Scilab Textbook Companion for Numerical Methods by B. Ram[1]

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Book Description

Title: Numerical Methods

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Scilab numbering policy used in this document and the relation to the above book.

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

AP Appendix to Example(Scilab Code that is an Appednix to a particular Example of the above book)

For example, Exa 3.51 means solved example 3.51 of this book. Sec 2.3 means a scilab code whose theory is explained in Section 2.3 of the book.

Contents

List of Scilab Codes

Chapter 1

Preliminaries

Scilab code Exa 1.1 Rounding off Numbers

```
1 //Example 1.1
2 //Rounding off Numbers
3 //Page no. 2
4 clc;clear;close;
5 a=[81.9773;48.365;21.385;12.865;27.553]
6 for i=1:5
7     printf('\n%g becomes %.4g\n',a(i),a(i))
8 end
```

Scilab code Exa 1.2 Relative Maximum Error

```
1 //Example 1.2
2 //Relative Maximum Error
3 //Page no. 5
4 clc;clear;close;
5 h=0.001;
6 x=1;y=1;z=1;dx=0.001;dy=0.001;dz=0.001;
7 deff('u=f(x,y,z)','u=(5*x*y^2)/z^3')
```

```
8  du=abs(f(x+h,y,z)-f(x,y,z))*dx+abs(f(x,y+h,z)-f(x,y,
      z))*dy+abs(f(x,y,z+h)-f(x,y,z))*dz;
9  du=du/h;
10 Er=du/f(x,y,z)
11 printf('\nMaximum Error = %.3f\n\nRelative maximum
      error = %.3f',du,Er)
```

Scilab code Exa 1.3 Absolute Error

```
1  //Example 1.3
2  //Absolute Error
3  //Page no. 6
4  clc;clear;close;
5  a=10;b=0.0356;c=15300;d=62000;
6  ea=0.05;eb=0.0002;ec=100;ed=500;
7  e=ea+eb+ec+ed;
8  printf('\nMaximum Absolute Error of a+b+c+d = %f\n\n
      ',e)
9  E=(c+2*ec)^3-(c+ec)^3
10 printf('                                    3\nMaximum
      Absolute Error of c = %f',E)
```

Chapter 2

Non Linear Equations

Scilab code Exa 2.1 Bisection Method

```
1  //Example 2.1
2  //Bisection Method
3  //Page no. 14
4  clc;clear;close;
5  deff('y=f(x)','y=x^3+x^2-1')
6  x1=0.5;x2=1;e=0.0001;i=0;
7  printf('Iteration\tx1\t\tx2\t\tz\t\tf(z)\n')
8  printf('
     ------------------------------------------------------------------------
     n')
9  while abs(x1-x2)>e
10     z=(x1+x2)/2
11     printf('      %i\t\t%f\t%f\t%f\t%f\n',i,x1,x2,z,f
         (z))
12     if f(z)*f(x1)>0
13         x1=z
14     else
15         x2=z
16     end
17     i=i+1
18 end
```

```
19 printf('\n\nThe solution of this equation is %g
      after %i Iterations',z,i-1)
```

Scilab code Exa 2.2 Bisection Method

```
1  //Example 2.2
2  //Bisection Method
3  //Page no. 15
4  clc;clear;close;
5  deff('y=f(x)','y=x^3-3*x-5')
6  x1=2;x2=2.5;e=0.0001;i=0;
7  printf('Iteration\tx1\t\tx2\t\tz\t\tf(z)\n')
8  printf('
      ------------------------------------------------------------------------------
      n')
9  while abs(x1-x2)>e
10     z=(x1+x2)/2
11     printf('      %i\t\t%f\t%f\t%f\t%f\n',i,x1,x2,z,f
          (z))
12     if f(z)*f(x1)>0
13         x1=z
14     else
15         x2=z
16     end
17     i=i+1
18 end
19 printf('\n\nThe solution of this equation is %.4g
      after %i Iterations',z,i-1)
```

Scilab code Exa 2.3 Regula Falsi Method

```
1  //Example 2.3
2  //Regula Falsi Method
3  //Page no. 17
4  clc;clear;close;
5  deff('y=f(x)','y=x^3-5*x-7')
6  x1=2;x2=3;e=0.01
7  printf('n\tx1\t\tf(x1)\t\tx2\t\tf(x2)\t\tx3\t\tf(x3)
       ')
8  printf('\n
       ----------------------------------------------------------------------------
       n')
9  for i=0:19
10     x3=x2*f(x1)/(f(x1)-f(x2))+x1*f(x2)/(f(x2)-f(x1))
11     printf(' %i\t%f\t%f\t%f\t%f\t%f\t%f\n',i,x1,f(x1
           ),x2,f(x2),x3,f(x3))
12     if f(x1)*f(x3)>0 then
13         x1=x3
14     else
15         x2=x3
16     end
17     if abs(f(x3))<e then
18         break
19     end
20 end
21 printf('\n\nThus the root is %.3f correct upto three
       places of decimal',x3)
```

Scilab code Exa 2.4 Regula Falsi Method

```
1  //Example 2.4
2  //Regula Falsi Method
3  //Page no. 18
4  clc;clear;close;
```

```
5  deff('y=f(x)','y=x*log10(x)-1.2')
6  x1=2;x2=3;e=0.000001
7  printf('n\tx1\t\tf(x1)\t\tx2\t\tf(x2)\t\tx3\t\tf(x3)
       ')
8  printf('\n
       ----------------------------------------------------------------------
       n')
9  for i=0:19
10     x3=x2*f(x1)/(f(x1)-f(x2))+x1*f(x2)/(f(x2)-f(x1))
11     printf(' %i\t%f\t%f\t%f\t%f\t%f\t%f\n',i,x1,f(x1
           ),x2,f(x2),x3,f(x3))
12     if f(x1)*f(x3)>0 then
13         x1=x3
14     else
15         x2=x3
16     end
17     if abs(f(x3))<e then
18         break
19     end
20 end
21 printf('\n\nThus the root is %.3f correct upto three
       places of decimal',x3)
```

Scilab code Exa 2.5 Regula Falsi Method

```
1  //Example 2.5
2  //Regula Falsi Method
3  //Page no. 19
4  clc;clear;close;
5  deff('y=f(x)','y=log10(x)-cos(x)')
6  x1=1;x2=1.5;e=0.00000001
7  printf('n\tx1\t\tf(x1)\t\tx2\t\tf(x2)\t\tx3\t\tf(x3)
       ')
```

```
8  printf('\n
     ------------------------------------------------------------------------
     n')
9  for i=0:19
10     x3=x2*f(x1)/(f(x1)-f(x2))+x1*f(x2)/(f(x2)-f(x1))
11     printf(' %i\t%f\t%f\t%f\t%f\t%f\t%f\n',i,x1,f(x1
          ),x2,f(x2),x3,f(x3))
12     if f(x1)*f(x3)>0 then
13         x1=x3
14     else
15         x2=x3
16     end
17     if abs(f(x3))<e then
18         break
19     end
20 end
21 printf('\n\nThus the root is %.4f correct upto four
     places of decimal',x3)
```

Scilab code Exa 2.6 Secant Method

```
1  //Example 2.6
2  //Secant Method
3  //Page no. 19
4  clc;clear;close;
5  deff('x=f(x)','x=cos(x)-x*exp(x)')
6  deff('x=f1(x)','x=-sin(x)-exp(x)-x*exp(x)')
7  printf('n\txn\t\tf(xn)\t\tXn+1\t\tf(Xn+1)\t\tXn+2\t\
     tError\n')
8  printf('
     ------------------------------------------------------------------------
     n')
9  x0=0;x1=1;e=0.00001
```

```
10 for i=1:6
11     x2=x1-f(x1)*(x1-x0)/(f(x1)-f(x0))
12     e1=abs(x0-x2)
13     printf(' %i\t%.10f\t%.10f\t%.10f\t%.10f\t%.10f\
          t%.10f\n',i-1,x0,f(x0),x1,f(x1),x2,e1)
14     x0=x1;
15     x1=x2
16     if abs(x0)<e then
17         break;
18     end
19 end
20 printf('\n\nTherefore, the root is %.4f correct upto
       4 decimal places',x2)
```

Scilab code Exa 2.7 Newton Raphson Method

```
1 //Example 2.7
2 //Newton Raphson Method
3 //Page no. 21
4 clc;clear;close;
5 deff('x=f(x)','x=x^3-5*x+3')
6 deff('x=f1(x)','x=3*x^2-5')
7 printf('n\txn\t\t\tf(xn)\t\tf1(xn)\t\tXn+1\t\tError\n
    ')
8 printf('
    ------------------------------------------------------------------------------
    n')
9 x0=1;e=0.00001
10 for i=1:6
11     x1=x0-f(x0)/f1(x0)
12     e1=abs(x0-x1)
13     printf(' %i\t%.10f\t%.10f\t%.10f\t%.10f\t%.10f\n
         ',i-1,x0,f(x0),f1(x0),x1,e1)
14     x0=x1;
15     if abs(x0)<e then
```

```
16          break;
17      end
18  end
19  printf('\n\nTherefore, this is convergent')
```

Scilab code Exa 2.8 Newton Raphson Method

```
1  //Example 2.8
2  //Newton Raphson Method
3  //Page no. 21
4  clc;clear;close;
5  deff('x=f(x)','x=x^4-3*x^3+2*x^2+2*x-7')
6  deff('x=f1(x)','x=4*x^3-9*x^2+4*x+2')
7  printf('n\txn\t\tf(xn)\t\tf1(xn)\t\tXn+1\t\tError\n
       ')
8  printf('
       ----------------------------------------------------------------------------
       n')
9  x0=2.1;e=0.00001
10 for i=1:6
11      x1=x0-f(x0)/f1(x0)
12      e1=abs(x0-x1)
13      printf(' %i\t%.10f\t%.10f\t%.10f\t%.10f\t%.10f\n
            ',i-1,x0,f(x0),f1(x0),x1,e1)
14      x0=x1;
15      if abs(x0)<e then
16          break;
17      end
18  end
19  printf('\n\nTherefore, this is convergent and root =
       %.8f',x0)
```

Scilab code Exa 2.9 Newton Raphson Method

```
1  //Example 2.9
2  //Newton Raphson Method
3  //Page no. 22
4  clc;clear;close;
5  deff('x=f(x)','x=exp(x)-5*x')
6  deff('x=f1(x)','x=exp(x)-5')
7  printf('n\txn\t\tf(xn)\t\tf1(xn)\t\tXn+1\t\tError\n
       ')
8  printf('
     ------------------------------------------------------------------------------
     n')
9  x0=0.4;e=0.00001
10 for i=1:5
11     x1=x0-f(x0)/f1(x0)
12     e1=abs(x0-x1)
13     printf(' %i\t%.10f\t%.10f\t%.10f\t%.10f\t%.10f\n
           ',i-1,x0,f(x0),f1(x0),x1,e1)
14     x0=x1;
15     if abs(x0)<e then
16         break;
17     end
18 end
19 printf('\n\nTherefore, this is convergent and the
       root is %.10f',x0)
```

Scilab code Exa 2.10 Newton Raphson Method

```
1  //Example 2.10
2  //Newton Raphson Method
3  //Page no. 22
4  clc;clear;close;
5  deff('x=f(x)','x=3*x-cos(x)-1')
6  deff('x=f1(x)','x=3+sin(x)')
7  printf('n\txn\t\tf(xn)\t\tf1(xn)\t\tXn+1\t\tError\n
       ')
```

```
8  printf('
     ------------------------------------------------------------------------
     n')
9  x0=0.6;e=0.00001
10 for i=1:3
11     x1=x0-f(x0)/f1(x0)
12     e1=abs(x0-x1)
13     printf(' %i\t%.10f\t%.10f\t%.10f\t%.10f\t%.10f\n
         ',i-1,x0,f(x0),f1(x0),x1,e1)
14     x0=x1;
15     if abs(x0)<e then
16         break;
17     end
18 end
19 printf('\n\nTherefore, this is convergent and root =
     %.4f',x0)
```

Scilab code Exa 2.11 Newton Raphson Method

```
1  //Example 2.11
2  //Newton Raphson Method
3  //Page no. 23
4  clc;clear;close;
5  deff('x=f(x)','x=x*sin(x)+cos(x)')
6  deff('x=f1(x)','x=x*cos(x)')
7  printf('n\txn\t\t\tf(xn)\t\tf1(xn)\t\tXn+1\t\tError\n
     ')
8  printf('
     ------------------------------------------------------------------------
     n')
9  x0=%pi;e=0.00001
10 for i=1:6
11     x1=x0-f(x0)/f1(x0)
```

```
12      e1=abs(x0-x1)
13      printf(' %i\t%.10f\t%.10f\t%.10f\t%.10f\t%.10f\n
            ',i-1,x0,f(x0),f1(x0),x1,e1)
14      x0=x1;
15      if abs(x0)<e then
16          break;
17      end
18  end
19  printf('\n\nTherefore, the root is %.4f',x0)
```

Scilab code Exa 2.12 Iteration Formula

```
1  //Example 2.12
2  //Iteration Formula
3  //Page no. 28
4  clc;clear;close;
5  deff('x=f(x)','x=1/sqrt(1+x)')
6  printf('n\txn\t\tf(xn)\t\tXn+1\t\tError\n')
7  printf('
       ------------------------------------------------------------------------------
       n')
8  x0=0.75;e=0.00001
9  for i=1:8
10      x1=f(x0)
11      e1=abs(x0-x1)
12      printf(' %i\t%.10f\t%.10f\t%.10f\t%.10f\n',i-1,
            x0,f(x0),x1,e1)
13      x0=x1;
14      if abs(x0)<e then
15          break;
16      end
17  end
18  printf('\n\nTherefore, the root is %.6f',x0)
```

Scilab code Exa 2.13 Iteration Formula

```
1 //Example 2.13
2 //Iteration Formula
3 //Page no. 28
4 clc;clear;close;
5 deff('x=f(x)','x=(log10(x)+7)/2')
6 printf('n\txn\t\t\f(xn)\t\tXn+1\t\tError\n')
7 printf('
    ------------------------------------------------------------------------
    n')
8 x0=3.8;e=0.00001
9 for i=1:6
10     x1=f(x0)
11     e1=abs(x0-x1)
12     printf(' %i\t%.10f\t%.10f\t%.10f\t%.10f\n',i-1,
         x0,f(x0),x1,e1)
13     x0=x1;
14     if abs(x0)<e then
15         break;
16     end
17 end
18 printf('\n\nTherefore, the root is %.6f',x0)
```

Scilab code Exa 2.14 Iteration Formula

```
1 //Example 2.14
2 //Iteration Formula
3 //Page no. 29
4 clc;clear;close;
5 deff('x=f(x)','x=exp(x)/5')
6 printf('n\txn\t\t\f(xn)\t\tXn+1\t\tError\n')
```

```
printf('
   ------------------------------------------------------------------------------
   n')
x0=0.3;e=0.00001
for i=1:11
    x1=f(x0)
    e1=abs(x0-x1)
    printf(' %i\t%.10f\t%.10f\t%.10f\t%.10f\n',i-1,
       x0,f(x0),x1,e1)
    x0=x1;
    if abs(x0)<e then
        break;
    end
end
printf('\n\nTherefore, the root is %.6f',x0)
```

Scilab code Exa 2.15 Newton Raphshon Method

```
//Example 2.15
//Newton Raphshon Method
//Page no. 30
clc;clear;close;
h=0.001
deff('x=f(x)','x=x^4-5*x^3-12*x^2+76*x-79')
deff('x=f1(x)','x=(f(x+h)-f(x))/h')
deff('x=f2(x)','x=(f1(x+h)-f1(x))/h')
printf('n\txn\t\t\f(xn)\t\tXn+1\t\tError\n')
printf('
   ------------------------------------------------------------------------------
   n')
x=2;e=0.00001
e2=sqrt((-2*f(x))/f2(x))
x0=x+e2
for i=1:4
    x1=x0-f(x0)/f1(x0)
```

```
16      e1=abs(x0-x1)
17      printf(' %i\t%.10f\t%.10f\t%.10f\t%.10f\n',i-1,
           x0,f(x0),x1,e1)
18      x0=x1;
19      if abs(x0)<e then
20          break;
21      end
22  end
23  printf('\n\nTherefore, the root is %.4f\n\n\n\n',x0)
24
25  x0=x-e2
26  for i=1:4
27      x1=x0-f(x0)/f1(x0)
28      e1=abs(x0-x1)
29      printf(' %i\t%.10f\t%.10f\t%.10f\t%.10f\n',i-1,
           x0,f(x0),x1,e1)
30      x0=x1;
31      if abs(x0)<e then
32          break;
33      end
34  end
35  printf('\n\nTherefore, the root is %.4f',x0)
```

Scilab code Exa 2.16 Newton Raphshon Method

```
1  //Example 2.16
2  //Newton Raphshon Method
3  //Page no. 31
4  clc;clear;close;
5  h=0.001
6  deff('x=f(x)','x=x^3-5*x^2+8*x-4')
7  deff('x=f1(x)','x=(f(x+h)-f(x))/h')
8  deff('x=f2(x)','x=(f1(x+h)-f1(x))/h')
9  printf('n\txn\t\t\tf(xn)\t\tXn+1\t\tError\n')
10 printf('
```

```
    n')
11 x0=1.8;e=0.00001
12 for i=1:10
13     x1=x0-2*f(x0)/f1(x0)
14     e1=abs(x0-x1)
15     printf(' %i\t%.10f\t%.10f\t%.10f\t%.10f\n',i-1,
          x0,f(x0),x1,e1)
16     x0=x1;
17     if abs(x0)<e then
18         break;
19     end
20 end
21 printf('\n\nTherefore, the root is %.4f\n\n\n\n',x0)
```

Scilab code Exa 2.17 Newton Raphshon Method

```
1  //Example 2.17
2  //Newton Raphshon Method
3  //Page no. 32
4  clc;clear;close;
5  h=0.001
6  deff('x=f(x)','x=x^3-x^2-x+1')
7  deff('x=f1(x)','x=(f(x+h)-f(x))/h')
8  deff('x=f2(x)','x=(f1(x+h)-f1(x))/h')
9  printf('n\txn\t\t\tf(xn)\t\tXn+1\t\tError\n')
10 printf('
    n')
11 x0=0.8;e=0.00001
12 for i=1:10
13     x1=x0-2*f(x0)/f1(x0)
14     e1=abs(x0-x1)
15     printf(' %i\t%.10f\t%.10f\t%.10f\t%.10f\n',i-1,
          x0,f(x0),x1,e1)
```

```
16      x0=x1;
17      if abs(x0)<e then
18          break;
19      end
20  end
21  printf('\n\nTherefore, the root is %.4f\n\n\n',x0)
```

Scilab code Exa 2.18 Newton Raphshon Method for simultaneous equations

```
1  //Example 2.18
2  //Newton Raphshon Method for simultaneous equations
3  //Page no. 33
4  clc;clear;close;
5
6  deff('y=f1(x,y)','y=x+3*log10(x)-y^2');
7  deff('y=f2(x,y)','y=2*x^2-x*y-5*x+1');
8  h=0.01;
9  function u=f3(x,y,z)
10      if z==1 then
11          u=(f1(x+h,y)-f1(x,y))/h
12      elseif z==2
13          u=(f1(x,y+h)-f1(x,y))/h
14      elseif z==3
15          u=(f2(x+h,y)-f2(x,y))/h
16      else
17          u=(f2(x,y+h)-f2(x,y))/h
18      end
19  endfunction
20  x=3.4;y=2.2;
21  for i=1:4
22      printf('\n\tx%i = %g\t\ty%i = %g\n',i-1,x,i-1,y)
23      printf('\nfi(x0,y0) = %g',f1(x,y));
24  printf('\nomega(x0,y0) = %g',f2(x,y));
25  printf('\nd(fi)/dx = %g',f3(x,y,1));
26  printf('\nd(fi)/dy = %g',f3(x,y,2));
```

```
27 printf('\nd(omega)/dx = %g',f3(x,y,3));
28 printf('\nd(omega)/dy = %g',f3(x,y,4));
29 A=[f3(x,y,1),f3(x,y,2);f3(x,y,3),f3(x,y,4)];
30 B=[-f1(x,y);-f2(x,y)];
31 C=inv(A)*B;
32 x=x+C(1);
33 y=y+C(2);
34 printf('\n\n\th%i = %g\t\tk%i = %g\n\n',i,C(1),i,C
      (2));
35 end
36 printf('\n\tx%i = %g\t\ty%i = %g\n\n\nNote :
      Computational Errors in Book',i,x,i,y)
```

Scilab code Exa 2.19 Newton Raphshon Method for simultaneous equations

```
1  //Example 2.19
2  //Newton Raphshon Method for simultaneous equations
3  //Page no. 35
4  clc;clear;close;
5
6  deff('y=f1(x,y)','y=1+x^2-y^2');
7  deff('y=f2(x,y)','y=2*x*y');
8  h=0.01;
9  function u=f3(x,y,z)
10     if z==1 then
11         u=(f1(x+h,y)-f1(x,y))/h
12     elseif z==2
13         u=(f1(x,y+h)-f1(x,y))/h
14     elseif z==3
15         u=(f2(x+h,y)-f2(x,y))/h
16     else
17         u=(f2(x,y+h)-f2(x,y))/h
18     end
19 endfunction
20 x=0.5;y=0.5;
```

```
21 for i=1:3
22     printf('\n\tx%i = %g\t\ty%i = %g\n',i-1,x,i-1,y)
23     printf('\nfi(x0,y0) = %g',f1(x,y));
24 printf('\nomega(x0,y0) = %g',f2(x,y));
25 printf('\nd(fi)/dx = %g',f3(x,y,1));
26 printf('\nd(fi)/dy = %g',f3(x,y,2));
27 printf('\nd(omega)/dx = %g',f3(x,y,3));
28 printf('\nd(omega)/dy = %g',f3(x,y,4));
29 A=[f3(x,y,1),f3(x,y,2);f3(x,y,3),f3(x,y,4)];
30 B=[-f1(x,y);-f2(x,y)];
31 C=inv(A)*B;
32 x=x+C(1);
33 y=y+C(2);
34 printf('\n\n\th%i = %g\t\tk%i = %g\n\n',i,C(1),i,C
       (2));
35 end
36 printf('\n\tx%i = %g\t\ty%i = %g\n',i,x,i,y)
```

Scilab code Exa 2.20 Graeffe Method

```
1  //Example 2.20
2  //Graeffe Method
3  //Page no. 38
4  clc;clear;close;
5
6  a=[1,-5,-17,20]
7  k=0;
8  for k=2:6
9      for i=1:4
10         a(k,i)=(-1)^(i-1)*(a(k-1,i))^2
11         j=1;
12         while i+j<5 & i+j>2
13             a(k,i)=a(k,i)+(-1)^(i-j-1)*2*(a(k-1,i-j)
                   )*a(k-1,i+j)
14             break
```

```
15              j=j+1;
16          end
17      end
18  end
19  printf('\t\t\ta1\t\t\ta2\t\t\ta3\n k\ta0\ta1\t
    \t--\t\ta2\t\t--\t\ta3\t\t--\t\n\t\t\ta0\t\t\t\
    a1\t\t\t\a2')
20  printf('\n
    ------------------------------------------------------------------------------
    n')
21  for i=1:4
22      printf(' %i\t%g\t%.4g\t\t%.5g\t\t%.9g\t\t%.8g\
        t%g\t\t%.10g\n',i-1,a(i,1),a(i,2),abs(a(i,2)/
        a(i,1))^(1/(2^(i-1))),a(i,3),abs(a(i,3)/a(i
        ,2))^(1/(2^(i-1))),a(i,4),abs(a(i,4)/a(i,3))
        ^(1/(2^(i-1))))
23  end
24  for i=5:6
25      printf(' %i\t%g\t%.4g\t%.5g\t\t%.9g\t%.8g\t%.7g\
        t%.10g\n',i-1,a(i,1),a(i,2),abs(a(i,2)/a(i,1)
        )^(1/(2^(i-1))),a(i,3),abs(a(i,3)/a(i,2))
        ^(1/(2^(i-1))),a(i,4),abs(a(i,4)/a(i,3))
        ^(1/(2^(i-1))))
26  end
27  printf('\n\nThe Absolute Values of the roots are %g,
     %.8g and %g',abs(a(i,2)/a(i,1))^(1/(2^(i-1))),
    abs(a(i,3)/a(i,2))^(1/(2^(i-1))),abs(a(i,4)/a(i
    ,3))^(1/(2^(i-1))))
```

Scilab code Exa 2.21 Graeffe Method

```
1  //Example 2.21
2  //Graeffe Method
3  //Page no. 39
4  clc;clear;close;
```

```
5
6  a=[1,-2,-5,6]
7  k=0;
8  for k=2:6
9      for i=1:4
10         a(k,i)=(-1)^(i-1)*(a(k-1,i))^2
11         j=1;
12         while i+j<5 & i+j>2
13             a(k,i)=a(k,i)+(-1)^(i-j-1)*2*(a(k-1,i-j)
                   )*a(k-1,i+j)
14             break
15             j=j+1;
16         end
17     end
18 end
19 printf('\t\t\ta1\t\t\ta2\t\t\ta3\n k\ta0\ta1\t
   \t--\t\ta2\t\t--\t\ta3\t\t--\t\n\t\t\ta0\t\t\t\
   a1\t\t\ta2')
20 printf('\n
   ------------------------------------------------------------------------------
   n')
21 for i=1:4
22     printf(' %i\t%g\t%.4g\t\t%.5g\t\t%.9g\t\t%.8g\
          t%g\t\t%.10g\n',i-1,a(i,1),a(i,2),abs(a(i,2)/
          a(i,1))^(1/(2^(i-1))),a(i,3),abs(a(i,3)/a(i
          ,2))^(1/(2^(i-1))),a(i,4),abs(a(i,4)/a(i,3))
          ^(1/(2^(i-1))))
23 end
24 for i=5:6
25     printf(' %i\t%g\t%.4g\t%.5g\t\t%.9g\t%.8g\t%.7g\
          t%.10g\n',i-1,a(i,1),a(i,2),abs(a(i,2)/a(i,1)
          )^(1/(2^(i-1))),a(i,3),abs(a(i,3)/a(i,2))
          ^(1/(2^(i-1))),a(i,4),abs(a(i,4)/a(i,3))
          ^(1/(2^(i-1))))
26 end
27 printf('\n\nThe Absolute Values of the roots are %g,
       %.8g and %g',abs(a(i,2)/a(i,1))^(1/(2^(i-1))),
   abs(a(i,3)/a(i,2))^(1/(2^(i-1))),abs(a(i,4)/a(i
```

```
,3))^(1/(2^(i-1))))
```

Scilab code Exa 2.22 Graeffe Method

```
1  //Example 2.22
2  //Graeffe Method
3  //Page no. 40
4  clc;clear;close;
5
6  a=[1,-4,5,-2]
7  k=0;
8  for k=2:6
9      for i=1:4
10         a(k,i)=(-1)^(i-1)*(a(k-1,i))^2
11         j=1;
12         while i+j<5 & i+j>2
13             a(k,i)=a(k,i)+(-1)^(i-j-1)*2*(a(k-1,i-j)
                   )*a(k-1,i+j)
14             break
15             j=j+1;
16         end
17     end
18 end
19 printf('\t\t\ta1\t\t\ta2\t\t\ta3\n k\ta0\ta1\t
   \t--\t\ta2\t\t--\t\ta3\t\t--\t\n\t\t\ta0\t\t\t\
   ta1\t\t\ta2')
20 printf('\n
   ----------------------------------------------------------------------------
   n')
21 for i=1:4
22     printf(' %i\t%g\t%.4g\t\t%.5g\t\t%.9g\t\t%.8g\
          t%g\t\t%.10g\n',i-1,a(i,1),a(i,2),abs(a(i,2)/
          a(i,1))^(1/(2^(i-1))),a(i,3),abs(a(i,3)/a(i
          ,2))^(1/(2^(i-1))),a(i,4),abs(a(i,4)/a(i,3))
          ^(1/(2^(i-1))))
```

```
23 end
24 for i=5:6
25     printf(' %i\t%g\t%.4g\t%.5g\t\t%.9g\t%.8g\t%.7g\
          t%.10g\n',i-1,a(i,1),a(i,2),abs(a(i,2)/a(i,1)
          )^(1/(2^(i-1))),a(i,3),abs(a(i,3)/a(i,2))
          ^(1/(2^(i-1))),a(i,4),abs(a(i,4)/a(i,3))
          ^(1/(2^(i-1))))
26 end
27 printf('\n\nThe Absolute Values of the roots are %g,
       %.8g and %g',abs(a(i,2)/a(i,1))^(1/(2^(i-1))),
     abs(a(i,3)/a(i,2))^(1/(2^(i-1))),abs(a(i,4)/a(i
     ,3))^(1/(2^(i-1))))
```

Scilab code Exa 2.23 Mullers Method

```
1  //Example 2.23
2  //Mullers Method
3  //Page no. 41
4  clc;clear;close;
5
6  deff('y=f(x)','y=x^3-x-1')
7  zi=[1;2;3];
8  s=["i","z2","z0","z1","f2","f0","f1","a0","a1","a2",
       "zr+","zr-"]
9  li(1)=(zi(3,1)-zi(2,1))/(zi(2,1)-zi(1,1))
10 hi(1)=zi(3,1)-zi(2,1);
11 for i=2:6
12     for j=1:3
13         fz(j,i-1)=f(zi(j,i-1))
14     end
15     di(i-1)=1+li(i-1)
16     gi(i-1)=fz(1,i-1)*li(i-1)^2-fz(2,i-1)*di(i-1)^2+
          fz(3,i-1)*(li(i-1)+di(i-1))
17     D1(i-1)=gi(i-1)+sqrt(gi(i-1)^2-4*fz(3,i-1)*di(i
          -1)*li(i-1)*(fz(1,i-1)*li(i-1)-fz(2,i-1)*di(i
```

```
        -1)+fz(3,i-1)))
18      D2(i-1)=gi(i-1)-sqrt(gi(i-1)^2-4*fz(3,i-1)*di(i
        -1)*li(i-1)*(fz(1,i-1)*li(i-1)-fz(2,i-1)*di(i
        -1)+fz(3,i-1)))
19      if abs(D1(i-1))>abs(D2(i-1)) then
20          li(i)=-2*fz(3,i-1)*di(i-1)/D1(i-1)
21      else
22          li(i)=-2*fz(3,i-1)*di(i-1)/D2(i-1)
23      end
24      hi(i)=li(i)*hi(i-1);
25      z(i-1)=zi(3,i-1)+hi(i)
26      for j=1:2
27          zi(j,i)=zi(j+1,i-1)
28      end
29      zi(3,i)=z(i-1)
30  end
31  for i=1:12
32      if i==1 then
33          printf(s(i))
34          for j=1:5
35              printf('\t\t\t%i',j-1)
36          end
37      elseif i<=4
38          printf('\n %s',s(i))
39          for j=1:5
40              printf('\t\t%.10f',zi(i-1,j))
41          end
42      elseif i<=7
43          printf('\n %s',s(i))
44          for j=1:5
45              printf('\t\t%.10f',fz(i-4,j))
46          end
47      elseif i<=8
48          printf('\n %s',s(i))
49          for j=1:5
50              printf('\t\t%.10f',li(j))
51          end
52      elseif i<=9
```

```
53          printf('\n %s',s(i))
54          for j=1:5
55              printf('\t\t%.10f',di(j))
56          end
57      elseif i<=10
58          printf('\n %s',s(i))
59          for j=1:5
60              printf('\t\t%.10f',gi(j))
61          end
62      elseif i<=11
63          printf('\n %s',s(i))
64          for j=1:5
65              printf('\t\t%.10f',z(j))
66          end
67      elseif i<=12
68          printf('\n %s',s(i))
69          for j=1:5
70              printf('\t\t%.10f',zi(j))
71          end
72      end
73  end
74  printf('\n\nAt the end of the %i iteration, the root
        of the equation is %.10f',j-2,z(j))
```

