Loops: Loops in programming languages are used for repeating the execution of the same statements again and again. In C++, there are three loops **for-loop**, **while-loop** and **do-while loop**.

for loop	while loop

Syntax:
 	
`for(<init>;<condition>;<inc/decrement>)`
`  <Statement>;`
	Syntax:
	
	`while (<Condition>)`
	`  <Statement>;`

Example:
`for (int I=1;I<=5;I++)`
`  cout<<I<<":";`
 	
`/*`
`OUTPUT`
`1:2:3:4:5:`
`*/`
	Example:
	`int I=1;`
	`while (I<=5)`
	`  cout<<I++<<":";`
	`/*`
	`OUTPUT`
	`1:2:3:4:5:`
	`*/`

It is an **Entry Contrclled Loop**, i.e., condition is in the **beginning**. This loop is ideal for a situation, when execute the loop statement(s) based on a finite sequence. In this loop, if the condition is not true in the very beginning, loop statement(s) is/are not executed even ones. For more than one statement in the loop, we require to enclose them in curly braces { }.	It is an **Entry Controlled Loop**, i.e., condition is in the **beginning**. This loop is ideal for a situation, when you require to execute the loop statement(s) only if the condition is true. The number of iterations (repetition of statement(s)) may not be known at the time of starting the loop. For more than one statement in the loop, we require to enclose them in curly braces { }.

do-while loop	

Syntax:
`do`
`{`
`  <Statement>;`
`}`
`while(<condition>);`
	Example 1:
	`int I=1;`
	`do`
	`{`
	`  cout<<I++<<":";`
	`}`
	`while(I<=5);`
	`/*`
	`OUTPUT`
	`1:2:3:4:5:`
	`*/`

Example 2:
`int A,B,C; char CH;`
`do`
`{`
`  cout<<"A:";cin>>A;`
`  cout<<"B:";cin>>B;`
`  C=A+B;`
`  cout<<"More(Y/N)?";cin>>CH;`
`}`
`while (CH!='N');`
	It is an **Exit Controlled Loop**, i.e., condition is at the **end**. This loop is ideal for a situation, when you require to execute the loop statement(s) at least once and the number of iterations (repetition of statement(s)) is not known at the time of starting the loop. Curly braces { } are essentially required even for a single statement in the loop.

Sample problems, which are solved ideally using **for-loop**.

1. Write a C++ code to display N even numbers.

```
//Solution 1 - OPTION 1
int N;
cout<<"N:";cin>>N;
for (int I=2;I<=2*N;I+=2)
  cout<<I<<":";
```

```
OUTPUT
N:5
2:4:6:8:10:
```

```
//Solution 1 - OPTION 2* (Preferred)
int N;
cout<<"N:";cin>>N;
for (int I=1;I<=N;I++)
  cout<<2*I<<":";
```

```
OUTPUT
N:5
2:4:6:8:10:
```

TRY YOURSELF To display N odd numbers, N multiples of 7, N multiples 19

2. Write a C++ code to find and display sum of following series:
   (a) 1+3+5+....Nth Term (b) 3+8+13+....Nth Term

```
//Solution 2 (a) & (b) OPTION 1
int N,Suma=0,Sumb=0;
cout<<"N:";cin>>N;
//Sum of Series a
for (int I=1;I<=2*N-1;I+=2)
{
  cout<<I<<"+";
  Suma+=I;
}
cout<<"\b="<<Suma<<endl;
//Sum of Series b
for (I=3;I<=5*N-2;I+=5)
{
  cout<<I<<"+";
  Sumb+=I;
}
cout<<"\b="<<Sumb<<endl;
```

```
OUTPUT
N:5
1+3+5+7+9=25
3+8+13+18+23=65
```

```
//Solution 2 (a) & (b) OPTION 2* (Preferred)
int N,Suma=0,Sumb=0;
cout<<"N:";cin>>N;
//Sum of Series a
for (int I=1;I<=N;I++)
{
  cout<<2*I-1<<"+";
  Suma+=2*I-1;
}
cout<<"\b="<<Suma<<endl;
//Sum of Series b
for (I=1;I<=N;I++)
{
  cout<<5*I-2<<"+";
  Sumb+=5*I-2;
}
cout<<"\b="<<Sumb<<endl;
```

