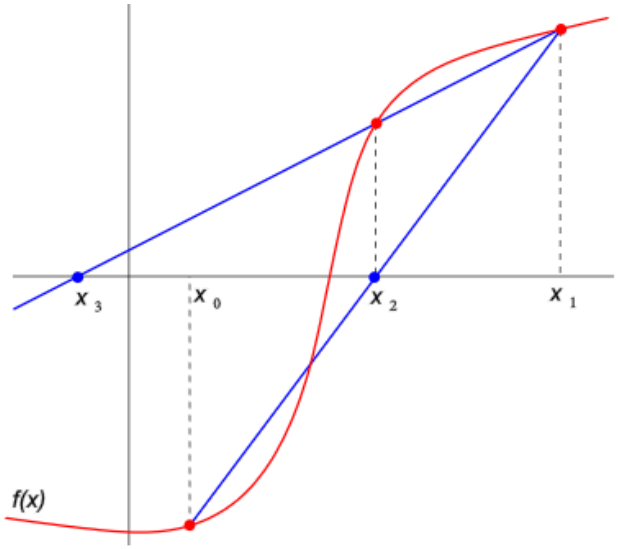
Secant Method – C Program

AUG 29, 2017 Manas Sharma (https://www.bragitoff.com/author/admin/)

Secant Method, is a Numerical Technique to find the root of an algebraic or transcendental equation.
The root is approximated by drawing secant lines repeatedly.



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A secant line is a line joining two points on a function. Secant method requires two initial guesses(x0 and x1), to draw the first secant line. The root of this line(x2), that is, where this line touches the x-axis, becomes the new point, and now

a secant line is drawn between the new point(x2) and one of the last points(x1).
This process is repeated until a root is found upto a certain tolerance.

The method is similar to Bisection Method, in that it requires two initial guesses, but still a lot different, as the guesses don't require to bracket(enclose) the root. Moreover, unlike Bisection Method, Secant Method may not always converge, so it might be a good idea to have a limit for the maximum iterations to be performed.

So, the program would ask the user to enter two initial guesses:x1 and x2.
Then, it will calculate the new point(x3) using the formula:

$$x_3 = \frac{x_1 f(x_2) - x_2 f(x_1)}{f(x_2) - f(x_1)}$$

PROGRAM (Simple Version):

```
/**********************************
*********SECANT METHOD*************
**********************************/
#include<stdio.h>
#include<math.h>
/*Function whose root is to be determined*/
double f(double x){
    return x*x-4;
}
main(){
    int iter=1,maxSteps;
    double x1,x2,x3,eps;
    printf("Enter the accuracy desired: \n");
    scanf("%lf",&eps);
    printf("Enter the intial guesses: \nx1 = ");
    scanf("%lf",&x1);
    printf("x2 = ");
    scanf("%lf",&x2);
    printf("Enter the max number of iterations to be performed: ");
    scanf("%d",&maxSteps);
    printf("iter\tx1\t\tx2\t\tx3\t\tf(x3)\n");
    printf("_____________________________________________________________________\n");
    do{
        x3=(x1*f(x2)-x2*f(x1))/(f(x2)-f(x1));
        printf("%d\t%lf\t%lf\t%lf\t%lf\n",iter,x1,x2,x3,f(x3));
        x1=x2;
        x2=x3;
        iter++;
    }while(fabs(f(x3))>eps&&iter<=maxSteps);
    printf("\nOne of the roots is: %lf",x3);
}
```

OUTPUT:

For x^3-27:

```
Enter the accuracy desired:
0.00001
Enter the intial guesses:
x1 = 5
x2 = 10
iter    x1              x2              x3              f(x3)
_____________________________________________________________________
1       5.000000        10.000000       4.440000        60.528384
2       10.000000       4.440000        4.071180        40.477798
3       4.440000        4.071180        3.326612        9.813446
4       4.071180        3.326612        3.088330        2.455808
5       3.326612        3.088330        3.008796        0.238203
6       3.088330        3.008796        3.000254        0.006845
7       3.008796        3.000254        3.000001        0.000020
8       3.000254        3.000001        3.000000        0.000000

One of the roots is: 3.000000
```

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For x*x-4:

```
Enter the accuracy desired:
0.001
Enter the intial guesses:
x1 = 0
x2 = 5
iter    x1              x2              x3              f(x3)
_____________________________________________________________
1       0.000000        5.000000        0.800000        -3.360000
2       5.000000        0.800000        1.379310        -2.097503
3       0.800000        1.379310        2.341772        1.483897
4       1.379310        2.341772        1.942991        -0.224785
5       2.341772        1.942991        1.995453        -0.018168
6       1.942991        1.995453        2.000066        0.000263

One of the roots is: 2.000066
-------------------------------
```

