



“Only Knowledge can provide salvation”

MATHS PRACTICAL NUMERICAL METHODS

Name – Ryan Jose

Course – BSc. H Computer Science

Sem – 4

Roll No. -10872

Practical - 01

Bisection Method

Q.1 Find the roots of $f(x) = x^3 + 4x^2 - 10$ using Bisection method.

```
f[x_] := x^3 + 4 x^2 - 10;
a = 1;
b = 2;
E = 0.01;
Nmax = 50;                                "Maximum number of iterations";
If[f[a] * f[b] > 0,
  Print["These values do not satisfy the IVP so change the initial value"],
  For[i = 1, i < Nmax, i++,
    c = (a + b)/2;
    If[Abs[(b - a)/2] > E, Return[c],
      Print[i, "th iteration value is ", c];
      Print["Estimated error in ", i, "th iteration is: ", (b - a)/2];
      If[f[a] * f[c] > 0, b = c, a = c]]];
  Print["The approximate root is: ", N[c]];
  Plot f[x], {x, 1, 2}]
```

1th iteration value is $\frac{3}{2}$
 Estimated error in 1th iteration is: $\frac{1}{2}$

2th iteration value is $\frac{5}{4}$
 Estimated error in 2th iteration is: $\frac{1}{4}$

3th iteration value is $\frac{11}{8}$
 Estimated error in 3th iteration is: $\frac{1}{8}$

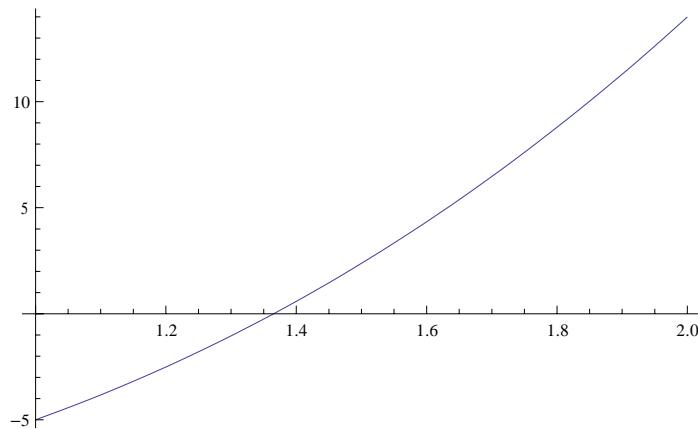
4th iteration value is $\frac{21}{16}$
 Estimated error in 4th iteration is: $\frac{1}{16}$

5th iteration value is $\frac{43}{32}$
 Estimated error in 5th iteration is: $\frac{1}{32}$

6th iteration value is $\frac{87}{64}$
 Estimated error in 6th iteration is: $\frac{1}{64}$

Return [$\frac{175}{128}$]

The approximate root is: 1.36719



Q.2 Find the roots of $f(x) = \cos x$ using Bisection method.

```
f[x_] := Cos[x];
a = 1;
b = 2;
E = 0.001;
Nmax = 20;                                "Maximum number of iterations";

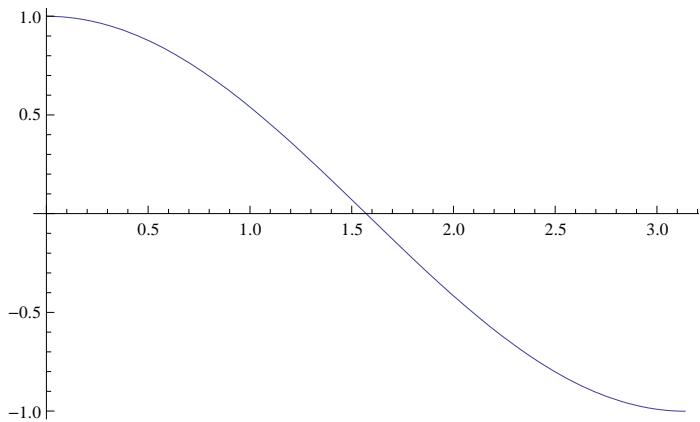
If[f[a] x f[b] > 0,
Print["These values do not satisfy the IVP so change the initial value"],
For[i = 1, i ) Nmax, i++, c =  $\frac{(a+b)}{2}$ ;
If[Abs[ $\frac{(b-a)}{2}$ ] ) E, Return[c],
Print[i, " th iteration value is : ", c ];
Print["Estimated error in ", i, "th iteration is: ",  $\frac{(b-a)}{2}$ ];
If[f[a] x f[c] ) 0, b = c, a = c]]];
Print["The approximate root is : ", N[c]]
Plot f x , x, 0, 3.14
```

```

1 th iteration value is :  $\frac{3}{2}$ 
Estimated error in 1th iteration is:  $\frac{1}{2}$ 
2 th iteration value is :  $\frac{7}{4}$ 
Estimated error in 2th iteration is:  $\frac{1}{4}$ 
3 th iteration value is :  $\frac{13}{8}$ 
Estimated error in 3th iteration is:  $\frac{1}{8}$ 
4 th iteration value is :  $\frac{25}{16}$ 
Estimated error in 4th iteration is:  $\frac{1}{16}$ 
5 th iteration value is :  $\frac{51}{32}$ 
Estimated error in 5th iteration is:  $\frac{1}{32}$ 
6 th iteration value is :  $\frac{101}{64}$ 
Estimated error in 6th iteration is:  $\frac{1}{64}$ 
7 th iteration value is :  $\frac{201}{128}$ 
Estimated error in 7th iteration is:  $\frac{1}{128}$ 
8 th iteration value is :  $\frac{403}{256}$ 
Estimated error in 8th iteration is:  $\frac{1}{256}$ 
9 th iteration value is :  $\frac{805}{512}$ 
Estimated error in 9th iteration is:  $\frac{1}{512}$ 
Return[ $\frac{1609}{1024}$ ]

```

The approximate root is : 1.57129



Practical-2(b)

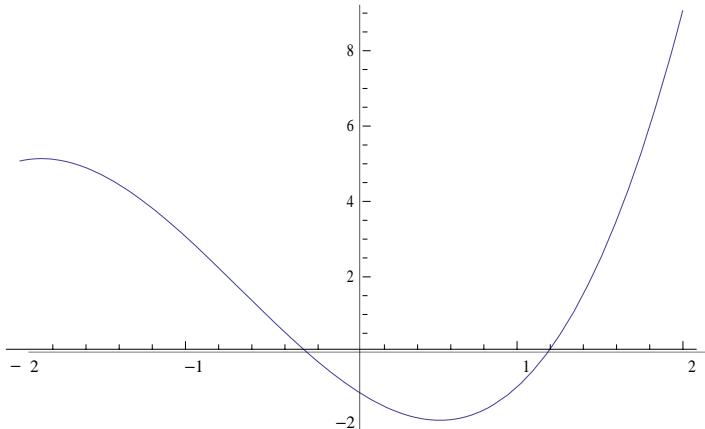
Secant Method

Q.1 Find the root of the function $f(x) = x^3 + 2x^2 - 3x - 1$ using Secant Method.

```
f[x_] := x^3 + 2 x x^2 - 3 x x - 1
x0 = 1;
x1 = 2;
E = 0.000001;
Nmax = 50;

For[n = 2, n < Nmax, n++,
  xn = N[xn-1 - (f[xn-1] x (xn-1 - xn-2)) / (f[xn-1] - f[xn-2])];
  If[Abs[xn - xn-1] > E, Return[xn]];
  Print[n - 1, "th iteration value is: ", xn];
  Print["Estimated error is: ", Abs[xn - xn-1]]];
Plot[f[x], {x, -2, 2}]
```

```
1th iteration value is: 1.1
Estimated error is: 0.9
2th iteration value is: 1.15174
Estimated error is: 0.0517436
3th iteration value is: 1.20345
Estimated error is: 0.0517062
4th iteration value is: 1.19848
Estimated error is: 0.00496995
5th iteration value is: 1.19869
Estimated error is: 0.000210411
Return 1.19869
```

