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

- $x - x^{x-cosx} = 0$
- $x - cos(senx) = 0$
- $x^5 - 3x^3 - 2x^2 + 2 = x$

**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 podición 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<<"\"i\",\"ai\",\"bi\",\"ri\",\"f(ri)\",\"f(ai)\",\"f(b1)\""<<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<<"\"Resultado Final\","<<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>
```

```cpp
#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\",\"ri-1\",\"ri\",\"f(ri-1)\",\"f(ri)\",\"ri+1\",\"f(r1+1)\""<<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<<"\"Resultado Final\","<<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_anteriror;
    int i = 0;
    archivo<<"\"i\",\"ri\",\"f(ri)\",\"f'(r1)\",\"ri+1\""<<endl;
    do{
        r_anteriror = 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_anteriror, r) > presicion and i != n)or i == 1);
    archivo<<"\"Resultado actual\","<<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_anteriror = 0;
    int i = 0;
    archivo<<"\"i\",\"ri\",\"f(ri)\",\"f(ri+h)\",\"ri+1\""<<endl;
    do{
        r_anteriror = 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++;
```

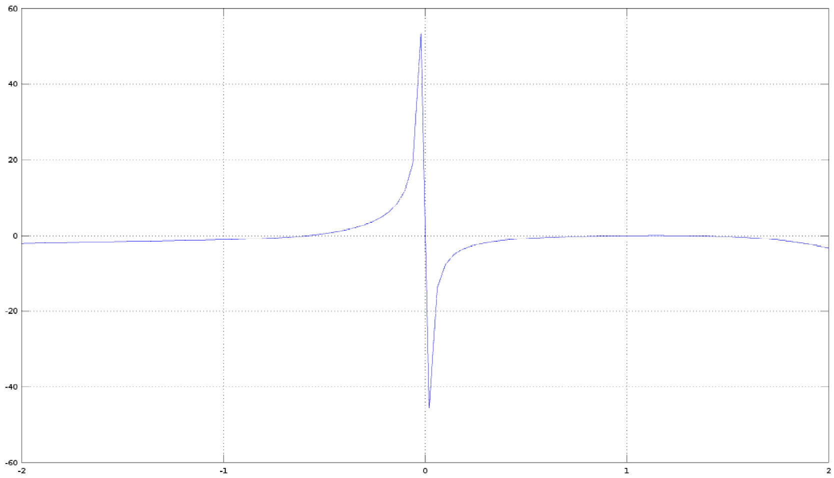
```
    }while((ErrorAbsoluto(r_anteriror , r) > presicion and i != n)or i == 1);
    archivo<<"\"Resultado actual\","<<r<<endl;
    archivo.close();
}

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 dende 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

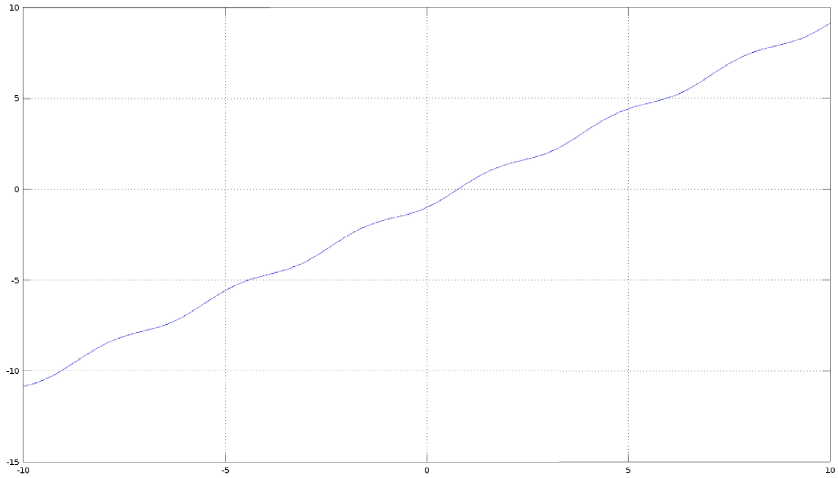
Todas las pruebas con todos los métodos se hicieron con una *presicion* igual a $10^{-6}$ y un $n$ igual a 100.