term = 5*i-2
Sum += term

```
OUTPUT
N:5
1+3+5+7+9=25
3+8+13+18+23=65
```

TRY YOURSELF To find and display sum of 7+14+21+.. N Terms and 4+10+16+.. N Terms, N to be entered by the user.

3. Write a C++ code for the following:
   (a) Check if a number N is prime (a number, which is divisible by 1 and self only) or not
   (b) Display N terms of Fibonacci Series of numbers (**0,1**,1,2,3,... i.e. sum of 2 previous terms of the series produces next term of the series)

```
//Solution 3 (a) Prime Number Check
int N,IsPrime=1;
cout<<"Enter N:";cin>>N;
for (int I=2;IsPrime && I<=N/2;I++)
  if (N%I==0)
    IsPrime=0;
if (N>1 && IsPrime)
  cout<<N<<"is a PrimeNumber"<<endl;
}
//Number is prime if it is not divisible by any
//number between 2 and half of the number
```

```
//Solution 3 (b) Fibonacci Series
int N,First=0,Second=1;
cout<<"Enter N:";cin>>N;
for (int I=1;I<=N;I++)
{
  cout<<First<<",";
  Next=First+Second;
  First=Second;
  Second=Next;
}
cout<<"\b "<<endl;// \b deletes the last ,
```

OUTPUT Enter N:5 5 is a PrimeNumber	OUTPUT Enter N:7 0,1,1,2,3,5,8

TRY YOURSELF To check a number is Composite (not Prime) or not and to display Tribonacci Series 0,0,1,1,2,4,....

4. Write a C++ code for finding sum of following series:
   (a) $X+X^2+X^3+$....Nth Term
   (b) $X+X^2/2!+X^3/3!+$....Nth Term

```
//Solution 4(a)
float X,Sum=0,PX=1;
int N;
cout<<"X:";cin>>X;
cout<<"N:";cin>>N;
for (int I=1;I<=N;I++)
{
  PX*=X;
  cout<<PX<<"+";
  Sum+=PX;
}
cout<<"\b="<<Sum<<endl;
```

```
OUTPUT
X:2
N:3
2+4+8=14
```

```
//Solution 4(b)
float X,Sum=0,PX=1;
int N;
cout<<"X:";cin>>X;
cout<<"N:";cin>>N;
for (int I=1;I<=N;I++)
{
  PX*=X/I;
  cout<<PX<<"+";
  Sum+=PX;
}
cout<<"\b="<<Sum<<endl;
```

```
OUTPUT
X:0.5
N:3
0.5+0.125+0.020833=0.645833
```

TRY YOURSELF To find and display sum of the following series:

(a) X + 2X + 3X +... Nth Term (b) X + $X^3/3!$ + $X^5/5!$ + ... Nth Term

5. Write a C++ code for finding sum of following series:
   (a) 1 + (1+2) + (1+2+3) +....Nth Term
   (b) 2 + (2+4) + (2+4+6) +....Nth Term

```
int N,SubSum=0,Sum=0;
cout<<"N:";cin>>N;
for (int I=1;I<=N;I++)
{
  SubSum+=I;
  cout<<SubSum<<"+";
  Sum+=SubSum;
}
cout<<"\b="<<Sum<<endl;
```

```
OUTPUT
N:3
1+3+6=10
```

```
int N,SubSum=0,Sum=0;
cout<<"N:";cin>>N;
for (int I=1;I<=N;I++)
{
  SubSum+=(2*I);
  cout<<SubSum<<"+";
  Sum+=SubSum;
}
cout<<"\b="<<Sum<<endl;
```

```
OUTPUT
N:3
2+6+12=20
```