Scilab code Exa 2.24 Mullers Method

```
1  //Example 2.24
2  //Mullers Method
3  //Page no. 42
4  clc;clear;close;
5
6  deff('y=f(x)','y=x^3-x-2')
7  zi=[1.4;1.5;1.6];
8  s=["i","z2","z0","z1","f2","f0","f1","a0","a1","a2",
       "zr+","zr-"]
```

```
li(1)=(zi(3,1)-zi(2,1))/(zi(2,1)-zi(1,1))
hi(1)=zi(3,1)-zi(2,1);
for i=2:6
    for j=1:3
       fz(j,i-1)=f(zi(j,i-1))
    end
    di(i-1)=1+li(i-1)
    gi(i-1)=fz(1,i-1)*li(i-1)^2-fz(2,i-1)*di(i-1)^2+
       fz(3,i-1)*(li(i-1)+di(i-1))
    D1(i-1)=gi(i-1)+sqrt(gi(i-1)^2-4*fz(3,i-1)*di(i
       -1)*li(i-1)*(fz(1,i-1)*li(i-1)-fz(2,i-1)*di(i
       -1)+fz(3,i-1)))
    D2(i-1)=gi(i-1)-sqrt(gi(i-1)^2-4*fz(3,i-1)*di(i
       -1)*li(i-1)*(fz(1,i-1)*li(i-1)-fz(2,i-1)*di(i
       -1)+fz(3,i-1)))
    if abs(D1(i-1))>abs(D2(i-1)) then
        li(i)=-2*fz(3,i-1)*di(i-1)/D1(i-1)
    else
        li(i)=-2*fz(3,i-1)*di(i-1)/D2(i-1)
    end
    hi(i)=li(i)*hi(i-1);
    z(i-1)=zi(3,i-1)+hi(i)
    for j=1:2
        zi(j,i)=zi(j+1,i-1)
    end
    zi(3,i)=z(i-1)
end
for i=1:12
    if i==1 then
        printf(s(i))
        for j=1:5
            printf('\t\t\t%i',j-1)
        end
    elseif i<=4
        printf('\n %s',s(i))
        for j=1:5
            printf('\t\t%.10f',zi(i-1,j))
        end
```

```
42      elseif i<=7
43          printf('\n %s',s(i))
44          for j=1:5
45              printf('\t\t%.10f',fz(i-4,j))
46          end
47      elseif i<=8
48          printf('\n %s',s(i))
49          for j=1:5
50              printf('\t\t%.10f',li(j))
51          end
52      elseif i<=9
53          printf('\n %s',s(i))
54          for j=1:5
55              printf('\t\t%.10f',di(j))
56          end
57      elseif i<=10
58          printf('\n %s',s(i))
59          for j=1:5
60              printf('\t\t%.10f',gi(j))
61          end
62      elseif i<=11
63          printf('\n %s',s(i))
64          for j=1:5
65              printf('\t\t%.10f',z(j))
66          end
67      elseif i<=12
68          printf('\n %s',s(i))
69          for j=1:5
70              printf('\t\t%.10f',zi(j))
71          end
72      end
73  end
74  printf('\n\nAt the end of the %i iteration, the root
        of the equation is %.10f',j-2,z(j))
```

Scilab code Exa 2.25 Mullers Method

```
1  //Example 2.25
2  //Mullers Method
3  //Page no. 43
4  clc;clear;close;
5
6  deff('y=f(x)','y=cos(x)-x*exp(x)')
7  zi=[-1;0;1];
8  s=["i","z2","z0","z1","f2","f0","f1","a0","a1","a2",
       "zr+","zr-"]
9  li(1)=(zi(3,1)-zi(2,1))/(zi(2,1)-zi(1,1))
10 hi(1)=zi(3,1)-zi(2,1);
11 for i=2:7
12     for j=1:3
13        fz(j,i-1)=f(zi(j,i-1))
14     end
15     di(i-1)=1+li(i-1)
16     gi(i-1)=fz(1,i-1)*li(i-1)^2-fz(2,i-1)*di(i-1)^2+
          fz(3,i-1)*(li(i-1)+di(i-1))
17     D1(i-1)=gi(i-1)+sqrt(gi(i-1)^2-4*fz(3,i-1)*di(i
          -1)*li(i-1)*(fz(1,i-1)*li(i-1)-fz(2,i-1)*di(i
          -1)+fz(3,i-1)))
18     D2(i-1)=gi(i-1)-sqrt(gi(i-1)^2-4*fz(3,i-1)*di(i
          -1)*li(i-1)*(fz(1,i-1)*li(i-1)-fz(2,i-1)*di(i
          -1)+fz(3,i-1)))
19     if abs(D1(i-1))>abs(D2(i-1)) then
20         li(i)=-2*fz(3,i-1)*di(i-1)/D1(i-1)
21     else
22         li(i)=-2*fz(3,i-1)*di(i-1)/D2(i-1)
23     end
24     hi(i)=li(i)*hi(i-1);
25     z(i-1)=zi(3,i-1)+hi(i)
26     for j=1:2
27         zi(j,i)=zi(j+1,i-1)
28     end
29     zi(3,i)=z(i-1)
30 end
```

```
for i=1:12
    if i==1 then
        printf(s(i))
        for j=1:6
            printf('\t\t\t%i',j-1)
        end
    elseif i<=4
        printf('\n %s',s(i))
        for j=1:6
            printf('\t\t%.10f',zi(i-1,j))
        end
    elseif i<=7
        printf('\n %s',s(i))
        for j=1:6
            printf('\t\t%.10f',fz(i-4,j))
        end
    elseif i<=8
        printf('\n %s',s(i))
        for j=1:6
            printf('\t\t%.10f',li(j))
        end
    elseif i<=9
        printf('\n %s',s(i))
        for j=1:6
            printf('\t\t%.10f',di(j))
        end
    elseif i<=10
        printf('\n %s',s(i))
        for j=1:6
            printf('\t\t%.10f',gi(j))
        end
    elseif i<=11
        printf('\n %s',s(i))
        for j=1:6
            printf('\t\t%.10f',z(j))
        end
    elseif i<=12
        printf('\n %s',s(i))
```

```
69          for j=1:6
70              printf('\t\t%.10f',zi(j))
71          end
72      end
73  end
74  printf('\n\nAt the end of the %i iteration, the root
        of the equation is %.10f',j-2,z(j))
```

Scilab code Exa 2.26 Mullers Method

```
1  //Example 2.26
2  //Mullers Method
3  //Page no. 44
4  clc;clear;close;
5
6  deff('y=f(x)','y=x^3-x^2-x-1')
7  zi=[0;1;2];
8  s=["i","z2","z0","z1","f2","f0","f1","a0","a1","a2",
       "zr+","zr-"]
9  li(1)=(zi(3,1)-zi(2,1))/(zi(2,1)-zi(1,1))
10 hi(1)=zi(3,1)-zi(2,1);
11 for i=2:7
12     for j=1:3
13        fz(j,i-1)=f(zi(j,i-1))
14     end
15     di(i-1)=1+li(i-1)
16     gi(i-1)=fz(1,i-1)*li(i-1)^2-fz(2,i-1)*di(i-1)^2+
          fz(3,i-1)*(li(i-1)+di(i-1))
17     D1(i-1)=gi(i-1)+sqrt(gi(i-1)^2-4*fz(3,i-1)*di(i
          -1)*li(i-1)*(fz(1,i-1)*li(i-1)-fz(2,i-1)*di(i
          -1)+fz(3,i-1)))
18     D2(i-1)=gi(i-1)-sqrt(gi(i-1)^2-4*fz(3,i-1)*di(i
          -1)*li(i-1)*(fz(1,i-1)*li(i-1)-fz(2,i-1)*di(i
          -1)+fz(3,i-1)))
19     if abs(D1(i-1))>abs(D2(i-1)) then
```

```
20          li(i)=-2*fz(3,i-1)*di(i-1)/D1(i-1)
21      else
22          li(i)=-2*fz(3,i-1)*di(i-1)/D2(i-1)
23      end
24      hi(i)=li(i)*hi(i-1);
25      z(i-1)=zi(3,i-1)+hi(i)
26      for j=1:2
27          zi(j,i)=zi(j+1,i-1)
28      end
29      zi(3,i)=z(i-1)
30  end
31  for i=1:12
32      if i==1 then
33          printf(s(i))
34          for j=1:6
35              printf('\t\t\t%i',j-1)
36          end
37      elseif i<=4
38          printf('\n %s',s(i))
39          for j=1:6
40              printf('\t\t%.10f',zi(i-1,j))
41          end
42      elseif i<=7
43          printf('\n %s',s(i))
44          for j=1:6
45              printf('\t\t%.10f',fz(i-4,j))
46          end
47      elseif i<=8
48          printf('\n %s',s(i))
49          for j=1:6
50              printf('\t\t%.10f',li(j))
51          end
52      elseif i<=9
53          printf('\n %s',s(i))
54          for j=1:6
55              printf('\t\t%.10f',di(j))
56          end
57      elseif i<=10
```

```
58          printf('\n %s',s(i))
59          for j=1:6
60              printf('\t\t%.10f',gi(j))
61          end
62      elseif i<=11
63          printf('\n %s',s(i))
64          for j=1:6
65              printf('\t\t%.10f',z(j))
66          end
67      elseif i<=12
68          printf('\n %s',s(i))
69          for j=1:6
70              printf('\t\t%.10f',zi(j))
71          end
72      end
73  end
74  printf('\n\nAt the end of the %i iteration, the root
      of the equation is %.10f',j-2,z(j))
```

Scilab code Exa 2.27 Bairstow Method

```
1  //Example 2.27
2  //Bairstow Method
3  //Page no. 48
4  clc;clear;close;
5  deff('y=f(x,p,q)','y=x^4+5*x^3+p*x^2-5*x-9')
6  n=4;
7  a=[1,5,3,-5,-9];
8  p0=a(3);q0=a(4);
9  b(1)=0;b(2)=1;c(1)=0;c(2)=1;
10 for j=1:4
11     for i=1:5
12     printf('\t\t%i',a(i))
13 end
14         for k=3:6
```

```
15              b(k)=a(k-1)-p0*b(k-1)-q0*b(k-2)
16              c(k)=b(k)-p0*c(k-1)-q0*c(k-2)
17          end
18
19
20  printf('\n  %.4f\t',-p0);
21  for i=1:4
22      printf('\t\t%.4f',-p0*b(i+1))
23  end
24  printf('\n  %.4f\t\t\t',-q0);
25  for i=1:3
26      printf('\t\t%.4f',-q0*b(i+1))
27  end
28  printf('\n
      ------------------------------------------------------------------------
      n')
29  for i=1:5
30      printf('\t\t%.2f=b%i',b(i+1),i-1)
31  end
32  printf('\n  %.4f\t',-p0);
33  for i=1:3
34      printf('\t\t%.4f',-p0*c(i+1))
35  end
36  printf('\n  %.4f\t\t\t',-q0);
37  for i=1:2
38      printf('\t\t%.4f',-q0*c(i+1))
39  end
40  printf('\n
      ------------------------------------------------------------------------
      n')
41  for i=1:4
42      printf('\t\t%.2f=c%i',c(i+1),i-1)
43  end
44  printf('\n\n')
45  cb=c(n+1)-b(n+1);
46        dp=-(b(n+2)*c(n-1)-b(n+1)*c(n))/(c(n)^2-cb*c(n
            -1))
47        dq=-(b(n+1)*cb-b(n+2)*c(n))/(c(n)^2-cb*c(n-1))
```

```
48          p0=p0+dp;
49          q0=q0+dq;
50          printf('\n dp = %.6f\t\tdq = %.6f\n p%i = %.6f\
                t\tq%i = %.6f\n\n\n',dp,dq,j,p0,j,q0);
51  end
```

Chapter 3

Linear System of Equations

Scilab code Exa 3.1 Direct Method

```
1 //Example 3.1
2 //Direct Method
3 //Page no. 3.1
4 clc;clear;close;
5
6 A=[1,1,2;1,2,3;2,3,1];          //Parameter Matrix
7 B=[1;1;2]
8 C=inv(A)*B;
9 disp(C,"Solution Matrix = ")
```

Scilab code Exa 3.2 Gaussian Elimination Method

```
1 //Example 3.2
2 //Gaussian Elimination Method
3 //Page no. 54
4 clc;clear;close;
5
6 A=[2,4,-6,-4;1,5,3,10;1,3,2,5];          //
    augmented matrix
```

```
7
8  //triangularization
9  for i=1:3
10     for j=1:4
11         if i==1 then
12             B(i,j)=A(i,j)
13         elseif i==2
14             B(i,j)=A(i,j)-A(i,1)*A(i-1,j)/A(1,1)
15             B(i+1,j)=A(i+1,j)-A(i+1,1)*A(i-1,j)/A
                   (1,1)
16         elseif i==3
17             if j==1 then
18                 A=B
19             end
20             B(i,j)=B(i,j)-A(i,2)*B(i-1,j)/B(2,2)
21         end
22     end
23 end
24 disp(A,'Augmented Matrix=')
25 disp(B,'Triangulated Matrix=')
26 //back substitution
27 x(3)=B(3,4)/B(3,3);
28 printf('\nx(3)= %i\n',x(3))
29 for i=2:-1:1
30     k=0
31     for j=i+1:3
32        k=k+B(i,j)*x(j)
33     end
34     x(i)=(1/B(i,i))*(B(i,4)-k)
35      printf('\nx(%i)= %i\n',i,x(i))
36 end
```

Scilab code Exa 3.3 Gaussian Elimination Method

```
1  //Example 3.3
```

```
2  //Gaussian Elimination Method
3  //Page no. 54
4  clc;clear;close;
5
6  A=[10,-7,3,5,6;-6,8,-1,-4,5;3,1,4,11,2;5,-9,-2,4,7];
                  //augmented matrix
7  disp(A,'Augmented Matrix=')
8  C=A;
9  //triangularization
10 for i=1:4
11     for j=1:5
12         if i==1 then
13             B(i,j)=A(i,j)
14         elseif i==2
15             B(i,j)=A(i,j)-A(i,1)*A(i-1,j)/A(1,1)
16             B(i+1,j)=A(i+1,j)-A(i+1,1)*A(i-1,j)/A
                  (1,1)
17             B(i+2,j)=A(i+2,j)-A(i+2,1)*A(i-1,j)/A
                  (1,1)
18         elseif i==3
19             if j==1 then
20                 C=B
21             else
22                 B(i,j)=B(i,j)-C(i,2)*B(i-1,j)/B(2,2)
23                 B(i+1,j)=C(i+1,j)-C(i+1,2)*C(i-1,j)/
                      C(2,2)
24             end
25         else
26             if j==1 then
27                 C=B
28             end
29                 B(i,j)=B(i,j)-C(i,3)*B(i-1,j)/B(3,3)
30         end
31     end
32 end
33
34 disp(B,'Triangulated Matrix=')
35 //back substitution
```

```
x(4)=B(4,5)/B(4,4);
printf('\nx(4) = %.0f\n',x(4))
for i=3:-1:1
    k=0
    for j=i+1:4
       k=k+B(i,j)*x(j)
    end
    x(i)=(1/B(i,i))*(B(i,5)-k)
     printf('\nx(%i) = %.0f\n',i,x(i))
end
```

Scilab code Exa 3.4 Gaussian Elimination Method

```
//Example 3.4
//Gaussian Elimination Method
//Page no. 55
clc;clear;close;

A=[2,1,1,10;3,2,3,18;1,4,9,16];            //
   augmented matrix
disp(A,'Augmented Matrix=')
//triangularization
for i=1:3
    for j=1:4
        if i==1 then
            B(i,j)=A(i,j)
        elseif i==2
            B(i,j)=A(i,j)-A(i,1)*A(i-1,j)/A(1,1)
            B(i+1,j)=A(i+1,j)-A(i+1,1)*A(i-1,j)/A
               (1,1)
        elseif i==3
            if j==1 then
             A=B
            end
            B(i,j)=B(i,j)-A(i,2)*B(i-1,j)/B(2,2)
```

```
21          end
22      end
23  end
24
25  disp(B,'Triangulated Matrix=')
26  //back substitution
27  x(3)=B(3,4)/B(3,3);
28  printf('\nx(3)= %i\n',x(3))
29  for i=2:-1:1
30      k=0
31      for j=i+1:3
32          k=k+B(i,j)*x(j)
33      end
34      x(i)=(1/B(i,i))*(B(i,4)-k)
35       printf('\nx(%i)= %i\n',i,x(i))
36  end
```

Scilab code Exa 3.5 Gauss Jordan Method

```
1  //Example 3.5
2  //Gauss-Jordan Method
3  //Page no. 57
4
5  clc;clear;close;
6
7  A=[1,2,1,8;2,3,4,20;4,3,2,16];      //augmented
       matrix
8
9  for i=1:3
10     j=i
11     while (A(i,i)==0 & j<=3)
12         for k=1:4
13             B(1,k)=A(j+1,k)
14             A(j+1,k)=A(i,k)
15             A(i,k)=B(1,k)
```

```
16          end
17          disp(A)
18          j=j+1
19      end
20      for k=4:-1:i
21          A(i,k)=A(i,k)/A(i,i)
22      end
23      disp(A)
24      for k=1:3
25          if(k~=i) then
26              l=A(k,i)/A(i,i)
27              for m=i:4
28                  A(k,m)=A(k,m)-l*A(i,m)
29              end
30          end
31
32      end
33      disp(A)
34  end
35
36  for i=1:3
37      printf('\nx(%i) = %g\n',i,A(i,4))
38  end
```

Scilab code Exa 3.6 Gauss Jordan Method

```
1  //Example 3.6
2  //Gauss-Jordan Method
3  //Page no. 57
4
5  clc;clear;close;
6
7  A=[10,1,1,12;1,10,1,12;1,1,10,12];      //augmented
       matrix
8
```

```
for i=1:3
    j=i
    while (A(i,i)==0 & j<=3)
        for k=1:4
            B(1,k)=A(j+1,k)
            A(j+1,k)=A(i,k)
            A(i,k)=B(1,k)
        end
        disp(A)
        j=j+1
    end
    for k=4:-1:i
        A(i,k)=A(i,k)/A(i,i)
    end
    disp(A)
    for k=1:3
        if(k~=i) then
            l=A(k,i)/A(i,i)
            for m=i:4
                A(k,m)=A(k,m)-l*A(i,m)
            end
        end

    end
    disp(A)
end

for i=1:3
    printf('\nx(%i) = %g\n',i,A(i,4))
end
```

Scilab code Exa 3.7 Gauss Jordan Method

```
//Example 3.7
//Gauss-Jordan Method
```

```
3  //Page no. 58
4
5  clc;clear;close;
6
7  A=[1,1,1,9;2,-3,4,13;3,4,5,40];      //augmented
       matrix
8
9  for i=1:3
10     j=i
11     while (A(i,i)==0 & j<=3)
12         for k=1:4
13             B(1,k)=A(j+1,k)
14             A(j+1,k)=A(i,k)
15             A(i,k)=B(1,k)
16         end
17         disp(A)
18         j=j+1
19     end
20     for k=4:-1:i
21         A(i,k)=A(i,k)/A(i,i)
22     end
23     disp(A)
24     for k=1:3
25         if(k~=i) then
26            l=A(k,i)/A(i,i)
27            for m=i:4
28                A(k,m)=A(k,m)-l*A(i,m)
29            end
30         end
31
32     end
33     disp(A)
34 end
35
36 for i=1:3
37     printf('\nx(%i) = %g\n',i,A(i,4))
38 end
```

Scilab code Exa 3.8 Triangularization Method

```
1  //Example 3.8
2  //Triangularization Method
3  //Page no. 60
4  clc;clear;close;
5
6  A=[1,2,3;2,5,2;3,1,5];
7  B=[14;18;20];
8  printf('A can be factorizaed as follows:\n')
9  printf('\tL\t\t *\t\tU\t\t =\t\tA')
10 U(2,1)=0;U(3,1)=0;U(3,2)=0;
11 L(1,2)=0;L(1,3)=0;L(2,3)=0;
12 for i=1:3
13     L(i,i)=1
14 end
15 for i=1:3
16     U(1,i)=A(1,i)
17 end
18 L(2,1)=A(1,2)/U(1,1);
19 for i=2:3
20     U(2,i)=A(2,i)-U(1,i)*L(2,1);
21 end
22 L(3,1)=A(1,3)/U(1,1);
23 L(3,2)=(A(3,2)-U(1,2)*L(3,1))/U(2,2);
24 U(3,3)=A(3,3)-U(1,3)*L(3,1)-U(2,3)*L(3,2);
25 printf('\n')
26 for i=1:3
27     for j=1:3
28         printf('%.2f\t',L(i,j))
29     end
30
31     if(i==2)
32         printf('  *      ')
```

```
33      else
34          printf('\t')
35      end
36
37      for j=1:3
38          printf('%.2f\t',U(i,j))
39      end
40      if(i==2)
41          printf('  =      ')
42      else
43          printf('\t')
44      end
45      for j=1:3
46          printf('%.2f\t',A(i,j))
47      end
48      printf('\n')
49  end
50  printf('\nY=U*X')
51      Y=inv(L)*B
52      X=inv(U)*Y
53  printf('\n\nX=')
54  for i=1:3
55      printf('\n    %i',X(i,1))
56  end
```

Scilab code Exa 3.9 Triangularization Method

```
1  //Example 3.9
2  //Triangularization Method
3  //Page no. 61
4  clc;clear;close;
5
6  A=[1,2,3;2,5,2;3,1,5];
7  B=[14;18;20];
8  printf('A =\n')
```

```
9
10 U(2,1)=0;U(3,1)=0;U(3,2)=0;
11 L(1,2)=0;L(1,3)=0;L(2,3)=0;
12 for i=1:3
13     L(i,i)=1
14 end
15 for i=1:3
16     U(1,i)=A(1,i)
17 end
18 L(2,1)=A(1,2)/U(1,1);
19 for i=2:3
20     U(2,i)=A(2,i)-U(1,i)*L(2,1);
21 end
22 L(3,1)=A(1,3)/U(1,1);
23 L(3,2)=(A(3,2)-U(1,2)*L(3,1))/U(2,2);
24 U(3,3)=A(3,3)-U(1,3)*L(3,1)-U(2,3)*L(3,2);
25 printf('\n')
26 for i=1:3
27     for j=1:3
28         printf('%.2f\t',L(i,j))
29     end
30
31     if(i==2)
32         printf('  *      ')
33     else
34         printf('\t')
35     end
36
37     for j=1:3
38         printf('%.2f\t',U(i,j))
39     end
40     printf('\n')
41 end
42
43     Y=inv(L)*B
44     X=inv(U)*Y
45 printf('\n\nX=')
46 for i=1:3
```

```
47      printf('\n    %i',X(i,1))
48  end
```

Scilab code Exa 3.10 Triangularization Method

```
1  //Example 3.10
2  //Triangularization Method
3  //Page no. 62
4  clc;clear;close;
5
6  A=[2,4,-6;1,5,3;1,3,2];
7  B=[-4;10;5];
8  printf('A can be factorizaed as follows:\n')
9  printf('\tL\t\t *\t\tU\t\t =\t\tA')
10 U(2,1)=0;U(3,1)=0;U(3,2)=0;
11 L(1,2)=0;L(1,3)=0;L(2,3)=0;
12 for i=1:3
13     L(i,i)=1
14 end
15 for i=1:3
16     U(1,i)=A(1,i)
17 end
18 L(2,1)=1/U(1,1);
19 for i=2:3
20     U(2,i)=A(2,i)-U(1,i)*L(2,1);
21 end
22 L(3,1)=1/U(1,1);
23 L(3,2)=(A(3,2)-U(1,2)*L(3,1))/U(2,2);
24 U(3,3)=A(3,3)-U(1,3)*L(3,1)-U(2,3)*L(3,2);
25 printf('\n')
26 for i=1:3
27     for j=1:3
28         printf('%.2f\t',L(i,j))
29     end
30
```

```
31      if(i==2)
32          printf('  *      ')
33      else
34          printf('\t')
35      end
36
37      for j=1:3
38          printf('%.2f\t',U(i,j))
39      end
40      if(i==2)
41          printf('  =      ')
42      else
43          printf('\t')
44      end
45      for j=1:3
46          printf('%.2f\t',A(i,j))
47      end
48      printf('\n')
49  end
50  printf('\nY=U*X')
51      Y=inv(L)*B
52      X=inv(U)*Y
53  printf('\n\nX=')
54  for i=1:3
55      printf('\n    %i',X(i,1))
56  end
```

Scilab code Exa 3.11 Triangularization Method

```
1  //Example 3.11
2  //Triangularization Method
3  //Page no. 63
4  clc;clear;close;
5
6  A=[1,3,8;1,4,3;1,3,4];
```

```
B=[4;-2;1];
printf('A can be factorizaed as follows:\n')
printf('\tL\t\t  *\t\tU\t\t  =\t\tA')
U(2,1)=0;U(3,1)=0;U(3,2)=0;
L(1,2)=0;L(1,3)=0;L(2,3)=0;
for i=1:3
    L(i,i)=1
end
for i=1:3
    U(1,i)=A(1,i)
end
L(2,1)=1/U(1,1);
for i=2:3
    U(2,i)=A(2,i)-U(1,i)*L(2,1);
end
L(3,1)=1/U(1,1);
L(3,2)=(A(3,2)-U(1,2)*L(3,1))/U(2,2);
U(3,3)=A(3,3)-U(1,3)*L(3,1)-U(2,3)*L(3,2);
printf('\n')
for i=1:3
    for j=1:3
        printf('%.2f\t',L(i,j))
    end

    if(i==2)
        printf('  *      ')
    else
        printf('\t')
    end

    for j=1:3
        printf('%.2f\t',U(i,j))
    end
    if(i==2)
        printf('  =      ')
    else
        printf('\t')
    end
```

```
45      for j=1:3
46          printf('%.2f\t',A(i,j))
47      end
48      printf('\n')
49  end
50  printf('\nY=U*X')
51      Y=inv(L)*B
52      X=inv(U)*Y
53  printf('\n\nX=')
54  for i=1:3
55      printf('\n    %.2f',X(i,1))
56  end
```

Scilab code Exa 3.12 Triangularization Method

```
1  //Example 3.12
2  //Triangularization Method
3  //Page no. 63
4  clc;clear;close;
5
6  A=[4,-1,2;-1,5,3;2,3,6];
7  B=[12;10;18];
8  printf('A can be factorizaed as follows:\n')
9  printf('\tL\t\t *\t\tU\t\t =\t\tA')
10 U(2,1)=0;U(3,1)=0;U(3,2)=0;
11 L(1,2)=0;L(1,3)=0;L(2,3)=0;
12 for i=1:3
13     L(i,i)=1
14 end
15 for i=1:3
16     U(1,i)=A(1,i)
17 end
18 L(2,1)=1/U(1,1);
19 for i=2:3
20     U(2,i)=A(2,i)-U(1,i)*L(2,1);
```

```
21 end
22 L(3,1)=1/U(1,1);
23 L(3,2)=(A(3,2)-U(1,2)*L(3,1))/U(2,2);
24 U(3,3)=A(3,3)-U(1,3)*L(3,1)-U(2,3)*L(3,2);
25 printf('\n')
26 for i=1:3
27     for j=1:3
28         printf('%.2f\t',L(i,j))
29     end
30
31     if(i==2)
32         printf('  *      ')
33     else
34         printf('\t')
35     end
36
37     for j=1:3
38         printf('%.2f\t',U(i,j))
39     end
40     if(i==2)
41         printf('  =      ')
42     else
43         printf('\t')
44     end
45     for j=1:3
46         printf('%.2f\t',A(i,j))
47     end
48     printf('\n')
49 end
50 printf('\nY=U*X')
51     Y=inv(L)*B
52     X=inv(U)*Y
53 printf('\n\nX=')
54 for i=1:3
55     printf('\n   %.2f',X(i,1))
56 end
```

Scilab code Exa 3.13 Crout Method

```
1  //Example 3.13
2  //Crout Method
3  //Page no. 67
4  clc;clear;close;
5
6  A=[1,2,3,1;3,1,1,0;2,1,1,0]
7  for i=1:3
8      for j=1:4
9          if j==1 then
10             M(i,j)=A(i,j)
11         elseif i==1
12             M(i,j)=A(i,j)/A(1,1)
13         elseif j==2
14             M(i,j)=A(i,j)-M(1,j)*M(i,j-1)
15         elseif i==2
16             M(i,j)=(A(i,j)-M(i,1)*M(i-1,j))/M(i,2)
17         elseif j==3
18             M(i,j)=A(i,j)-(M(i,j-2)*M(i-2,j)+M(i,j
                   -1)*M(i-1,j))
19         else
20             M(i,j)=(A(i,j)-(M(i,j-3)*M(i-2,j)+M(i,j
                   -2)*M(i-1,j)))/M(i,j-1)
21         end
22     end
23 end
24 disp(M,'M = ')
25 for i=1:3
26     for j=1:4
27         if j~=4 then
28             U1(i,j)=M(i,j)
29         else
30             Y(i,1)=M(i,j)
```

```
31          end
32      end
33  end
34  U=eye(3,3)
35  for i=1:3
36      for j=1:3
37          if j>i then
38              U(i,j)=U1(i,j)
39          end
40      end
41  end
42  disp(U,'U = ')
43  disp(Y,'Y = ')
44  X=inv(U)*Y
45  printf('\n\nHence, the solution is : \t')
46  for i=1:3
47      printf('x%i = %i\t\t',i,X(i))
48  end
```

Scilab code Exa 3.14 Crout Method

```
1  //Example 3.14
2  //Crout Method
3  //Page no. 68
4  clc;clear;close;
5
6  A=[2,1,4,12;8,-3,2,20;4,11,-1,33]
7  for i=1:3
8      for j=1:4
9          if j==1 then
10             M(i,j)=A(i,j)
11         elseif i==1
12             M(i,j)=A(i,j)/A(1,1)
13         elseif j==2
14             M(i,j)=A(i,j)-M(1,j)*M(i,j-1)
```

```
15          elseif i==2
16              M(i,j)=(A(i,j)-M(i,1)*M(i-1,j))/M(i,2)
17          elseif j==3
18              M(i,j)=A(i,j)-(M(i,j-2)*M(i-2,j)+M(i,j
                    -1)*M(i-1,j))
19          else
20              M(i,j)=(A(i,j)-(M(i,j-3)*M(i-2,j)+M(i,j
                    -2)*M(i-1,j)))/M(i,j-1)
21          end
22      end
23  end
24  disp(M,'M = ')
25  for i=1:3
26      for j=1:4
27          if j~=4 then
28              U1(i,j)=M(i,j)
29          else
30              Y(i,1)=M(i,j)
31          end
32      end
33  end
34  U=eye(3,3)
35  for i=1:3
36      for j=1:3
37          if j>i then
38              U(i,j)=U1(i,j)
39          end
40      end
41  end
42  disp(U,'U = ')
43  disp(Y,'Y = ')
44  X=inv(U)*Y
45  printf('\n\nHence, the solution is : \t')
46  for i=1:3
47      printf('x%i = %i\t\t',i,X(i))
48  end
```

Scilab code Exa 3.15 Crout Method

```
1  //Example 3.15
2  //Crout Method
3  //Page no. 69
4  clc;clear;close;
5
6  A
      =[1,2,-12,8,27;5,4,7,-2,4;-3,7,9,5,11;6,-12,-8,3,49]

7  for i=1:4
8      for j=1:5
9          if j==1 then
10             M(i,j)=A(i,j)
11         elseif i==1
12             M(i,j)=A(i,j)/A(1,1)
13         elseif j==2
14             M(i,j)=A(i,j)-M(1,j)*M(i,j-1)
15         elseif i==2
16             M(i,j)=(A(i,j)-M(i,1)*M(i-1,j))/M(i,2)
17         elseif j==3
18             M(i,j)=A(i,j)-(M(i,j-2)*M(1,j)+M(i,j-1)*
                  M(2,j))
19         elseif i==3
20             M(i,j)=(A(i,j)-(M(i,1)*M(i-2,j)+M(i,2)*M
                  (i-1,j)))/M(i,3)
21         elseif j==4
22             M(i,j)=A(i,j)-(M(i,j-2)*M(i-2,j)+M(i,j
                  -1)*M(i-1,j)+M(i,j-3)*M(i-3,j))
23         else
24             M(i,j)=(A(i,j)-(M(i,j-2)*M(i-1,j)+M(i,j
                  -3)*M(i-2,j)+M(i,j-4)*M(i-3,j)))/M(i,
                  j-1)
25         end
```

```
26      end
27  end
28  disp(M,'M = ')
29  for i=1:4
30      for j=1:5
31          if j~=5 then
32              U1(i,j)=M(i,j)
33          else
34              Y(i,1)=M(i,j)
35          end
36      end
37  end
38  U=eye(4,4)
39  for i=1:4
40      for j=1:4
41          if j>i then
42              U(i,j)=U1(i,j)
43          end
44      end
45  end
46  disp(U,'U = ')
47  disp(Y,'Y = ')
48  X=inv(U)*Y
49  printf('\n\nHence, the solution is : \t')
50  for i=1:4
51      printf('x%i = %i  \t',i,X(i))
52  end
```

