

Scilab Textbook Companion for
Introductory Methods Of Numerical Analysis
by S. S. Sastry¹

Created by
Rohit Kumar Singh
B Tech
Others
NIT, JAMSHEDPUR
College Teacher
NA

Cross-Checked by
Lavitha Pereira

July 31, 2019

¹Funded by a grant from the National Mission on Education through ICT, <http://spoken-tutorial.org/NMEICT-Intro>. This Textbook Companion and Scilab codes written in it can be downloaded from the "Textbook Companion Project" section at the website <http://scilab.in>

Book Description

Title: Introductory Methods Of Numerical Analysis

Author: S. S. Sastry

Publisher: Phi Learning

Edition: 5

Year: 2012

ISBN: 9788120345928

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	4
1 Errors in numerical calculation	5
2 Solution of Algebraic and Transcendental Equation	13
3 interpolation	40
4 least squares and fourier transform	61
5 spline functions	77
6 Numerical Diffrentiation and Integration	83
7 Numerical linear algebra	103
8 Numerical Solution of ordinary diffrential equation	117
9 Numerical Solution of Partial Diffrential Equation	132

List of Scilab Codes

Exa 1.1	rounding off	5
Exa 1.2	percentage accuracy	5
Exa 1.3	absolute and relative errors	6
Exa 1.4	best approximation	6
Exa 1.5	relative error	7
Exa 1.6	absolute error and relative error	8
Exa 1.7	absolute error	8
Exa 1.8	difference in 3 significant figures	9
Exa 1.10	relative error	9
Exa 1.11	relative error	9
Exa 1.12	taylor series	10
Exa 1.13	taylor series	10
Exa 1.14	maclaurins expansion	11
Exa 1.15	series approximation	12
Exa 2.1	bisection method	13
Exa 2.2	bisection method	14
Exa 2.3	bisection method	14
Exa 2.4	bisection method	15
Exa 2.5	bisection method	16
Exa 2.6	false position method	17
Exa 2.7	false position method	18
Exa 2.8	false position method	18
Exa 2.9	false position method	19
Exa 2.10	iteration method	20
Exa 2.11	iteration method	21
Exa 2.12	iteration method	21
Exa 2.13	iteration method	22
Exa 2.14	aitkens process	22

Exa 2.15	newton raphson method	23
Exa 2.16	newton raphson method	24
Exa 2.17	newton raphson method	25
Exa 2.18	newton raphson method	26
Exa 2.19	newton raphson method	26
Exa 2.20	newton raphson method	27
Exa 2.21	ramanujans method	28
Exa 2.22	ramanujans method	29
Exa 2.23	ramanujans method	29
Exa 2.24	ramanujans method	30
Exa 2.25	secant method	31
Exa 2.26	secant method	32
Exa 2.27	mullers method	33
Exa 2.28	graeffes method	34
Exa 2.29	quadratic factor by lins bairsttow method .	35
Exa 2.31	method of iteration	36
Exa 2.32	newton raphson method	36
Exa 2.33	newton raphson method	37
Exa 2.34	newton raphson method	38
Exa 3.4	interpolation	40
Exa 3.6	interpolation	41
Exa 3.7	interpolation	42
Exa 3.8	interpolation	43
Exa 3.9	Gauss forward formula	45
Exa 3.10	practical interpolation	47
Exa 3.11	practical interpolation	48
Exa 3.12	practical interpolation	49
Exa 3.13	lagranges interpolation formula	50
Exa 3.14	lagranges interpolation formula	51
Exa 3.15	lagranges interpolation formula	52
Exa 3.16	lagranges interpolation formula	52
Exa 3.17	lagranges interpolation	53
Exa 3.18	error in lagranges interpolation formula . . .	54
Exa 3.19	error in lagranges interpolation formula . . .	55
Exa 3.21	hermites interpolation formula	55
Exa 3.22	newtons general interpolation formula . . .	56
Exa 3.23	newtons divided formula	57
Exa 3.24	interpolation by iteration	58

Exa 3.25	inverse intrpolation	58
Exa 3.26	double interpolation	59
Exa 4.1	least square curve fitting procedure	61
Exa 4.2	least square curve fitting procedure	62
Exa 4.3	least square curve fitting procedure	63
Exa 4.4	linearization of non linear law	64
Exa 4.5	linearization of non linear law	65
Exa 4.6	curve fitting by polynomial	66
Exa 4.7	curve fitting by polynomial	67
Exa 4.8	curve fitting by sum of exponentials	69
Exa 4.9	linear weighted least approx	72
Exa 4.10	linear weighted least approx	73
Exa 4.11	least square for quadratic equations	75
Exa 4.20	cooley Tukey method	75
Exa 5.1	linear splines	77
Exa 5.2	quadratic splines	77
Exa 5.3	cubic splines	78
Exa 5.4	cubic splines	79
Exa 5.5	cubic splines	80
Exa 5.7	surface fitting by cubic spline	80
Exa 5.8	cubic B splines	81
Exa 5.9	cubic B spline	81
Exa 6.1	numerical diffrentiation by newtons difference formula	83
Exa 6.2	numerical diffrentiation by newtons difference formula	84
Exa 6.3	numerical diffrentiation by newtons difference formula	86
Exa 6.4	estimation of errors	87
Exa 6.5	cubic spline method	89
Exa 6.6	derivative by cubic spline method	89
Exa 6.7	maximun and minimun of functions	90
Exa 6.8	trapezoidal method for integration	91
Exa 6.9	simpson 1by3 method for integration	91
Exa 6.10	integration by trapezoidal and simpsons method	92
Exa 6.11	rommbergs method	95
Exa 6.12	Trapezoidal and Simpsons rule	97
Exa 6.13	area using cubic spline method	98

Exa 6.15	eulers maclaurin formula	99
Exa 6.17	error estimate in evaluation of the integral .	99
Exa 6.18	error estimate in evaluation of the integral .	100
Exa 6.19	gauss formula	100
Exa 6.20	double integration	101
Exa 7.1	inverse of matrix	103
Exa 7.2	Factorize by triangulation method	103
Exa 7.3	Vector Norms	104
Exa 7.6	Gauss Jordan	105
Exa 7.7	modern gauss jordan method	106
Exa 7.8	LU decomposition method	107
Exa 7.9	ill conditioned linear systems	109
Exa 7.10	ill condiioned linear systems	110
Exa 7.11	ill conditioned linear systems	110
Exa 7.12	ill conditioned system	111
Exa 7.14	solution of equations by iteration method . .	111
Exa 7.15	eigenvalues and eigenvectors	112
Exa 7.16	largest eigenvalue and eigenvectors	113
Exa 7.17	housrholders method	114
Exa 7.18	single value decommposition	114
Exa 8.1	taylors method	117
Exa 8.2	taylors method	118
Exa 8.3	picards method	119
Exa 8.4	picards method	119
Exa 8.5	eulers method	120
Exa 8.6	error estimates in eulers	120
Exa 8.7	modified eulers method	121
Exa 8.8	runge kutta formula	122
Exa 8.9	runge kutta formula	123
Exa 8.10	initial value problems	124
Exa 8.11	adams moulton method	124
Exa 8.12	milnes method	125
Exa 8.13	milnes method	127
Exa 8.14	initial value problems	127
Exa 8.15	boundary value problem using finite differ- ence method	128
Exa 8.16	boundary value problem using finite differ- ence method	129

Exa 8.17	cubic spline method	129
Exa 8.18	cubic spline method	130
Exa 8.19	boundary value problem by cubic spline method	130
Exa 9.1	standard five point formula	132
Exa 9.2	solution of laplace equation by jacobi method	
	gauss seidel method and SOR method . . .	132
Exa 9.4	poisson equation	133
Exa 9.6	bender schmidt formula	134
Exa 9.7	bender schmidts formula and crank nicolson formula	135
Exa 9.8	heat equation using crank nicolson method .	136

Chapter 1

Errors in numerical calculation

Scilab code Exa 1.1 rounding off

```
1 //example 1.1
2 //rounding off
3 //page 7
4 clc;clear;close;
5 a1=1.6583;
6 a2=30.0567;
7 a3=0.859378;
8 a4=3.14159;
9 printf('\nthe numbers after rounding to 4
    significant figures are given below\n')
10 printf('      %f      %.4g\n',a1,a1);
11 printf('      %f      %.4g\n',a2,a2);
12 printf('      %f      %.4g\n',a3,a3);
13 printf('      %f      %.4g\n',a4,a4);
```

Scilab code Exa 1.2 percentage accuracy

```
1 //example 1.2
```

```

2 //percentage accuracy
3 //page 9
4 clc;clear;close;
5 x=0.51;// the number given
6 n=2;//correcting upto 2 decimal places
7 dx=((10^-n)/2)
8 p_a=(dx/x)*100;//percentage accuracy
9 printf('the percentage accuracy of %f after
    correcting to two decimal places is %f',x,p_a);

```

Scilab code Exa 1.3 absolute and relative errors

```

1 //example 1.3
2 //absolute and relative errors
3 //page 9
4 clc;clear;close;
5 X=22/7;//approximate value of pi
6 T_X=3.1415926;// true value of pi
7 A_E=T_X-X;//absolute error
8 R_E=A_E/T_X;//relative error
9 printf('Absolute Error = %0.7f \n Relative Error =
    %0.7f ',A_E,R_E);

```

Scilab code Exa 1.4 best approximation

```

1 //example 1.4
2 //best approximation
3 //page 10
4 clc;clear;close;
5 A_X=1/3;//the actual number
6 X1=0.30;
7 X2=0.33;
8 X3=0.34;

```

```

9  A_E1=abs(A_X-X1);
10 A_E2=abs(A_X-X2);
11 A_E3=abs(A_X-X3);
12 if(A_E1<A_E2)
13 if(A_E1<A_E3)
14     B_A=X1;
15 end
16 end
17 if(A_E2<A_E1)
18 if(A_E2<A_E3)
19     B_A=X2;
20 end
21 end
22 if(A_E3<A_E2)
23 if(A_E3<A_E1)
24     B_A=X3;
25 end
26 end
27 printf('the best approximation of 1/3 is %.2g ',B_A)
    ;

```

Scilab code Exa 1.5 relative error

```

1  //relative error
2  //example 1.5
3  //page 10
4  clc;clear;close;
5  n=8.6; // the corrected number
6  N=1; //the no is rounded to one decimal places
7  E_A=(10^-N)/2;
8  E_R=E_A/n;
9  printf('the relative error of the number is:%0.4f',
    E_R);

```

Scilab code Exa 1.6 absolute error and relative error

```
1 //example 1.6
2 //absolute error and relative error
3 //page 10
4 clc;clear;close;
5 s=sqrt(3)+sqrt(5)+sqrt(7);//the sum square root of
   3,5,7
6 n=4;
7 Ea=3*((10^-n)/2);//absolute error
8 R_E=Ea/s;
9 printf('the sum of square roots is %0.4g \n',s );
10 printf('the absolute error is %f \n',Ea);
11 printf('the relative error is %f ',R_E);
```

Scilab code Exa 1.7 absolute error

```
1 //absolute error
2 //example 1.7
3 //page 10
4 clc;clear;close;
5 n=[0.1532 15.45 0.0000354 305.1 8.12 143.3 0.0212
   0.643 0.173];//original numbbbers
6 //rounding all numbers to 2 decimal places
7 n=[305.1 143.3 0.15 15.45 0.00 8.12 0.02 0.64];
8 sum=0;
9 l=length(n);
10 for i=1:l
11     sum=sum+n(i);
12 end
13 E_A=2*(10^-1)/2+7*(10^-2)/2;
14 printf('the absolute error is:%0.2f',E_A);
```

Scilab code Exa 1.8 difference in 3 significant figures

```
1 //difference in 3 significant figures
2 //example 1.8
3 //page 11
4 clc;clear;close;
5 X1=sqrt(6.37);
6 X2=sqrt(6.36);
7 d=X1-X2;//difference between two numbers
8 printf('the differencecorrected to 3 significant
    figures is %0.3g',d);
```