TRY YOURSELF To find and display sum of the following series:

(a) 3 + (3+6) + (3+6+9) +... Nth Term (b) 1 + (1+4) + (1+4+7) + ... Nth Term

6. Write a C++ code to display (a) a range of alphabets and (b) N multiples of 10 in reversed order

```
char Alpha1,Alpha2;
cout<<"Alphabet From:";cin>>Alpha1;
cout<<"Alphabet To:";cin>>Alpha2;
for (char CH=Alpha1;CH<=Alpha2;CH++)
  cout<<CH;
cout<<endl;
```

```
int N;
cout<<"Enter N:";cin>>N;
for (int I=N;I>=1;I--)
  cout<<10*I<<",";
cout<<endl;
```

```
OUTPUT
Alpha1:D
Alpha2:J
DEFGHIJ
```

```
OUTPUT
Enter N:5
50:40:30:20:10:
```

TRY YOURSELF To display a range of alphabets in reversed order

Sample problems, which are solved ideally using **while-loop**.

1. Write a C++ code for reversing a number up to 4 digits.
2. Write a C++ code for calculating LCM of two numbers

```
//Solution for 1
int N,TN,Rev=0;
cout<<"N:";cin>>N;
TN=N;
while (TN>0)
{
  Rev=Rev*10+TN%10;
  TN=TN/10;
}
cout<<N<<" Reversed "<<Rev<<endl;
```

```
OUTPUT
N:123
123 Reversed 321
```

```
//Solution for 2
int N1,N2,Big;
cout<<"N1:";cin>>N1;
cout<<"N2:";cin>>N2;
Big=(N1>N2)?N1:N2;
while (Big%N1!=0 || Big%N2!=0)
  Big++;
cout<<"LCM:"<<Big<<endl;
```

```
OUTPUT
N1:4
N2:6
LCM:12
```

TRY YOURSELF (a) To check if the number entered by the user is palindrome or not (Palindrome numbers remain same, if their digits are reversed. For example 121, 3223, 77 are Palindrome numbers) (b) To find the HCF of two numbers entered by the user.

Sample problems, which are solved ideally using **do-while**.

1. Write a C++ code for disbursing the fund as per various claims on first cum first serve basis till the fund is more than 0.

```
//Solution for 1
int ClaimNo=1;
float Fund,Claim;
cout<<"Fund:";cin>>Fund;
do
{
  cout<<"AvailableFund:"<<Fund<<endl;
  cout<<"Claim No:"<<ClaimNo++;
  cout<<" Your Claim:";cin>>Claim;
  Fund-=Claim;
}
while (Fund>0);
```

```
OUTPUT
Fund:32000
AvailableFund:32000
Claim No:1 Your Claim:23000
AvailableFund:9000
Claim No:2 Your Claim:9000
```

2. Write a C++ code for ensuring the valid Age and valid Gender as input from the user.

```
//Solution for 2
int Age;
do
{
  cout<<"Enter Age:";cin>>Age;
}
while (Age<1 || Age>150);
char Gender;
do
{
  cout<<"Gender:";cin>>Gender;
}
while (Gender!='F' && Gender!='M');
cout<<"Age:"<<Age<<"Gender:"<<Gender;
```

```
OUTPUT
Age:-23
Age:32
Gender:A
Gender:F
Age:32 Gender:F
```

Additional Examples of **for loop using multiple initializations and multiple increment/decrement steps.**

1. Write a C++ code to display N alternative alphabets starting from A

```
char CH='A';
int N;
cout<<"Enter N:";cin>>N;
for (int I=1;I<=N;I++,CH+=2)
  cout<<I<<"#"<<CH<<endl;
```

```
OUTPUT
Enter N:5
1#A
2#C
3#E
4#G
```

