Practical 1

Prakhar Khugshal

20211441 B.Sc(H) Computer Science

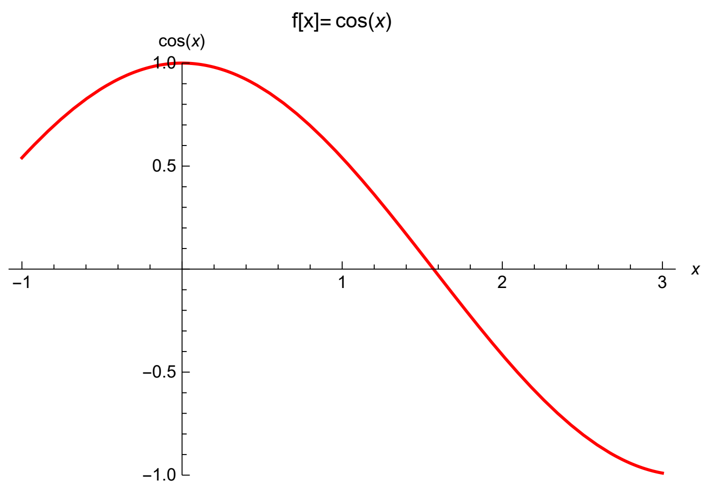
4th Semester

Bisection Method

Question 1

```
x0 = 1.0;
x1 = 2.0;
NMax = 20;
eps = 0.0001;
f[x_] := Cos[x];
If[N[f[x0] * f[x1]] > 0,
 Print[
  "Yours values do  opt staisfy the IVP so change the value."],
 For[i = 1, i ≤ NMax, i++, m = (x0 + x1) / 2;
  If[Abs[(x1 - x0) / 2] < eps, Return[m],
   Print[i, "th iteration value is :", m];
   Print["Estimated error in ",
     i, "th iteration is:", (x1 - x0) / 2]
    If[f[m] * f[x1] > 0, x1 = m, x0 = m]]];
 Print ["Estimated error in", i, "th iteration is:", (x1 - x0) / 2]]
Plot[f[x], {x, -1, 3}, PlotRange → {-1, 1},
 PlotStyle → Red, PlotLabel → "f[x]=" f[x], AxesLabel → {x, f[x]}]
```

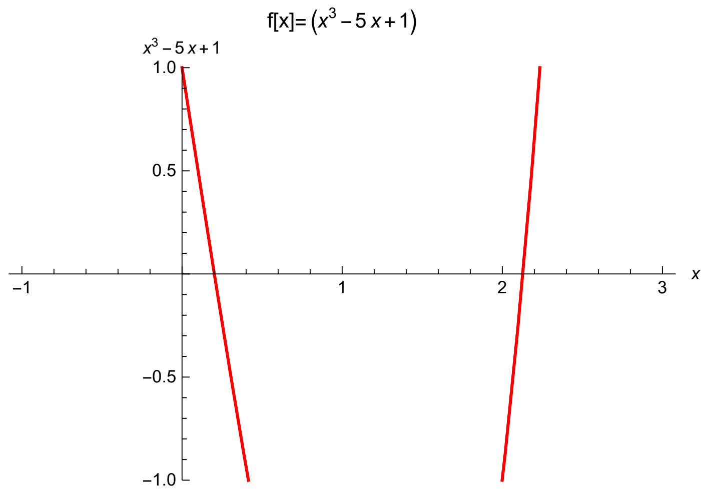
```
1th iteration value is :1.5
Estimated error in 1th iteration is:0.5
2th iteration value is :1.75
Estimated error in 2th iteration is:0.25
3th iteration value is :1.625
Estimated error in 3th iteration is:0.125
4th iteration value is :1.5625
Estimated error in 4th iteration is:0.0625
5th iteration value is :1.59375
Estimated error in 5th iteration is:0.03125
6th iteration value is :1.57813
Estimated error in 6th iteration is:0.015625
7th iteration value is :1.57031
Estimated error in 7th iteration is:0.0078125
8th iteration value is :1.57422
Estimated error in 8th iteration is:0.00390625
9th iteration value is :1.57227
Estimated error in 9th iteration is:0.00195313
10th iteration value is :1.57129
Estimated error in 10th iteration is:0.000976563
11th iteration value is :1.5708
Estimated error in 11th iteration is:0.000488281
12th iteration value is :1.57056
Estimated error in 12th iteration is:0.000244141
13th iteration value is :1.57068
Estimated error in 13th iteration is:0.00012207
Return[1.57074]
```



Question 2

```
x0 = 0;
x1 = 1.0;
NMax = 20;
eps = 0.0001;
f[x_] := x^3 - 5 x + 1;
If[N[f[x0] * f[x1]] > 0,
 Print[
  "Yours values do  opt staisfy the IVP so change the value."],
 For[i = 1, i ≤ NMax, i++, m = (x0 + x1) / 2;
  If[Abs[(x1 - x0) / 2] < eps, Return[m],
   Print[i, "th iteration value is :", m];
   Print["Estimated error in ",
     i, "th iteration is:", (x1 - x0) / 2]
    If[f[m] * f[x1] > 0, x1 = m, x0 = m]]];
 Print ["Estimated error in", i, "th iteration is:", (x1 - x0) / 2]]
Plot[f[x], {x, -1, 3}, PlotRange → {-1, 1},
 PlotStyle → Red, PlotLabel → "f[x]=" f[x], AxesLabel → {x, f[x]}]
```

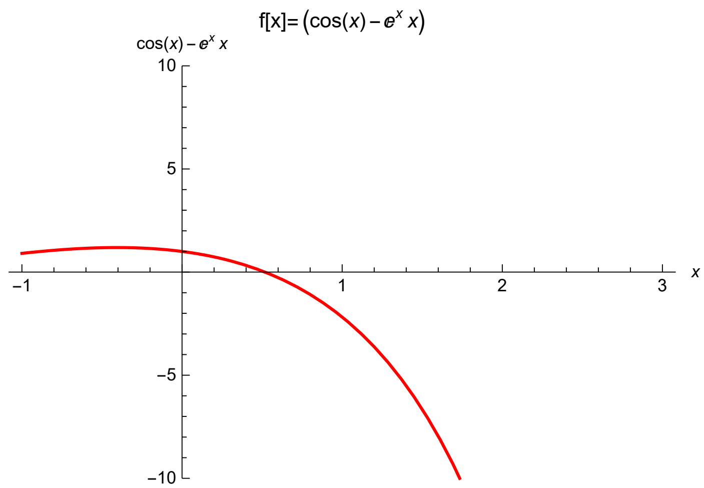
```
1th iteration value is :0.5
Estimated error in 1th iteration is:0.5
2th iteration value is :0.25
Estimated error in 2th iteration is:0.25
3th iteration value is :0.125
Estimated error in 3th iteration is:0.125
4th iteration value is :0.1875
Estimated error in 4th iteration is:0.0625
5th iteration value is :0.21875
Estimated error in 5th iteration is:0.03125
6th iteration value is :0.203125
Estimated error in 6th iteration is:0.015625
7th iteration value is :0.195313
Estimated error in 7th iteration is:0.0078125
8th iteration value is :0.199219
Estimated error in 8th iteration is:0.00390625
9th iteration value is :0.201172
Estimated error in 9th iteration is:0.00195313
10th iteration value is :0.202148
Estimated error in 10th iteration is:0.000976563
11th iteration value is :0.20166
Estimated error in 11th iteration is:0.000488281
12th iteration value is :0.201416
Estimated error in 12th iteration is:0.000244141
13th iteration value is :0.201538
Estimated error in 13th iteration is:0.00012207
Return[0.201599]
```



