Session 7: Iteration Structure

7.1 Objectives

- Introduce the Iteration Structure
- The three types of Iteration structure
    - Definite loop structure
    - Indefinite loop structure
    - Infinite loop structure
- The two statements used to implement the Iteration Structure:
    - for..loop structure
    - while loop structure

7.2 Iteration Structure

The iteration structure repeats the execution of a block of statements, depending on the truth value of a conditional expression in the structure.

There are three types of iteration structures, namely:

(i.) definite loop structure

(ii.) indefinite loop structure

(iii.) infinite loop structure

7.2.1 Definite Loop Structure

The number of times the definite loop structure repeats the execution of a block statements, is known before the start of execution of the loop body.

In C this loop structure is implemented using the for loop structure, which has the following general syntax:

```
syntax
for(initialization stmt; conditional expression; increment/decrement stmt)
{
      Loop body
}
```

The for clause is the header of the for loop structure and has the three major components, namely:

- `initialization statement` – this statement is executed once in the lifetime of execution of the for loop structure, the first time the for clause is evaluate. This statement assigns the loop control variable (lcv) its initial value.
- `Conditional expression` – this expression is evaluate if true, then control of execution is passed to the loop body, once the last statement is executed in the loop body, control is passed back to the for clause and the increment/decrement statement is executed. After execution of the increment/decrement statement the cycle begins, the conditional expression is again evaluated and if true, the control is passed to the loop body, which passes control to the for clause where the increment/decrement statement will be executed and then evaluate the conditional expression again. The for loop structure will terminate the execution of the loop body when the conditional expression is false, that is when the for clause will pass control of execution to the first statement after the structure.

Example 1

```
...
for (i = 0; i <= 100; i++)
{
       printf("James Kamangu Kenga");
}
...
```

7.2.2 Indefinite Loop Structure

For the indefinite loop structure, the number of times the loop body is repeated is unknown, before the beginning of execution of the loop body.

In C this loop structure is implemented using the while loop structure, which has two variants, namely:

- where the conditional expression is at the beginning of the structure,
- where the conditional expression is at the end of the structure

A. Where the conditional expression is at the beginning of the structure

Here we normally use the while loop structure which has the following syntax:

```
syntax
while(conditional expression)
{
       loop body
```

```
}
```

In this structure the while clause evaluates the conditional expression and if true, then the loop body is executed. After the last statement in the loop body is executed, control of execution is passed back to the while clause, which again evaluates the control structure and if true the loop body is executed and then control is passed to the while clause again. This will be repeated until the conditional expression evaluates to a false, that is when the while clause will pass control of execution to the first statement after the structure.

Example 2

```
...
i = 0;
while(i <= 100)
{
       printf("James Kamangu Kenga");
       i++;
}
...
```

B. Where the conditional expression is at the end of the structure

The variant of the while loop structure called do…while is used. It has the following syntax:

```
syntax
do{

       loop body

}while(conditional expression);
```

In this structure, the conditional expression is evaluated as the last clause in the structure. This structure allow the execution of the loop body at least once, and then the conditional expression in the while clause is evaluated. If true control of execution is passed to the loop body, then we revaluate the conditional expression again, until that time when the conditional expression evaluates to a false, that is when control is passed to the first statement after this structure.

Example 3

```
...
i = 0;
do{
       printf("James Kamangu Kenga");
       i++;
}while(i <= 100);
...
```

Exercice

Write a program that will compute and display the sum of the following series:

$$S = 1 + 3 + 5 + 7 + ... + 199$$

Assignment

Question 1

Write a program that will compute and display the sum of the following series:

$$S = \frac{1}{2} + \frac{2}{3} + \frac{3}{4} + \frac{4}{5} + ... + \frac{99}{100}$$

Question 2

Write a program to display an addition table with the format shown below. The range of the table is given as program output below:

+	1	2	3	4	5	6
1	2	3	4	5	6	7
2	3	4	5	6	7	8
3	4	5	6	7	8	9
4	5	6	7	8	9	10
5	6	7	8	9	10	11
6	7	8	9	10	11	12

Question 3

Write a program to compute and print the fractional powers of 2 (two) in decimal form. You program should print two columns of information as shown below:

Power	Fraction
1	0.5
2	0.25
3	0.125
4	0.0625
⋮	⋮

The program should terminate when the decimal fraction becomes less than or equal to 0.000001.

Question 4

Write a program that will display the following pattern:

1 2 3 4 5

1 2 3 4

1 2 3

1 2

1