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PROGRAM (USING FUNCTIONS)

```c
/**********************************
*********SECANT METHOD**************
**********************************/
#include<stdio.h>
#include<math.h>
/*Function whose root is to be determined*/
double f(double x){
    return x*x-4;
}
/*Function that returns the root from Secant Method*/
double secant(double f(double x), double x1, double x2, double eps, int maxSteps){
    int iter=1;
    double x3;
    do{
        x3=(x1*f(x2)-x2*f(x1))/(f(x2)-f(x1));
        x1=x2;
        x2=x3;
        iter++;
    }while(fabs(f(x3))>eps&&iter<=maxSteps);
    return x3;
}
/*Secant Method Function that tabulates the values at each iteration*/
double secantPrint(double f(double x), double x1, double x2, double eps, int maxSteps){
    int iter=1;
    double x3;
    printf("_____________________________________________________________\n");
    printf("iter\tx1\t\tx2\t\tx3\t\tf(x3)\n");
    printf("_____________________________________________________________\n");
    do{
        x3=(x1*f(x2)-x2*f(x1))/(f(x2)-f(x1));
        printf("%d\t%lf\t%lf\t%lf\t%lf\n",iter,x1,x2,x3,f(x3));
        x1=x2;
        x2=x3;
        iter++;
    }while(fabs(f(x3))>eps&&iter<=maxSteps);
    printf("_____________________________________________________________\n");
    return x3;
}
main(){
    int maxSteps;
    double x1,x2,x3,eps;
    printf("Enter the accuracy desired: \n");
    scanf("%lf",&eps);
    printf("Enter the intial guesses: \nx1 = ");
    scanf("%lf",&x1);
    printf("x2 = ");
    scanf("%lf",&x2);
    printf("Enter the max number of iterations to be performed: ");
    scanf("%d",&maxSteps);
    printf("\nOne of the roots is: %lf",secantPrint(f,x1,x2,eps,maxSteps));
}
```

OUTPUT:

```
Enter the accuracy desired:
0.001
Enter the intial guesses:
x1 = 0
x2 = 5
Enter the max number of iterations to be performed: 15

iter    x1              x2              x3              f(x3)
---------------------------------------------------------------
1       0.000000        5.000000        0.800000        -3.360000
2       5.000000        0.800000        1.379310        -2.097503
3       0.800000        1.379310        2.341772        1.483897
4       1.379310        2.341772        1.942991        -0.224785
5       2.341772        1.942991        1.995453        -0.018168
6       1.942991        1.995453        2.000066        0.000263
---------------------------------------------------------------

One of the roots is: 2.000066
--------------------------------
```

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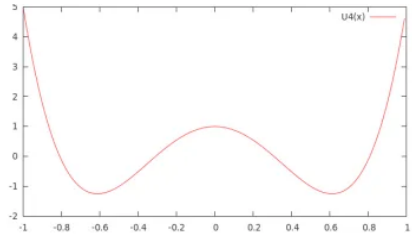

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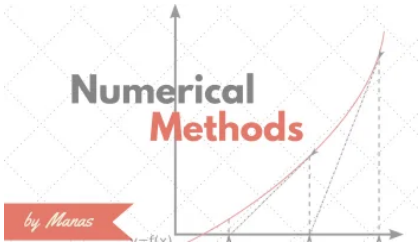

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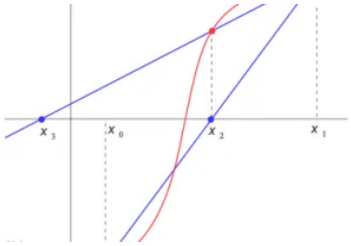

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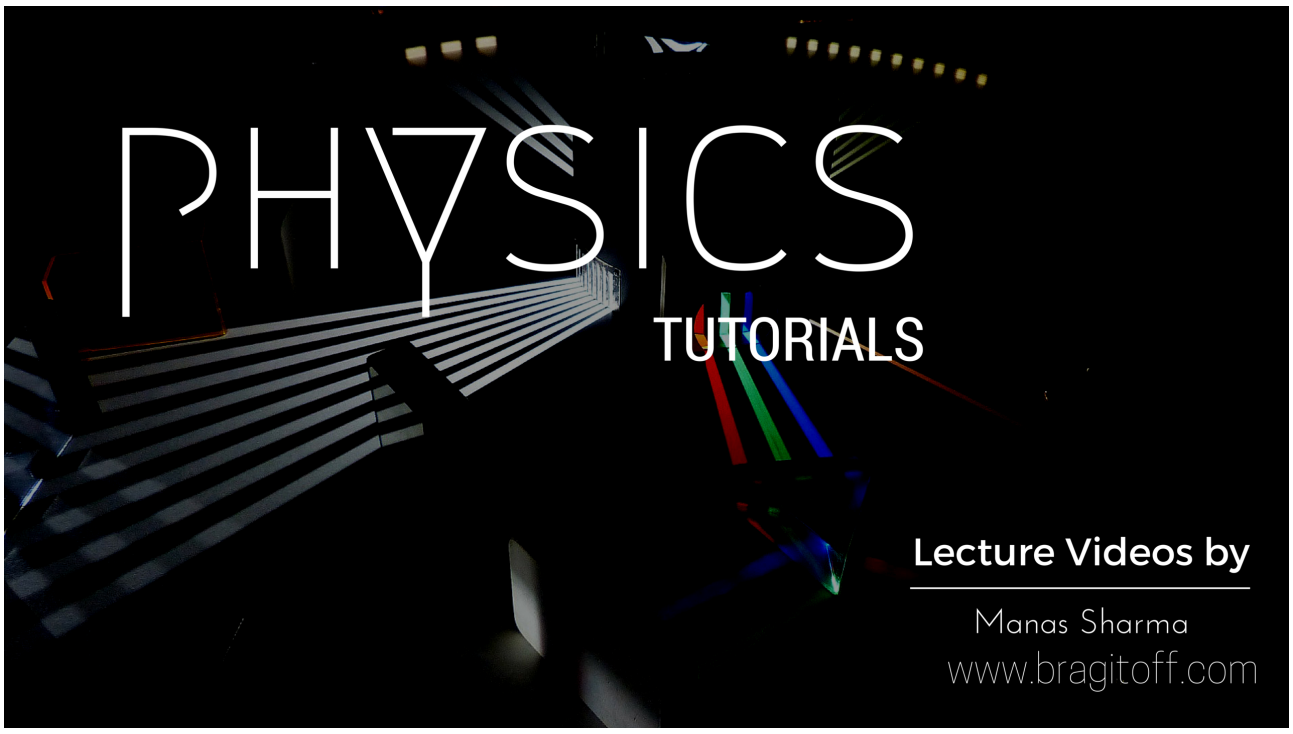

