

# CHRISTOFER FABIÁN CHÁVEZ CARAZAS

Programar los cinco métodos iterativos planteados en clase, para dar solución a las siguientes ecuaciones:

- $x - x^{x-\cos x} = 0$
- $x - \cos(\operatorname{sen} x) = 0$
- $x^5 - 3x^3 - 2x^2 + 2 = x$

**NOTA:** Dar la respuesta más próxima a cero.

## 1. Código

### 1.1. formulas.h

Contiene funciones necesarias en todos los métodos.

```
#ifndef FORMULAS_H
#define FORMULAS_H

#include <iostream>
#include <cmath>

using namespace std;
typedef long double Number;

Number ErrorRelativo(Number x, Number xs){
    return abs(xs - x) / abs(x);
}

Number ErrorAbsoluto(Number x, Number xs){
    return abs(xs - x);
}

#endif
```

### 1.2. MetodosCerrados.cpp

Contiene la función **Metodo Cerrado()** que sirve tanto para el Método de Bisección como para el Método de Falsa posición, teniendo el mismo algoritmo con una única diferencia: la forma de calcular su siguiente aproximación. Para el Método de Bisección se utiliza la función **Bisección()**, mientras que para el método de Falsa posición se utiliza la función **FalsaPosicion()**. La ecuación que se quiere resolver debe ser programada dentro de la función **Funcion()**.

El resultado del programa es un archivo .csv con una tabla con los resultados, que podrá ser abierto con cualquier editor de tablas de datos(Excel ó LibreOffice).

```
#include <iostream>
#include <fstream>
#include <cmath>
#include "formulas.h"

/// rjhancco@impa.br
```

```

using namespace std;

enum Tipos{BISECCION ,FALSA_POSICION };

Number Biseccion(Number a, Number b){
    return (a + b) / 2;
}

Number FalsaPosicion(Number a, Number b, Number fa, Number fb){
    return a - ((b-a)/(fb-fa)) * fa;
}

Number Funcion(Number x){
    return x - pow(x,x-cos(x));
}

bool MetodoCerrado(Number a, Number b, string file, Number(*f)(Number), int tipo, Number presicion, int <>n){
    if(f(a) * f(b) >= 0 or tipo < BISECCION or tipo > FALSA_POSICION) return false;
    string fi = file + ".csv";
    ofstream archivo(fi);
    if(archivo.fail()) return false;
    archivo.precision(15);
    archivo<<"\n i "\<<" ai "\<<" bi "\<<" ri "\<<" f(ri) "\<<" f(ai) "\<<" f(b1) "\n" << endl;
    Number r = 0;
    Number fr = 0;
    Number fa = 0;
    Number fb = 0;
    Number r_anterior= 0;
    int i = 0;
    do{
        r_anterior = r;
        fa = f(a);
        fb = f(b);
        if(tipo == BISECCION) r = Biseccion(a,b);
        else r = FalsaPosicion(a,b,fa,fb);
        fr = f(r);
        archivo<<i<<" ,<<a<<" ,<<b<<" ,<<r<<" ,<<fr<<" ,<<fa<<" ,<<fb<< endl;
        if(fa * fr < 0) b = r;
        else a = r;
        i++;
    }while((ErrorAbsoluto(r_anterior, r) > presicion and i != n) or i == 1);
    archivo<<"\n Resultado Final\n" <<r<< endl;
    archivo.close();
    return true;
}

int main(){
    Number (*f)(Number) = Funcion;
    Number a;
    Number b;
    Number presicion;
    int n;
    int tt;
    string file;
    cout<<"Ingrese a->";
    cin>>a;
    cout<<"Ingrese b->";
    cin>>b;
    cout<<"BISECCION (1) o FALSA POSICION (2)";
    cin>>tt;
    cout<<"Ingrese la precision->";
    cin>>presicion;
    cout<<"Ingrese la n->";
    cin>>n;
    cout<<"Nombre del archivo donde quiere que salga la tabla->";
    cin>>file;
    if(!MetodoCerrado(a,b,file,f,tt-1,presicion,n)) cout<<"Hubo un Problema"<< endl;
    else cout<<"Archivo generado correctamente"<< endl;
}

```

### 1.3. MetodosAbiertos.cpp

En este caso hay una función para cada método restante: Método de la Secante(**MetodoSecante()**), Método de Newton(**MetododeNewton\_A()**), Método de Newton con derivada aproximada(**MetodoNewton\_B()**). La ecuación que se quiere resolver debe ser programada dentro de la función **funcion()**.