Q.2 Find the root of the function $f(x) = e^{-x} - x$ using Secant Method.

```

f[x_] := Exp[-x] - x
x0 = 0;
x1 = 1;
E = 0.000001;
Nmax = 50;

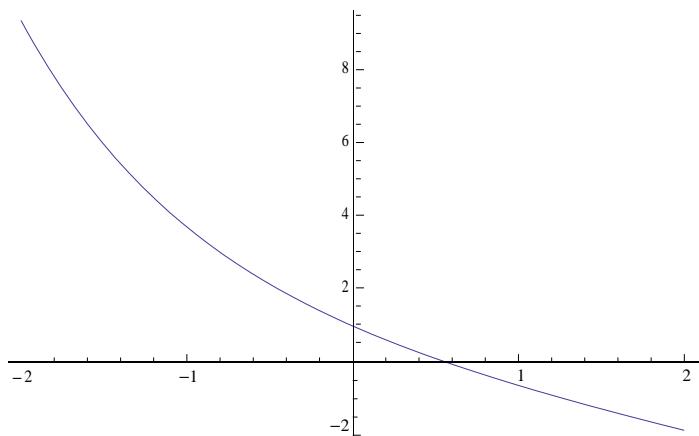
For[n = 2, n <= Nmax, n++,
  xn = N[xn-1 - f[xn-1] x (xn-1 - xn-2) ] ;
  If[f[xn-1] == f[xn-2]
    Print["Estimated error is: ", Abs[xn - xn-1]]];
  Print[n - 1, "th iteration value is: ", xn];
  Plot[f[x], {x, -2, 2}]
]

```

```

1th iteration value is: 0.6127
Estimated error is: 0.3873
2th iteration value is: 0.563838
Estimated error is: 0.0488614
3th iteration value is: 0.56717
Estimated error is: 0.00333197
4th iteration value is: 0.567143
Estimated error is: 0.0000270518
Return 0.567143

```



Q.3 Find the root of the function $f(x) = \cos(x)$ using Secant Method.

```

f[x_] := Cos[x]
x0 = 1;
x1 = 2;
E = 0.000001;
Nmax = 50;

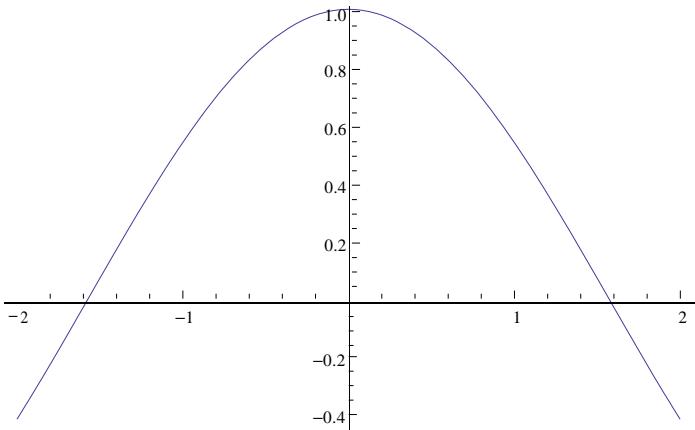
For[n = 2, n < Nmax, n++,
  xn = N[xn-1 - (f[xn-1] * (xn-1 - xn-2)) / (f[xn-1] - f[xn-2])];
  If[Abs[xn - xn-1] > E, Return[xn]];
  Print[n - 1, "th iteration value is: ", xn];
  Print["Estimated error is: ", Abs[xn - xn-1]]];
Plot[f[x], {x, -2, 2}]

```

```

1th iteration value is: 1.5649
Estimated error is: 0.435096
2th iteration value is: 1.57098
Estimated error is: 0.0060742
3th iteration value is: 1.5708
Estimated error is: 0.000182249
Return 1.5708

```



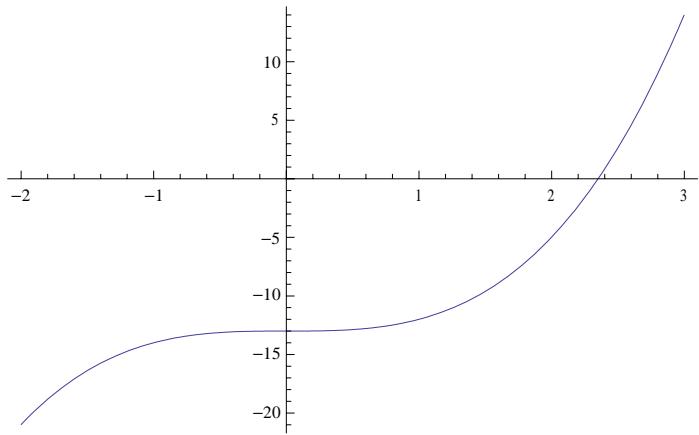
Q.4 Find the root of the function $f(x) = x^3 - 13$ using Secant Method.

```

f[x_] := x^3 - 13
x0 = 1;
x1 = 2;
E = 0.000001;
Nmax = 50;
For[n = 2, n < Nmax, n++,
  xn = N[xn-1 - (f[xn-1] x (xn-1 - xn-2)) / (f[xn-1] - f[xn-2])];
  If[Abs[xn - xn-1] > E, Return[xn]];
  Print[n - 1, "th iteration value is: ", xn];
  Print["Estimated error is: ", Abs[xn - xn-1]]];
Plot[f[x], {x, -2, 3}]

```

```
1th iteration value is: 2.71429
Estimated error is: 0.714286
2th iteration value is: 2.29769
Estimated error is: 0.416594
3th iteration value is: 2.34374
Estimated error is: 0.0460513
4th iteration value is: 2.35151
Estimated error is: 0.00776829
5th iteration value is: 2.35133
Estimated error is: 0.000176826
Return 2.35133
```



Practical-2(a)

