Advanced Programming (C++)

BY

Dr. EMAD SAMI

http://www.bu.edu.eg/staff/emadattwa3

Course Chapters

1. Introduction
2. Variables and Constants
3. Expressions and Statements
4. Loops and Decisions
5. Functions
6. Arrays and Strings
7. Pointers
8. Miscellaneous

4. Loops and Decisions

Chapter Objectives:

4-1   Introduction

- Loops: make a section of your program to be repeated a certain number of times.

- The repetition continues while the condition is TRUE. When the condition becomes FALSE, the loop ends and the statements following the loop will be executed.

- There are THREE kinds of loop in C++:

    1- **for loop** … is used when the number of repetitions is *limited*.

    2- **while loop**   …   is used when the number of repetitions is _unlimited_.

    3- **do…while loop** … is used when the number of repetitions is _unlimited_.

4-2   *for…. loop*

- The general form of *for* loop is:

```
for (expression1; expression2; expression3)
    {
    statement1;
    statement2;
    …
    }
```
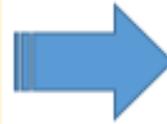
```
for (i=0 ; i<100 ; i++)
    {
    statement1;
    statement2;
    …
    }
```

- *for* loop used **three expressions** separated by semicolons (**;**).
- If the number of **statements** is two or more; you must use the braces (**{   }**).

4-2   *for…. Loop* …

- <u>First</u> **expression1** (i=0;) is evaluated.
- <u>Second</u> if **expression2** (i <100) is TRUE, the statements within the braces ({   }) are executed. But, if **expression2** (i <100;) is FALSE, the looping is stopped and the execution of *for* loop is finished.

بداية العد · نهاية العد · الزيادة · العداد

```
for ( i = 0 ; i < 100 ; i++ )
{
        ..........;
        ..........;
        ....
}
```

- **Expression3** (i++;), is evaluated after the first looping.
- However, **expression3** is evaluated after each looping and before the statement goes back to test **expression2** again.
- Here are other forms of *for* loop.
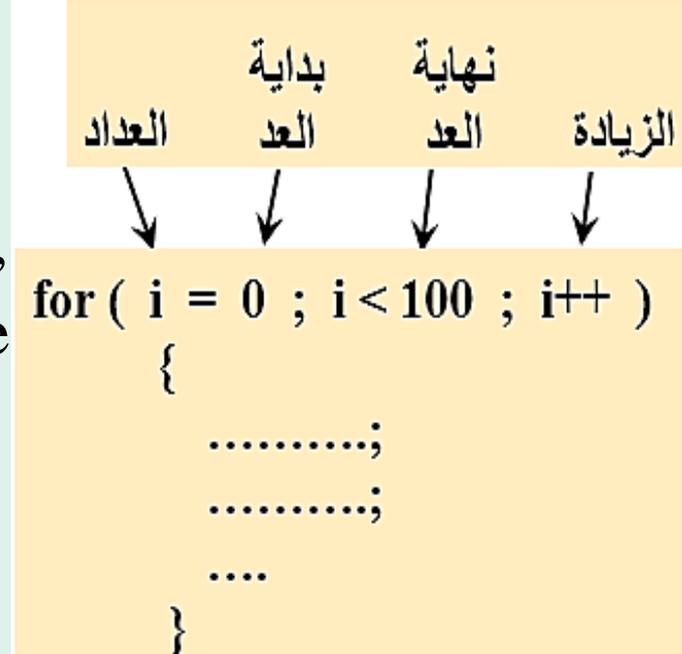
```
for ( i = 0 ; i < 100 ; i = i+3 )
for ( i = 100 ; i < 200 ; i++ )
for ( i = 100 ; i > 0 ; i - - )
for ( i = 100 ; i > 0 ; i - =2)
```

syntax of for loop

Initialization expression

Test expression

Increment expression

a)   for (j=0; j<15; j++)   ⚬—— Note: no semicolon
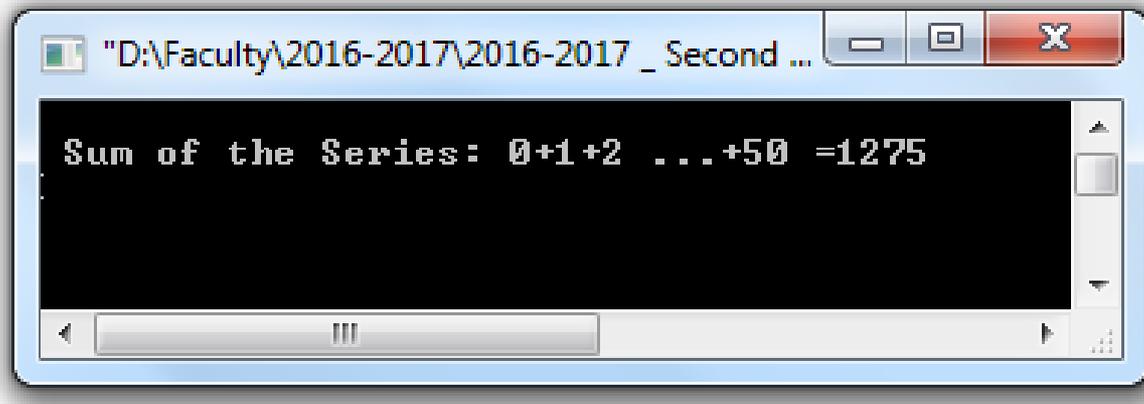
     statement;   Single-statement

b)   for (j=0; j<15; j++)   ⚬—— Note: no semicolon

     {

     statement;

     statement;   Multiple-statement a block of code

     statement;