El resultado del programa es un archivo .csv con una tabla con los resultados, que podrá ser abierto con cualquier editor de tablas de datos(Excel ó LibreOffice).

```

#include <iostream>
#include <fstream>
#include <cmath>
#include "formulas.h"

using namespace std;

// x-x^(x-cosx) = 0
// x - cos(sen(x)) = 0
// x^5 - 3x^3 - 2x^2 + 2 = x

enum Tipos{SECANTE = 1, NEWTON_A, NEWTON_B};

Number funcion(Number x){
    return x*x*x - 2;
}

Number _funcion(Number x){
    return 3 * x*x;
}

Number _MetodoSecante(Number r0, Number r1, Number fr0, Number fr1){
    return r0 - ((r1-r0)/(fr1-fr0))*fr0;
}

Number _MetodoNewton_A(Number r, Number fr, Number f_r){
    return r - (fr/f_r);
}

Number _MetodoNewton_B(Number r, Number fr, Number frh, Number h){
    return r * ((fr * h)/(frh - fr));
}

void MetodoSecante(Number r0, Number r1, Number(*f)(Number), int n, Number presicion, string fi){
    string file = fi + ".csv";
    ofstream archivo(file);
    Number fr0 = f(r0);
    Number fr1 = f(r1);
    Number fr2 = 0;
    Number r2 = 0;
    int i = 1;
    archivo << i << ", " << r1 << ", " << r1 << ", " << f(r1) << ", " << r1 << ", " << f(r1) << endl;
    do{
        r2 = _MetodoSecante(r0, r1, fr0, fr1);
        fr2 = f(r2);
        archivo << i << ", " << r0 << ", " << r1 << ", " << fr0 << ", " << fr1 << ", " << r2 << ", " << fr2 << endl;
        r0 = r1;
        r1 = r2;
        fr0 = fr1;
        fr1 = fr2;
        i++;
    } while((ErrorAbsoluto(r0,r1) > presicion and i != n) or i == 2);
    archivo << "\n Resultado Final\n" << r1 << endl;
    archivo.close();
}

void MetodoNewton_A(Number r, Number(*f)(Number), Number(*df)(Number), Number presicion, int n, string fi){
    string file = fi + ".csv";
    ofstream archivo(file);
    Number fr = 0;
    Number f_r = 0;
    Number r2 = 0;
    Number r_anterioror;
    int i = 0;
    archivo << i << ", " << r << ", " << f(r) << ", " << f'(r) << ", " << r+1 << endl;
    do{
        r_anterioror = r;
        fr = f(r);
        f_r = df(r);
        r2 = _MetodoNewton_A(r,fr,f_r);
        archivo << i << ", " << r << ", " << fr << ", " << f_r << ", " << r2 << endl;
        r = r2;
        i++;
    } while((ErrorAbsoluto(r_anterioror, r) > presicion and i != n) or i == 1);
    archivo << "\n Resultado actual\n" << r << endl;
    archivo.close();
}

void MetodoNewton_B(Number r, Number(*f)(Number), Number h, Number presicion, int n, string fi){
    string file = fi + ".csv";
    ofstream archivo(file);
    Number fr = 0;
    Number frh = 0;
    Number r2 = 0;
    Number r_anterioror = 0;
    int i = 0;
    archivo << i << ", " << r << ", " << f(r) << ", " << f(r+h) << ", " << r+1 << endl;
    do{
        r_anterioror = r;
        fr = f(r);
        frh = f(r+h);
    }
}