Regula - Falsi method

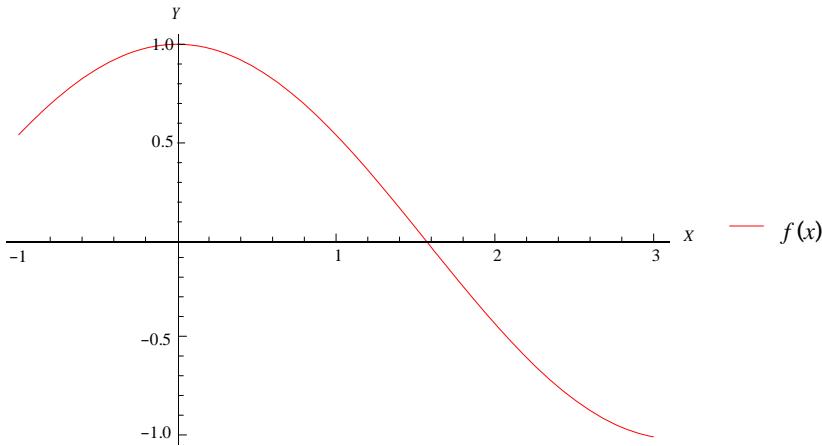
Q.1 Find the root of function $f(x)=\cos(x)$ by Regula Falsi method.

```
f[x_] := Cos[x];
a = 0;
b = 2;
E = 0.00000001;
Nmax = 50;

If[f[a] x f[b] > 0,
  Print["These values do not satisfy the IVP so change the initial value"],
  For[i = 1, i < Nmax, i++,
    x = N[  $\frac{a \times f[b] - b \times f[a]}{f[b] - f[a]}$  ];
    If[f[x] x f[b] > 0, b = x, a = x];
    If[Abs[b - a] > E, Return[x]];
    Print[i, "th iteration value is :", N[x]];
    Print["Estimated error is :", N[b - a]]];
  Print["Approximate root is :", N[x]];
  Print["Estimated error is :", N[b - a]];
  Plot[f[x], {x, -1, 3}, PlotStyle > Red,
    PlotLegends > "Expressions", AxesLabel > {X, Y}]

1th iteration value is :1.41228
Estimated error is :0.587717
2th iteration value is :1.57391
Estimated error is :0.161623
3th iteration value is :1.57078
Estimated error is :0.0031228
4th iteration value is :1.5708
Estimated error is :0.0000128049
Return 1.5708

Approximate root is :1.5708
Estimated error is :2.05567 x 10-11
```

Q.2 Find the root of function $f(x)=e^{-x} - x$ by Regula Falsi method.

```

f[x_] := Exp[-x] - x;
a = 0;
b = 2;
E = 0.00000001;
Nmax = 50;
If[f[a] x f[b] > 0,
  Print["These values do not satisfy the IVP so change the initial value"],
  For[i = 1, i < Nmax, i++,
    x = N[  $\frac{a x f[b] - b x f[a]}{f[b] - f[a]}$  ];
    If[f[x] x f[b] > 0, b = x, a = x];
    If[Abs[b - a] > E, Return[x]];
    Print[i, "th iteration value is :", N[x]];
    Print["Estimated error is :", N[b - a]]];
  Print["Approximate root is :", N[x]];
  Print["Estimated error is :", N[b - a]];
  Plot[f[x], {x, -1, 3}, PlotStyle -> Red,
    PlotLegends -> "Expressions", AxesLabel -> {x, y}
  ]
]
1th iteration value is :0.698162
Estimated error is :0.698162
2th iteration value is :0.58148
Estimated error is :0.58148
3th iteration value is :0.568735
Estimated error is :0.568735
4th iteration value is :0.56732

```

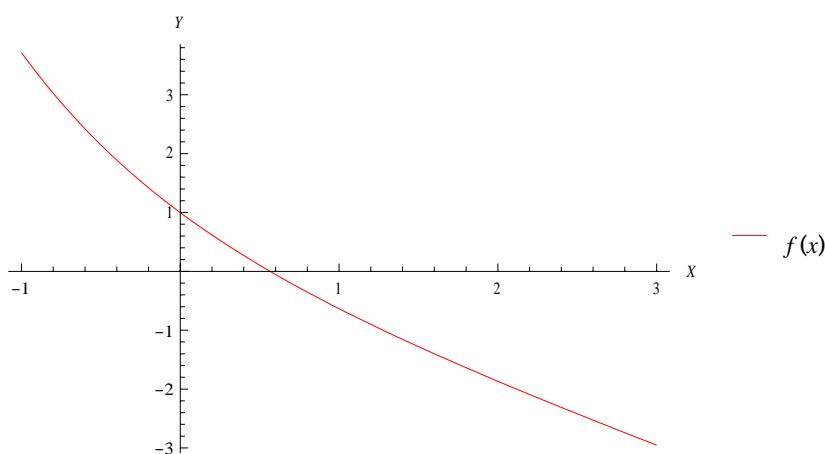
```
Estimated error is :0.56732
5th iteration value is :0.567163
Estimated error is :0.567163
6th iteration value is :0.567145
Estimated error is :0.567145
7th iteration value is :0.567144
Estimated error is :0.567144
8th iteration value is :0.567143
Estimated error is :0.567143
9th iteration value is :0.567143
Estimated error is :0.567143
10th iteration value is :0.567143
Estimated error is :0.567143
11th iteration value is :0.567143
Estimated error is :0.567143
12th iteration value is :0.567143
Estimated error is :0.567143
13th iteration value is :0.567143
Estimated error is :0.567143
14th iteration value is :0.567143
Estimated error is :0.567143
15th iteration value is :0.567143
Estimated error is :0.567143
16th iteration value is :0.567143
Estimated error is :0.567143
17th iteration value is :0.567143
Estimated error is :0.567143
18th iteration value is :0.567143
Estimated error is :0.567143
19th iteration value is :0.567143
Estimated error is :0.567143
20th iteration value is :0.567143
Estimated error is :0.567143
21th iteration value is :0.567143
Estimated error is :0.567143
22th iteration value is :0.567143
```

```
Estimated error is :0.567143
23th iteration value is :0.567143
Estimated error is :0.567143
24th iteration value is :0.567143
Estimated error is :0.567143
25th iteration value is :0.567143
Estimated error is :0.567143
26th iteration value is :0.567143
Estimated error is :0.567143
27th iteration value is :0.567143
Estimated error is :0.567143
28th iteration value is :0.567143
Estimated error is :0.567143
29th iteration value is :0.567143
Estimated error is :0.567143
30th iteration value is :0.567143
Estimated error is :0.567143
31th iteration value is :0.567143
Estimated error is :0.567143
32th iteration value is :0.567143
Estimated error is :0.567143
33th iteration value is :0.567143
Estimated error is :0.567143
34th iteration value is :0.567143
Estimated error is :0.567143
35th iteration value is :0.567143
Estimated error is :0.567143
36th iteration value is :0.567143
Estimated error is :0.567143
37th iteration value is :0.567143
Estimated error is :0.567143
38th iteration value is :0.567143
Estimated error is :0.567143
39th iteration value is :0.567143
Estimated error is :0.567143
40th iteration value is :0.567143
```

```

Estimated error is :0.567143
41th iteration value is :0.567143
Estimated error is :0.567143
42th iteration value is :0.567143
Estimated error is :0.567143
43th iteration value is :0.567143
Estimated error is :0.567143
44th iteration value is :0.567143
Estimated error is :0.567143
45th iteration value is :0.567143
Estimated error is :0.567143
46th iteration value is :0.567143
Estimated error is :0.567143
47th iteration value is :0.567143
Estimated error is :0.567143
48th iteration value is :0.567143
Estimated error is :0.567143
49th iteration value is :0.567143
Estimated error is :0.567143
50th iteration value is :0.567143
Estimated error is :0.567143
Approximate root is :0.567143
Estimated error is :0.567143