Scilab code Exa 3.16 Jacobi Method

```
1  //Example 3.16
2  //Jacobi Method
3  //Page no. 72
4  clc;clear;close;
5
```

```
x0=0;y0=0;z0=0;
deff('x=f1(y,z)','x=(y-z+10)/5')
deff('y=f2(x,z)','y=(-2*x+z+11)/8')
deff('z=f3(x,y)','z=(x-y+3)/4')
for i=1:13
    x1=f1(y0,z0);
    y1=f2(x0,z0);
    z1=f3(x0,y0);
    printf('\tx(%i) = %g\n\n\ty(%i) = %g\n\n\tz(%i)
       = %g\n\n\n',i,x1,i,y1,i,z1)
    x0=x1;y0=y1;z0=z1;
end
printf('Thus we find that solution converges to %g,
   %g and %g',x0,y0,z0)
```

Scilab code Exa 3.17 Gauss Seidel Method

```
//Example 3.17
//Gauss Seidel Method
//Page no. 73
clc;clear;close;

x0=0;y0=0;z0=0;
deff('x=f1(y,z)','x=(y-z+10)/5')
deff('y=f2(x,z)','y=(-2*x+z+11)/8')
deff('z=f3(x,y)','z=(x-y+3)/4')
for i=1:8
    x0=f1(y0,z0);
    y0=f2(x0,z0);
    z0=f3(x0,y0);
    printf('\tx(%i) = %g\n\n\ty(%i) = %g\n\n\tz(%i)
       = %g\n\n\n',i,x0,i,y0,i,z0)
end
printf('Thus we find that solution converges to %g,
   %g and %g',x0,y0,z0)
```

Scilab code Exa 3.18 Gauss Seidel Method

```
1 //Example 3.18
2 //Gauss Seidel Method
3 //Page no. 74
4 clc;clear;close;
5
6 x0=0;y0=0;z0=0;
7 deff('x=f1(y,z)','x=(110-y-z)/54')
8 deff('y=f2(x,z)','y=(72-2*x-6*z)/15')
9 deff('z=f3(x,y)','z=(85+x-6*y)/27')
10 for i=1:5
11     x0=f1(y0,z0);
12     y0=f2(x0,z0);
13     z0=f3(x0,y0);
14     printf('\tx(%i) = %g\n\n\ty(%i) = %g\n\n\tz(%i)
          = %g\n\n\n',i,x0,i,y0,i,z0)
15 end
16 printf('Thus we find that solution converges to %.3f
    , %.3f and %.3f',x0,y0,z0)
```

Scilab code Exa 3.19 Gauss Seidel Method

```
1 //Example 3.19
2 //Gauss Seidel Method
3 //Page no. 75
4 clc;clear;close;
5
6 x0=0;y0=0;z0=0;
7 deff('x=f1(y,z)','x=(32-4*y+z)/28')
8 deff('y=f2(x,z)','y=(35-2*x-4*z)/17')
```

```
deff('z=f3(x,y)','z=(24-x-3*y)/10')
for i=1:6
    x0=f1(y0,z0);
    y0=f2(x0,z0);
    z0=f3(x0,y0);
    printf('\tx(%i) = %g\n\n\ty(%i) = %g\n\n\tz(%i)
       = %g\n\n\n',i,x0,i,y0,i,z0)
end
printf('Thus we find that solution converges to %.4f
   , %.4f and %.4f',x0,y0,z0)
```

Scilab code Exa 3.20 Gauss Seidel Method

```
//Example 3.20
//Gauss Seidel Method
//Page no. 75
clc;clear;close;

x0=0;y0=0;z0=0;
deff('x=f1(y,z)','x=(17-y+2*z)/20')
deff('y=f2(x,z)','y=(-18-3*x+z)/20')
deff('z=f3(x,y)','z=(25-3*x+3*y)/20')
for i=1:3
    x0=f1(y0,z0);
    y0=f2(x0,z0);
    z0=f3(x0,y0);
    printf('\tx(%i) = %g\n\n\ty(%i) = %g\n\n\tz(%i)
       = %g\n\n\n',i,x0,i,y0,i,z0)
end
printf('Thus we find that solution converges to %.1g
   , %.1g and %.1g',x0,y0,z0)
```

Scilab code Exa 3.21 Relaxation Method

```
1  //Example 3.21
2  //Relaxation Method
3  //Page no. 79
4  clc;clear;close;
5
6  A=[10,-2,-2,-6;-1,10,-2,-7;-1,-1,10,-8]
7  deff('y=R(i,x,y,z)','y=A(i,1)*x+A(i,2)*y+A(i,3)*z+A(
       i,4)')
8  printf('dx\tdy\tdz\tdR1\tdR2\tdR3\n
       ----------------------------------------------------')
9  I=eye(3,3)
10 for i=1:3
11     printf('\n')
12     for j=1:3
13         printf(' %g\t',I(i,j))
14     end
15     for j=1:3
16         printf('%g\t',A(j,i))
17     end
18 end
19 printf('\n\n\n\n\n xi\tyi\tzi\tR1\tR2\tR3\n
       ----------------------------------------------------\n')
20 I1=[0,0,0;0,0,1;0,1,0;1,0,0]
21 for i=1:4
22     for j=1:3
23         l=0;
24         for k=1:i
25             l=l+I1(k,j)
26         end
27         I(i,j)=l
28     end
29 end
30 X=eye(1,6)-eye(1,6)
31 for i=1:4
32     printf('\n')
33     for j=1:3
34         printf(' %g\t',I1(i,j))
35         X(j)=X(j)+I1(i,j)
```

```
36      end
37      for j=1:3
38          printf('%g\t',R(j,I(i,1),I(i,2),I(i,3)))
39          if i==4 then
40              X(j+3)=X(j+3)+R(j,I(i,1),I(i,2),I(i,3))
41          end
42      end
43  end
44  printf('\n
    ------------------------------------------------\n')
45  for i=1:6
46      printf(' %g\t',X(i))
47  end
48  printf('\n\n\nHence the solution is \n\t x = %g\n\t
    y = %g\n\t z = %g',X(1),X(2),X(3))
```

Scilab code Exa 3.22 Relaxation Method

```
1  //Example 3.22
2  //Relaxation Method
3  //Page no. 80
4  clc;clear;close;
5
6  A=[10,-2,1,-12;1,9,-1,-10;2,-1,11,-20]
7  deff('y=R(i,x,y,z)','y=A(i,1)*x+A(i,2)*y+A(i,3)*z+A(
    i,4)')
8  printf('dx\tdy\tdz\tdR1\tdR2\tR3\n
    ------------------------------------------------')
9  I=eye(3,3)
10 for i=1:3
11     printf('\n')
12     for j=1:3
13         printf(' %g\t',I(i,j))
14     end
15     for j=1:3
```

```
16          printf('%g\t',A(j,i))
17      end
18  end
19  printf('\n\n\n\n\n xi\tyi\tzi\tR1\tR2\tR3\n
    ----------------------------------------------------\n')
20  I1
    =[0,0,0;0,0,2;0,1,0;1,0,0;0,0,-0.3;0.2,0,0;0,0.2,0;0,-0.03,0;-0.0

21  for i=1:10
22      for j=1:3
23          l=0;
24          for k=1:i
25              l=l+I1(k,j)
26          end
27          I(i,j)=l
28      end
29  end
30  X=eye(1,6)-eye(1,6)
31  for i=1:10
32      printf('\n')
33      for j=1:3
34          printf(' %g\t',I1(i,j))
35          X(j)=X(j)+I1(i,j)
36      end
37      for j=1:3
38          printf('%g\t',R(j,I(i,1),I(i,2),I(i,3)))
39          if i==10 then
40              X(j+3)=X(j+3)+R(j,I(i,1),I(i,2),I(i,3))
41          end
42      end
43  end
44  printf('\n
    ----------------------------------------------------\n')
45  for i=1:6
46      printf(' %g\t',X(i))
47  end
48  printf('\n\n\nHence the solution is \n\t x = %g\n\t
    y = %g\n\t z = %g',X(1),X(2),X(3))
```

Scilab code Exa 3.23 Relaxation Method

```
1  //Example 3.23
2  //Relaxation Method
3  //Page no. 81
4  clc;clear;close;
5
6  A=[10,-2,-3,-205;-2,10,-2,-154;-2,-1,10,-120]
7  deff('y=R(i,x,y,z)','y=A(i,1)*x+A(i,2)*y+A(i,3)*z+A(
       i,4)')
8  printf('dx\tdy\tdz\tdR1\tdR2\tdR3\n
       ----------------------------------------------------')
9  I=eye(3,3)
10 for i=1:3
11     printf('\n')
12     for j=1:3
13         printf(' %g\t',I(i,j))
14     end
15     for j=1:3
16         printf('%g\t',A(j,i))
17     end
18 end
19 printf('\n\n\n\n\n xi\tyi\tzi\tR1\tR2\tR3\n
       ----------------------------------------------------\n')
20 I1
       =[0,0,0;20,0,0;0,19,0;0,0,18;10,0,0;0,6,0;0,0,2;2,0,0;0,0,1;0,1,0]

21 for i=1:10
22     for j=1:3
23         l=0;
24         for k=1:i
25             l=l+I1(k,j)
26         end
27         I(i,j)=l
```

```
28      end
29  end
30  X=eye(1,6)-eye(1,6)
31  for i=1:10
32      printf('\n')
33      for j=1:3
34          printf(' %g\t',I1(i,j))
35          X(j)=X(j)+I1(i,j)
36      end
37      for j=1:3
38          printf('%g\t',R(j,I(i,1),I(i,2),I(i,3)))
39          if i==10 then
40              X(j+3)=X(j+3)+R(j,I(i,1),I(i,2),I(i,3))
41          end
42      end
43  end
44  printf('\n
    ----------------------------------------------------\n')
45  for i=1:6
46      printf(' %g\t',X(i))
47  end
48  printf('\n\n\nHence the solution is \n\t x = %g\n\t
    y = %g\n\t z = %g',X(1),X(2),X(3))
```

Chapter 4

Eigenvalues and Eigenvectors

Scilab code Exa 4.1 Power Method

```
1  //Example 4.1
2  //Power Method
3  //Page no. 89
4  clc;close;clear;
5
6  A=[1,3,-1;3,2,4;-1,4,10];
7  e=0.001;
8  q0=[0;0;1];
9  for i=1:5
10     q1=A*q0;
11     a=max(q1)
12     for j=1:3
13         q2(j)=q1(j)/a;
14     end
15     printf('\nq(%i) = %.4f      a = %.4f      Scaled
          q(%i) = %.3f\n        %.3f
                                                %.3f\n
                %.3f
                                                %i\n\n',
          i,q1(1),a,i,q2(1),q1(2),q2(2),q1(3),q2(3))
16     q1=q2;
```

```
17      q0=q1;
18  end
19  printf('Hence the largest eigenvalue is %.2f with
       the corresponding eigenvector as %.3f\n

      %.3f\n

      %i',a,q0(1),q0(2),q0(3))
```

Scilab code Exa 4.2 Power Method

```
1  //Example 4.2
2  //Power Method
3  //Page no. 90
4  clc;close;clear;
5
6  A=[1,-3,2;4,4,-1;6,3,5];
7  e=0.001;
8  q0=[1;1;1];
9  for i=1:9
10      q1=A*q0;
11      a=max(q1)
12      for j=1:3
13          q2(j)=q1(j)/a;
14      end
15      printf('\nq(%i) = %.4f      a = %.4f      Scaled
           q(%i) = %.3f\n        %.3f
                                                %.3f\n
                  %.3f
                                                    %i\n\n',
          i,q1(1),a,i,q2(1),q1(2),q2(2),q1(3),q2(3))
16      q1=q2;
17      q0=q1;
18  end
19  q0=q0*30
```

```
20 printf('Hence the largest eigenvalue is %.1g with
      the corresponding eigenvector as %.1g\n

   %.1g\n

   %i',a,q0(1),q0(2),q0(3))
```

Scilab code Exa 4.3 Power Method

```
1  //Example 4.3
2  //Power Method
3  //Page no. 91
4  clc;close;clear;
5
6  A=[2,-1,0;-1,2,-1;0,-1,2];
7  e=0.001;
8  q0=[1;1;1];
9  for i=1:6
10     q1=A*q0;
11     a=max(q1)
12     for j=1:3
13         q2(j)=q1(j)/a;
14     end
15     printf('\nq(%i) = %.4f      a = %.4f       Scaled
          q(%i) = %.3f\n        %.3f
                                              %.3f\n
                 %.3f
                                                    %i\n\n',
          i,q1(1),a,i,q2(1),q1(2),q2(2),q1(3),q2(3))
16     q1=q2;
17     q0=q1;
18 end
19 q0=-q0/q0(2)
20 printf('Hence the largest eigenvalue is %.3f with
      the corresponding eigenvector as %.1f\n
```

```
%.1g\n

%.1f',a,q0(1),q0(2),q0(3))
```

Scilab code Exa 4.4 Power Method

```
1  //Example 4.4
2  //Power Method
3  //Page no. 93
4  clc;close;clear;
5
6  A=[3,-1,0;-1,2,-1;0,-1,3];
7  e=0.001;
8  q0=[1;1;1];
9  for i=1:5
10     q1=A*q0;
11     a=max(q1)
12     for j=1:3
13         q2(j)=q1(j)/a;
14     end
15     printf('\nq(%i) = %.4f      a = %.4f       Scaled
          q(%i) = %.3f\n        %.3f
                                          %.3f\n
                 %.3f
                                                  %i\n\n',
          i,q1(1),a,i,q2(1),q1(2),q2(2),q1(3),q2(3))
16     q1=q2;
17     q0=q1;
18 end
19 q0=-q0/q0(2)
20 printf('Hence the largest eigenvalue is %.1g with
      the corresponding eigenvector as %.1g\n

   %.1g\n
```

```
%.1g',a,q0(1),q0(2),q0(3))
```

Scilab code Exa 4.5 Jacobi Method

```
1  //Example 4.5
2  //Jacobi Method
3  //Page no. 95
4  clc;close;clear;
5
6  A=[10,7,8,7;7,5,6,5;8,6,10,9;7,5,9,10];
7  n=4;
8  for k=1:14
9      max1=0
10 for i=1:n
11     for j=1:n
12         if A(i,j)>max1 & i~=j then
13             max1=A(i,j)
14             i1=i;j1=j;
15         end
16     end
17 end
18 fi=(atan((2*A(i1,j1))/(A(i1,i1)-A(j1,j1)+10^-20)))/2
19 disp(fi,'fi = ')
20 O1=eye(n,n)
21 O1(i1,j1)=-sin(fi)
22 O1(j1,i1)=sin(fi)
23 O1(i1,i1)=cos(fi)
24 O1(j1,j1)=cos(fi)
25 disp(O1,'O1 = ')
26 A=inv(O1)*A*O1
27 disp(A,'A1 = ')
28 end
29 printf('\n\n The eigenvalues are : \n\n')
30 for i=1:n
```

```
31      printf('\tl%i = %g\t',i,A(i,i))
32  end
33  printf('\n\n')
34  l=poly(0,'lb')
35  A=A-l*eye(n,n)
36  disp(det(A),'Characteristic Equation = ')
37  printf("\n\n\n\nNote : Computation Errors in some
       parts in calculation performed in book")
```

Scilab code Exa 4.6 Jacobi Method

```
1  //Example 4.6
2  //Jacobi Method
3  //Page no. 97
4  clc;close;clear;
5
6  A=[1,sqrt(2),2;sqrt(2),3,sqrt(2);2,sqrt(2),1];
7  C=A;
8  V=[sqrt(2),0,1/2;sqrt(2),0,1/4;3/(4*sqrt(2)),-1/(4*
       sqrt(2)),2]
9  S=eye(3,3)
10 disp(A,"A =")
11 VI=0;
12 for i=1:3
13      for j=1:3
14          if(i~=j)
15              VI=VI+A(i,j)^2
                    //initial off diag norm
16          end
17      end
18 end
19 VI=sqrt(VI);
20 VF=VI*10^-7;          //final threshold
21 V1=VI/3;
22 o=poly(0,"o");
```

```
for i=1:3
for q=2:3
    for p=q-1:-1:1
        if(A(p,q)>V1)
            a=-A(p,q);
            b=(A(p,p)-A(q,q))/2
            if(b~=0)
                w=b*abs(1/b)*(a/sqrt(a^2+b^2));
            else
                w=(a/sqrt(a^2+b^2));
            end
            sin0=w/sqrt(2*(1+sqrt(1-w^2)));
            cos0=sqrt(1-sin0^2)
        end
        B(p,p)=A(p,p)*cos0^2+A(q,q)*sin0^2-2*A(p,q)*
           sin0*cos0
            B(q,q)=A(p,p)*sin0^2+A(q,q)*cos0^2+2*A(p
               ,q)*sin0*cos0
            B(p,q)=(A(p,p)-A(q,q))*sin0*cos0+A(p,q)
               *(cos0^2-sin0^2)
            S(i,i)=S(i,i)
            S(i,p)=S(i,p)*cos0-S(i,q)*sin0
            S(i,q)=S(i,p)*sin0+S(i,q)*cos0

    end
end
end
disp(B,"B =")
disp(S,"S =")
printf('\n\n\nComputation error in the solution
   provided by book')
```

Scilab code Exa 4.7 Jacobi Method

```
1 //Example 4.7
```

```
2  //Jacobi Method
3  //Page no. 99
4  clc;close;clear;
5
6  A=[2,3,1;3,2,2;1,2,1];
7  n=3;
8  for k=1:10
9      max1=0
10 for i=1:n
11     for j=1:n
12         if A(i,j)>max1 & i~=j then
13             max1=A(i,j)
14             i1=i;j1=j;
15         end
16     end
17 end
18 fi=(atan((2*A(i1,j1))/(A(i1,i1)-A(j1,j1)+10^-20)))/2
19 disp(fi,'fi = ')
20 O1=eye(n,n)
21 O1(i1,j1)=-sin(fi)
22 O1(j1,i1)=sin(fi)
23 O1(i1,i1)=cos(fi)
24 O1(j1,j1)=cos(fi)
25 disp(O1,'O1 = ')
26 A=inv(O1)*A*O1
27 disp(A,'A1 = ')
28 end
29 printf('\n\n The eigenvalues are : \n\n')
30 for i=1:n
31     printf('\tl%i = %g\t',i,A(i,i))
32 end
```

Scilab code Exa 4.8 Jacobi Method

```
1  //Example 4.8
```

```
2 //Givens Method
3 //Page no. 103
4 clc;close;clear;
5
6 A=[2,3,1;3,2,2;1,2,1];
7 n=3;
8 for k=1:1
9     max1=0
10 i1=2;j1=3;
11 fi=(atan((2*A(i1,j1))/(A(i1,i1)-A(j1,j1)+10^-20)))/2
12 disp(fi,'fi = ')
13 O1=eye(n,n)
14 O1(i1,j1)=-sin(fi)
15 O1(j1,i1)=sin(fi)
16 O1(i1,i1)=cos(fi)
17 O1(j1,j1)=cos(fi)
18 disp(O1,'O1 = ')
19 A=inv(O1)*A*O1
20 disp(A,'B = ')
21 end
22 printf('\n\n')
23 l=poly(0,'lb')
24 A=A-l*eye(n,n)
25 disp(-det(A),'Characteristic Equation = ')
26 A=roots(det(A))
27 printf('\n\n The approximate roots of characteristic
    equation are: \n\n')
28 for i=1:n
29     printf('\tl%i = %g\t',i,A(i))
30 end
```

Scilab code Exa 4.9 Givens Method

```
1 //Example 4.9
2 //Givens Method
```

```
3  //Page no. 104
4  clc;close;clear;
5
6  A=[3,2,1;2,3,2;1,2,3];
7  n=3;
8  for k=1:1
9      max1=0
10 i1=2;j1=3;
11 fi=(atan((2*A(i1,j1))/(A(i1,i1)-A(j1,j1)+10^-20)))/2
12 disp(fi,'fi = ')
13 O1=eye(n,n)
14 O1(i1,j1)=-sin(fi)
15 O1(j1,i1)=sin(fi)
16 O1(i1,i1)=cos(fi)
17 O1(j1,j1)=cos(fi)
18 disp(O1,'O1 = ')
19 A=inv(O1)*A*O1
20 disp(A,'B = ')
21 end
22 printf('\n\n')
23 l=poly(0,'lb')
24 A=A-l*eye(n,n)
25 disp(-det(A),'Characteristic Equation = ')
26 A=roots(det(A))
27 printf('\n\n The eigenvalues are : \n\n')
28 for i=1:n
29     printf('\tl%i = %g\t',i,A(i))
30 end
```

Scilab code Exa 4.10 Givens Method

```
1  //Example 4.10
2  //Givens Method
3  //Page no. 105
4  clc;close;clear;
```

```
5
6  A=[8,-6,2;-6,7,-4;2,-4,3];
7  n=3;
8  for k=1:1
9      max1=0
10 i1=2;j1=3;
11 fi=(atan((2*A(i1,j1))/(A(i1,i1)-A(j1,j1)+10^-20)))/2
12 disp(fi,'fi = ')
13 O1=eye(n,n)
14 O1(i1,j1)=-sin(fi)
15 O1(j1,i1)=sin(fi)
16 O1(i1,i1)=cos(fi)
17 O1(j1,j1)=cos(fi)
18 disp(O1,'O1 = ')
19 A=inv(O1)*A*O1
20 disp(A,'B = ')
21 end
22 printf('\n\n')
23 l=poly(0,'lb')
24 A=A-l*eye(n,n)
25 disp(det(A),'Characteristic Equation = ')
26 A=roots(det(A))
27 printf('\n\n The eigenvalues are : \n\n')
28 for i=1:n
29     printf('\tl%i = %g\t',i,A(i))
30 end
```

Scilab code Exa 4.11 Givens Method

```
1  //Example 4.11
2  //Givens Method
3  //Page no. 106
4  clc;close;clear;
5
6  A=[1,2,2;2,1,2;2,2,1];
```

```
n=3;
for k=1:1
    max1=0
i1=2;j1=3;
fi=(atan((2*A(i1,j1))/(A(i1,i1)-A(j1,j1)+10^-20)))/2
disp(fi,'fi = ')
O1=eye(n,n)
O1(i1,j1)=-sin(fi)
O1(j1,i1)=sin(fi)
O1(i1,i1)=cos(fi)
O1(j1,j1)=cos(fi)
disp(O1,'O1 = ')
A=inv(O1)*A*O1
disp(A,'B = ')
end
printf('\n\n')
l=poly(0,'lb')
A=A-l*eye(n,n)
disp(-det(A),'Characteristic Equation = ')
A=roots(det(A))
printf('\n\n The eigenvalues are : \n\n')
for i=1:n
    printf('\tl%i = %g\t',i,A(i))
end
```

Scilab code Exa 4.12 Givens Method

```
//Example 4.12
//Givens Method
//Page no. 107
clc;close;clear;

A=[1,2,2,2;2,1,2,2;2,2,1,3;2,2,3,1];
n=4;
for k=1:3
```

```
    max1=0
    if k==1 then
        i1=2;j1=3;
    elseif k==2
        i1=2;j1=4;
    else
        i1=3;j1=4;
    end
fi=(atan((2*A(i1,j1))/(A(i1,i1)-A(j1,j1)+10^-20)))/2
disp(fi,'fi = ')
O1=eye(n,n)
O1(i1,j1)=-sin(fi)
O1(j1,i1)=sin(fi)
O1(i1,i1)=cos(fi)
O1(j1,j1)=cos(fi)
disp(O1,'O1 = ')
A=inv(O1)*A*O1
disp(A,'B = ')
end
printf('\n\n')
l=poly(0,'lb')
A=A-l*eye(n,n)
disp(-det(A),'Characteristic Equation = ')
A=roots(det(A))
printf('\n\n The eigenvalues are : \n\n')
for i=1:n
    printf('\tl%i = %g\t',i,A(i))
end
```

Scilab code Exa 4.13 House Holder Transformation

```
//Example 4.13
//House Holder Transformation
//Page no. 113
clc;clear;close;
```

```
5
6  A=[3,2,1;2,3,2;1,2,3]
7  disp(A,'A=')
8  k=0;
9  for j=2:3
10     k=k+A(j,1)^2;
11 end
12 a=A(2,1)*abs(1/A(2,1))*sqrt(k);
13 disp(a,'alpha=')
14 U=[0;a+A(2,1);A(3,1)];
15 disp(U,'U=')
16 U1=U'*U;
17 disp(U1,'UT*U=')
18 U2=U*U';
19 disp(U2,'U*UT=')
20 P=eye(3,3)-(2*U2)/U1;
21 disp(P,'P=');
22 B=P*A*P;
23 disp(B,'B=');
```

Scilab code Exa 4.14 House Holder Transformation

```
1  //Example 4.14
2  //House Holder Transformation
3  //Page no. 114
4  clc;clear;close;
5
6  A=[1,3,4;3,1,2;4,2,1]
7  disp(A,'A=')
8  k=0;
9  for j=2:3
10     k=k+A(j,1)^2;
11 end
12 a=A(2,1)*abs(1/A(2,1))*sqrt(k);
13 disp(a,'alpha=')
```

```
14 U=[0;a+A(2,1);A(3,1)];
15 disp(U,'U=')
16 U1=U'*U;
17 disp(U1,'UT*U=')
18 U2=U*U';
19 disp(U2,'U*UT=')
20 P=eye(3,3)-(2*U2)/U1;
21 disp(P,'P=');
22 B=P*A*P;
23 disp(B,'B=');
```

Scilab code Exa 4.15 Strum Sequence

```
1  //Example 4.15
2  //Strum Sequence
3  //Page no. 116
4  clc;clear;close;
5
6  A=[1,2,2;2,1,2;2,2,1]
7  disp(A,'A=')
8  k=0;
9  for j=2:3
10     k=k+A(j,1)^2;
11 end
12 a=A(2,1)*abs(1/A(2,1))*sqrt(k);
13 U=[0;a+A(2,1);A(3,1)];
14 U1=U'*U;
15 U2=U*U';
16 P=eye(3,3)-(2*U2)/U1;
17 B=P*A*P;
18 disp(B,'Reduced Matrix = ');
19 lb=poly(0,"lb")
20 f0l=1;                                    //strum
     sequence
21 f1l=(B(1,1)-lb)*f0l;
```

```
22 f2l=(B(2,2)-lb)*f1l-B(1,2)^2*f0l
23 f3l=(B(3,3)-lb)*f2l-B(2,3)^2*f1l
24 disp(f3l,"f3(lambda) = ")
25 disp(roots(f3l),"Therefore the eigenvalues are : ")
```

Scilab code Exa 4.16 Strum Sequence

```
1  //Example 4.16
2  //Strum Sequence
3  //Page no. 117
4  clc;clear;close;
5
6  A=[8,-6,2;-6,7,-4;2,-4,3]
7  disp(A,'A=')
8  k=0;
9  for j=2:3
10     k=k+A(j,1)^2;
11 end
12 a=A(2,1)*abs(1/A(2,1))*sqrt(k);
13 U=[0;a+A(2,1);A(3,1)];
14 U1=U'*U;
15 U2=U*U';
16 P=eye(3,3)-(2*U2)/U1;
17 B=P*A*P;
18 disp(B,'Reduced Matrix = ');
19 lb=poly(0,"lb")
20 f0l=1;                                    //strum
     sequence
21 f1l=(B(1,1)-lb)*f0l;
22 f2l=(B(2,2)-lb)*f1l-B(1,2)^2*f0l
23 f3l=(B(3,3)-lb)*f2l-B(2,3)^2*f1l
24 disp(f3l,"f3(lambda) = ")
25 disp(roots(f3l),"Therefore the eigenvalues are : ")
```

Scilab code Exa 4.17 Gerschgorin Circles

```
1  //Example 4.17
2  //Gerschgorin Circles
3  //Page no. 118
4  clc;clear;close;
5
6  A=[1,2,3;2,4,6;3,6,1];
7  j=2;
8  k=3;
9  printf('The Gerschgorin Circles are : \n\n  A =' )
10 for i=1:3
11     printf('\t|z-%i| = |%i| + |%i| = %i\n',A(i,i),A(
           i,j),A(i,k),A(i,j)+A(i,k))
12     if j~=1 then
13         j=j-1
14     end
15     if i==2 then
16         k=k-1
17     end
18 end
```

Chapter 5

Finite Differences and Interpolation

Scilab code Exa 5.1 Backward Difference Formula

```
1 //Example 5.1
2 //Backward Difference Formula
3 //Page no. 124
4 clc;close;clear;
5 printf('\tx\t\ty\t1st Difference    2nd Difference
    3rd Difference  4th Difference\n')
6 printf('
    ----------------------------------------------------------------------
    ')
7 h=0.02;
8 z=[-1;0;1;2;3;4;5]
9 deff('y=f(x)','y=x^3-3*x^2+5*x-7')
10 for i=1:7
11     z(i,2)=f(z(i,1))
12 end
13 for i=3:8
14     for j=1:9-i
15         z(j,i)=z(j+1,i-1)-z(j,i-1)
16     end
```

```
17 end
18 printf('\n')
19 for i=1:7
20     for j=1:6
21         if z(i,j)==0 then
22             printf('\t%i\t',z(i,j))
23         else
24             printf('\t%i\t',z(i,j))
25         end
26     end
27     printf('\n')
28 end
```

Scilab code Exa 5.3 Factorial Notation Method

```
1  //Example 5.3
2  //Factorial Notation Method
3  //Page no. 131
4  clc;close;clear;
5
6  h=0.00000001;h1=0000000.1
7  deff('y=f(x)','y=x^3-2*x^2+x-1')
8  deff('y=f1(x)','y=x*(x-1)*(x-2)')
9  deff('y=f2(x)','y=x*(x-1)')
10 for i=0:2
11     A(i+1,1)=f2(i);
12     A(i+1,2)=i;
13     A(i+1,3)=1
14     B(i+1,1)=f(i)-f1(i)
15 end
16 x=poly(0,'x')
17 C=inv(A)*B
18 disp(C(3),'+',C(2)*x,'+',C(1)*f2(x),'+',f(x))
19 printf('\n\nf(x) = ')
20 deff('y=f3(x)','y=C(3)+C(2)*x+C(1)*f2(x)+f(x)')
```

```
disp(f3(x))
deff('y=f4(x)','y=(f3(x+h)-f3(x))/h')    //1st
    derivative
disp(f4(x),'dx = ')
deff('y=f5(x)','y=(f4(x+h1)-f4(x))/h1')    //2nd
    derivative
disp(f5(x),'d2x = ')
deff('y=f6(x)','y=(f5(x+h1)-f5(x))/h1')    //3rd
    derivative
disp(f6(x),'d3x = ')
deff('y=f7(x)','y=(f6(x+h1)-f6(x))/h1')    //4th
    derivative
disp(f7(x),'d4x = ')
```

Scilab code Exa 5.5 Finite Differences

```
//Example 5.5
//Finite Differences
//Page no. 132
clc;close;clear;
printf('   x\t f(x)\tdf(x)\t     d2f(x)\td3f(x)\t
          d4f(x)\n')
printf('
    ------------------------------------------------------------------------------
    ')
x=[0,1;1,3;2,9;3,poly(0,"y3");4,81]
for i=3:6
    for j=1:7-i
        x(j,i)=x(j+1,i-1)-x(j,i-1)
    end
end
disp(x)
disp(roots(x(1,6)),"y3 = ")
```