Question 3 :

```
x0 = 0;
x1 = 1.0;
NMax = 20;
eps = 0.0001;
f[x_] := Cos[x] - x * Exp[x];
If[N[f[x0] * f[x1]] > 0,
 Print[
  "Yours values do  opt staisfy the IVP so change the value."],
 For[i = 1, i ≤ NMax, i++, m = (x0 + x1) / 2;
  If[Abs[(x1 - x0) / 2] < eps, Return[m],
   Print[i, "th iteration value is :", m];
   Print["Estimated error in ",
     i, "th iteration is:", (x1 - x0) / 2]
    If[f[m] * f[x1] > 0, x1 = m, x0 = m]]];
 Print ["Estimated error in", i, "th iteration is:", (x1 - x0) / 2]]
Plot[f[x], {x, -1, 3}, PlotRange → {-10, 10},
 PlotStyle → Red, PlotLabel → "f[x]=" f[x], AxesLabel → {x, f[x]}]
```

```
1th iteration value is :0.5
Estimated error in 1th iteration is:0.5
2th iteration value is :0.75
Estimated error in 2th iteration is:0.25
3th iteration value is :0.625
Estimated error in 3th iteration is:0.125
4th iteration value is :0.5625
Estimated error in 4th iteration is:0.0625
5th iteration value is :0.53125
Estimated error in 5th iteration is:0.03125
6th iteration value is :0.515625
Estimated error in 6th iteration is:0.015625
7th iteration value is :0.523438
Estimated error in 7th iteration is:0.0078125
8th iteration value is :0.519531
Estimated error in 8th iteration is:0.00390625
9th iteration value is :0.517578
Estimated error in 9th iteration is:0.00195313
10th iteration value is :0.518555
Estimated error in 10th iteration is:0.000976563
11th iteration value is :0.518066
Estimated error in 11th iteration is:0.000488281
12th iteration value is :0.517822
Estimated error in 12th iteration is:0.000244141
13th iteration value is :0.5177
Estimated error in 13th iteration is:0.00012207
Return[0.517761]
```


f[x]= (cos(x) − e^x x)
cos(x) − e^x x
10
5
−5
−10
−1
1
2
3
x

Practical 2(a) --> Secant Method Prakhar Khugshal || 20211441 || B Sc Hon Computer science ||

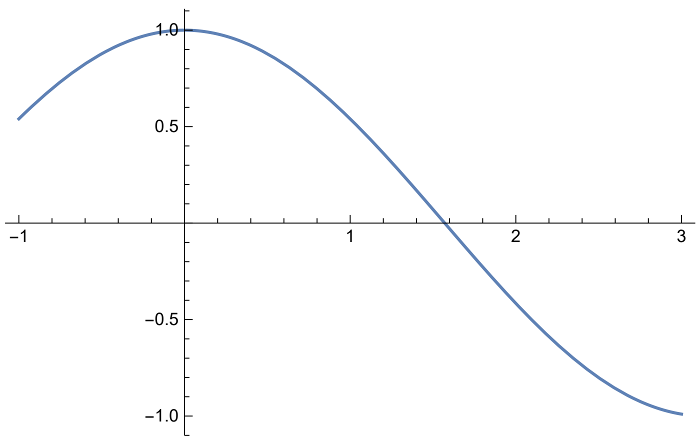
```
x0 = Input["Enter first guess: "];
x1 = Input ["Enter scond guess: "];
Nmax = Input["Enter maximum of iterations : " ];
eps = Input["Enter the value of covergence parameter: "];
Print["x0=", x0];
Print["x1=", x1];
Print["Nmax=", Nmax];
Print["epsilon=", eps];
f[x_] := Cos[x];
Print["f[x]:=", f[x]]
For [i = 1, i ≤ Nmax, i++,
  x2 = N[x1 - (f[x] /. x → x1) * (x1 - x0) / ((f[x] /. x → x1) - (f[x] /. x → x0))];
  If[Abs[x1 - x2] < eps, Return[x2], x0 = x1; x1 = x2];
  Print["In", i, "th number of iterations the root is :", x2];
  Print["estimated error is: ", Abs[x1 - x0]]];
Print["root is : ", x2];
Print["Estimated error is :", Abs [x2 - x1]];
Plot[f[x], {x, -1, 3}]
```

```
x0=1
x1=2
Nmax=20
```

epsilon= $\frac{1}{1\,000\,000}$

```
f[x]:=Cos[x]
In1th number of iterations the root is :1.5649
estimated error is: 0.435096
In2th number of iterations the root is :1.57098
estimated error is: 0.0060742
In3th number of iterations the root is :1.5708
estimated error is: 0.000182249
Return[1.5708]
root is : 1.5708
```

Estimated error is :1.02185×10^{-9}



```
x0 = Input["Enter first guess: "];
x1 = Input ["Enter scond guess: "];
Nmax = Input["Enter maximum of iterations : " ];
eps = Input["Enter the value of covergence parameter: "];
Print["x0=", x0];
Print["x1=", x1];
Print["Nmax=", Nmax];
Print["epsilon=", eps];
f[x_] := x^3 - 5 * x + 1;
Print["f[x]:=", f[x]]
For [i = 1, i ≤ Nmax, i++,
  x2 = N[x1 - (f[x] /. x → x1) * (x1 - x0) / ((f[x] /. x → x1) - (f[x] /. x → x0))];
  If[Abs[x1 - x2] < eps, Return[x2], x0 = x1; x1 = x2];
  Print["In", i, "th number of iterations the root is :", x2];
  Print["estimated error is: ", Abs[x1 - x0]]];
Print["root is : ", x2];
Print["Estimated error is :", Abs [x2 - x1]];
Plot[f[x], {x, -1, 3}]
```

x0=1

x1=2

Nmax=20

epsilon=$\frac{1}{1\,000\,000}$

f[x]:=$1 - 5 x + x^3$

In1th number of iterations the root is :2.5

estimated error is: 0.5

In2th number of iterations the root is :2.09756

estimated error is: 0.402439

In3th number of iterations the root is :2.12134

estimated error is: 0.0237786

In4th number of iterations the root is :2.12859

estimated error is: 0.0072456

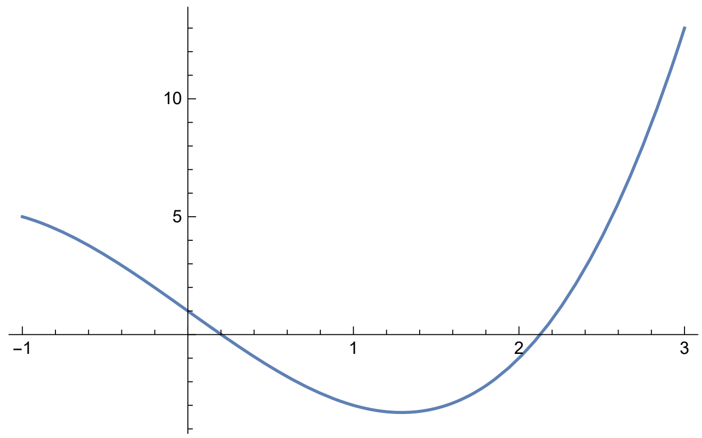
In5th number of iterations the root is :2.12842

