

Northern University, Nowshera

Programming Fundamentals (ECS-121)

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(Week 8) Lecture 15 and 16

Objectives: Learning objectives of this lecture are

- **Loops**
- **for**
- **Conversion of for into while**
- **Loop base programs**



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Lecture # 15 Loops (for)

We discussed about Goto statement that is used to execute repeated block statements. Using Goto statement is not recommended because of complexity and for a programmer it becomes difficult to make unique labels keeping labels track etc. In C++ we are provided with following loops.

- 1) For
- 2) While
- 3) Do-while
- 4) Extended for (for each)

We shall be discussing for loop in this lecture.

For loop

Before discussing any program let us first discuss syntax of for loop. Figure given below explains for loop.

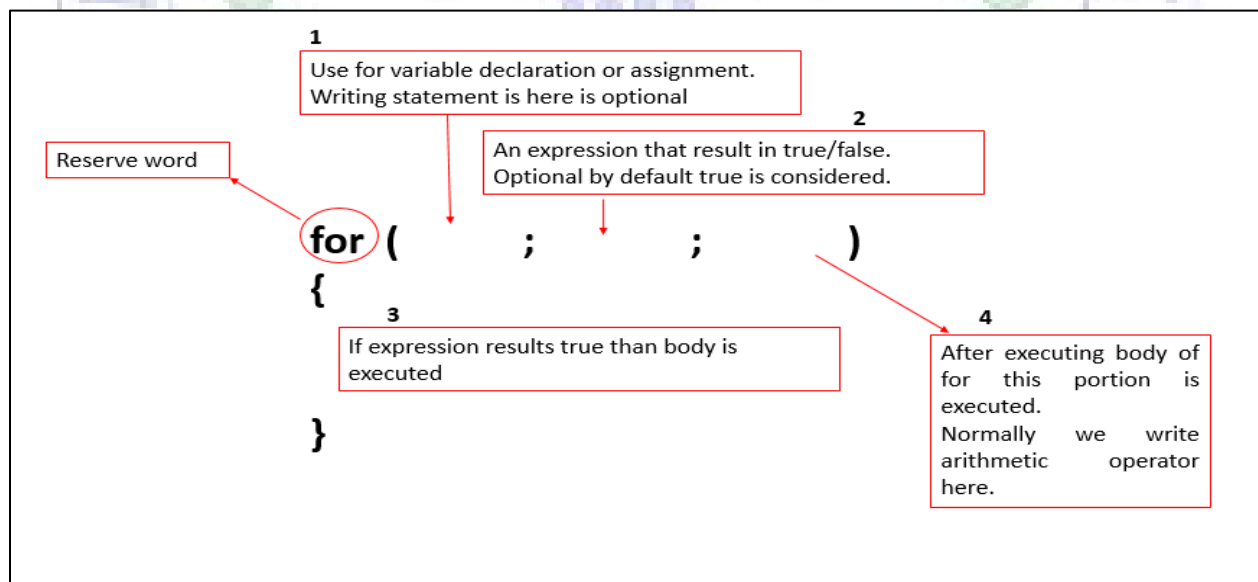


Figure 1 for loop

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Above figure shows 4 portions. Portion 1 is executed once when entering a loop. After executing portion 4 portion 2 is executed if it is true than body of if again and process repeats in such a way. Note that portion 1, 2 and 4 are optional (Semi colons must be placed).

Program 1: Write a program to print even numbers from 0 to 10.

Solution:

Version 1:

```
#include "iostream"
using namespace std;
void main()
{
    for (int numbers = 0 ; numbers < 10; numbers=numbers+1)
    {
        if (numbers % 2 == 0)
        {
            cout << "Numbers " << numbers << endl;
        }
    }
}
```

Visible only inside for loop. This variable is not accessed outside for

Version 2: (Optional Initialization portion)

```
#include "iostream"
using namespace std;
void main()
{
    int numbers = 0 ;
    for ( ; numbers < 10; numbers=numbers+1)
    {
        if (numbers % 2 == 0)
        {
            cout << "Numbers " << numbers << endl;
        }
    }
}
```

