintained. Syntax is:

**JMP opcode *destination***

- **CMP INSTRUCTION**

The CMP instruction compares two operands. It is generally used in conditional execution. This instruction basically subtracts one operand from the other for comparing whether the operands are equal or not. It does not disturb the destination or source operands. It is used along with the conditional jump instruction for decision making. Syntax is:

**CMP Destination, Source**

Some conditional jump instructions treat operands of the CMP(compare) instruction as signed numbers.

Mnemonic	Description
<b>JE</b>	Jump if equal
<b>JG/JNLE</b>	Jump if greater/Jump if not less than or equal
<b>JL/JNGE</b>	Jump if less/Jump if not greater
<b>JGE/JNL</b>	Jump if greater or equal/Jump if less
<b>JLE/JNG</b>	Jump if less or equal/Jump if not greater
<b>JNE</b>	Jump if not equal



Some conditional jump instructions can also test values of the individual CPU flags:

Mnemonic	Description	Flags / Registers
JZ	Jump if zero	ZF = 1
JNZ	Jump if not zero	ZF = 0
JC	Jump if carry	CF = 1
JNC	Jump if not carry	CF = 0
JO	Jump if overflow	OF = 1
JNO	Jump if not overflow	OF = 0
JS	Jump if signed	SF = 1
JNS	Jump if not signed	SF = 0
JP	Jump if parity (even)	PF = 1
JNP	Jump if not parity (odd)	PF = 0

#### EXAMPLE # 02:

```

.data

.code
main PROC
mov eax, 1

start1:
add eax, 1
cmp eax, 9
call DumpRegs
je endd
jmp start1

endd:
exit
main ENDP
END main

```

#### Task 01:

Implement the following C if statement into assembly code:

```

int a, b;
if (a > b) {
    ... code ...
}
... more code ...

```

## LOOP INSTRUCTION

The LOOP instruction, formally known as *Loop According to ECX Counter*, repeats a block of statements a specific number of times. ECX is automatically used as a counter and is decremented each time the loop repeats.

Its syntax is:

### LOOP *destination*

The execution of the LOOP instruction involves two steps: First, it subtracts 1 from ECX. Next, it compares ECX to zero. If ECX is not equal to zero, a jump is taken to the label identified by *destination*. Otherwise, if ECX equals zero, no jump takes place, and control passes to the instruction following the loop.

#### EXAMPLE # 01:

```
INCLUDE Irvine32.inc
.code
main PROC
    mov ax,0
    mov ecx,5
L1:
    Inc ax
    call dumpregs
loop L1
exit
main ENDP
END main
```

#### EXAMPLE # 02:

```
INCLUDE Irvine32.inc
.data
intArray WORD 100h, 200h, 300h, 400h, 500h
.code
main PROC
    mov esi, 0
    mov eax, 0
    mov ecx, LENGTHOF intArray
    call dumpregs
L1:
    mov ax, intArray[esi]
    add esi, TYPE intArray
    call dumpregs
loop L1
exit
main ENDP
END main
```



## o NESTED LOOPS

When creating a loop inside another loop, special consideration must be given to the outer loop counter in ECX. You can save it in a variable.

### EXAMPLE # 03

```
INCLUDE Irvine32.inc
.code
main PROC
    mov eax, 0
    mov ebx, 0
    mov ecx, 5
L1:
    inc eax
    mov edx, ecx
    call dumpregs
    mov ecx, 10
    L2:
        inc ebx
        call dumpregs
    loop L2
    mov ecx, edx
loop L1
call DumpRegs
exit
main ENDP
```

## PROCEDURE IN IRVINE32 LIBRARY

### 1. **Clrscr**

Clears the console window and locates the cursor at the above left corner.

### 2. **Crlf**

Writes the end of line sequence to the console window.

### 3. **WriteBin**

Writes an unsigned 32-bit integer to the console window in ASCII binary format.

### 4. **WriteChar**

Writes a single character to the console window.

### 5. **WriteDec**

Writes an unsigned 32-bit integer to the console window in decimal format.

### 6. **WriteHex**

Writes a 32-bit integer to the console window in hexadecimal format.

**7. WriteInt**

Writes a signed 32-bit integer to the console window in decimal format.

**8. WriteString (EDX= OFFSET String)**

Write a null-terminated string to the console window.

**9. ReadChar**

Waits for single character to be typed at the keyboard and returns that character.

**10. ReadDec**

Reads an unsigned 32-bit integer from the keyboard.

**11. ReadHex**

Reads a 32-bit hexadecimal integers from the keyboard, terminated by the enter key.

**12. ReadInt**

Reads a signed 32-bit integer from the keyboard, terminated by the enter key.

**13. ReadString (EDX=OFFSET, ECX=SIZEOF)**

Reads a string from the keyboard, terminated by the enter key.

**14. Delay (EAX)**

Pauses the program execution for a specified interval (in milliseconds).

**15. Randomize**

Seeds the random number generator with a unique value.

**16. DumpRegs**

Displays the EAX, EBX, ECX, EDX, ESI, EDI, ESP, EIP and EFLAG registers.

**17. DumpMem (ESI=Starting OFFSET, ECX=LengthOf, EBX=Type)**

Writes the block of memory to the console window in hexadecimal.

**18. getDateTime**

Gets the current date and time from system

**19. GetMaxXY (DX=col, AX=row)**

Gets the number of columns and rows in the console window buffer.

**20. GetTextColor (Background= Upper AL, Foreground= Lower AL)**

Returns the active foreground and background text colors in the console window.

**21. Gotoxy (DH=row , DL=col)**

Locates the cursor at a specific row and column in the console window. By default X coordinate range is 0-79, and Y coordinate range is 0-24.

**22. MsgBox (EDX=OFFSET String, EBX= OFFSET Title)**

Displays a pop-up message box.