     } ⚬

          Note: no semicolon here

4-2   *for*…. *Loop* …

- Write a C++ program to sum the series: 0+1+2+3+4 ….+50

- Series1.cpp

```cpp
1 //Series1.cpp
2 //Demonstrates use of for loop
3 #include <iostream.h>
4 void main ( )
5 {
6    int i, S=0;
7    for (i=0; i<=50;i++)
8      S=S+i;
9      cout<<"\n Sum of the Series: 0+1+2 ...+50 ="<<S<<endl;
10 }
```

```
"D:\Faculty\2016-2017\2016-2017 _ Second ...

Sum of the Series: 0+1+2 ...+50 =1275
```

4-2 *for*…. *Loop* …

- What is the output of the program?

- Series2.cpp

```
1 //Series2.cpp
2 //Demonstrates using of for...loop
3 #include <iostream.h>
4 void main ( )
5 {
6     int i;
7     for (i=0; i<=5;i++)
8         cout<<" \n "<<i;
9 }
```

4-2   *for…. Loop …*

- What is the output of the program?

- Series3.cpp

```
1 //Series3.cpp
2 //Demonstrates using of for...loop
3 #include <iostream.h>
4 int main ( )
5 {
6     int j;
7     for (j=0;j<6;j++)
8         cout<<j*j<<endl;
9 return 0;
10 }
```

4-2 *for…. Loop …*

- What is the output of the program?

-

```
1 //Series4.cpp
2 //Demonstrates using of for...loop
3 #include <iostream.h>
4 int main ( )
5 {
6     int counter;
7     for (counter=0;counter<9;counter+=2)
8         cout<<counter*3<<endl;
9 return 0;
10 }
```

4-2   *for…. Loop* …

- Write a C++ program to calculate:

    Sum = 0 + 1 + 4 + 9 + 16 + … + 625

- Series5.cpp

```cpp
//Series5.cpp
//Demonstrates using of for...loop
//Calculate Sum= 0+1+4+9+16+... +625
#include <iostream.h>
int main ( )
{
    int i, Sum=0;
    for (i=0;i<=25;i++)
        Sum=Sum+i*i;
        cout<<"\n Sum of 0+1+4+ ... +625 = "<<Sum;
return 0;
}
```

```
 "D:\Faculty\2016-2017\2016-2017 _ Second Term\HTI\Advanced P
 Sum of 0+1+4+ ... +625 = 5525
```

4-2 *for…. Loop …*

- Write a C++ program to calculate:

    F = 1*2*3*4 … *N

- Series6.cpp

```cpp
//Series6.cpp
//Demonstrates using of for...loop
//Calculate F = 1*2*3*4 ...*N
#include <iostream.h>
void main ( )
{
    long int i,N,F=1;
    cout<<" Calculate Factorial of Input Number: ";
    cin>>N;
    for (i=1;i<=N;i++)
        F=F*i;
        cout<<"\n The Series 1*2*3 ... *N = "<<F;
```

```
"D:\Faculty\2016-2017\2016-2017 _ Second Ter...
Calculate Factorial of Input Number: 8

The Series 1*2*3 ... *N = 40320
```

الرقم الناتج يعتمد على **Variable Type** المحجوز للمتغير **F** بمعنى ممكن يكون الناتج يحتاج مساحة على الشاشة أكبر من نوع المتغير **int**

4-2   *for* .... *Loop* ...

- Write a C++ program to get the following formula:

$$Sum = x + \frac{x^2}{2} + \frac{x^3}{3} + \frac{x^4}{4} + ... + \frac{x^n}{n}$$

- Series7.cpp

```cpp
//Series7.cpp
//Demonstrates using of for...loop
#include <iostream.h>
#include <math.h>
void main ( )
{
    float Sum=0,x,term;
    int i,n;
    cout<<"\n Enter Value of x = "; cin>>x;
    cout<<"\n Enter Value of n = "; cin>>n;
    for (i=1;i<=n;i++)
    {
        term=pow(x,i)/i;
        Sum=Sum+term;
    }
    cout<<"\n The Sum of The Series = "<<Sum;
}
```

```
Enter Value of x = 3
Enter Value of n = 3
The Sum of The Series = 16.5
```

4-2   *for…. Loop …*

- Write a C++ program to get the following formula:

$$Sum = x + \frac{x^2}{2} + \frac{x^3}{3} + \frac{x^4}{4} + \ldots + \frac{x^n}{n}$$

- Series71.cpp نفس السؤال السابق بطريقة كتابة مختلفة

```cpp
1 //Series71.cpp
2 //Demonstrates using of for...loop
3 #include <iostream.h>
4 #include <math.h>
5 void main ( )
6 {
7     float Sum=0,i,x,n;
8     cout<<"\n Enter Value of x = "; cin>>x;
9     cout<<"\n Enter Value of n = "; cin>>n;
10    for (i=1;i<=n;i++)
11        Sum=Sum+pow(x,i)/i;
12    cout<<"\n The Sum of The Series = "<<Sum;
13 }
```

```
Enter Value of x = 3

Enter Value of n = 3

The Sum of The Series = 16.5
```