Scilab code Exa 5.6 Finite Differences

```
1 //Example 5.6
2 //Finite Differences
3 //Page no. 132
4 clc;close;clear;
5 printf('   x\t f(x)\t   df(x)\t    d2f(x)     d3f(x)
     d4f(x)\n')
6 printf('
     ------------------------------------------------------------------------------
     ')
7 x=[0,3;1,12;2,81;3,2000;4,100]
8 for i=3:6
9     for j=1:7-i
10         x(j,i)=x(j+1,i-1)-x(j,i-1)
11     end
12 end
13 disp(x)
14 disp(x(1,6),"d4 y(0) = ")
```

Scilab code Exa 5.11 Finite Differences

```
1 //Example 5.11
2 //Finite Differences
3 //Page no. 136
4 clc;close;clear;
5 printf('   x\t f(x)\tdf(x)   d2f(x)   d3f(x) d4f(x)\n'
     )
6 printf('
     ------------------------------------------------------------------------------
     ')
7 x=[0,-5;1,1;2,9;3,25;4,55;5,105]
```

```
for i=3:6
    for j=1:8-i
        x(j,i)=x(j+1,i-1)-x(j,i-1)
    end
end
disp(x)
x1=poly(0,"x")
fx=x(1,2)+x1*x(1,3)+(x1^2-x1)*x(1,4)/2+(x1^3-3*x1
   ^2+2*x1)*x(1,5)/6
disp("is the required polynomial",fx)
```

Scilab code Exa 5.16 Finite Differences

```
//Example 5.16
//Finite Differences
//Page no. 138
clc;close;clear;

printf('   x\tf(x)\tdf(x)  d2f(x)  d3f(x) d4f(x)\n')
printf('
   ------------------------------------------------\n'
   )
x=[0,1;1,-1;2,1;3,-1;4,1;5,0;6,0;7,0];
for i=3:6
    for j=1:8-i
        if x(j+1,i-1)~=0 then
            x(j,i)=x(j+1,i-1)-x(j,i-1)
        end
    end
end
k=-9;
for i=1:8
    printf('    ')
    for j=1:6
        if i==j+k then
```

```
21              break
22          elseif x(i,j)==0 & j~=1 & j~=2 then
23              printf('d%iy%i\t',j-1,i-1)
24          elseif x(i,j)==0 & i~=1
25              printf('y%i\t',i-1)
26          else
27              printf('%i\t',x(i,j))
28          end
29      end
30      printf('\n')
31      k=k+2
32  end
33  x1=poly(0,"x")
34  fx=x(1,2)+x1*x(1,3)+(x1^2-x1)*x(1,4)/2+(x1^3-3*x1
       ^2+2*x1)*x(1,5)/6
35  for i=1:3
36      x(1+i,6)=16;
37      printf('\nd5y%i = 16',i)
38  end
39  printf('\nElements should be constant\n\n');
40  i=1;k=2;
41  for j=5:-1:2
42      while i<4
43          x(k+1,j)=x(k,j)+x(k,j+1);
44          if j>2 then
45              printf('\nd%iy%i = %i',j-1,k,x(k+1,j))
46          else
47              printf('\ny%i = %i',k,x(k+1,j))
48          end
49          k=k+1;
50          i=i+1;
51      end
52      i=1;k=k-2;
53  end
```

Scilab code Exa 5.17 Error Propagation

```
1 //Example 5.17
2 //Error Propagation
3 //Page no. 140
4 clc;close;clear;
5 printf('   x\t      y\t\tdy\td2y\t    d3y\t          d4y
     \t  d5y\n')
6 printf('
     ------------------------------------------------------------------------------
     ')
7 x
     =[1,1;1.1,1.5191;1.2,2.0736;1.3,2.6611;1.4,3.2816;1.5,3.9375;1.6,4

8 for i=3:7
9     for j=1:13-i
10        x(j,i)=x(j+1,i-1)-x(j,i-1)
11    end
12 end
13 disp(x)
14 for i=1:11
15    if abs(x(i,7))<10^-5 then
16        continue
17    else
18        break
19    end
20 end
21 printf("\n\Therefore the error is in the value
     corresponding to %g i.e. %g",x(i+5,1),x(i+5,2))
```

Scilab code Exa 5.18 Error Propagation

```
1 //Example 5.18
2 //Error Propagation
3 //Page no. 141
```

```
clc;close;clear;
printf('   x\t      y\t\tdy\td2y\t    d3y\t          d4y
   \t  d5y\n')
printf('
   ------------------------------------------------------------------------------
   ')
x
   =[0,2;1,5;2,8;3,17;4,38;5,75;6,140;7,233;8,362;9,533;10,752]

for i=3:6
    for j=1:13-i
        x(j,i)=x(j+1,i-1)-x(j,i-1)
    end
end
disp(x)
for i=1:11
    if abs(x(i,6))<10^-5 then
        continue
    else
        break
    end
end
printf("\n\Therefore the error is in the value
   corresponding to %g i.e. %g",x(i+4,1),x(i+4,2))
```

Scilab code Exa 5.20 Newtons Forward Difference Formula

```
//Example 5.20
//Newtons Forward Difference Formula
//Page no. 144
clc;close;clear;
printf(' x\t  sin x\t\t   1st\t\t   2nd\t\t   3rd\t\
   t   4th\t\t   5th\n\t\t\tdifference\tdifference\
   tdifference\tdifference\tdifference\t')
printf('\n
```

```
    ')
h=0.2;
z
    =[0.5,0.47943;0.7,0.64422;0.9,0.78333;1.1,0.89121;1.3,0.96356;1.5

deff('y=f(x,p)','y=z(x,2)+p*z(x,3)+p*(p+1)*z(x,4)/2+
    p*(p+1)*(p+2)*z(x,5)/6+p*(p+1)*(p+2)*(p+3)*z(x,6)
    /24')
deff('y=f1(x,p)','y=z(x,2)+p*z(x,3)+p*(p-1)*z(x,4)
    /2+p*(p-1)*(p-2)*z(x,5)/6+p*(p-1)*(p-2)*(p-3)*z(x
    ,6)/24+p*(p-1)*(p-2)*(p-3)*(p-4)*z(x,7)/120')
x01=0.5;x11=0.54;
x02=1.3;x12=1.36
for i=3:7
    for j=1:8-i
        z(j,i)=z(j+1,i-1)-z(j,i-1)
    end
end
printf('\n')
for i=1:6
    for j=1:7
        if z(i,j)==0 then
            printf(' \t')
        else
            if j==1 then
                printf(' %.1f\t',z(i,j))
            else
                printf('%.7f\t',z(i,j))
            end
        end
    end
    printf('\n')
end
p=(x11-x01)/h;
disp(f1(1,p),"fp (0.54) =");
p=(x12-x02)/h;
disp(f(5,p),"fp (1.36) =");
```

Scilab code Exa 5.21 Newtons Forward Difference Formula

```
1  //Example 5.21
2  //Newton's Forward Difference Formula
3  //Page no. 145
4  clc;close;clear;
5  printf(' x\t  f(x)\t\t   1st\t\t   2nd\t\t   3rd\t\t
       \n\t\t\tdifference\tdifference\tdifference\t')
6  printf('\n
       ----------------------------------------------------------------------
       ')
7  h=1;
8  z=[0,-4;1,-1;2,2;3,11;4,32;5,71]
9  deff('y=f1(x,p)','y=z(x,2)+p*z(x,3)+p*(p-1)*z(x,4)
       /2+p*(p-1)*(p-2)*z(x,5)/6')
10 x01=0;x11=6;
11 x02=2;x12=2.5
12 for i=3:7
13     for j=1:8-i
14         z(j,i)=z(j+1,i-1)-z(j,i-1)
15     end
16 end
17 printf('\n')
18 for i=1:6
19     for j=1:5
20         if z(i,j)==0 & i~=1 then
21             printf(' \t')
22         else
23             if j==1 then
24                 printf(' %.1f\t',z(i,j))
25             else
26                 printf('%.7f\t',z(i,j))
27             end
28         end
```

```
29      end
30      printf('\n')
31  end
32  x=poly(0,'x')
33  l=z(1,2)+x*z(1,3)+x*(x-1)*z(1,4)/2+x*(x-1)*(x-2)*z
       (1,5)/6
34  disp(l,"The required equation is :")
35  p=(x11-x01)/h;
36  disp(f1(1,p),"fp (6) =");
37  p=(x12-x02)/h;
38  disp(f1(3,p),"fp (2.5) =");
```

Scilab code Exa 5.22 Newtons Forward Difference Formula

```
1  //Example 5.22
2  //Newton's Forward Difference Formula
3  //Page no. 147
4  clc;close;clear;
5  printf(' x\t  y\t\t   1st\t\t   2nd\t\t   3rd\t\t\n\
       t\t\tdifference\tdifference\tdifference\t')
6  printf('\n
       ----------------------------------------------------------------------------
       ')
7  h=1;
8  z=[0,-3;1,3;2,11;3,27;4,57;5,107]
9  deff('y=f1(x,p)','y=z(x,2)+p*z(x,3)+p*(p-1)*z(x,4)
       /2+p*(p-1)*(p-2)*z(x,5)/6')
10 x01=0;x11=6;
11 x02=2;x12=2.5
12 for i=3:7
13      for j=1:8-i
14          z(j,i)=z(j+1,i-1)-z(j,i-1)
15      end
16 end
17 printf('\n')
```

```
for i=1:6
    for j=1:5
        if z(i,j)==0 & i~=1 then
            printf(' \t')
        else
            if j==1 then
                printf(' %.1f\t',z(i,j))
            else
                printf('%.7f\t',z(i,j))
            end
        end
    end
    printf('\n')
end
x=poly(0,'x')
l=z(1,2)+x*z(1,3)+x*(x-1)*z(1,4)/2+x*(x-1)*(x-2)*z
   (1,5)/6
disp(l,"The required equation is :")
```

Scilab code Exa 5.23 Newtons Forward Difference Formula

```
//Example 5.23
//Newton's Forward Difference Formula
//Page no. 147
clc;close;clear;
printf(' x\t  y\t d1\td2\td3\td4\t')
printf('\n
   ----------------------------------------------------------------------------
   ')
h=5;
z=[80,5026;85,5674;90,6362;95,7088;100,7854]
deff('y=f(x,p)','y=z(x,2)+p*z(x-1,3)+p*(p+1)*z(x
   -2,4)/2+p*(p+1)*(p+2)*z(x-3,5)/6+p*(p+1)*(p+2)*(p
   +3)*z(x-4,6)/24')
x01=100;x11=105;
```

```
for i=3:7
    for j=1:7-i
        z(j,i)=z(j+1,i-1)-z(j,i-1)
    end
end
printf('\n')
for i=1:5
    for j=1:6
        if z(i,j)==0 then
            printf(' \t')
        else
            if j==1 then
                printf(' %i\t',z(i,j))
            else
                printf('%i\t',z(i,j))
            end
        end
    end
    printf('\n')
end
x=poly(0,'x')
l=z(1,2)+x*z(1,3)+x*(x-1)*z(1,4)/2+x*(x-1)*(x-2)*z
   (1,5)/6
disp(l,"The required equation is :")
p=(x11-x01)/h;
disp(f(5,p),"fp (105) =");
```

Scilab code Exa 5.24 Central Difference Derivatives

```
//Example 5.24
//Central Difference Derivatives
//Page no. 160
clc;close;clear;
printf('   x\t\t    y\t\t    d\t\t    d2\t\t    d3\t
   \t    d4\n')
```

```
printf('
   ------------------------------------------------------------------------------
   ')
h=0.01;s=0.5;
deff('y=f1(x,p)','y=z(x,2)+p*z(x,3)+p*(p-1)*(z(x,4)+
   z(x-1,4))/4')
z
   =[0.01,98.4342;0.02,48.4392;0.03,31.7775;0.04,23.4492;0.05,18.454

for i=3:6
    for j=1:7-i
        z(j,i)=z(j+1,i-1)-z(j,i-1)
    end
end
printf('\n')
for i=1:5
    for j=1:6
        if z(i,j)==0 then
            printf(' \t')
        else
            printf('%.7f\t',z(i,j))
        end
    end
    printf('\n')
end
x00=0.03;x01=0.0341;
p=(x01-x00)/h
printf('\n\nf(0.0341) = %g',f1(3,p))
```

Scilab code Exa 5.27 Central Difference Derivatives

```
//Example 5.27
//Divided Difference Interpolation
//Page no. 165
clc;close;clear;
```

```
5
6  x=[-4,-1,0,2,5]
7  y=[1245,33,5,9,1335];
8  y1=y;
9  deff('yi=P(a,b,d,e)','yi=(b(d+1)-b(d))/(a(d+e)-a(d))
       ')  //function for finding polynomials
10 for i=1:4
11     for j=1:5-i
12         z(j,i)=P(x,y,j,i)
13          y(j)=z(j,i)
14     end
15 end
16 z(6,1)=0;
17 printf('x\ty        f(x0,x1)        f(x0,x1,x3)      f(x0,
       x1,x2,x3)      f(x0,x1,x2,x3,x4)\n')
18 printf('
       ------------------------------------------------------------------------------
       n')
19     for j=1:5
20         printf(' %i\t%i \t%i\t\t%i\t\t%i\t\t      %i\
              n',x(1,j),y1(1,j),z(j,1),z(j,2),z(j,3),z(
              j,4))
21     end
22     x1=poly(0,'x')
23     fx=y1(1)+(x1-x(1))*z(1,1)+(x1-x(1))*(x1-x(2))*z
          (1,2)+(x1-x(1))*(x1-x(2))*(x1-x(3))*z(1,3)+(
          x1-x(1))*(x1-x(2))*(x1-x(3))*(x1-x(4))*z(1,4)
24     disp(fx,"The Required Equation = ")
```

Scilab code Exa 5.28 Divided Difference Interpolation

```
1  //Example 5.28
2  //Divided Difference Interpolation
3  //Page no. 167
4  clc;close;clear;
```

```
5
6  x=[-1,0,3,6,7]
7  y=[3,-6,39,822,1611];
8  y1=y;
9  deff('yi=P(a,b,d,e)','yi=(b(d+1)-b(d))/(a(d+e)-a(d))
       ')  //function for finding polynomials
10 for i=1:4
11     for j=1:5-i
12         z(j,i)=P(x,y,j,i)
13          y(j)=z(j,i)
14     end
15 end
16 z(6,1)=0;
17 printf('x\ty        f(x0,x1)        f(x0,x1,x3)      f(x0,
       x1,x2,x3)      f(x0,x1,x2,x3,x4)\n')
18 printf('
       ------------------------------------------------------------------------------
       n')
19     for j=1:5
20         printf(' %i\t%i \t%i\t\t%i\t\t%i\t\t      %i\
              n',x(1,j),y1(1,j),z(j,1),z(j,2),z(j,3),z(
              j,4))
21     end
22     x1=poly(0,'x')
23     fx=y1(1)+(x1-x(1))*z(1,1)+(x1-x(1))*(x1-x(2))*z
          (1,2)+(x1-x(1))*(x1-x(2))*(x1-x(3))*z(1,3)+(
          x1-x(1))*(x1-x(2))*(x1-x(3))*(x1-x(4))*z(1,4)
24     disp(fx,"The Required Equation = ")
```

Scilab code Exa 5.29 Divided Difference Interpolation

```
1  //Example 5.29
2  //Divided Difference Interpolation
3  //Page no. 167
4  clc;close;clear;
```

```
5
6  x=[4,5,7,10,11,13]
7  y=[48,100,294,900,1210,2028];
8  y1=y;
9  deff('yi=P(a,b,d,e)','yi=(b(d+1)-b(d))/(a(d+e)-a(d))
       ')  //function for finding polynomials
10 for i=1:6
11     for j=1:6-i
12         z(j,i)=P(x,y,j,i)
13          y(j)=z(j,i)
14     end
15 end
16 z(6,1)=0;
17 printf('x\ty        f(x0,x1)       f(x0,x1,x3)      f(x0,
       x1,x2,x3)      f(x0,x1,x2,x3,x4)\n')
18 printf('
       ------------------------------------------------------------------------------
       n')
19     for j=1:5
20         printf(' %i\t%i \t%i\t\t%i\t\t%i\t\t      %i
                  %i\n',x(1,j),y1(1,j),z(j,1),z(j,2),z(
              j,3),z(j,4),z(j,5))
21     end
22     deff('y=f(x1)','y=y1(1)+(x1-x(1))*z(1,1)+(x1-x
          (1))*(x1-x(2))*z(1,2)+(x1-x(1))*(x1-x(2))*(x1
          -x(3))*z(1,3)')
23     printf('\n\nf(8) = %g',f(8))
24     printf('\n\nf(15) = %i',f(15))
```

Scilab code Exa 5.30 Maximum Error in Interpolation

```
1  //Example 5.30
2  //Maximum Error in Interpolation
3  //Page no. 169
4  clc;close;clear;
```

```
5  s=1;
6  for i=0:6
7      s=s*((5*%pi)/24-i*%pi/12)
8  end
9  s=s/factorial(7)
10 printf('Maximum Error = %g',s)
```

Scilab code Exa 5.32 Divided Difference Interpolation

```
1  //Example 5.32
2  //Divided Difference Interpolation
3  //Page no. 170
4  clc;close;clear;
5
6  x=[0,1,2,4]
7  y=[1,3,9,81];
8  y1=y;
9  deff('yi=P(a,b,d,e)','yi=(b(d+1)-b(d))/(a(d+e)-a(d))
       ')  //function for finding polynomials
10 for i=1:4
11     for j=1:4-i
12         z(j,i)=P(x,y,j,i)
13          y(j)=z(j,i)
14     end
15 end
16 z(6,1)=0;
17 printf('x\ty        f(x0,x1)        f(x0,x1,x3)      f(x0,
       x1,x2,x3)\n')
18 printf('
       ------------------------------------------------------------\
       n')
19     for j=1:3
20         printf(' %i\t%i \t%i\t\t%i\t\t%i\t\t\n',x(1,
               j),y1(1,j),z(j,1),z(j,2),z(j,3))
21     end
```

```
22      deff('y=f(x1)','y=y1(1)+(x1-x(1))*z(1,1)+(x1-x
           (1))*(x1-x(2))*z(1,2)+(x1-x(1))*(x1-x(2))*(x1
           -x(3))*z(1,3)')
23      printf('\n\nf(3) = %g',f(3))
```

Scilab code Exa 5.36 Lagranges Interpolation Method

```
1  //Example 5.36
2  //Lagrange's Interpolation Method
3  //Page no. 176
4  clc;close;clear;
5
6  x=[7,8,9,10]
7  y=[3,1,1,9]
8  x0=9.5
9  printf('\tx\ty=f(x)\n-------------------------\n')
10 for i=1:4
11     printf('x%i\t%i\t  %i\n',i-1,x(i),y(i))
12 end
13 p=1;p1=1;i=1;
14 for k=1:4
15     for j=1:4
16         if k~=j then
17             p=p*(x0-x(j))
18             p1=p1*(x(k)-x(j))
19         end
20 end
21 L(k)=p/p1
22 p=1;p1=1;
23 end
24 p=0;
25 for i=1:4
26     printf('\n L%i (x) = %g\n',i-1,L(i))
27     p=p+L(i)*y(i)
28 end
```

```
29 disp(p,"P(9.5) = ")
```

Scilab code Exa 5.37 Lagranges Interpolation Method

```
1  //Example 5.37
2  //Lagranges Interpolation Method
3  //Page no. 177
4  clc;close;clear;
5
6  x=[0,1,2,5]
7  y=[2,3,12,147]
8  x0=poly(0,'x')
9  printf('\tx\ty=f(x)\n-------------------------\n')
10 for i=1:4
11     printf('x%i\t%i\t  %i\n',i-1,x(i),y(i))
12 end
13 p=1;p1=1;i=1;
14 for k=1:4
15     for j=1:4
16         if k~=j then
17             p=p*(x0-x(j))
18             p1=p1*(x(k)-x(j))
19         end
20 end
21 L(k)=p/p1
22 p=1;p1=1;
23 end
24 p=0;
25 for i=1:4
26     disp(L(i),"L(x) = ")
27     p=p+L(i)*y(i)
28 end
29 disp(p,"P(x) = ")
```

Scilab code Exa 5.38 Lagranges Interpolation Method

```
1  //Example 5.38
2  //Lagranges Interpolation Method
3  //Page no. 178
4  clc;close;clear;
5
6  x=[1,2,3,4,7]
7  y=[2,4,8,16,128]
8  x0=5
9  printf('\tx\ty=f(x)\n-------------------------\n')
10 for i=1:5
11     printf('x%i\t%i\t  %i\n',i-1,x(i),y(i))
12 end
13 p=1;p1=1;i=1;
14 for k=1:5
15     for j=1:5
16         if k~=j then
17             p=p*(x0-x(j))
18             p1=p1*(x(k)-x(j))
19         end
20 end
21 L(k)=p/p1
22 p=1;p1=1;
23 end
24 p=0;
25 for i=1:5
26     printf('\n L%i (x) = %g\n',i-1,L(i))
27     p=p+L(i)*y(i)
28 end
29 disp(p,"P(5) = ")
```

Scilab code Exa 5.39 Hermite Interpolation Method

```
1  //Example 5.39
2  //Hermite Interpolation Method
3  //Page no. 181
4  clc;close;clear;
5
6  x=[-1,0,1]
7  y=[-10,-4,-2]
8  y1=[10,3,2]
9  x0=poly(0,'x')
10 printf('\tx\ty=f(x)\n-------------------------\n')
11 for i=1:3
12     printf('x%i\t%i\t  %i\n',i-1,x(i),y(i))
13 end
14 p=1;p1=1;i=1;
15 for k=1:3
16     for j=1:3
17         if k~=j then
18             p=p*(x0-x(j))
19             p1=p1*(x(k)-x(j))
20         end
21 end
22 L(k)=p/p1
23 p=1;p1=1;
24 end
25 p=0;
26 L1=[-3/2,0,3/2]
27 for i=1:3
28     disp(L(i),"L(x) = ")
29     p=p+(1-2*L1(i)*(x0-x(i)))*L(i)^2*y(i)+(x0-x(i))
          *((L(i))^2)*y1(i)
30 end
31 disp(p,"P(x) = ")
```

Scilab code Exa 5.40 Hermite Interpolation Method

```
1  //Example 5.40
2  //Hermite Interpolation Method
3  //Page no. 182
4  clc;close;clear;
5
6  x=[0,1,2]
7  y=[1,3,21]
8  y1=[0,6,36]
9  x0=poly(0,'x')
10 printf('\tx\ty=f(x)\n-------------------------\n')
11 for i=1:3
12     printf('x%i\t%i\t  %i\n',i-1,x(i),y(i))
13 end
14 p=1;p1=1;i=1;
15 for k=1:3
16     for j=1:3
17         if k~=j then
18             p=p*(x0-x(j))
19             p1=p1*(x(k)-x(j))
20         end
21 end
22 L(k)=p/p1
23 p=1;p1=1;
24 end
25 p=0;
26 L1=[-3/2,0,3/2]
27 for i=1:3
28     disp(L(i),"L(x) = ")
29     p=p+(1-2*L1(i)*(x0-x(i)))*L(i)^2*y(i)+(x0-x(i))
          *((L(i))^2)*y1(i)
30 end
31 disp(p,"P(x) = ")
```

Scilab code Exa 5.41 Piecewise Cubic Hermite Interpolation Method

```
1  //Example 5.41
2  //Piecewise Cubic Hermite Interpolation Method
3  //Page no. 182
4  clc;close;clear;
5
6  x=[0,1]
7  y=[1,3]
8  y1=[0,6]
9  x0=poly(0,'x')
10 printf('\tx\ty=f(x)\n-------------------------\n')
11 for i=1:2
12     printf('x%i\t%i\t  %i\n',i-1,x(i),y(i))
13 end
14 p=1;p1=1;i=1;
15 for k=1:2
16     for j=1:2
17         if k~=j then
18             p=p*(x0-x(j))
19             p1=p1*(x(k)-x(j))
20         end
21 end
22 L(k)=p/p1
23 p=1;p1=1;
24 end
25 p=0;
26 L1=[-1,1]
27 for i=1:2
28     disp(L(i),"L(x) = ")
29     p=p+(1-2*L1(i)*(x0-x(i)))*L(i)^2*y(i)+(x0-x(i))
          *((L(i))^2)*y1(i)
30 end
31 disp(p,"P2(x) = ")
32 printf('\n\n\n\n')
33 x=[1,2]
34 y=[3,21]
35 y1=[6,36]
```

```
x0=poly(0,'x')
printf('\tx\ty=f(x)\n-------------------------\n')
for i=1:2
    printf('x%i\t%i\t  %i\n',i-1,x(i),y(i))
end
p=1;p1=1;i=1;
for k=1:2
    for j=1:2
        if k~=j then
            p=p*(x0-x(j))
            p1=p1*(x(k)-x(j))
        end
end
L(k)=p/p1
p=1;p1=1;
end
p=0;
L1=[-1,1]
for i=1:2
    disp(L(i),"L(x) = ")
    p=p+(1-2*L1(i)*(x0-x(i)))*L(i)^2*y(i)+(x0-x(i))
       *((L(i))^2)*y1(i)
end
disp(p,"P3(x) = ")
```

Scilab code Exa 5.43 Inverse Interpolation using Newtons Forward Difference Formul

```
//Example 5.43
//Inverse Interpolation using Newton's Forward
   Difference Formula
//Page no. 189
clc;close;clear;
printf(' \tx\ty\td\td2\td3\n')
printf('\t-----------------------------------------')
h=1;
```

```
z=[2,8;3,27;4,64;5,125];
deff('y=f1(x,s)','y=(z(x,3)+(s-1/2)*z(x,4)+z(x,5)
   *(3*s^2-6*s+2)/6)/h')
deff('y=f2(x,s)','y=(z(x,4)+z(x,5)*(s-1))/h^2')
deff('y=f3(x,s)','y=z(x,5)/h^3')
for i=3:5
    for j=1:6-i
        z(j,i)=z(j+1,i-1)-z(j,i-1)
    end
end
printf('\n')
for i=1:4
    for j=1:5
        if z(i,j)==0 then
            printf(' \t')
        else
            printf('\t%g',z(i,j))
        end
    end
    printf('\n')
end
fp=10;
f0=z(1,2);x0=z(1,1);x=fp-f0;p=(z(2,1)-z(1,1))/h;y=0;
   k=1;p=1;
for i=1:5
    if i>3 then
        l=3;
    else
        l=i;
    end
    for j=1:l
        for k=j:-1:2
            if k==j then
                y=1;
            end
            y=y*(p-(k-1))
        end
        y=y*z(1,j+2)*p/factorial(j);
```

```
44          x=x-y;
45      end
46      p=(x)/z(1,3)
47      x=fp-f0;y=0;
48      printf('\n   p%i = %g\n',i,p)
49  end
50  printf('\n\n   Hence, x = x0+ph = %g ',x+p*h)
```

Scilab code Exa 5.44 Inverse Interpolation using Everett Formula

```
1  //Example 5.44
2  //Inverse Interpolation using Everett Formula
3  //Page no. 191
4  clc;close;clear;
5  printf(' \tx\td(log(x!)/dx)\t\td2\t     d4\n')
6  printf('\t
       ------------------------------------------------------------
       ')
7  x
       =[0.46,-0.0015805620,-0.0000888096,-0.000000396;0.47,0.0080664890

8  h=0.001
9  for i=1:2
10     printf('\n')
11     for j=1:4
12         printf('\t%g',x(i,j))
13     end
14 end
15 p(1)=-(x(1,2))/(x(2,2)-x(1,2))
16 for i=1:2
17     p(i+1)=(-x(1,2)-(p(i)^3-p(i))*x(1,3)/6-(-p(i)
           ^3+3*p(i)^2-2*p(i))*x(1,3)/6)/(x(2,2)-x(1,2))
18 end
19 for i=1:3
20     printf('\n\n p(%i) = %g',i,p(i))
```

```
21 end
22 x=x(1,1)+p(3)*h
23 printf('\n\n    x = x0 + ph = %.8g',x);
```

Scilab code Exa 5.45 Inverse Lagrange Method

```
1 //Example 5.45
2 //Inverse Lagrange Method
3 //Page no. 192
4 clc;close;clear;
5
6 x=[30,34,38,42];
7 y=[-30,-13,3,18];
8 P=0;
9 y1=0;
10 for k=0:3
11     p=1
12     for j=0:3
13         if(j~=k)
14             p=p*((y1-y(j+1))/(y(k+1)-y(j+1)))
15         end
16     end
17     printf('\n  L%i(f) = %g\n',k,p)
18     p=p*x(k+1)
19     P=P+p;
20 end
21 disp(P,'Inverse Lagrange interpolation x=')
```

Scilab code Exa 5.46 Newtons Divided Difference Interpolation

```
1 //Example 5.46
2 //Newton's Divided Difference Interpolation
3 //Page no. 192
```

```
clc;close;clear;

x=[3,3.6,3.8]
y=[0.13515,0.83059,0.26253];
deff('y=f1(x1,x2,y1,y2)','y=(y2-y1)/(x2-x1)');
deff('y=f2(x1,x2,x3,y1,y2,y3)','y=(f1(x2,x3,y2,y3)-
    f1(x1,x2,y1,y2))/(x3-x1)');
function [x]=f(x1,x2,x3,y1,y2,y3)
    x=(x1+2*x2+x3)/4-(f1(x1,x2,y1,y2)+f1(x2,x3,y2,y3
       ))/(4*f2(x1,x2,x3,y1,y2,y3))
endfunction
disp(f1(x(1),x(2),y(1),y(2)),' f(x1,x2) = ')
disp(f1(x(2),x(3),y(2),y(3)),' f(x2,x3) = ')
disp(f2(x(1),x(2),x(3),y(1),y(2),y(3)),' f(x1,x2,x3)
    = ')
disp(f(x(1),x(2),x(3),y(1),y(2),y(3)),' x0 = ')
```

Scilab code Exa 5.47 Bessel Interpolation

```
//Example 5.47
//Bessel Interpolation
//Page no. 194
clc;close;clear;

deff('y=f(x)','y=x^3-15*x+4');
h=0.02;p=1;
for i=1:9
    z(i,1)=0.22+(i-1)*h
    z(i,2)=f(z(i))
end
printf('   x\t\t   f(x) \t    d\t\t    d2\t\t    d3\
   t\t    d4\n')
printf('
   ')
```

```
for i=3:6
    for j=1:11-i
        z(j,i)=z(j+1,i-1)-z(j,i-1)
    end
end
printf('\n')
for i=1:9
    for j=1:6
        if z(i,j)==0 then
            printf(' \t')
        else
            printf('%.7f\t',z(i,j))
        end
    end
    printf('\n')
end
for l=1:8
    if abs(z(l+1,2))/z(l+1,2)~=abs(z(l,2))/z(l,2)
       then
        break;
    else
        l=9;
    end
end
function [y]=f1(x,p1)
    if x==1 then
        y=z(l,2)
    elseif x==2
        y=z(l,2)+(p1*(p1-1))/factorial(2)*((z(l-1,4)
           +z(l,4))/2)
    elseif x==3
        y=z(l,2)+(p1*(p1-1))/factorial(2)*((z(l-1,4)
           +z(l,4))/2)+(p1*(p1-1)*(p1-0.5))/
           factorial(3)*(z(l,5))
    end
endfunction
for i=1:3
    p=-(f1(i,p))/z(l,3)
```

```
48      printf('\n    p%i = %g\n',i,p)
49  end
50  x=z(l,1)+p*h;
51  printf(' \n\n    x = x0 + ph = %g+(%g)(%g) = %g',z(l
        ,1),p,h,x)
```

Scilab code Exa 5.48 Chebyshev Polynomial

```
1  //Example 5.48
2  //Chebyshev Polynomial
3  //Page no. 199
4  clc;close;clear;
5
6  deff('y=f(x)','y=4*x^3+2*x^2');
7  n=4;
8  for i=3:-1:0
9      x(i+1)=cosd(((2*i+1)*%pi)/(2*n))
10     printf('\n  x(%i) = %g\n',i,x(i+1))
11 end
```

Scilab code Exa 5.50 Spline Interpolation

```
1  //Example 5.50
2  //Spline Interpolation
3  //Page no. 204
4  clc;close;clear;
5
6  xi=[1,2,3];
7  yi=[-1,4,21];
8  x=poly(0,'x')
9  deff('y=S(x0,x1)','y=(x-xi(x1))*yi(x0)/(xi(x0)-xi(x1
       ))+(x-xi(x0))*yi(x1)/(xi(x1)-xi(x0))');
10 S1=S(1,2);
```

```
11 S2=S(2,3);
12 printf('\n The required Spline is : \n')
13 disp(S2,'S2 = ',S1,'S1 = ');
```

