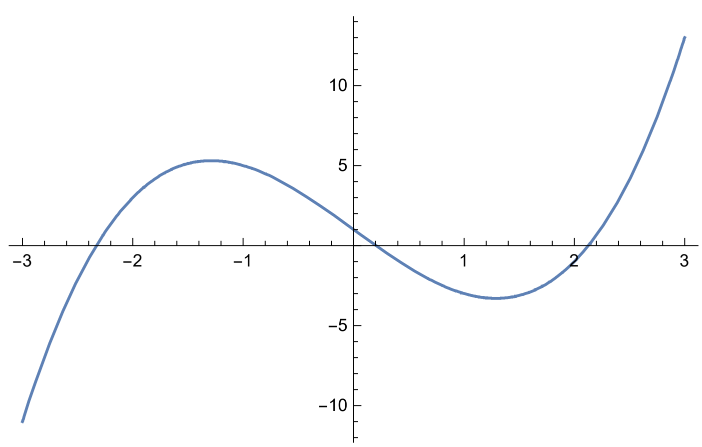
ALL PRACTICALS

practicals 1 date: 01/19/23

In[ ]:=
```
regulaFalsi[f_, xo_, xo1_, n_] := Module[{}, prev = N[xo]; next = N[xo1];
  If[f[prev] * f[next] > 0, Print["regula falsi can not be applied "]; Return[]];
  i = 1;
  While[i ≤ n,
   temp = next;
   next = (prev * f[next] - next * f[prev]) / (f[next] - f[prev]);
   prev = temp;
   Print[i, "   ", prev, "   ", next];
   i++;];
  Print["root = ", next]]
f[x_] = x^3 - 5 x + 1;
Plot[f[x], {x, -3, 3}]
regulaFalsi[f, 0, 1, 5]
```

```
1  1.  0.25
2  0.25  0.186441
3  0.186441  0.201736
4  0.201736  0.20164
5  0.20164  0.20164
```

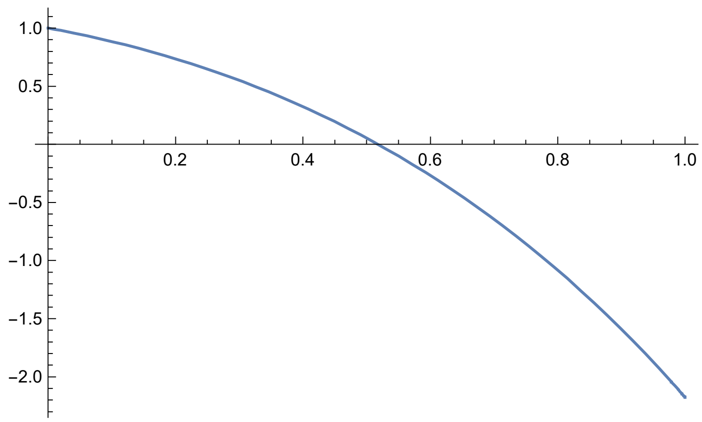
Out[ ]=



```
1  1.  0.25
2  0.25  0.186441
3  0.186441  0.201736
4  0.201736  0.20164
5  0.20164  0.20164
root = 0.20164
```

In[ ]:=
```
f[x_] = Cos[x] - x * Exp[x];
Plot[f[x], {x, 0, 1}]
regulaFalsi[f, 0, 1, 5]
```

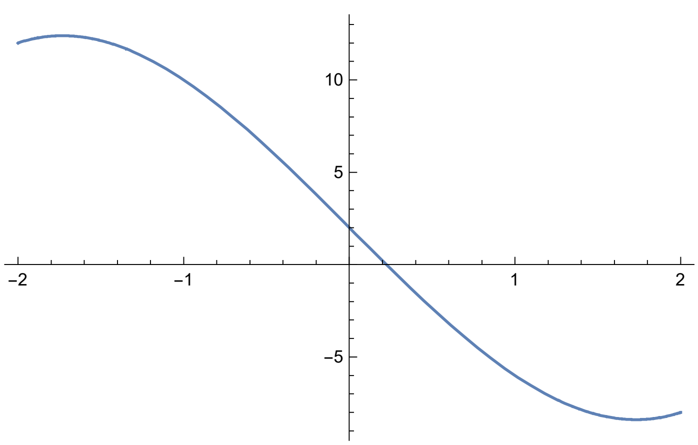
Out[ ]=




```
1  1.  0.314665
2  0.314665  0.446728
3  0.446728  0.531706
4  0.531706  0.516904
5  0.516904  0.517747
root = 0.517747
```