```

```

        r2 = _MetodoNewton_B(r,fr,frh,h);
        archivo<<i<<" ,<<r<<" ,<<fr<<" ,<<frh<<" ,<<r2<<endl;
        r = r2;
        i++;
    }while((ErrorAbsoluto(r_anterior, r) > presicion and i != n)or i == 1);
    archivo<<"\ Resultado actual\ ",<<r<<endl;
    archivo.close();
}

int main(){
    Number r0;
    int n;
    Number presicion;
    Number (*f)(Number) = funcion;
    string file;
    int tipo;
    cout<<"Que metodo quiere usar->Secante(1) - Newton_A (2) - Newton_B (3)";
    cin>>tipo;
    cout<<"Ingrese el r0->";
    cin>>r0;
    cout<<"Ingrese el la presicion->";
    cin>>presicion;
    cout<<"Ingrese n->";
    cin>>n;
    cout<<"Ingrese nombre del archivo donde saldra la tabla->";
    cin>>file;
    if(tipo == SECANTE){
        Number r1;
        cout<<"Ingrese el r1->";
        cin>>r1;
        MetodoSecante(r0,r1,f,n,presicion,file);
        cout<<" Archivo generado correctamente"<<endl;
    }
    else if(tipo == NEWTON_A){
        Number (*df)(Number) = _funcion;
        MetodoNewton_A(r0,f,df,presicion,n,file);
        cout<<" Archivo generado correctamente"<<endl;
    }
    else if(tipo == NEWTON_B){
        Number h;
        cout<<"Ingrese el h->";
        cin>>h;
        MetodoNewton_B(r0,f,h,presicion,n,file);
        cout<<" Archivo generado correctamente"<<endl;
    }
    else cout<<"Ocurrio algo"<<endl;
}

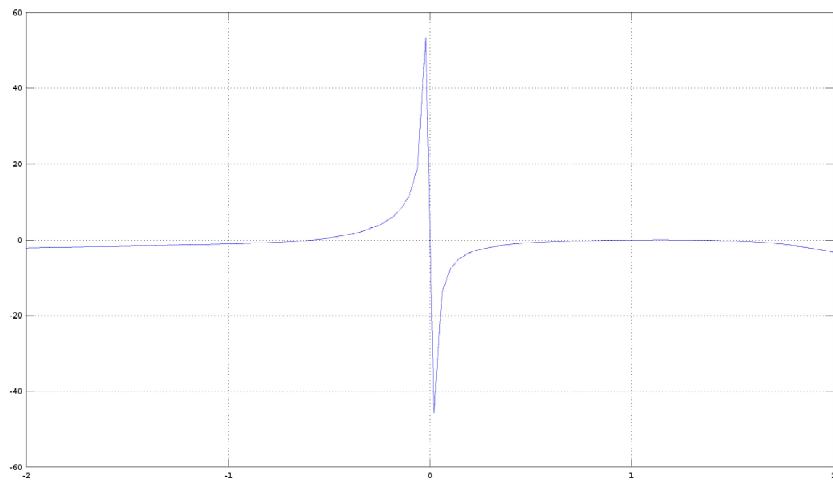
```

## 2. Soluciones

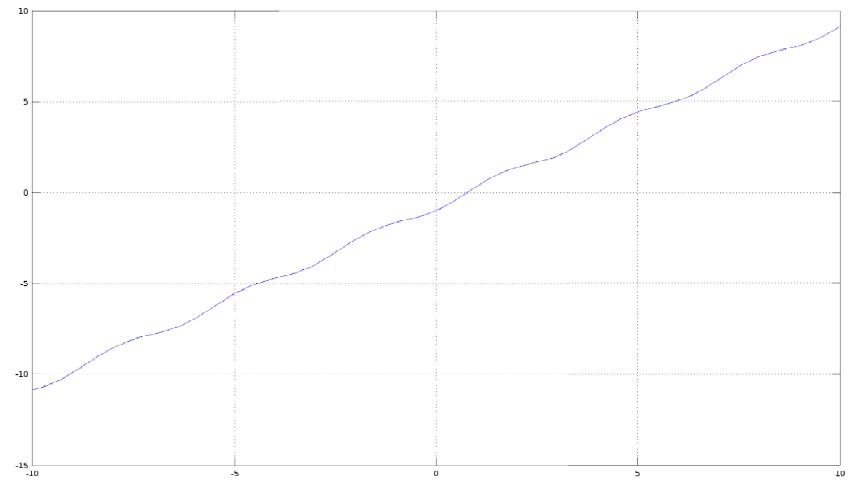
Todas las pruebas con todos los métodos se hicieron con una *precision* igual a  $10^{-6}$  y un  $n$  igual a 100.

### 2.1. Gráficas

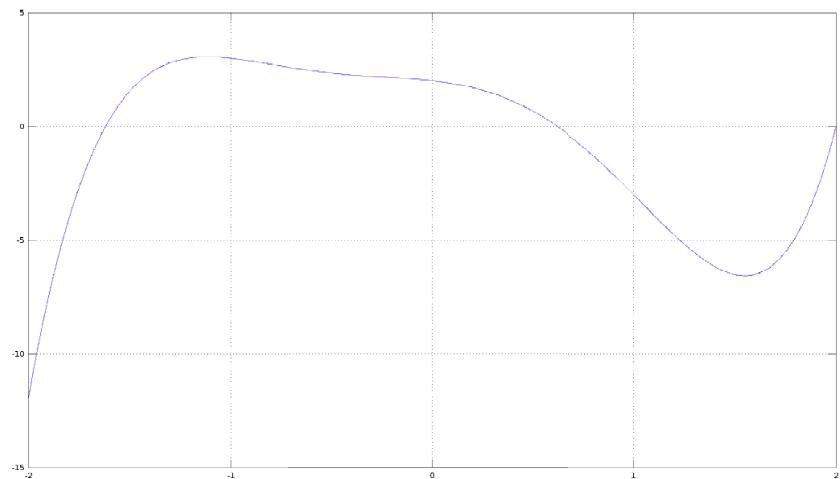
■  $x - x^{x - \cos x} = 0$



■  $x - \cos(\sin x) = 0$



■  $x^5 - 3x^3 - 2x^2 + 2 = x$



## 2.2. Método de Bisección

■  $x - x^{x-\cos x} = 0$

Esta ecuación tiene varias respuestas dependiendo del intervalo que se le asigne.