### 23. **MsgBoxAsk (EDX=OFFSET String, EBX= OFFSET Title)**

Displays a yes/no question in a pop-up message box.

(EAX=6 YES, EAX=7 NO)

### 24. **SetTextColors (EAX= Foreground + (Background\*16))**

Sets the foreground and background colors of all subsequent text output to the console.

### 25. **WaitMsg**

Display a message and wait for the Enter key to be pressed.

black = 0	red = 4	gray = 8	lightRed = 12
blue = 1	magenta = 5	lightBlue = 9	lightMagenta = 13
green = 2	brown = 6	lightGreen = 10	yellow = 14
cyan = 3	lightGray = 7	lightCyan = 11	white = 15

## EXAMPLE # 04

**WriteDec:** The integer to be displayed is passed in EAX

**WriteString:** The offset of string to be written is passed in EDX

**WriteChar:** The character to be displayed is passed in AL

```
INCLUDE Irvine32.inc
```

```
.data
```

```
    Dash BYTE " - ", 0
```

```
.code
```

```
main PROC
```

```
    mov ecx, 255
```

```
    mov eax, 1
```

```
    mov edx, OFFSET Dash
```

```
L1:
```

```
    call WriteDec      ; EAX is a counter
```

```
    call WriteString   ; EDX points to string
```

```
    call WriteChar     ; AL is the character
```

```
    call Crlf
```

```
    inc al             ; next character
```

```
    Loop L1
```

```
exit
```

```
main ENDP
```

```
END main
```



**EXAMPLE # 05**

**DumpMem:** Pass offset of array in ESI, length of array in ECX & type in EBX

**ReadInt:** Reads the signed integer into EAX

**WriteInt:** Signed integer to be written is passed in EAX

**WriteHex:** Hex value to be written is passed in EAX

**WriteBin:** Binary value to be written is passed in EAX

```

INCLUDE Irvine32.inc
.data
    COUNT = 4
    arrayD SDWORD 12345678h, 1A4B2000h, 3434h, 7AB9h
    prompt BYTE "Enter a 32-bit signed integer: ", 0
.code
main PROC
    ; Display an array using DumpMem.
    mov esi, OFFSET arrayD                ; starting OFFSET

    mov ebx, TYPE arrayD                  ; doubleword = 4 bytes
    mov ecx, LENGTHOF arrayD              ; number of units in arrayD
    call DumpMem                          ; display memory
    call DumpRegs
    ; Ask the user to input a sequence of signed integers
    call Crlf                             ; new line
    mov ecx, COUNT
L1:
    mov edx, OFFSET prompt
    call WriteString
    call ReadInt                          ; input integer into EAX
    call Crlf ; new line

    ; Display the integer in decimal, hexadecimal, and binary
    call WriteInt                          ; display in signed decimal
    call Crlf
    call WriteHex                          ; display in hexadecimal
    call Crlf
    call WriteBin                          ; display in binary
    call Crlf
    call Crlf
    Loop L1                               ; repeat the loop

    exit
main ENDP
END main

```

**EXAMPLE # 06**

**SetTextColors:** Background & foreground colors are passed to EAX

. INCLUDE Irvine32.inc

.data

str1 BYTE "Sample string in color", 0dh, 0ah, 0

.code

main PROC



```
    mov eax, yellow + (blue*16)
    call SetTextColor

    mov edx, OFFSET str1
    call WriteString
    call DumpRegs

exit
main ENDP
END main
```

**EXAMPLE # 07**

INCLUDE Irvine32.inc

.data

```
caption BYTE "Dialog Title", 0
HelloMsg BYTE "This is a pop-up message box.", 0dh, 0ah
          BYTE "Click OK to continue...", 0
```

.code

main PROC

```
    mov ebx, 0                      ; no caption
    mov edx, OFFSET HelloMsg        ; contents
    call MsgBox
```

```
    mov ebx, OFFSET caption         ; caption
    mov edx, OFFSET HelloMsg        ; contents
    call MsgBox
```

exit

main ENDP

END main

**EXAMPLE # 08:**

**MsgBoxAsk:** Offset of question string is passed in EDX. Offset of caption is passed in EBX. Selected value is returned in EAX (IDYES equal to 6 or IDNO equal to 7)

INCLUDE Irvine32.inc

.data

```
caption BYTE "Survey Completed", 0
question BYTE "Thank you for completing the survey."
          BYTE 0dh, 0ah
          BYTE "Would you like to receive the results?", 0
```

.code

main PROC

```
    mov ebx, OFFSET caption
    mov edx, OFFSET question
    call MsgBoxAsk
    ;(check return value in EAX)
```

exit

main ENDP

END main

## Exercise: Dry Run on Paper First then on IDE

### Task: 1

Write a program that uses a loop to calculate the first ten numbers of Fibonacci sequence.

### Task: 2

Initialize a double word array consisting of elements 8,5,1,2,6. Sort the given array in ascending order using bubble sort.

### Task: 3

Write a program that uses a nested loop to implement following patterns.

1	1111	4321	1234
11	111	432	123
111	11	43	12
1111	1	4	1

### Task: 4

Write a program to take input data for 5 employees and store it in appropriate variables. The program should ask for Employee ID, Name, Year of Birth & Annual Salary from the user. All variables should be stored in an array whose index represent employee number.

The program should then calculate the annual salary for all employees by adding all the elements in AnnualSalary array.

### Task: 5

Initialize an array named Source and use a loop with indexed addressing to copy a string represented as an array of bytes with a null terminator value in an array named as target.

### Task: 6

Use a loop with direct or indirect addressing to reverse the elements of an integer array in place. Do not copy

elements to any other array. Use SIZEOF, TYPE and LENGTHOF operators to make program flexible.