4-2 *for…. Loop* …

- **Quiz:** Write a C++ program to get the following formula:

$$Sum = x + \frac{x^3}{3} + \frac{x^5}{5} + \frac{x^7}{7} + … + \frac{x^n}{n}$$

- Series8.cpp

```cpp
//Series8.cpp
//Demonstrates using of for...loop
#include <iostream.h>
#include <math.h>
void main ( )
{
    float Sum=0,x,term;
    int i,n;
    cout<<"\n Enter Value of x = "; cin>>x;
    cout<<"\n Enter Value of n = "; cin>>n;
    for (i=1;i<=n;i+=2)
    {
       term=pow(x,i)/i;
       Sum=Sum+term;
    }
    cout<<"\n The Sum of The Series = "<<Sum;
}
```

```
Enter Value of x = 3
Enter Value of n = 3
The Sum of The Series = 12
```

4-2   *for…. Loop …*

- Note the difference between (**endl** and **setw**)

- **endl** : means begin from a new line *i.e* "\n" and this function exist in the header file <iostream.h>.

- **setw** : means set width with **n** spaces and this function exist in the header file <iomanip.h>.

- Write a C++ program to print number and its square as follows:

- setw.cpp

```
1 //setw.cpp
2 //Demonstrates using of stew manipulator
3 #include <iostream.h>
4 #include <iomanip.h>
5 void main ( )
6 {
7     int number;
8     for (number=1;number<=10;number++)
9         cout<<number<<setw(7)<<number*number<<endl;
10 }
```

```
1        1
2        4
3        9
4       16
5       25
6       36
7       49
8       64
9       81
10      100
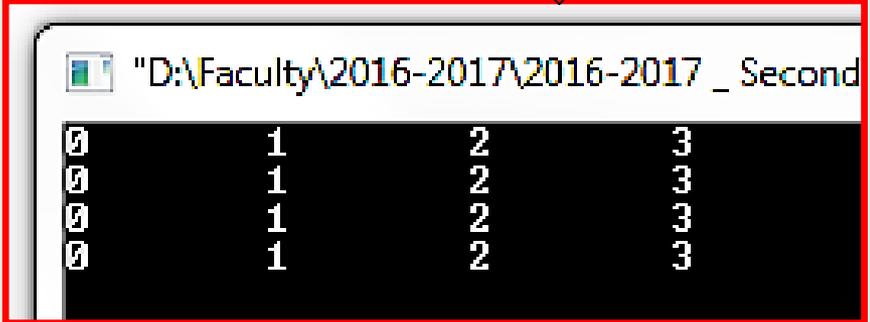```

# 4-3   Nested *for*…. *Loop*

- You can put a loop inside another one to make nested loops.
- The computer will run the inner loop first before it resumes the looping for the outer loop.
- The general form for nested loop may be as:

```
for (i=0; i<4; i++)
 {
    for (j=0; j<4; j++)
     {

          --------;
          --------;

     }
 }
```

4-3   Nested *for…. Loop …*

- Write a C++ program to find the following output:
- Nestedfor.cpp

```
"D:\Faculty\2016-2017\2016-2017 _ Second
0          1          2          3
0          1          2          3
0          1          2          3
0          1          2          3
```
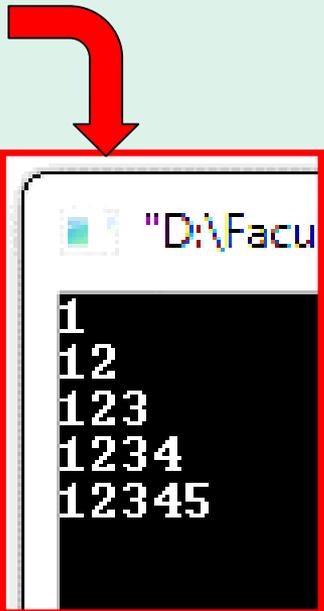
```cpp
1 //Nestedfor.cpp
2 //Demonstrates nested for loop
3 #include <iostream.h>
4 void main ( )
5 {
6     int i,j;
7     for(i=0;i<4;i++)
8       {
9           for(j=0;j<4;j++)
10            {
11              cout<<j<<"\t";
12            }
13          cout<<"\n";
14      }
15 }
```

4-3   Nested *for…. Loop …*

- Write a C++ program to find the following output:

- Nestedfor2.cpp

```
1  //Nestedfor2.cpp
2  //Demonstrates nested for loop
3  #include <iostream.h>
4  void main ( )
5  {
6     int i,j;
7     for(i=1;i<=5;i++)
8       {
9           for(j=1;j<=i;j++)
10              cout<<j;
11              cout<<"\n";
12       }
13 }
```
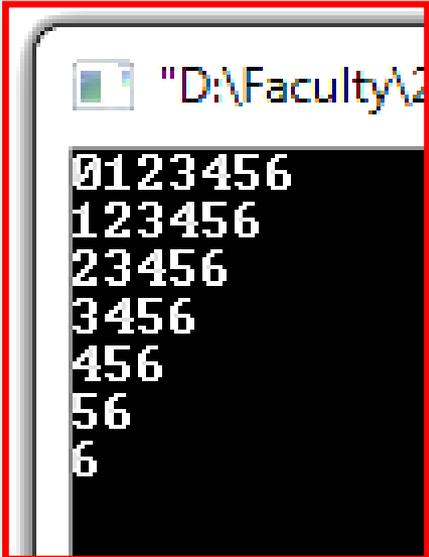
```
"D:\Facu
1
12
123
1234
12345
```

4-3 Nested *for…. Loop* …

- What is the output of the following code:
- Nestedfor3.cpp