### 2.1. Gráficas

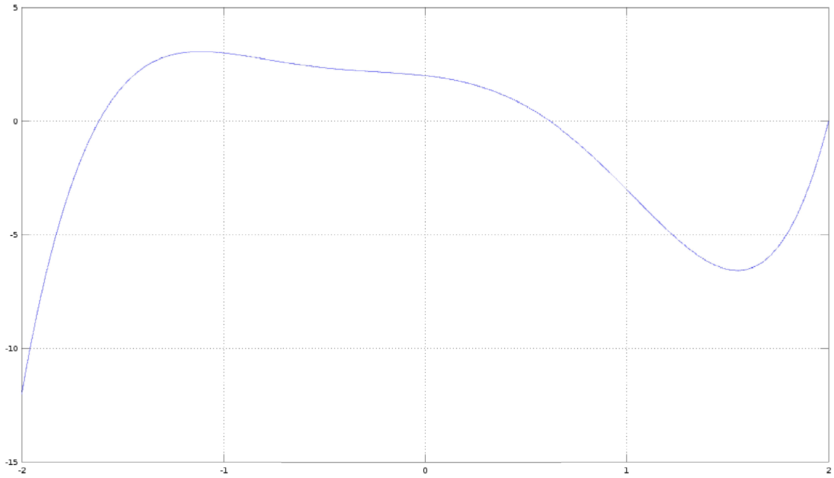
- $x - x^{x-cosx} = 0$




- $x - cos(senx) = 0$



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




## 2.2. Método de Bisección

- $x - x^{x-cosx} = 0$

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

  - $a = 0{,}7$ $b = 1{,}2$

| i | ai | bi | ri | f(ri) | f(ai) | f(b1) |
|---|---|---|---|---|---|---|
| 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 | -0.0107328707 | -0.0312851511 | 0.0064849104 |
| 4 | 0.98125 | 1.0125 | 0.996875 | -0.0017052073 | -0.0107328707 | 0.0064849104 |
| 5 | 0.996875 | 1.0125 | 1.0046875 | 0.0024949063 | -0.0017052073 | 0.0064849104 |
| 6 | 0.996875 | 1.0046875 | 1.00078125 | 0.0004210629 | -0.0017052073 | 0.0024949063 |
| 7 | 0.996875 | 1.00078125 | 0.998828125 | -0.0006355247 | -0.0017052073 | 0.0004210629 |
| 8 | 0.998828125 | 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 | 0.999987793 | -6.59574302683334E-06 | -3.95821349156289E-05 | 2.63778541764563E-05 |
| 13 | 0.999987793 | 1.0000488281 | 1.0000183105 | 9.89265493264062E-06 | -6.59574302683334E-06 | 2.63778541764563E-05 |
| 14 | 0.999987793 | 1.0000183105 | 1.0000030518 | 1.64885578959211E-06 | -6.59574302683334E-06 | 9.89265493264062E-06 |
| 15 | 0.999987793 | 1.0000030518 | 0.9999954224 | -2.47334365979448E-06 | -6.59574302683334E-06 | 1.64885578959211E-06 |
| 16 | 0.9999954224 | 1.0000030518 | 0.9999992371 | -4.12218945351414E-07 | -2.47334365979448E-06 | 1.64885578959211E-06 |
| 17 | 0.9999992371 | 1.0000030518 | 1.0000011444 | 6.18324669563234E-07 | -4.12218945351414E-07 | 1.64885578959211E-06 |
| 18 | 0.9999992371 | 1.0000011444 | 1.0000001907 | 1.0305442396598E-07 | -4.12218945351414E-07 | 6.18324669563234E-07 |
| Resultado Final | 1.0000001907 | | | | | |