```



Q.3 Find the root of function $f(x)=x^5+2*x-1$ by Regula Falsi method.

```

f[x_] := x^5 + 2 x x - 1
a = 0;
b = 2;
E = 0.00000001;
Nmax = 50;
If[f[a] x f[b] > 0,
  Print["These values do not satisfy the IVP so change the initial value"],

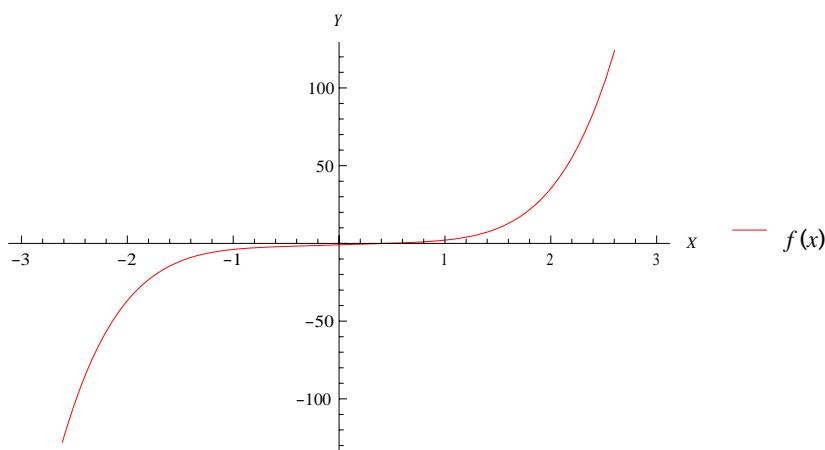
  For[i = 1, i < Nmax, i++,
    x = N[ $\frac{a x f[b] - b x f[a]}{f[b] - f[a]}$ ];
    If[f[x] x f[b] > 0, b = x, a = x];
    If[Abs[b - a] > E, Return[x]];
    Print[i, "th iteration value is :", N[x]];
    Print["Estimated error is :", N[b - a]]];
  Print["Approximate root is :", N[x]];
  Print["Estimated error is :", N[b - a]];
  Plot[f[x], {x, -3, 3}, PlotStyle > Red,
    PlotLegends > "Expressions", AxesLabel > X, Y
  ]
1th iteration value is :0.0555556
Estimated error is :1.94444
2th iteration value is :0.103715
Estimated error is :1.89628
3th iteration value is :0.145705
Estimated error is :1.8543
4th iteration value is :0.182497
Estimated error is :1.8175
5th iteration value is :0.214875
Estimated error is :1.78513
6th iteration value is :0.243471
Estimated error is :1.75653
7th iteration value is :0.268806
Estimated error is :1.73119
8th iteration value is :0.291311
Estimated error is :1.70869
9th iteration value is :0.311347
Estimated error is :1.68865
10th iteration value is :0.329219
Estimated error is :1.67078

```

```
11th iteration value is :0.345185
Estimated error is :1.65482
12th iteration value is :0.359468
Estimated error is :1.64053
13th iteration value is :0.372261
Estimated error is :1.62774
14th iteration value is :0.383728
Estimated error is :1.61627
15th iteration value is :0.394017
Estimated error is :1.60598
16th iteration value is :0.403254
Estimated error is :1.59675
17th iteration value is :0.411551
Estimated error is :1.58845
18th iteration value is :0.419009
Estimated error is :1.58099
19th iteration value is :0.425714
Estimated error is :1.57429
20th iteration value is :0.431744
Estimated error is :1.56826
21th iteration value is :0.43717
Estimated error is :1.56283
22th iteration value is :0.442053
Estimated error is :1.55795
23th iteration value is :0.446448
Estimated error is :1.55355
24th iteration value is :0.450404
Estimated error is :1.5496
25th iteration value is :0.453967
Estimated error is :1.54603
26th iteration value is :0.457176
Estimated error is :1.54282
27th iteration value is :0.460065
Estimated error is :1.53993
28th iteration value is :0.462668
Estimated error is :1.53733
```

```
29th iteration value is :0.465013
Estimated error is :1.53499
30th iteration value is :0.467125
Estimated error is :1.53287
31th iteration value is :0.469028
Estimated error is :1.53097
32th iteration value is :0.470743
Estimated error is :1.52926
33th iteration value is :0.472288
Estimated error is :1.52771
34th iteration value is :0.47368
Estimated error is :1.52632
35th iteration value is :0.474935
Estimated error is :1.52507
36th iteration value is :0.476066
Estimated error is :1.52393
37th iteration value is :0.477084
Estimated error is :1.52292
38th iteration value is :0.478003
Estimated error is :1.522
39th iteration value is :0.47883
Estimated error is :1.52117
40th iteration value is :0.479576
Estimated error is :1.52042
41th iteration value is :0.480248
Estimated error is :1.51975
42th iteration value is :0.480854
Estimated error is :1.51915
43th iteration value is :0.4814
Estimated error is :1.5186
44th iteration value is :0.481892
Estimated error is :1.51811
45th iteration value is :0.482336
Estimated error is :1.51766
46th iteration value is :0.482735
Estimated error is :1.51726
```

```
47th iteration value is :0.483096
Estimated error is :1.5169
48th iteration value is :0.483421
Estimated error is :1.51658
49th iteration value is :0.483713
Estimated error is :1.51629
50th iteration value is :0.483977
Estimated error is :1.51602
Approximate root is :0.483977
Estimated error is :1.51602
```



Practical-3

Newton's Raphson Method

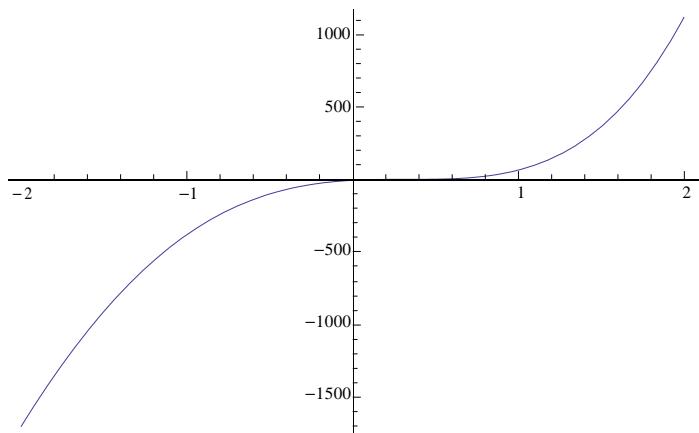
Q.1 Find the roots of the function $f(x) = 27x^4 + 162x^3 - 180x^2 + 62x - 7$ using Newton Raphson Method.

```
f[x_] := 27 x4 + 162 x3 - 180 x2 + 62 x - 7
x0 = 0;
Nmax = 10;
E = 0.0000001;

For[n = 1, n < Nmax, n++,
  xn = N[xn-1 -  $\frac{f[x_{n-1}]}{f'[x_{n-1}]}$ ];
  If[Abs[xn - xn-1] > E, Return[xnn];
  Print["Estimated error is: ", N[xn - xn-1]]];
Plot f[x], x, -2, 2
```



```
1th iteration value is: 0.112903
Estimated error is: 0.112903
2th iteration value is: 0.187147
Estimated error is: 0.0742436
3th iteration value is: 0.236208
Estimated error is: 0.0490615
4th iteration value is: 0.268729
Estimated error is: 0.0325205
5th iteration value is: 0.290328
Estimated error is: 0.0215988
6th iteration value is: 0.304691
Estimated error is: 0.0143635
7th iteration value is: 0.314251
Estimated error is: 0.0095599
8th iteration value is: 0.320617
Estimated error is: 0.00636631
9th iteration value is: 0.324858
Estimated error is: 0.00424112
10th iteration value is: 0.327685
Estimated error is: 0.00282605
```



