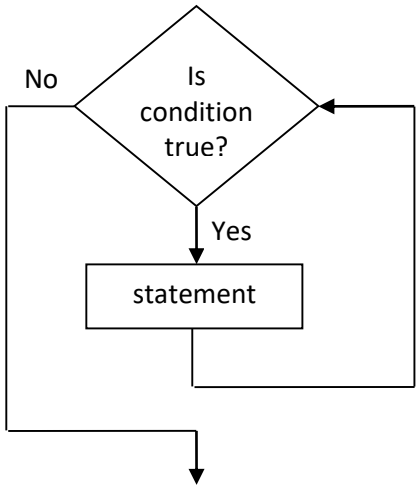
Iteration (Repetition) statements

1. Iteration (Repetition) statements

1) `while` statement 2) `do/while` statement 3) `for` statement

1.1 `while` statement

while (condition)
statement;



The statement within the loop must modify variables in the condition; otherwise, the value of the condition will never change, and will never be able to exit the loop (i.e. **infinite loop**). Infinite loop is generated if the condition in a loop is always true.

Example: Write a C++ program that computes the sum of consecutive integer numbers 1 + 2 + 3 + ….. + n.

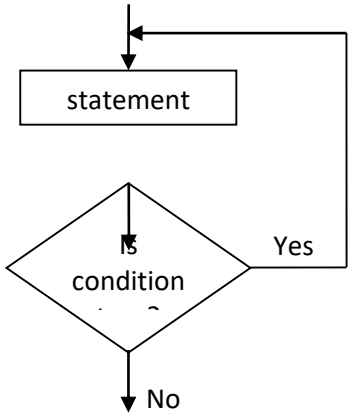
```
#include <iostream.h>
void main()
{
  int  n , i = 1;
  long  sum = 0;
  cout << "Enter a positive integer number: ";
  cin >> n;

  while (i <= n)
       sum += i++;
  cout << "The sum of the first " << n
       << " integers is " << sum;
}
```

Example: Write a C++ program that computes the sum of ten numbers input by the user. Use while loop.

```
#include <iostream.h>
void main()
{
  int  number , sum = 0 , i = 1 ;
  while( i <= 10 )
   {
    cout << ”Enter an integer number: ”;
    cin >> number;
    sum += number;
    i++;
   }
  cout<<”Sum = ” << sum << endl;
}
```

1.2 do/while statement

```
do
   statement;
while (condition);
```



Example: Consecutive integer numbers 1 + 2 + 3 + … + n. Use do/while loop.

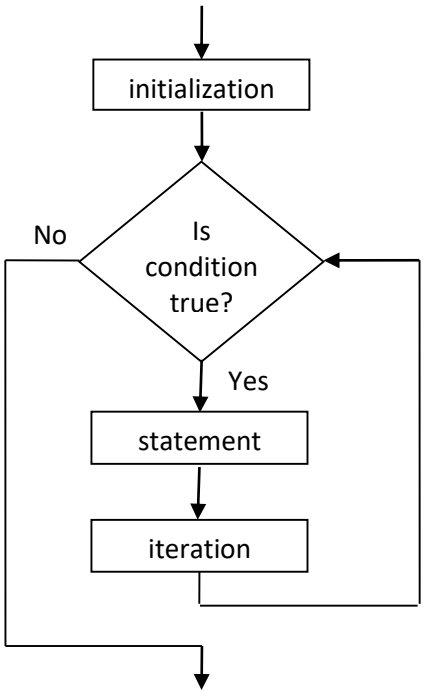
```
#include <iostream.h>
void main()
{
  int n , i = 1;
  long sum = 0;
  cout << "Enter a positive integer: ";
  cin >> n;
  do
    sum += i++;
  while (i <= n);
  cout << "The sum of the first " << n
       << " integers is " << sum;
}
```

Example: Write a C++ program that computes the sum of integer numbers input by the user. The program should stop when the user enters zero.

```
#include <iostream.h>
void main()
{
  int number;
  long sum = 0;
  do
   {
    cout<<"Enter an integer number: ";
    cin >> number;
    sum += number;
   }while(number);   // or while(number != 0);
  cout << "Sum = " << sum;
}
```

1.3 `for` statement

for (initialization ; condition ; iteration)
statement ;



Examples:

1. increasing
   ```
   for ( int i = 1 ; i <= 100 ; i++ )
   ```
2. decreasing
   ```
   for ( int i = 100 ; i >= 1 ; --i )
   ```
3. increasing by 7
   ```
   for ( int i = 7 ; i <= 77 ; i += 7 )
   ```
4. decreasing by 5
   ```
   for ( int i = 20 ; i >= 2 ; i -= 5 )
   ```

Example: Write a C++ program that prints the numbers from 1 to 20.

```
#include <iostream.h>
void main()
{
  for ( int i = 1 ; i <= 20 ; i++ )
      cout << i << " ";
  cout << endl;
}
```

Example: Write a C++ program that computes the sum of ten integer numbers input by the user. Use for loop.

```
#include <iostream.h>
void main()
{
  int number;
  long sum = 0;
  for ( int i = 1 ; i <= 10 ; i++ )
    {
     cout << "Enter an integer number: ";
     cin >> number;
     sum += number;
    }
  cout << "Sum = " << sum << endl;
}
```

Example: Write a C++ program that computes the factorial of an integer number.

```
#include <iostream.h>
void main()
{
  int  number;
  long  fact = 1;
  cout << "Enter a positive integer number: ";
  cin >> number;
  for ( int i = number ; i > 1 ; i-- )
      fact *= i;
  cout << "The factorial is " << fact << endl;
}
```

1.4 Nested `for` statements

```
cout<<"i\tj\n";
for (int i = 1 ; i <= 3 ; i++)
  for (int j = 1 ; j <= 3 ; j++)
     cout << i << "\t" << j <<"\n";
```

The output is:

i	j
1	1
1	2
1	3
2	1
2	2
2	3
3	1
3	2
3	3

Example: Write a C++ program that prints the multiplication table.

```
#include <iostream.h>
#include <iomanip.h>
void main()
{
  cout << "\t\tMultiplication Table\n\n\n ";
  for ( int i = 1 ; i <= 10 ; i++ )
       cout << setw(5) << i;
  for ( i = 1 ; i <= 10 ; i++ )
   {
     cout<< "\n\n" << i << setw(5);
     for ( int j = 1 ; j <= 10 ; j++ )
         cout << i*j << setw(5);
   }
}
```

1.5 `break` and `continue` statements

The `break` statement is used to exit immediately from the loop in which it is contained.

The `continue` statement is used to skip the remaining statements in the body of the loop and then continue with the next iteration of the loop.

Example: break statement

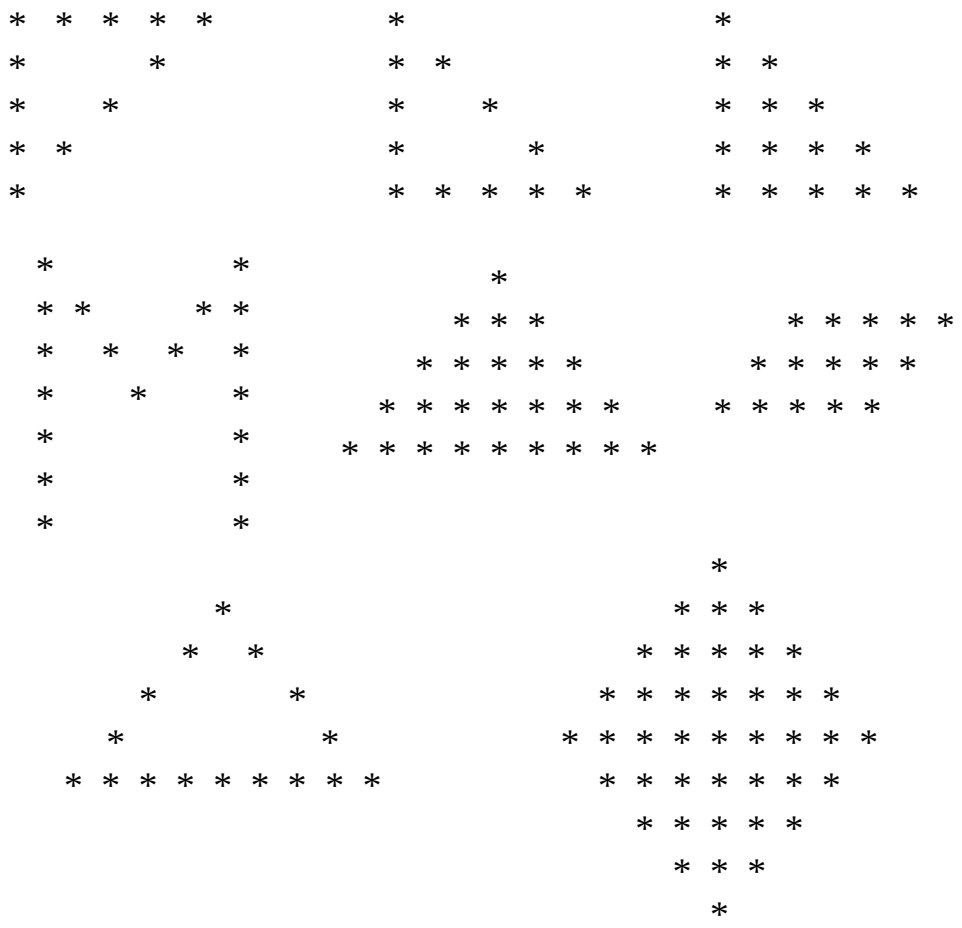
```
#include <iostream.h>
void main()
{
  for ( int i = 1 ; i <= 10 ; i++ )
     {
       if ( i == 5)
          break;
       cout<< i << " ";
     }
  cout << "\nBroke out of loop at i =  " << i
       << endl;
}
```