In[ ]:=
```
f[x_] = x^3 - 9 * x + 2;
Plot[f[x], {x, -2, 2}]
```

Out[ ]=

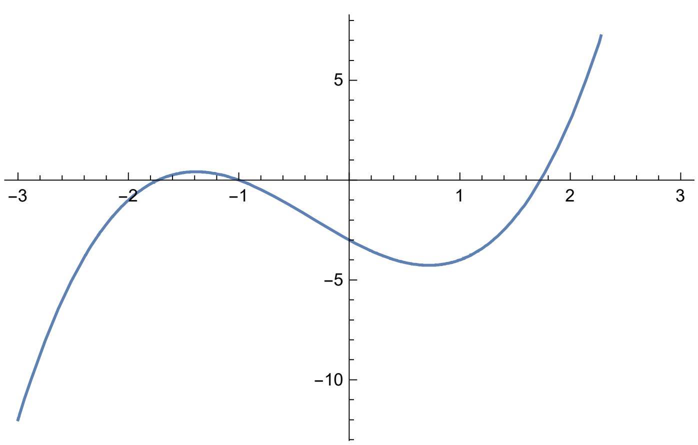


In[]:=
```
regulaFalsi[f, 0, 1, 5]
```

```
1  1.  0.25
2  0.25  0.219512
3  0.219512  0.22347
4  0.22347  0.223462
5  0.223462  0.223462
root = 0.223462
```

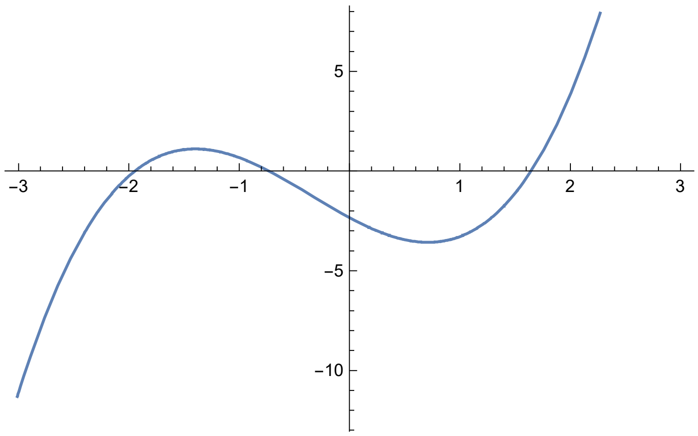
practicals 1 19/01/23

In[]:=
```
bisection[f_, a0_, b0_, n_] := Module[{}, a = N[a0];
  b = N[b0];
  If[f[a] * f[b] > 0, Print["bisection method can not be applied"];
   Return[]];
  p = (a + b) / 2;
  i = 1;
  While[i ≤ n,
   If[f[a] * f[p] < 0, b = p, a = p];
   Print[i, "    ", a, "    ", b, "   ", f[a]];
   i++;
   p = (a + b) / 2];
  Print["  Root = ", p]]
f[x_] := x^3 + x^2 - 3 * x - 3;
Plot[f[x], {x, -3, 3}]
bisection[f, 1, 2, 5]
```

Out[]=


1	1.5	2.	-1.875
2	1.5	1.75	-1.875
3	1.625	1.75	-0.943359
4	1.6875	1.75	-0.409424
5	1.71875	1.75	-0.124786

Root = 1.73438

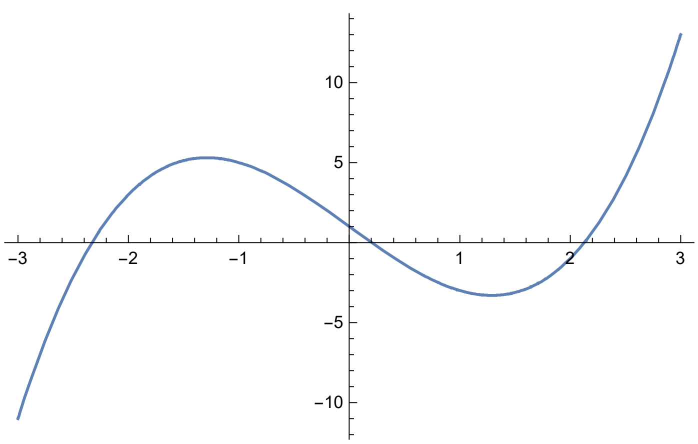


1	1.5	2.	-1.875
2	1.5	1.75	-1.875
3	1.625	1.75	-0.943359
4	1.6875	1.75	-0.409424
5	1.71875	1.75	-0.124786