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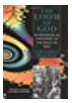

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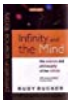

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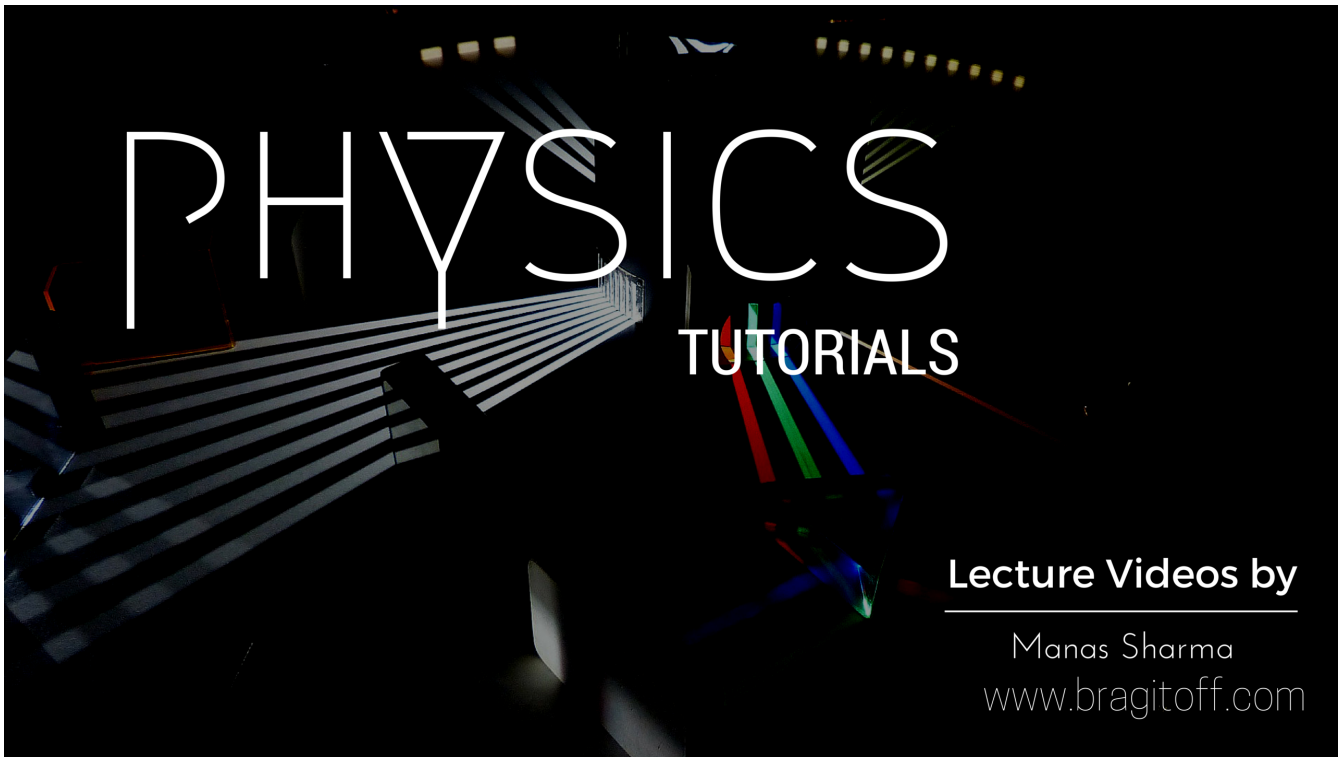

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