Example: continue statement

```
#include <iostream.h>
void main()
{
  for ( int i = 1 ; i <= 10 ; i++ )
     {
       if ( i == 5)
          continue;
       cout<< i << " ";
     }
  cout << "\nUsed continue to skip printing 5" << endl;
}
```

Homework:

1. Write a C++ program that prints the following shapes:



2. Write a C++ program that computes the sum of integer numbers divisible by 6 that are from 20 to 100.

3. Write a C++ program that computes the power of an integer number.

4. Write a program that computes the following equation:

$$y = 1 + \frac{1}{x} + \frac{2}{x^2} + \cdots + \frac{n}{x^n}$$

5. Write a C++ program that computes the following series:

$$z = x - \frac{x^2}{2!} + \frac{x^3}{3!} - \frac{x^4}{4!} + \cdots \frac{x^n}{n!}$$

6. What is the output of the following C++ program?

```
#include <iostream.h>
void main()
{
 for(int c = 7 ; c <= 16 ; c++)
 switch(c % 10)
  {
    case 0: cout<<", "; break;
    case 1: cout<<"OFTEN "; break;
    case 2:
    case 8: cout<<"IS "; break;
    case 3: cout<<"NOT "; break;
    case 4:
    case 9: cout<<"DONE "; break;
    case 5: cout<<"WELL "; break;
    case 6: cout<<". "; break;
    case 7: cout<<"WHAT "; break;
    default: cout<<" bad number. ";
  }
 cout<<endl;
}
```

7. Write a program that calculates the value of (pi) from the following series. Stop calculation when the value of (pi) exceeds 8.7235.

   Pi = 4 + 4/3 + 4/5 + 4/7 + 4/9 + ……..

8. Write a program that converts a positive integer number into binary.

9. Write a program that converts a positive integer number into octal.

10. Write a C++ program that reads several integer numbers input by the user and finds the smallest number. The user should first enter a value that specifies the number of integer values remaining to be entered.

    Ex: n=9

    10, 8, 4 ,33, 6, 91, 44, 22, 89

    Smallest is 4

11. An integer number is said to be a prime if it is divisible only by 1 and itself. Write a C++ program that determines if a number is a prime and use this program to determine and print all the prime numbers between 10 and 30.

12. Assume j=0, what is the new value of j at the end of each of the following loops?

- ```
  for(int i = 8 ; i >= 0 ;  i = i - 3 )
          j = j + 1;
  ```
- ```
  for(int i = 0 ; i <= 8 ;  i = i + 2 )
          j = j + 1;
          i = i + 1;
  ```

13. If (i=0) and (g=5), what are the new values of i and g after the following program segment?

```
while ((i <= 4) && (g > 0))
{
   i = i + 1;
   g = g - 1;
}
```

14. Replace the following `for` loop with a corresponding `while` loop.

```
float a = 8;
for (int i = 0 ; i < 10 ; i ++)
{
  if (a == 0) continue;
  cout << 1/a << endl;
  a = a - 1;
}
```

15. What is the output of each of the following C++ code segments:

a)
```
int x = 0;
while (x < 10)
     cout << x++ << endl;
cout <<"Done\n";
```

b)
```
char ch;
for (ch = 'A' ; ch <= 'F' ; ch = ch + 1)
      cout << ch;
cout << endl;
```

16. Write a C++ program that reads a positive integer number and computes the sum of its decimal digits.

Ex: 7354
Sum is 19