Version 3: (optional 4th portion)

```
#include "iostream"
```

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```
using namespace std;
void main()
{
    int numbers = 0 ;
    for ( ; numbers < 10;)
    {
        if (numbers % 2 == 0)
        {
            cout << "Numbers " << numbers << endl;
        }
        numbers=numbers+1;
    }
}
```

Version 4: (Optional Conditional Part)

```
#include "iostream"
using namespace std;
void main()
{
    int numbers = 0 ;
    for ( ;;)
    {
        if(numbers < 10)
        {
            if (numbers % 2 == 0)
            {
                cout << "Numbers " << numbers << endl;
            }
        }
        else
        {
            break;
        }
        numbers=numbers+1;
    }
}
```

break will terminate the loop.

Version 5:

```
#include "iostream"
using namespace std;
void main()
{
    for (int numbers = 0; numbers < 10; numbers=numbers+2)
    {

```

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```
cout << "Numbers " << numbers << endl;
```

```
}  
}
```

Program Number 2: Input a number from user and print its factorial. Factorial of 4 is
 $4! = 4 \times 3 \times 2 \times 1$

```
#include "iostream"  
using namespace std;  
void main()  
{  
    int number;  
    cout << "Enter a number ";  
    cin >> number;  
    int fact = 1;  
    for (int limit = number; limit > 0; limit = limit - 1)  
        fact = fact * limit;  
}
```

Dry run

number has value 4 (instead of 4 there can be any value)	fact has value 1
--	------------------

Now look at iteration of loop. Read the table left to right

Initialization	Conditional	Body	Expression
limit=number limit→4	limit > 0 4 > 0→ True	fact=fact*limit fact=1*4→4 now fact has value 4	limit=limit-1 limit=4-1→3 limit has value 3
	limit > 0 3 > 0→ True	fact=fact*limit fact=4*3→12 now fact has value 12	limit=limit-1 limit=3-1→2 limit has value 2
	limit > 0 2 > 0→ True	fact=fact*limit fact=12*2→24 now fact has value 24	limit=limit-1 limit=2-1→1 limit has value 1
	limit > 0 1 > 0→ True	fact=fact*limit fact=24*1→24 now fact has value 24	limit=limit-1 limit=1-1→0 limit has value 0
	limit > 0 0 > 0→ false	As conditional portion is false body will not be executed.	

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Program Number 3: Write a C++ program in which you have to input a number from user and print next 10 even number from that number. **Sample Execution:** Enter a number 27 **Output:** 28 30 32 34 36 38 40 42 44 46

```
#include "iostream"
using namespace std;
void main()
{
    int number;
    cout << "Enter a number ";
    cin >> number;
    if (number % 2 != 0)
        number = number - 1;
    for (int i = 1; i <= 10; i++)
    {
        number += 2;
        cout << "Number " << number << endl;
    }
}
```

Dry run let us say number entered is 3. if statement is return i.e $3\%2 \neq 0 \rightarrow$ True reduce number by 1 and it becomes 2. Now iteration of loop in table given below. Read from left to right.

Initialization	Conditional	Body	Increment
i=1	$i \leq 10 \rightarrow 1 \leq 10 \rightarrow \text{true}$	number+=2 number = 4 Will print 4	i++ i becomes 2
	$i \leq 10 \rightarrow 2 \leq 10 \rightarrow \text{true}$	number+=2 number = 6 Will print 6	i++ i becomes 3
	$i \leq 10 \rightarrow 3 \leq 10 \rightarrow \text{true}$	number+=2 number = 8 Will print 8	i++ i becomes 4
	$i \leq 10 \rightarrow 4 \leq 10 \rightarrow \text{true}$	number+=2 number = 10 Will print 10	i++ i becomes 5
	$i \leq 10 \rightarrow 5 \leq 10 \rightarrow \text{true}$	number+=2 number = 12 Will print 12	i++ i becomes 6
	$i \leq 10 \rightarrow 6 \leq 10 \rightarrow \text{true}$	number+=2 number = 14 Will print 14	i++ i becomes 7
	$i \leq 10 \rightarrow 7 \leq 10 \rightarrow \text{true}$	number+=2 number = 16	i++ i becomes 8