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

| i | ai | bi | ri | f(ri) | f(ai) | f(b1) |
|---|---|---|---|---|---|---|
| 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 | 1.2875 | 1.284375 | -0.000596043 | 0.0013543752 | -0.002598264 |
| 7 | 1.28125 | 1.284375 | 1.2828125 | 0.0003856184 | 0.0013543752 | -0.000596043 |
| 8 | 1.2828125 | 1.284375 | 1.28359375 | -0.0001035963 | 0.0003856184 | -0.000596043 |
| 9 | 1.2828125 | 1.28359375 | 1.283203125 | 0.0001414146 | 0.0003856184 | -0.0001035963 |
| 10 | 1.283203125 | 1.28359375 | 1.2833984375 | 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 | -1.16225763114697E-05 | 1.90101038493694E-05 | -4.22678767979292E-05 |
| 13 | 1.2833984375 | 1.2834472656 | 1.2834228516 | 3.6953412217535E-06 | 1.90101038493694E-05 | -1.16225763114697E-05 |
| 14 | 1.2834228516 | 1.2834472656 | 1.2834350586 | -3.96322317067048E-06 | 3.6953412217535E-06 | -1.16225763114697E-05 |
| 15 | 1.2834228516 | 1.2834350586 | 1.2834289551 | -1.33842382284946E-07 | 3.6953412217535E-06 | -3.96322317067048E-06 |
| Resultado Final | 1.2834289551 | | | | | |

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

| i | ai | bi | ri | f(ri) | f(ai) | f(b1) |
|---|---|---|---|---|---|---|
| 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 | 0.0646698337 | -0.0265412342 | 0.1553814435 |
| 4 | 0.75 | 0.8125 | 0.78125 | 0.0190992315 | -0.0265412342 | 0.0646698337 |
| 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 | 2.82157338201746E-05 | -0.0001500627 | 0.0002064935 |
| 13 | 0.7680664063 | 0.7681884766 | 0.7681274414 | -6.09234187635125E-05 | -0.0001500627 | 2.82157338201746E-05 |
| 14 | 0.7681274414 | 0.7681884766 | 0.768157959 | -1.63538203440438E-05 | -6.09234187635125E-05 | 2.82157338201746E-05 |
| 15 | 0.768157959 | 0.7681884766 | 0.7681732178 | 0.000005931 | -1.63538203440438E-05 | 2.82157338201746E-05 |
| 16 | 0.768157959 | 0.7681732178 | 0.7681655884 | -5.21142765200536E-06 | -1.63538203440438E-05 | 0.000005931 |
| 17 | 0.7681655884 | 0.7681732178 | 0.7681694031 | 3.59767656524625E-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 | 0.7681684494 | | | | | |

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

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

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

| i | ai | bi | ri | f(ri) | f(ai) | f(b1) |
|---|---|---|---|---|---|---|
| 0 | -2 | -1 | -1.5 | 1.53125 | -12 | 3 |
| 1 | -2 | -1.5 | -1.75 | -2.7099609375 | -12 | 1.53125 |
| 2 | -1.75 | -1.5 | -1.625 | -0.1141662598 | -2.7099609375 | 1.53125 |
| 3 | -1.625 | -1.5 | -1.5625 | 0.8105535507 | -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 | -1.617980957 | 0.0008579874 | -0.0001295002 | 0.0018452531 |
| 14 | -1.6180419922 | -1.617980957 | -1.6180114746 | 0.0003642713 | -0.0001295002 | 0.0008579874 |
| 15 | -1.6180419922 | -1.6180114746 | -1.6180267334 | 0.0001173925 | -0.0001295002 | 0.0003642713 |
| 16 | -1.6180419922 | -1.6180267334 | -1.6180343628 | -6.05214823733505E-06 | -0.0001295002 | 0.0001173925 |
| 17 | -1.6180343628 | -1.6180267334 | -1.6180305481 | 5.56706015022064E-05 | -6.05214823733505E-06 | 0.0001173925 |
| 18 | -1.6180343628 | -1.6180305481 | -1.6180324554 | 2.48093350379008E-05 | -6.05214823733505E-06 | 5.56706015022064E-05 |
| 19 | -1.6180343628 | -1.6180324554 | -1.6180334091 | 9.37862050170903E-06 | -6.05214823733505E-06 | 2.48093350379008E-05 |
| Resultado Final | -1.6180334091 | | | | | |