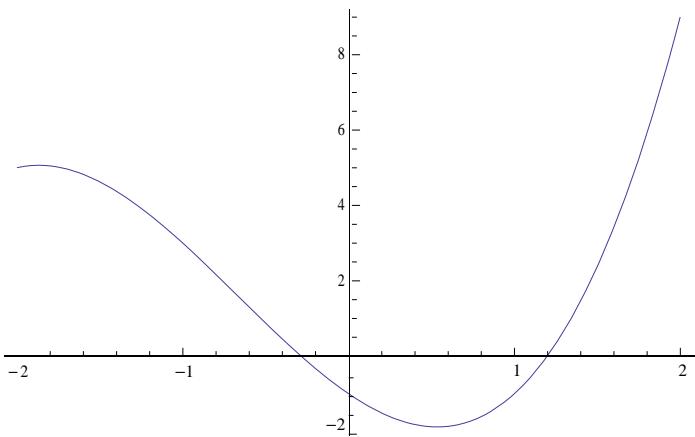
Q.2 Find the roots of the function $f(x) = x^3 + 2x^2 - 3x - 1$ using Newton Raphson Method.

```

f[x_] := x^3 + 2 x x^2 - 3 x x - 1
x0 = 1;
Nmax = 10;
E = 0.000001;
For[n = 1, n < Nmax, n++,
  xn = N[xn-1 - f[xn-1]/f'[xn-1]];
  If[Abs[xn - xn-1] > E, Return[xn]];
  Print[n, "th iteration value is: ", xn];
  Print["Estimated error is: ", N[xn - xn-1]]];
Plot f[x], x, -2, 2

```

1th iteration value is: 1.25
 Estimated error is: 0.25
 2th iteration value is: 1.20093
 Estimated error is: -0.0490654
 3th iteration value is: 1.1987
 Estimated error is: -0.00223874
 4th iteration value is: 1.19869
 Estimated error is: -4.59753 x 10⁻⁶
 Return 1.19869



Q.3 Find the roots of the function $f(x) = e^{-x} - x$ using Newton Raphson Method.

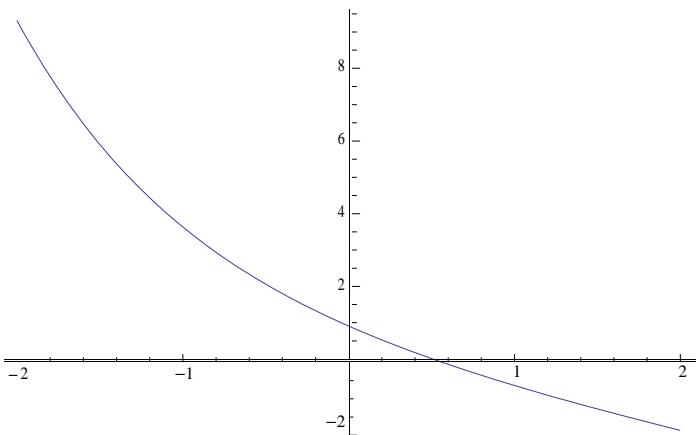
```

f[x_] := Exp[-x] - x
x0 = 0;
Nmax = 10;
E = 0.0000001;

For[n = 1, n < Nmax, n++,
  xn = N[xn-1 - f[xn-1]/f'[xn-1]];
  If[Abs[xn - xn-1] > E, Return[xn]];
  Print[n, "th iteration value is: ", xn];
  Print["Estimated error is: ", N[xn - xn-1]]];
Plot f[x], x, -2, 2

```

1th iteration value is: 0.5
 Estimated error is: 0.5
 2th iteration value is: 0.566311
 Estimated error is: 0.066311
 3th iteration value is: 0.567143
 Estimated error is: 0.000832162
 4th iteration value is: 0.567143
 Estimated error is: 1.25375 x 10⁻⁷
 Return 0.567143



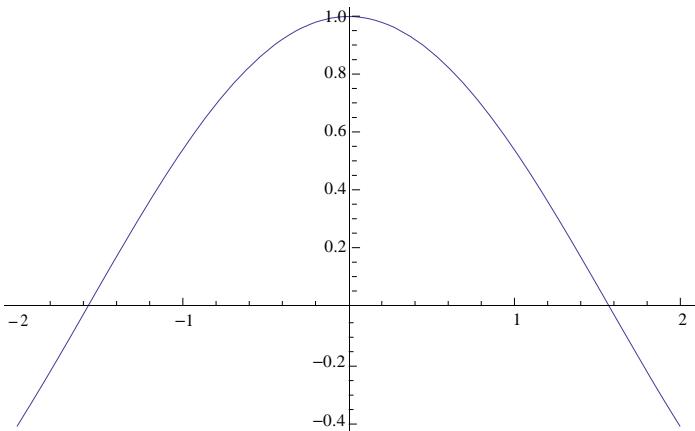
Q.4 Find the roots of the function $f(x) = \cos(x)$ using Newton Raphson Method.

```

f[x_] := Cos[x]
x0 = 1;
Nmax = 10;
E = 0.000001;
For[n = 1, n < Nmax, n++,
  xn = N[xn-1 - f[xn-1]/f'[xn-1]];
  If[Abs[xn - xn-1] > E, Return[xn]];
  Print[n, "th iteration value is: ", xn];
  Print["Estimated error is: ", N[xn - xn-1]]];
Plot f[x], x, -2, 2

```

1th iteration value is: 1.64209
 Estimated error is: 0.642093
 2th iteration value is: 1.57068
 Estimated error is: - 0.0714173
 3th iteration value is: 1.5708
 Estimated error is: 0.00012105
 Return 1.5708

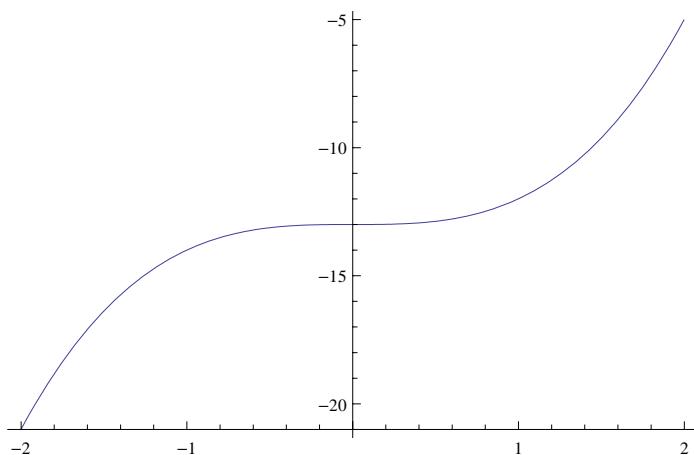


Q.5 Find the roots of the function $f(x) = x^3 - 13$ using Newton Raphson Method.

```

f[x_] := x^3 - 13
x0 = 1;
Nmax = 10;
E = 0.000001;
For[n = 1, n <= Nmax, n++,
  xn = N[xn - f[xn]/f'[xn]];
  If[Abs[xn - xn] > E, Return[xn]];
  Print[n, "th iteration value is: ", xn];
  Print["Estimated error is: ", N[xn - xn]]];
Plot f[x], x, -2, 2
1th iteration value is: 5.
Estimated error is: 4.
2th iteration value is: 3.50667
Estimated error is: - 1.49333
3th iteration value is: 2.69018
Estimated error is: - 0.816491
4th iteration value is: 2.39222
Estimated error is: - 0.297954
5th iteration value is: 2.35203
Estimated error is: - 0.040192
6th iteration value is: 2.35133
Estimated error is: -0.000694633
Return 2.35133