Root = 1.73438

In[ ]:=
```
f[x_]  = x^3 - 5 x + 1;
Plot[f[x], {x, -3, 3}]
bisection[f, 0, 1, 5]
```

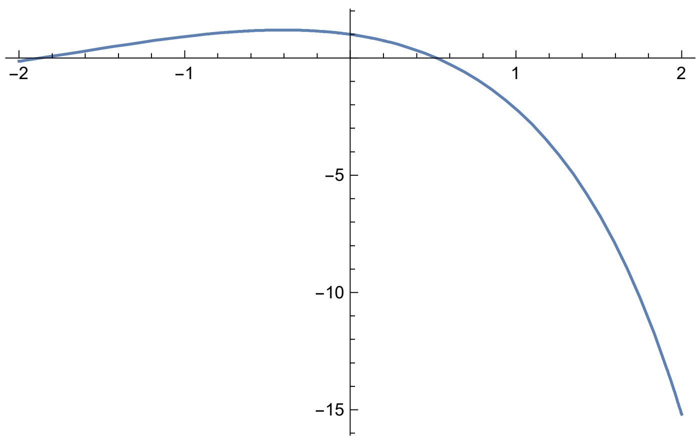
Out[ ]=



```
1    0.     0.5
2    0.     0.25
3    0.125    0.25
4    0.1875    0.25
5    0.1875    0.21875
  Root = 0.203125
```

In[]:=
```
f[x_] = Cos[x] - x * Exp[x];
Plot[f[x], {x, -2, 2}]
bisection[f, 0, 1, 5]
```

Out[]=

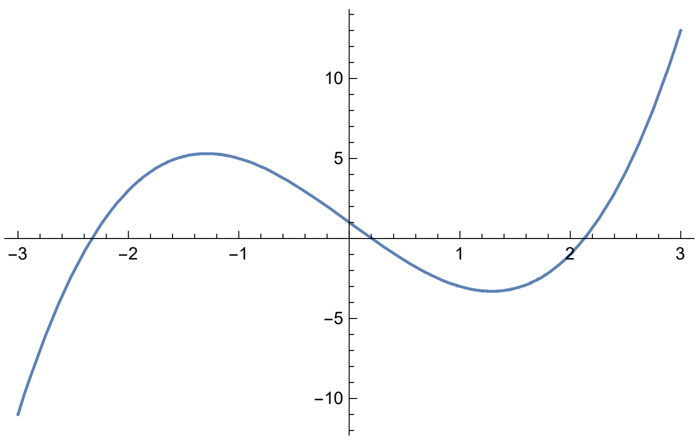



```
1    0.5    1.
2    0.5    0.75
3    0.5    0.625
4    0.5    0.5625
5    0.5    0.53125
  Root = 0.515625
```

Practicals 1 date: 01/19/23

```
secantMethod[f_, xo_, xo1_, n_] := Module[{},
  prev = N[xo];
  next = N[xo1];
  i = 1;
  While[i ≤ n,
   temp = next;
   next = (prev * f[next] - next * f[prev]) / (f[next] - f[prev]);
   prev = temp;
   Print[i, "   ", prev, "   ", next];
   i++;];
  Print["root = ", next]]
f[x_] = x^3 - 5 x + 1;
Plot[f[x], {x, -3, 3}]
secantMethod[f, 0, 1, 5]
```

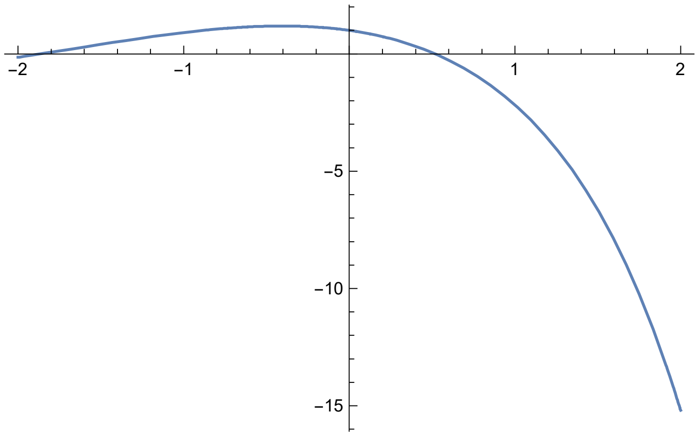
Out[ ]=




```
1  1.  0.25
2  0.25  0.186441
3  0.186441  0.201736
4  0.201736  0.20164
5  0.20164  0.20164
root = 0.20164
```

