MPHYCC-09: M.Sc. (Physics) Practical

By
Dr. Santosh Prasad Gupta

Series

Exponential series: *Exponential Series* is a series which is used to find the value of e^x.

The formula used to express the e^x as Exponential Series is

$$e^x = \sum_{n=0}^{\infty} \frac{x^n}{n!}$$

Expanding the above notation, the formula of Exponential Series is

$$e^x = 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \cdots$$

For example,

Let the value of **x** be **3**.

$$e^3 = 1 + 3 + \frac{3^2}{2!} + \frac{3^3}{3!} + \cdots$$

So, the value of $\mathbf{e^3}$ is **20.0855**

C-programme:

```
/* Program for Exponential Series */
#include<stdio.h>
#include<conio.h>

int main()
{
   int i, n;
   float x, sum=1, t=1;
   printf("Enter the value for x : ");
   scanf("%f", &x);
   printf("\nEnter the value for n : ");
   scanf("%d", &n);
   /* Loop to calculate the value of Exponential */
   for(i=1;i<=n;i++)
   {
```

```
        t=t*x/i; // to calculate the nth term of the series
        sum=sum+t;
    }
    printf("\nThe Exponential Value of %f = %.4f", x, sum);
    getch();
}
    printf("\nThe Exponential Value of %f = %.4f", x, sum);
    getch();
}
```

Sine Series: *Sine Series* is a series which is used to find the value of Sin(x). where, **x** is the angle in **degree** which is converted to **Radian**. The formula used to express the Sin(x) as Sine Series is

$$\sin x = \sum_{x=0}^{\infty} (-1)^n \frac{x^{2n+1}}{(2n+1)!}$$

Expanding the above notation, the formula of Sine Series is

$$\sin x = x - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!} + \ldots$$

C-programme:

```
#include<stdio.h>
#include<conio.h>
int main()
{
    int i, n;
    float x, sum, t;
    clrscr();
    printf(" Enter the value for x : ");
    scanf("%f",&x);
    printf(" Enter the value for n : ");
    scanf("%d",&n);
    x=x*3.14159/180;//convert degree to radian
    t=x;
    sum=x;
    /* Loop to calculate the value of Sine */
    for(i=1;i<=n;i++)
    {
        t=(t*(-1)*x*x)/(2*i*(2*i+1));// calculate nth term of the series
```

```
        sum=sum+t;
    }
     printf(" The value of Sin(%f) = %.4f",x,sum);
     getch();
}
```

Cosine Series: *Cosine Series* is a series which is used to find the value of Cos(x). where, **x** is the angle in **degree** which is converted to **Radian**. The formula used to express the Cos(x) as Cosine Series is

$$\cos x = \sum_{n=0}^{\infty} (-1)^n \frac{x^{2n}}{(2n)!}$$

Expanding the above notation, the formula of Cosine Series is

$$\cos x = 1 - \frac{x^2}{2!} + \frac{x^4}{4!} - \frac{x^6}{6!} + \ldots$$

```
#include<stdio.h>
#include<conio.h>
int main()
{
    int i, n;
    float x, sum=1, t=1;
    printf(" Enter the value for x : ");
    scanf("%f",&x);
    printf(" Enter the value for n : ");
    scanf("%d",&n);
    x=x*3.14159/180;//convert  degree to radian
    /* Loop to calculate the value of Cosine */
    for(i=1;i<=n;i++)
    {
        t=t*(-1)*x*x/(2*i*(2*i-1));
        sum=sum+t;
    }
    printf(" The value of Cos(%f) is : %.4f", x, sum);
    getch();
}
```

Factorial C-Programme:

```
#include <stdio.h>
#include <math.h>
int main ()
{
        int i, n, fact=1;
        printf("enter the value whose factorial has to be calculated:\n");
        scanf("%d",&n);
        for (i=1;i<=n;i++)
  {

        fact=fact * i;
  }
        printf("factorial of %d \n is equal to %d\n", n, fact);
        return 0;
}
```

Series using factorial

Exponential series programme:

```
#include <stdio.h>
#include <math.h>

int fac(int x)
{
        int i,fac=1;
        for(i=1;i<=x;i++)
                fac=fac*i;
        return fac;
}
```

```
int main()
{
	float x,sum=1,a;
	int i,n;
printf("Enter the value of x of expx series: ");
	scanf("%f",&x);

	printf("Enter the limit upto which you want to expand the series: ");
	scanf("%d",&n);
	for(i=1;i<=n;i++)
	{
	a=pow(x,i)/fac(i);
	sum=sum+a;
	}
	printf("Exp(%0.1f): %f",x,sum);
	return 0;
}
```