- $a = 0$ $b = 1$

| i | ai | bi | ri | f(ri) | f(ai) | f(b1) |
|---|---|---|---|---|---|---|
| 0 | 0 | 1 | 0.5 | 0.65625 | 2 | -3 |
| 1 | 0.5 | 1 | 0.75 | -0.9033203125 | 0.65625 | -3 |
| 2 | 0.5 | 0.75 | 0.625 | -0.0433044434 | 0.65625 | -0.9033203125 |
| 3 | 0.5 | 0.625 | 0.5625 | 0.3270654678 | 0.65625 | -0.0433044434 |
| 4 | 0.5625 | 0.625 | 0.59375 | 0.1470051706 | 0.3270654678 | -0.0433044434 |
| 5 | 0.59375 | 0.625 | 0.609375 | 0.0531249708 | 0.1470051706 | -0.0433044434 |
| 6 | 0.609375 | 0.625 | 0.6171875 | 0.0052278605 | 0.0531249708 | -0.0433044434 |
| 7 | 0.6171875 | 0.625 | 0.62109375 | -0.0189590391 | 0.0052278605 | -0.0433044434 |
| 8 | 0.6171875 | 0.62109375 | 0.619140625 | -0.0068457572 | 0.0052278605 | -0.0189590391 |
| 9 | 0.6171875 | 0.619140625 | 0.6181640625 | -0.000803988 | 0.0052278605 | -0.0068457572 |
| 10 | 0.6171875 | 0.6181640625 | 0.6176757813 | 0.0022131766 | 0.0052278605 | -0.000803988 |
| 11 | 0.6176757813 | 0.6181640625 | 0.6179199219 | 0.0007049044 | 0.0022131766 | -0.000803988 |
| 12 | 0.6179199219 | 0.6181640625 | 0.6180419922 | -4.946429785804E-05 | 0.0007049044 | -0.000803988 |
| 13 | 0.6179199219 | 0.6180419922 | 0.617980957 | 0.0003277394 | 0.0007049044 | -4.946429785804E-05 |
| 14 | 0.617980957 | 0.6180419922 | 0.6180114746 | 0.0001391424 | 0.0003277394 | -4.946429785804E-05 |
| 15 | 0.6180114746 | 0.6180419922 | 0.6180267334 | 4.48402641951115E-05 | 0.0001391424 | -4.946429785804E-05 |
| 16 | 0.6180267334 | 0.6180419922 | 0.6180343628 | -2.3117140570282E-06 | 4.48402641951115E-05 | -4.946429785804E-05 |
| 17 | 0.6180267334 | 0.6180343628 | 0.6180305481 | 2.12643507627872E-05 | 4.48402641951115E-05 | -2.3117140570282E-06 |
| 18 | 0.6180305481 | 0.6180343628 | 0.6180324554 | 9.47633727629881E-06 | 2.12643507627872E-05 | -2.3117140570282E-06 |
| 19 | 0.6180324554 | 0.6180343628 | 0.6180334091 | 3.58231634048801E-06 | 9.47633727629881E-06 | -2.3117140570282E-06 |
| Resultado Final | 0.6180334091 | | | | | |

- $a = 1$ $b = 2$

| i | ai | bi | ri | f(ri) | f(ai) | f(b1) |
|---|---|---|---|---|---|---|
| 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 | -1.0362758934 | -1.9620065689 | 0 |
| 5 | 1.96875 | 2 | 1.984375 | -0.5323671112 | -1.0362758934 | 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 | 1.9997558594 | -0.0085413461 | -0.0170755429 | 0 |
| 12 | 1.9997558594 | 2 | 1.9998779297 | -0.0042715669 | -0.0085413461 | 0 |
| 13 | 1.9998779297 | 2 | 1.9999389648 | -0.002136007 | -0.0042715669 | 0 |
| 14 | 1.9999389648 | 2 | 1.9999694824 | -0.0010680594 | -0.002136007 | 0 |
| 15 | 1.9999694824 | 2 | 1.9999847412 | -0.0005340436 | -0.0010680594 | 0 |
| 16 | 1.9999847412 | 2 | 1.9999923706 | -0.0002670253 | -0.0005340436 | 0 |
| 17 | 1.9999923706 | 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 | 1.9999990463 | | | | | |