```cpp
1 //Nestedfor3.cpp
2 //Demonstrates nested for loop
3 #include <iostream.h>
4 void main ( )
5 {
6     int i,j;
7     for(i=0;i<=6;i++)
8     {
9         for(j=i;j<=6;j++)
10            cout<<j;
11        cout<<"\n";
12    }
13 }
```

```
"D:\Faculty\
0123456
123456
23456
3456
456
56
6
```

4-3   Nested *for…. Loop …*

- Home Work: Write a C++ program to get the following formula:

$$Sum = x + \frac{x^2}{2!} + \frac{x^3}{3!} + \frac{x^4}{4!} + ... + \frac{x^n}{n!}$$

- Series9.cpp

4-4 *while…. Loop*

- The *while* loop causes your program to repeat a sequence of statements as long as the starting condition remains TRUE.
- أقل عدد مرات التكرار = 0 .....(بمعنى لو الشرط حالته خطأ فلا يدخل فى الحلقة).
- إختبار الشرط قبل التنفيذ.
- The general form of *while* statement is:

```
while (expression)
    {
    statement1;
    statement2;
    …
    }
```

- *while* statement uses only <u>one</u> **expression**.
- If the **expression** is TRUE, the **statements** inside the block are executed over and over until the **expression** is FALSE, the looping is stopped and the execution of *while* loop is finished.

syntax of while loop

Test expression

```
while (n!=0)        ◯——Note: no semicolon here
    statement;                          Single-statement loop
```

Test expression

```
while (v2<45)       ◯——Note: no semicolon here
    {
    statement;
    statement;      }  Multiple-statement loop body
    statement;
    } ◯
        └——Note: no semicolon here
```
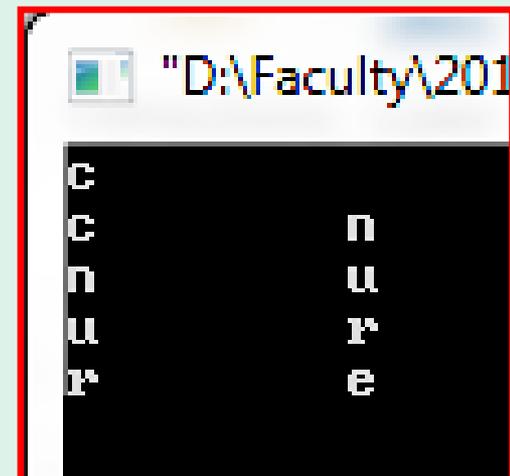
4-4   *while*…. *Loop* …

- What is the output of the following code, if you enter the letters c, n, u, r, e.

```cpp
1  //while.cpp
2  //Demonstrates while loop
3  #include <iostream.h>
4  void main ( )
5  {
6      char Letter;
7      cin>>Letter;
8      while(Letter!='E' && Letter!='e')
9      {
10          cout<<Letter<<"\t";
11          cin>>Letter;
12      }
13 }
```

```
"D:\Faculty\201
c
c              n
n              u
u              r
r              e
```

4-4   *while…. Loop …*

- Write a C++ program to calculate the formula using while loop:

    F = 1*2*3*4 … *n

- WhileF.cpp

```
1 //whileF.cpp
2 //Demonstrates using of while...loop
3 //Calculate F = 1*2*3*4 ...*n
4 #include <iostream.h>
5 void main ( )
6 {
7     int n,F=1;
8     cin>>n;
9     while(n>0)
10       {
11        F = F *n;
12        n = n-1;
13       }
14       cout<<"\n The Series 1*2*3 ... *n = "<<F;
15 }
```

```
"D:\Faculty\2016-2017\2016-2017 _ Second Term\HTT\
5
 The Series 1*2*3 ... *n = 120
```

4-4 *while…. Loop …*

- Write a C++ program to calculate the series using while loop:

    Sum = 0 + 1 + 4 + 9 + 16 + ... + 625

- WhileS.cpp

```cpp
//whileS.cpp
//Demonstrates using of while...loop
//Calculate Sum= 0+1+4+9+16+... +625
#include <iostream.h>
void main ( )
{
    int n,Sum=0;
    cin>>n;
    while(n>=0)
        {
            Sum=Sum+n*n;
            n=n-1;
        }
    cout<<"\n Sum of 0+1+4+ ... +625 = "<<Sum;
}
```

```
"D:\Faculty\2016-2017\2016-2017 _ Second Term\HTI\Adv

25

Sum of 0+1+4+ ... +625 = 5525
```

4-4   *while…. Loop …*

- Write a C++ program to calculate the series using while loop:

$$Sum = x + \frac{x^2}{2} + \frac{x^3}{3} + \frac{x^4}{4} + ... + \frac{x^n}{n}$$

- WhileS2.cpp

```cpp
//whileS2.cpp
//Demonstrates using of while...loop
#include <iostream.h>
#include <math.h>
void main ( )
{
    float Sum=0,x,n;
    cout<<"\n Enter Value of x = "; cin>>x;
    cout<<"\n Enter Value of n = "; cin>>n;
    while(n>=1)
        {
            Sum=Sum+pow(x,n)/n;
            n=n-1;
        }
    cout<<"\n The Sum of The Series = "<<Sum;
}
```