- $a = 0,7 \ b = 1,2$

j	ai	bi	ri	f(ri)	f(ai)	f(bi)
0	0.7	1.2	0.95	-0.0312851511	-0.3233970998	0.0350009888
1	0.95	1.2	1.075	0.0307076901	-0.0312851511	0.0350009888
2	0.95	1.075	1.0125	0.0064849104	-0.0312851511	0.0307076901
3	0.95	1.0125	0.98125	-0.0107320707	-0.0312851511	0.0064849104
4	0.98125	1.0125	0.996075	-0.0017052073	-0.0107320707	0.0064849104
5	0.996075	1.0125	1.0046875	0.0024949063	-0.0017052073	0.0064849104
6	0.996075	1.0046875	1.00078125	0.0004210629	-0.0017052073	0.0024949063
7	0.996075	1.00078125	0.9998828125	-0.0006355247	-0.0017052073	0.0004210629
8	0.9998828125	1.00078125	0.9998046875	-0.0001055933	-0.0006355247	0.0004210629
9	0.9998046875	1.00078125	1.0002929688	0.0001581443	-0.0001055933	0.0004210629
10	0.9998046875	1.0002929688	1.0000488281	2.63778541764563E-05	-0.0001055933	0.0001581443
11	0.9998046875	1.0000488281	0.9999267578	-3.95821349156289E-05	-0.0001055933	2.63778541764563E-05
12	0.9999267578	1.0000488281	0.9999877793	-6.5957430268334E-06	-3.95821349156289E-05	2.63778541764563E-05
13	0.9999877793	1.0000488281	1.0000183105	9.89265493264062E-06	-6.5957430268334E-06	2.63778541764563E-05
14	0.9999877793	1.0000183105	1.0000030518	1.64085570959211E-06	-6.5957430268334E-06	9.09265493264062E-06
15	0.9999877793	1.0000030518	0.9999854224	-2.47334365979448E-06	-6.5957430268334E-06	1.64085570959211E-06
16	0.9999954224	1.0000030518	0.9999992371	-4.12218945351414E-07	-2.47334365979448E-06	1.64085570959211E-06
17	0.9999992371	1.0000030518	1.0000011444	6.18324660563234E-07	4.12218945351414E-07	1.64085570959211E-06
18	0.9999992371	1.0000011444	1.0000001907	1.0305442396598E-07	4.12218945351414E-07	6.18324660563234E-07
Resultado Final <span style="background-color: #ffffcc;">1.0000001907</span>						

- $a = 1,1 \ b = 1,5$

j	ai	bi	ri	f(ri)	f(ai)	f(bi)
0	1.1	1.5	1.3	0.0111326873	0.0364537216	0.2851745455
1	1.1	1.3	1.2	0.0350009888	0.0364537216	-0.0111326873
2	1.2	1.3	1.25	0.0180881806	0.0350009888	-0.0111326873
3	1.25	1.3	1.275	0.0051012698	0.0180881806	-0.0111326873
4	1.275	1.3	1.2875	-0.002598264	0.0051012698	-0.0111326873
5	1.275	1.2875	1.28125	0.0013543752	0.0051012698	-0.002598264
6	1.28125	1.2075	1.204375	-0.000596043	0.0013543752	-0.000596043
7	1.28125	1.204375	1.2028125	0.0003656104	0.0013543752	-0.000596043
8	1.2828125	1.284375	1.28359375	-0.0001035963	0.0003656104	-0.000596043
9	1.2828125	1.28359375	1.283203125	0.0001414146	0.0003656104	-0.0001035963
10	1.283203125	1.28359375	1.2833094375	1.90101038493694E-05	0.0001414146	0.0001035963
11	1.2833984375	1.28359375	1.2834960938	-4.22678767979292E-05	1.90101038493694E-05	-0.0001035963
12	1.2833984375	1.2834960938	1.2834472656	-1.6225763114697E-05	1.90101038493694E-05	-4.22678767979292E-05
13	1.2833984375	1.2834472656	1.28344228516	3.6953412217535E-06	1.90101038493694E-05	-1.6225763114697E-05
14	1.28344228516	1.2834472656	1.2834350586	-3.96322317067048E-06	3.6953412217535E-06	-1.6225763114697E-05
15	1.28344228516	1.2834350586	1.2834289551	-1.33842382284946E-07	3.6953412217535E-06	-3.96322317067048E-06
Resultado Final <span style="background-color: #ffffcc;">1.2834289551</span>						