estimated error is: 0.000166952

Return[2.12842]

root is : 2.12842

Estimated error is :8.77361×10^{-7}



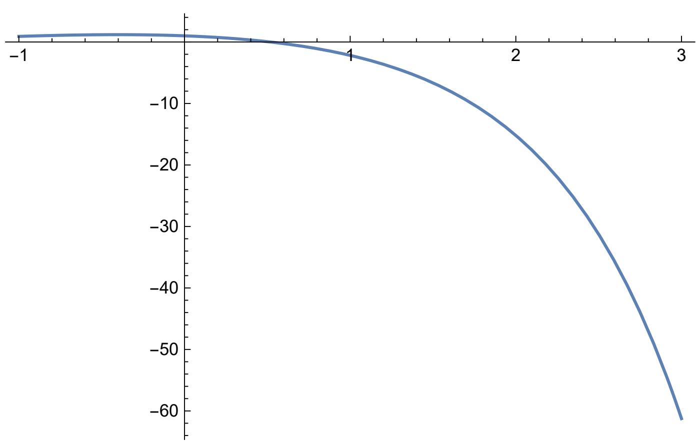
In[1]:=
```
x0 = Input["Enter first guess: "];
x1 = Input ["Enter scond guess: "];
Nmax = Input["Enter maximum of iterations : " ];
eps = Input["Enter the value of covergence parameter: "];
Print["x0=", x0];
Print["x1=", x1];
Print["Nmax=", Nmax];
Print["epsilon=", eps];
f[x_] := Cos[x] - x * Exp[x];
Print["f[x]:=", f[x]]
For [i = 1, i ≤ Nmax, i++,
  x2 = N[x1 - (f[x] /. x → x1) * (x1 - x0) / ((f[x] /. x → x1) - (f[x] /. x → x0))];
  If[Abs[x1 - x2] < eps, Return[x2], x0 = x1; x1 = x2];
  Print["In", i, "th number of iterations the root is :", x2];
  Print["estimated error is: ", Abs[x1 - x0]]];
Print["root is : ", x2];
Print["Estimated error is :", Abs [x2 - x1]];
Plot[f[x], {x, -1, 3}]
```

```
x0=1
x1=2
Nmax=20
epsilon=1.×10^-6
f[x]:=-e^x x + Cos[x]
In1th number of iterations the root is :0.832673
estimated error is: 1.16733
In2th number of iterations the root is :0.728779
estimated error is: 0.103894
In3th number of iterations the root is :0.562401
estimated error is: 0.166377
In4th number of iterations the root is :0.524782
estimated error is: 0.0376189
In5th number of iterations the root is :0.518014
estimated error is: 0.00676874
In6th number of iterations the root is :0.517759
estimated error is: 0.0002547
In7th number of iterations the root is :0.517757
estimated error is: 1.50138×10^-6
```

Out[11]= Return[0.517757]

```
root is : 0.517757
Estimated error is :3.22103×10^-10
```

Out[14]=



Prakhar Khugshal || BSc(Hons) Computer Science || Semester IV || 20211441

Regular Falsi

Q1

```
x0 = Input["Enter first guess: "];
x1 = Input ["Enter scond guess: "];
Nmax = Input["Enter maximum of iterations : " ];
eps = Input["Enter the value of covergence parameter: "];
Print["x0=", x0];
Print["x1=", x1];
Print["Nmax=", Nmax];
Print["epsilon=", eps];
f[x_] := Cos[x];
Print["f(x):=", f[x]]; If[N[f[x0] * f[x1]] > 0,
 Print["These values does not satisfy the IVP so change the values "],
 For[i = 1, i ≤ Nmax, i++, a = N[x1 - f[x1] * (x1 - x0) / (f[x1] - f[x0]), 16];
  If[Abs[x1 - x0 / 2] < eps, Return[N[a, 16]], Print[i, "the iteration value is:", N[a16]];
   Print["Estimated error is: ", N[x1 - x0, 16]];
   If[f[a] * f[x1] > 0, x1 = a, x0 = a]]];
 Print["Root is: ", N[a, 16]];
 Print["Estimated eror is:", N[x1 - x0, 16]]];
Plot[f[x], {x, -1, 3}]
```

x0=1

x1=2

Nmax=20

epsilon=$\frac{1}{1\,000\,000}$

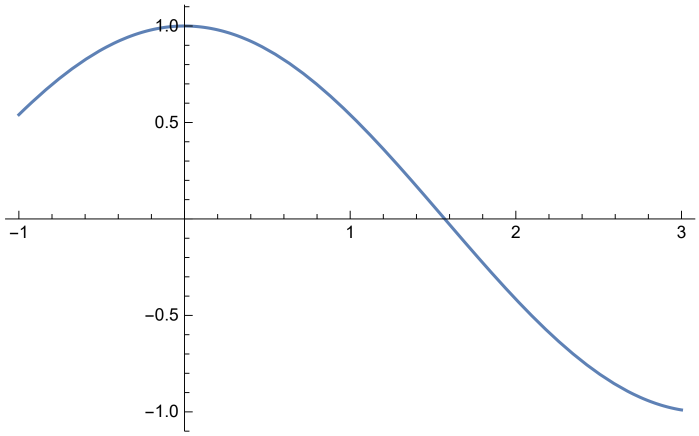
f(x):=Cos[x]

1the iteration value is:a16

Estimated error is: 1.000000000000000

```
2the iteration value is:a16
Estimated error is: 0.435095624108422
3the iteration value is:a16
Estimated error is: 0.006074198643440
4the iteration value is:a16
Estimated error is: 0.000182248761967
5the iteration value is:a16
Estimated error is: 0.00018224774012
6the iteration value is:a16
Estimated error is: 0.00018224774012
7the iteration value is:a16
Estimated error is: 0.0001822477401
8the iteration value is:a16
Estimated error is: 0.0001822477401
9the iteration value is:a16
Estimated error is: 0.0001822477401
10the iteration value is:a16
Estimated error is: 0.000182247740
11the iteration value is:a16
Estimated error is: 0.000182247740
12the iteration value is:a16
Estimated error is: 0.000182247740
13the iteration value is:a16
Estimated error is: 0.000182247740
14the iteration value is:a16
Estimated error is: 0.00018224774
15the iteration value is:a16
Estimated error is: 0.00018224774
16the iteration value is:a16
Estimated error is: 0.00018224774
17the iteration value is:a16
Estimated error is: 0.0001822477
18the iteration value is:a16
Estimated error is: 0.0001822477
19the iteration value is:a16
Estimated error is: 0.0001822477
```

```
20the iteration value is:a16

Estimated error is: 0.000182248

Root is: 1.570796327

Estimated eror is:0.000182248
```



