Flow Control Instructions

Course Code: CSC 2106

Course Title: Computer Organization and Architecture

Dept. of Computer Science
Faculty of Science and Technology

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Lecture Outline

Decision making and repeating statement

Jump and loop instructions

Algorithm conversion to assembly language

High-Level Language Structures

Branches with Compound Conditions

Sometimes the branching condition in an IF or CASE takes the form

condition_1' AND condition_2'

or

condition_1 OR condition_2

Where condition 1 and condition:2 are either true or false. We will refer to the

First of these as an AND condition and to the second as an OR condition.

Example : AND

An AND condition is true if and only if Condition_1 and Condition_2 are both true. Likewise, if either condition is false, then the whole thing is false.

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

```
Read a character (into AL)

IF ('A'<= character) and (character <= 'Z')

THEN
        display character

END IF
```

Converting to Assembly

```
;read a character

MOV AH,1

INT 21H

if ('A' <= char> and (chai: <= 'Z')

CMP AL, ‘A      ;char >’A’

JNGE END_IF  ;no exit
```

```
CMP AL, 'Z'

JNGE END_IF  ;no exit

MOV DL, AL.

MOV AH, 2

INT 21H

END_IF:
```

OR Conditions

Condition_1 OR condition_2 is true if at least one of the conditions is true; it is only false when both conditions are false.

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

```
Read a character (into AL)

IF (character = ‘y‘) OR (character = 'Y‘)

    THEN
                display it
ELSE
    terminate the program
END IF
```

Assembly Conversion

```
MOV AH,1

INT 21H

CMP AL,’y’ ;AL==‘y’

JE THEN

CMP AL, 'Y';char ~ 'Y'?

JE THEN
;yes, go to display it

JMP ELSE_
;no - Terminate
```

```
        THEN:

        MOV AH,2          ;prepare to
display

            MOV CL,AL ;get char

            INT 21H     ;display it

            JMP END IF ;and exit –

        ELSE_:

            MOV AH, 4CH

            INT 21H     ;DOS exit

        END_IF:
```

Looping Structure

A loop Is a sequence of instructions that is repeated.

The number of times to repeat may be known in advance, or
It may depend on conditions

1. FOR LOOP

2. WHILE LOOP

3. REPEAT LOOP

FOR LOOP

FOR LOOP is a loop structure in which the loop statements are repeated a **known number of times** (**a count-controlled loop**). In pseudo code,

```
FOR loop_count times DO

            Statements
END_FOR
```

The **LOOP** instruction can be used to implement a FOR loop. i.e.

```
               LOOP   destination_label
```

The **counter** for the loop is the **register CX** which is initialized to loop_count.

Execution of the **LOOP** Instruction causes **CX to be decremented** automatically,

FOR LOOP

The control is transferred to destination_label until CX becomes 0.

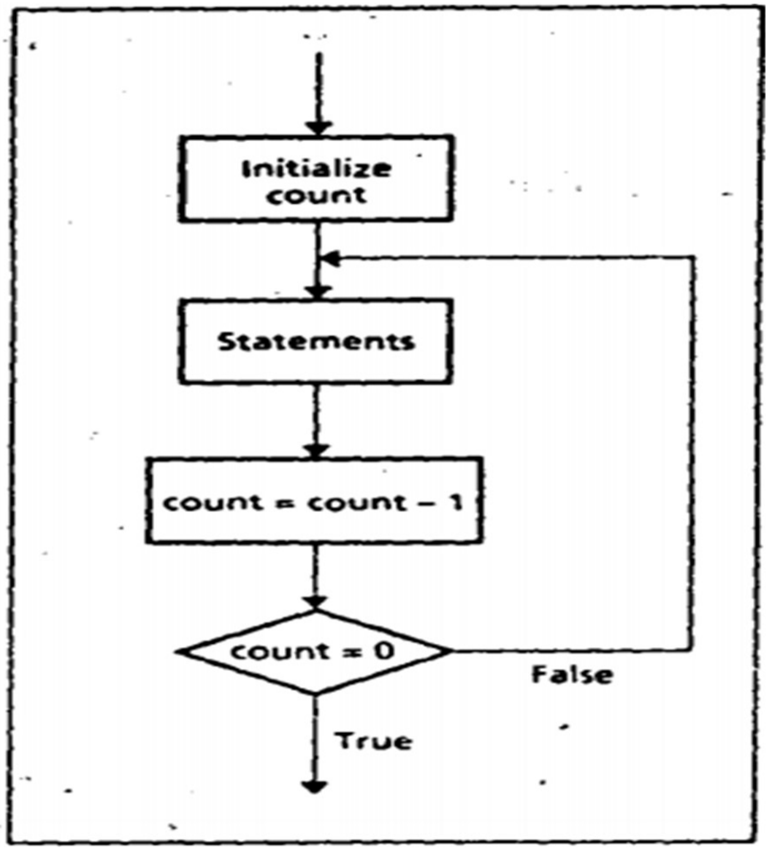
A FOR LOOP can be implemented using the LOOP instruction:

TOP:

;initialize CX to loop_count

;body of the loop

LOOP TOP



Example:

Write a count-controlled loop to display a row of 80 stars:

```
FOR 80 times DO
        display ‘*’
END_FOR
```

```
MOV CX,0
MOV AH,2
MOV DL, '*‘
TOP:
    INT 21H
  LOOP TOP
```

JCXZ and The LOOP

FOR LOOP executes at least once.

if CX contains 0 when the loop is entered, the LOOP instruction causes CX to be decremented to FFFFh

The loop is then executed FFFFh=65535 times more!

To Prevent this, the instruction **JCXZ (jump if CX is zero)** may be used before the loop. Its syntax

JCXZ destination_label

Use of JCXZ

If CX contains 0, control transferred to the destination label. So a loop implemented as follows is bypassed if CX is 0:

```
JCXZ SKIP

TOP:

        ;body of the loop

        LOOP TOP

    SKIP:
```

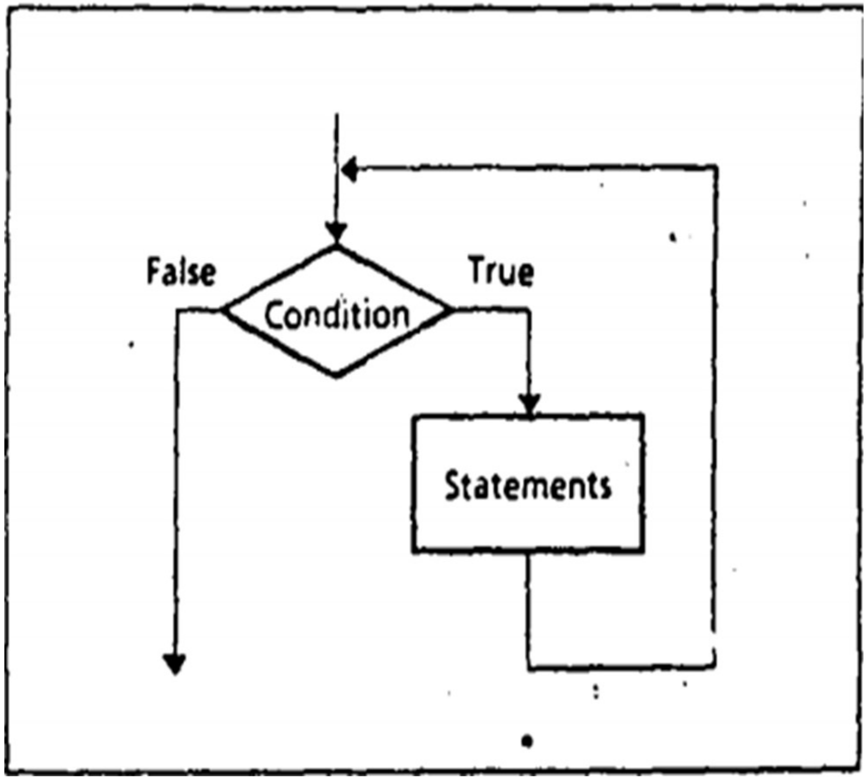
WHILE LOOP

This WHILE LOOP depends on a condition.

```
WHILE condition DO

    statements

        END_WHILE
```



WHILE LOOP

The condition is **checked** at the **top of the loop**.