Scilab code Exa 1.10 relative error

```
1 //relative error
2 //example 1.10
3 //page 12
4 clc;clear;close;
5 a=6.54;b=48.64;c=13.5
6 da=0.01;db=0.02;dc=0.03;
7 s=(a^2*sqrt(b))/c^3;
8 disp(s,'s=');
9 r_err=2*(da/a)+(db/b)/2+3*(dc/c);
10 printf(' the relative error is :%f',r_err);
```

Scilab code Exa 1.11 relative error

```
1 //relative error
2 //example 1.11
```

```

3 //page 13
4 clc;clear;close;
5 x=1;y=1;z=1;
6 u=(5*x*y^3)/z^3;
7 dx=0.001;dy=0.001;dz=0.001;
8 u_max=((5*y^2)/z^3)*dx+((10*x*y)/z^3)*dy+((15*x*y^2)
    /z^4)*dz;
9 r_err=u_max/u;
10 printf(' the relative error is :%f',r_err);

```

Scilab code Exa 1.12 taylor series

```

1 //taylor series
2 //example 1.12
3 //page 12
4 clc;clear;close;
5 deff('y=f(x)', 'y=x^3+5*x-10');
6 deff('y=f1(x)', 'y=3*x^2-6*x+5')//first derivative
7 deff('y=f2(x)', 'y=6*x-6')//second derivative
8 deff('y=f3(x)', 'y=6')//third derivative
9 D=[f(0) f1(0) f2(0) f3(0)]
10 S1=0;
11 h=1;
12 for i=1:4
13     S1=S1+h^(i-1)*D(i)/factorial(i-1);
14 end
15 printf('the third order taylors series approximation
    of f(1) is :%d',S1);

```

Scilab code Exa 1.13 taylor series

```

1 //taylor series
2 //example 1.13

```

```

3 //page 16
4 clc;clear;close;
5 deff('y=f(x)', 'y=sin(x)');
6 deff('y=f1(x)', 'y=cos(x)');
7 deff('y=f2(x)', 'y=-sin(x)');
8 deff('y=f3(x)', 'y=-cos(x)');
9 deff('y=f4(x)', 'y=sin(x)');
10 deff('y=f5(x)', 'y=cos(x)');
11 deff('y=f6(x)', 'y=-sin(x)');
12 deff('y=f7(x)', 'y=-cos(x)');
13 D=[f(%pi/6) f1(%pi/6) f2(%pi/6) f3(%pi/6) f4(%pi/6)
    f5(%pi/6) f6(%pi/6) f7(%pi/6)];
14 S1=0;
15 h=%pi/6;
16 printf('order of approximation   computed value of
    sin(pi/3)   absolute error\n\n');
17 for j=1:8
18 for i=1:j
19     S1=S1+h^(i-1)*D(i)/factorial(i-1);
20 end
21 printf('%d                                %0.9 f
                                %0.9 f\n', j, S1, abs(sin(%pi
    /3)-S1));
22 S1=0;
23 end

```

Scilab code Exa 1.14 maclaurins expansion

```

1 //maclaurins expansion
2 //example 1.14
3 //page 18
4 clc;clear;close;
5 x=1;
6 n=8; //correct to 8 decimal places
7 for i=1:50

```

```

8      if x/factorial(i)<(10^-8/2) then
9          c=i;
10         break;
11
12     end
13 end
14 printf('no of terms needed to correct to 8 decimal
        places is :%d',c)

```

Scilab code Exa 1.15 series approximation

```

1 //series apprixamation
2 //example 1.15
3 //page 18
4 clc;clear;close;
5 x=1/11;
6 S1=0;
7 for i=1:2:5
8     S1=S1+(x^i/(i))
9 end
10 printf('value of log(1.2) is : %0.8f\n\n',2*S1)
11 c=0;
12 for i=1:50
13     if (1/11)^i/i<(2*10^-7) then
14         c=i;
15         break;
16     end
17 end
18 printf('min no of terms needed to get value wuth
        same accuracy is :%d',c)

```

Chapter 2

Solution of Algebraic and Transcendental Equation

Scilab code Exa 2.1 bisection method

```
1 //example 2.1
2 //bisection method
3 //page 24
4 clc;clear;close;
5 deff('y=f(x)', 'y=x^3-x-1');
6 x1=1,x2=2;//f(1) is negative and f(2) is positive
7 d=0.0001;//for accuracy of root
8 c=1;
9 printf('Successive approximations \t x1\t \tx2\t
\tm\t \tf(m)\n');
10 while abs(x1-x2)>d
11     m=(x1+x2)/2;
12     printf(' \t%f\t%f\t%f\t%f\n',x1,x2,m,f(m));
13     if f(m)*f(x1)>0
14         x1=m;
15     else
16         x2=m;
17 end
```

```

18 c=c+1; // to count number of iterations
19 end
20 printf('the solution of equation after %i iteration
    is %g',c,m)

```

Scilab code Exa 2.2 bisection method

```

1 //example 2.2
2 //bisection method
3 //page 25
4 clc;clear;close;
5 deff('y=f(x)', 'y=x^3-2*x-5');
6 x1=2,x2=3; //f(2) is negative and f(3) is positive
7 d=0.0001; //for accuracy of root
8 c=1;
9 printf('Successive approximations \t x1\t \tx2\t
    \tm\t \tf(m)\n');
10 while abs(x1-x2)>d
11     m=(x1+x2)/2;
12     printf(' \t%f\t%f\t%f\t%f\n
    ',x1,x2,m,f(m));
13     if f(m)*f(x1)>0
14         x1=m;
15     else
16         x2=m;
17 end
18 c=c+1; // to count number of iterations
19 end
20 printf('the solution of equation after %i iteration
    is %0.4g',c,m)

```

Scilab code Exa 2.3 bisection method

```

1 //example 2.3
2 //bisection method
3 //page 26
4 clc;clear;close;
5 deff('y=f(x)', 'y=x^3+x^2+x+7');
6 x1=-3,x2=-2; //f(-3) is negative and f(-2) is
    positive
7 d=0.0001; //for accuracy of root
8 c=1;
9 printf('Successive approximations \t x1\t \tx2\t
    \tm\t \tf(m)\n');
10 while abs(x1-x2)>d
11     m=(x1+x2)/2;
12     printf(' \t%f\t%f\t%f\t%f\n
    ',x1,x2,m,f(m));
13     if f(m)*f(x1)>0
14         x1=m;
15     else
16         x2=m;
17 end
18 c=c+1; // to count number of iterations
19 end
20 printf('the solution of equation after %i iteration
    is %0.4g',c,m)

```

Scilab code Exa 2.4 bisection method

```

1 //example 2.4
2 //bisection method
3 //page 26
4 clc;clear;close;
5 deff('y=f(x)', 'y=x*exp(x)-1');
6 x1=0,x2=1; //f(0) is negative and f(1) is positive
7 d=0.0005; //maximum tolerance value
8 c=1;

```

```

9 printf('Successive approximations \t x1\t \tx2\t
\tm\t \ttol\t \tf(m)\n');
10 while abs((x2-x1)/x2)>d
11     m=(x1+x2)/2; //tolerance value for each iteration
12     tol=((x2-x1)/x2)*100;
13 printf(' \t%f\t%f\t%f\t%f\t
\t%f\n',x1,x2,m,tol,f(m));
14     if f(m)*f(x1)>0
15         x1=m;
16     else
17         x2=m;
18 end
19 c=c+1; // to count number of iterations
20 end
21 printf('the solution of equation after %i iteration
is %0.4g',c,m)

```

Scilab code Exa 2.5 bisection method

```

1 //example 2.5
2 //bisection method
3 //page 27
4 clc;clear;close;
5 deff('y=f(x)', 'y=4*exp(-x)*sin(x)-1');
6 x1=0,x2=0.5; //f(0) is negative and f(1) is positive
7 d=0.0001; //for accuracy of root
8 c=1;
9 printf('Successive approximations \t x1\t \tx2\t
\tm\t \ttol\t \tf(m)\n');
10 while abs(x2-x1)>d
11     m=(x1+x2)/2;
12 printf(' \t%f\t%f\t%f\t%f\t
\t%f\n',x1,x2,m,f(m));
13     if f(m)*f(x1)>0
14         x1=m;

```

```

15         else
16             x2=m;
17     end
18     c=c+1; // to count number of iterations
19 end
20 printf('the solution of equation after %i iteration
        is %0.3g',c,m)

```

Scilab code Exa 2.6 false position method

```

1 //example 2.6
2 //false position method
3 //page 28
4 clc;clear;close
5 deff('y=f(x)', 'y=x^3-2*x-5');
6 a=2,b=3; //f(2) is negative and f(3) is positive
7 d=0.00001;
8 printf('successive iterations      \ta\t      b\t      f(a
        )\t      f(b)\t\t x1\n');
9 for i=1:25
10     x1=b*f(a)/(f(a)-f(b))+a*f(b)/(f(b)-f(a));
11     if(f(a)*f(x1))>0
12         b=x1;
13     else
14         a=x1;
15     end
16     if abs(f(x1))<d
17         break
18     end
19     printf('                        \t%f   %f   %f
        %f   %f\n',a,b,f(a),f(b),x1);
20 end
21 printf('the root of the equation is   %f',x1);

```

Scilab code Exa 2.7 false position method

```
1 //example 2.7
2 //false position method
3 //page 29
4 clc;clear;close
5 deff('y=f(x)', 'y=x^2.2-69');
6 a=5,b=6; //f(5) is negative and f(6) is positive
7 d=0.00001;
8 printf('successive iterations      \ta\t      b\t      f(a)
      )\t      f(b)\t\t      x1\n');
9 for i=1:25
10     x1=b*f(a)/(f(a)-f(b))+a*f(b)/(f(b)-f(a));
11     if(f(a)*f(x1))>0
12         b=x1;
13     else
14         a=x1;
15     end
16     if abs(f(x1))<d
17         break
18     end
19     printf('
      \t%f      %f      %f
      %f      %f\n',a,b,f(a),f(b),x1);
20 end
21 printf('the root of the equation is      %f',x1);
```

Scilab code Exa 2.8 false position method

```
1 //example 2.8
2 //false position method
3 //page 29
4 clc;clear;close
```

```

5  deff('y=f(x)', 'y=2*x-log10(x)-7');
6  a=3,b=4; //f(3) is negative and f(4) is positive
7  d=0.00001;
8  printf('successive iterations      \ta\t      b\t      f(a)
          )\t      f(b)\t\t      x1\n');
9  for i=1:25
10     x1=b*f(a)/(f(a)-f(b))+a*f(b)/(f(b)-f(a));
11     if(f(a)*f(x1))>0
12         b=x1;
13     else
14         a=x1;
15     end
16     if abs(f(x1))<d
17         break
18     end
19     printf('                        \t%f      %f      %f
          %f      %f\n', a, b, f(a), f(b), x1);
20 end
21 printf('the root of the equation is      %0.4g', x1);

```

Scilab code Exa 2.9 false position method

```

1  //example 2.9
2  //false position method
3  //page 30
4  clc;clear;close
5  deff('y=f(x)', 'y=4*exp(-x)*sin(x)-1');
6  a=0,b=0.5; //f(0) is negative and f(0.5) is positive
7  d=0.00001;
8  printf('successive iterations      \ta\t      b\t      f(a)
          )\t      f(b)\t\t      x1\n');
9  for i=1:25
10     x1=b*f(a)/(f(a)-f(b))+a*f(b)/(f(b)-f(a));
11     if(f(a)*f(x1))>0
12         b=x1;

```

```

13     else
14         a=x1;
15     end
16     if abs(f(x1))<d
17         break
18     end
19     printf('          \t%f   %f   %f
           %f   %f\n',a,b,f(a),f(b),x1);
20 end
21 printf('the root of the equation is   %f',x1);