## 2.3. Método de Falsa Posición

- $x - x^{x - cosx} = 0$

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

| i | ai | bi | ri | f(ri) | f(ai) | f(b1) |
|---|---|---|---|---|---|---|
| 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 | 1.0005650648 | 0.0003047574 | -0.3233970998 | 0.0006088442 |
| 10 | 0.7 | 1.0005650648 | 1.0002820901 | 0.0001522773 | -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 | 1.0000087162 | 4.70924274561905E-06 | -0.3233970998 | 9.44086807286814E-06 |
| 16 | 0.7 | 1.0000087162 | 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 | | | | | |

- $x - cos(senx) = 0$ $a = 0$ $b = 1$

| i | ai | bi | ri | f(ri) | f(ai) | f(b1) |
|---|---|---|---|---|---|---|
| 0 | 0 | 1 | 0.7498313322 | -0.0267876602 | -1 | 0.3336332546 |
| 1 | 0.7498313322 | 1 | 0.7684246851 | 0.0003731862 | -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 dá la respuesta 0,618033409118652 (La más cercana a cero):

| i | ai | bi | ri | f(ri) | f(ai) | f(b1) |
|---|---|---|---|---|---|---|
| 0 | 0 | 1 | 0.4 | 1.09824 | 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 | 1.62329164917987E-06 | 7.61725422410663E-06 | -3 |
| Resultado Final | 0.6180337261 | | | | | |

## 2.4. Método de la Secante

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

| i | ri-1 | ri | f(ri-1) | f(ri) | ri+1 | f(r1+1) |
|---|---|---|---|---|---|---|
| 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 | | | | | |

- $x - cos(senx) = 0$ $r_0 = 0$ $r_1 = 0{,}5$

| i | ri-1 | ri | f(ri-1) | f(ri) | ri+1 | f(r1+1) |
|---|---|---|---|---|---|---|
| 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 | ri-1 | ri | f(ri-1) | f(ri) | ri+1 | f(r1+1) |
|---|---|---|---|---|---|---|
| 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

- $x - x^{x-cosx} = 0$ $r_0 = 0{,}5$

| i | ri | f(ri) | f'(r1) | ri+1 |
|---|---|---|---|---|
| 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 | | | |

- $x - cos(senx) = 0$ $r_0 = 1$

| i | ri | f(ri) | f'(r1) | ri+1 |
|---|---|---|---|---|
| 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 | ri | f(ri) | f'(r1) | ri+1 |
|---|---|---|---|---|
| 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 | | | |

## 2.6. Método de Newton con derivada aproximada

- $x - x^{x-cosx} = 0$ $r_0 = 0{,}5$

| i | ri | f(ri) | f(ri+h) | ri+1 |
|---|---|---|---|---|
| 0 | 0.5 | -0.799163 | -0.79916 | 0.741197 |
| 1 | 0.741197 | -0.257744 | -0.257742 | 0.913441 |
| 2 | 0.913441 | -0.059551 | -0.0595502 | 0.9847 |
| 3 | 0.9847 | -0.00866769 | -0.0086671 | 0.999325 |
| 4 | 0.999325 | -0.000365746 | -0.000365203 | 0.999999 |
| 5 | 0.999999 | -7.78889E-07 | -2.38583E-07 | 1 |
| 6 | 1 | -1.09315E-12 | 5.40299E-07 | 1 |
| Resultado actual | 1 | | | |

- $x - cos(senx) = 0$ $r_0 = 1$

| i | ri | f(ri) | f(ri+h) | ri+1 |
|---|---|---|---|---|
| 0 | 1 | 0.333633 | 0.333635 | 0.762177 |
| 1 | 0.762177 | -0.00875243 | -0.00875097 | 0.768169 |
| 2 | 0.768169 | -7.20422E-07 | 0.00000074 | 0.768169 |
| Resultado actual | 0.768169 | | | |

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

| i | ri | f(ri) | f(ri+h) | ri+1 |
|---|---|---|---|---|
| 0 | 1 | -3 | -3.00001 | 0.666667 |
| 1 | 0.666667 | -0.312757 | -0.312764 | 0.61984 |
| 2 | 0.61984 | -0.0111777 | -0.0111839 | 0.618037 |
| 3 | 0.618037 | -1.69113E-05 | -2.30917E-05 | 0.618034 |
| 4 | 0.618034 | -5.31792E-11 | -6.1804E-06 | 0.618034 |
| Resultado actual | 0.618034 | | | |