```
Enter Value of x = 4

Enter Value of n = 4

The Sum of The Series = 97.3333
```

4-4   *while…. Loop …*

- **Quiz:** Write a C++ program to get the following formula using while loop:

$$Sum = x + \frac{x^3}{3} + \frac{x^5}{5} + \frac{x^7}{7} + ... + \frac{x^n}{n}$$

- WhileS3.cpp

```cpp
1  //whileS3.cpp
2  //Demonstrates using of while...loop
3  #include <iostream.h>
4  #include <math.h>
5  void main ( )
6  {
7      float Sum=0,x,n;
8      cout<<"\n Enter Value of x = "; cin>>x;
9      cout<<"\n Enter Value of n = "; cin>>n;
10     while(n>=1)
11         {
12             Sum=Sum+pow(x,n)/n;
13             n=n-2;
14         }
15     cout<<"\n The Sum of The Series = "<<Sum;
16 }
```

```
Enter Value of x = 5

Enter Value of n = 5

The Sum of The Series = 671.667
```

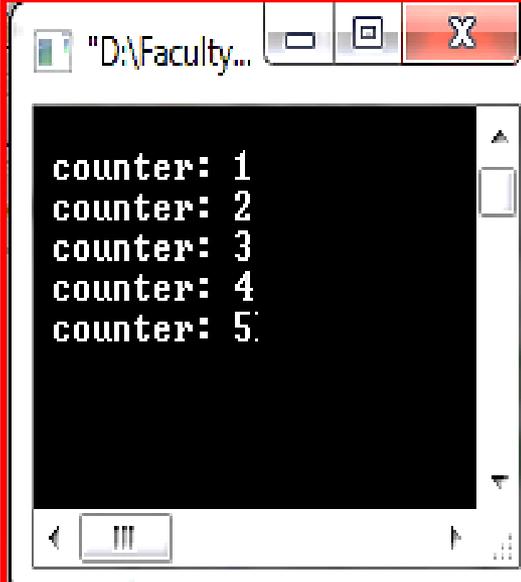# 4-4 *while…. Loop …*

- Write a C++ program such that: Enter sequence of numbers less than 100, until you enter a negative number the program will be terminated.

- WhileS4.cpp

```cpp
1 //WhileS4.cpp
2 //Demonstrates using of while...loop
3 #include <iostream.h>
4 void main ( )
5 {
6     int n=100;
7     while(n>=0)
8         {
9             cout<<n<<endl;
10            cin>>n;
11        }
12 }
```

```
100
70
70
50
50
5
5
0
0
6
6
-8
```

4-5 *while…. Loop … (using break statement)*

- *break;* if the statement before *break* is TRUE, then exit the loop. But if the statement before *break* is FALSE, then complete the rest of the loop body.

- DoWhileD3.cpp

```cpp
//DowhileD3.cpp
//Demonstrates Break; statement
#include <iostream.h>
void main ( )
{
    int counter=0;
    while (1)          ← True for ever
    {
        counter++;
        if(counter>5)  ← if it is True, then break exit the loop.
        break;            if it is False, then break complete the rest of the loop.
        cout<<"\n counter: "<<counter;
    }
}
```

```
"D:\Faculty...

counter: 1
counter: 2
counter: 3
counter: 4
counter: 5
```

4-6 *do-while…. Loop*

- If you want to allow the body of the loop to be executed at least one time, you should use the *do-while* loop.
  - أقل عدد مرات التكرار = 1 .... (بمعنى يقوم بتنفيذ مابداخل ال do كلما كانت الحالة الشرطية داخل while صحيحة).
  - إختبار الشرط بعد التنفيذ.
- The general form of *do-while* statement is:

```
do
  {
     statement1;
     statement2;
     …
  }
while (expression);
```

Here is a semicolon (;)

- *do-while* statement uses only <u>one</u> **expression**.
- The sequence of do-while is: *do* **statements** *while* TRUE *do* **statements** *while* TRUE *do* **statements** *while* False exit from the loop.

syntax of do-while loop

```
do ◯── Note: no semicolon here
    statement;                          Single-statement loop
while (ch!='n');
  Test expression        └─Note: semicolon