```

Scilab code Exa 2.10 iteration method

```

1 //example 2.10
2 //iteration method
3 //page 33
4 clc;clear,close;
5 deff('x=f(x)', 'x=1/(sqrt(x+1))');
6 x1=0.75,x2=0;
7 n=1;
8 d=0.0001; // accuracy upto 10^-4
9 c=0; // to count no of iterations
10 printf('successive iterations \t\x1\tf(x1)\n')
11 while abs(x1-x2)>d
12     printf('          \t%f      %f\n',x1,f(x1)
           )
13     x2=x1;
14     x1=f(x1);
15     c=c+1;
16 end
17 printf(' the root of the eqaution after %i iteration
           is %0.4g',c,x1)

```

Scilab code Exa 2.11 iteration method

```
1 //example 2.11
2 //iteration method
3 //page34
4 clc;clear,close;
5 deff('x=f(x)', 'x=(cos(x)+3)/2');
6 x1=1.5; // as roots lies between 3/2 and pi/2
7 x2=0;
8 d=0.0001; // accuracy upto 10^-4
9 c=0; // to count no of iterations
10 printf('successive iterations \t\x1\tf(x1)\n')
11 while abs(x2-x1)>d
12 printf('                \t%f      %f\n',x1,f(x1)
13 )
14 x2=x1;
15 x1=f(x1);
16 c=c+1;
17 end
18 printf(' the root of the eqaution after %i iteration
19 is %0.4g',c,x1)
```

Scilab code Exa 2.12 iteration method

```
1 //example 2.12
2 //iteration method
3 //page 35
4 clc;clear,close;
5 deff('x=f(x)', 'x=exp(-x)');
6 x1=1.5; // as roots lies between 0 and 1
7 x2=0;
8 d=0.0001; // accuracy upto 10^-4
9 c=0; // to count no of iterations
10 printf('successive iterations \t\x1\t f(x1)\n')
11 while abs(x2-x1)>d
```

```

12 printf('                                \t%f      %f\n',x1,f(x1)
    )
13 x2=x1;
14 x1=f(x1);
15 c=c+1;
16 end
17 printf(' the root of the eqaution after %i iteration
    is %0.4g',c,x1)

```

Scilab code Exa 2.13 iteration method

```

1 //example 2.12
2 //iteration method
3 //page 35
4 clc;clear,close;
5 deff('x=f(x)', 'x=1+(sin(x)/10)');
6 x1=1; // as roots lies between 1 and pi evident from
    graph
7 x2=0;
8 d=0.0001; // accuracy upto 10-4
9 c=0; // to count no of iterations
10 printf('successive iterations \t\x1\tf(x1)\n')
11 while abs(x2-x1)>d
12 printf('                                \t%f      %f\n',x1,f(x1))
13 x2=x1;
14 x1=f(x1);
15 c=c+1;
16 end
17 printf(' the root of the eqaution after %i iteration
    is %0.4g',c,x1)

```

Scilab code Exa 2.14 aitkens process

```

1 //example 2.14
2 //aitken's process
3 //page 36
4 clc,clear,close
5 deff('x=f(x)', 'x=(3+cos(x))/2');
6 x0=1.5;
7 y=0;
8 e=0.0001;
9 c=0;
10 printf('successive iterations      \tx0\t      x1\t
        x2\t      x3\t      y\n')
11 for i=1:10
12     x1=f(x0),x2=f(x1),x3=f(x2);
13     y=x3-((x3-x2)^2)/(x3-2*x2+x1);
14     d=y-x0;
15     x0=y;
16     if abs(f(x0))<e then
17         break;
18     end
19     c=c+1;
20 printf('      \t%f      %f      %f
        %f      %f\n',x0,x1,x2,x3,y)
21 end
22 printf('the root of the equation after %i iteration
        is %f',c,y);

```

Scilab code Exa 2.15 newton raphson method

```

1 //example 2.15
2 //newton-raphson method
3 //page 39
4 clc;clear;close
5 deff('y=f(x)', 'y=x^3-2*x-5');
6 deff('y1=f1(x)', 'y1=3*x^2-2'); // first derivative of
    the function

```

```

7  x0=2; // initial value
8  d=0.0001;
9  c=0;n=1;
10 printf('successive iterations \tx0\t          f(x0)\t
          f1(x0)\n');
11 while n==1
12     x2=x0;
13     x1=x0-(f(x0)/f1(x0));
14     x0=x1;
15 printf('          \t%f\t%f\t%f\n',x2,f(
          x1),f1(x1))
16 c=c+1;
17 if abs(f(x0))<d then
18 break;
19 end
20 end
21 printf('the root of %i iteration is:%f',c,x0);

```

Scilab code Exa 2.16 newton raphson method

```

1  //example 2.16
2  //newton-raphson method
3  //page 40
4  clc;clear;close
5  deff('y=f(x)', 'y=x*sin(x)+cos(x)');
6  deff('y1=f1(x)', 'y1=x*cos(x)');//first derivation of
    the function
7  x0=%pi; // initial value
8  d=0.0001;
9  c=0;n=1;
10 printf('successive iterations \tx0\t          f(x0)\t
          f1(x0)\n');
11 while n==1
12     x2=x0
13     x1=x0-(f(x0)/f1(x0));

```

```

14     x0=x1;
15     printf('                \t%f\t%f\t%f\n',x2,f(
        x1),f1(x1))
16     c=c+1;
17     if abs(f(x0))<d then
18     break;
19     end
20     end
21     printf('the root of %i iteration is:%f',c,x0);

```

Scilab code Exa 2.17 newton raphson method

```

1 //example 2.17
2 //newton-raphson method
3 //page 40
4 clc;clear;close
5 deff('y=f(x)', 'y=x*exp(x)-1');
6 deff('y1=f1(x)', 'y1=exp(x)+x*exp(x)'); // first
    derivative of the function
7 x0=0; // initial value
8 d=0.0001;
9 c=0;n=1
10 printf('successive iterations \tx0\t          f(x0)\t
        f1(x0)\n');
11 while n==1
12     x2=x0;
13     x1=x0-(f(x0)/f1(x0));
14     x0=x1;
15     printf('                \t%f\t%f\t%f\n',x2,f(
        x1),f1(x1))
16     c=c+1;
17     if abs(f(x0))<d then
18     break;
19     end
20     end

```

```
21 printf('the root of %i iteration is:%f',c,x0);
```

Scilab code Exa 2.18 newton raphson method

```

1 //example 2.18
2 //newton-raphson method
3 //page 41
4 clc;clear;close
5 deff('y=f(x)', 'y=sin(x)-x/2');
6 deff('y1=f1(x)', 'y1=cos(x)-1/2');
7 x0=%pi/2; // initial value
8 d=0.0001;
9 c=0;n=1;
10 printf('successive iterations \tx0\t\t\t f(x0)\t\t\t\n\t\t\t f1(x0)\n');
11 while n==1
12     x2=x0;
13     x1=x0-(f(x0)/f1(x0));
14     x0=x1;
15
16     printf('\t%f\t%f\t%f\n',x2,f(x2),f1(x2));
17     c=c+1;
18     if abs(f(x0))<d then
19         break;
20     end
21 end
22 printf('the root of %i iteration is:%0.4g',c,x0);

```

Scilab code Exa 2.19 newton raphson method

```
1 //example 2.19
2 //newton-raphson method
```



```

x2\n')
11 while n==1
12 x1=x0-(f(x0)/f1(x0));
13 x2=x0-(f1(x0)/f2(x0));
14 if abs(x1-x2)<0.000000001 then
15     x0=(x1+x2)/2;
16     break;
17 else
18     x0=(x1+x2)/2;
19 end
20 printf('                %f\t%f\t%f\n',x0,
        x1,x2);
21 end
22 printf('\n \nthe double root is at: %f',x0 );

```

Scilab code Exa 2.21 ramanujans method

```

1 //ramanujan's method
2 //example 2.21
3 //page 45
4 clc;clear;close;
5 deff('y=f(x)', '1-((13/12)*x-(3/8)*x^2+(1/24)*x^3)');
6 a1=13/12,a2=-3/8,a3=1/24;
7 b1=1;
8 b2=a1;
9 b3=a1*b2+a2*b1;
10 b4=a1*b3+a2*b2+a3*b1;
11 b5=a1*b4+a2*b3+a3*b2;
12 b6=a1*b5+a2*b4+a3*b3;
13 b7=a1*b6+a2*b5+a3*b4;
14 b8=a1*b7+a2*b6+a3*b5;
15 b9=a1*b8+a2*b7+a3*b6;
16 printf('\n\n%f',b1/b2);
17 printf('\n%f',b2/b3);
18 printf('\n%f',b3/b4);

```

```

19 printf( '\n%f', b4/b5);
20 printf( '\n%f', b5/b6);
21 printf( '\n%f', b6/b7);
22 printf( '\n%f', b7/b8);
23 printf( '\n%f', b8/b9);
24 printf( '\n it appears as if the roots are converging
    at 2')

```

Scilab code Exa 2.22 ramanujans method

```

1 //ramanujan's method
2 //example 2.22
3 //page 46
4 clc;clear;close;
5 deff( 'y=f(x)', 'x+x^2+x^3/2+x^4/6+x^5/24' );
6 a1=1, a2=1, a3=1/2, a4=1/6, a5=1/24;
7 b1=1;
8 b2=a2;
9 b3=a1*b2+a2*b1;
10 b4=a1*b3+a2*b2+a3*b1;
11 b5=a1*b4+a2*b3+a3*b2;
12 b6=a1*b5+a2*b4+a3*b3;
13 printf( '\n%f', b1/b2);
14 printf( '\n%f', b2/b3);
15 printf( '\n%f', b3/b4);
16 printf( '\n%f', b4/b5);
17 printf( '\n%f', b5/b6);
18 printf( '\n it appears as if the roots are converging
    at around %f', b5/b6);

```

Scilab code Exa 2.23 ramanujans method

```

1 //ramanujan's method

```

```

2 //example 2.23
3 //page 47
4 clc;clear;close;
5 deff('y=f(x)', '1-2*((3/2)*x+(1/4)*x^2-(1/48)*x^4+x
    ^6/1440-x^8/80640)');
6 a1=3/2, a2=1/4, a3=0, a4=1/48, a5=0, a6=1/1440, a7=0, a8
    =-1/80640;
7 b1=1;
8 b2=a1;
9 b3=a1*b2+a2*b1;
10 b4=a1*b3+a2*b2+a3*b1;
11 b5=a1*b4+a2*b3+a3*b2;
12 b6=a1*b5+a2*b4+a3*b3;
13 b7=a1*b6+a2*b5+a3*b4;
14 b8=a1*b7+a2*b6+a3*b5;
15 b9=a1*b8+a2*b7+a3*b6;
16 printf('\n%f', b1/b2);
17 printf('\n%f', b2/b3);
18 printf('\n%f', b3/b4);
19 printf('\n%f', b4/b5);
20 printf('\n%f', b5/b6);
21 printf('\n%f', b6/b7);
22 printf('\n%f', b7/b8);
23 printf('\n it appears as if the roots are converging
    at around %f', b7/b8)

```

Scilab code Exa 2.24 ramanujans method

```

1 //ramanujan's method
2 //example 2.23
3 //page 47
4 clc;clear;close;
5 deff('y=f(x)', '1-(x-x^2/factorial(2)^2+x^3/factorial
    (3)^2-x^4/factorial(4)^2)');
6 a1=1, a2=-1/(factorial(2)^2), a3=1/(factorial(3)^2), a4