■  $x - \cos(\sin x) = 0 \ a = 0 \ b = 1$

j	ai	bi	ri	f(ri)	f(ai)	f(bi)
0	0	1	0.5	-0.3872600507	-1	0.3336332546
1	0.5	1	0.75	-0.0265412342	-0.3872600507	0.3336332546
2	0.75	1	0.875	0.1553814435	-0.0265412342	0.3336332546
3	0.75	0.875	0.8125	0.0646690337	-0.0265412342	0.1553014435
4	0.75	0.8125	0.78125	0.0190992315	-0.0265412342	0.0646690337
5	0.75	0.78125	0.765625	-0.0037157761	-0.0265412342	0.0190992315
6	0.765625	0.78125	0.7734375	0.0076934753	-0.0037157761	0.0190992315
7	0.765625	0.7734375	0.76953125	0.0019892315	-0.0037157761	0.0076934753
8	0.765625	0.76953125	0.767578125	-0.0008631837	-0.0037157761	0.0019892315
9	0.767578125	0.76953125	0.7685546875	0.0005630469	-0.0008631837	0.0019892315
10	0.767578125	0.7685546875	0.7680664063	-0.0001500627	-0.0008631837	0.0005630469
11	0.7680664063	0.7685546875	0.7683105469	0.0002064935	-0.0001500627	0.0005630469
12	0.7680664063	0.7683105469	0.7681884766	-0.001500627	-0.0001500627	0.002157330201746E-05
13	0.7680664063	0.7681884766	0.7681274414	-6.09234107635125E-05	-0.001500627	2.02157330201746E-05
14	0.7681274414	0.7681884766	0.768157959	-1.63538023440438E-05	-6.09234107635125E-05	2.02157330201746E-05
15	0.768157959	0.7681884766	0.7681732178	0.000005931	-1.63538023440438E-05	2.82157338201746E-05
16	0.768157959	0.7681732178	0.7681655884	-5.21142765200536E-06	0.000005931	0.000005931
17	0.7681655884	0.7681732178	0.7681694031	3.50767856524625E-07	-5.21142765200536E-06	0.000005931
18	0.7681655884	0.7681694031	0.7681674957	2.42582991127226E-06	5.21142765200536E-06	3.59767656524625E-07
19	0.7681674957	0.7681694031	0.7681684494	-0.000001033	-2.42582991127226E-06	3.59767656524625E-07
Resultado Final <span style="background-color: #ffffcc;">0.7681684494</span>						

■  $x^5 - 3x^3 - 2x^2 + 2 = x$

Esta ecuación tiene varias respuestas dependiendo del intervalo que se le asigne.

- $a = -2$   $b = -1$

$i$	$a_i$	$b_i$	$r_i$	$f(r_i)$	$f(a_i)$	$f(b_i)$	
0	-2	-1	-1.5	1.53125	-12	-12	3
1	-2	-1	-1.75	-2.7099609375	-12	-12	1.53125
2	-1.75	-1	-1.625	-0.1141662598	-2.7099609375	-0.1141662598	1.53125
3	-1.625	-1	-1.5625	0.8105535507	-0.1141662598	-0.1141662598	1.53125
4	-1.625	-1.5625	-1.59375	0.3756798804	-0.1141662598	0.8105535507	
5	-1.625	-1.59375	-1.609375	0.1378861601	-0.1141662598	0.3756798804	
6	-1.625	-1.609375	-1.6171875	0.0136751379	0.1141662598	0.1378861601	
7	-1.625	-1.6171875	-1.62109375	-0.0497876182	0.1141662598	0.0136751379	
8	-1.62109375	-1.6171875	-1.619140625	-0.0179422745	-0.0497876182	0.0136751379	
9	-1.619140625	-1.6171875	-1.6181640625	-0.0021051417	-0.0179422745	0.0136751379	
10	-1.6181640625	-1.6171875	-1.6176757813	0.0057920967	-0.0021051417	0.0136751379	
11	-1.6181640625	-1.6176757813	-1.6179199219	0.0018452531	-0.0021051417	0.0057920967	
12	-1.6181640625	-1.6179199219	-1.6180419922	-0.0001295002	-0.0021051417	0.0018452531	
13	-1.6180419922	-1.6179199219	-1.617900957	0.0009579074	-0.0001295002	0.0018452531	
14	-1.6180419922	-1.617900957	-1.6180114746	0.0003642713	-0.0001295002	0.0008579074	
15	-1.6180419922	-1.6180114746	-1.6180267334	0.000173925	-0.0001295002	0.0003642713	
16	-1.6180419922	-1.6180267334	-1.6180343628	-6.05214823733505E-06	-0.0001295002	0.0001173925	
17	-1.6180343628	-1.6180305481	-1.6180324554	5.56706015022064E-06	6.05214823733505E-06	5.56706015022064E-05	
18	-1.6180343628	-1.6180334091	-1.6180334091	2.48093350379008E-05	-6.05214823733505E-06	2.48093350379008E-05	
19	-1.6180343628	-1.6180334091	-1.6180334091	9.37862050170903E-06	-6.05214823733505E-06	2.48093350379008E-05	
Resultado Final <span style="border: 1px solid black; padding: 2px;">-1.6180334091</span>							