do ◯── Note: no semicolon here
    {
    statement;
    statement;           } Multiple-statement loop body
    statement;
    }
while (numb<96);
  Test expression        └─Note: semicolon
```
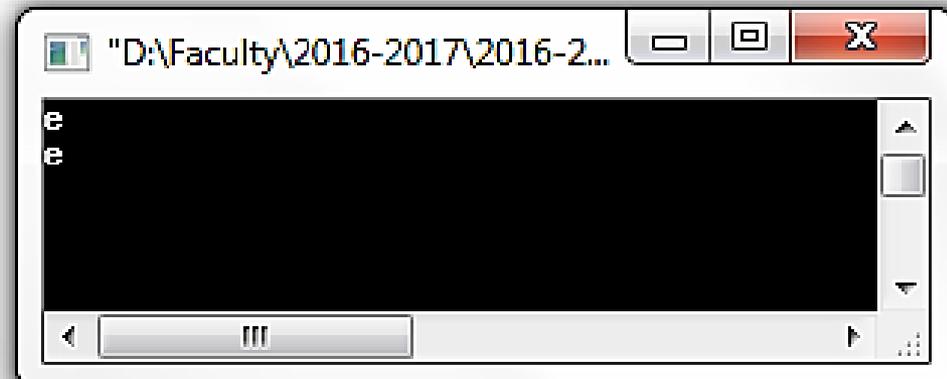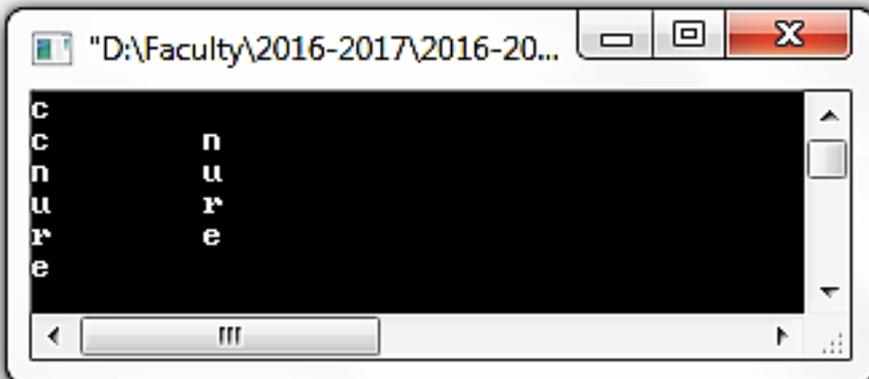
4-6 *do-while…. Loop …*

- What is the output of the following code, if you enter the letters c, n, u, r, e. DoWhile.cpp

```cpp
//DoWhile.cpp
//Demonstrates Do-While loop
#include <iostream.h>
void main ( )
{
    char Letter;
    do
       {
          cin>>Letter;
          cout<<Letter<<"\t";
       }
    while(Letter!='E' && Letter!='e');
}
```
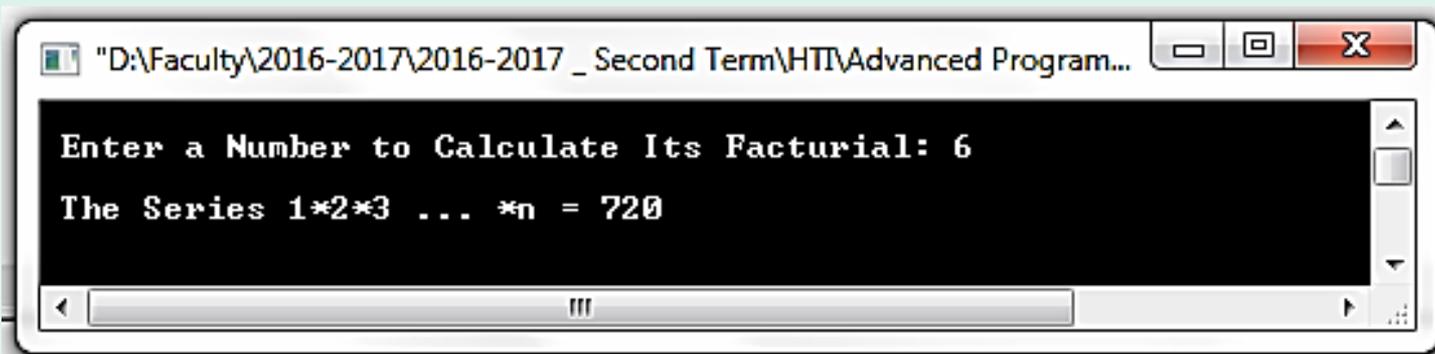
```
c
c         n
n         u   r
u         r
r         e
e
```

```
e
e
```

4-6 *do-while…. Loop …*

- Write a C++ program using do-while loop to calculate the formula:

$$F = 1*2*3*4 … *n$$

- DoWhileF.cpp

```cpp
1 //DoWhileF.cpp
2 //Demonstrates using of D-while...loop
3 //Calculate F = 1*2*3*4 ...*n
4 #include <iostream.h>
5 void main ( )
6 {
7     int n,F=1;
8     cout<<"\n Enter a Number to Calculate Its Facturial: ";
9     cin>>n;
10  do
11    {
12        F = F *n;
13        n = n-1;
14    }
15  while(n>0);
16        cout<<"\n The Series 1*2*3 ... *n = "<<F;
17 }
```

```
"D:\Faculty\2016-2017\2016-2017 _ Second Term\HTI\Advanced Program...