```

```

        =-1/(factorial(4)^2),a5=-1/(factorial(5)^2),a6
        =1/(factorial(6)^2);
7  b1=1;
8  b2=a1;
9  b3=a1*b2+a2*b1;
10 b4=a1*b3+a2*b2+a3*b1;
11 b5=a1*b4+a2*b3+a3*b2;
12 printf( '\n\n%f',b1/b2);
13 printf( '\n%f',b2/b3);
14 printf( '\n%f',b3/b4);
15 printf( '\n%f',b4/b5);
16 printf( '\n it appears as if the roots are converging
        at around %f',b4/b5);

```

Scilab code Exa 2.25 secant method

```

1  //example 2.25
2  //secant method
3  //page 49
4  clc;clear;close;
5  deff( 'y=f(x)', 'y=x^3-2*x-5' );
6  x1=2,x2=3// initial values
7  n=1;
8  c=0;
9  printf( 'successive iterations      \tx1          \tx2\
        t          x3\t          f(x3)\n' )
10 while n==1
11     x3=(x1*f(x2)-x2*f(x1))/(f(x2)-f(x1));
12     printf( '                  \t%f\t%f\t%f\t%f\n
        ',x1,x2,x3,f(x3));
13     if f(x3)*f(x1)>0 then
14         x2=x3;
15     else
16         x1=x3;
17     end

```

```

18 if abs(f(x3))<0.000001 then
19     break;
20 end
21 c=c+1;
22 end
23 printf('the root of the equation after %i iteration
        is: %f',c,x3 )

```

Scilab code Exa 2.26 secant method

```

1 //example 2.26
2 //secant method
3 //page 50
4 clc;clear;close;
5 deff('y=f(x)', 'y=x*exp(x)-1');
6 x1=0,x2=1// initial values
7 n=1;
8 c=0;
9 printf('successive iterations \tx1 \tx2\
        t \tx3\t f(x3)\n')
10 while n==1
11     x3=(x1*f(x2)-x2*f(x1))/(f(x2)-f(x1));
12     printf(' \t%f\t%f\t%f\t%f\n
        ',x1,x2,x3,f(x3));
13     if f(x3)*f(x1)>0 then
14         x2=x3;
15     else
16         x1=x3;
17     end
18     if abs(f(x3))<0.0001 then
19         break;
20     end
21     c=c+1;
22     end
23 printf('the root of the equation after %i iteration

```

```
is : %0.4g',c,x3 )
```

Scilab code Exa 2.27 mulllers method

```
1 // example 2.27
2 //muller's method
3 //page 52
4 clc;clear;close;
5 deff ('y=f(x)', 'y=x^3-x-1');
6 x0=0,x1=1,x2=2; // initial values
7 n=1;c=0;
8 printf(' successive iterations      \tx0\t      x1\t
          x2\t      f(x0)\t      f(x1)\t      f(x2)\n')
9 while n==1
10     c=c+1;
11     y0=f(x0),y1=f(x1),y2=f(x2);
12     h2=x2-x1,h1=x1-x0;
13     d2=f(x2)-f(x1),d1=f(x1)-f(x0);
14     printf('                        \t%f\t      %f\t      %f
          \t      %f\t      %f\t      %f\n',x0,x1,x2,f(x0),f(x1),f(x2))
          ;
15     A=(d2/h2-d1/h1)/(h1+h2);
16     B=d2/h2+A*h2;;
17     S=sqrt(B^2-4*A*f(x2));
18     x3=x2-(2*f(x2))/(B+S);
19     E=abs((x3-x2)/x2)*100;
20     if E<0.003 then
21         break;
22     else
23         if c==1 then
24             x2=x3;
25         end
26         if c==2 then
27             x1=x2;
28             x2=x3;
```

```

29 end
30 if c==3 then
31     x0=x1;
32     x1=x2;
33     x2=x3;
34 end
35 if c==3 then
36     c=0;
37 end
38 end
39 end
40 printf('the required root is : %0.4f',x3)

```

Scilab code Exa 2.28 graeffes method

```

1 //graeffe's method
2 //example 2.28
3 //page 55
4 clc;clear;close;
5 deff('y=f(x)', 'y=x^3-6*x^2+11*x-6');
6 x=poly(0, 'x');
7 g=f(-x);
8 printf('the equation is:\n')
9 disp(g(x)*f(x));
10 A=[1 14 49 36]; //coefficients of the above equation
11 printf('%0.4g\n',sqrt(A(4)/A(3)));
12 printf('%0.4g\n',sqrt(A(3)/A(2)));
13 printf('%0.4g\n',sqrt(A(2)/A(1)));
14 printf('the equation is:\n')
15 disp(g*(-1*g));
16 B=[1 98 1393 1296];
17 printf('%0.4g\n',(B(4)/B(3))^(1/4));
18 printf('%0.4g\n',(B(3)/B(2))^(1/4));
19 printf('%0.4g\n',(B(2)/B(1))^(1/4));
20 printf('It is apparent from the outputs that the

```

roots converge at 1 2 3')

Scilab code Exa 2.29 quadratic factor by lins bairsttow method

```
1 //quadratic factor by lin 's—bairsttow method
2 //example 2.29
3 //page 57
4 clc;clear;close;
5 deff('y=f(x)', 'y=x^3-x-1');
6 a=[-1 -1 0 1];
7 r1=1;s1=1;
8 b4=a(4);
9 deff('b3=f3(r)', 'b3=a(3)-r*a(4)');
10 deff('b2=f2(r,s)', 'b2=a(2)-r*a(3)+r^2*a(4)-s*a(4)');
11 deff('b1=f1(r,s)', 'b1=a(1)-s*a(3)+s*r*a(4)');
12 A=[1,1;2,-1];
13 C=[0;1];
14 X=A^-1*C;
15 dr=X(1,1);ds=X(2,1);
16 r2=r1+dr;s2=s1+ds;
17 //second pproximation
18 r1=r2;s1=s2;
19 b11=f1(r2,s2);
20 b22=f2(r2,s2);
21 h=0.001;
22 dr_b1=(f1(r1+h,s1)-f1(r1,s1))/h;
23 ds_b1=(f1(r1,s1+h)-f1(r1,s1))/h;
24 dr_b2=(f2(r1+h,s1)-f2(r1,s1))/h;
25 ds_b2=(f2(r1,s1+h)-f2(r1,s1))/h;
26 A=[dr_b1,ds_b1;dr_b2,ds_b2];
27 C=[-f1(r1,s1);-f2(r1,s2)];
28 X=A^-1*C;
29 r2=r1+X(1,1);
30 s2=s1+X(2,1);
31 printf(' roots correct to 3 decimal places are : %0
```

```
.3 f          %0.3 f ',r2,s2);
```

Scilab code Exa 2.31 method of iteration

```
1 //method of iteration
2 //example 2.31
3 //page 62
4 clc;clear;close;
5 deff('x=f(x,y)', '(3*y*x^2+7)/10');
6 deff('y=g(x,y)', '(y^2+4)/5');
7 h=0.0001;
8 x0=0.5;y0=0.5;
9 f1_dx=(f(x0+h,y0)-f(x0,y0))/h;
10 f1_dy=(f(x0,y0+h)-f(x0,y0))/h;
11 g1_dx=(g(x0+h,y0)-g(x0,y0))/h;
12 g1_dy=(g(x0+h,y0)-g(x0,y0))/h;
13 if f1_dx+f1_dy<1 & g1_dx+g1_dy<1 then
14     printf('conditions for convergence is satisfied\n
15           \n')
16 end
17 printf(' X\t          Y\t\n\n');
18 for i=1:10
19     X=(3*y0*x0^2+7)/10;
20     Y=(y0^2+4)/5;
21     printf('%f\t          %f\t\n',X,Y);
22     x0=X;y0=Y;
23 end
24 printf('\n\n CONVERGENCE AT (1 1) IS OBVIOUS');
```

Scilab code Exa 2.32 newton raphson method

```
1 //newton raphson method
2 //example 2.32
```

```

3 //page 65
4 clc;clear;close;
5 deff('y=f(x,y)', 'y=3*y*x^2-10*x+7');
6 deff('x=g(y)', 'x=y^2-5*y+4');
7 hh=0.0001;
8 x0=0.5,y0=0.5; //initial values
9 f0=f(x0,y0);
10 g0=g(y0);
11 df_dx=(f(x0+hh,y0)-f(x0,y0))/hh;
12 df_dy=(f(x0,y0+hh)-f(x0,y0))/hh;
13 dg_dx=(g(y0)-g(y0))/hh;
14 dg_dy=(g(y0+hh)-g(y0))/hh;
15 D1=determ([df_dx,df_dy;dg_dx,dg_dy]);
16 h=determ([-f0,df_dy;-g0,dg_dy])/D1;
17 k=determ([df_dx,-f0;dg_dx,-g0])/D1;
18 x1=x0+h;
19 y1=y0+k;
20 f0=f(x1,y1);
21 g0=g(y1);
22 df_dx=(f(x1+hh,y1)-f(x1,y1))/hh;
23 df_dy=(f(x1,y1+hh)-f(x1,y1))/hh;
24 dg_dx=(g(y1)-g(y1))/hh;
25 dg_dy=(g(y1+hh)-g(y1))/hh;
26 D2=determ([df_dx,df_dy;dg_dx,dg_dy]);
27 h=determ([-f0,df_dy;-g0,dg_dy])/D2;
28 k=determ([df_dx,-f0;dg_dx,-g0])/D2;
29 x2=x1+h;
30 y2=y1+k;
31 printf(' the roots of the equation are x2=%f and y2=
%f ',x2,y2);

```

Scilab code Exa 2.33 newton raphson method

```

1 //newton raphson method
2 //example 2.33

```

```

3 //page 66
4 clc;clear;close;
5 deff('y=f(x,y)', 'y=x^2+y^2-1');
6 deff('x=g(x,y)', 'x=y-x^2');
7 hh=0.0001;
8 x0=0.7071,y0=0.7071;//initial values
9 f0=f(x0,y0);
10 g0=g(x0,y0);
11 df_dx=(f(x0+hh,y0)-f(x0,y0))/hh;
12 df_dy=(f(x0,y0+hh)-f(x0,y0))/hh;
13 dg_dx=(g(x0+hh,y0)-g(x0,y0))/hh;
14 dg_dy=(g(x0,y0+hh)-g(x0,y0))/hh;
15 D1=determ([df_dx,df_dy;dg_dx,dg_dy]);
16 h=determ([-f0,df_dy;-g0,dg_dy])/D1;
17 k=determ([df_dx,-f0;dg_dx,-g0])/D1;
18 x1=x0+h;
19 y1=y0+k;
20 f0=f(x1,y1);
21 g0=g(x1,y1);
22 df_dx=(f(x1+hh,y1)-f(x1,y1))/hh;
23 df_dy=(f(x1,y1+hh)-f(x1,y1))/hh;
24 dg_dx=(g(x1+hh,y1)-g(x1,y1))/hh;
25 dg_dy=(g(x1,y1+hh)-g(x1,y1))/hh;
26 D2=determ([df_dx,df_dy;dg_dx,dg_dy]);
27 h=determ([-f0,df_dy;-g0,dg_dy])/D2;
28 k=determ([df_dx,-f0;dg_dx,-g0])/D2;
29 x2=x1+h;
30 y2=y1+k;
31 printf(' the roots of the equation are x2=%f and y2=
    %f ',x2,y2);

```

Scilab code Exa 2.34 newton raphson method

```

1 //newton raphson method
2 //example 2.33