If **true**, the statements are executed;

If **false**, the program goes on to whatever follows.

It is possible the condition will be **false initially**, in which case the loop body Is **not executed at all**.

The loop executes as long as the condition is true

Example: WHILE LOOP

Write some code to count the number of characters in an input line.

```
Initialize count to 0

Read a character

WHILE character <> carriage_return DO

count =count + 1

read a character


END_WHILE
```

```
                MOV DX,0 ; char count
                MOV AH,1
                INT 21H
WHILE_:
        CMP AL,0DH          ; CR ?
        JE END_WHILE  ;yes, exit
        INC DX      ; not CR so inc

    INT 21H ; read next char

    JMP WHILE_  ; loop again

    END_WHILE:
```

WHILE LOOP Insights

A WHILE loop **checks** the terminating condition at the **top of the loop,**

So, you must make sure that **any variables involved** in the condition are **initialized before the loop is entered**.

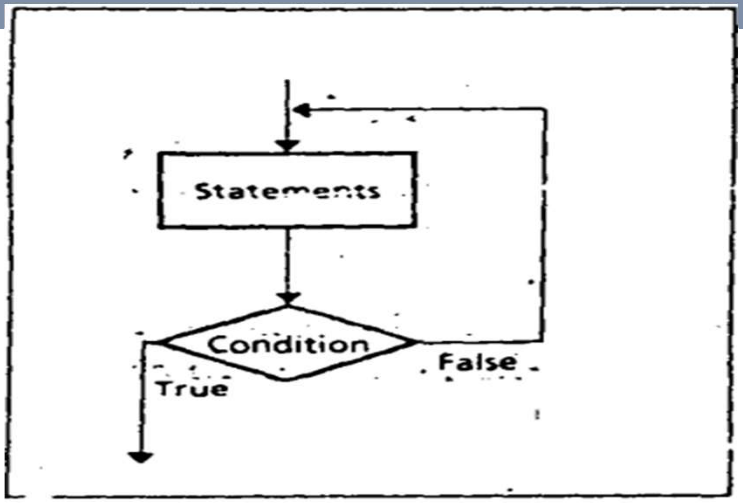
So you read a character before entering the loop, and **read another one at the bottom**.

The label **WHILE_:** .is used because **WHILE** is a reserved word

REPEAT LOOP

```
REPEAT
        statements


UNTIL condition
```



In a REPEAT…UNTIL loop, the statements are executed, and then the condition is checked.

If true, the loop terminates;

If false, control branches to the top of the loop.

Example: REPEAT LOOP

- Write code to read characters until a blank is read.

```
REPEAT
        read a character
UNTIL character is a BLANK
```

```
        MOV AH,1
REPEAT:
        INT 21H
        CMP AL,' '
        JNE REPEAT
```

Difference between WHILE and REPEAT

Use of a WHILE loop or a REPEAT loop Is a matter of **personal preference**.

The advantage of a **WHILE** is that the loop **can be bypassed** if the terminating, condition is **initially false.**

Whereas the statements in a **REPEAT must be done at least once.**

However, the code for a REPEAT loop Is likely to be a **little shorter** because there is **only a conditional jump** at the end,

But a WHILE loop has **two jumps**: a **conditional jump** at the **top** and a JMP at the **bottom**.

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References

- Assembly Language Programming and Organization of the IBM PC, Ytha Yu and Charles Marut, McGraw Hill, 1992. (ISBN: 0-07-072692-2).

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Books

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