Department of Computer Science and Engineering

Course Code: CSE341	**Credits: 1.5**
Course Name: Microprocessors	**Semester: Fall’18**

Lab 04

Flow control instructions and Branching Structures

I. Topic Overview:

For assembly language-programs to carry out useful tasks, there must be a way to make decisions. In this lab, students will familiarize themselves with how decisions can be made with the jump instruction. The jump instructions transfer control to another part of the program. This transfer can be unconditional or can depend on a particular combination of status flag settings. After introducing the jump instructions, we'll use them to implement high-level language decision structures.

II. Lesson Fit:

There is prerequisite to this lab. Students must have a basic idea on the following concepts:

a. Flag register
b. Some basic operations such as MOV, ADD, SUB, MUL and DIV
c. Basic I/O operations
d. Character encoding using ASCII

III. Learning Outcome:

After this lecture, the students will be able to:

a. Control flow of the program
b. Write conditional statements in assembly

IV. Anticipated Challenges and Possible Solutions

a. Students may find it difficult to visualize how the program control flow changes when using jump

   Solutions:

   i. Step by step simulation

b. Directly coding in assembly may come off as challenging.

   Solutions:

   i. Writing the pseudocode first then then converting it to assembly may help

V. Acceptance and Evaluation

Students will show their progress as they complete each problem. They will be marked according to their class performance. There may be students who might not be able to finish all the tasks, they will submit them later and give a viva to get their performance mark. A deduction of 30% marks is applicable for late submission. The marks distribution is as follows:

Code: 50%

Viva: 50%

VI. Activity Detail

a. **Hour: 1**

   Discussion: Jump instruction

   Conditional Jumps:

```
if (x>5){

// code

}
```

In the line if (x>5), a comparison is done between the content of x and 5. The decision whether to execute the enclosed code or not depends on the result of the comparison. In assembly the comparison is done by a piece of code called CMP. The syntax of CMP is CMP destination, source. The comparison is done by destination - source. The result is not saved anywhere but affects the flags. The result of subtraction can be 0, AX > BX or AX< BX. Below is a piece of code.

```
MOV AX, first_number

MOV BX, second_number

CMP AX, BX
```

The comparison is done in the third line. Now there could be 5 possibilities AX==BX, AX> BX, AX< BX, AX>= BX, AX<= BX. We will take the decision based on one of these options. This decision is performed by "jump" instruction denote as "j".

Condition	Jump Instruction	Explanation
AX == BX	JE	jump if destination and source are equal
AX > BX	JG	jump if destination > source
AX < BX	JL	jump if destination < source
AX >= BX	JGE	jump if destination >= source
AX <= BX	JLE	jump if destination <= source

But jump where???

Jump in that line which we want to execute when one of the above conditions is satisfied. How will we get the line number? We do not have to worry about the line numbers because we will name the line(s) ourselves.

```
int x = 5;


if (x > 4) {
    //code
}
```

```
mov ax, 5
cmp ax, 4
JG My_Line

My_Line:
;code
```

Node the declaration of the line name ends with a colon (:).

Please go through page number 96 of the book to know about more conditional jumps.

Unconditional jump

For skipping a portion of code, we use/ need unconditional jump. There is no comparison, it is just a jump from one line to the one we want. The instruction is called JMP and its syntax is JMP destination line_name.

```
mov ax,5

mov bx,8
```

```
jmp my_line

mov ah,4

mov dl,6

my_line

mov dl,7
```

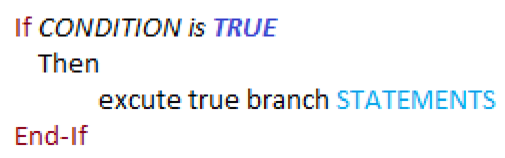
In the above code, when the 3rd line is executing the program jumps to the line named my_line without executing the codes in between, This is how codes are skipped.

Branching Structures

In high-level languages, branching structures enable a program to take different paths, depending on conditions. In this section, we'll look at three structures.

IF-THEN :

The IF-THEN structure may be expressed in pseudo code as follows:



```
If CONDITION is TRUE
  Then
       excute true branch STATEMENTS
End-If
```

The condition is an expression that is true or false. If it is true, the true-branch statements are executed. If it is false, nothing is done, and the program goes on to whatever follows.

Example: Replace the number in AX by its absolute value

Solution: A pseudocode algorithm is:

```
IF AX < 0

THEN replace AX by -AX

END_IF
```

It can be coded as follows:

```
; if AX < 0
    CMP AX, 0     ; AX < 0 ?
    JNL END_IF    ; IF No, then exit
;then
    NEG AX        ; IF yes, then change sign

END_IF:
```

The condition AX < 0 is expressed by CMP AX,0. If AX is not less than 0, there is nothing to do, so we use a JNL (jump if not less) to jump around the NEG AX. If condition AX < 0 is true, the program goes on to execute NEG AX.