Enter a Number to Calculate Its Facturial: 6

The Series 1*2*3 ... *n = 720
```
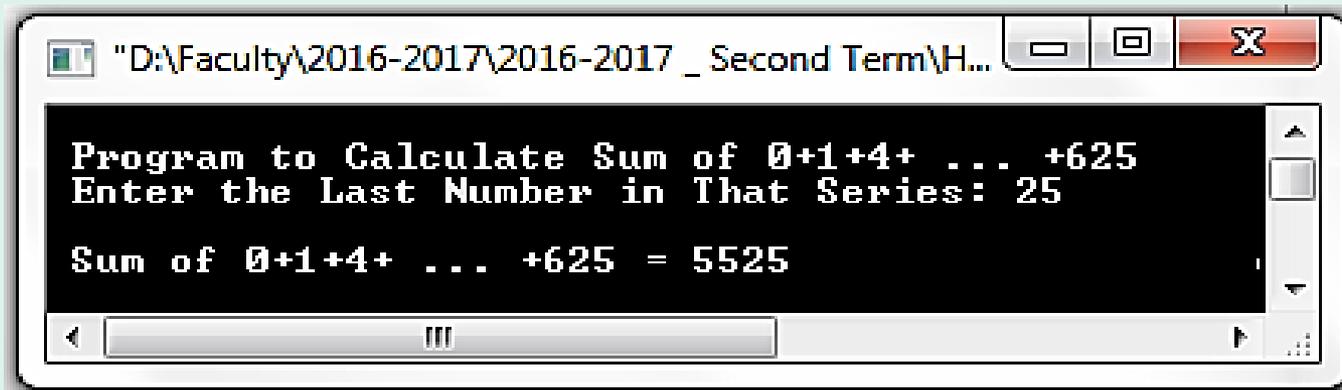
4-6   *do-while…. Loop …*

- Write a C++ program to calculate the series using do-while loop:

  Sum = 0 + 1 + 4 + 9 + 16 + ... + 625

- DoWhileS.cpp

```cpp
//DowhileS.cpp
//Demonstrates using of Do-while...loop
//Calculate Sum= 0+1+4+9+16+... +625
#include <iostream.h>
void main ( )
{
    int n,Sum=0;
    cout<<"\n Program to Calculate Sum of 0+1+4+ ... +625 ";
    cout<<"\n Enter the Last Number in That Series: ";
    cin>>n;
  do
   {
     Sum=Sum+n*n;
     n=n-1;
   }
  while(n>=0);
        cout<<"\n Sum of 0+1+4+ ... +625 = "<<Sum;
}
```

```
"D:\Faculty\2016-2017\2016-2017 _ Second Term\H...

Program to Calculate Sum of 0+1+4+ ... +625
Enter the Last Number in That Series: 25

Sum of 0+1+4+ ... +625 = 5525
```
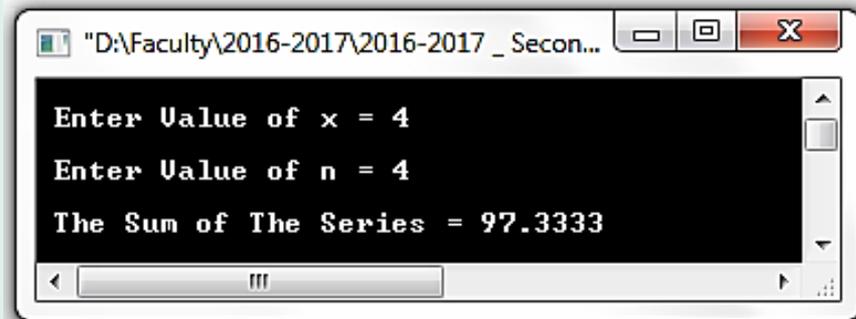
4-6   *do-while…. Loop …*

- Write a C++ program to calculate the series using do-while loop:

$$Sum = x + \frac{x^2}{2} + \frac{x^3}{3} + \frac{x^4}{4} + \ldots + \frac{x^n}{n}$$

- DoWhileS2.cpp

```cpp
//Dowhiles2.cpp
//Demonstrates using of Do-while...loop
#include <iostream.h>
#include <math.h>
void main ( )
{
    float Sum=0,x,n;
    cout<<"\n Enter Value of x = "; cin>>x;
    cout<<"\n Enter Value of n = "; cin>>n;
  do
   {
     Sum=Sum+pow(x,n)/n;
     n=n-1;
   }
  while(n>=1);
    cout<<"\n The Sum of The Series = "<<Sum;
}
```

```
"D:\Faculty\2016-2017\2016-2017 _ Secon...

Enter Value of x = 4

Enter Value of n = 4

The Sum of The Series = 97.3333
```
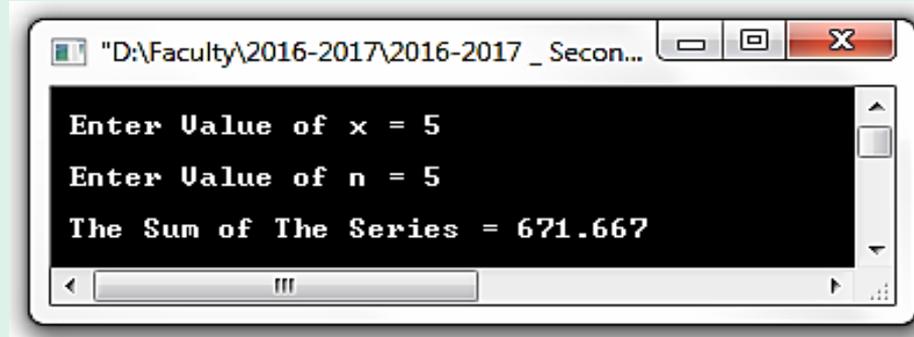
4-6   *do-while…. Loop …*

- **Quiz:** Write a C++ program to get the following formula using do-while loop:

$$Sum = x + \frac{x^3}{3} + \frac{x^5}{5} + \frac{x^7}{7} + ... + \frac{x^n}{n}$$

- DoWhileS3.cpp

```cpp
//DoWhileS3.cpp
//Demonstrates using of Do-while...loop
#include <iostream.h>
#include <math.h>
void main ( )
{
    float Sum=0,x,n;
    cout<<"\n Enter Value of x = "; cin>>x;
    cout<<"\n Enter Value of n = "; cin>>n;
  do
   {
     Sum=Sum+pow(x,n)/n;
     n=n-2;
   }
  while(n>=1);
    cout<<"\n The Sum of The Series = "<<Sum;
}
```

```
"D:\Faculty\2016-2017\2016-2017 _ Secon...