Q2

```
x0 = Input["Enter first guess: "];
x1 = Input ["Enter scond guess: "];
Nmax = Input["Enter maximum of iterations : " ];
eps = Input["Enter the value of covergence parameter: "];
Print["x0=", x0];
Print["x1=", x1];
Print["Nmax=", Nmax];
Print["epsilon=", eps];
f[x_] := x^3 - 5 * x + 1;
Print["f(x):=", f[x]]; If[N[f[x0] * f[x1]] > 0,
 Print["These values does not satisfy the IVP so change the values "],
 For[i = 1, i ≤ Nmax, i++, a = N[x1 - f[x1] * (x1 - x0) / (f[x1] - f[x0]), 16];
  If[Abs[x1 - x0 / 2] < eps, Return[N[a, 16]], Print[i, "the iteration value is:", N[a16]];
   Print["Estimated error is: ", N[x1 - x0, 16]];
   If[f[a] * f[x1] > 0, x1 = a, x0 = a]]];
 Print["Root is: ", N[a, 16]];
 Print["Estimated eror is:", N[x1 - x0, 16]]];
Plot[f[x], {x, -1, 3}]
```

x0=1

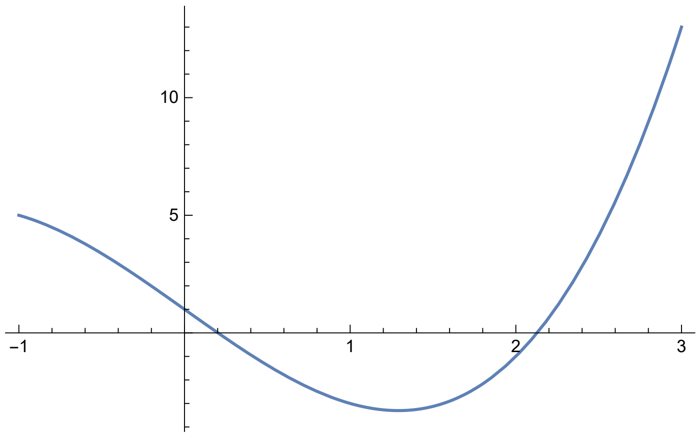
x1=2

Nmax=20

epsilon=$\frac{1}{1\,000\,000}$

f(x):=$1-5x+x^3$

These values does not satisfy the IVP so change the values



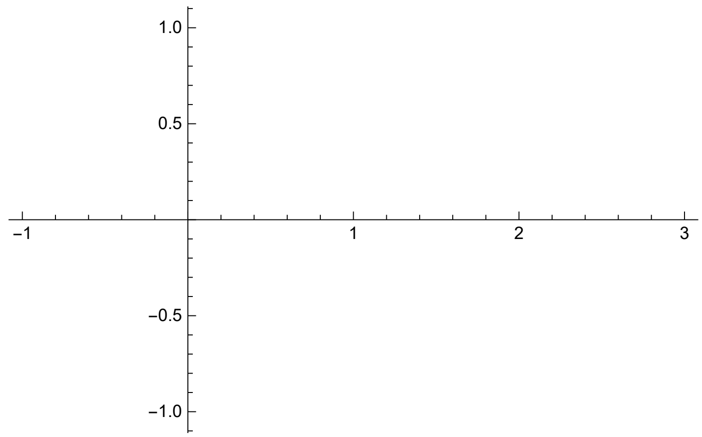
Q3

```
x0 = Input["Enter first guess: "];
x1 = Input ["Enter scond guess: "];
Nmax = Input["Enter maximum of iterations : " ];
eps = Input["Enter the value of covergence parameter: "];
Print["x0=", x0];
Print["x1=", x1];
Print["Nmax=", Nmax];
Print["epsilon=", eps];
f[x_] := Cos[x] - x * e^x;
Print["f(x):=", f[x]]; If[N[f[x0] * f[x1]] > 0,
 Print["These values does not satisfy the IVP so change the values "],
 For[i = 1, i ≤ Nmax, i++, a = N[x1 - f[x1] * (x1 - x0) / (f[x1] - f[x0]), 16];
  If[Abs[x1 - x0 / 2] < eps, Return[N[a, 16]], Print[i, "the iteration value is:", N[a16]];
   Print["Estimated error is: ", N[x1 - x0, 16]];
   If[f[a] * f[x1] > 0, x1 = a, x0 = a]]];
 Print["Root is: ", N[a, 16]];
 Print["Estimated eror is:", N[x1 - x0, 16]]];
Plot[f[x], {x, -1, 3}]
```

```
x0=1

x1=2

Nmax=20
```

epsilon= $\frac{1}{1\,000\,000}$

$f(x) := -e^x x + \mathrm{Cos}[x]$



Prakhar Khugshal | BSC(hons) CS | 20211441 | IV semester

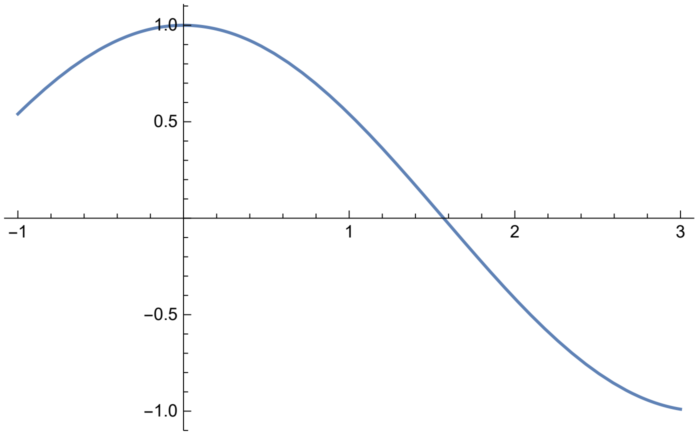
Newton Raphson Method

Q1

```
x0 = Input["Enter first guess: "];
Nmax = Input["Enter maximum of iterations : " ];
eps = Input["Enter the value of covergence parameter: "];
Print["x0=", x0];
Print["Nmax=", Nmax];
Print["epsilon=", eps];
f[x_] := Cos[x];
Print["f[x]:=", f[x]]
Print["f'[x]:=", D[f[x], x]];
For[i = 1, i ≤ Nmax, i++, x1 = N[x0 - (f[x] /. x → x0) / (D[f[x], x] /. x → x0)];
  If[Abs[x1 - x0] < eps, Return[x1], x0p = x0; x0 = x1];
  Print["In", i, "Th number of iteration the root is :", x1];
  Print["estimated error is:", Abs[x1 - x0p]]];
Print["The final approximationof the root is :", x1];
Print["estimated error is :", Abs[x1 - x0]];
Plot[f[x], {x, -1, 3}]
```

```
x0=1

Nmax=2

epsilon=10

f[x]:=Cos[x]

f'[x]:=-Sin[x]

Return[1.64209]
```

```
The final approximationof the root is :1.64209

estimated error is :0.642093
```



Q2

```
x0 = Input["Enter first guess: "];
Nmax = Input["Enter maximum of iterations : " ];
eps = Input["Enter the value of covergence parameter: "];
Print["x0=", x0];
Print["Nmax=", Nmax];
Print["epsilon=", eps];
f[x_] := x^3 - 5 * x + 1;
Print["f[x]:=", f[x]]
Print["f'[x]:=", D[f[x], x]];
For[i = 1, i ≤ Nmax, i++, x1 = N[x0 - (f[x] /. x → x0) / (D[f[x], x] /. x → x0)];
  If[Abs[x1 - x0] < eps, Return[x1], x0p = x0; x0 = x1];
  Print["In", i, "Th number of iteration the root is :", x1];
  Print["estimated error is:", Abs[x1 - x0p]]];
Print["The final approximationof the root is :", x1];
Print["estimated error is :", Abs[x1 - x0]];
Plot[f[x], {x, -1, 3}]
```

```
x0=1

Nmax=20
```