Problem Task: Task 01 (Page 8)

b. **Hour: 2**

Discussion: Branching Structures (Cont.)

IF-THEN-ELSE:

```
If CONDITION is TRUE
  Then
       excute true branch STATEMENTS

Else
       execute false branch STATEMENTS
```

The jmp instruction comes in use when if - else condition is employed. Let us see the use of conditional and unconditional jumps together in a program where we will find the greater of 2 numbers.

JAVA

```
System.out.println("enter the first number");

int x = k.nextInt();

System.out.println("enter the second number");

int y = k.nextInt();

if (x>y){

     System.out.println(x+" is greater");

}

else{

     System.out.println(y+" is greater");
```

```
                }
```

Assembly:

```
data segment
  ; add your data here!
  pkey db "press any key...$"
  a db "Enter first number$"
  b db "Enter second number$"
  c db " is larger$"
ends
stack segment
  dw 128 dup(0)
ends
code segment
start:
  ; set segment registers:
  mov ax, data
  mov ds, ax
  mov es, ax
  ; add your code here
  lea dx, a ;Print a
  mov ah,9
  int 21h

  mov ah,1
  int 21h
  mov bl,al ;move input to bl

  lea dx, b ;Print b
  mov ah,9
  int 21h

  mov ah,1
  int 21h
  mov cl,al ;move input to cl

  cmp cl,bl ;compare the two
  inputs
  jg line1

  mov dl,bl
  mov ah,2
  int 21h
```

```
  lea dx, c
  mov ah,9
  int 21h
  jmp e

  line1:
   mov dl,cl
   mov ah,2
   int 21h

   lea dx, c
   mov ah,9
   int 21h

  e:
   lea dx, pkey
   mov ah, 9
   int 21h ;output string at
   ds:dx

   ;wait for any key....
   mov ah, 1
   int 21h

   mov ax, 4c00h ;exit to
   operating
   system.
   int 21h
ends
end start ; set entry point and
stop the assembler.
```

Discuss why was the ‘jmp e’ statement crucial in this program.

CASE

A CASE is a multiway branch structure that tests a register, variable, or expression for particular values or a range of values. The general form is as follows:

```
CASE expression
Values _ 1: statements_1
Values _ 2: statements_2
..
..
 Values_n: statements_n
 END_CASE
```

In this structure, expression is tested; if its value is a member of the set values_1, then statements_1 are executed. We assume that sets values_l, … , values_n are disjoint

Problem Task: Task 02 – 09 (Page 8)

c. **Hour: 3**

Discussion:

Check progress while the students carry on with the rest of the tasks.

Problem Task: Task 10-14 (Page 9)

VII. Home Tasks: All the unfinished lab tasks.

Lab 4 Activity List

Task 01

Take a number in AX, and if it’s a negative number, replace it by 5.

Task 02

Suppose AL and BL contain extended ASCII characters. Display the one that comes first in the character sequence.

Task 03

If AX contains a negative number, put -1 in BX; if AX contains 0, put 0 In BX; if AX contains a positive number, put 1 in BX.

Task 04

If AL contains 1 or 3, display “o”; if AL contains 2 or 4 display "e".

Task 05

Read a character, and if it's an uppercase letter, display it.

Task 06

Read a character. If it's "y" or "Y", display it; otherwise, terminate the program.

Task 07

Write an assembly program to check whether a number is even or odd.

Task 08

Write a program to input any alphabet and check whether it is vowel or consonant.

Task 09

Write a program to check whether a number is divisible by 5 and 11 or not.

Task 10

Write a program to find the maximum and minimum between three numbers.

Sample execution:

User input : 2 3 4

Output: Maximum number is 4

Minimum number is 1

Task 11

Write a program that takes as input all sides of a triangle and check whether triangle is valid or not. If the sides form a triangle, print “Y”, otherwise print “N”.

Task 12

Write a program that takes a digit as an input and outputs the following. If the digit is within 0-3, it prints “i”, If it’s within 4-6, it prints “k”, If it’s within 7-9, it prints “l” and if it’s 10, it prints “m”.

Task 13

Write a case to print the name of the day of the week. Consider the first day of the week is Saturday.

Sample execution:

User Input: 3

Output: Monday

Task 14

Write a case to print the total number of days in a month.

Sample execution:

User Input : 3

Output: 31 days