In[ ]:=
```
f[x_] = Cos[x] - x * Exp[x];
Plot[f[x], {x, -2, 2}]
```

Out[ ]=

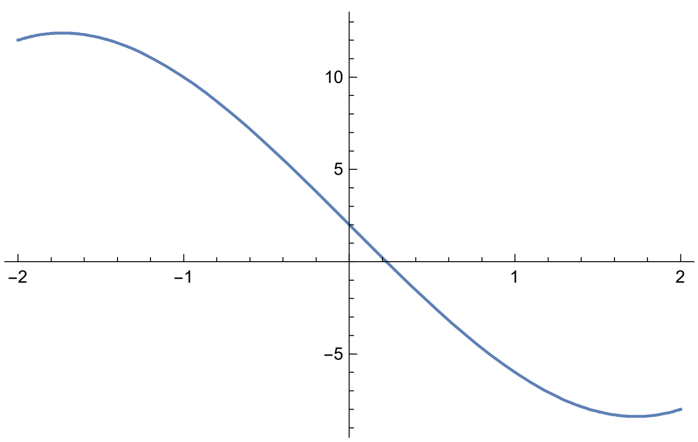


In[ ]:=
```
regulaFalsi[f, 0, 1, 5]
```

```
1  1.  0.314665
2  0.314665  0.446728
3  0.446728  0.531706
4  0.531706  0.516904
5  0.516904  0.517747
root = 0.517747
```

In[ ]:=
```
f[x_] = x^3 - 9 * x + 2;
Plot[f[x], {x, -2, 2}]
```

Out[ ]=



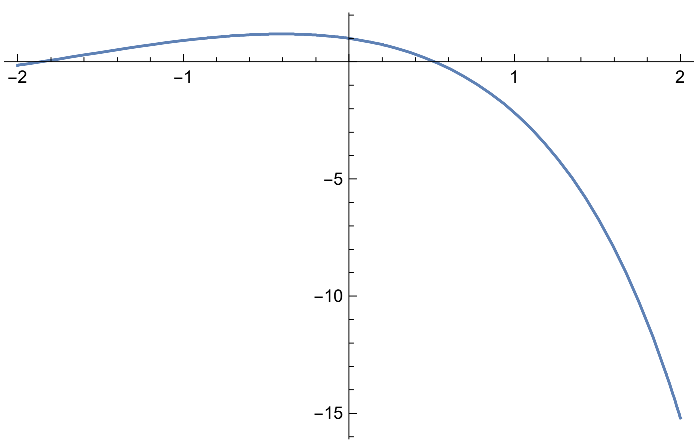
In[ ]:=
```
regulaFalsi[f, 0, 1, 5]
```

```
1  1.  0.25
2  0.25  0.219512
3  0.219512  0.22347
4  0.22347  0.223462
5  0.223462  0.223462
root = 0.223462
```

Practicals 3 date: 09/02/23

In[ ]:=
```
newtonRaphson[f_, p0_, n_] := Module[{}, pold = N[p0];
  i = 1;
  df[x_] = D[f[x], x];
  While[i ≤ n,
   pnew = N[pold - N[f[pold]] / N[df[pold]]];
   Print[i, "    ", pnew];
   i++;
   pold = pnew];
  Print[" Root = " , pnew]]

f[x_] = Cos[x] - x * Exp[x];
Plot[f[x], {x, -2, 2}]
```

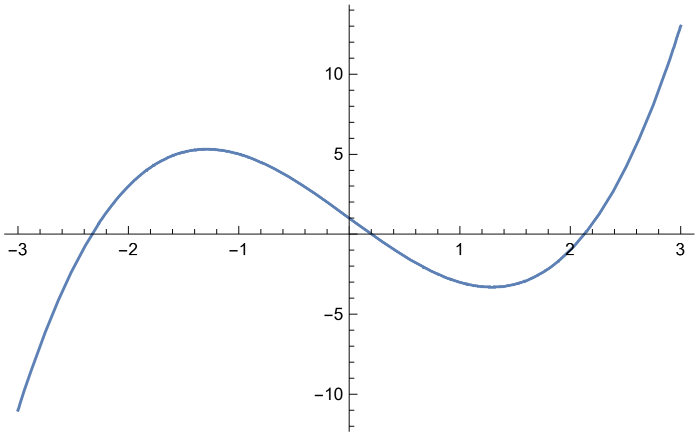
Out[ ]=


In[ ]:=
```
newtonRaphson[f, 0, 5]
```

```
1    1.
2    0.653079
3    0.531343
4    0.51791
5    0.517757
 Root = 0.517757
```