Scilab code Exa 5.51 Spline Interpolation

```
1  //Example 5.51
2  //Spline Interpolation
3  //Page no. 204
4  clc;close;clear;
5
6  xi=[1,2,3];
7  yi=[-6,-1,16];
8  h=1;n=2;
9  x=poly(0,'x')
10 m(2)=(6*(yi(3)-2*yi(2)+yi(1)))/4
11 m(1)=0;m(3)=0;
12 function [y]=S(i,x)
13     y=m(i)*(xi(i+1)-x)^3/(6*h)
14     y=y+m(i+1)*(x-xi(i))^3/(6*h)
15     y=y+(yi(i)/h-(m(i)*h)/6)*(xi(i+1)-x)
16     y=y+(yi(i+1)/h-(m(i+1)*h)/6)*(-xi(i)+x)
17 endfunction
18 for i=1:2
19     S1(i)=S(i);
20 end
21 printf('\n The required Spline is : \n')
22 disp(' ','2<x<=3',S1(2),'S2 = ',' ','1<=x<=2',S1(1),
      'S1 = ');
23 x=1.5;
24 if x>=1 & x<=2 then
25     i=1;
26 else x>2 & x<=3
27     i=2;
28 end
```

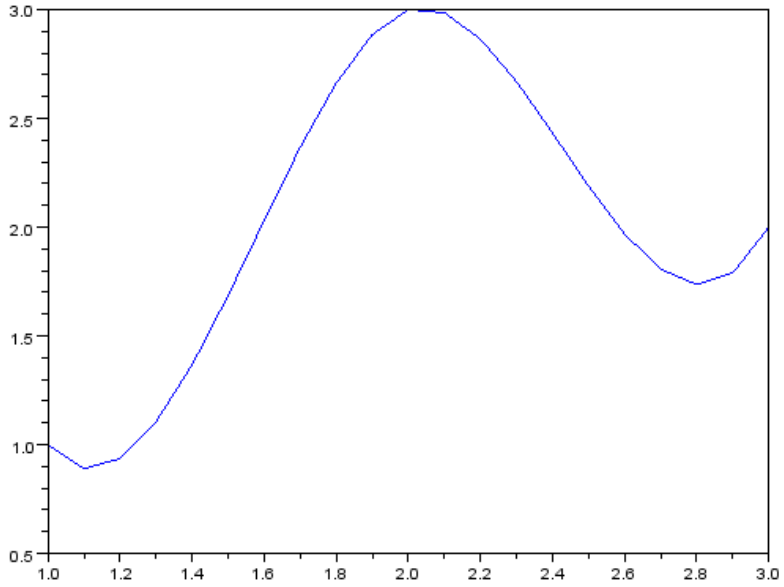

Figure 5.1: Spline Interpolation

```
29 disp(S(i,x),'y(1.5) = ')
30 x=2;h1=0.01;
31 for i=1:2
32     Sd(i,x)=(S(i,x+h1)-S(i,x))/h1
33 end
34 disp(Sd(2,2),Sd(1,2),'y`(2) = ')
```

Scilab code Exa 5.52 Spline Interpolation

```
1 //Example 5.52
2 //Spline Interpolation
```

```
3  //Page no. 205
4  clc;close;clear;
5  deff('y=S1(x)','y=18-(75*x)/2+26*x^2-11*x^3/2')
6  deff('y=S2(x)','y=-70+(189*x)/2-(40*x^2)+(11*x^3)/2'
       )
7  x=2;h=0.01;
8  S=[S1(x),S2(x)]
9  for i=1:2
10     printf('\n  S%i (%i) = %g\n',i-1,x,S(i))
11 end
12 deff('y=S3(x)','y=(S1(x+h)-S1(x))/h')
13 deff('y=S4(x)','y=(S2(x+h)-S2(x))/h')
14 S=[S3(x),S4(x)]
15 for i=1:2
16     printf('\n  S`%i (%i) = %g\n',i-1,x,S(i))
17 end
18 deff('y=S5(x)','y=(S3(x+h)-S3(x))/h')
19 deff('y=S6(x)','y=(S4(x+h)-S4(x))/h')
20 S=[S5(x),S6(x)]
21 for i=1:2
22     printf('\n  S``%i (%i) = %g\n',i-1,x,S(i))
23 end
24 printf('\n\n')
25 for i=1:2
26     for j=1:3
27         if i==1 then
28             printf('\t%i',j)
29         elseif j<3
30             printf('\t%g',S1(j))
31         else
32             printf('\t%g',S2(j))
33         end
34     end
35     printf('\n')
36 end
37 x=[1:0.1:2]
38 plot(x,S1(x))
39 x=[2:0.1:3]
```

```
40 plot(x,S2(x))
```

Scilab code Exa 5.53 Spline Interpolation

```
1  //Example 5.53
2  //Spline Interpolation
3  //Page no. 206
4  clc;close;clear;
5
6  xi=[1,2,3];
7  yi=[-3,4,23];
8  h=1;n=2;
9  x=poly(0,'x')
10 m(2)=(6*(yi(3)-2*yi(2)+yi(1)))/4
11 m(1)=0;m(3)=0;
12 function [y]=S(i,x)
13     y=m(i)*(xi(i+1)-x)^3/(6*h)
14     y=y+m(i+1)*(x-xi(i))^3/(6*h)
15     y=y+(yi(i)/h-(m(i)*h)/6)*(xi(i+1)-x)
16     y=y+(yi(i+1)/h-(m(i+1)*h)/6)*(-xi(i)+x)
17 endfunction
18 for i=1:2
19     S1(i)=S(i);
20 end
21 printf('\n The required Spline is : \n')
22 disp(' ','2<x<=3',S1(2),'S2 = ',' ','1<=x<=2',S1(1),
     'S1 = ');
23 x=1.5;
24 if x>=1 & x<=2 then
25     i=1;
26 else x>2 & x<=3
27     i=2;
28 end
29 disp(S(i,x),'y(1.5) = ')
30 x=1;h1=0.01;
```

```
for i=1:1
    Sd(i,x)=(S(i,x+h1)-S(i,x))/h1
end
disp(Sd(1,1),'y`(1) = ')
```

Scilab code Exa 5.54 Spline Interpolation

```
//Example 5.54
//Spline Interpolation
//Page no. 207
clc;close;clear;

xi=[0,1,2,3];
yi=[1,-1,-1,0];
h=1;n=3;
x=poly(0,'x')
m=[4,1;1,4];
mb=[12;6];
m=inv(m)*mb
m(3)=m(2);
m(2)=m(1);
m(1)=0;m(4)=0;
function [y]=S(i,x)
    y=m(i)*(xi(i+1)-x)^3/(6*h)
    y=y+m(i+1)*(x-xi(i))^3/(6*h)
    y=y+(yi(i)/h-(m(i)*h)/6)*(xi(i+1)-x)
    y=y+(yi(i+1)/h-(m(i+1)*h)/6)*(-xi(i)+x)
endfunction
for i=1:3
    S1(i)=S(i);
end
printf('\n The required Spline is : \n')
disp(' ',S1(3),'S3 = ',' ',S1(2),'S2 = ',' ',S1(1),'
   S1 = ');
```

Chapter 6

Curve Fitting

Scilab code Exa 6.2 Least Line Square Approximation

```
1  //Example 6.2
2  //Least Line Square Approximation
3  //Page no. 216
4  clc;close;clear;
5
6  x=[2;5;6;9;11];
7  y=[2;4;6;9;10];n=1;
8  printf('\t 2\t\t\t  2\nn\tx\tx\ty\txy\ty\n
     ----------------------------------------------\n')
9  x1=0;x2=0;x3=0;x4=0;x5=0;x6=0;
10 for i=1:5
11     printf(' %i\t%i\t%i\t%i\t%i\t%i\n',n,x(i),x(i)
         ^2,y(i),x(i)*y(i),y(i)^2)
12     x1=x1+n;
13     x2=x2+x(i);
14     x3=x3+x(i)^2;
15     x4=x4+y(i);
16     x5=x5+x(i)*y(i);
17     x6=x6+y(i)^2;
18 end
19 printf('
```

```
    ----------------------------------------------------\n %i
    \t%i\t%i\t%i\t%i\t%i\n',x1,x2,x3,x4,x5,x6)
20
21 A=[x1,x2;x2,x3]
22 B=[x4;x5]
23 C=inv(A)*B;
24 x7=poly(0,'x')
25 y=C(1)+C(2)*x7
26 disp(y,'y=')
27 x0=x2/x1;
28 y0=x4/x1;
29 A=x3-x1*x0^2;
30 B=x5-x1*x0*y0;
31 C=x6-x1*y0^2;
32 x7=poly(0,'b')
33 y=x7^2+(A-C)*x7/B-1
34 b=roots(y)
35 a=y0-b(2)*x0
36 x7=poly(0,'x')
37 disp('is the required least line',a+b(2)*x7,'y = ')
```

Scilab code Exa 6.3 Least Square Method

```
1 //Example 6.3
2 //Least Square Method
3 //Page no. 217
4 clc;close;clear;
5
6 x=[1,2,3,4,5,6,7,8];
7 y=[3,3,4,5,5,6,6,7];n=1;
8 printf('\t 2\t\t 2\n n\tx\tx\ty\txy\ty\n
    ----------------------------------------------------\n')
9 x1=0;x2=0;x3=0;x4=0;x5=0;x6=0;
10 for i=1:8
11     printf(' %i\t%i\t%i\t%i\t%i\t%i\n',n,x(i),x(i)
```

```
         ^2,y(i),x(i)*y(i),y(i)^2)
12       x1=x1+n;
13       x2=x2+x(i);
14       x3=x3+x(i)^2;
15       x4=x4+y(i);
16       x5=x5+x(i)*y(i);
17       x6=x6+y(i)^2;
18   end
19   printf('
     ------------------------------------------------------\n %i
     \t%i\t%i\t%i\t%i\t%i\n',x1,x2,x3,x4,x5,x6)
20   x0=x2/x1;
21   y0=x4/x1;
22   A=x3-x1*x0^2;
23   B=x5-x1*x0*y0;
24   C=x6-x1*y0^2;
25   x7=poly(0,'b')
26   y=x7^2+(A-C)*x7/B-1
27   b=roots(y)
28   a=y0-b(2)*x0
29   x7=poly(0,'x')
30   disp('is the required least line',a+b(2)*x7,'y = ')
```

Scilab code Exa 6.4 Least Square Method

```
1  //Example 6.4
2  //Least Square Method
3  //Page no. 219
4  clc;close;clear;
5
6  t=[0.2,0.4,0.6,0.8,1]
7  h=[0.196,0.785,1.7665,3.1406,4.9075]
8  m=2;
9  for i=1:5
10     t1(i)=t(i)^(2*m)
```

```
11      h1(i)=h(i)*t(i)^2
12  end
13  g=sum(h1)/sum(t1)
14  disp(g,'y = ')
15  g=g*2
16  disp(g,'Gravitational Constatnt :')
```

Scilab code Exa 6.5 Power Fit Method

```
1  //Example 6.5
2  //Power Fit Method
3  //Page no. 220
4  clc;close;clear;
5
6  x=[2,2.3,2.6,2.9,3.2]
7  y=[5.1,7.5,10.6,14.4,19]
8  printf('\t 2\t 3\t 4\t 6\t\t  2\t  3\n x\tx\tx\tx\tx
      \ty\tyx\tyx\n
      ------------------------------------------------------------------\
      n')
9  x1=0;x2=0;x3=0;x4=0;
10 for i=1:5
11      printf(' %g\t%g\t%g\t%g\t%g\t%g\t%g\t%g\n',x(i),
           x(i)^2,x(i)^3,x(i)^4,x(i)^6,y(i),x(i)^2*y(i),
           y(i)*x(i)^3)
12      x1=x1+x(i)^4;
13      x2=x2+x(i)^6;
14      x3=x3+x(i)^2*y(i);
15      x4=x4+y(i)*x(i)^3;
16 end
17 printf('
      ------------------------------------------------------------------\
      n \t\t\t%g\t%g\t\t\t%g\t%g\n',x1,x2,x3,x4)
18 a(1)=x3/x1;
19 x5=poly(0,'x')
```

```
20 disp(a(1)*x5^2,'The power fit , y =')
21 a(2)=x4/x2;
22 disp(a(2)*x5^3,'The power fit , y =')
23 e=[0,0]
24 for i=1:2
25     for j=1:5
26         e(i)=e(i)+(a(i)*x(j)^(i+1)-y(j))^2
27     end
28     e(i)=sqrt(e(i)/5)
29     printf('\n\nerror%i = %.2g\n',i,e(i))
30 end
31 if e(1)>e(2) then
32     disp(a(2)*x5^3,'y = ','Hence the best power fir
         curve is')
33 else
34     disp(a(1)*x5^2,'y = ','Hence the best power fir
         curve is')
35 end
```

Scilab code Exa 6.6 Least Square Method

```
1 //Example 6.6
2 //Least Square Method
3 //Page no. 221
4 clc;close;clear;
5
6 x=[2,3,4,5];
7 y=[27.8,62.1,110,161];
8 printf('\t 2\t 4\t\t  2\nx\tx\tx\ty\tyx\n
    ----------------------------------------\n')
9 x1=0;x2=0;
10 for i=1:4
11     printf(' %g\t%g\t%g\t%g\t%g\n',x(i),x(i)^2,x(i)
         ^4,y(i),y(i)*x(i)^2)
12     x1=x1+x(i)^4;
```

```
13      x2=x2+y(i)*x(i)^2;
14  end
15  printf('-----------------------------------------------\n \
       t\t%g\t\t%g\n',x1,x2)
16  a=x2/x1;
17  x1=poly(0,'x')
18  disp(a*x1^2,'y = ')
```

Scilab code Exa 6.7 Parabola Best Fit

```
1   //Example 6.7
2   //Parabola Best Fit
3   //Page no. 222
4   clc;close;clear;
5
6   x=[0,1,2,3,4]
7   y=[-2.1,-0.4,2.1,3.6,9.9]
8   n=1;
9   printf('\t\t 2\t 3\t 4\t\t\t 2\n n\tx\tx\tx\tx\ty\
       txy\tx y\n
       ------------------------------------------------------------------------\
       n')
10  x1=0;x2=0;x3=0;x4=0;x5=0;x6=0;x7=0;x8=0;
11  for i=1:5
12      printf(' %g\t%g\t%g\t%g\t%g\t%g\t%g\t%g\n',n,x(i
           ),x(i)^2,x(i)^3,x(i)^4,y(i),y(i)*x(i),x(i)^2*
           y(i))
13      x1=x1+n;
14      x2=x2+x(i);
15      x3=x3+x(i)^2;
16      x4=x4+x(i)^3;
17      x5=x5+x(i)^4;
18      x6=x6+y(i);
19      x7=x7+y(i)*x(i);
20      x8=x8+x(i)^2*y(i)
```

```
21 end
22 printf('
   ------------------------------------------------------------------------\
   n %g\t%g\t%g\t%g\t%g\t%g\t%g\t%g\n',x1,x2,x3,x4,
   x5,x6,x7,x8)
23 A=[x1,x2,x3;x2,x3,x4;x3,x4,x5]
24 B=[x6;x7;x8]
25 C=inv(A)*B;
26 disp(C)
27 x=poly(0,'x')
28 y=C(1)+C(2)*x+C(3)*x^2
29 disp(y,'y =')
```

Scilab code Exa 6.8 Parabola Best Fit

```
1  //Example 6.8
2  //Parabola Best Fit
3  //Page no. 223
4  clc;close;clear;
5
6  x=[0.78,1.56,2.34,3.12,3.81]
7  y=[2.5,1.2,1.12,2.25,4.28]
8  n=1;
9  for i=1:5
10     x(i)=(x(i)-2.34)/0.78
11 end
12 printf('\t\t 2\t 3\t 4\t\t\t 2\n n\tX\tX\tX\tX\ty\
   tXy\tX y\n
   ------------------------------------------------------------------------\
   n')
13 x1=0;x2=0;x3=0;x4=0;x5=0;x6=0;x7=0;x8=0;
14 for i=1:5
15     printf(' %.2g\t%.2g\t%.2g\t%.2g\t%.2g\t%.2g\t%.2
          g\t%.2g\n',n,x(i),x(i)^2,x(i)^3,x(i)^4,y(i),y
          (i)*x(i),x(i)^2*y(i))
```

```
16      x1=x1+n;
17      x2=x2+x(i);
18      x3=x3+x(i)^2;
19      x4=x4+x(i)^3;
20      x5=x5+x(i)^4;
21      x6=x6+y(i);
22      x7=x7+y(i)*x(i);
23      x8=x8+x(i)^2*y(i)
24  end
25  printf('
    ------------------------------------------------------------------------\
    n %.2f\t%.2f\t%.2f\t%.2f\t%.2f\t%.2f\t%.2f\t%.2f\
    n',x1,x2,x3,x4,x5,x6,x7,x8)
26  A=[x1,x2,x3;x2,x3,x4;x3,x4,x5]
27  B=[x6;x7;x8]
28  C=inv(A)*B;
29  disp(C)
30  x=poly(0,'X')
31  y=C(1)+C(2)*x+C(3)*x^2
32  disp(y,'y =')
```

Scilab code Exa 6.9 Least Square Fit

```
1  //Example 6.9
2  //Least Square Fit
3  //Page no. 224
4  clc;close;clear;
5
6  x=[-3,-1,1,3]
7  y=[15,5,1,5]
8  n=1;
9  printf('\t\t 2\t 3\t 4\t\t\t 2\n n\tx\tx\tx\tx\ty\
   txy\tx y\n
   ------------------------------------------------------------------------\
   n')
```

```
10 x1=0;x2=0;x3=0;x4=0;x5=0;x6=0;x7=0;x8=0;
11 for i=1:4
12     printf(' %g\t%g\t%g\t%g\t%g\t%g\t%g\t%g\n',n,x(i
       ),x(i)^2,x(i)^3,x(i)^4,y(i),y(i)*x(i),x(i)^2*
       y(i))
13     x1=x1+n;
14     x2=x2+x(i);
15     x3=x3+x(i)^2;
16     x4=x4+x(i)^3;
17     x5=x5+x(i)^4;
18     x6=x6+y(i);
19     x7=x7+y(i)*x(i);
20     x8=x8+x(i)^2*y(i)
21 end
22 printf('
   ------------------------------------------------------------------------\
   n %g\t%g\t%g\t%g\t%g\t%g\t%g\t%g\n',x1,x2,x3,x4,
   x5,x6,x7,x8)
23 A=[x1,x2,x3;x2,x3,x4;x3,x4,x5]
24 B=[x6;x7;x8]
25 C=inv(A)*B;
26 disp(C)
27 x=poly(0,'x')
28 y=C(1)+C(2)*x+C(3)*x^2
29 disp(y,'y =')
```

Scilab code Exa 6.10 Least Square Fit

```
1 //Example 6.10
2 //Least Square Fit
3 //Page no. 224
4 clc;close;clear;
5
6 x=[1,2,3,4]
7 y=[0.3,0.64,1.32,5.4]
```

```
n=1;
printf('\t\t 2\t 3\t 4\t\t\t 2\n n\tx\tx\tx\tx\ty\
   txy\tx y\n
   ------------------------------------------------------------------------\
   n')
x1=0;x2=0;x3=0;x4=0;x5=0;x6=0;x7=0;x8=0;
for i=1:4
    printf(' %g\t%g\t%g\t%g\t%g\t%g\t%g\t%g\n',n,x(i
       ),x(i)^2,x(i)^3,x(i)^4,y(i),y(i)*x(i),x(i)^2*
       y(i))
    x1=x1+n;
    x2=x2+x(i);
    x3=x3+x(i)^2;
    x4=x4+x(i)^3;
    x5=x5+x(i)^4;
    x6=x6+y(i);
    x7=x7+y(i)*x(i);
    x8=x8+x(i)^2*y(i)
end
printf('
   ------------------------------------------------------------------------\
   n %g\t%g\t%g\t%g\t%g\t%g\t%g\t%g\n',x1,x2,x3,x4,
   x5,x6,x7,x8)
A=[x1,x2,x3;x2,x3,x4;x3,x4,x5]
B=[x6;x7;x8]
C=inv(A)*B;
disp(C)
x=poly(0,'x')
y=C(1)+C(2)*x+C(3)*x^2
disp(y,'y =')
```

Scilab code Exa 6.11 Least Square Fit

```
//Example 6.9
//Least Square Fit
```

```
3  //Page no. 224
4  clc;close;clear;
5
6  x=[2,4,6,8,10]
7  y=[3.07,12.85,31.47,57.38,91.29]
8  n=1;
9  printf('\t\t 2\t 3\t 4\t\t\t 2\n n\tx\tx\tx\tx\ty\
       txy\tx y\n
       ------------------------------------------------------------------------\
       n')
10 x1=0;x2=0;x3=0;x4=0;x5=0;x6=0;x7=0;x8=0;
11 for i=1:5
12     printf(' %g\t%g\t%g\t%g\t%g\t%g\t%g\t%g\n',n,x(i
          ),x(i)^2,x(i)^3,x(i)^4,y(i),y(i)*x(i),x(i)^2*
          y(i))
13     x1=x1+n;
14     x2=x2+x(i);
15     x3=x3+x(i)^2;
16     x4=x4+x(i)^3;
17     x5=x5+x(i)^4;
18     x6=x6+y(i);
19     x7=x7+y(i)*x(i);
20     x8=x8+x(i)^2*y(i)
21 end
22 printf('
       ------------------------------------------------------------------------\
       n %g\t%g\t%g\t%g\t%g\t%g\t%g\t%g\n',x1,x2,x3,x4,
       x5,x6,x7,x8)
23 A=[x1,x2,x3;x2,x3,x4;x3,x4,x5]
24 B=[x6;x7;x8]
25 C=inv(A)*B;
26 disp(C)
27 x=poly(0,'x')
28 y=C(1)+C(2)*x+C(3)*x^2
29 disp(y,'y =')
```

Scilab code Exa 6.12 Least Square Fit

```
1  //Example 6.12
2  //Least Square Fit
3  //Page no. 224
4  clc;close;clear;
5
6  x=[10,20,30,40,50]
7  y=[8,10,15,21,30]
8  n=1;
9  printf('\t\t 2\t 4\t\t\t 2\n n\tx\tx\tx\t\ty\tx y\n
       ----------------------------------------------------------------------\
       n')
10 x1=0;x2=0;x3=0;x4=0;x5=0;x6=0;x7=0;x8=0;
11 for i=1:5
12     printf(' %g\t%g\t%g\t%.9g\t\t%g\t%g\n',n,x(i),x(
           i)^2,x(i)^4,y(i),x(i)^2*y(i))
13     x1=x1+n;
14     x2=x2+x(i);
15     x3=x3+x(i)^2;
16     x4=x4+x(i)^4;
17     x5=x5+y(i);
18     x6=x6+x(i)^2*y(i)
19 end
20 printf('
       ----------------------------------------------------------------------\
       n %g\t%g\t%g\t%.9g\t\t%g\t%g\n',x1,x2,x3,x4,x5,x6
       )
21 A=[x1,x3;x3,x4;]
22 B=[x5;x6]
23 C=inv(A)*B;
24 disp(C)
25 x=poly(0,'x')
26 y=C(1)+C(2)*x^2
```

```
27 disp(y,'y =')
```

Chapter 7

Numerical Differentiation

Scilab code Exa 7.1 Differentiation

```
1 //Example 7.1
2 //Differentiation
3 //Page no. 230
4 clc;close;clear;
5 deff('y=f(x)','y=sin(x)')
6 deff('y=f1(x,h)','y=(f(x+h)-f(x-h))/(2*h)')
7 deff('y=f2(x,h)','y=(-f(x+2*h)+8*f(x+h)-8*f(x-h)+f(x
    -2*h))/(12*h)')
8 h=0.01;x=0.5
9 d=f1(x,h)
10 d1=f2(x,h)
11 printf('Centred Formula of Order O(h2) = %g\n',d)
12 printf('\n Centred Formula of Order O(h4) = %g',d1)
```

Scilab code Exa 7.2 Differentiation

```
1 //Example 7.2
2 //Differentiation
```

```
3 //Page no. 232
4 clc;close;clear;
5
6 t=[1,1.1,1.2,1.3,1.4]
7 I=[8.2277,7.2428,5.9908,4.5260,2.9122]
8 L=0.05;R=2;h=0.1;
9 deff('y=f(x)','y=L*i1(x)+R*I(x)')
10 deff('y=f1(x,h1)','y=(I(x+h1)-I(x-h1))/(2*h)')
11 deff('y=f2(x,h1)','y=(-I(x+2*h1)+8*I(x+h1)-8*I(x-h1)
   +I(x-2*h1))/(12*h)')
12 x=3;h1=1;
13 i1(x)=f1(x,h1)
14 E=f(x)
15 printf('Using Centred Tendency of Order O(h2)\n')
16 printf('I`(1.2) = %g\n',i1(x))
17 printf('\n E(1.2) = %g',E)
18 i1(x)=f2(x,h1)
19 E=f(x)
20 printf('\n\n\nUsing Centred Tendency of Order O(h4)\
   n')
21 printf('I`(1.2) = %g\n',i1(x))
22 printf('\n E(1.2) = %g',E)
```

Scilab code Exa 7.3 Richardson Extrapolation

```
1 //Example 7.3
2 //Richardson Extrapolation
3 //Page no. 233
4 clc;close;clear;
5
6 t=[1,1.1,1.2,1.3,1.4]
7 I=[8.2277,7.2428,5.9908,4.5260,2.9122]
8 h=0.1;
9 deff('y=f1(x,h1)','y=(I(x+h1)-I(x-h1))/(2*h)')
10 deff('y=f2(x,h1)','y=(I(x+2*h1)-I(x-2*h1))/(4*h)')
```

```
11 deff('y=f3(x,h1)','y=(I(x+h1)-I(x-h1))/(2*h)')
12 x=3;h1=1;
13 D0h=f1(x,h1)
14 printf('\nD0(h) = %g\n',D0h)
15 D02h=f2(x,h1)
16 printf('\nD0(2h) = %g\n',D02h)
17 I1=(4*D0h-D02h)/x
18 printf('\nI' (1.2) = %g',I1)
```

Scilab code Exa 7.4 Differentiation

```
1 //Example 7.4
2 //Differentiation
3 //Page no. 233
4 clc;close;clear;
5
6 t=[1.2,1.3,1.4,1.5,1.6]
7 I=[1.5095,1.6984,1.9043,2.1293,2.3756]
8 h=0.1;
9 deff('y=f2(x,h1)','y=(-I(x+2*h1)+8*I(x+h1)-8*I(x-h1)
    +I(x-2*h1))/(12*h)')
10 x=3;h1=1;
11 i1(x)=f2(x,h1)
12 printf('\nUsing Centred Tendency of Order O(h4)\n')
13 printf('f'(1.4) = %g\n',i1(x))
```

Scilab code Exa 7.5 Stirlings Central Difference Derivatives

```
1 //Example 7.5
2 //Stirlings Central Difference Derivatives
3 //Page no. 238
4 clc;close;clear;
```

```
5  printf('    x\t\t     y\t\t     d\t\t     d2\t\t     d3\t
      \t     d4\n')
6  printf('
      ------------------------------------------------------------------------
      ')
7  h=0.1;s=1;
8  e=[1,6,30]
9  deff('y=f1(x,s)','y=((z(x,3)+z(x-1,3))/2+s*z(x-1,4)
      +(z(x-1,5)+z(x-2,5))*(3*s^2-1)/12)/h')
10 deff('y=f2(x,s)','y=(z(x-1,4))/h^2')
11 deff('y=f3(x,s)','y=(z(x-1,5)+z(x-2,5))/(2*h^3)')
12 z
      =[0.7,0.644218;0.8,0.717356;0.9,0.783327;1,0.841471;1.1,0.891207;

13 for i=3:6
14     for j=1:9-i
15         z(j,i)=z(j+1,i-1)-z(j,i-1)
16     end
17 end
18 printf('\n')
19 for i=1:7
20     for j=1:6
21         if z(i,j)==0 then
22             printf(' \t')
23         elseif j==1
24             printf('    %.1f\t\t',z(i,j))
25         else
26             printf('%.6f\t',z(i,j))
27         end
28     end
29     printf('\n')
30 end
31 fp=0;i=5;
32 for j=2:2:6
33     fp=fp+((-1)^(j/2+1))*(z(i,j)-z(i-2,j))/(2*h*e(j
         /2))
34     i=i-1;
35 end
```

```
36 printf('\n\nf'p (sin'(x))= %g',fp)
```

Scilab code Exa 7.6 Stirlings Central Difference Derivatives

```
1  //Example 7.6
2  //Stirlings Central Difference Derivatives
3  //Page no. 239
4  clc;close;clear;
5  printf('   x\t\t    y\t\t    d\t\t    d2\t\t    d3\t
       \t    d4\t\t    d5\n')
6  printf('
       ------------------------------------------------------------------------
       ')
7  h=0.2;s=1;
8  deff('y=f1()','y=(z(4,3)+(3*p^2-1)*z(4,4)/factorial
       (3)-(3*p^2-6*p+2)*z(3,4)/factorial(3))/h')
9  z
       =[0.2,2.10022;0.4,1.98730;0.6,1.90940;0.8,1.86672;1,1.85937;1.2,1

10 x0=0.8;p=poly(0,'p');
11 for i=3:7
12     for j=1:9-i
13         z(j,i)=z(j+1,i-1)-z(j,i-1)
14     end
15 end
16 printf('\n')
17 for i=1:7
18     for j=1:7
19         if z(i,j)==0 then
20             printf(' \t')
21         elseif j==1
22             printf('   %.1f\t\t',z(i,j))
23         else
24             printf('%.6f\t',z(i,j))
25         end
```

```
26      end
27      printf('\n')
28  end
29  f1p=f1()
30  disp(f1p)
31  r=roots(f1p);
32  for i=1:2
33      if abs(r(i))==r(i) then
34          r1=r(i)
35          disp(r(i),"p = ")
36      end
37  end
38  x=x0+r1*h;
39  disp(x,"x = ")
```

Scilab code Exa 7.7 Stirlings Central Difference Derivatives

```
1  //Example 7.7
2  //Stirlings Central Difference Derivatives
3  //Page no. 240
4  clc;close;clear;
5  printf('   x\t\t    y\t\t    d\t\t    d2\t\t    d3\t
       \t    d4\n')
6  printf('
       ------------------------------------------------------------------------------
       ')
7  h=0.2;s=1;
8  a=poly(0,'a');
9  b=poly(0,'b');
10 deff('y=f3(x)','y=z(x,1)*y2(x)+(z(x,1)-b)*z(x,2)')
11 deff('y=f4(x)','y=y1(x)*a')
12 deff('y=f1(x)','y=(z(x+1,2)-z(x-1,2)-(z(x,4)-z(x
       -2,4))/factorial(3)+4*(z(x-1,6)-z(x-3,6))/
       factorial(5))/(2*h)')
13 deff('y=f2(x)','y=(z(x-1,4)-2*(z(x-2,6))/factorial
```

```
    (4))/h^2')
14  z
    =[0.8,1.73036;1,1.95532;1.2,2.19756;1.4,2.45693;1.6,2.73309;1.8,3

15  x0=0.8;
16  for i=3:6
17      for j=1:10-i
18          z(j,i)=z(j+1,i-1)-z(j,i-1)
19      end
20  end
21  printf('\n')
22  for i=1:8
23      for j=1:6
24          if z(i,j)==0 then
25              printf(' \t')
26          elseif j==1
27              printf('   %.1f\t\t',z(i,j))
28          else
29              printf('%.6f\t',z(i,j))
30          end
31      end
32      printf('\n')
33  end
34  y1(4)=f1(4);
35  y2(4)=f2(4);
36  y1(5)=f1(5);
37  y2(5)=f2(5);
38  g=f3(4)
39  printf('\n\ny`(1.4) = %g\n\ny``(1.4) = %g\n\ny`(1.6)
    = %g\n\ny``(1.6) = %g\n\n',y1(4),y2(4),y1(5),y2
    (5))
40  disp(f3(4),f4(4))
41  printf('\n\n')
42  A=[y1(4),z(4,2);y1(5),z(5,2)];
43  B=[z(4,1)*(y2(4)+z(4,2));z(5,1)*(y2(5)+z(5,2))];
44  disp(f3(5),f4(5))
45
46  C=inv(A)*B;
```

```
47 printf('\n\n a = %g\n\n b = %g',C(1),C(2))
```