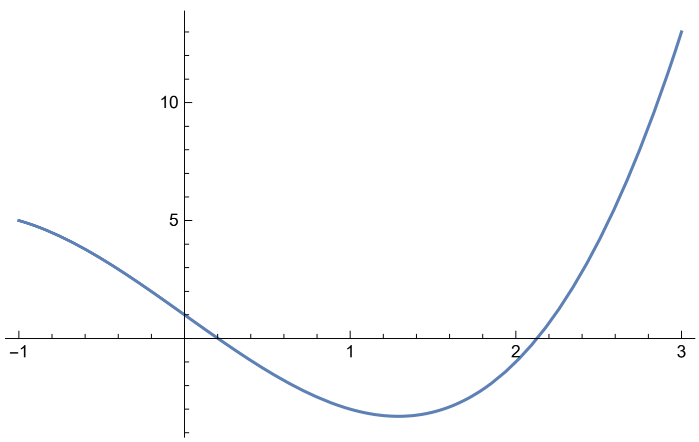
epsilon= $\frac{1}{1\,000\,000}$

f[x]:=1 - 5 x + x^3

f'[x]:=-5 + 3 x^2

```
In1Th number of iteration the root is :-0.5

estimated error is:1.5

In2Th number of iteration the root is :0.294118

estimated error is:0.794118

In3Th number of iteration the root is :0.200215

estimated error is:0.093903

In4Th number of iteration the root is :0.201639

estimated error is:0.00142474

Return[0.20164]

The final approximationof the root is :0.20164
```

estimated error is :2.50538×10^{-7}



Q3

```
x0 = Input["Enter first guess: "];
Nmax = Input["Enter maximum of iterations : " ];
eps = Input["Enter the value of covergence parameter: "];
Print["x0=", x0];
Print["Nmax=", Nmax];
Print["epsilon=", eps];
f[x_] := Cos[x] - x * Exp[x];
Print["f[x]:=", f[x]]
Print["f'[x]:=", D[f[x], x]];
For[i = 1, i ≤ Nmax, i++, x1 = N[x0 - (f[x] /. x → x0) / (D[f[x], x] /. x → x0)];
  If[Abs[x1 - x0] < eps, Return[x1], x0p = x0; x0 = x1];
  Print["In", i, "Th number of iteration the root is :", x1];
  Print["estimated error is:", Abs[x1 - x0p]]];
Print["The final approximationof the root is :", x1];
Print["estimated error is :", Abs[x1 - x0]];
Plot[f[x], {x, -1, 3}]
```

x0=1

Nmax=20

epsilon=$1.\times 10^{-6}$

f[x]:=$-e^{x}\, x + \mathrm{Cos}[x]$

f'[x]:=$-e^{x} - e^{x}\, x - \mathrm{Sin}[x]$

In1Th number of iteration the root is :0.653079

estimated error is:0.346921

In2Th number of iteration the root is :0.531343

estimated error is:0.121736

In3Th number of iteration the root is :0.51791

estimated error is:0.0134335

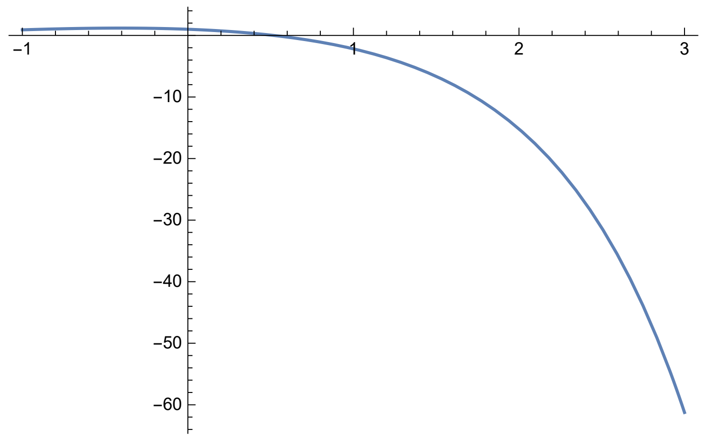
In4Th number of iteration the root is :0.517757

estimated error is:0.00015253

Return[0.517757]

The final approximationof the root is :0.517757

estimated error is :1.94824×10^{-8}



-1
1
2
3
-10
-20
-30
-40
-50
-60

Practical 4

Prakhar Khugshal | BSc(H) Computer Science | Sem - IV | 20211441

1. Gaussian Elimination Method

Q1. Solve the following system of equations by using Gaussian Elimination Method

2x1-3x2+10x3=-2

x1-2x2+3x3=-2

-x1+3x2+x3=4

```
MatrixForm[A = {{2, -3, 10, -2}, {1, -2, 3, -2}, {-1, 3, 1, 4}}]
```

$$\begin{pmatrix} 2 & -3 & 10 & -2 \\ 1 & -2 & 3 & -2 \\ -1 & 3 & 1 & 4 \end{pmatrix}$$

```
MatrixForm[A = {A[[2]], A[[1]], A[[3]]}]
```

$$\begin{pmatrix} 1 & -2 & 3 & -2 \\ 2 & -3 & 10 & -2 \\ -1 & 3 & 1 & 4 \end{pmatrix}$$

```
MatrixForm[A = {A[[1]], A[[2]] - 2 A[[1]], A[[3]] + A[[1]]}]
```

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

```
MatrixForm[A = {A[[1]], A[[2]], A[[3]] - A[[2]]}]
```

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

```
Solve[{x1 - 2 x2 + 3 x3 == -2, x2 + 4 x3 == 2}, {x3, x2, x1}]
```

Solve: Equations may not give solutions for all "solve" variables.

```
{{x2 → 2 - 4 x3, x1 → 2 - 11 x3}}
```

Q1. Solve the following system of equations by using Gaussian Elimination Method

2x1+x2+x3=10

3x1+2x2+3x3=18

x1+4x2+9x3=16

```
MatrixForm[A = {{2, 1, 1, 10}, {3, 2, 3, 18}, {1, 4, 9, 16}}]
```

$$\begin{pmatrix} 2 & 1 & 1 & 10 \\ 3 & 2 & 3 & 18 \\ 1 & 4 & 9 & 16 \end{pmatrix}$$

```
MatrixForm[A = {A[[1]], A[[2]] - 3/2 A[[1]], A[[3]] - 1/2 A[[1]]}]
```

$$\begin{pmatrix} 2 & 1 & 1 & 10 \\ 0 & \frac{1}{2} & \frac{3}{2} & 3 \\ 0 & \frac{7}{2} & \frac{17}{2} & 11 \end{pmatrix}$$

```
MatrixForm[A = {A[[1]], A[[2]], A[[3]] - 7 A[[2]]}]
```

$$\begin{pmatrix} 2 & 1 & 1 & 10 \\ 0 & \frac{1}{2} & \frac{3}{2} & 3 \\ 0 & 0 & -2 & -10 \end{pmatrix}$$

```
Solve[{2 x1 + x2 + x3 == 10, 1/2 x2 + 3/2 x3 == 3, -2 x3 == -10}, {x3, x2, x1}]
```

```
{{x3 → 5, x2 → -9, x1 → 7}}
```

2. Gauss Jordan Elimination Method

Q1. Solve the following system of equations by using Gauss Jordan Elimination Method