In[ ]:=
```
f[x_] = x^3 - 5 x + 1;
Plot[f[x], {x, -3, 3}]
```

Out[ ]=

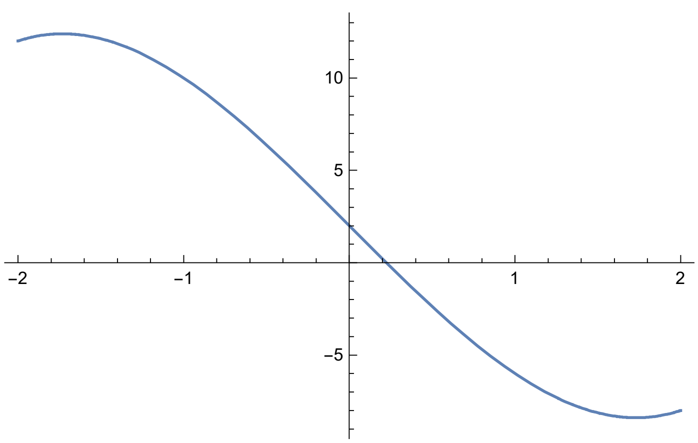


In[ ]:=
```
newtonRaphson[f, 0, 5]
```

```
1    0.2
2    0.201639
3    0.20164
4    0.20164
5    0.20164
 Root = 0.20164
```

In[ ]:=
```
f[x_] = x^3 - 9 * x + 2;
Plot[f[x], {x, -2, 2}]
newtonRaphson[f, 0, 5]
```

Out[ ]=



```
1    0.222222
2    0.223462
3    0.223462
4    0.223462
5    0.223462
 Root = 0.223462
```

Practicals 4   date: 16/03/2023

Gauss elimination method

```
In[ ]:= gausselimination[mat_] := Module[{m = mat,  n = Length[mat]},
          Print["initial matrix is:\n", MatrixForm[m]];
          For[i = 1, i ≤ n - 1, i ++,
           For[j = i + 1, j ≤ n, j ++,
            m[[j]] = m[[j]] - m[[i]] / m[[i, i]] * m[[j, i]];
           ]
          ];
          Print["after making lower trianglular:\n", MatrixForm[m]];
          For[i = n, i ≥ 1, i --,

          ]
        ]
        m1 = Table[10 i + j, {i, 3}, {j, 4}];
        gausselimination[m1];
        m2 = {{2, 3, 1, 1}, {1, 2, 2, 4}, {1, 3, 1, 3}};
        gausselimination[m2];
```

```
initial matrix is:
```

$$\begin{pmatrix} 11 & 12 & 13 & 14 \\ 21 & 22 & 23 & 24 \\ 31 & 32 & 33 & 34 \end{pmatrix}$$

```
after making lower trianglular:
```

$$\begin{pmatrix} 11 & 12 & 13 & 14 \\ 0 & -\frac{10}{11} & -\frac{20}{11} & -\frac{30}{11} \\ 0 & 0 & 0 & 0 \end{pmatrix}$$

```
initial matrix is:
```

$$\begin{pmatrix} 2 & 3 & 1 & 1 \\ 1 & 2 & 2 & 4 \\ 1 & 3 & 1 & 3 \end{pmatrix}$$

```
after making lower trianglular:
```

$$\begin{pmatrix} 2 & 3 & 1 & 1 \\ 0 & \frac{1}{2} & \frac{3}{2} & \frac{7}{2} \\ 0 & 0 & -4 & -8 \end{pmatrix}$$