```



Practical-4(a)

Gauss Elimination Method

Q.1 Solve

```
x + 10y + 100z + 1000w = 227.04
x + 15y + 225z + 3375w = 362.78
x + 20y + 400z + 8000w = 517.35
x + 22.5y + 506.25z + 11391w = 602.97

A = {1, 10, 100, 1000}, {1, 15, 225, 3375},
     {1, 20, 400, 8000}, {1, 22.5, 506.25, 11391}};

A // MatrixForm
b = {227.04, 362.78, 517.35, 602.97};
b // MatrixForm
m1 = Length[A];
m2 = Length[b];
x = Table[0, {m1}];
If[m1 == m2, Print["The system cannot be solved"],
Table[AppendTo[A[[i]], b[[i]]], {i, m1}]; Print["[A|b]=", A // MatrixForm];
For[i = 1, i <= m1 - 1, i++, s = Abs[A[[i, i]]]; c = i;
    For[j = i + 1, j <= m1, j++, If[Abs[A[[j, i]]] > s, s = A[[j, i]]; c = j]];
    For[k = 1, k <= m1 + 1, k++, d[k] = A[[i, k]]; A[[i, k]] = A[[c, k]]; A[[c, k]] = d[k]];
    Print["Step=", i, A // MatrixForm];
    For[j = i + 1, j <= m1, j++, m = A[[j, i]] / A[[i, i]];
        For[k = 1, k <= m1 + 1, k++, A[[j, k]] = A[[j, k]] - (m * A[[i, k]])];
    Print[A // MatrixForm];
    For[i = 0, i <= m1 - 1, i++,
        x[[m1 - i]] = (A[[m1 - i, m1 + 1]] - Sum[A[[m1 - i, j]] * x[[j]], {j, m1 - i + 1, m1}]) /
        A[[m1 - i, m1 - i]]];
Print "x=", x // MatrixForm ;
{{1, 10, 100, 1000}, {1, 15, 225, 3375}, {1, 20, 400, 8000}, {1, 22.5, 506.25, 11391}} //
{{227.04}, {362.78}, {517.35}, {602.97}}
```

$$[A|b] = \left| \begin{array}{ccccc} 1 & 10 & 100 & 1000 & 227.04 \\ 1 & 15 & 225 & 3375 & 362.78 \\ 1 & 20 & 400 & 8000 & 517.35 \\ 1 & 22.5 & 506.25 & 11391 & 602.97 \end{array} \right|$$

$$\text{Step 1} \quad \left| \begin{array}{ccccc} 1 & 10 & 100 & 1000 & 227.04 \\ 1 & 15 & 225 & 3375 & 362.78 \\ 1 & 20 & 400 & 8000 & 517.35 \\ 1 & 22.5 & 506.25 & 11391 & 602.97 \end{array} \right|$$

$$\left| \begin{array}{ccccc} 1 & 10 & 100 & 1000 & 227.04 \\ 0 & 5 & 125 & 2375 & 135.74 \\ 0 & 10 & 300 & 7000 & 290.31 \\ 0 & 12.5 & 406.25 & 10391 & 375.93 \end{array} \right|$$

$$\text{Step 2} \quad \left(\begin{array}{ccccc} 1 & 10 & 100 & 1000 & 227.04 \\ 0 & 12.5 & 406.25 & 10391 & 375.93 \\ 0 & 10 & 300 & 7000 & 290.31 \\ 0 & 5 & 125 & 2375 & 135.74 \end{array} \right)$$

$$\left| \begin{array}{ccccc} 1 & 10 & 100 & 1000 & 227.04 \\ 0 & 12.5 & 406.25 & 10391 & 375.93 \\ 0. & 0. & -25. & -1312.8 & -10.434 \\ 0. & 0. & -37.5 & -1781.4 & -14.632 \end{array} \right|$$

$$\text{Step 3} \quad \left(\begin{array}{ccccc} 1 & 10 & 100 & 1000 & 227.04 \\ 0 & 12.5 & 406.25 & 10391 & 375.93 \\ 0. & 0. & -37.5 & -1781.4 & -14.632 \\ 0. & 0. & -25. & -1312.8 & -10.434 \end{array} \right),$$

$$\left| \begin{array}{ccccc} 1 & 10 & 100 & 1000 & 227.04 \\ 0 & 12.5 & 406.25 & 10391 & 375.93 \\ 0. & 0. & -37.5 & -1781.4 & -14.632 \\ 0. & 0. & 3.55271 \times 10^{-15} & -125.2 & -0.679333 \end{array} \right|$$

$$x = \begin{pmatrix} -4.22796 \\ 21.2599 \\ 0.132431 \\ 0.00542599 \end{pmatrix}$$

Practical – 04 (b)

Gauss – Jordan Method

Q.1

$$\begin{aligned}2x + y + z - 2w &= -10 \\4x + 2z + w &= 8 \\3x + 2y + 2z &= 7 \\x + 3y + 2z - w &= -5\end{aligned}$$

```
A = {{2, 1, 1, -2, -10}, {4, 0, 2, 1, 8}, {3, 2, 2, 0, 7}, {1, 3, 2, -1, -5}}
```

```
A // MatrixForm
```

```
RowReduce A MatrixForm
```

```
2, 1, 1, -2, -10 , 4, 0, 2, 1, 8 , 3, 2, 2, 0, 7 , 1, 3, 2, -1, -5
```

$$\left(\begin{array}{ccccc} 2 & 1 & 1 & -2 & -10 \\ 4 & 0 & 2 & 1 & 8 \\ 3 & 2 & 2 & 0 & 7 \\ 1 & 3 & 2 & -1 & -5 \end{array} \right)$$

$$\left| \begin{array}{ccccc} 1 & 0 & 0 & 0 & 5 \\ 0 & 1 & 0 & 0 & 6 \\ 0 & 0 & 1 & 0 & -10 \\ 0 & 0 & 0 & 1 & 8 \end{array} \right|$$

```
Solve x == 5, y == 6, z == -10, w == 8 , x, y, z, w
```

```
x c 5, y c 6, z c -10, w c 8
```

qn -2

Q.2

$$\begin{aligned}3x + 3y + 4z &= 20 \\2x + y + 3z &= 13 \\x + y + 3z &= 6\end{aligned}$$

```
A = {{3, 3, 4, 20}, {2, 1, 3, 13}, {1, 1, 3, 6}}
```

```
A // MatrixForm
```

```
RowReduce A MatrixForm
```

```
3, 3, 4, 20 , 2, 1, 3, 13 , 1, 1, 3, 6
```

$$\left| \begin{array}{cccc} 3 & 3 & 4 & 20 \\ 2 & 1 & 3 & 13 \\ 1 & 1 & 3 & 6 \end{array} \right|$$

$$\left| \begin{array}{cccc} 1 & 0 & 0 & 7 \\ 0 & 1 & 0 & \frac{1}{5} \\ 0 & 0 & 1 & -\frac{2}{5} \end{array} \right|$$

```
Solve[{x == 7, y == 1/5, z == -2/5}, {x, y, z}]  
{x == 7, y == 1/5, z == -2/5}
```