Scilab code Exa 7.8 Stirlings Central Difference Derivatives

```
1  //Example 7.8
2  //Stirlings Central Difference Derivatives
3  //Page no. 242
4  clc;close;clear;
5  printf('   x\t\t    y\t\t    d\t\t    d2\t\t    d3\t
       \t    d4\n')
6  printf('
       ------------------------------------------------------------------------------
       ')
7  h=0.01;
8  a=poly(0,'n');
9  deff('y=f3(x)','y=z(x,1)^2*y2(x)+z(x,1)*y1(x)+(z(x
       ,1)^2-a^2)*z(x,2)')
10 deff('y=f1(x)','y=(z(x+1,2)-z(x-1,2)-(z(x,4)-z(x
       -2,4))/factorial(3))/(2*h)')
11 deff('y=f2(x)','y=(z(x-1,4)-2*(z(x-2,6))/factorial
       (4))/h^2')
12 z
       =[85,0.0353878892;85.01,0.0346198696;85.02,0.0338490002;85.03,0.0
13 for i=3:6
14     for j=1:7-i
15         z(j,i)=z(j+1,i-1)-z(j,i-1)
16     end
17 end
18 printf('\n')
19 for i=1:5
20     for j=1:6
21         if z(i,j)==0 then
22             printf(' \t')
23         elseif j==1
```

```
24                 printf('    %.2f\t',z(i,j))
25             else
26                 printf('%.10f\t',z(i,j))
27             end
28         end
29         printf('\n')
30     end
31     y1(3)=f1(3);
32     y2(3)=f2(3);
33
34     printf('\n\ny''(85.02) = %g\n\ny''''(85.02) = %.7g\n\n'
       ,y1(3),y2(3))
35     n=f3(3)
36     disp(n,"0 =")
37     n=roots(n)
38     for i=1:2
39         if abs(n(i))==n(i) then
40             n1=n(i)
41         end
42     end
43     printf('\n\nn = %.2g',n1)
```

Scilab code Exa 7.9 Newtons Backward Formula

```
1  //Example 7.9
2  //Newtons Backward Formula
3  //Page no. 243
4  clc;close;clear;
5  printf('   x\t   y\t   d\t   d2\t   d3\t   d4\t   d5\t   d6
       \n')
6  printf('
       ------------------------------------------------------------------------
       ')
7  h=0.1;
8  deff('y=f2(x)','y=(z(x-2,4)+z(x-3,5)+z(x-4,6))/h^2')
```

```
z
   =[1,7.989;1.1,8.403;1.2,8.781;1.3,9.129;1.4,9.451;1.5,9.750;1.6,1
for i=3:8
    for j=1:9-i
        z(j,i)=z(j+1,i-1)-z(j,i-1)
    end
end
printf('\n')
for i=1:7
    for j=1:8
        if z(i,j)==0 then
            printf(' \t')
        elseif j==1
            printf('   %.1f\t',z(i,j))
        else
            printf('%.3f\t',z(i,j))
        end
    end
    printf('\n')
end

j=6;y1=0;
for i=3:6
    y1=y1+z(j,i)/(i-2)
j=j-1
end
y1=y1/h;
y2(7)=f2(7);
printf('\n\n dy\n -- = %.10g\n dx',y1)
printf('\n\n\n d2y\n --- = %.5g\n dx2',y2(7))
```

Scilab code Exa 7.10 Lagranges Differentiation

```
//Example 7.10
```

```
2 //Lagrange's Differentiation
3 //Page no. 246
4 clc;close;clear;
5
6 z
    =[0,0.989992;0.1,0.999135;0.2,0.998295;0.3,0.987480];

7 h=0.1;
8 deff('y=f(x)','y=(-3*z(x,2)+4*z(x+1,2)-z(x+2,2))/(2*
    h)')
9 printf('\n f`(0) = %g\n\n f`(0.1) = %g',f(1),f(2))
```

Scilab code Exa 7.11 Newtons Divided Difference Interpolation

```
1 //Example 7.11
2 //Newton's Divided Difference Interpolation
3 //Page no. 247
4 clc;close;clear;
5
6 x=[-1,1,2,3]
7 y=[-21,15,12,3];
8 y1=y;h=0.0000001
9 deff('yi=P(a,b,d,e)','yi=(b(d+1)-b(d))/(a(d+e)-a(d))
    ') //function for finding polynomials
10 for i=1:3
11     for j=1:4-i
12         z(j,i)=P(x,y,j,i)
13          y(j)=z(j,i)
14     end
15 end
16 z(6,1)=0;
17 printf('x      y        f(x0,x1)          f(x0,x1,x3)      f
    (x0,x1,x2,x3)\n')
18 printf('
    ----------------------------------------------------------------\
```

```
    n')
19      for j=1:4
20          printf(' %i     %i \t%i\t\t%i\t\t%i\n',x(1,j)
                ,y1(1,j),z(j,1),z(j,2),z(j,3))
21      end
22  x1=poly(0,'x');
23  p=1;f=y1(1);
24  for i=1:3
25      for j=1:i
26          p=p*(x1-x(j))
27      end
28      p=p*z(1,i)
29      f=f+p
30      p=1;
31  end
32  disp(f,"f(x) = ")
33  f1=y1(1)
34  x2=poly(h,'x');
35  for i=1:3
36      for j=1:i
37          p=p*(x2-x(j))
38      end
39      p=p*z(1,i)
40      f1=f1+p
41      p=1;
42  end
43  f1=(f1-f)/h
44  disp(f1,"f'(x) = ")
45  r=roots(f1)
46  disp(r,"Roots = ")
47  x1=r(2)
48  p=1;f=y1(1);
49  for i=1:3
50      for j=1:i
51          p=p*(x1-x(j))
52      end
53      p=p*z(1,i)
54      f=f+p
```

```
55      p=1;
56  end
57  disp(f,"Maximum Value = ")
```

Scilab code Exa 7.12 Stirlings Central Difference Derivatives

```
1  //Example 7.12
2  //Stirlings Central Difference Derivatives
3  //Page no. 248
4  clc;close;clear;
5  printf('   x\t    y\t    d\t    d2\t    d3\t    d4\n
       ')
6  printf('
       ----------------------------------------------------
       ')
7  function [x]=f(x1)
8      x=0;
9      for i=3:6
10         x=x+(-1)^(i-1)*(z(x1,i))/((i-2)*h)
11     end
12 endfunction
13 h=1;
14 z=[-3,-33;-2,-12;-1,-3;0,0;1,3;2,12;3,33];
15 for i=3:6
16     for j=1:9-i
17         z(j,i)=z(j+1,i-1)-z(j,i-1)
18     end
19 end
20 printf('\n')
21 for i=1:7
22     for j=1:6
23         if j==1
24             printf('   %g\t    ',z(i,j))
25         else
26             printf('%i\t    ',z(i,j))
```

```
27          end
28      end
29      printf('\n')
30  end
31  printf("\n\nf'(-3) = %g\n\nf'(0) = %g",f(1),f(4))
```

Scilab code Exa 7.13 Newtons Backward Formula

```
1  //Example 7.13
2  //Newtons Backward Formula
3  //Page no. 248
4  clc;close;clear;
5  printf('   x\t   y\t   d\t   d2\t   d3\t   d4\t   d5\n')
6  printf('
       ')
7  h=0.5;
8  deff('y=f2(x)','y=(z(x,4)-z(x,5)+z(x,6))/h^2')
9  z=[1.5,3.375;2,7;2.5,13.625;3,24;3.5,38.875;4,59];
10 for i=1:6
11     for j=3:7
12         z(i,j)=-1
13     end
14 end
15 for i=3:7
16     for j=1:8-i
17         z(j,i)=z(j+1,i-1)-z(j,i-1)
18     end
19 end
20 printf('\n')
21 for i=1:6
22     for j=1:7
23         if z(i,j)==-1 then
24             printf(' \t')
25         elseif j==1
```

```
26                 printf('    %.1f\t',z(i,j))
27             else
28                 printf('%.3f\t',z(i,j))
29             end
30         end
31         printf('\n')
32     end
33
34     j=1;y1=0;
35     for i=3:6
36         y1=y1+(-1)^(i-1)*z(j,i)/(i-2)
37     end
38     y1=y1/h;
39     y2(7)=f2(1);
40     printf('\n\n f'(1.5)= %g',y1)
41     printf('\n\n f''(1.5) = %g',y2(7))
```

Scilab code Exa 7.14 Newtons Divided Difference

```
1  //Example 7.14
2  //Newtons Divided Difference
3  //Page no. 249
4  clc;close;clear;
5
6  x=[3,5,11,27,34]
7  y=[-13,23,899,17315,35606]
8  deff('y=f(x1)','y=a1+a2*((x1-x(2))+(x1-x(3)))')
9  a1=(y(3)-y(2))/(x(3)-x(2))
10 a2=((y(4)-y(3))/(x(4)-x(3))-(y(3)-y(2))/(x(3)-x(2)))
      /(x(4)-x(2))
11 disp(y,"y:",x,"x:")
12 printf('\n\n a1 = %g\t\ta2 = %g\n\n',a1,a2)
13 disp(f(10),"f'(10) = ")
```

Chapter 8

Numerical Quadrature

Scilab code Exa 8.1 Simpsons 1 3rd Rule

```
1  //Example 8.1
2  //Simpsons 1/3rd Rule
3  //Page no 264
4  clc;clear;close;
5  a=0;b=5;n=10;h=(-a+b)/n
6
7  for i=1:n
8      if i==1 then
9          x(1,i)=a
10     else
11         x(1,i)=x(i-1)+h
12     end
13     y(1,i)=1/(4*x(i)+5)
14 end
15 disp(y,"f(x) = ",x,"x = ")
16 S=0;
17 for i=1:n
18     if(i==1 | i==n)
19         S=S+y(1,i)
20     elseif(((i)/2)-fix((i)/2)==0)
21         S=S+4*y(1,i)
```

```
22      else
23          S=S+2*y(1,i)
24      end
25  end
26  S=S*h/3;
27  printf('\n\nSimpsons 1/3rd Rule Sum = %g\n\nlog(5) =
        %.3g',S,log(5))
```

Scilab code Exa 8.2 Simpsons 1 3rd Rule and Richardson Extrapolation

```
1   //Example 8.2
2   //Simpsons 1/3rd Rule and Richardson Extrapolation
3   //Page no 264
4   clc;clear;close;
5   a=1;b=2;
6   // simpsons rule when h=0.5
7   h=0.5
8   n=(b-a)/h+1;
9   for i=1:n
10      if i==1 then
11          x(1,i)=a
12      else
13          x(1,i)=x(i-1)+h
14      end
15      y(1,i)=1/x(i)
16  end
17  disp(y,"f(x) = ",x,"x = ")
18  S=0;
19  for i=1:n
20      if(i==1 | i==n)
21          S=S+y(1,i)
22      elseif(((i)/2)-fix((i)/2)==0)
23          S=S+4*y(1,i)
24      else
25          S=S+2*y(1,i)
```

```
26      end
27  end
28  S=S*h/3;
29  printf('\n\nSimpsons 1/3rd Rule Sum when h is 0.5  =
        %g\n\n\n',S)
30
31
32  //simpsons rule when h=0.25
33  h=0.25
34  n=(b-a)/h+1;
35  for i=1:n
36      if i==1 then
37          x(1,i)=a
38      else
39          x(1,i)=x(i-1)+h
40      end
41      y(1,i)=1/x(i)
42  end
43  disp(y,"f(x) = ",x,"x = ")
44  S2=0;
45  for i=1:n
46      if(i==1 | i==n)
47          S2=S2+y(1,i)
48      elseif(((i)/2)-fix((i)/2)==0)
49          S2=S2+4*y(1,i)
50      else
51          S2=S2+2*y(1,i)
52      end
53  end
54  S2=S2*h/3;
55  printf('\n\nSimpsons 1/3rd Rule Sum when h is 0.25
      = %g\n\n\n',S2)
56
57
58  //Richardson Extrapolation
59  Q12=16*S2/15-S/15;
60  disp(Q12,"Q12 = ")
61  disp(log(2)-log(1),"Exact Value = ")
```

Scilab code Exa 8.6 Simpsons 1 3rd Rule and Bessels Quadrature

```
1  //Example 8.6
2  //Simpsons 1/3rd Rule and Bessels Quadrature
3  //Page no 271
4  clc;clear;close;
5
6  z
      =[0,0.5;0.25,0.4794;0.5,0.4594;0.75,0.4398;1,0.4207]

7  h=0.25;
8  for i=1:3
9      printf('\nWhen x = %g',z(i,1))
10     if i==1 then
11         printf(' clearly we have \n\n')
12         for j=1:5
13             y(i,j)=1
14         end
15     elseif i==2
16         printf(', using Bessels formula \n\n')
17         for j=1:5
18             if j==1 then
19                 y(i,j)=1
20             else
21                 y(i,j)=1+h*(z(i-1,2)*y(i-1,j)+z(i,2)
                       *y(i,j-1))/2
22             end
23         end
24     else
25         printf(', using Simpsons formula \n\n')
26         for j=1:5
27             if j==1 then
28                 y(i,j)=1+h*(z(i-2,2)+4*z(i-1,2)+z(i
                       ,2))/3
```

```
29              else
30                  y(i,j)=1+h*(z(i-2,2)*y(i-2,j)+4*z(i
                       -1,2)*y(i-1,j)+z(i,2)*y(i,j-1))/3
31              end
32          end
33      end
34      for j=1:5
35          printf('y%i(%g) = %g\n\n',j,z(i,1),y(i,j))
36      end
37  end
```

Scilab code Exa 8.7 Simpsons 1 3rd Rule

```
1  //Example 8.7
2  //Simpsons 1/3rd Rule
3  //Page no 273
4  clc;clear;close;
5
6  a=100;b=200;
7  h=50;
8  n=(b-a)/h+1
9  for i=1:n
10     x(1,i)=a+(i-1)*h
11     f(1,i)=1/log(x(1,i))
12 end
13 disp(f,"f = ",x,"x = ","If h = 50")
14 l=h*(f(1,1)+4*f(1,2)+f(1,3))/3
15 disp(l,"I = ")
16 printf('\n\n')
17 h=25;
18 n=(b-a)/h+1
19 for i=1:n
20     x(1,i)=a+(i-1)*h
21     f(1,i)=1/log(x(1,i))
22 end
```

```
23 disp(f,"f = ",x,"x = ","If h = 25")
24 l=h*(f(1,1)+f(1,5)+4*(f(1,2)+f(1,4))+2*f(1,3))/3
25 disp(l,"I = ")
26 f1=0;
27 for i=100:200
28     l=0;
29     for j=2:i/2+1
30         if fix(i/j)~=i/j then
31             l=l+1;
32         end
33     end
34     if l==fix(i/2) then
35         f1=f1+1
36     end
37 end
38 disp(f1,"Exact no. of Prime Numbers = ")
```

Scilab code Exa 8.8 Rombers Method

```
1  //Example 8.8
2  //Rombers Method
3  //Page no 274
4  clc;clear;close;
5
6  a=0;b=1;
7  h=[0.5,0.25,0.125];
8  for j=1:3
9      n=(b-a)/h(j)+1
10 for i=1:n
11     x(1,i)=a+(i-1)*h(j)
12     y(1,i)=1/(1+x(1,i))
13 end
14 Q(j)=0;
15 for i=1:n
16     if i==1 | i==n then
```

```
17          Q(j)=Q(j)+h(j)*(y(1,i))/2
18      else
19          Q(j)=Q(j)+h(j)*(y(1,i))
20      end
21  end
22  printf('\nx :')
23  for k=1:n
24      printf('\t %g',x(1,k))
25  end
26  printf('\nf(x) :')
27  for k=1:n
28      printf('\t%.4f',y(1,k))
29  end
30  printf('\n\nQ(%i) = %g\n\n\n',j,Q(j))
31  end
32  R1=4*Q(2)/3-Q(1)/3
33  S=16*Q(3)/15-R1/15;
34  printf('S = %g',S)
```

Scilab code Exa 8.9 Rombers Method

```
1  //Example 8.9
2  //Rombers Method
3  //Page no 275
4  clc;clear;close;
5
6  a=4;b=5.2;
7  h=[0.4,0.2];
8  for j=1:2
9      n=(b-a)/h(j)+1
10 for i=1:n
11     x(1,i)=a+(i-1)*h(j)
12     y(1,i)=log(x(1,i))
13 end
14 Q(j)=0;
```

```
15 for i=1:n
16     if i==1 | i==n then
17         Q(j)=Q(j)+h(j)*(y(1,i))/2
18     else
19         Q(j)=Q(j)+h(j)*(y(1,i))
20     end
21 end
22 printf('\nx :')
23 for k=1:n
24     printf('\t %g',x(1,k))
25 end
26 printf('\nf(x) :')
27 for k=1:n
28     printf('\t%.4f',y(1,k))
29 end
30 printf('\n\nQ(%i) = %g\n\n\n',j,Q(j))
31 end
32 R1=4*Q(2)/3-Q(1)/3
33 printf('R1 = %g',R1)
```

Scilab code Exa 8.10 Rombers Method

```
1  //Example 8.10
2  //Rombers Method
3  //Page no 275
4  clc;clear;close;
5
6  a=0;b=1;
7  h=[0.5,0.25,0.125];
8  for j=1:3
9      n=(b-a)/h(j)+1
10 for i=1:n
11     x(1,i)=a+(i-1)*h(j)
12     y(1,i)=1/(1+x(1,i)^2)
13 end
```

```
Q(j)=0;
if j~=3 then
    for i=1:n
    if i==1 | i==n then
        Q(j)=Q(j)+h(j)*(y(1,i))/2
    else
        Q(j)=Q(j)+h(j)*(y(1,i))
    end
end
else
    R2=0;
for i=1:n
    if(i==1 | i==n)
        R2=R2+y(1,i)
    elseif(((i)/2)-fix((i)/2)==0)
        R2=R2+4*y(1,i)
    else
        R2=R2+2*y(1,i)
    end
end
R2=R2*h(j)/3
end
printf('\nx :')
for k=1:n
    printf('\t %g',x(1,k))
end
printf('\nf(x) :')
for k=1:n
    printf('\t%.4f',y(1,k))
end
if j~=3 then
    printf('\n\nQ(%i) = %g\n\n\n',j,Q(j))
else
    printf('\n\nR2 = %.4g\n\n\n',R2)
end
end

R1=4*Q(2)/3-Q(1)/3
```

```
52 S=16*R2/15-R1/15;
53 printf('\nTherefore by Rombergs Method, S = %.4g',S)
```

Scilab code Exa 8.11 Integration by Various Methods

```
1  //Example 8.11
2  //Integration by Various Methods
3  //Page no 276
4  clc;clear;close;
5  deff('y=f(x)','y=1/(1+x^2)')
6  a=0;b=1;
7  S=0;h=1/4;
8  n=(b-a)/h+1
9  for i=1:n
10     x(i)=(i-1)*h
11     y(i)=f(x(i))
12 end
13 c=['x','f(x)']
14 for i=1:2
15     printf('\n%s :\t ',c(i))
16     for j=1:n
17         if i==1 then
18             printf('%g\t',x(j))
19         else
20             printf('%.4g\t',y(j))
21         end
22     end
23 end
24
25 //trapezoidal rule
26 for i=1:n
27         if(i==1 | i==n)
28             S=S+y(i)
29         else
30             S=S+2*y(i)
```

```
31          end
32      end
33      S=S*h/2
34      printf('\n\n By Trapezoidal Method, I = %.4f',S)
35  //Simpsons 1/3rd Rule
36  S=0;
37  for i=1:n
38      if(i==1 | i==n)
39          S=S+y(i)
40      elseif(((i)/2)-fix((i)/2)==0)
41          S=S+4*y(i)
42      else
43          S=S+2*y(i)
44      end
45  end
46  S=S*h/3;
47  printf('\n\n By Simpsons 1/3rd Rule, I = %.4g \n\n\n
        ',S)
48
49  S=0;h=1/6;
50  n=(b-a)/h+1
51  for i=1:n
52      x(i)=(i-1)*h
53      y(i)=f(x(i))
54  end
55  for i=1:2
56      printf('\n%s :\t ',c(i))
57      for j=1:n
58          if i==1 then
59              printf('%.4g\t',x(j))
60          else
61              printf('%.4g\t',y(j))
62          end
63      end
64  end
65  //Simpsons 3/8 rule
66  for i=1:n
67          if(i==1 | i==n)
```

```
68              S=S+y(i)
69          elseif i~=(n+1)/2
70              S=S+3*y(i)
71          else
72              S=S+2*y(i)
73          end
74      end
75      S=S*3*h/8
76      printf('\n\n By Simpsons 3/8 rule, I = %.5f',S)
77
78  //Weddle's Rule
79  S=0;
80  for i=1:n
81      if i==(n+1)/2
82          S=S+6*y(i)
83      elseif(((i)/2)-fix((i)/2)~=0)
84          S=S+y(i)
85      else
86          S=S+5*y(i)
87      end
88  end
89  S=S*3*h/10;
90  printf('\n\n By Weddles Rule, I = %.5f ',S)
```

Scilab code Exa 8.12 Euler Maclaurin Methods

```
1  //Example 8.12
2  //Euler Maclaurin Methods
3  //Page no 278
4  clc;clear;close;
5
6  a=0;b=1;h=[0.5,0.25]
7  h1=[6,360,15120]
8  for j=1:2
9      n=(b-a)/h(j)+1
```

```
10      for i=1:n
11          x(i)=(i-1)*h(j)
12          y(i)=sin(%pi*x(i))
13      end
14      printf('\n x = \t')
15      for i=1:n
16          printf('\t%g',x(i))
17      end
18      printf('\n f(x) = \t')
19      for i=1:n
20          printf('%.4f\t',y(i))
21      end
22      s=0;
23      for i=0:2
24          s=s+((-1)^i)*(%pi^(2*i+1))*(h(j)^(2*(i+1)))/
               h1(i+1)
25      end
26      for i=1:n
27          if i==1 | i==n then
28              s=s+y(i)*(h(j))/2
29          else
30              s=s+2*y(i)*(h(j))/2
31          end
32      end
33      printf('\n\nI = %g\n\n\n',s)
34  end
```

Scilab code Exa 8.13 Trapezoidal and Simpsons Rule

```
1  //Example 8.13
2  //Trapezoidal and Simpsons Rule
3  //Page no. 283
4  clc;close;clear;
5
6  ax=4;bx=4.4;ay=2;by=2.4;h=0.1
```

```
n=(bx-ax)/h+1
n=5;
for i=1:n
    x(i)=ax+(i-1)*h
    y(i)=ay+(i-1)*h
end
printf(' y/x\t|')
for i=1:n
    printf('\t%g',x(i))
end
printf('\n
   ---------|-------------------------------------------------------
   ')
for i=1:n
     printf('\n%g\t|\t',y(i))
    for j=1:n
        z(i,j)=x(j)*y(i)
        printf('%g\t',z(i,j))
    end
end

//trapezoidal rule
s=0;
for i=1:n
    for j=1:n
        if (i==1 | i==n) & (j==1 | j==n) then
            s=s+z(i,j)
        elseif i==1 | i==n | j==1 | j==n
            s=s+2*z(i,j)
        else
            s=s+4*z(i,j)
        end
    end
end
s=(s*(h^2))/4
printf('\n\n')
disp(s,'Trapezoidal Rule Sum = ')
printf('\n\n')
```

```
43 //simpsons rule
44 s=0;
45 for i=1:n
46     for j=1:n
47         if (i==1 | i==n) & (j==1 | j==n) then
48             s=s+z(i,j)
49         elseif (i/2-fix(i/2)~=0) & (j/2-fix(j/2)~=0)
               & (i==1 | j==1 | i==n | j==n)
50             s=s+2*z(i,j)
51         elseif (i/2-fix(i/2)==0) & (j/2-fix(j/2)==0)
               & (i==1 | j==1 | i==n | j==n)
52             s=s+4*z(i,j)
53         elseif (i/2-fix(i/2)==0) & (j/2-fix(j/2)==0)
               & (i==ceil(n/2) | j==ceil(n/2))
54             s=s+8*z(i,j)
55         elseif (i/2-fix(i/2)==0) & (j/2-fix(j/2)==0)
56             s=s+16*z(i,j)
57         else
58             s=s+4*z(i,j)
59         end
60     end
61 end
62 s=(s*(h^2))/9
63 disp(s,'Simpsons Rule Sum = ')
```

Scilab code Exa 8.14 Trapezoidal Rule

```
1 //Example 8.14
2 //Trapezoidal Rule
3 //Page no. 284
4 clc;close;clear;
5
6 ax=1;bx=2;ay=1;by=2;h=0.25
7 n=(bx-ax)/h+1
8 n=5;
```

```
for i=1:n
    x(i)=ax+(i-1)*h
    y(i)=ay+(i-1)*h
end
printf(' y/x\t|')
for i=1:n
    printf('\t%g\t',x(i))
end
printf('\n
   ---------|-------------------------------------------------------------------------------
   ')
for i=1:n
     printf('\n%g\t|\t',y(i))
    for j=1:n
        z(i,j)=1/(x(j)+y(i))
        printf('%.5g\t\t',z(i,j))
    end
end

//trapezoidal rule
s=0;
for i=1:n
    for j=1:n
        if (i==1 | i==n) & (j==1 | j==n) then
            s=s+z(i,j)
        elseif i==1 | i==n | j==1 | j==n
            s=s+2*z(i,j)
        else
            s=s+4*z(i,j)
        end
    end
end
s=(s*(h^2))/4
printf('\n\n')
disp(s,'Trapezoidal Rule Sum = ')
```

Chapter 9

Difference Equations

Scilab code Exa 9.1 Recurrence formula

```
1 //Example 9.1
2 //Recurrence formula
3 //Page no. 288
4 clc;clear;close;
5
6 y(1)=5;
7 for i=2:7
8     y(i)=2*y(i-1)
9     printf('\ny(%i) = %g\n',i-1,y(i-1))
10 end
```

Scilab code Exa 9.2 Recurrence formula

```
1 //Example 9.3
2 //Recurrence formula
3 //Page no. 291
4 clc;clear;close;
5
```

```
x=poly(0,'x')
f=16*x^2-8*x+1;
z=roots(f)
disp(z,f)
printf('\t\tn\n(c1+n*c2) (%g)',z(1))
```

Scilab code Exa 9.3 Recurrence formula

```
//Example 9.3
//Recurrence formula
//Page no. 291
clc;clear;close;

x=poly(0,'x')
f=16*x^2-8*x+1;
z=roots(f)
disp(z,f)
printf('\t\tn\n(c1+n*c2) (%g)',z(1))
```

Scilab code Exa 9.4 Recurrence formula

```
//Example 9.4
//Recurrence formula
//Page no. 291
clc;clear;close;

x=poly(0,'x')
n=3;
f=x^(n)-2*x^(n-1)-x^(n-2)+2;
z=roots(f)
disp(z,f)
printf('\n\n')
printf('       n        n        n\n')
```

```
for i=1:n
    printf('c%i(%g)',i,z(i))
    if i~=n then
        printf(' + ')
    end
end
```

Scilab code Exa 9.5 Difference Equation

```
//Example 9.5
//Difference Equation
//Page no. 291
clc;clear;close;

y(1)=1.5;y(2)=3;
n=poly(0,'n')
x=poly(0,'x')
f=x^2-2*x+1;
disp(f)
x=roots(f)
disp(x,"x = ")
A=[1,1;1,2];
B=[y(1);y(2)]
C=inv(A)*B
for i=1:2
    printf('\nc(%i) = %g\n',i,C(i))
end
yn=C(1)+C(2)*n
disp(yn,"yn = ")
```

Scilab code Exa 9.6 Difference Equation

```
//Example 9.6
```

```
2 //Recurrence formula
3 //Page no. 292
4 clc;clear;close;
5
6 x=poly(0,'x')
7 f=x^2-2*x+2;
8 z=roots(f)
9 disp(z,f)
10 r=z(1)*z(2);
11 r=sqrt(r);
12 theta=atan(real(z(1)));
13 printf('\n\n\t n\n(%g)    (c1*cos(n*%g)+c2*sin(n*%g))
     ',r,theta,theta)
```

Scilab code Exa 9.8 Recurrence formula

```
1 //Example 9.8
2 //Recurrence formula
3 //Page no. 292
4 clc;clear;close;
5
6 x=poly(0,'x')
7 n=2;
8 f=x^(n)-5*x^(n-1)+6*x^(n-2);
9 z=roots(f)
10 disp(z,f)
11 printf('\n\n')
12 printf('              n        n\nf(n) = ')
13 for i=1:n
14     printf('c%i(%g)',i,z(i))
15     if i~=n then
16         printf(' + ')
17     end
18 end
```

Scilab code Exa 9.9 Particular Solution

```
1  //Example 9.9
2  //Particular Solution
3  //Page no. 293
4  clc;clear;close;
5
6  x=poly(0,'x')
7  n=2;
8  f=x^(n)-x^(n-1)-2*x^(n-2);
9  z=roots(f)
10 disp(z,f)
11 printf('\n\n')
12 printf('              n         n\nC.F. = ')
13 for i=1:n
14     printf('c%i(%g)',i,z(i))
15     if i~=n then
16         printf(' + ')
17     end
18 end
19 A=[-2,0,0;10,-2,0;9,-5,2];
20 B=[2;0;0];
21 C=inv(A)*B;
22 printf('\n\n\t    2\nP.I = (%g)n+(%g)n+(%g)',C(1),C
   (2),C(3))
```

Scilab code Exa 9.10 Particular Solution

```
1  //Example 9.10
2  //Particular Solution
3  //Page no. 294
4  clc;clear;close;
```

```
5
6  x=poly(0,'x')
7  n=2;
8  f=x^(n)-0*x^(n-1)-4*x^(n-2);
9  z=roots(f)
10 disp(z,f)
11 printf('\n\n')
12 printf('              n         n\nC.F. = ')
13 for i=1:n
14     printf('c%i(%g)',i,z(i))
15     if i~=n then
16         printf(' + ')
17     end
18 end
19 A=[-3,0,0;4,-3,0;4,2,-3];
20 B=[9;0;0];
21 C=inv(A)*B;
22 printf('\n\n\t    2\nP.I = (%g)n+(%g)n+(%g)',C(1),C
   (2),C(3))
```

Scilab code Exa 9.11 Particular Solution

```
1  //Example 9.11
2  //Particular Solution
3  //Page no. 294
4  clc;clear;close;
5
6  x=poly(0,'x')
7  n=2;
8  f=x^(n)-0*x^(n-1)-4*x^(n-2);
9  z=roots(f)
10 disp(z,f)
11 printf('\n\n')
12 printf('              n         n\nC.F.  = ')
13 for i=1:n
```

```
14      printf('c%i(%g)',i,z(i))
15      if i~=n then
16          printf(' + ')
17      end
18  end
19  A=[-3,0,0;4,-3,0;4,2,-3];
20  B=[1;1;-1];
21  C=inv(A)*B;
22  printf('\n\n\t  \t  2\nP.I = (%g)n+(%g)n+(%g)',C(1),
      C(2),C(3))
```

Scilab code Exa 9.12 Particular Solution

```
1   //Example 9.12
2   //Particular Solution
3   //Page no. 295
4   clc;clear;close;
5
6   x=poly(0,'x')
7   n=2;s=['+','-'];
8   f=x^(n)-4*x^(n-1)+5*x^(n-2);
9   z=roots(f)
10  disp(z,f)
11  printf('\n\n')
12  printf('                    n                n\nC.F. = ')
13  for i=1:n
14      printf('c%i(%g %s i)',i,z(i),s(i))
15      if i~=n then
16          printf(' + ')
17      end
18  end
19  C=1;
20  printf('\n\n\t  \nP.I = %g',C)
```