Practicals 4 date: 16/03/2023

Gauss elimination method using inbuilt function

In[ ]:=
```
gausselimination[mat_, last_] := Module[{a = mat, n = Length[mat], b = last},
   aug = ArrayFlatten[{{a, b}}];
   Print["augmented matrix is:\n", MatrixForm[aug]];
   Print[MatrixForm[RowReduce[aug]]];
   Print[LinearSolve[a, b]];
  ]
m = {{2, 3, 1}, {1, 2, 2}, {1, 3, 1}};
l = {{1}, {4}, {3}};
gausselimination[m, l];
```

```
augmented matrix is:
```

$$\begin{pmatrix} 2 & 3 & 1 & 1 \\ 1 & 2 & 2 & 4 \\ 1 & 3 & 1 & 3 \end{pmatrix}$$

$$\begin{pmatrix} 1 & 0 & 0 & -2 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 2 \end{pmatrix}$$

```
{{-2}, {1}, {2}}
```

|

Practicals 5
Gauss Jacobi method
date: 06/04/2023

In[ ]:=
```
GaussJacobi[a0_, b0_, x0_, max_] :=
 Module[{a = N[a0], b = N[b0], i, j, k = 0, n = Length[x0], x = x0, xold = x0},
  Print["x0=", x];
  While[k < max,
   For[i = 1, i ≤ n, i = i + 1,
    x[[i]] = (b[[i]] + a[[i, i]] * xold[[i]] - Sum[a[[i, j]] * xold[[j]], {j, 1, n}]) / a[[i, i]]];
   Print["x", k + 1, "=", x];
   xold = x;
   k = k + 1;];
 ]
```

In[ ]:=
```
a0 = {{4, -1, 0}, {-1, 4, -1}, {0, -1, 4}}
b0 = {{2}, {4}, {10}}
x0 = {{0}, {0}, {0}}
GaussJacobi[a0, b0, x0, 10];
```

Out[ ]= {{4, -1, 0}, {-1, 4, -1}, {0, -1, 4}}

Out[ ]= {{2}, {4}, {10}}

Out[ ]= {{0}, {0}, {0}}

```
x0={{0}, {0}, {0}}
x1={{0.5}, {1.}, {2.5}}
x2={{0.75}, {1.75}, {2.75}}
x3={{0.9375}, {1.875}, {2.9375}}
x4={{0.96875}, {1.96875}, {2.96875}}
x5={{0.992188}, {1.98438}, {2.99219}}
x6={{0.996094}, {1.99609}, {2.99609}}
x7={{0.999023}, {1.99805}, {2.99902}}
x8={{0.999512}, {1.99951}, {2.99951}}
x9={{0.999878}, {1.99976}, {2.99988}}
x10={{0.999939}, {1.99994}, {2.99994}}
```

In[ ]:=

$$a0 = \begin{pmatrix} 4 & 1 & 1 \\ 1 & 5 & 2 \\ 1 & 2 & 3 \end{pmatrix}$$

$$b0 = \begin{pmatrix} 2 \\ -6 \\ -4 \end{pmatrix}$$

$$x0 = \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}$$

```
GaussJacobi[a0, b0, x0, 10];
```

Out[ ]= {{4, 1, 1}, {1, 5, 2}, {1, 2, 3}}

Out[ ]= {{2}, {-6}, {-4}}

Out[ ]= {{0}, {0}, {0}}

```
x0={{0}, {0}, {0}}
x1={{0.5}, {-1.2}, {-1.33333}}
x2={{1.13333}, {-0.766667}, {-0.7}}
x3={{0.866667}, {-1.14667}, {-1.2}}
x4={{1.08667}, {-0.893333}, {-0.857778}}
x5={{0.937778}, {-1.07422}, {-1.1}}
x6={{1.04356}, {-0.947556}, {-0.929778}}
x7={{0.969333}, {-1.0368}, {-1.04948}}
x8={{1.02157}, {-0.974074}, {-0.965244}}
x9={{0.98483}, {-1.01822}, {-1.02447}}
x10={{1.01067}, {-0.987176}, {-0.982799}}
```

Practicals 6
Gauss Seidel method
date : 06 / 04 / 2023

In[ ]:=
```
GaussSeidel[a0_, b0_, x0_, max_] :=
 Module[{a = N[a0], b = N[b0], i, j, k = 0, n = Length[x0], x = x0},
  Print["x0=", x];
  While[k < max,
   For[i = 1, i ≤ n, i = i + 1,
    x[[i]] = (b[[i]] + a[[i, i]] * x[[i]] - Sum[a[[i, j]] * x[[j]], {j, 1, n}]) / a[[i, i]]];
   Print["x", k + 1, "=", x];
   k = k + 1;];
 ]
```