```

```

3 //page 66
4 clc;clear;close;
5 deff('y=f(x,y)', 'y=sin(x)-y+0.9793');
6 deff('x=g(x,y)', 'x=cos(y)-x+0.6703');
7 hh=0.0001;
8 x0=0.5,y0=1.5; //initial values
9 f0=f(x0,y0);
10 g0=g(x0,y0);
11 df_dx=(f(x0+hh,y0)-f(x0,y0))/hh;
12 df_dy=(f(x0,y0+hh)-f(x0,y0))/hh;
13 dg_dx=(g(x0+hh,y0)-g(x0,y0))/hh;
14 dg_dy=(g(x0,y0+hh)-g(x0,y0))/hh;
15 D1=determ([df_dx,df_dy;dg_dx,dg_dy]);
16 h=determ([-f0,df_dy;-g0,dg_dy])/D1;
17 k=determ([df_dx,-f0;dg_dx,-g0])/D1;
18 x1=x0+h;
19 y1=y0+k;
20 f0=f(x1,y1);
21 g0=g(x1,y1);
22 df_dx=(f(x1+hh,y1)-f(x1,y1))/hh;
23 df_dy=(f(x1,y1+hh)-f(x1,y1))/hh;
24 dg_dx=(g(x1+hh,y1)-g(x1,y1))/hh;
25 dg_dy=(g(x1,y1+hh)-g(x1,y1))/hh;
26 D2=determ([df_dx,df_dy;dg_dx,dg_dy]);
27 h=determ([-f0,df_dy;-g0,dg_dy])/D2;
28 k=determ([df_dx,-f0;dg_dx,-g0])/D2;
29 x2=x1+h;
30 y2=y1+k;
31 printf(' the roots of the equation are x2=%0.4f and
        y2=%0.4f ',x2,y2);

```

Chapter 3

interpolation

Scilab code Exa 3.4 interpolation

```
1 //example 3.4
2 //interpolation
3 //page 86
4 clc;clear;close;
5 x=[1 3 5 7];
6 y=[24 120 336 720];
7 h=2//interval between values of x
8 c=1;
9 for i=1:3
10     d1(c)=y(i+1)-y(i);
11     c=c+1;
12 end
13 c=1;
14 for i=1:2
15     d2(c)=d1(i+1)-d1(i);
16     c=c+1
17 end
18 c=1;
19 for i=1:1
20     d3(c)=d2(i+1)-d2(i);
21     c=c+1;
```

```

22 end
23
24 d=[d1(1) d2(1) d3(1)];
25 x0=8; //value at 8;
26 pp=1;
27 y_x=y(1);
28 p=(x0-1)/2;
29 for i=1:3
30     pp=1;
31     for j=1:i
32         pp=pp*(p-(j-1))
33     end
34 y_x=y_x+(pp*d(i))/factorial(i);
35 end
36 printf('value of function at %f is :%f',x0,y_x);

```

Scilab code Exa 3.6 interpolation

```

1 //example 3.6
2 //interpolation
3 //page 87
4 clc;clear;close;
5 x=[15 20 25 30 35 40];
6 y=[0.2588190 0.3420201 0.4226183 0.5 0.5735764
    0.6427876];
7 h=5//interval between values of x
8 c=1;
9 for i=1:5
10     d1(c)=y(i+1)-y(i);
11     c=c+1;
12 end
13 c=1;
14 for i=1:4
15     d2(c)=d1(i+1)-d1(i);
16     c=c+1

```

```

17 end
18 c=1;
19 for i=1:3
20     d3(c)=d2(i+1)-d2(i);
21     c=c+1;
22 end
23 c=1;
24 for i=1:2
25     d4(c)=d3(i+1)-d3(i);
26     c=c+1;
27 end
28 c=1;
29 for i=1:1
30     d5(c)=d4(i+1)-d4(i);
31     c=c+1;
32 end
33 c=1;
34 d=[d1(5) d2(4) d3(3) d4(2) d5(1)];
35 x0=38; //value at 38 degree
36 pp=1;
37 y_x=y(6);
38 p=(x0-x(6))/h;
39 for i=1:5
40     pp=1;
41     for j=1:i
42         pp=pp*(p+(j-1))
43     end
44     y_x=y_x+((pp*d(i))/factorial(i));
45 end
46 printf('value of function at %i is :%f',x0,y_x);

```

Scilab code Exa 3.7 interpolation

```

1 //example 3.7
2 //interpolation

```

```

3 //page 89
4 clc;clear;close;
5 x=[0 1 2 4];
6 y=[1 3 9 81];
7 //equation is  $y(5)-4*y(4)+6*y(2)-4*y(2)+y(1)$ 
8 y3=(y(4)+6*y(3)-4*y(2)+y(1))/4;
9 printf(' the value of missing term of table is :%d',
        y3);

```

Scilab code Exa 3.8 interpolation

```

1 //example 3.8
2 //interpolation
3 //page 89
4 clc;clear;close;
5 x=[0.10 0.15 0.20 0.25 0.30];
6 y=[0.1003 0.1511 0.2027 0.2553 0.3093];
7 h=0.05//interval between values of x
8 c=1;
9 for i=1:4
10     d1(c)=y(i+1)-y(i);
11     c=c+1;
12 end
13 c=1;
14 for i=1:3
15     d2(c)=d1(i+1)-d1(i);
16     c=c+1
17 end
18 c=1;
19 for i=1:2
20     d3(c)=d2(i+1)-d2(i);
21     c=c+1;
22 end
23 c=1;
24 for i=1:1

```

```

25         d4(c)=d3(i+1)-d3(i);
26         c=c+1;
27     end
28
29     d=[d1(1) d2(1) d3(1) d4(1)];
30     x0=0.12; //value at 0.12;
31     pp=1;
32     y_x=y(1);
33     p=(x0-x(1))/h;
34     for i=1:4
35         pp=1;
36         for j=1:i
37             pp=pp*(p-(j-1))
38         end
39         y_x=y_x+(pp*d(i))/factorial(i);
40     end
41     printf('value of function at %f is :%0.4g\n \n',x0,
        y_x);
42     d=[d1(4) d2(3) d3(2) d4(1)];
43     x0=0.26; //value at 0.26;
44     pp=1;
45     y_x=y(5);
46     p=(x0-x(5))/h;
47     for i=1:4
48         pp=1;
49         for j=1:i
50             pp=pp*(p-(j-1))
51         end
52         y_x=y_x+(pp*d(i))/factorial(i);
53     end
54     printf('value of function at %f is :%0.4g\n \n',x0,
        y_x);
55     d=[d1(4) d2(3) d3(2) d4(1)];
56     x0=0.40; //value at 0.40;
57     pp=1;
58     y_x=y(5);
59     p=(x0-x(5))/h;
60     for i=1:4

```

```

61     pp=1;
62     for j=1:i
63         pp=pp*(p+(j-1))
64     end
65     y_x=y_x+(pp*d(i))/factorial(i);
66 end
67 printf('value of function at %f is :%0.4g\n \n',x0,
        y_x);
68 d=[d1(4) d2(3) d3(2) d4(1)];
69 x0=0.50; //value at 0.50;
70 pp=1;
71 y_x=y(5);
72 p=(x0-x(5))/h;
73 printf('value of function at %f is :%0.5g\n \n',x0,
        y_x);

```

Scilab code Exa 3.9 Gauss forward formula

```

1 //example 3.9
2 //Gauss' forward formula
3 //page 3.9
4 clc;clear;close;
5 x=[1.0 1.05 1.10 1.15 1.20 1.25 1.30];
6 y=[2.7183 2.8577 3.0042 3.1582 3.3201 3.4903
    3.66693];
7 h=0.05//interval between values of x
8 c=1;
9 for i=1:6
10     d1(c)=y(i+1)-y(i);
11     c=c+1;
12 end
13 c=1;
14 for i=1:5
15     d2(c)=d1(i+1)-d1(i);
16     c=c+1

```

```

17 end
18 c=1;
19 for i=1:4
20     d3(c)=d2(i+1)-d2(i);
21     c=c+1;
22 end
23 c=1;
24 for i=1:3
25     d4(c)=d3(i+1)-d3(i);
26     c=c+1;
27 end
28 c=1;
29 for i=1:2
30     d5(c)=d4(i+1)-d4(i);
31     c=c+1;
32 end
33 c=1;
34 for i=1:1
35     d6(c)=d5(i+1)-d5(i);
36     c=c+1;
37 end
38 d=[d1(4) d2(3) d3(3) d4(2) d5(1) d6(1)];
39 x0=1.17; //value at 1.17;
40 pp=1;
41 y_x=y(4);
42 p=(x0-x(4))/h;
43 for i=1:6
44     pp=1;
45     for j=1:i
46         pp=pp*(p-(j-1))
47     end
48 y_x=y_x+(pp*d(i))/factorial(i);
49 end
50 printf('value of function at %f is :%0.4g\n \n',x0,
        y_x);

```

Scilab code Exa 3.10 practical interpolation

```
1 //practical interpolation
2 //example 3.10
3 //page 97
4 clc;clear;close;
5 x=[0.61 0.62 0.63 0.64 0.65 0.66 0.67];
6 y=[1.840431 1.858928 1.877610 1.896481 1.915541
    1.934792 1.954237];
7 h=0.01//interval between values of x
8 c=1;
9 for i=1:6
10     d1(c)=y(i+1)-y(i);
11     c=c+1;
12 end
13 c=1;
14 for i=1:5
15     d2(c)=d1(i+1)-d1(i);
16     c=c+1
17 end
18 c=1;
19 for i=1:4
20     d3(c)=d2(i+1)-d2(i);
21     c=c+1;
22 end
23 c=1;
24 for i=1:3
25     d4(c)=d3(i+1)-d3(i);
26     c=c+1;
27 end
28 d=[d1(1) d2(1) d3(1) d4(1)];
29 x0=0.644;
30 p=(x0-x(4))/h;
31 y_x=y(4);
```

```

32 y_x=y_x+p*(d1(3)+d1(4))/2+p^2*(d2(2))/2; //stirling
    formula
33 printf(' the value at %f by stirling formula is : %f
    \n\n',x0,y_x);
34 y_x=y(4);
35 y_x=y_x+p*d1(4)+p*(p-1)*(d2(3)+d2(4))/2;
36 printf(' the value at %f by bessels formula is : %f\
    n\n',x0,y_x);
37 y_x=y(4);
38 q=1-p;
39 y_x=q*y(4)+q*(q^2-1)*d2(3)/2+p*y(5)+p*(q^2-1)*d2(4)
    /2;
40 printf(' the value at %f by everrets formula is : %f
    \n\n',x0,y_x);

```

Scilab code Exa 3.11 practical interpolation

```

1 //practical interpolation
2 //example 3.11
3 //page 99
4 clc;clear;close;
5 x=[0.61 0.62 0.63 0.64 0.65 0.66 0.67];
6 y=[1.840431 1.858928 1.877610 1.896481 1.915541
    1.934792 1.954237];
7 h=0.01//interval between values of x
8 c=1;
9 for i=1:6
10     d1(c)=y(i+1)-y(i);
11     c=c+1;
12 end
13 c=1;
14 for i=1:5
15     d2(c)=d1(i+1)-d1(i);
16     c=c+1
17 end

```

```

18 c=1;
19 for i=1:4
20     d3(c)=d2(i+1)-d2(i);
21     c=c+1;
22 end
23 c=1;
24 for i=1:3
25     d4(c)=d3(i+1)-d3(i);
26     c=c+1;
27 end
28 d=[d1(1) d2(1) d3(1) d4(1)];
29 x0=0.638;
30 p=(x0-x(4))/h;
31 y_x=y(4);
32 y_x=y_x+p*(d1(3)+d1(4))/2+p^2*(d2(2))/2; //stirling
    formula
33 printf(' the value at %f by stirling formula is : %f\n\n',x0,y_x);
34 y_x=y(3);
35 p=(x0-x(3))/h;
36 y_x=y_x+p*d1(3)+p*(p-1)*(d2(2)/2);
37 printf(' the value at %f by bessels formula is : %f\n\n',x0,y_x);

```

Scilab code Exa 3.12 practical interpolation

```

1 //practical interpolation
2 //example 3.12
3 //page 99
4 clc;clear;close;
5 x=[1.72 1.73 1.74 1.75 1.76 1.77 1.78];
6 y=[0.1790661479 0.1772844100 0.1755204006
    0.1737739435 0.1720448638 0.1703329888
    0.1686381473];
7 h=0.01//interval between values of x