2x1+x2+x3=10

3x1+2x2+3x3=18

x1+4x2+9x3=16

```
MatrixForm[B = {{2, 1, 1, 10}, {3, 2, 3, 18}, {1, 4, 9, 16}}]
```

$$\begin{pmatrix} 2 & 1 & 1 & 10 \\ 3 & 2 & 3 & 18 \\ 1 & 4 & 9 & 16 \end{pmatrix}$$

```
MatrixForm[RowReduce[B]]
```

$$\begin{pmatrix} 1 & 0 & 0 & 7 \\ 0 & 1 & 0 & -9 \\ 0 & 0 & 1 & 5 \end{pmatrix}$$

```
Solve[{x1 == 7, x2 == -9, x3 == 5}, {x3, x2, x1}]
```

{{x3 → 5, x2 → -9, x1 → 7}}

Inverse

```
MatrixForm[B = {{2, 1, 1, 1, 0, 0}, {3, 2, 3, 0, 1, 0}, {1, 4, 9, 0, 0, 1}}]
```

$$\begin{pmatrix} 2 & 1 & 1 & 1 & 0 & 0 \\ 3 & 2 & 3 & 0 & 1 & 0 \\ 1 & 4 & 9 & 0 & 0 & 1 \end{pmatrix}$$

```
MatrixForm[RowReduce[B]]
```

$$\begin{pmatrix} 1 & 0 & 0 & -3 & \frac{5}{2} & -\frac{1}{2} \\ 0 & 1 & 0 & 12 & -\frac{17}{2} & \frac{3}{2} \\ 0 & 0 & 1 & -5 & \frac{7}{2} & -\frac{1}{2} \end{pmatrix}$$

Practical 5(a)

Prakhar Khugshal| BSc(H) Computer Science | Sem - IV | 20211441

Gauss Jacobi method

Question 1 :

```
GaussJacobi[A0_, b0_, X0_, maxiter_] :=
 Module[{A = N[A0], b = N[b0], xk = X0, xk1, i, j, k = 0, n, m, OutputDetails},
  size = Dimensions[A];
  n = size[[1]];
  m = size[[2]];
  If[n ≠ m,
   Print["Not a square matrix, cannot proceed with Gauss Jacobi method"];
   Return[]];
  OutputDetails = {xk};
  xk1 = Table[0, {n}];
  While[k < maxiter,
   For[i = 1, i ≤ n, i++,
```

$$\texttt{xk1[[i]]} = \frac{1}{\texttt{A[[i, i]]}}\left(\texttt{b[[i]]} - \sum_{j=1}^{i-1}\texttt{A[[i, j]]} * \texttt{xk[[j]]} - \sum_{j=i+1}^{n}\texttt{A[[i, j]]} * \texttt{xk[[j]]}\right);];$$

```
   k++;
   OutputDetails = Append[OutputDetails, xk1];
   xk = xk1;];
  colHeading = Table[X[s], {s, 1, n}];
  Print[NumberForm[TableForm[OutputDetails,
     TableHeadings → {None, colHeading}], 6]];
  Print["No. of iterations performed ", maxiter];];
A = {{5, 1, 2}, {-3, 9, 4}, {1, 2, -7}};
b = {10, -14, -33};
X0 = {0, 0, 0};
GaussJacobi[A, b, X0, 15]
```

X[1]	X[2]	X[3]
0	0	0
2.	-1.55556	4.71429
0.425397	-2.98413	4.55556
0.774603	-3.43845	3.92245
1.11871	-3.04067	3.84253
1.07112	-2.89044	4.00534
0.975953	-2.97867	4.04146
0.979148	-3.02644	4.00266
1.00422	-3.00813	3.98947
1.00584	-2.99391	3.99828
0.99947	-2.99729	4.00257
0.998428	-3.00132	4.0007
0.999985	-3.00083	3.9994
1.00041	-2.99974	3.99976
1.00004	-2.99976	4.00013
0.999898	-3.00004	4.00008

No. of iterations performed 15

Question 11:

```
GaussJacobi[A0_, b0_, X0_, maxiter_] :=
  Module[{A = N[A0], b = N[b0], xk = X0, xk1, i, j, k = 0, n, m, OutputDetails},
   size = Dimensions[A];
   n = size[[1]];
   m = size[[2]];
   If[n ≠ m,
    Print["Not a square matrix, cannot proceed with Gauss Jacobi method"];
    Return[]];
   OutputDetails = {xk};
   xk1 = Table[0, {n}];
   While[k < maxiter,
    For[i = 1, i ≤ n, i++,
```

$$xk1[[i]] = \frac{1}{A[[i,i]]}\left(b[[i]] - \sum_{j=1}^{i-1} A[[i,j]] * xk[[j]] - \sum_{j=i+1}^{n} A[[i,j]] * xk[[j]]\right);];$$

```
    k++;
    OutputDetails = Append[OutputDetails, xk1];
    xk = xk1;];
   colHeading = Table[X[s], {s, 1, n}];
   Print[NumberForm[TableForm[OutputDetails,
      TableHeadings → {None, colHeading}], 6]];
   Print["No. of iterations performed ", maxiter];];
A = {{5, 1, 2}, {-3, 9, 4}, {1, 2, -7}, {2, 1, 3}};
b = {10, -14, -33};
X0 = {0, 0, 0};
GaussJacobi[A, b, X0, 15]
```

Not a square matrix, cannot proceed with Gauss Jacobi method

Question III :

```
GaussJacobi[A0_, b0_, X0_, maxiter_] :=
  Module[{A = N[A0], b = N[b0], xk = X0, xk1, i, j, k = 0, n, m, OutputDetails},
   size = Dimensions[A];
   n = size[[1]];
   m = size[[2]];
   If[n ≠ m,
    Print["Not a square matrix, cannot proceed with Gauss Jacobu method"];
    Return[]];
   OutputDetails = {xk};
   xk1 = Table[0, {n}];
   While[k < maxiter,
    For[i = 1, i ≤ n, i++,
     xk1[[i]] = 1/A[[i, i]] (b[[i]] - Sum[A[[i, j]] * xk[[j]], {j, 1, i-1}] - Sum[A[[i, j]] * xk[[j]], {j, i+1, n}]);];
    k++;
    OutputDetails = Append[OutputDetails, xk1];
    xk = xk1;];
   colHeading = Table[X[s], {s, 1, n}];
   Print[NumberForm[TableForm[OutputDetails,
      TableHeadings → {None, colHeading}], 6]];
   Print["No. of iterations performed ", maxiter];];
A = {{5, 1, 2}, {-3, 9, 4}, {1, 9, -7}};
b = {11, -14, -30};
X0 = {0, 0, 0};
GaussJacobi[A, b, X0, 15]
```

X[1]	X[2]	X[3]
0	0	0
2.2	-1.55556	4.28571
0.796825	-2.72698	2.6
1.7054	-2.4455	0.893424
2.33173	-1.38417	1.38512
1.92278	-1.39392	2.83918
1.34311	-2.17648	2.76821
1.52801	-2.33817	1.67925
1.99593	-1.79255	1.49779
1.9594	-1.55593	2.26614
1.60473	-1.9096	2.56515
1.55586	-2.16071	2.05977
1.80824	-1.95239	1.72992
1.89851	-1.72166	2.03382
1.7308	-1.82664	2.34336
1.62798	-2.02011	2.18444