Practical - 05(a)

Gauss-Jacobi method

Q.1 Solve the system of linear equations :-

$$5x_1 + 2x_2 + x_3 = 10$$

$$3x_1 + 7x_2 + 4x_3 = 21$$

$$x_1 + x_2 + 9x_3 = 12$$

```
n = 3;
a = {{5, 2, 1}, {3, 7, 4}, {1, 1, 9}};
MatrixForm[a]
x = {0, 0, 0}
y = {0, 0, 0}
b = {10, 21, 12}
For[k = 1, k <= 25, k++,
  For[i = 1, i <= n, i++,
    y[[i]] = (b[[i]] - Sum[a[[i, j]] * x[[j]], {j, 1, i - 1}] -
      Sum[a[[i, j]] * x[[j]], {j, i + 1, n}]) / a[[i, i]];
    For[m = 1, m <= n, m++, x[[m]] = N[y[[m]]]];
  For p = 1, p <= n, p++, Print "x ", p, " =", x[p]
  ]
  ]
  
```

$$\begin{pmatrix} 5 & 2 & 1 \\ 3 & 7 & 4 \\ 1 & 1 & 9 \end{pmatrix}$$

0, 0, 0
0, 0, 0
10, 21, 12
x 1 =1.
x 2 =2.
x 3 =1.

Q. Solve the system of linear equations :-

$$6x_1 - 2x_2 - x_3 = 4$$

$$x_1 + 5x_2 + x_3 = 3$$

$$2x_1 + x_2 + 4x_3 = 27$$

```

n = 3;
a = {{6, -2, -1}, {1, 5, 1}, {2, 1, 4}};
MatrixForm[a]
x = {0, 0, 0}
y = {0, 0, 0}
b = {4, 3, 27}
For[k = 1, k <= 25, k++,
  For[i = 1, i <= n, i++,
    y[[i]] = (b[[i]] - Sum[a[[i, j]] x[[j]], {j, 1, i - 1}] -
      Sum[a[[i, j]] x[[j]], {j, i + 1, n}]) / a[[i, i]]];
  For[m = 1, m <= n, m++, x[[m]] = N[y[[m]]]];
  For[p = 1, p <= n, p++, Print "x ", p, " =", x[[p]]]
]
{{6, -2, -1}, {1, 5, 1}, {2, 1, 4}}
0, 0, 0
0, 0, 0
4, 3, 27
x[1] = 1.40157
x[2] = -0.937008
x[3] = 6.28346

```

Q.3 Solve the system of linear equations :-

$$\begin{aligned}
 10x_1 - 5x_2 - 2x_3 &= 3 \\
 4x_1 - 10x_2 + 3x_3 &= -3 \\
 x_1 - 6x_2 + 10x_3 &= -3
 \end{aligned}$$

```

n = 3;
a = {{10, -5, -2}, {4, -10, 3}, {1, -6, 10}};
MatrixForm[a]
x = {0, 0, 0}
y = {0, 0, 0}
b = {3, -3, -3}
For[k = 1, k <= 25, k++,
  For[i = 1, i <= n, i++,
    y[[i]] = (b[[i]] - Sum[a[[i, j]] x[[j]], {j, 1, i - 1}] -
      Sum[a[[i, j]] x[[j]], {j, i + 1, n}]) / a[[i, i]]];
  For[m = 1, m <= n, m++, x[[m]] = N[y[[m]]]];
  For[p = 1, p <= n, p++, Print "x ", p, " =", x[[p]]]
]


$$\begin{pmatrix} 10 & -5 & -2 \\ 4 & -10 & 3 \\ 1 & -6 & 10 \end{pmatrix}$$


0, 0, 0
0, 0, 0
3, -3, -3
x[1] = 0.538709
x[2] = 0.499171
x[3] = -0.0543701

```

Practical - 05(b)

Gauss-Seidel method

Q.1 Solve the system of linear equations :-

$$5x_1 + 2x_2 + x_3 = 10$$

$$3x_1 + 7x_2 + 4x_3 = 21$$

$$x_1 + x_2 + 9x_3 = 12$$

```
n = 3;
a = {{5, 2, 1}, {3, 7, 4}, {1, 1, 9}};
MatrixForm[a]
x = {0, 0, 0}
y = {0, 0, 0}
b = {10, 21, 12}
For[k = 1, k <= 25, k++,
  For[i = 1, i <= n, i++,
    y[[i]] = (b[[i]] - Sum[a[[i, j]] * y[[j]], {j, 1, i - 1}] -
      Sum[a[[i, j]] * x[[j]], {j, i + 1, n}]) / a[[i, i]];
    For[m = 1, m <= n, m++, x[[m]] = N[y[[m]]]];
  For[p = 1, p <= n, p++, Print "x ", p, " =", x[p]
  ]
  ]
  ]
  
```

$$\begin{pmatrix} 5 & 2 & 1 \\ 3 & 7 & 4 \\ 1 & 1 & 9 \end{pmatrix}$$

0, 0, 0
0, 0, 0
10, 21, 12
x 1 =1.
x 2 =2.
x 3 =1.

Q.2 Solve the system of linear equations :-

$$6x_1 - 2x_2 - x_3 = 4$$

$$x_1 + 5x_2 + x_3 = 3$$

$$2x_1 + x_2 + 4x_3 = 27$$

```

n = 3;
a = {{6, -2, -1}, {1, 5, 1}, {2, 1, 4}};
MatrixForm[a]
x = {0, 0, 0}
y = {0, 0, 0}
b = {4, 3, 27}
For[k = 1, k <= 25, k++,
  For[i = 1, i <= n, i++,
    y[[i]] = (b[[i]] - Sum[a[[i, j]] x[y[[j]]], {j, 1, i - 1}] -
      Sum[a[[i, j]] x[x[[j]]], {j, i + 1, n}]) / a[[i, i]]];
  For[m = 1, m <= n, m++, x[[m]] = N[y[[m]]]];
  For[p = 1, p <= n, p++, Print "x ", p, " =", x[p]]
]

$$\begin{pmatrix} 6 & -2 & -1 \\ 1 & 5 & 1 \\ 2 & 1 & 4 \end{pmatrix}$$

0, 0, 0
0, 0, 0
4, 3, 27
x[1] = 1.40157
x[2] = -0.937008
x[3] = 6.28346