Scilab code Exa 9.13 Particular Solution

```
1  //Example 9.13
2  //Particular Solution
3  //Page no. 295
4  clc;clear;close;
5
6  x=poly(0,'x')
7  n=2;
8  f=x^(n)-7*x^(n-1)+10*x^(n-2);
9  z=roots(f)
10 disp(z,f)
11 printf('\n\n')
12 printf('              n         n\nC.F. = ')
13 for i=1:n
14     printf('c%i(%g)',i,z(i))
15     if i~=n then
16         printf(' + ')
17     end
18 end
19 C=-6;
20 printf('\n\n\t    n\t    \nP.I = %g(4)',C)
```

Scilab code Exa 9.14 Particular Solution

```
1  //Example 9.14
2  //Particular Solution
3  //Page no. 296
4  clc;clear;close;
5
6  x=poly(0,'x')
7  n=2;
```

```
f=x^(n)+5*x^(n-1)+4*x^(n-2);
z=roots(f)
disp(z,f)
printf('\n\n')
printf('                n          n\nC.F. = ')
for i=1:n
    printf('c%i(%g)',i,z(i))
    if i~=n then
        printf(' + ')
    end
end
C=18;
printf('\n\n\t   n\t   \nP.I = %g(3)',C)
```

Scilab code Exa 9.15 Particular Solution

```
//Example 9.15
//Particular Solution
//Page no. 296
clc;clear;close;

x=poly(0,'x')
n=2;
f=x^(n)-1*x^(n-1)-2*x^(n-2);
z=roots(f)
disp(z,f)
printf('\n\n')
printf('              n          n\nC.F. = ')
for i=1:n
    printf('c%i(%g)',i,z(i))
    if i~=n then
        printf(' + ')
    end
end
A=[5/8,0;1/2,5/8];
```

```
20 B=[3;0]
21 C=inv(A)*B;
22 printf('\n\n\t \t      n\t     \nP.I = (%gn%g)(4)',C(1),
      C(2))
```

Scilab code Exa 9.16 Particular Solution

```
1 //Example 9.16
2 //Particular Solution
3 //Page no. 297
4 clc;clear;close;
5
6 x=poly(0,'x')
7 n=2;
8 f=x^(n)-2*x^(n-1)+x^(n-2);
9 z=roots(f)
10 disp(z,f)
11 printf('\t\t\nC.F. = (c1+n*c2) (%g)',z(1))
12 A=[1,0,0;8,1,0;12,4,1];
13 B=[1;0;0];
14 C=inv(A)*B;
15 printf('\n\n\t  2\nP.I = (%g)n+(%g)n+(%g)',C(1),C(2)
      ,C(3))
```

Scilab code Exa 9.17 Particular Solution

```
1 //Example 9.17
2 //Particular Solution
3 //Page no. 298
4 clc;clear;close;
5
6 x=poly(0,'x')
7 n=2;
```

```
f=x^(n)-3*x^(n-1)+2*x^(n-2);
z=roots(f)
disp(z,f)
printf('\t\t      n\nC.F. = (c1+n*c2) (%g)',z(1))
A=[-4,0;2,-2];
B=[2;0];
C=inv(A)*B;
printf('\n\n\t       2\nP.I = (%g)n+(%g)n',C(1),C(2))
```

Scilab code Exa 9.18 Particular Solution

```
//Example 9.16
//Particular Solution
//Page no. 297
clc;clear;close;

x=poly(0,'x')
n=1;
f=x^(n)-4*x^(n-1);
z=roots(f)
disp(z,f)
printf('\t         n\nC.F. = (c1) (%g)',z(1))
A=[1,1;0,1];
B=[6;0];
C=inv(A)*B;
printf('\n\n\t \t       n\nP.I = ((%g)n+(%g)n)*(4)',C
   (1),C(2))
```

Chapter 10

Ordinary Differential Equations

Scilab code Exa 10.1 Taylor Method

```
1  //Example 10.1
2  //Taylor Method
3  //Page no. 302
4  clc;clear;close;
5
6  deff('y=f1(x,y)','y=y-2*x/y')
7  deff('y=f2(x,y)','y=(2*y*f1(x,y)-2-f1(x,y)^2)/y')
8  deff('y=f3(x,y)','y=(2*y*f2(x,y)-3*f1(x,y)*f2(x,y)
     +2*f1(x,y)^2)/y')
9  h=0.1;y=1;
10     x=[0.1;-0.1]
11     for i=1:2
12     k=y;
13     for j=1:3
14     if j==1 then
15         k=k+(-1)^((i-1)*j)*(h^j)*f1(0,y)/factorial(j
             )
16     elseif j==2
17         k=k+(-1)^((i-1)*j)*(h^j)*f2(0,y)/factorial(j
             )
18     elseif j==3
```

```
19          k=k+(-1)^((i-1)*j)*(h^j)*f3(0,y)/factorial(j
               )
20      end
21  end
22  printf('\ny(%g) = %g\n\n',x(i),k)
23  end
```

Scilab code Exa 10.2 Taylor Method

```
1  //Example 10.2
2  //Taylor Method
3  //Page no. 303
4  clc;clear;close;
5
6  deff('y=f1(x,y)','y=x-y^2')
7  deff('y=f2(x,y)','y=1-2*x*y+2*y^3')
8  deff('y=f3(x,y)','y=-2*(y-4*x*y^2+3*y^4+x^2)')
9  deff('y=f4(x,y)','y=-2*y*f3(x,y)-6*f1(x,y)*f2(x,y)')
10 h=0.2;y=1;
11      x=[0.2,0.4]
12      for i=1:2
13          if i==1 then
14              k=y;
15          end
16      for j=1:4
17      if j==1 then
18          k=k+(h^j)*f1((i-1)*h,y)/factorial(j)
19      elseif j==2
20          k=k+(h^j)*f2((i-1)*h,y)/factorial(j)
21      elseif j==3
22          k=k+(h^j)*f3((i-1)*h,y)/factorial(j)
23      elseif j==4
24          k=k+(h^j)*f4((i-1)*h,y)/factorial(j)
25      end
26  end
```

```
27 printf('\ny(%g) = %g\n\n',x(i),k)
28 y=k
29 end
```

Scilab code Exa 10.3 Taylor Method

```
1  //Example 10.3
2  //Taylor Method
3  //Page no. 304
4  clc;clear;close;
5
6  deff('y=f1(x,y)','y=1')
7  deff('y=f2(x,y)','y=x*y')
8  deff('y=f3(x,y)','y=x*f1(x,y)+y')
9  deff('y=f4(x,y)','y=x*f2(x,y)+2*f1(x,y)')
10 deff('y=f5(x,y)','y=x*f3(x,y)+3*f2(x,y)')
11 h=0.5;y=0;
12     x=[0.5,1]
13     for i=1:2
14         if i==1 then
15             k=y;
16         end
17     for j=1:5
18     if j==1 then
19         k=k+(h^j)*f1((i-1)*h,y)/factorial(j)
20     elseif j==2
21         k=k+(h^j)*f2((i-1)*h,y)/factorial(j)
22     elseif j==3
23         k=k+(h^j)*f3((i-1)*h,y)/factorial(j)
24     elseif j==4
25         k=k+(h^j)*f4((i-1)*h,y)/factorial(j)
26     elseif j==5
27         k=k+(h^j)*f5((i-1)*h,y)/factorial(j)
28     end
29 end
```

```
30 printf('\ny(%g) = %g\n\n',x(i),k)
31 y=k
32 end
```

Scilab code Exa 10.4 Euler Method

```
1 //Example 10.4
2 //Euler Method
3 //Page no. 309
4 clc;clear;close;
5 deff('y=f(x,y)','y=(x-y)/2')
6 y(1)=1;
7 h=0.5;
8 for i=1:7
9     printf('\ny(%g) = %g\n',(i-1)*h,y(i))
10    y(i+1)=y(i)+h*f((i-1)*h,y(i))
11
12 end
```

Scilab code Exa 10.5 Euler Method

```
1 //Example 10.5
2 //Euler Method
3 //Page no. 309
4 clc;clear;close;
5 deff('y=f(x,y)','y=(y-x)/(x+y)')
6 y(1)=1;
7 h=0.02;
8 for i=1:6
9     printf('\ny(%g) = %g\n',(i-1)*h,y(i))
10    y(i+1)=y(i)+h*f((i-1)*h,y(i))
11
12 end
```

Scilab code Exa 10.6 Euler and Modified Euler Method

```
1 //Example 10.6
2 //Euler and Modified Euler Method
3 //Page no. 311
4 clc;clear;close;
5 deff('y=f(x,y)','y=y-x^2')
6 y(1)=1;
7 h=0.2;
8 for i=1:4
9     printf('\ny(%g) = %g\n',(i-1)*h,y(i))
10    y(i+1)=y(i)+h*f((i-1)*h,y(i))
11 end
12 printf('\n\n\n By Modified Euler Method\n')
13 for i=1:4
14    printf('\ny(%g) = %g\n',(i-1)*h,y(i))
15    y(i+1)=y(i)+h*f((i-1)*h+h/2,y(i)+h*f((i-1)*h,y(i
          ))/2)
16 end
```

Scilab code Exa 10.7 Modified Euler Method

```
1 //Example 10.7
2 //Modified Euler Method
3 //Page no. 312
4 clc;clear;close;
5 deff('y=f(x,y)','y=x+abs(sqrt(y))')
6 y(1)=1;
7 h=0.2;
8 for i=1:4
9     printf('\ny(%g) = %g\n',(i-1)*h,y(i))
```

```
10      y(i+1)=y(i)+h*f((i-1)*h+h/2,y(i)+h*f((i-1)*h,y(i
           ))/2)
11  end
12  disp("Computation Error in book solved example 10.7"
       )
```

Scilab code Exa 10.8 Picard Method

```
1  //Example 10.8
2  //Picard Method
3  //Page no. 313
4  clc;clear;close;
5  deff('y=f(x,y)','y=x^2-y')
6  y(1)=1;
7  for i=1:5
8      y(i+1)=y(1)+integrate('f(x,y(i))','x',0,0.2)
9      printf('\n y%g = %g\n',i,y(i+1))
10 end
```

Scilab code Exa 10.9 Picard Method

```
1  //Example 10.9
2  //Picard Method
3  //Page no. 313
4  clc;clear;close;
5  x=poly(0,'x')
6  deff('y=f1(x,y)','y=x^2')
7  deff('y=f2(x,y)','y=2*x*y')
8  y(1)=0;
9  h=poly(0,'x')
10 for i=1:4
11     for j=1:i
12         if j==1 then
```

```
13              y1(j)=y(1)+integrate('f1(x,y(j))','x'
                    ,0,1)
14          else
15              y1(j)=integrate('f2(x,y1(j)*(x^(2*j-1)))
                    ','x',0,1)
16          end
17      end
18
19      printf("\n\n y%i = ",i)
20      for j=1:i
21          if j==i then
22              printf("x^%i * %g",2*j+1,y1(j))
23          else
24              printf("x^%i * %g + ",2*j+1,y1(j))
25          end
26      end
27      for j=i:-1:1
28          y1(j+1)=y1(j)
29      end
30  end
```

Scilab code Exa 10.10 Picard Method

```
1  //Example 10.10
2  //Picard Method
3  //Page no. 314
4  clc;clear;close;
5  deff('y=f(x,y)','y=1+x*y')
6  y(1)=1;
7  for i=1:5
8      y(i+1)=y(1)+integrate('f(x,y(i))','x',0,0.1)
9      printf('\n y%g = %.10g\n',i,y(i+1))
10 end
```

Scilab code Exa 10.11 Heun Method

```
1 //Example 10.11
2 //Heun Method
3 //Page no. 316
4 clc;clear;close;
5 deff('y=f(x,y)','y=(x-y)/2')
6 y=1;
7 h=0.5;
8 for i=1:4
9     x=(i-1)*h
10    x1=x+h
11    p=y+h*f(x,y)
12    y=y+h*(f(x,y)+f(x1,p))/2
13    printf('\n  p(%g) = %g\n  y(%g) = %g\n\n',i,p,i,
        y)
14
15 end
```

Scilab code Exa 10.12 Third Order Runge Kutta Method

```
1 //Example 10.12
2 //Third Order Runge Kutta Method
3 //Page no. 322
4 clc;clear;close;
5 deff('y=f(x,y)','y=x^2-y')
6 y=1;h=0.1;
7 for i=1:2
8     x=(i-1)*h
9 K1=h*f(x,y);
10 K2=h*f(x+h/2,y+K1/2);
11 K3=h*f(x+h,y+K2);
```

```
y=y+(K1+4*K2+K3)/6
printf('\ny(%g) = %.9f\n\n',x+h,y)
end
```

Scilab code Exa 10.13 Fourth Order Runge Kutta Method

```
//Example 10.13
//Fourth Order Runge Kutta Method
//Page no. 323
clc;clear;close;
deff('y=f(x,y)','y=x+y')
y=1;x=0;h=0.1;
K1=h*f(x,y);
K2=h*f(x+h/2,y+K1/2);
K3=h*f(x+h/2,y+K2/2);
K4=h*f(x+h,y+K3);
disp(K4,'K4 =',K3,'K3 =',K2,'K2 =',K1,'K1 =')
y1=y+(K1+2*K2+2*K3+K4)/6
printf('\ny(1.1) = %.8f\n\n',y1)
```

Scilab code Exa 10.14 Fourth Order Runge Kutta Method for higher order equations

```
//Example 10.18
//Fourth Order Runge Kutta Method for higher order
   equations
//Page no. 328
clc;clear;close;
deff('y=f(x,y,z)','y=z')
deff('y=g(x,y,z)','y=(x^2-y^2)/(1+z^2)')
y=1;h=0.5;z=0;
for i=1:2
    x=(i-1)*h
    K(1)=h*f(x,y,z);
```

```
11      L(1)=h*g(x,y,z);
12      K(2)=h*f(x+h/2,y+K(1)/2,z+L(1)/2);
13      L(2)=h*g(x+h/2,y+K(1)/2,z+L(1)/2);
14      K(3)=h*f(x+h/2,y+K(2)/2,z+L(2)/2);
15      L(3)=h*g(x+h/2,y+K(2)/2,z+L(2)/2);
16      K(4)=h*f(x+h,y+K(3),z+L(3));
17      L(4)=h*g(x+h,y+K(3),z+L(3));
18      y=y+(K(1)+2*K(2)+2*K(3)+K(4))/6
19      z=z+(L(1)+2*L(2)+2*L(3)+L(4))/6
20      for j=1:4
21          printf('\n K%i = %g\t\tL%i = %g\n',j,K(j),j,
               L(j))
22      end
23      printf('\ny(%g) = %.8f\t\tz(%g) = %.8f\n\n\n',
           x+h,y,x+h,z)
24  end
```

Scilab code Exa 10.15 Fourth Order Runge Kutta Method

```
1  //Example 10.15
2  //Fourth Order Runge Kutta Method
3  //Page no. 324
4  clc;clear;close;
5  deff('y=f(x,y)','y=x^2+y^2')
6  y=1;h=0.1;
7  for i=1:2
8      x=(i-1)*h
9      K1=h*f(x,y);
10 K2=h*f(x+h/2,y+K1/2);
11 K3=h*f(x+h/2,y+K2/2);
12 K4=h*f(x+h,y+K3);
13 disp(K4,'K4 =',K3,'K3 =',K2,'K2 =',K1,'K1 =')
14 y=y+(K1+2*K2+2*K3+K4)/6
15 printf('\ny(%g) = %.13f\n\n\n',x+h,y)
16 end
```

Scilab code Exa 10.16 Fourth Order Runge Kutta Method

```
1 //Example 10.16
2 //Fourth Order Runge Kutta Method
3 //Page no. 326
4 clc;clear;close;
5 deff('y=f(x,y)','y=(2*x*y+exp(x))/(x^2+x*exp(x))')
6 y=0;h=0.2;
7 for i=1:2
8     x=1+(i-1)*h
9     K1=h*f(x,y);
10 K2=h*f(x+h/2,y+K1/2);
11 K3=h*f(x+h/2,y+K2/2);
12 K4=h*f(x+h,y+K3);
13 disp(K4,'K4 =',K3,'K3 =',K2,'K2 =',K1,'K1 =')
14 y=y+(K1+2*K2+2*K3+K4)/6
15 printf('\ny(%g) = %.13f\n\n\n',x+h,y)
16 end
```

Scilab code Exa 10.17 Fourth Order Runge Kutta Method for system of 1st order equa

```
1 //Example 10.17
2 //Fourth Order Runge Kutta Method for system of 1st
     order equations
3 //Page no. 327
4 clc;clear;close;
5 deff('y=f(x,y,z)','y=x+z')
6 deff('y=g(x,y,z)','y=x-y')
7 y=0;h=0.1;z=1;
8 for i=1:2
9     x=(i-1)*h
```

```
10      K(1)=h*f(x,y,z);
11      L(1)=h*g(x,y,z);
12      K(2)=h*f(x+h/2,y+K(1)/2,z+L(1)/2);
13      L(2)=h*g(x+h/2,y+K(1)/2,z+L(1)/2);
14      K(3)=h*f(x+h/2,y+K(2)/2,z+L(2)/2);
15      L(3)=h*g(x+h/2,y+K(2)/2,z+L(2)/2);
16      K(4)=h*f(x+h,y+K(3),z+L(3));
17      L(4)=h*g(x+h,y+K(3),z+L(3));
18      y=y+(K(1)+2*K(2)+2*K(3)+K(4))/6
19      z=z+(L(1)+2*L(2)+2*L(3)+L(4))/6
20      for j=1:4
21          printf('\n K%i = %g\t\tL%i = %g\n',j,K(j),j,
               L(j))
22      end
23      printf('\ny(%g) = %.8f\t\tz(%g) = %.8f\n\n\n',
           x+h,y,x+h,z)
24  end
```

Scilab code Exa 10.18 Fourth Order Runge Kutta Method for higher order equations

```
1  //Example 10.18
2  //Fourth Order Runge Kutta Method for higher order
      equations
3  //Page no. 328
4  clc;clear;close;
5  deff('y=f(x,y,z)','y=z')
6  deff('y=g(x,y,z)','y=(x^2-y^2)/(1+z^2)')
7  y=1;h=0.5;z=0;
8  for i=1:2
9      x=(i-1)*h
10     K(1)=h*f(x,y,z);
11     L(1)=h*g(x,y,z);
12     K(2)=h*f(x+h/2,y+K(1)/2,z+L(1)/2);
13     L(2)=h*g(x+h/2,y+K(1)/2,z+L(1)/2);
14     K(3)=h*f(x+h/2,y+K(2)/2,z+L(2)/2);
```

```
15      L(3)=h*g(x+h/2,y+K(2)/2,z+L(2)/2);
16      K(4)=h*f(x+h,y+K(3),z+L(3));
17      L(4)=h*g(x+h,y+K(3),z+L(3));
18      y=y+(K(1)+2*K(2)+2*K(3)+K(4))/6
19      z=z+(L(1)+2*L(2)+2*L(3)+L(4))/6
20      for j=1:4
21          printf('\n K%i = %g\t\tL%i = %g\n',j,K(j),j,
               L(j))
22      end
23      printf('\ny(%g) = %.8f\t\tz(%g) = %.8f\n\n\n',
           x+h,y,x+h,z)
24  end
```

Scilab code Exa 10.19 Adams Basforth formula

```
1  //Example 10.19
2  //Adams Basforth formula
3  //Page no. 333
4  clc;clear;close;
5  x=[0,0.1,0.2,0.3,0.4];i=5;
6  y=[1,1.0025,1.0101,1.0228];
7  h=0.1;
8  deff('y=f(x,y)','y=x*y/2')
9  //adams basforth formula
10 y(i)=y(i-1)+h*(55*f(x(i-1),y(i-1))-59*(f(x(i-2),y(i
       -2)))+37*f(x(i-3),y(i-3))-9*f(x(i-4),y(i-4)))/24
11 disp(y(i),"By Adams Basforth Formula : ")
12 //adams moulton formula
13 y(i)=y(i-1)+h*(9*f(x(i),y(i))+19*f(x(i-1),y(i-1))
       -5*(f(x(i-2),y(i-2)))+f(x(i-3),y(i-3)))/24
14 disp(y(i),"By Adams Moulton Formula : ")
```

Scilab code Exa 10.20 Adams Moulton formula

```
1  //Example 10.20
2  //Adams Moulton formula
3  //Page no. 334
4  clc;clear;close;
5  x=[1,1.1,1.2,1.3,1.4];i=5;
6  y=[1,1.233,1.548488,1.978921];
7  h=0.1;
8  deff('y=f(x,y)','y=x^2*y+x^2')
9  //adams basforth formula
10 y(i)=y(i-1)+h*(55*f(x(i-1),y(i-1))-59*(f(x(i-2),y(i
       -2)))+37*f(x(i-3),y(i-3))-9*f(x(i-4),y(i-4)))/24
11 disp(y(i),"By Adams Basforth Formula : ")
12 //adams moulton formula
13 y(i)=y(i-1)+h*(9*f(x(i),y(i))+19*f(x(i-1),y(i-1))
       -5*(f(x(i-2),y(i-2)))+f(x(i-3),y(i-3)))/24
14 disp(y(i),"By Adams Moulton Formula : ")
```

Scilab code Exa 10.21 Adams formula

```
1  //Example 10.21
2  //Adams formula
3  //Page no. 335
4  clc;clear;close;
5  h=0.1;
6  deff('y=f(x,y)','y=x-y^2')
7  y(1)=1;
8  for i=1:5
9      x(i)=(i-1)*h
10     K(1)=h*f(x(i),y(i));
11 K(2)=h*f(x(i)+h/2,y(i)+K(1)/2);
12 K(3)=h*f(x(i)+h/2,y(i)+K(2)/2);
13 K(4)=h*f(x(i)+h,y(i)+K(3));
14 y(i+1)=y(i)+(K(1)+2*K(2)+2*K(3)+K(4))/6
15 printf('\ny(%g) = %.13f\n\n',x(i)+h,y(i+1))
16 end
```

```
17 i=5;
18 //adams basforth formula
19 y(i)=y(i-1)+h*(55*f(x(i-1),y(i-1))-59*(f(x(i-2),y(i
      -2)))+37*f(x(i-3),y(i-3))-9*f(x(i-4),y(i-4)))/24
20 disp(y(i),"By Adams Basforth Formula : ")
21 //adams moulton formula
22 y(i)=y(i-1)+h*(9*f(x(i),y(i))+19*f(x(i-1),y(i-1))
      -5*(f(x(i-2),y(i-2)))+f(x(i-3),y(i-3)))/24
23 disp(y(i),"By Adams Moulton Formula : ")
```

Scilab code Exa 10.22 Milne Simpson Predictor Corrector Method

```
1  //Example 10.22
2  //Milne Simpson Predictor Corrector Method
3  //Page no. 336
4  clc;clear;close;
5  deff('y=f11(x,y)','y=x^2+y^2-2')
6  deff('y=f22(x,y)','y=2*x+2*y*f11(x,y)')
7  deff('y=f33(x,y)','y=2+2*y*f22(x,y)+2*f11(x,y)^2')
8  deff('y=f44(x,y)','y=2*y*f33(x,y)+6*f11(x,y)*f22(x,y
      )')
9  h=0.1;
10 y=1;y1=y;
11 x(1)=0;k=y;
12 for i=2:3
13     x(i)=x(i-1)+h
14     for j=1:4
15     if j==1 then
16         k=k+(h^j)*f11(x(i-1),y)/factorial(j)
17     elseif j==2
18         k=k+(h^j)*f22(x(i-1),y)/factorial(j)
19     elseif j==3
20         k=k+(h^j)*f33(x(i-1),y)/factorial(j)
21     elseif j==4
22         k=k+(h^j)*f44(x(i-1),y)/factorial(j)
```

```
23      end
24  end
25  printf('\ny%i = %g\n\n',i-1,k)
26  if i==2 then
27      y=k;
28  else
29      y2=k;
30  end
31  end
32  k=y1;
33  for j=1:4
34      if j==1 then
35          k=k+(-h^j)*f11(x(1),y1)/factorial(j)
36      elseif j==2
37          k=k+(-h^j)*f22(x(1),y1)/factorial(j)
38      elseif j==3
39          k=k+(-h^j)*f33(x(1),y1)/factorial(j)
40      elseif j==4
41          k=k+(-h^j)*f44(x(1),y1)/factorial(j)
42      end
43  end
44  printf('\ny%i = %g\n\n',-1,k)
45  y3=k+4*h*(2*f11(x(1),y1)-f11(x(2),y)+2*f11(x(3),y2))
    /3
46  printf('\nPredictor y(0.3) = %.9f\n\n',y3)
47  y4=y+h*(f11(x(3),y)+4*f11(x(3)+h,y2)+f11(x(3)+2*h,y3
    ))/3
48  printf('Corrector y(0.3) = %.9f',y4)
49  y3=y1+4*h*(2*f11(x(2),y)-f11(x(3),y2)+2*f11(x(3)+h,
    y3))/3
50  printf('\n\nPredictor y(0.4) = %.9f\n\n',y3)
51  y4=y2+h*(f11(x(3)+h,y2)+4*f11(x(3)+2*h,y3)+f11(x(3)
    +3*h,y3))/3
52  printf('Corrector y(0.4) = %.9f',y4)
```

Scilab code Exa 10.23 Milne Simpson Predictor Corrector Method

```
1 //Example 10.23
2 //Milne Simpson Predictor Corrector Method
3 //Page no. 338
4 clc;clear;close;
5 deff('y=f11(y)','y=2*y-y^2')
6 h=0.05;
7 y=[1,1.0499584,1.0996680,1.1488850]
8 for i=1:6
9     x(i)=(i-1)*h
10 end
11 for i=5:6
12     y(i)=y(i-4)+4*h*(2*f11(y(i-1))-f11(y(i-2))+2*f11
       (y(i-3)))/3
13     printf('\nPredictor y(%g) = %.9f\n\n',x(i),y(i))
14     y(i)=y(i-2)+h*(f11(y(i-2))+4*f11(y(i-1))+f11(y(i
       )))/3
15     printf('Corrector y(%g) = %.9f\n\n',x(i),y(i))
16 end
```

Scilab code Exa 10.24 Milne Simpson Predictor Corrector Method

```
1 //Example 10.24
2 //Milne Simpson Predictor Corrector Method
3 //Page no. 339
4 clc;clear;close;
5 deff('y=f11(x,y)','y=1+x*y^2')
6 h=0.1;
7 y=[1,1.105,1.223,1.355]
8 for i=1:5
9     x(i)=(i-1)*h
10 end
11 i=5;
12     y(i)=y(i-4)+4*h*(2*f11(x(i-1),y(i-1))-f11(x(i-2)
```

```
        ,y(i-2))+2*f11(x(i-3),y(i-3)))/3
13      printf('\nPredictor y(%g) = %.9f\n\n',x(i),y(i))
14      y(i)=y(i-2)+h*(f11(x(i-2),y(i-2))+4*f11(x(i-1),y
        (i-1))+f11(x(i),y(i)))/3
15      printf('Corrector y(%g) = %.9f\n\n',x(i),y(i))
```

Scilab code Exa 10.25 Milne Simpsons formula

```
1  //Example 10.25
2  //Milne Simpsons formula
3  //Page no. 340
4  clc;clear;close;
5  h=0.1;
6  deff('y=f(x,y)','y=x*y+y^2')
7  y(1)=1;
8  for i=1:5
9      x(i)=(i-1)*h
10 end
11 for i=1:3
12     K(1)=h*f(x(i),y(i));
13     K(2)=h*f(x(i)+h/2,y(i)+K(1)/2);
14     K(3)=h*f(x(i)+h/2,y(i)+K(2)/2);
15     K(4)=h*f(x(i)+h,y(i)+K(3));
16     y(i+1)=y(i)+(K(1)+2*K(2)+2*K(3)+K(4))/6
17     for j=1:4
18         printf('\n K%i = %.4g\n',j,K(j))
19     end
20     printf('\ny(%g) = %.4f\n\n',x(i)+h,y(i+1))
21 end
22 i=5;
23     y(i)=y(i-4)+4*h*(2*f(x(i-1),y(i-1))-f(x(i-2),y(i
       -2))+2*f(x(i-3),y(i-3)))/3
24     printf('\nPredictor y(%g) = %.4f\n\n',x(i),y(i))
25     y(i)=y(i-2)+h*(f(x(i-2),y(i-2))+4*f(x(i-1),y(i
       -1))+f(x(i),y(i)))/3
```

```
26      printf('Corrector y(%g) = %.4f\n\n',x(i),y(i))
```

Scilab code Exa 10.26 Mullers Method

```
1  //Example 10.26
2  //Milne Simpson and Picard Method
3  //Page no. 341
4  clc;clear;close;
5  deff('y=f(x,y)','y=x-y^2')
6  y(1)=0;h=0.2;
7  for i=1:4
8      x(i)=(i-1)*h
9      y(i+1)=y(1)+integrate('f(x,y(i))','x',0,x(i))
10     printf('\n y%g = %.4g\n\n y`%g = %.4g\n\n',i-1,y
           (i+1),i-1,f(x(i),y(i+1)))
11 end
12 for i=5:6
13     x(i)=(i-1)*h
14     if i==5 then
15         y1=y(i)
16     else
17         y1=y(i-1)
18     end
19     y(i)=y(i-3)+4*h*(2*f(x(i-1),y(i-(i-5)))-f(x(i-2)
           ,y(i-1))+2*f(x(i-3),y(i-2)))/3
20     printf('\nPredictor y(%g) = %.4f\n\n',x(i),y(i))
21     y(i)=y(i-1)+h*(f(x(i-2),y(i-2))+4*f(x(i-1),y1)+f
           (x(i),y(i)))/3
22
23     printf('Corrector y(%g) = %.4f\n\n',x(i),y(i))
24 end
25 printf('\n\n\nNote : Computation error in book
       while calculation of predictor and corrector')
```

Scilab code Exa 10.33 Numerov Method

```
1  //Example 10.33
2  //Numerov Method
3  //Page no. 350
4  clc;clear;close;
5  k=0.5;h=%pi/6
6  y(1)=0;y(2)=k;
7  deff('y=f2(x,y)','y=-y')
8  deff('y=g()','y=-1')
9  fi=acos(((2+5*h^2*g()/6)-(1-h^2*g()/12)*y(1))/(2*(1-
       h^2*g()/12)))
10 y6=k*(sin(6*fi)/sin(fi))
11 disp(y6,"y6 = ")
```

Scilab code Exa 10.34 Numerov Method

```
1  //Example 10.34
2  //Numerov Method
3  //Page no. 351
4  clc;clear;close;
5  k=0.42;h=0.5
6  y(1)=0.5;y(2)=k;
7  deff('y=f2(x,y)','y=-y')
8  deff('y=g(x)','y=(x-1)*(x-2)')
9  for i=1:4
10     x(i)=(i-1)*h
11 end
12
13 for i=3:4
14     y(i)=((2+5*h^2*g(x(i-1))/6)*y(i-1)-(1-h^2*g(x(i
           -2))/12)*y(i-2))/(1-h^2*g(x(i))/12)
```

```
15      printf('\ny(%g) = %.6g\n',x(i),y(i))
16  end
```

Scilab code Exa 10.36 Finite Difference Method

```
1  //Example 10.36
2  //Finite Difference Method
3  //Page no. 353
4  clc;close;clear;
5
6  h=0.2;
7  y(1)=0;
8  deff('y=f2(x,y)','y=x+y')
9  for i=1:4
10     x(i)=i*h
11 end
12 for i=1:4
13     B(i,1)=h^2*x(i)
14     if i==4 then
15         B(4,1)=1-B(4,1)
16     end
17     printf('\ny%i - 2.04y%i + y%i = %g\n',i-1,i,i+1,
          B(i,1))
18 end
19 A=[-2-h^2,1,0,0;1,-2-h^2,1,0;0,1,-2-h^2,1;0,0,1,-2-h
      ^2]
20 C=inv(A)*B;
21 printf('\n\n')
22 for i=1:4
23     printf('\ny%i = %g\n',i,C(i))
24 end
```