```

```

8  c=1;
9  for i=1:6
10     d1(c)=y(i+1)-y(i);
11     c=c+1;
12 end
13 c=1;
14 for i=1:5
15     d2(c)=d1(i+1)-d1(i);
16     c=c+1;
17 end
18 c=1;
19 for i=1:4
20     d3(c)=d2(i+1)-d2(i);
21     c=c+1;
22 end
23 c=1;
24 for i=1:3
25     d4(c)=d3(i+1)-d3(i);
26     c=c+1;
27 end
28 x0=1.7475;
29 y_x=y(3);
30 p=(x0-x(3))/h;
31 y_x=y_x+p*d1(3)+p*(p-1)*((d2(2)+d2(3))/2)/2;
32 printf(' the value at %f by bessels formula is : %0
        .10f\n\n',x0,y_x);
33 y_x=y(4);
34 q=1-p;
35 y_x=q*y(3)+q*(q^2-1)*d2(2)/6+p*y(4)+p*(p^2-1)*d2(2)
        /6;
36 printf(' the value at %f by everrets formula is : %0
        .10f\n\n',x0,y_x);

```

Scilab code Exa 3.13 lagranges interpolation formula

```

1 //example 3.13
2 //lagrange's interpolation formula
3 //page 104
4 clc;clear;close;
5 x=[300 304 305 307];
6 y=[2.4771 2.4829 2.4843 2.4871];
7 x0=301;
8 log_301=0;
9 poly(0,'x');
10 for i=1:4
11     p=y(i);
12     for j=1:4
13         if i~=j then
14             p=p*((x0-x(j))/(x(i)-x(j)))
15         end
16     end
17     log_301=log_301+p;
18 end
19 disp(log_301,'log_301=');

```

Scilab code Exa 3.14 lagranges interpolation formula

```

1 //example 3.14
2 //lagrange's interpolation formula
3 //page 105
4 clc;clear;close;
5 y=[4 12 19];
6 x=[1 3 4];
7 y_x=7;
8 Y_X=0;
9 poly(0,'y');
10 for i=1:3
11     p=x(i);
12     for j=1:3
13         if i~=j then

```

```

14         p=p*((y_x-y(j))/(y(i)-y(j)))
15     end
16 end
17     Y_X=Y_X+p;
18 end
19 disp(Y_X, 'Y_X=');

```

Scilab code Exa 3.15 lagranges interpolation formula

```

1 //example 3.15
2 //lagrange's interpolation formula
3 //page 105
4 clc;clear;close;
5 x=[2 2.5 3.0];
6 y=[0.69315 0.91629 1.09861];
7 deff('y=l0(x)', 'y=(x-2.5)*(x-3.0)/((-0.5)*(-1.0))')
8 x=poly(0, 'x');
9 disp(l0(x), 'l0(x)=');
10 deff('y=l1(x)', 'y=((x-2.0)*(x-3.0))/((0.5)*(-0.5))')
11 x=poly(0, 'x');
12 disp(l1(x), 'l1(x)=');
13 deff('y=l2(x)', 'y=((x-2.0)*(x-2.5))/((1.0)*(0.5))')
14 x=poly(0, 'x');
15 disp(l2(x), 'l2(x)=');
16 f_x=l0(2.7)*y(1)+l1(2.7)*y(2)+l2(2.7)*y(3);
17 printf(' the calculated value is %f:', f_x);
18 printf('\n\n the error occured in the value is %0.9f\n', abs(f_x-log(2.7)))

```

Scilab code Exa 3.16 lagranges interpolation formula

```

1 //example 3.16
2 //lagrange's interpolation formula

```

```

3 //page 104
4 clc;clear;close;
5 x=[0 %pi/4 %pi/2];
6 y=[0 0.70711 1.0];
7 x0=%pi/6;
8 sin_x0=0;
9 poly(0,'x');
10 for i=1:3
11     p=y(i);
12     for j=1:3
13         if j~=i then
14             p=p*((x0-x(j))/(x(i)-x(j)))
15         end
16     end
17     sin_x0=sin_x0+p;
18 end
19 disp(sin_x0,'sin_x0=');

```

Scilab code Exa 3.17 lagranges interpolation

```

1 //lagrange's interpolation
2 //example 3.17
3 //page 106
4 clc;clear;close;
5 x=[0 3 4];
6 y=[-12 12 24];
7 //1 appears to be one the roots the polynomial
8 for i=1:3
9     r_x(i)=y(i)/(x(i)-1);
10 end
11 deff('y=l0(x)','y=((x-3)*(x-4))/((-3)*(-4))')
12 x=poly(0,'x');
13 disp(l0(x),'l0(x)=');
14 deff('y=l1(x)','y=((x-0)*(x-4))/((3)*(-1))')
15 x=poly(0,'x');

```

```

16 disp(l1(x), 'l1(x)=');
17 deff('y=l2(x)', 'y=((x-0)*(x-3))/((4)*(1))');
18 x=poly(0, 'x');
19 disp(l2(x), 'l2(x)=');
20 disp(10(x)*r_x(1)+l1(x)*r_x(2)+l2(x)*r_x(3), 'f_(x)=');
21 disp((x-1)*(10(x)*r_x(1)+l1(x)*r_x(2)+l2(x)*r_x(3))
    ', 'the required polynimial is :')

```

Scilab code Exa 3.18 error in lagranges interpolation formula

```

1 //error in lagrange's interpolation formula
2 //example 3.18
3 //page 107
4 clc;clear;close;
5 x=[2 2.5 3.0];
6 y=[0.69315 0.91629 1.09861];
7 deff('y=l0(x)', 'y=(x-2.5)*(x-3.0)/((-0.5)*(-1.0))');
8 x=poly(0, 'x');
9 disp(l0(x), 'l0(x)=');
10 deff('y=l1(x)', 'y=((x-2.0)*(x-3.0))/((0.5)*(-0.5))');
11 x=poly(0, 'x');
12 disp(l1(x), 'l1(x)=');
13 deff('y=l2(x)', 'y=((x-2.0)*(x-2.5))/((1.0)*(0.5))');
14 x=poly(0, 'x');
15 disp(l2(x), 'l2(x)=');
16 f_x=l0(2.7)*y(1)+l1(2.7)*y(2)+l2(2.7)*y(3);
17 printf(' the calculated value is %f:', f_x);
18 err=abs(f_x-log(2.7));
19 deff('y=R_n(x)', 'y=((x-2)*(x-2.5)*(x-3))/6)');
20 est_err=abs(R_n(2.7)*(2/8))
21 if est_err>err then
22     printf('\n\n the error agrees with the actual
        error ')
23 end

```

Scilab code Exa 3.19 error in lagranges interpolation formula

```
1 //error in lagrange's interpolation
2 //example 3.19
3 //page 107
4 clc;clear;close;
5 x=[0 %pi/4 %pi/2];
6 y=[0 0.70711 1.0];
7 deff('y=l0(x)', 'y=((x-0)*(x-%pi/2))/((%pi/4)*(-%pi
    /4))');
8 x=poly(0, 'x');
9 disp(l0(x), 'l0(x)=');
10 deff('y=l1(x)', 'y=((x-0)*(x-%pi/4))/((%pi/2)*(%pi/4)
    )');
11 x=poly(0, 'x');
12 disp(l1(x), 'l1(x)=');
13 f_x=l0(%pi/6)*y(2)+l1(%pi/6)*y(3);
14 err=abs(f_x-sin(%pi/6));
15 deff('y=f(x)', 'y=((x-0)*(x-%pi/4)*(x-%pi/2))/6');
16 if abs(f(%pi/6))>err then
17     printf('\n\n the error agrees with the actual
        error')
18 end
```

Scilab code Exa 3.21 hermites interpolation formula

```
1 //hermite's interpolation formula
2 //example 3.21
3 //page 110
4 clc;clear;close;
5 x=[2.0 2.5 3.0]
```

```

6 y=[0.69315 0.91629 1.09861]
7 deff('y=f(x)', 'y=log(x)')
8 h=0.0001;
9 for i=1:3
10     y1(i)=(f(x(i)+h)-f(x(i)))/h;
11 end
12 deff('y=l0(x)', 'y=(x-2.5)*(x-3.0)/(-0.5)*(-1.0)')
13 a=poly(0, 'x');
14 disp(10(a), 'l0(x)=');
15 deff('y=l1(x)', 'y=((x-2.0)*(x-3.0))/((0.5)*(-0.5))')
16 a=poly(0, 'x');
17 disp(11(a), 'l1(x)=');
18 deff('y=l2(x)', 'y=((x-2.0)*(x-2.5))/((1.0)*(0.5))')
19 a=poly(0, 'x');
20 disp(12(a), 'l2(x)=');
21 d10=(10(x(1)+h)-10(x(1)))/h;
22 d11=(11(x(2)+h)-11(x(2)))/h;
23 d12=(12(x(3)+h)-12(x(3)))/h;
24 x0=2.7;
25 u0=[1-2*(x0-x(1))*d10]*(10(x0))^2;
26 u1=[1-2*(x0-x(2))*d11]*(11(x0))^2;
27 u2=[1-2*(x0-x(3))*d12]*(12(x0))^2;
28 v0=(x0-x(1))*10(x0)^2;
29 v1=(x0-x(2))*11(x0)^2;
30 v2=(x0-x(3))*12(x0)^2;
31 H=u0*y(1)+u1*y(2)+u2*y(3)+v0*y1(1)+v1*y1(2)+v2*y1(3)
    ;
32 printf(' the approximate value of ln(%0.2f) is %0.6f
    : ', x0, H);

```

Scilab code Exa 3.22 newtons general interpolation formula

```

1 //newton's general interpolation formula
2 //example 3.22
3 //page 114

```

```

4  clc;clear;close;
5  x=[300 304 305 307];
6  y=[2.4771 2.4829 2.4843 2.4871];
7  for i=1:3
8      d1(i)=(y(i+1)-y(i))/(x(i+1)-x(i));
9  end
10 for i=1:2
11     d2(i)=(d1(i+1)-d1(i))/(x(i+2)-x(i));
12 end
13 x0=301;
14 log301=y(1)+(x0-x(1))*d1(1)+(x0-x(2))*d2(1);
15 printf(' value of log(%d) is :%0.4f',x0,log301);

```

Scilab code Exa 3.23 newtons divided formula

```

1  //example 3.22
2  //newton's divided formula
3  //page 114
4  clc;clear;close
5  x=[-1 0 3 6 7];
6  y=[3 -6 39 822 1611];
7  for i=1:4
8      d1(i)=(y(i+1)-y(i))/(x(i+1)-x(i));
9  end
10 for i=1:3
11     d2(i)=(d1(i+1)-d1(i))/(x(i+2)-x(i));
12 end
13 for i=1:2
14     d3(i)=(d2(i+1)-d2(i))/(x(i+3)-x(i));
15 end
16 for i=1:1
17     d4(i)=(d3(i+1)-d3(i))/(x(i+4)-x(i));
18 end
19 X=poly(0,'X')
20 f_x=y(1)+(X-x(1))*(d1(1))+(X-x(2))*(X-x(1))*d2(1)+(X

```

```

        -x(1))*(X-x(2))*(X-x(3))*d3(1)+(X-x(1))*(X-x(2))
        *(X-x(3))*(X-x(4))*d4(1)
21  disp(f_x,'the polynomial equation is =')