In[ ]:=
```
a0 = {{8, 1, -1}, {-1, 7, -2}, {2, 1, 9}}
b0 = {{8}, {4}, {12}}
x0 = {{0}, {0}, {0}}
GaussSeidel[a0, b0, x0, 10];
```

$$a0 = \begin{pmatrix} 8 & 1 & -1 \\ -1 & 7 & -2 \\ 2 & 1 & 9 \end{pmatrix}$$

$$b0 = \begin{pmatrix} 8 \\ 4 \\ 12 \end{pmatrix}$$

$$x0 = \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}$$

$$x[[i]] = \left(b[[i]] + a[[i, i]] * x[[i]] - \sum_{j=1}^{n} a[[i, j]] * x[[j]]\right) \Big/ a[[i, i]]$$

Out[ ]= {{8, 1, -1}, {-1, 7, -2}, {2, 1, 9}}

Out[ ]= {{8}, {4}, {12}}

Out[ ]= {{0}, {0}, {0}}

```
x0={{0}, {0}, {0}}
x1={{1.}, {0.714286}, {1.03175}}
x2={{1.03968}, {1.01474}, {0.989544}}
x3={{0.996851}, {0.996563}, {1.00108}}
x4={{1.00056}, {1.00039}, {0.999831}}
x5={{0.99993}, {0.999942}, {1.00002}}
x6={{1.00001}, {1.00001}, {0.999997}}
x7={{0.999999}, {0.999999}, {1.}}
x8={{1.}, {1.}, {1.}}
x9={{1.}, {1.}, {1.}}
x10={{1.}, {1.}, {1.}}
```

In[ ]:= $a0 = \begin{pmatrix} 45 & 2 & 3 \\ -3 & 22 & 2 \\ 5 & 1 & 20 \end{pmatrix}$

$b0 = \begin{pmatrix} 58 \\ 47 \\ 67 \end{pmatrix}$

$x0 = \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}$

GaussJacobi[a0, b0, x0, 10];

Out[ ]= {{45, 2, 3}, {-3, 22, 2}, {5, 1, 20}}

Out[ ]= {{58}, {47}, {67}}

Out[ ]= {{0}, {0}, {0}}

```
x0={{0}, {0}, {0}}
x1={{1.28889}, {2.13636}, {3.35}}
x2={{0.970606}, {2.00758}, {2.92096}}
x3={{1.00493}, {2.00318}, {3.00697}}
x4={{0.999394}, {2.00004}, {2.99861}}
x5={{1.00009}, {2.00004}, {3.00015}}
x6={{0.999988}, {2.}, {2.99998}}
x7={{1.}, {2.}, {3.}}
x8={{1.}, {2.}, {3.}}
x9={{1.}, {2.}, {3.}}
x10={{1.}, {2.}, {3.}}
```

In[ ]:=

$$a0 = \begin{pmatrix} 4 & -1 & 0 \\ -1 & 4 & -1 \\ 0 & -1 & 4 \end{pmatrix}$$

$$b0 = \begin{pmatrix} 2 \\ 4 \\ 10 \end{pmatrix}$$

$$x0 = \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}$$

```
GaussSeidel[a0, b0, x0, 10]
```

Out[ ]= {{4, -1, 0}, {-1, 4, -1}, {0, -1, 4}}

Out[ ]= {{2}, {4}, {10}}

Out[ ]= {{0}, {0}, {0}}

```
x0={{0}, {0}, {0}}
x1={{0.5}, {1.125}, {2.78125}}
x2={{0.78125}, {1.89063}, {2.97266}}
x3={{0.972656}, {1.98633}, {2.99658}}
x4={{0.996582}, {1.99829}, {2.99957}}
x5={{0.999573}, {1.99979}, {2.99995}}
x6={{0.999947}, {1.99997}, {2.99999}}
x7={{0.999993}, {2.}, {3.}}
x8={{0.999999}, {2.}, {3.}}
x9={{1.}, {2.}, {3.}}
x10={{1.}, {2.}, {3.}}
```

Practicals 7
divided difference
date 13/04/2023

In[ ]:=
```
sum = 0;
points = {{3, 293}, {5, 508}, {6, 585}, {9, 764}};
n = Length[points]
y = points[[All, 1]]
f = points[[All, 2]]
dd[k_] :=
 Sum[(f[[i]] / Product[If[Equal[j, i], 1, (y[[i]] - y[[j]])], {j, 1, k}]), {i, 1, k}]
p[x_] = Sum[(dd[i] * Product[If[i ≤ j, 1, x - y[[j]]], {j, 1, i - 1}]), {i, 1, n}]
Simplify[p[x]]
Evaluate[p[2.5]]
```