```

Q.3 Solve the system of linear equations :-

$$\begin{aligned}
 10x_1 - 5x_2 - 2x_3 &= 3 \\
 4x_1 - 10x_2 + 3x_3 &= -3 \\
 x_1 - 6x_2 + 10x_3 &= -3
 \end{aligned}$$

```

n = 3;
a = {{10, -5, -2}, {4, -10, 3}, {1, -6, 10}};
MatrixForm[a]
x = {0, 0, 0}
y = {0, 0, 0}
b = {3, -3, -3}
For[k = 1, k <= 25, k++,
  For[i = 1, i <= n, i++,
    y[[i]] = (b[[i]] - Sum[a[[i, j]] x[y[[j]], {j, 1, i-1}] -
      Sum[a[[i, j]] x[x[[j]], {j, i+1, n}]] / a[[i, i]]);
    For[m = 1, m <= n, m++, x[[m]] = N[y[[m]]]];
  ];
  For[p = 1, p <= n, p++, Print "x ", p, " =", x[p]
]
{{10, -5, -2}, {4, -10, 3}, {1, -6, 10}}
0, 0, 0
0, 0, 0
3, -3, -3
x[1] = 0.538715
x[2] = 0.499176
x[3] = -0.0543657

```

Practical - 06(a)

Lagrange Interpolation

Q.1

```
xi = {-1, 0, 1, 2};
fi = {5, 1, 1, 11};
n = Length[xi];

For[k = 1, k <= n, k++,
  Lk[x_] = 
$$\prod_{j=1}^{k-1} \frac{x - xi[[j]]}{xi[[k]] - xi[[j]]}$$
 
$$\times \prod_{j=k+1}^n \frac{x - xi[[j]]}{xi[[k]] - xi[[j]]}$$
];
  P[x_] = 
$$\sum_{k=1}^n Lk[x] \times N[fi[[k]]];$$

Print["Lagrange Polynomial, P[x]= ", P[x]];
Print["Simplified Polynomial, P [x]= ", Simplify[P[x]]];
Print "Approximate value of f at x = 1.5 is ", P 1.5

Lagrange Polynomial, P[x]= -0.833333 (1-x) (2-x) x +
  0.5 1-x 2-x 1+x + 0.5 2-x x 1+x + 1.83333 -1+x x 1+x

Simplified Polynomial, P [x] = 1. - 3. x + 2. x^2 + 1. x^3
Approximate value of f at x = 1.5 is 4.375
```

Q.2

```
Clear[x, k, f, l, P]
xi = {1, 2, 3};
f[x_] := Log[x];
n = Length[xi];

For[k = 1, k <= n, k++,
  Lk[x_] = 
$$\prod_{j=1}^{k-1} \frac{x - xi[[j]]}{xi[[k]] - xi[[j]]}$$
 
$$\times \prod_{j=k+1}^n \frac{x - xi[[j]]}{xi[[k]] - xi[[j]]}$$
];
  P[x_] = 
$$\sum_{k=1}^n Lk[x] \times N[f[xi[[k]]]];$$

Print["Lagrange Polynomial, P[x]= ", P[x]];
Print["Simplified Polynomial, P [x]= ", Simplify[P[x]]];
Print "Approximate value of f at x = 1.5 is ", P 1.5

Lagrange Polynomial, P [x] = 0. + 0.693147 3 - x - 1 + x + 0.549306 - 2 + x - 1 + x
Simplified Polynomial, P [x] = -0.980829 + 1.12467 x - 0.143841 x^2
Approximate value of f at x = 1.5 is 0.382534
```

Practical - 06(b)

Newton's Interpolation

Q.1 By using points (3,293), (5,508), (6,585), (9,764). Evaluate at point [2.5]

```
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
4
3, 5, 6, 9
293, 508, 585, 764
293 +  $\frac{215}{2}$  (-3 + x) -  $\frac{61}{6}$  (-5 + x) (-3 + x) +  $\frac{35}{36}$  (-6 + x) (-5 + x) (-3 + x)
 $\frac{1}{36}$  (-9702 + 9003 x - 856 x2 + 35 x3)
222.288
```

Practical 7 -(a) - trapezoidal Rule

Find the integral

$$\int_{1}^{5} \frac{1}{x^2} dx$$

```
f[x_] := 1/x^2
n = 10
a = 1
b = 5
h = (b-a)/n
sol = h/2 * x (f[a] + 2 (Sum[f[a+i*h], {i, 1, n-1}]) + f[b]);
sol2 = h/2 * x (f[a] + 2 (Sum[f[i], {i, a+h, b-h, h}]) + f[b]);
N[sol]
N[sol2]
10
1
5
2
5
0.825681
0.825681
```

```

f[x_] :=  $\frac{1}{1+x}$ 
n = 8
a = 0
b = 1
h =  $\frac{b-a}{n}$ 
sol =  $\frac{h}{2} \left( f[a] + 2 \sum_{i=1}^{n-1} f[a + i \cdot h] + f[b] \right)$ ;
sol2 =  $\frac{h}{2} \left( f[a] + 2 \sum_{i=a+h}^{b-h} f[i] + f[b] \right)$ ;
N[sol]
N sol2
8
0
1
 $\frac{1}{8}$ 
0.694122
0.694122

f[x_] :=  $\frac{1}{3x+5}$ 
n = 10
a = 1
b = 2
h =  $\frac{b-a}{n}$ 
sol =  $\frac{h}{2} \left( f[a] + 2 \sum_{i=1}^{n-1} f[a + i \cdot h] + f[b] \right)$ ;
sol2 =  $\frac{h}{2} \left( f[a] + 2 \sum_{i=a+h}^{b-h} f[i] + f[b] \right)$ ;
N[sol]
N sol2
10
1
2
 $\frac{1}{10}$ 
0.10617
0.10617

```

```
f[x_] := Exp[-x^2]
h = 0.1
a = 0
b = 0.6
n = (b - a)/h
sol = h/2 * x (f[a] + 2 (Sum[f[a + i * h], {i, 1, n - 1}]) + f[b]);
sol2 = h/2 * x (f[a] + 2 (Sum[f[i], {i, a + h, b - h, h}]) + f[b]);
N[sol]
N sol2
0.1
0
0.6
6.
0.534455
0.534455
```

Practical 07 - (b) Simpson's Rule

Q.1) Find $\int_0^1 \frac{1}{5+3x} dx$ using Simpson's Rule.

```
a = 0;
b = 1; n = 6;
h = (b - a) / n;
f[x_] := 1 / (5 + 3 x x);
sol = (h / 3) x (f[a] + 4 x Sum[f[i], {i, a+h, b-h, 2 x h}] +
    2 x Sum[f[i], {i, a+2 h, b-2 h, 2 x h}] + f[b]);
Print[" Simpson's Estimate is : ", sol]
```

Simpson's Estimate is : $\frac{338743}{2162160}$

```
N sol
0.156669
```

Practical 08

Euler's Method

```
f[x_, y_] = (y - x) / (y + x); y[1] = 1;
x[1] = 0;
h = 0.02;
For[i = 1, i <= 7, i++, x[i + 1] = x[i] + h;
y[i + 1] = y[i] + h x f[x[i], y[i]];
Print x[i], y[i]
0, 1
0.02, 1.02
0.04, 1.03923
0.06, 1.05775
0.08, 1.0756
0.1, 1.09283
```