```

Scilab code Exa 3.24 interpolation by iteration

```

1  //interpolation by iteration
2  //example 3.24
3  //page 116
4  clc;clear;close;
5  x=[300 304 305 307];
6  y=[2.4771 2.4829 2.4843 2.4871];
7  x0=301;
8  for i=1:3
9      d=determ([y(i),(x(i)-x0);y(i+1),(x(i+1)-x0)])
10      d1(i)=d/(x(i+1)-x(i));
11  end
12  for i=1:2
13      d=determ([d1(i),(x(i+1)-x0);d1(i+1),(x(i+2)-x0)
14      ])
15      d2(i)=d/(x(i+2)-x(i+1));
16  end
17  for i=1:1
18      d=determ([d2(i),(x(i+2)-x0);d2(i+1),(x(i+3)-x0)
19      ])
20      d3(i)=d/(x(i+3)-x(i+2));
21  end
22  printf(' the value of log(%d) is : %f',x0,d3(1))

```

Scilab code Exa 3.25 inverse intrpolation

```

1  //inverse intrpolation
2  //example 3.25

```

```

3 //page 118
4 clc;clear;close;
5 x=[2 3 4 5];
6 y=[8 27 64 125];
7 for i=1:3
8     d1(i)=y(i+1)-y(i);
9 end
10 for i=1:2
11     d2(i)=d1(i+1)-d1(i);
12 end
13 for i=1:1
14     d3(i)=d2(i+1)-d2(i);
15 end
16 yu=10; //square rooot of 10
17 y0=y(1);
18 d=[d1(1) d2(1) d3(1)];
19 u1=(yu-y0)/d1(1);
20 u2=((yu-y0-u1*(u1-1)*d2(1)/2)/d1(1));
21 u3=(yu-y0-u2*(u2-1)*d2(1)/2-u2*(u2-1)*(u2-2)*d3(1)
    /6)/d1(1);
22 u4=(yu-y0-u3*(u3-1)*d2(1)/2-u3*(u3-1)*(u3-2)*d3(1)
    /6)/d1(1);
23 u5=(yu-y0-u4*(u4-1)*d2(1)/2-u4*(u4-1)*(u4-2)*d3(1)
    /6)/d1(1);
24 printf(' %f \n %f \n %f \n %f \n %f \n ',u1,u2,u3,u4
    ,u5);
25 printf(' the approximate square root of %d is: %0.3f
    ',yu,x(1)+u5)

```

Scilab code Exa 3.26 double interpolation

```

1 //double interpolation
2 //example 3.26
3 //page 119
4 clc;clear;close;

```

```

5 y=[0 1 2 3 4];
6 x=[0 1 4 9 16;2 3 6 11 18;6 7 10 15 22;12 13 16 21
    28;18 19 22 27 34];
7 printf(' y\t\n');
8 for i=1:5
9     printf('\n%d',y(i));
10 end
11 printf('\n\n
    _____x
    _____\n');
12 printf('0\t    1\t    2\t    3\t    4\t\n');
13 printf('
    _____
    n');
14 for i=1:5
15     for j=1:5
16         printf('%d\t',x(i,j));
17     end
18     printf('\n');
19 end
20 //for x=2.5;
21 for i=1:5
22     z(i)=(x(i,3)+x(i,4))/2;
23 end
24 //y=1.5;
25 Z=(z(2)+z(3))/2;
26 printf(' the interpolated value when x=2.5 and y=1.5
    is : %f',Z);
    _____

```

Chapter 4

least squares and fourier transform

Scilab code Exa 4.1 least square curve fitting procedure

```
1 //example 4.1
2 //least square curve fitting procedure
3 //page 128
4 clc;clear;close;
5 x=[1 2 3 4 5];
6 y=[0.6 2.4 3.5 4.8 5.7];
7 for i=1:5
8     x_2(i)=x(i)^2;
9     x_y(i)=x(i)*y(i);
10 end
11 S_x=0,S_y=0,S_x2=0,S_xy=0,S1=0,S2=0;
12 for i=1:5
13     S_x=S_x+x(i);
14     S_y=S_y+y(i);
15     S_x2=S_x2+x_2(i);
16     S_xy=S_xy+x_y(i);
17 end
18 a1=(5*S_xy-S_x*S_y)/(5*S_x2-S_x^2);
19 a0=S_y/5-a1*S_x/5;
```

```

20 printf('x\t      y\t      x^2\t      x*y\t      (y-
    avg(S_y))\t(y-a0-a1x)^2\n\n');
21 for i=1:5
22 printf('%d\t      %0.2f\t      %d\t      %0.2f\t
    %0.2f\t      %.4f\t\n',x(i),y(i),
    x_2(i),x_y(i),(y(i)-S_y/5)^2,(y(i)-a0-a1*x(i))^2)
    ;
23 S1=S1+(y(i)-S_y/5)^2;
24 S2=S2+(y(i)-a0-a1*x(i))^2;
25 end
26 printf('
    n\n');
27 printf('%d\t      %0.2f\t      %d\t      %0.2f\t
    %0.2f\t      %0.4f\t\n',S_x,S_y,
    S_x2,S_xy,S1,S2);
28 cc=sqrt((S1-S2)/S1); //correlation coefficient
29 printf('the correlation coefficient is:%0.4f',cc);

```

Scilab code Exa 4.2 least square curve fitting procedure

```

1 //example 4.2
2 //least square curve fitting procedure
3 //page 129
4 clc;clear;close;
5 x=[0 2 5 7];
6 y=[-1 5 12 20];
7 for i=1:4
8     x_2(i)=x(i)^2;
9     xy(i)=x(i)*y(i);
10 end
11 printf('x\t      y\t      x^2\t      xy\t      \n\n');
12 S_x=0,S_y=0,S_x2=0,S_xy=0;
13 for i=1:4
14 printf('%d\t      %d\t      %d\t      %d\t\n',x(i),y(i)

```



```

19     S_y=S_y+y(i);
20     S_z=S_z+z(i);
21     S_x2=S_x2+x2(i);
22     S_y2=S_y2+y2(i);
23     S_z2=S_z2+z2(i);
24     S_xy=S_xy+xy(i);
25     S_zx=S_zx+zx(i);
26     S_yz=S_yz+yz(i);
27 end
28 printf('x\t      y\t      z\t      x^2\t      xy\t
      zx\t      y^2\t      yz\n\n');
29 for i=1:5
30     printf('%d\t      %d\t      %d\t      %d\t      %d\t
      %d\t      %d\t      %d\n',x(i),y(i),z(i),x2(i),
      xy(i),zx(i),y2(i),yz(i));
31     end
32 printf('
      n\n\n');
33 printf('%d\t      %d\t      %d\t      %d\t      %d\t      %d
      \t      %d\t      %d\n\n',S_x,S_y,S_z,S_x2,S_xy,S_zx
      ,S_y2,S_yz);
34 A=[5,13,14;13,57,63;14,63,78];
35 B=[33;122;109];
36 C=A^-1*B;
37 printf('solution of above equation is:a=%d b=%d c=%d
      ',C(1,1),C(2,1),C(3,1));

```

Scilab code Exa 4.4 linearization of non linear law

```

1 //example 4.4
2 //linearization of non-linear law
3 //page 131
4 clc;clear;close;
5 x=[1 3 5 7 9];

```

```

6 y=[2.473 6.722 18.274 49.673 135.026];
7 for i=1:5
8     Y(i)=log(y(i));
9     x2(i)=x(i)^2;
10    xy(i)=x(i)*Y(i);
11 end
12 S_x=0,S_y=0,S_x2=0,S_xy=0;
13 printf('X\t      Y=lny\t      X^2\t      XY\n\n');
14 for i=1:5
15     printf('%d\t      %0.3f\t      %d\t      %0.3f\n',x(i),
16           Y(i),x2(i),xy(i));
17     S_x=S_x+x(i);
18     S_y=S_y+Y(i);
19     S_x2=S_x2+x2(i);
20     S_xy=S_xy+xy(i);
21 end
22 printf('
n\n')
23 printf('%d\t      %0.3f\t      %d\t      %0.3f\t\n\n',S_x,
24       S_y,S_x2,S_xy);
25 A1=((S_x/5)*S_xy-S_x*S_y)/((S_x/5)*S_x2-S_x^2);
26 A0=(S_y/5)-A1*(S_x/5);
27 a=exp(A0);
28 printf('y=%0.3fexp(%0.2fx)',a,A1);

```

Scilab code Exa 4.5 linearization of non linear law

```

1 //example 4.5
2 //linearization of non-linear law
3 //page 131
4 clc;clear;close;
5 x=[3 5 8 12];
6 y=[7.148 10.231 13.509 16.434];
7 for i=1:4

```

```

8      X(i)=1/x(i);
9      Y(i)=1/y(i);
10     X2(i)=X(i)^2;
11     XY(i)=X(i)*Y(i);
12 end
13 S_X=0,S_Y=0,S_X2=0,S_XY=0;
14 printf('X\t      Y\t      X^2\t      XY\t\n\n');
15 for i=1:4
16 printf('%0.3f\t      %0.3f\t      %0.3f\t      %0.3f\t\n',X(
      i),Y(i),X2(i),XY(i));
17 S_X=S_X+X(i);
18 S_Y=S_Y+Y(i);
19 S_X2=S_X2+X2(i);
20 S_XY=S_XY+XY(i);
21 end
22 printf('
      n\n');
23 printf('%0.3f\t      %0.3f\t      %0.3f\t      %0.3f\n\n',
      S_X,S_Y,S_X2,S_XY);
24 A1=(4*S_XY-S_X*S_Y)/(4*S_X2-S_X^2);
25 Avg_X=S_X/4;
26 Avg_Y=S_Y/4;
27 A0=Avg_Y-A1*Avg_X;
28 printf('y=x/(%f+%f*x)',A1,A0);

```

Scilab code Exa 4.6 curve fitting by polynomial

```

1 //example 4.6
2 //curve fitting by polynomial
3 //page 134
4 clc;clear;close;
5 x=[0 1 2];
6 y=[1 6 17];
7 for i=1:3

```

```

8      x2(i)=x(i)^2;
9      x3(i)=x(i)^3;
10     x4(i)=x(i)^4;
11     xy(i)=x(i)*y(i);
12     x2y(i)=x2(i)*y(i);
13 end
14 printf('x\t    y\t    x^2\t    x^3\t    x^4\t    x*y\t
      x^2*y\t\n\n');
15 S_x=0,S_y=0,S_x2=0,S_x3=0,S_x4=0,S_xy=0,S_x2y=0;
16 for i=1:3
17     printf('%d\t    %d\t    %d\t    %d\t    %d\t    %d\t
      %d\n',x(i),y(i),x2(i),x3(i),x4(i),xy(i),x2y
      (i));
18     S_x=S_x+x(i);
19     S_y=S_y+y(i);
20     S_x2=S_x2+x2(i);
21     S_x3=S_x3+x3(i);
22     S_x4=S_x4+x4(i);
23     S_xy=S_xy+xy(i);
24     S_x2y=S_x2y+x2y(i);
25 end
26 printf('
      n\n');
27 printf('%d\t    %d\t    %d\t    %d\t    %d\t    %d\t    %d
      \n',S_x,S_y,S_x2,S_x3,S_x4,S_xy,S_x2y);
28 A=[3,S_x,S_x2;S_x,S_x2,S_x3;S_x2,S_x3,S_x4];
29 B=[S_y;S_xy;S_x2y];
30 C=A^-1*B;
31 printf('a=%d    b=%d    c=%d \n\n',C(1,1),C(2,1),C(3,1))
      ;
32 printf('exact polynomial :%d + %d*x +%d*x^2',C(1,1),
      C(2,1),C(3,1))