- $a = 0$   $b = 1$

$i$	$a_i$	$b_i$	$r_i$	$f(r_i)$	$f(a_i)$	$f(b_i)$	
0	0	1	0.5	0.65625	0.65625	0.65625	-3
1	0.5	1	0.75	-0.9033203125	0.65625	-0.9033203125	-3
2	0.5	0.75	0.625	0.0433044434	0.65625	-0.9033203125	-3
3	0.5	0.625	0.5625	0.3270654678	0.65625	-0.9033203125	-3
4	0.5625	0.625	0.59375	0.1470051706	0.3270654678	-0.9033203125	-3
5	0.59375	0.625	0.609375	0.0531249708	0.1470051706	-0.9033203125	-3
6	0.609375	0.625	0.6171875	0.00522278605	0.0531249708	-0.9033203125	-3
7	0.6171875	0.625	0.62109375	-0.0189590391	0.00522278605	-0.9033203125	-3
8	0.6171875	0.62109375	0.619140625	-0.0068457572	0.00522278605	-0.9033203125	-3
9	0.6171875	0.619140625	0.6181640625	-0.000803988	0.00522278605	-0.9033203125	-3
10	0.6171875	0.6181640625	0.6176575013	0.0022131766	0.00522278605	-0.9033203125	-3
11	0.6176575013	0.6181640625	0.6179199219	0.0007049044	0.0022131766	-0.9033203125	-3
12	0.6179199219	0.6181640625	0.6180419922	-4.946429785804E-05	0.0007049044	-0.9033203125	-3
13	0.6179199219	0.6180419922	0.617900957	0.0003277394	0.0007049044	-4.946429785804E-05	-3
14	0.617900957	0.6180419922	0.6180114746	0.0001391424	0.0003277394	-4.946429785804E-05	-3
15	0.6180114746	0.6180419922	0.6180267334	4.48402641951115E-05	0.0001391424	-4.946429785804E-05	-3
16	0.6180267334	0.6180419922	0.6180343628	-2.3117140570282E-06	4.48402641951115E-05	-4.946429785804E-05	-3
17	0.6180343628	0.6180305481	0.6180305481	2.12643507627872E-05	4.48402641951115E-05	-2.3117140570282E-06	-3
18	0.6180305481	0.6180343628	0.6180324554	9.47633727629881E-06	2.12643507627872E-05	-2.3117140570282E-06	-3
19	0.6180324554	0.6180343628	0.6180334091	3.58231634048801E-06	9.47633727629881E-06	-2.3117140570282E-06	-3
Resultado Final <span style="border: 1px solid black; padding: 2px;">0.6180334091</span>							

- $a = 1$   $b = 2$

$i$	$a_i$	$b_i$	$r_i$	$f(r_i)$	$f(a_i)$	$f(b_i)$	
0	1	2	1.5	-6.53125	-3	0	
1	1.5	2	1.75	-5.5400390625	-6.53125	0	
2	1.75	2	1.875	-3.5073547363	-5.5400390625	0	
3	1.875	2	1.9375	-1.9620065689	-3.5073547363	0	
4	1.9375	2	1.96875	1.0362758034	-1.9620065689	0	
5	1.96875	2	1.984375	-0.5323671112	-1.0362758034	0	
6	1.984375	2	1.9921875	-0.2697929964	-0.5323671112	0	
7	1.9921875	2	1.99609375	-0.1358054257	-0.2697929964	0	
8	1.99609375	2	1.998046875	-0.0681307687	-0.1358054257	0	
9	1.998046875	2	1.9990234375	-0.0341225015	-0.0681307687	0	
10	1.9990234375	2	1.9995117188	0.0170755429	-0.0341225015	0	
11	1.9995117188	2	1.999558594	-0.0085413461	0.0170755429	0	
12	1.999558594	2	1.9998779297	-0.0042715669	-0.0085413461	0	
13	1.9998779297	2	1.9999389648	-0.002136007	-0.0042715669	0	
14	1.9999389648	2	1.999964824	-0.0010680594	-0.002136007	0	
15	1.999964824	2	1.9999847412	-0.0005340436	-0.0010680594	0	
16	1.9999847412	2	1.99999023706	0.0002670253	0.0005340436	0	
17	1.99999023706	2	1.9999961853	-0.0001335135	-0.0002670253	0	
18	1.9999961853	2	1.9999980927	-0.000066757	-0.0001335135	0	
19	1.9999980927	2	1.9999990463	-3.33785465045679E-05	-0.000066757	0	
Resultado Final <span style="border: 1px solid black; padding: 2px;">1.999990463</span>							