Enter Value of x = 5

Enter Value of n = 5

The Sum of The Series = 671.667
```

4-6 *do-while…. Loop* …

- Write a C++ program, using do-while loop, to show the Quotient and the remainder if the user enter the dividend and the divisor.

- DoWhileD.cpp

```cpp
//DoWhileD.cpp
//Demonstrates Do-While loop
#include <iostream.h>
void main ( )
{
  char ch;
  long int Dividend, Divisor;
  do
   {
    cout<<"\n Enter Dividend: ";
    cin>>Dividend;
    cout<<"\n Enter Divisor: ";
    cin>>Divisor;
    cout<<"\n Quotient is: "<<Dividend/Divisor;
    cout<<"\t  Renmainder is: "<<Dividend%Divisor;
    cout<<"\n Do Another? (y/n)";
    cin>>ch;
   }
  while(ch=='y' || ch=='Y');
}
```
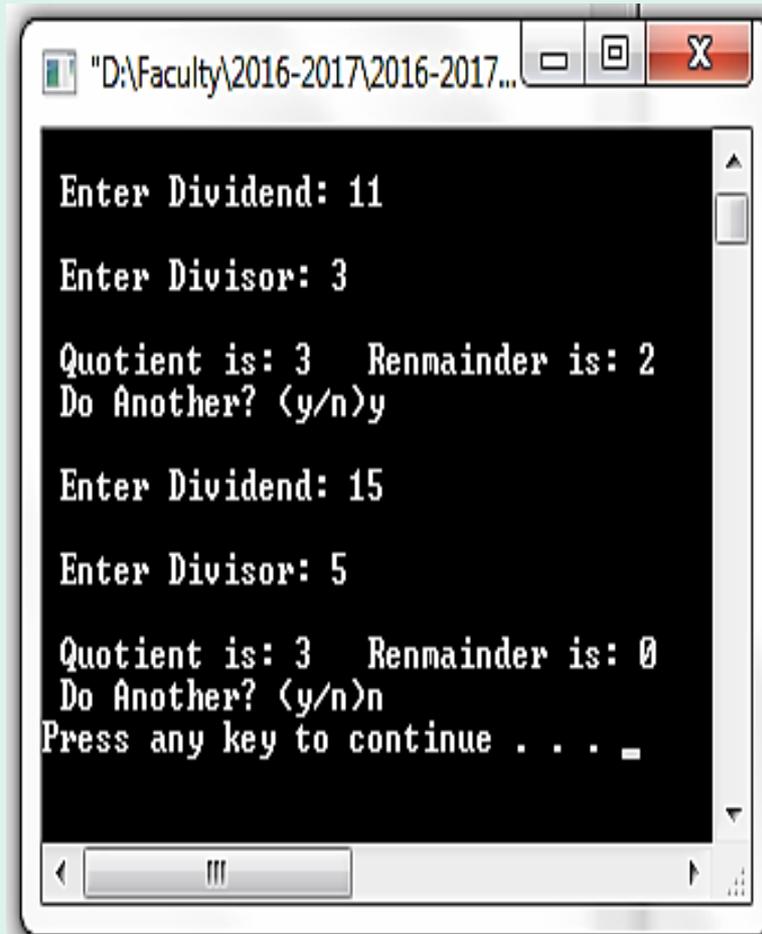
```
Enter Dividend: 11

Enter Divisor: 3

Quotient is: 3    Renmainder is: 2
Do Another? (y/n)y

Enter Dividend: 15

Enter Divisor: 5

Quotient is: 3    Renmainder is: 0
Do Another? (y/n)n
Press any key to continue . . .
```

4-7 *do-while…. Loop … (using continue statement)*

- *continue;* is used to go to the top of the loop.
- In the previous example, if the divisor is Zero, it is a must to go to the top of the loop because the division on Zero is Denied.
- DoWhileD2.cpp

```cpp
//DoWhileD2.cpp
//Demonstrates Do-While loop
#include <iostream.h>
void main ( )
{
  char ch;
  long int Dividend, Divisor;
  do
   {
    cout<<"\n Enter Dividend: "; cin>>Dividend;
    cout<<"\n Enter Divisor: "; cin>>Divisor;
     if(Divisor==0)
      {
       cout<<"\n Illegal Divisor ! \n";
       continue;
      }
    cout<<"\n Quotient is: "<<Dividend/Divisor;
    cout<<"\t  Renmainder is: "<<Dividend%Divisor;
    cout<<"\n Do Another? (y/n)";
    cin>>ch;
   }
  while(ch=='y' || ch=='Y');
}
```

```
"D:\Faculty\2016-2017\2016-20...

Enter Dividend: 11

Enter Divisor: 3

Quotient is: 3    Renmainder is: 2
Do Another? (y/n)y

Enter Dividend: 15

Enter Divisor: 0

Illegal Divisor !

Enter Dividend: 15

Enter Divisor: 2

Quotient is: 7    Renmainder is: 1
Do Another? (y/n)n
Press any key to continue . . .
```