Scilab code Exa 10.37 Finite Difference Method

```
1  //Example 10.37
2  //Finite Difference Method
3  //Page no. 354
4  clc;close;clear;
5
6  h=0.2;
7  y(1)=1;y(2)=1;
8  deff('y=f2(x,y)','y=x+y')
9  for i=1:4
10     x(i)=i*h
11 end
12 A=[0,1,0,0;1,0,1,0;0,1,0,1;0,0,1,0]
13 j=1;
14 for i=1:4
15     A(i,i)=-(1.96+2*x(i)^2)/(1+x(i)^2)
16 end
17 for i=1:4
18     B(i,1)=7*h^2*x(i)
19     if i==4 then
20         B(4,1)=2-B(4,1)
21     end
22     printf('\ny%i %gy%i + y%i = %g\n',i-1,A(i,i),i,i
          +1,B(i,1))
23 end
24 C=inv(A)*B;
25 printf('\n\n')
26 for i=1:4
27     printf('\ny%i = %g\n',i,C(i))
28 end
```

Scilab code Exa 10.38 Finite Difference Method

```
1  //Example 10.38
2  //Finite Difference Method
3  //Page no. 354
```

```
clc;close;clear;

h=0.25;
y(1)=0;
deff('y=f2(x,y)','y=x+y')
for i=1:3
    x(i)=i*h
end
A=[0,1,0;1,0,1;0,1,0]
j=1;
for i=1:3
    A(i,i)=-(2-h^2*x(i)^2)
end
for i=1:3
    B(i,1)=0
    if i==3 then
        B(3,1)=-1
    end
    printf('\ny%i %gy%i + y%i = %g\n',i-1,A(i,i),i,i
       +1,B(i,1))
end
C=inv(A)*B;
printf('\n\n')
for i=1:3
    printf('\ny%i = %g\n',i,C(i))
end
```

Scilab code Exa 10.39 Finite Difference Method

```
//Example 10.39
//Finite Difference Method
//Page no. 355
clc;close;clear;

h=0.25;
```

```
y(1)=0;
deff('y=f2(x,y)','y=x+y')
for i=1:3
    x(i)=i*h
end
A=[0,1,0;1,0,1;0,1,0]
j=1;
for i=1:3
    A(i,i)=-(2+64*h^2)
end
for i=1:3
    B(i,1)=-10*h^2
    printf('\ny%i %gy%i + y%i = %g\n',i-1,A(i,i),i,i
       +1,B(i,1))
end
C=inv(A)*B;
printf('\n\n')
for i=1:3
    printf('\ny%i = %g\n',i,C(i))
end
```

Scilab code Exa 10.40 Formula Method

```
//Example 10.40
//Formula Method
//Page no. 355
clc;clear;close;

deff('y=f(x,y)','y=x*y')
y(1)=0;y(6)=1;h=0.2;
for i=1:6
    x(i)=(i-1)*h
end
A=eye(4,5)-eye(4,5)
B=eye(4,1)-eye(4,1)
```

```
13 B(4,1)=-y(6)
14 for i=1:4
15          A(i,i)=1;
16          A(i,i+1)=-2-h^2*x(i+1)
17          A(i,i+2)=1;
18 end
19 for i=1:4
20     for j=1:4
21          C(i,j)=A(i,j+1)
22     end
23 end
24 printf('\n\n')
25 A=C;
26 D=inv(A)*B
27 for i=1:4
28     y(i+1)=D(i);
29     printf('\ty%i = %.5f\t',i,y(i+1))
30 end
31 printf('\n\n----------------------------------\n')
32 k=0;
33 for i=1:6
34     for j=1:3
35          if j==1 then
36              D(i,j)=x(i)*y(i)
37              printf(' f%i\t%.4f\t',i-1,D(i,j))
38          elseif (i~=1 & i~=2) | k==1
39              D(i,j)=D(i,j-1)-D(i-1,j-1)
40              printf('%.4f\t',D(i,j))
41              if i==2 then
42                  k=2;
43              end
44          end
45     end
46     if i==1 then
47          k=1;
48     end
49     printf('\n')
50 end
```

```
51 printf('-----------------------------------\n')
52 for i=1:4
53     B(i)=D(i+2,3)*(h^2)/12
54 end
55
56 B(4,1)=-(B(4,1)-y(6))
57 printf('\n\n')
58 for i=1:4
59     A(i,i)=-2
60 end
61 z=inv(A)*B
62 for i=1:4
63     printf('\tz%i = %.5f\t',i,z(i))
64 end
65 printf('\n\n')
66 for i=1:4
67     y(i+1)=y(i+1)+z(i);
68     printf('\ty%i = %.5f\t',i,y(i+1))
69 end
70 printf('\n\n\n\n\n Note : Computation errors in book
    ')
```

Scilab code Exa 10.41 Eigenvalue Problem

```
1 //Example 10.41
2 //Eigenvalue Priblem
3 //Page no. 359
4 clc;close;clear;
5
6 h=0.25;
7 y(1)=0;
8 l=poly(0,'lbd')
9 deff('y=f2(x,y)','y=x+y')
10 for i=1:3
11     x(i)=i*h
```

```
12 end
13 A=[0,1,0;1,0,1;0,1,0]
14 j=1;
15 for i=1:3
16     A(i,i)=-(2-l*h^2)
17 end
18 for i=1:3
19     B(i,1)=0
20     printf('\ny%i -(2-0.0625*lbd)y%i + y%i = %g\n',i
          -1,i,i+1,B(i,1))
21 end
22 disp(A)
23 disp(det(A),"Determinant of A =")
24 disp(roots(det(A)),"Roots = ")
25 a=roots(det(A))
26 disp(a(3),"Minimum Value =")
```

Chapter 11

Partial Differential Equations

Scilab code Exa 11.1 Gauss Seidel Method

```
1  //Example 11.1
2  //Gauss-Seidel Method
3  //Page no. 366
4  clc;clear;close;
5
6  U=[50,100,100,50;0,0,0,0;0,0,0,0;0,0,0,0]
7  A=[4,0,0,-1;0,4,-1,0;0,-1,4,0;-1,0,0,4]          //
       equation matrix
8  B=[150;150;0;0]          //solution matrix
9  X=inv(A)*B
10 for i=1:4
11     printf('\n U%i = %g\n',i,X(i))
12 end
13
14 //Jacobi method
15
16 for k=1:2
17     printf('\n')
18     p=0;
19 for i=1:2
20     for j=1:2
```

```
21          U(i+1,j+1)=X(i+p)
22      end
23      p=2;
24  end
25  p=3;
26  for i=2:3
27      for j=2:3
28          X(i+j-p)=(U(i,j-1)+U(i,j+1)+U(i-1,j)+U(i+1,j
                ))/4
29      end
30      p=2;
31  end
32  for i=1:4
33      printf('\n U%i(%i) = %g\n',i,k,X(i))
34  end
35  printf('\n')
36  end
37  printf('\nHence the solution is : \n\n')
38  for i=1:4
39      printf(' U%i = %g, ',i,X(i))
40  end
```

Scilab code Exa 11.2 Gauss Seidel Method

```
1  //Example 11.2
2  //Gauss-Seidel Method
3  //Page no. 368
4  clc;clear;close;
5
6  U=[0,1,2,0;1,0,0,4;2,0,0,5;0,4,5,0]
7  k=1;
8  for i=2:3
9      for j=2:3
10         if (i==2 & j==3) | (i==3 & j==2) then
11             U(i,j)=0
```

```
12          else
13              U(i,j)=(U(i-1,j)+U(i+1,j)+U(i,j-1)+U(i,j
                    +1))/4
14          end
15          printf(" u%i=%g, ",k,U(i,j))
16          k=k+1
17      end
18  end
19  for l=1:7
20      printf('\n\n')
21      k=1;
22      for i=2:3
23      for j=2:3
24          U(i,j)=(U(i-1,j)+U(i+1,j)+U(i,j-1)+U(i,j+1))
                /4
25          printf("\n u%i(%i)=%.13g\n",k,l,U(i,j))
26          k=k+1
27      end
28  end
29  end
```

Scilab code Exa 11.3 Gauss Seidel Method

```
1  //Example 11.3
2  //Gauss-Seidel Method
3  //Page no. 370
4  clc;clear;close;
5
6  U=[60,60,60,60;40,0,0,50;20,0,0,40;0,10,20,30]
7  deff('y=d(i,j)','y=(U(i-1,j-1)+U(i+1,j+1)+U(i-1,j+1)
       +U(i+1,j-1))/4')          //diagonal 5 point
       formula
8  deff('y=s(i,j)','y=(U(i-1,j)+U(i+1,j)+U(i,j-1)+U(i,j
       +1))/4')          //std 5 point formula
9  U(2,2)=d(2,2);
```

```
for k=0:5
    for i=2:3
        p=3;
        for j=2:3
            if k==0 & i==2 & j==2 then
                U(i,j)=d(i,j)
            else
                U(i,j)=s(i,j)
            end
            if k==0 then
                printf('\n U%i = %g\n',i+j-p,U(i,j))
            else
                printf('\n U%i(%i) = %g\n',i+j-p,k,U
                   (i,j))
            end
        end
        p=2;
    end
    printf('\n\n')
end
printf('\nHence the solution is : \n\n')
for i=2:3
    for j=2:3
        printf(' U%i = %g, ',i,U(i,j))
    end
end
```

Scilab code Exa 11.4 Gauss Seidel Method

```
//Example 11.4
//Gauss-Seidel Method
//Page no. 372
clc;clear;close;

U=[1,2,2,2;0,0,0,2;0,0,0,2;0,0,0,1]
```

```
7  deff('y=d(i,j)','y=(U(i-1,j-1)+U(i+1,j+1)+U(i-1,j+1)
     +U(i+1,j-1))/4')          //diagonal 5 point
     formula
8  deff('y=s(i,j)','y=(U(i-1,j)+U(i+1,j)+U(i,j-1)+U(i,j
     +1))/4')          //std 5 point formula
9  U(2,2)=d(2,2);
10 for k=0:4
11     for i=2:3
12         p=3;
13         for j=2:3
14             if k==0 & i==2 & j==2 then
15                 U(i,j)=d(i,j)
16             else
17                 U(i,j)=s(i,j)
18             end
19             if k==0 then
20                 printf('\n U%i = %g\n',i+j-p,U(i,j))
21             else
22                 printf('\n U%i(%i) = %g\n',i+j-p,k,U
                       (i,j))
23             end
24         end
25         p=2;
26     end
27     printf('\n\n')
28 end
29 printf('\nHence the solution is : \n\n')
30 for i=2:3
31     for j=2:3
32         printf(' U%i = %.3f, ',i,U(i,j))
33     end
34 end
```

Scilab code Exa 11.5 Gauss Seidel Method

```
1  //Example 11.5
2  //Gauss-Seidel Method
3  //Page no. 373
4  clc;clear;close;
5
6  U
       =[0,500,1000,500,0;1000,0,0,0,1000;2000,0,0,0,2000;1000,0,0,0,100

7  deff('y=d(i,j)','y=(U(i-1,j-1)+U(i+1,j+1)+U(i-1,j+1)
       +U(i+1,j-1))/4')          //diagonal 5 point
       formula
8  deff('y=s(i,j,l)','y=(U(i-l,j)+U(i+l,j)+U(i,j-l)+U(i
       ,j+l))/4')          //std 5 point formula
9  U(3,3)=s(3,3,2);
10 for k=0:10
11     p=3;
12     for i=2:4
13         for j=2:4
14             if k==0 & (i==3 & j==3) | (i==2 & j==4)
                  | (i==4 & j==2) | (i==4 & j==4) then
15                 printf('\n U%i(%i) = %g\n',i+j-p,k,U
                      (i,j))
16                 continue
17             end
18             if k==0 & i==2 & j==2 then
19                 U(i,j)=d(i,j)
20             else
21                 U(i,j)=s(i,j,1)
22             end
23             if i==2 & j==2 then
24                 U(2,4)=U(2,2);
25                 U(4,2)=U(2,2);
26                 U(4,4)=U(2,2);
27             end
28             if k==0 then
29                 printf('\n U%i = %g\n',i+j-p,U(i,j))
30             else
31                 printf('\n U%i(%i) = %g\n',i+j-p,k,U
```

```
                    (i,j))
32              end
33          end
34          p=p-2;
35      end
36      printf('\n\n')
37  end
38  printf('\nHence the solution is : \n\n')
39  p=3;
40  for i=2:4
41      for j=2:4
42          printf(' U%i = %.3f, ',i+j-p,U(i,j))
43      end
44      p=p-2
45  end
```

Scilab code Exa 11.6 Gaussian Elimination Method

```
1  //Example 11.6
2  //Gaussian Elimination Method
3  //Page no. 374
4  clc;clear;close;
5  A
     =[-4,1,1,0,-80;1,-4,0,1,-10;1,0,-4,1,-160;0,1,1,-4,-90]
                //augmented matrix
6  disp(A,'Augmented Matrix=')
7  C=A;
8  //triangularization
9  for i=1:4
10     for j=1:5
11         if i==1 then
12             B(i,j)=A(i,j)
13         elseif i==2
14             B(i,j)=A(i,j)-A(i,1)*A(i-1,j)/A(1,1)
15             B(i+1,j)=A(i+1,j)-A(i+1,1)*A(i-1,j)/A
```

```
                (1,1)
16              B(i+2,j)=A(i+2,j)-A(i+2,1)*A(i-1,j)/A
                (1,1)
17          elseif i==3
18              if j==1 then
19                  C=B
20              else
21                  B(i,j)=B(i,j)-C(i,2)*B(i-1,j)/B(2,2)
22                  B(i+1,j)=C(i+1,j)-C(i+1,2)*C(i-1,j)/
                       C(2,2)
23              end
24          else
25              if j==1 then
26                  C=B
27              end
28                  B(i,j)=B(i,j)-C(i,3)*B(i-1,j)/B(3,3)
29          end
30      end
31  end
32
33  disp(B,'Triangulated Matrix=')
34  //back substitution
35  x(4)=B(4,5)/B(4,4);
36  printf('\n p(4) = %.2f\n',x(4))
37  for i=3:-1:1
38      k=0
39      for j=i+1:4
40         k=k+B(i,j)*x(j)
41      end
42      x(i)=(1/B(i,i))*(B(i,5)-k)
43       printf('\n p(%i) = %.2f\n',i,x(i))
44  end
```

Scilab code Exa 11.7 Relaxation Method

```
1  //Example 11.7
2  //Relaxation Method
3  //Page no. 376
4  clc;clear;close;
5
6  for i=0:4
7      for j=0:4
8          if i==0 | j==0 then
9              U(5-i,j+1)=0
10         elseif i==4 | j==4
11             U(5-i,j+1)=(i*j)^2
12         else
13             U(5-i,j+1)=0;
14         end
15     end
16 end
17 S=['A','B','C','D','E','F','G','H','I']
18 disp(U)
19 deff('y=d(i,j)','y=(U(i-1,j-1)+U(i+1,j+1)+U(i-1,j+1)
       +U(i+1,j-1))/4')          //diagonal 5 point
       formula
20 deff('y=s(i,j,l)','y=(U(i-l,j)+U(i+l,j)+U(i,j-l)+U(i
       ,j+l))/4')          //std 5 point formula
21 U(3,3)=s(3,3,2);
22 for k=0:0
23     p=3;
24     for i=2:4
25         for j=2:4
26             if k==0 & (i==3 & j==3) then
27                 printf('\n U %s(%i) = %g\n',S(i+j-p)
                       ,k,U(i,j))
28                 continue
29             end
30             if k==0 & i==4 & j==2 then
31                 U(i,j)=d(i,j)
32             else
33                 U(i,j)=s(i,j,1)
34             end
```

```
35              if k==0 then
36                  printf('\n U %s = %g\n',S(i+j-p),U(i
                        ,j))
37              else
38                  printf('\n U %s(%i) = %g\n',S(i+j-p)
                        ,k,U(i,j))
39              end
40          end
41          p=p-2;
42      end
43      printf('\n\n')
44  end
45  printf('\nHence the solution is : \n\n')
46  p=3;
47  for i=2:4
48      for j=2:4
49          printf(' U%s = %.3f, ',S(i+j-p),U(i,j))
50      end
51      p=p-2
52  end
```

Scilab code Exa 11.8 Relaxation Method

```
1  //Example 11.7
2  //Relaxation Method
3  //Page no. 378
4  clc;clear;close;
5  h=1/3;k=1/3;
6  for i=0:3
7      for j=0:3
8          if i==0 | j==0 then
9              U(4-i,j+1)=i*h+j*k
10         elseif i==3 | j==3
11             U(4-i,j+1)=i*h+j*k
12         end
```

```
13      end
14  end
15  //disp(U,'U = ')
16  for i=1:4
17      for j=1:4
18          if U(i,j)==0 then
19              U(i,j)=1;
20          end
21      end
22  end
23  U(3,2)=U(3,2)-1/3;
24  U(2,2)=U(2,2)-1/3;
25  U(3,3)=U(3,3)-1/3;
26  U(3,2)=U(3,2)-1/3;
27  U(2,3)=U(2,3)+1/3;
28  //disp(U,'U = ')
29  for i=2:3
30      for j=2:3
31          U1(i,j)=U(i+1,j)+U(i-1,j)+U(i,j+1)+U(i,j-1)
                -4*U(i,j)
32      end
33  end
34  for i=2:3
35      for j=2:3
36          U(i,j)=U1(i,j)
37      end
38  end
39  //disp(U,'U = ')
40  disp(U,'U = ')
41  disp(' ')
42  k=1;
43  for i=2:3
44      for j=2:3
45          printf('\t u%i = %g  ,',k,U(i,j))
46          k=k+1
47      end
48  end
```

Scilab code Exa 11.9 Gauss Seidel Method

```
1  //Example 11.9
2  //Gauss-Seidel Method
3  //Page no. 380
4  clc;clear;close;
5
6  U=eye(4,4)-eye(4,4)
7  U(2,1)=150;U(3,1)=120;
8  U(2,4)=180;U(3,4)=150
9  deff('y=d(i,j)','y=(U(i-1,j-1)+U(i+1,j+1)+U(i-1,j+1)
       +U(i+1,j-1))/4')          //diagonal 5 point
       formula
10 deff('y=s(i,j)','y=(U(i-1,j)+U(i+1,j)+U(i,j-1)+U(i,j
       +1))/4')          //std 5 point formula
11 for k=1:6
12     for i=2:3
13         p=3;
14         for j=2:3
15                 U(i,j)=s(i,j)
16                 if i==2 & j==2 then
17                     U(i+1,j+1)=U(i,j)
18                 elseif i==3 & j==3
19                     continue
20                 end
21                 printf('\n U%i(%i) = %g\n',i+j-p,k,U
                       (i,j))
22         end
23         p=2;
24     end
25     printf('\n\n')
26 end
27 printf('\nHence the solution is : \n\n')
28     p=3;
```

```
for i=2:3

    for j=2:3
        printf(' U%i = %.3f,  ',i+j-p,U(i,j))
    end
    p=2
end
```

Scilab code Exa 11.10 Gauss Seidel Method

```
//Example 11.10
//Gauss Seidel Method
//Page no. 382
clc;clear;close;

O=0.5;
A=[-8,8,0;2,-8,4;0,4,-8];        //equation matrix
B=[-1;-1;-1];        //solution matrix
Ov=inv(A)*B;
disp(Ov,'Values = ')
Ox=Ov(1)+(Ov(1)-O)/3
disp(Ox,'O* = ')
```

Scilab code Exa 11.11 Eigenvalue Problem

```
//Example 11.11
//Eigenvalue Problem
//Page no. 383
clc;clear;close;
h1=1;h2=3/4;
lbd1=2;
lbd=poly(0,'lbd')
mu=9*lbd/16;
```

```
A=[4-mu,-2,0;-2,4-mu,-1;0,-4,4-mu];
disp(determ(A),'Characteristic Equation = ');
r=roots(determ(A))
disp(r,'Roots = ')
r1=r(3)
Q=((h1/h2)^2*r1-lbd1)/((h1/h2)^2-1)
disp(Q,'Q12 = ')
```

Scilab code Exa 11.12 Eigenvalue Problem

```
//Example 11.12
//Eigenvalue Problem
//Page no. 385
clc;clear;close;

h1=1/4;h2=1/5;
lbd=poly(0,'lbd')
mu=9*lbd/16;
A=[lbd-64,16;32,lbd-64];
disp(determ(A),'Characteristic Equation = ');
r=roots(determ(A))
disp(r,'Roots = ')
r1(1)=r(2)
A=[lbd-100,0,25;0,lbd-100,50;25,50,lbd-100];
disp(determ(A),'Characteristic Equation = ');
r=roots(determ(A))
disp(r,'Roots = ')
r1(2)=r(3)
Q=((h1/h2)^2*r1(2)-r1(1))/((h1/h2)^2-1)
disp(Q,'Q12 = ')
```

Scilab code Exa 11.13 Eigenvalue Problem

```
//Example 11.13
//Eigenvalue Problem
//Page no. 387
clc;clear;close;

h1=1/2;h2=1/3;
lbd=poly(0,'lbd')
mu=9*lbd/16;
r1(1)=64
A=[2*lbd-324,81;243,lbd-324];
disp(determ(A),'Characteristic Equation = ');
r=roots(determ(A))
disp(r,'Roots = ')
r1(2)=r(2)
Q=((h1/h2)^2*r1(2)-r1(1))/((h1/h2)^2-1)
disp(Q,'Q12 = ')
```

Scilab code Exa 11.14 Crank Nicolson Method

```
//Example 11.14
//Crank Nicolson Method
//Page no. 390
clc;clear;close;
h=1/2;k=1/8;
r=k/h^2;
for i=1:3
    for j=1:2
        if i==1 | j==1 then
            u(i,j)=0;
        end
        if i==3 then
            u(i,j)=(j-1)*k
        end
    end
end
```

```
for j=2:2
        u(2,j)=(u(1,j-1)+2*u(2,j-1)+u(3,j-1)+u(1,j)+
           u(3,j))/6
end
u=u'
printf('\nfor h = 1/2 and k=1/8\n\n')
printf('i\\j --> ')
for i=1:1
    printf('\tu%i\t',i)
end
printf('\n
   ------------------------------------------------------\n'
   )
for i=2:2
    for j=2:2
        printf('\t   %.9f',u(i,j))
    end
end



h=1/4;k=1/8;
r=k/h^2;
for i=1:5
    for j=1:5
        if i==1 | j==1 then
            u(i,j)=0;
        end
        if i==5 then
            u(i,j)=(j-1)*k
        end
    end
end
a=[3,-1,0;-1,3,-1;0,-1,3];
a=inv(a);
for j=2:5
        b=[u(1,j-1)-u(2,j-1)+u(3,j-1)+u(1,j);u(2,j
```

```
            -1)-u(3,j-1)+u(4,j-1);u(3,j-1)-u(4,j-1)+u
            (5,j-1)+u(5,j)]
52      x=a*b
53      u(2,j)=x(1);u(3,j)=x(2);u(4,j)=x(3);
54  end
55  u=u'
56  printf('\n\n\n\nfor h = 1/4 and k=1/8\n\n')
57  printf('i\\j --> ')
58  for i=1:3
59      printf('\tu%i\t',i)
60  end
61  printf('\n
    ------------------------------------------------------------------\
    n')
62  for i=2:2
63      for j=2:4
64          printf('\t   %.9f',u(i,j))
65      end
66  end
67
68
69
70
71
72  h=1/4;k=1/16;
73  r=k/h^2;
74  for i=1:5
75      for j=1:3
76          if i==1 | j==1 then
77              u(i,j)=0;
78          end
79          if i==5 then
80              if j==3 then
81                  k=1/8;
82              end
83              u(i,j)=(j-1)*k
84          end
85      end
```

```
end
a=[4,-1,0;-1,4,-1;0,-1,4];
a=inv(a);
for j=2:3
        b=[u(1,j-1)-u(2,j-1)+u(3,j-1)+u(1,j);u(2,j
           -1)-u(3,j-1)+u(4,j-1);u(3,j-1)-u(4,j-1)+u
           (5,j-1)+u(5,j)]
    x=a*b
    u(2,j)=x(1);u(3,j)=x(2);u(4,j)=x(3);
end
u=u'
printf('\n\n\n\nfor h = 1/4 and k=1/16\n\n')
printf('i\\j --> ')
for i=1:3
    printf('\tu%i\t',i)
end
printf('\n
   ------------------------------------------------------------------\
   n')
for i=2:3
    printf('\n')
    for j=2:4
        printf('\t   %.9f',u(i,j))
    end
end
```

Scilab code Exa 11.15 Bender Schmidt Method

```
//Example 11.15
//Bender Schmidt Method
//Page no. 393
clc;clear;close;

h=1;k=1;c=1/sqrt(2);
r=k*c^2/h^2;
```

```
for i=1:5
    u(4,i)=i-1;
end
k=0;
for i=4:-1:1
    u(i,1)=0
    k=k+1;
end
k=1;
for i=2:5
    u(4,i)=k*(4-k)
    k=k+1;
end
disp(u,'u = ')
k=1;
printf('\n\n')
for i=3:-1:1
    for j=2:4
        u(i,j)=(u(i+1,j-1)+u(i+1,j+1))/2
        printf('\n\tu%i = %g\n',k,u(i,j))
        k=k+1;
    end
end
```

Scilab code Exa 11.16 Crank Nicolson Method

```
//Example 11.16
//Crank Nicolson Method
//Page no. 394
clc;clear;close;
//case 1
h=1/4;k=1/8;
r=k/h^2;
n=1/h+1;
for i=1:2
```

```
    for j=1:n
        if i==2 then
            u(i,j)=sin(%pi*(j-1)*h)
        end
        if j==1 | j==n then
            u(i,j)=0;
        end
    end
end

a=[3,-1,0;-1,3,-1;0,-1,3];
a=inv(a);
for j=2:4

end
for i=2:-1:2
    for j=2:4
      b(j-1)=u(i,j-1)+(1-r)*u(i,j)+u(i,j+1)
    end
    x=a*b
    u(i-1,2)=x(1);u(i-1,3)=x(2);u(i-1,4)=x(3);
end
printf('\nfor h = 1/4 and k=1/8\n\n')
for i=1:1
    for j=2:4
        printf('\t  u%i  = %.9f',j-1,u(i,j))
    end
end
printf('\n\n\n')


//case 2
h=1/4;k=1/16;
r=k/h^2;
n=1/h+1;
for i=1:3
    for j=1:n
```

```
48          if i==3 then
49              u(i,j)=sin(%pi*(j-1)*h)
50          end
51          if j==1 | j==n then
52              u(i,j)=0;
53          end
54      end
55  end
56
57  a=[4,-1,0;-1,4,-1;0,-1,4];
58  a=inv(a);
59  for j=2:4
60
61  end
62  for i=3:-1:2
63      for j=2:4
64        b(j-1)=u(i,j-1)+(1-r)*u(i,j)+u(i,j+1)
65      end
66      x=a*b
67      u(i-1,2)=x(1);u(i-1,3)=x(2);u(i-1,4)=x(3);
68  end
69  printf('\nfor h = 1/4 and k=1/16\n\n')
70  l=1;
71  for i=2:-1:1
72      for j=2:4
73          printf('\t  u%i  = %.9f',j+l-i,u(i,j))
74      end
75      printf('\n')
76      l=3;
77  end
78  printf('\n\n\n')
79  printf('The Anlytical Solution u1 = %g',exp(-%pi^2*k
    )*sin(%pi*h))
80  printf('\n\n\n\nNote : Computation Errors in the
    book')
```

Scilab code Exa 11.17 Bender Schmidt Method

```
1  //Example 11.17
2  //Bender Schmidt Method
3  //Page no. 396
4  clc;clear;close;
5
6  h=1;k=1/10;c=sqrt(5);
7  r=k*c^2/h^2;
8  for i=1:6
9      if i<4 then
10         u(6,i)=20*(i-1)
11     else
12         u(6,i)=60
13     end
14 end
15 disp(u,'u = ')
16 k=1;
17 printf('\n\n')
18 for i=5:-1:1
19     for j=2:6
20         if j~=6 then
21             u(i,j)=(u(i+1,j-1)+u(i+1,j+1))/2
22         else
23             u(i,j)=60
24         end
25         printf('\t u%i = %g \t',k,u(i,j))
26         k=k+1;
27     end
28 end
29 printf('\n')
30 printf('\n\n j\\i |\t')
31 for i=1:6
32     printf('%i\t',i-1)
```

```
33 end
34 printf('\n')
35 for i=1:51
36     printf('_')
37 end
38
39 k=0;
40 for i=6:-1:1
41     printf('\n %i    |\t',k)
42     for j=1:6
43         printf('%g\t',u(i,j))
44     end
45     k=k+1;
46 end
```

Scilab code Exa 11.18 Bender Schmidt Method

```
1  //Example 11.18
2  //Bender Schmidt Method
3  //Page no. 398
4  clc;clear;close;
5
6  h=1;k=1/8;c=sqrt(4);
7  r=k*c^2/h^2;
8  deff('y=f(x)','y=4*x-x^2/2')
9  for i=1:9
10     if i~=1 & i~=9 then
11         u(6,i)=f(i-1)
12     else
13         u(6,i)=0
14     end
15 end
16 k=1;
17 printf('\n\n')
18 for i=5:-1:1
```

```
19      for j=2:8
20              u(i,j)=(u(i+1,j-1)+u(i+1,j+1))/2
21          printf('\t u%i = %.4f \t',k,u(i,j))
22          k=k+1;
23      end
24  end
25  printf('\n')
26  printf('\n\n j\\i |\t')
27  for i=1:9
28      printf('  %i\t',i-1)
29  end
30  printf('\n')
31  for i=1:80
32      printf('_')
33  end
34
35  k=0;
36  for i=6:-1:1
37      printf('\n %i   |\t',k)
38      for j=1:9
39          printf('%.4f\t',u(i,j))
40      end
41      k=k+1;
42  end
```

Scilab code Exa 11.19 Gauss Seidel Method

```
1  //Example 11.19
2  //Gauss Seidel Method
3  //Page no. 399
4  clc;clear;close;
5
6  h=0.2;k=0.02;r=k/h^2;
7  deff('y=f(x)','y=sin(%pi*x)')
8  n=1/h+1;
```

```
for i=1:n
    u(n,i)=f((i-1)*h)
end
disp(u)
m=1;l=1;
printf('\n\n')
for i=5:-1:1
    for j=2:5
        u(i,j)=(u(i,j-1)+u(i+1,j+1))/6+2*(u(i+1+l-1,
           j)+r*(u(i+1+l-1,j-1)-2*(u(i+1+l-1,j))+u(i
           +1+l-1,j+1))/2)/3
        printf(' u%i(%i) = %g \t',m,l,u(i,j))
        m=m+1;
    end
    printf('\n')
    l=l+1
end
printf('\n\n\n')
printf('The Anlytical Solution u1 = %g',exp(-%pi^2*k
   )*sin(%pi*h))
```

Scilab code Exa 11.20 Finite Difference Method

```
//Example 11.20
//Finite Difference Method
//Page no. 403
clc;clear;close;

h=1;k=0.5;c=sqrt(4);
r=k^2*c^2/h^2;
for i=2:5
    if i<5 then
        u(4,i)=(i-1)*(4-(i-1))
        u(5,i)=(i-1)*(4-(i-1))
    else
```

```
13          u(5,i)=0
14      end
15  end
16  disp(u,'u = ')
17  k=2;
18  printf('\n\n')
19  for i=3:-1:1
20      for j=2:4
21          u(i,j)=u(i+1,j-1)+u(i+1,j+1)-u(i+2,j)
22          printf('\tu%i,%i = %g',j-1,k,u(i,j))
23      end
24      k=k+1;
25      printf('\n')
26  end
```

Scilab code Exa 11.21 Finite Difference Method

```
1  //Example 11.21
2  //Finite Difference Method
3  //Page no. 404
4  clc;clear;close;
5
6  h=1;k=0.25;c=sqrt(16);
7  r=k^2*c^2/h^2;
8  for i=2:6
9      if i<6 then
10         u(6,i)=(i-1)^2*(5-(i-1))
11         u(5,i)=(i-1)^2*(5-(i-1))
12     else
13         u(5,i)=0
14     end
15 end
16 disp(u,'u = ')
17 k=2;
18 printf('\n\n')
```

```
19 for i=4:-1:1
20     for j=2:5
21         u(i,j)=u(i+1,j-1)+u(i+1,j+1)-u(i+2,j)
22         printf('\tu%i,%i = %g',j-1,k,u(i,j))
23     end
24     k=k+1;
25     printf('\n')
26 end
```