## 2.3. Método de Falsa Posición

- $x - x^{x-\cos x} = 0$

Desde este punto solo se calculará el intervalo  $a = 0,7$ ,  $b = 1,2$  que dà la respuesta 1 (La más cercana a cero):

i	ai	bi	ri	f(ri)	f(ai)	f(bi)
0	0.7	1.2	1.1511702351	0.040787715	-0.3233970998	0.0350009888
1	0.7	1.1511702351	1.1006403882	0.0365703409	-0.3233970998	0.040787715
2	0.7	1.1006403882	1.0599379414	0.0261405626	-0.3233970998	0.0365703409
3	0.7	1.0599379414	1.0330195824	0.015957136	-0.3233970998	0.0261405626
4	0.7	1.0330195824	1.0173603149	0.0088607711	-0.3233970998	0.015957136
5	0.7	1.0173603149	1.0088968371	0.0046708602	-0.3233970998	0.0088607711
6	0.7	1.0088968371	1.0044989253	0.0023959971	-0.3233970998	0.0046708602
7	0.7	1.0044989253	1.002259533	0.0012120603	-0.3233970998	0.0023959971
8	0.7	1.002259533	1.0011309242	0.0006088442	-0.3233970998	0.0012120603
9	0.7	1.0011309242	1.0005650618	0.0003047574	-0.3233970998	0.0006088442
10	0.7	1.0005650618	1.0002820901	0.0001527773	-0.3233970998	0.0003047574
11	0.7	1.0002820901	1.0001407635	7.60208005152024E-05	-0.3233970998	0.0001522773
12	0.7	1.0001407635	1.0000702261	3.79348586977581E-05	-0.3233970998	7.60208005152024E-05
13	0.7	1.0000702261	1.0000350316	1.89255721480463E-05	-0.3233970998	3.79348586977581E-05
14	0.7	1.0000350316	1.0000174743	9.44086807286814E-06	-0.3233970998	1.89255721480463E-05
15	0.7	1.0000174743	1.0000007162	4.70924274561905E-06	-0.3233970998	9.44086807286814E-06
16	0.7	1.0000007162	1.0000043476	0.000002349	-0.3233970998	4.70924274561905E-06
17	0.7	1.0000043476	1.0000021685	1.17165501680567E-06	-0.3233970998	0.000002349
18	0.7	1.0000021685	1.0000010816	5.84410742994284E-07	-0.3233970998	1.17165501680567E-06
19	0.7	1.0000010816	1.0000005395	2.91497714657602E-07	-0.3233970998	5.84410742994284E-07
Resultado Final		1.0000005395				

- $x - \cos(\operatorname{sen}x) = 0$   $a = 0$   $b = 1$

i	ai	bi	ri	f(ri)	f(ai)	f(bi)
0	0	1	0.7498313322	0.0267876602	1	0.3336332546
1	0.7498313322	1	0.7684246051	0.0003731062	-0.0267876602	0.3336332546
2	0.7498313322	0.7684246851	0.768169215	8.51617274879386E-08	-0.0267876602	0.0003731862
3	0.7498313322	0.768169215	0.7681691568	1.93494582335918E-11	-0.0267876602	8.51617274879386E-08
Resultado Final		0.7681691568				

- $x^5 - 3x^3 - 2x^2 + 2 = x$

Desde este punto solo se calculará el intervalo  $a = 0$ ,  $b = 1$  que dà la respuesta 0,618033409118652 (La más cercana a cero):

i	ai	bi	ri	f(ri)	f(ai)	f(bi)
0	0	1	0.4	1.09024	2	-3
1	0.4	1	0.5607870696	0.3366373955	1.09824	-3
2	0.5607870696	1	0.6050997951	0.0790658282	0.3366373955	-3
3	0.6050997951	1	0.6152402446	0.0172256718	0.0790658282	-3
4	0.6152402446	1	0.6174368802	0.003688479	0.0172256718	-3
5	0.6174368802	1	0.6179066613	0.0007868426	0.003688479	-3
6	0.6179066613	1	0.6180068508	0.000167718	0.0007868426	-3
7	0.6180068508	1	0.6180282053	3.57434909681402E-05	0.000167718	-3
8	0.6180282053	1	0.6180327563	7.61725422410663E-06	3.57434909681402E-05	-3
9	0.6180327563	1	0.6180337261	1.6232916417907E-06	7.61725422410663E-06	-3
Resultado Final		0.6180337261				