2. Write a C++ code to find sum of following series:
1*10+2*8+3*6+... N Terms

```
int A,B,N,Sum=0;
cout<<"Start1?";cin>>A;
cout<<"Start2?";cin>>B;
cout<<"Terms?";cin>>N;
for(int I=A,J=B ;I<=N; Sum+=I*J,I++,J-=2);
//Above for loop is terminated with a ;
//It contains multiple initializations
//and multiple increments, it works but
//highly discouraged due to its complex
//structure
cout<<"Sum:"<<Sum<<endl;
```

```
OUTPUT
Start1?1
Start2?10
Terms?3
Sum:44
```

Nested loops: Using a loop inside the other loop is known as nesting of loops or nested loops. Nested Loops examples are as follows:

```
int N;
cout<<"Enter N:";cin>>N;
for (int I=1;I<=N;I++)  //Outer Loop
{
  for (int J=1;J<=N;J++)//Inner Loop
    cout<<J;
  cout<<endl;
}
```

```
OUTPUT
Enter N:4
1234
1234
1234
1234
```

```
int N;
cout<<"Enter N:";cin>>N;
for (int I=1;I<=N;I++)  //Outer Loop
{
  for (int J=1;J<=N;J++) //Inner Loop
    cout<<I;
  cout<<endl;
}
```

```
OUTPUT
Enter N:4
1111
2222
3333
4444
```

```
int N;
cout<<"Enter N:";cin>>N;
for (int I=1;I<=N;I++)  //Outer Loop
{
  for (int J=1;J<=I;J++)//Inner Loop
    cout<<J;
  cout<<endl;
}
```

```
OUTPUT
Enter N:4
1
12
123
1234
```

```
int N;
cout<<"Enter N:";cin>>N;
for (int I=1;I<=N;I++)  //Outer Loop
{
  for (int J=1;J<=I;J++) //Inner Loop
    cout<<I;
  cout<<endl;
}
```

```
OUTPUT
Enter N:4
1
22
333
4444
```

```
int N;
cout<<"Enter N:";cin>>N;
for (int I=1;I<=N;I++)   //Outer Loop
{
  for (int J=1;J<=I;J++)//Inner Loop
    cout<<'*';
  cout<<endl;
}
```

```
OUTPUT
Enter N:4
*
**
***
****
```

```
int N;
cout<<"Enter N:";cin>>N;
for (int I=N;I>=1;I--)    //Outer Loop
{
  for (int J=1;J<=I;J++) //Inner Loop
    cout<<I;
  cout<<endl;
}
```

```
OUTPUT
Enter N:4
4444
333
22
1
```

```
int N;
cout<<"Enter N:";cin>>N;
for (int I=1;I<=N;I++) //Outer Loop
{
  for (int J=1;J<=N-I;J++)//Inner Loop 1
    cout<<<' ';
  for (J=1;J<=I;J++)        //Inner Loop 2
    cout<<'*';
  cout<<endl;
}
```

```
OUTPUT
Enter N:4
   *
  **
 ***
****
```

```
int N;
cout<<"Enter N:";cin>>N;
for (int I=1;I<=N;I++)    //Outer Loop
{
  for (int J=1;J<=N-I;J++)//Inner Loop 1
    cout<<<' ';
  for (int J=1;J<=I;J++)   //Inner Loop 2
    cout<<I;
  cout<<endl;
}
```

```
OUTPUT
Enter N:4
   1
  12
 123
1234
```

TRY YOURSELF Write C++ Codes for generating the following patterns on screen as per value of N entered by the user.

```
(a) Enter N:4
   *
  ***
 *****
*******
```

```
(b) Enter N:4
   1
  121
 12321
1234321
```

```
(c) Enter N:4
*******
 *****
  ***
   *
```

```
(d) Enter N:4
1234321
 12321
  121
   1
```

```
(e) Enter N:4
A
AB
ABC
ABCD
```

```
(f) Enter N:4
4321
321
21
1
```

Kindly note, any loop (**for**,**while** and **do..while**) can be nested inside the other (**for**,**while** and **do..while**).