No. of iterations performed 15

Practical 6

Prakhar Khugshal | B.Sc (Hons) Computer Science | IV Semester | 20211441

Lagrange Interpolation Polynomial

```
In[44]:= LagrangePolynomial[x0_, f0_] :=
  Module[{xi = x0, fi = f0, n, m, polynomial},
   n = Length[xi];
   m = Length[fi];
   If[n ≠ m,
    Print["List of points  and function values are not of same size"];
    Return[];];
   For[i = 1, i ≤ n, i++,
    L[i, x_] = (∏_{j=1}^{i-1} (x - xi[[j]])/(xi[[i]] - xi[[j]])) (∏_{j=i+1}^{n} (x - xi[[j]])/(xi[[i]] - xi[[j]]));];
   polynomial[x_] = ∑_{k=1}^{n} L[k, x] * fi[[k]];
   Return[polynomial[x]];]
```

Q1

```
In[45]:= nodes = {0, 1, 3};
values = {1, 3, 55};
LagrangePolynomial[x_] = LagrangePolynomial[nodes, values]
Expand[1/3 (1 - x) (3 - x) + 3/2 (3 - x) x + 55/6 (-1 + x) x]
```

Out[47]= $\frac{1}{3}(1-x)(3-x)+\frac{3}{2}(3-x)x+\frac{55}{6}(-1+x)x$

Out[48]= $1-6x+8x^2$

In[49]:=
```
nodes = {0, 1, 3};
values = {1, 3};
LagrangePolynomial[x_] = LagrangePolynomial[nodes, values]
```

List of points and function values are not of same size

P2

In[52]:=
```
nodes = {1, 3, 5, 7, 9};
values = {N[Log[1]], N[Log[3]], N[Log[5]], N[Log[7]], N[Log[9]]};
LagrangePolynomial[x_] = LagrangePolynomial[nodes, values]
```

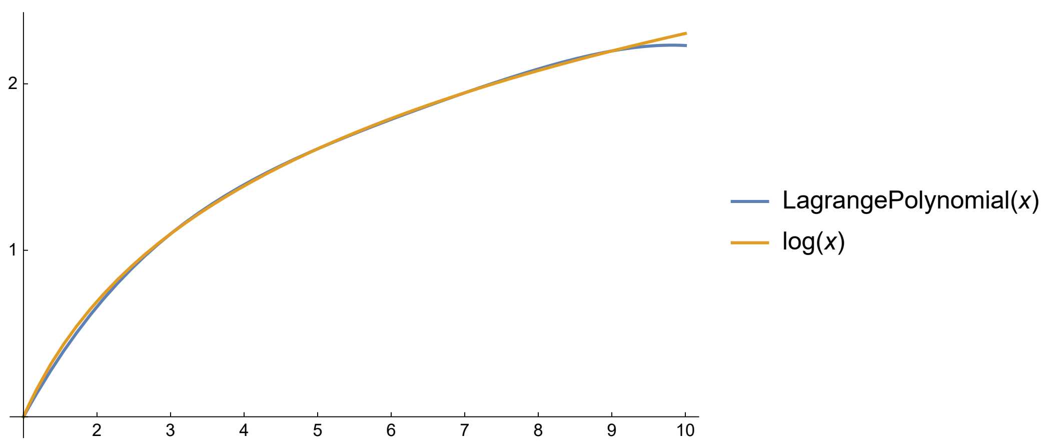
Out[54]= $0. + 0.0114439\,(5-x)\,(7-x)\,(9-x)\,(-1+x) + 0.0251475\,(7-x)\,(9-x)\,(-3+x)\,(-1+x) + 0.0202699\,(9-x)\,(-5+x)\,(-3+x)\,(-1+x) + 0.00572194\,(-7+x)\,(-5+x)\,(-3+x)\,(-1+x)$

In[55]:=
```
Simplify[0.` + 0.011443878006959476` (5 - x) (7 - x) (9 - x) (-1 + x) +
  0.025147467381782817` (7 - x) (9 - x) (-3 + x) (-1 + x) +
  0.020269897385992844` (9 - x) (-5 + x) (-3 + x) (-1 + x) +
  0.005721939003479738` (-7 + x) (-5 + x) (-3 + x) (-1 + x)]
```

Out[55]= $-0.987583 + 1.18991\,x - 0.223608\,x^2 + 0.0221231\,x^3 - 0.000844369\,x^4$

In[56]:=
```
Plot[{LagrangePolynomial[x], Log[x]}, {x, 1, 10},
 Ticks → {Range[0, 10]}, PlotLegends → "Expressions"]
```

Out[56]=



In[57]:=
```
nodes = {-1, 0, 1, 2};
values = {5, 1, 1, 11};
LagrangePolynomial[x_] = LagrangePolynomial[nodes, values]
```

Out[59]= $-\frac{5}{6}\,(1-x)\,(2-x)\,x + \frac{1}{2}\,(1-x)\,(2-x)\,(1+x) + \frac{1}{2}\,(2-x)\,x\,(1+x) + \frac{11}{6}\,(-1+x)\,x\,(1+x)$

In[60]:= $\texttt{Simplify}\left[-\frac{5}{6}\,(1-x)\,(2-x)\,x + \frac{1}{2}\,(1-x)\,(2-x)\,(1+x) + \frac{1}{2}\,(2-x)\,x\,(1+x) + \frac{11}{6}\,(-1+x)\,x\,(1+x)\right]$

Out[60]= $1 - 3\,x + 2\,x^2 + x^3$

In[61]:=
```
LagrangePolynomial[1.5]
```

Out[61]= 4.375

Practica 6(b)
Prakhar Khugshal | B.Sc(Hons) Computer Science | IV Semester | 20211441 |

Newton Divided Difference Interpolating polyomial

```
In[4]:= NthDividedDiff[x0_, f0_, startindex_, endindex_] :=
          Module[{x = x0, f = f0, i = startindex, j = endindex, answer},
           If[i == j, Return[f[[i]]],
             answer =
              (NthDividedDiff[x, f, i + 1, j] - NthDividedDiff[x, f, i, j - 1]) / (x[[j]] - x[[i]]);
             Return[answer]];
          ];
        x = {0, 1, 3};
        f = {1, 3, 55};
        NthDividedDiff[x, f, 2, 3]

Out[7]= 26

In[8]:= NthDividedDiff[x, f, 1, 3]

Out[8]= 8

In[9]:= x = {-1, 0, 1, 2};
        f = {5, 1, 1, 11};
        NthDividedDiff[x, f, 1, 2]

Out[11]= -4

In[12]:= NthDividedDiff[x, f, 2, 3]

Out[12]= 0

In[13]:= NthDividedDiff[x, f, 1, 3]

Out[13]= 2

In[14]:= NthDividedDiff[x, f, 2, 4]

Out[14]= 5
```

In[15]:=
```
NthDividedDiff[x, f, 1, 4]
```
Out[15]= 1

Q2

In[21]:=
```
NewtonDDPoly[x0_, f0_] :=
  Module[{x1 = x0, f = f0, n, newtonPolynomial, k, j},
   n = Length[x1];
   newtonPolynomial[Y_] = 0;
   For[i = 1, i ≤ n, i++,
    prod[Y_] = 1;
    For[k = 1, k ≤  i - 1, k++,
     prod[Y_] = prod[Y] * (y - x1[[k]])];
    newtonPolynomial[Y_] = newtonPolynomial[Y] + NthDividedDiff[x1, f, 1, i] * prod[Y]];
   Return[newtonPolynomial[Y]];];
nodes = {0, 1, 3};
values = {1, 3, 55};
NewtonDDPoly[nodes, values]
```
Out[24]= $1 + 2\,y + 8\,(-1 + y)\,y$