## 2.4. Método de la Secante

- $x - x^{x-\cos x} = 0 \ r_0 = 0,5 \ r_1 = 0,8$

i	r <sub>i-1</sub>	r <sub>i</sub>	f(r <sub>i-1</sub> )	f(r <sub>i</sub> )	r <sub>i+1</sub>	f(r <sub>i+1</sub> )
1	0.5	0.8	-0.799163	-0.177214	0.88548	-0.0842688
2	0.8	0.88548	-0.177214	-0.0842688	0.962981	-0.0223447
3	0.88548	0.962981	-0.0842688	-0.0223447	0.990946	-0.00503258
4	0.962981	0.990946	-0.0223447	-0.00503258	0.999075	-0.000501113
5	0.990946	0.999075	-0.00503258	-0.000501113	0.999974	-1.39183E-05
6	0.999075	0.999974	-0.000501113	-1.39183E-05	1	-4.07762E-08
7	0.999974	1	-1.39183E-05	-4.07762E-08	1	-3.33801E-12
Resultado Final		1				

- $x - \cos(\operatorname{sen}x) = 0 \ r_0 = 0 \ r_1 = 0,5$

i	r <sub>i-1</sub>	r <sub>i</sub>	f(r <sub>i-1</sub> )	f(r <sub>i</sub> )	r <sub>i+1</sub>	f(r <sub>i+1</sub> )
1	0	0.5	-1	-0.38726	0.816007	0.0697769
2	0.5	0.816007	-0.38726	0.0697769	0.767761	-0.000595616
3	0.816007	0.767761	0.0697769	-0.000595616	0.76817	7.47771E-07
4	0.767761	0.76817	-0.000595616	7.47771E-07	0.768169	4.93715E-12
Resultado Final		0.768169				

- $x^5 - 3x^3 - 2x^2 + 2 = x \ r_0 = 0 \ r_1 = 0,5$

i	r <sub>i-1</sub>	r <sub>i</sub>	f(r <sub>i-1</sub> )	f(r <sub>i</sub> )	r <sub>i+1</sub>	f(r <sub>i+1</sub> )
1	0	0.5	2	0.65625	0.744186	-0.859983
2	0.5	0.744186	0.65625	-0.859983	0.605688	0.0755102
3	0.744186	0.605688	0.859983	0.0755102	0.616867	0.00720637
4	0.605688	0.616867	0.0755102	0.00720637	0.618046	-0.000075975
5	0.616867	0.618046	0.00720637	-0.000075975	0.618034	7.4718E-08
6	0.618046	0.618034	-0.000075975	7.4718E-08	0.618034	7.73038E-13
Resultado Final		0.618034				

## 2.5. Método de Newton

- $x - x^{x-\cos x} = 0 \ r_0 = 0,5$

i	r <sub>i</sub>	f(r <sub>i</sub> )	f'(r <sub>i</sub> )	r <sub>i+1</sub>
0	0.5	-0.799163	3.31332	0.741197
1	0.741197	-0.257745	1.4964	0.91344
2	0.91344	-0.0595514	0.835697	0.9847
3	0.9847	-0.00866787	0.59269	0.999324
4	0.999324	-0.000365782	0.542622	0.999999
5	0.999999	-7.80195E-07	0.540307	1
6	1	-3.58069E-12	0.540302	1
Resultado actual				
		1		

- $x - \cos(\operatorname{sen}x) = 0 \ r_0 = 1$

i	r <sub>i</sub>	f(r <sub>i</sub> )	f'(r <sub>i</sub> )	r <sub>i+1</sub>
0	1	0.333633	1.40286	0.762177
1	0.762177	-0.00875238	1.46071	0.768169
2	0.768169	-7.20523E-07	1.46046	0.768169
Resultado actual				
	0.768169			

- $x^5 - 3x^3 - 2x^2 + 2 = x \ r_0 = 1$

i	r <sub>i</sub>	f(r <sub>i</sub> )	f'(r <sub>i</sub> )	r <sub>i+1</sub>
0	1	-3	-9	0.666667
1	0.666667	-0.312757	-6.67901	0.61984
2	0.61984	-0.0111775	-6.19912	0.618037
3	0.618037	-1.69013E-05	-6.18037	0.618034
4	0.618034	-3.88998E-11	-6.18034	0.618034
Resultado actual				
	0.618034			