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		Will print 16	
	$i \leq 10 \rightarrow 8 \leq 10 \rightarrow \text{true}$	number+=2 number = 18 Will print 18	i++ i becomes 9
	$i \leq 10 \rightarrow 9 \leq 10 \rightarrow \text{true}$	number+=2 number = 20 Will print 20	i++ i becomes 10
	$i \leq 10 \rightarrow 10 \leq 10 \rightarrow \text{true}$	number+=2 number = 22 Will print 22	i++ i becomes 11
	$i \leq 10 \rightarrow 11 \leq 10 \rightarrow \text{false}$	Out of loop	

Lecture # 16 Loop

In today's lecture we will be discussing some more programs regarding loop and conversion of for into while loop.

Program 1: Input two numbers from user and print all those numbers that divides both the numbers.

Version 1:

```
#include "iostream"
using namespace std;
void main()
{
    int num1, num2;
    cout << "Enter first number ";
    cin >> num1;
    cout << "Enter second number ";
    cin >> num2;
    for (int divisor = 1; divisor <= num1 && divisor <= num2; divisor++)
    {
        if (num1 % divisor == 0 && num2 % divisor == 0)
            cout << "Numbers divided by " << divisor << endl;
    }
}
```

Version 2:

```
#include "iostream"
using namespace std;
void main()
```

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```
{
    int num1, num2;
    cout << "Enter first number ";
    cin >> num1;
    cout << "Enter second number ";
    cin >> num2;
    int min;
    if (num1 > num2)
        min = num1;
    else
        min = num2;
    for (int divisor = min; divisor >= 1; divisor--)
    {
        if (num1 % divisor == 0 && num2 % divisor == 0)
            cout << "Numbers divided by " << divisor << endl;
    }
}
```

Now modifying statement of program 1 as following.

Program 2: Input two numbers and find their GCD (greatest common divisor). GCD is a number that is commonly divided on both entered number. There may be more than one common divisors but GCD is greatest among all.

Version 1:

```
#include "iostream"
using namespace std;
void main()
{
    int num1, num2;
    cout << "Enter first number ";
    cin >> num1;
    cout << "Enter second number ";
    cin >> num2;
    int gcd;
    for (int divisor = 1; divisor <= num1 && divisor <= num2; divisor++)
    {
        if (num1 % divisor == 0 && num2 % divisor == 0)
            gcd=divisor
    }
    cout << "GCD "<<gcd<<endl;
}
```

Version 2:

```
#include "iostream"
using namespace std;
void main()
{
    int num1, num2;
    cout << "Enter first number ";
    cin >> num1;
    cout << "Enter second number ";
    cin >> num2;
```

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```
int gcd;
int min;
if (num1 > num2)
    min = num1;
else
    min = num2;
for (int divisor = min; divisor >= 1; divisor--)
{
    if (num1 % divisor == 0 && num2 % divisor == 0)
    {
        gcd = divisor;
        break;
    }
}
cout << "GCD " << gcd << endl;
}
```

Program 3: Input a number from user and tell how many digit number is entered by user.

```
#include "iostream"
using namespace std;
void main()
{
    int num1;
    cout << "Enter a number ";
    cin >> num1;
    int count = 0;
    if (num1 == 0)
        count = 1;

    for ( ; num1 != 0; )
    {
        count++;
        num1 /= 10;
    }
    cout << "You have entered " << count << " digit number " << endl;
}
```

From lets discuss structure of loop

```
for ( ; num1 != 0; )
{
    count++;
    num1 /= 10;
}
```

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As we have discussed in previous lecture that all portion (initialization, conditional and increment portion) is optional. For loop can easily be converted into while loop as figure below illustrate.

<pre>for (; num1 != 0;) { count++; num1 /= 10; }</pre>	<pre>while (num1 != 0) { count++; num1 /= 10; }</pre>
--	---

Figure 1 Conversion from for to while

While loop just checks conditional parts if true execute body and then checks conditional part loop keep on repeat until false value is in conditional part.