Out[ ]= 4

Out[ ]= {3, 5, 6, 9}

Out[ ]= {293, 508, 585, 764}

Out[ ]= $293 + \frac{215}{2}(-3+x) - \frac{61}{6}(-5+x)(-3+x) + \frac{35}{36}(-6+x)(-5+x)(-3+x)$

Out[ ]= $\frac{1}{36}\left(-9702 + 9003\,x - 856\,x^2 + 35\,x^3\right)$

Out[ ]= 222.288

Practicals 7
Simpson’s 1/3 rule
date : 13/04/2023

```
a = Input["enter the left end point : "];
b = Input["enter the right end point : "];
n = Input["enter the number of sub intrevals tyo be formed : "];
h = (b - a) / n;
y = Table[a + ih, {i, 1, n}];
f[x] := 1 / x;
sumodd = 0;
sumeven = 0;
For[i = 1, i < n, i += 2, sumodd += 4 * f[x] /. x → y[[i]]];
For[i = 2, i < n, i += 2, sumeven += 2 * f[x] /. x → y[[i]]];
Sn = (h / 3) * ((f[x] /. x → a) + N[sumodd] + N[sumeven] + (f[x] /. x → b));
Print["for n = ", n, ", simpson estimate is : ", Sn]
in = Integrate[1 / x, {x, 1, 2}]
Print["true value is ", in]
Print["absolute error is ", Abs[Sn - in]]
```

for n = 2, simpson estimate is : $\frac{1}{6}\left(1.5+\frac{4.}{1.+ih}\right)$

Out[ ]= Log[2]

true value is Log[2]

absolute error is $\mathrm{Abs}\left[\frac{1}{6}\left(1.5+\frac{4.}{1.+ih}\right)-\mathrm{Log}[2]\right]$

Practicals 7

Trapezoidal rule

date: 13/04/2023

In[ ]:=
```
ClearAll[n, x, f, h, a, b, sum]
a = Input["enter the left end point : "]
b = Input["enter the right end point : "]
n = Input["enter the number of sub intervals to be formed : "]
sum = 0;
h = (b - a) / n
f[x] = Sin[x]
For[i = 1, i ≤ n - 1, i++, sum += N[f[x] /. x → (a + i * h)]]
sum = N[(2 * sum + f[x] /. x → a + f[x] /. x → b) * h / 2]
```

Out[ ]= 0

Out[ ]= 2π

Out[ ]= 50

Out[ ]= $\frac{\pi}{25}$

Out[ ]= Sin[x]

Out[ ]= -1.74393×10^{-16}

Practicals 7
Euler's method
date : 13/04/2023

In[ ]:=
```
Euler[a0_, b0_, h0_, f_, alpha_] := Module[{a = N[a0], b = N[b0], h = N[h0], n, x},
   n = (b - a) / h;
  y[0] = alpha;
  For[i = 0, i ≤ n, i++,
     x[i] = a + h * i;
     y[i + 1] = y[i] + h * f[x[i], y[i]];
     Print["value at x[", i, "]=" x[i], " is ", y[i]];
   ];
  ];
  f[x_, y_] := y * x^3 - 1.5 * y;
  Euler[0, 2, 0.5, f, 1]
```

```
value at x[00. is 1

value at x[10.5 ]= is 0.25

value at x[21. ]= is 0.078125

value at x[31.5 ]= is 0.0585938

value at x[42. ]= is 0.113525
```

Practicals 7
Lagrange Interpolating polynomial
date: 13/04/2023

In[ ]:=
```
ClearAll;
points = {{1, 0}, {3, 18}, {4, 48}, {6, 180}, {10, 900}};
N0 = Length[points];
y = points[[All, 1]];
f = points[[All, 2]];
lagrange[sizee_, n_] :=
  Product[If[Equal[k, n], 1, (x - y[[k]]) / (y[[n]] - y[[k]])], {k, 1, sizee}] ;
Approx = Expand[Simplify[Sum[(f[[i]] * lagrange[N0, i]), {i, 1, N0}]]]
```

Out[ ]= $-x^2 + x^3$

In[ ]:=
```
Approx /. x → 5
```

Out[ ]= 100

In[ ]:=
```
Print[points]
```

{{1, 0}, {3, 18}, {4, 48}, {6, 180}, {10, 900}}