Sine series programme:

```
#include <stdio.h>
#include <math.h>

int fac(int x)
{
	int i,fac=1;
	for(i=1;i<=x;i++)
		fac=fac*i;
	return fac;
}

int main()
{
	float x,sum=0,a,b;
	int i,n;
printf("Enter the value of x of sinx series: ");
	scanf("%f",&x);
```

```
        printf("Enter the limit upto which you want to expand the series: ");
        scanf("%d",&n);
        x = x*(3.1415/180);

        for(i=1;i<=n;i++)
        {

        a=pow(-1,(i-1));
        b=pow(x,(2*i-1))/fac(2*i-1);
        sum=sum+a*b;

        }
        printf("Sin(%0.1f): %f",x,sum);
        return 0;
}
```

Cosine series programme:

```
#include <stdio.h>
#include <math.h>

int fac(int x)
{
        int i,fac=1;
        for(i=1;i<=x;i++)
                fac=fac*i;
        return fac;
}

int main()
{
        float x,sum=1,a,b;
        int i,n;
printf("Enter the value of x of cosx series: ");
        scanf("%f",&x);
```

```
        printf("Enter the limit upto which you want to expand the series: ");
        scanf("%d",&n);
        x = x*(3.1415/180);

        for(i=1;i<=n;i++)
        {

        a=pow(-1,i);
        b=pow(x,(2*i))/fac(2*i);
        sum=sum+a*b;

        }
        printf("Cos(%0.1f): %f",x,sum);
        return 0;
}
```

Natural Log series: The formula used to express the **log(1+x)** as log Series is

$$\log(1+x) = x - \frac{x^2}{2} + \frac{x^3}{3} - \frac{x^4}{4} \ldots (-1)^{n+1}\frac{x^n}{n}$$

```
#include <stdio.h>
#include <math.h>
int main()
{
        float x,sum=0,a,b;
        int i,n;
printf("Enter the value of x of log(1+x)) series: ");
        scanf("%f",&x);
        printf("Enter the limit upto which you want to expand the series: ");
        scanf("%d",&n);
        for(i=1;i<=n;i++)
        {

        a=pow(-1,(i+1));
        b=pow(x,n)/n;
```

```
        sum=sum+a*b;

        }
        printf("Log(1+%0.1f): %f",x,sum);
        return 0;
}
```

Natural Log series: The formula used to express the **log(1- x)** as log Series is

$$\log(1+x) = x - \frac{x^2}{2} - \frac{x^3}{3} - \frac{x^4}{4} \ldots - \frac{x^n}{n}$$

```
#include <stdio.h>
#include <math.h>

int main()
{
        float x,sum=0,b;
        int i,n;
    printf("Enter the value of x of log(1-x)) series: ");
        scanf("%f",&x);
        printf("Enter the limit upto which you want to expand the series: ");
        scanf("%d",&n);
        for(i=1;i<=n;i++)
        {
        b=(-1)*(pow(x,n)/n);
        sum=sum+b;
                }
        printf("Log(1-%0.1f): %f",x,sum);
        return 0;
}
```

pre-processor directive, macros and function

pre-processor: begin with a hash symbol (#). Preprocessor directives are preprocessor commands. The most common preprocessor directive is #include

```
#include <stdio.h>
#define PI 3.14 // #define is the pre-processor directive similarly as #include
int main()
{
  float radius, area;
  printf("Enter radius of circle:");
  scanf("%f", &radius);
  area = PI*radius*radius;
  printf("Area of circle is %.3f:", area);
  return 0;
}
```

macro: #define can be used to write macro definitions also as follows. **Macros** are also like function but are a bit different from that. They can also take arguments

```
#include <stdio.h>
#define area(r) (3.14*r*r)
int main()
{
 float radius, area;
  printf("Enter radius of circle:");
 scanf("%f", &radius);
 area = area(radius);
 printf("Area of circle is %.2f:", area);
return 0;
}
```

We have defined a macro 'area' which takes one argument that is 'r'. So, when we called area(radius), it got replaced by 3.14*radius*radius (as area(r) is 3.14*r*r).

function:

```
#include <stdio.h>
float CircleArea(float r)//function to calculate area
{
  float a;
```

```
  a = 3.14*r*r;
  float radius;
  return a;
}
int main()
{
  float radius, area;
  printf("Enter radius of circle:");
  scanf("%f", &radius);
  area = CircleArea(radius);
  printf("Area of circle is %.2f:", area);
  return 0;
}
```

The first difference is that macros replace codes by their value (as it replaced area(r) with (3.14*r*r)). So, every time code will be allocated some space. This means that every time area(r) will appear, it will be space allocated in the memory. But this is not the case with function. Secondly, function call takes some time but macro is defined before the actual program. So, macro is faster.