In[25]:=
```
Simplify[1 + 2 y + 8 (-1 + y) y]
```
Out[25]= $1 - 6\,y + 8\,y^2$

Practical 7 (a)

Prakhar Khugshal | BSc(H) Computer Science | Sem - IV | 20211441

Trapezoidal Method

Q1.

```
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: "];
h = (b - a) / n;
y = Table[a + i * h, {i, 1, n}];
f[x] := Log[x];
sumodd = 0;
sumeven = 0;
For[i = 1, i < n, i += 2, sumodd += 2 * f[x] /. x → y[[i]]];
For[i = 2, i < n, i += 2, sumeven += 2 * f[x] /. x → y[[i]]];
Tn = (h / 2) * ((f[x] /. x → a) + N[sumodd] + N[sumeven] + (f[x] /. x → b));
Print["For n= ", n, " Trapezoidal estimate is :", Tn]
in = Integrate[Log[x], {x, 4, 5.2}]
Print["True value is ", in]
Print["Absolute error is ", Abs[Tn - in]]
```

```
For n= 6 Trapezoidal estimate is :26.8772

1.82785

True value is 1.82785

Absolute error is 25.0494
```

Q2.

```
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: "];
h = (b - a) / n;
y = Table[a + i * h, {i, 1, n}];
f[x] := Sin[x];
sumodd = 0;
sumeven = 0;
For[i = 1, i < n, i += 2, sumodd += 2 * f[x] /. x → y[[i]]];
For[i = 2, i < n, i += 2, sumeven += 2 * f[x] /. x → y[[i]]];
Tn = (h / 2) * ((f[x] /. x → a) + N[sumodd] + N[sumeven] + (f[x] /. x → b));
Print["For n= ", n, " Trapezoidal estimate is :", Tn]
in1 = Integrate[Sin[x], {x, 0, π/2}]
Print["True value is ", in1]
Print["Absolute error is ", Abs[Tn - in1]]
```

```
For n= 6 Trapezoidal estimate is :-0.944145

1

True value is 1

Absolute error is 1.94415
```

Q3.

```
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: "];
h = (b - a) / n;
y = Table[a + i * h, {i, 1, n}];
f[x] := Sin[x] - Log[x] + Exp[x];
sumodd = 0;
sumeven = 0;
For[i = 1, i < n, i += 2, sumodd += 2 * f[x] /. x → y[[i]]];
For[i = 2, i < n, i += 2, sumeven += 2 * f[x] /. x → y[[i]]];
Tn = (h / 2) * ((f[x] /. x → a) + N[sumodd] + N[sumeven] + (f[x] /. x → b));
Print["For n= ", n, " Trapezoidal estimate is :", Tn]
in1 = Integrate[Sin[x] - Log[x] + Exp[x], {x, 0.2, 1.4}]
Print["True value is ", in1]
Print["Absolute error is ", Abs[Tn - in1]]
```

For n= 6 Trapezoidal estimate is :5.92567×10^{8}

4.05095

True value is 4.05095

Absolute error is 5.92567×10^{8}

Q4.

```
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: "];
h = (b - a) / n;
y = Table[a + i * h, {i, 1, n}];
f[x] := 1/(1 + x^2);
sumodd = 0;
sumeven = 0;
For[i = 1, i < n, i += 2, sumodd += 2 * f[x] /. x → y[[i]]];
For[i = 2, i < n, i += 2, sumeven += 2 * f[x] /. x → y[[i]]];
Tn = (h / 2) * ((f[x] /. x → a) + N[sumodd] + N[sumeven] + (f[x] /. x → b));
Print["For n= ", n, " Trapezoidal estimate is :", Tn]
in1 = Integrate[1/(1 + x^2), {x, 0, 1}]
Print["True value is ", in1]
Print["Absolute error is ", Abs[Tn - in1]]
```

For n= 6 Trapezoidal estimate is :0.0501042

$\frac{\pi}{4}$

True value is $\frac{\pi}{4}$

Absolute error is 0.735294

Practical 7 (b)
N. Prakhar Khugshal | BSc(H) Computer Science | Sem - IV | 20211441

Simpson Method

Q1.

```
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: "];
h = (b - a) / n;
y = Table[a + i * h, {i, 1, n}];
f[x] := 1/x;
sumodd = 0;
sumeven = 0;
For[i = 1, i < n, i += 2, sumodd += 2 * 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]
in1 = Integrate[1/x, {x, 1, 2}]
Print["True value is ", in1]
Print["Absolute error is ", Abs[Sn - in1]]
```

```
For n= 6 Simpson estimate is :0.463252
```

```
Log[2]
```

```
True value is Log[2]
```

```
Absolute error is 0.229896
```

Q2.

```
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: "];
h = (b - a) / n;
y = Table[a + i * h, {i, 1, n}];
f[x] := Log[x];
sumodd = 0;
sumeven = 0;
For[i = 1, i < n, i += 2, sumodd += 2 * 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]
in1 = Integrate[Log[x], {x, 4, 5.2}]
Print["True value is ", in1]
Print["Absolute error is ", Abs[Sn - in1]]
```

```
For n= 6 Simpson estimate is :17.9182

1.82785

True value is 1.82785

Absolute error is 16.0903
```

Q3.

```
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: "];
h = (b - a) / n;
y = Table[a + i * h, {i, 1, n}];
f[x] := Sin[x] - Log[x] + Exp[x];
sumodd = 0;
sumeven = 0;
For[i = 1, i < n, i += 2, sumodd += 2 * 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]
in1 = Integrate[Sin[x] - Log[x] + Exp[x], {x, 0.2, 1.4}]
Print["True value is ", in1]
Print["Absolute error is ", Abs[Sn - in1]]
```

For n= 6 Simpson estimate is :3.95045×10^8

4.05095

True value is 4.05095

Absolute error is 3.95045×10^8

Q4.

```
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: "];
h = (b - a) / n;
y = Table[a + i * h, {i, 1, n}];
f[x] := Sin[x];
sumodd = 0;
sumeven = 0;
For[i = 1, i < n, i += 2, sumodd += 2 * 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]
in1 = Integrate[Sin[x], {x, 0, π/2}]
Print["True value is ", in1]
Print["Absolute error is ", Abs[Sn - in1]]
```

```
For n= 6 Simpson estimate is :-0.62943

1

True value is 1

Absolute error is 1.62943
```

Q5.:

```
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: "];
h = (b - a) / n;
y = Table[a + i * h, {i, 1, n}];
f[x] := (x^0.5) * Exp[x];
sumodd = 0;
sumeven = 0;
For[i = 1, i < n, i += 2, sumodd += 2 * 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]
in1 = Integrate[(x^0.5) * Exp[x], {x, 1, 2}]
Print["True value is ", in1]
Print["Absolute error is ", Abs[Sn - in1]]
```

For n= 6 Simpson estimate is :1.73692×10^9

5.85023

True value is 5.85023

Absolute error is 1.73692×10^{9}