```

Scilab code Exa 4.7 curve fitting by polynomial

```

1 //example 4.7
2 //curve fitting by polynomial
3 //page 134
4 clc;clear;close;
5 x=[1 3 4 6];
6 y=[0.63 2.05 4.08 10.78];
7 for i=1:4
8     x2(i)=x(i)^2;
9     x3(i)=x(i)^3;
10    x4(i)=x(i)^4;
11    xy(i)=x(i)*y(i);
12    x2y(i)=x2(i)*y(i);
13 end
14 printf('x\t    y\t    x^2\t    x^3\t    x^4\t    x*y\t
    x^2*y\t\n\n');
15 S_x=0,S_y=0,S_x2=0,S_x3=0,S_x4=0,S_xy=0,S_x2y=0;
16 for i=1:4
17     printf('%d\t    %0.3f\t    %d\t    %d\t    %d\t    %0
        .3f\t    %d\n',x(i),y(i),x2(i),x3(i),x4(i),xy(
        i),x2y(i));
18     S_x=S_x+x(i);
19     S_y=S_y+y(i);
20     S_x2=S_x2+x2(i);
21     S_x3=S_x3+x3(i);
22     S_x4=S_x4+x4(i);
23     S_xy=S_xy+xy(i);
24     S_x2y=S_x2y+x2y(i);
25 end
26 printf('
    n\n');
27 printf('%d\t    %0.3f\t    %d\t    %d\t    %d\t    %0.3f\t
    %0.3f\n',S_x,S_y,S_x2,S_x3,S_x4,S_xy,S_x2y);
28 A=[4,S_x,S_x2;S_x,S_x2,S_x3;S_x2,S_x3,S_x4];
29 B=[S_y;S_xy;S_x2y];
30 C=A^-1*B;
31 printf('a=%0.2f    b=%0.2f    c=%0.2f \n\n',C(1,1),C
    (2,1),C(3,1));

```

```
32 printf('exact polynomial :%0.2f + %0.2f*x +%0.2f*x^2
    ',C(1,1),C(2,1),C(3,1))
```

Scilab code Exa 4.8 curve fitting by sum of exponentials

```
1 //curve fitting by sum of exponentials
2 //example 4.8
3 //page 137
4 clc;clear;close;
5 x=[1 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9];
6 y=[1.54 1.67 1.81 1.97 2.15 2.35 2.58 2.83 3.11];
7 s1=y(1)+y(5)-2*y(3);
8 h=x(2)-x(1);
9 I1=0;
10 for i=1:3
11     if i==1|i==3 then
12         I1=I1+y(i)
13
14     elseif (modulo(i,2))==0 then
15         I1=I1+4*y(i)
16
17     elseif (modulo(i,2))~=0 then
18         I1=I1+2*y(i)
19     end
20 end
21 I1=(I1*h)/3
22
23 I2=0;
24 for i=3:5
25     if i==3|i==5 then
26         I2=I2+y(i)
27
28     elseif (modulo(i,2))==0 then
29         I2=I2+4*y(i)
30
```

```

31     elseif (modulo(i,2))~=0 then
32         I2=I2+2*y(i)
33         end
34     end
35     I2=(I2*h)/3;
36     for i=1:5
37         y1(i)=(1.0-x(i))*y(i);
38     end
39     for i=5:9
40         y2(i)=(1.4-x(i))*y(i);
41     end
42     I3=0;
43     for i=1:3
44         if i==1|i==3 then
45             I3=I3+y1(i)
46         elseif (modulo(i,2))==0 then
47             I3=I3+4*y1(i)
48             elseif (modulo(i,2))~=0 then
49                 I3=I3+2*y1(i)
50             end
51         end
52         I3=(I3*h)/3
53     I4=0;
54     for i=3:5
55         if i==3|i==5 then
56             I4=I4+y2(i)
57         elseif (modulo(i,2))==0 then
58             I4=I4+4*y2(i)
59         elseif (modulo(i,2))~=0 then
60             I4=I4+2*y2(i)
61         end
62         end
63         I4=(I4*h)/3;
64         s2=y(5)+y(9)-2*y(7);
65     I5=0;
66     for i=5:7

```

```

69     if i==5|i==7 then
70         I5=I5+y(i)
71     elseif (modulo(i,2))==0 then
72         I5=I5+4*y(i)
73
74     elseif (modulo(i,2))~=0 then
75         I5=I5+2*y(i)
76     end
77 end
78 I5=(I5*h)/3;
79 I6=0;
80 for i=7:9
81     if i==7|i==9 then
82         I6=I6+y(i)
83
84     elseif (modulo(i,2))==0 then
85         I6=I6+4*y(i)
86
87     elseif (modulo(i,2))~=0 then
88         I6=I6+2*y(i)
89     end
90 end
91 I6=(I6*h)/3;
92 I7=0;
93 for i=5:7
94     if i==5|i==7 then
95         I7=I7+y2(i)
96
97     elseif (modulo(i,2))==0 then
98         I7=I7+4*y2(i)
99
100    elseif (modulo(i,2))~=0 then
101        I7=I7+2*y2(i)
102    end
103 end
104 I7=(I7*h)/3;
105 I8=0;
106 for i=7:9

```

```

107     if i==7|i==9 then
108         I8=I8+y2(i)
109
110     elseif (modulo(i,2))==0 then
111         I8=I8+4*y2(i)
112
113     elseif (modulo(i,2))~=0 then
114         I8=I8+2*y2(i)
115     end
116 end
117 I8=(I8*h)/3;
118 A=[1.81 2.180;2.88 3.104];
119 C=[2.10;3.00];
120 Z=A^-1*C
121 X=poly(0,'X');
122 y=X^2-Z(1,1)*X-Z(2,1);
123 R=roots(y)
124 printf(' the unknown value of equation is %1.0f    %1
    .0 f ',R(1,1),R(2,1));

```

Scilab code Exa 4.9 linear weighted least approx

```

1 //linear weighted least approx
2 //example 4.9
3 //page 139
4 clc;clear;close;
5 x=[0 2 5 7];
6 y=[-1 5 12 20];
7 w=10;//given weight 10;
8 W=[1 1 10 1];
9 for i=1:4
10     Wx(i)=W(i)*x(i);
11     Wx2(i)=W(i)*x(i)^2;
12     Wx3(i)=W(i)*x(i)^3;
13     Wy(i)=W(i)*y(i);

```

```

14     Wxy(i)=W(i)*x(i)*y(i);
15     end
16     S_x=0,S_y=0,S_W=0,S_Wx=0,S_Wx2=0,S_Wy=0,S_Wxy=0;
17     for i=1:4
18         S_x=S_x+x(i)
19         S_y=S_y+y(i)
20         S_W=S_W+W(i)
21         S_Wx=S_Wx+Wx(i)
22         S_Wx2=S_Wx2+Wx2(i)
23         S_Wy=S_Wy+Wy(i)
24         S_Wxy=S_Wxy+Wxy(i)
25     end
26     A=[S_W,S_Wx;S_Wx,S_Wx2];
27     C=[S_Wy;S_Wxy];
28     printf('x\t    y\t    W\t    Wx\t    Wx^2\t    Wy\t    Wxy\n\n');
29     for i=1:4
30         printf('%d\t    %d\t    %d\t    %d\t    %d\t    %d\t\n',x(i),y(i),W(i),Wx(i),Wx2(i),Wy(i),Wxy(i))
31     end
32     printf('
n\n');
33     printf('%d\t    %d\t    %d\t    %d\t    %d\t    %d\t\n',S_x,S_y,S_W,S_Wx,S_Wx2,S_Wy,S_Wxy);
34     X=A^-1*C;
35     printf('\n\nthe equation is y=%f+%fx',X(1,1),X(2,1))

```

Scilab code Exa 4.10 linear weighted least approx

```

1 //linear weighted least approx
2 //example 4.10
3 //page 139
4 clc;clear;close;

```

```

5 x=[0 2 5 7];
6 y=[-1 5 12 20];
7 w=100; //given weight 100;
8 W=[1 1 100 1];
9 for i=1:4
10     Wx(i)=W(i)*x(i);
11     Wx2(i)=W(i)*x(i)^2;
12     Wx3(i)=W(i)*x(i)^3;
13     Wy(i)=W(i)*y(i);
14     Wxy(i)=W(i)*x(i)*y(i);
15 end
16 S_x=0, S_y=0, S_W=0, S_Wx=0, S_Wx2=0, S_Wy=0, S_Wxy=0;
17 for i=1:4
18     S_x=S_x+x(i)
19     S_y=S_y+y(i)
20     S_W=S_W+W(i)
21     S_Wx=S_Wx+Wx(i)
22     S_Wx2=S_Wx2+Wx2(i)
23     S_Wy=S_Wy+Wy(i)
24     S_Wxy=S_Wxy+Wxy(i)
25 end
26 A=[S_W, S_Wx; S_Wx, S_Wx2];
27 C=[S_Wy; S_Wxy];
28 printf('x\t    y\t    W\t    Wx\t    Wx^2\t    Wy\t    Wxy\n\n');
29 for i=1:4
30     printf('%d\t    %d\t    %d\t    %d\t    %d\t    %d\t\n', x(i), y(i), W(i), Wx(i), Wx2(i), Wy(i), Wxy(i))
31 end
32 printf('
n\n');
33 printf('%d\t    %d\t    %d\t    %d\t    %d\t    %d\t\n', S_x, S_y, S_W, S_Wx, S_Wx2, S_Wy, S_Wxy);
34 X=A^-1*C;
35 printf('\n\nthe equation is y=%f+%fx', X(1,1), X(2,1))
36 printf('\n\nthe value of y(5) is %f', X(1,1)+X(2,1)

```

*5)

Scilab code Exa 4.11 least square for quadratic equations

```
1 //least square for quadratic equations
2 //example 4.11
3 //page 141
4 clc;clear;close;
5 I1=integrate('1','x',0,%pi/2);
6 I2=integrate('x','x',0,%pi/2);
7 I3=integrate('x^2','x',0,%pi/2);
8 I4=integrate('x^3','x',0,%pi/2);
9 I5=integrate('x^4','x',0,%pi/2);
10 I6=integrate('sin(x)','x',0,%pi/2);
11 I7=integrate('x*sin(x)','x',0,%pi/2);
12 I8=integrate('x^2*sin(x)','x',0,%pi/2);
13 printf('the equations are:\n\n');
14 A=[I1,I2,I3;I2,I3,I4;I3,I4,I5];
15 C=[I6;I7;I8];
16 X=A^-1*C;
17 printf(' the quadratic equation is of the form %f+
    %fx+%fx^2 ',X(1,1),X(2,1),X(3,1));
18 //value of sin pi/4
19 y=X(1,1)+X(2,1)*%pi/4+X(3,1)*(%pi/4)^2
20 printf(' \n\nsin(pi/4)=%0.9f',y)
21 printf(' \n\nerror in the preecing solution %0.9f',
    abs(y-sin(%pi/4)))
```

Scilab code Exa 4.20 cooley Tukey method

```
1 //cooley-Tukey method
2 //example 4.20
3 //page 168
```

```

4  clc;clear;close;
5  f=[1,2,3,4,4,3,2,1];
6  F1(1,1)=f(1)+f(5);
7  F1(1,2)=f(1)-f(5);
8  F1(2,1)=f(3)+f(7);
9  F1(2,2)=f(3)-f(7);
10 F1(3,1)=f(2)+f(6);
11 F1(3,2)=f(2)-f(6);
12 F1(4,1)=f(4)+f(8);
13 F1(4,2)=f(4)-f(8);
14 printf('the solutions after first key equation\n\n')
15 disp(F1);
16 F2(1,1)=F1(1,1)+F1(2,1);
17 F2(1,2)=F1(1,1)+F1(2,1);
18 F2(2,1)=F1(1,2)+%i*F1(3,2);
19 F2(2,2)=F1(3,2)-%i*F1(4,2);
20 F2(3,1)=F1(1,1)-F1(2,1);
21 F2(3,2)=F1(1,1)-F1(2,1);
22 F2(4,1)=F1(1,2)+%i*F1(2,2);
23 F2(4,2)=F1(3,2)-%i*F1(1,2);
24 printf('the solutions after second key equation\n\n'
    )
25 disp(F2);
26
27 W=[1,(1-%i)/sqrt(2),-%i,-(1+%i)/sqrt(2),-1,-(1-%i)/
    sqrt(2),%i,(1+%i)/sqrt(2)];
28 F3(1)=F2(1,1)+F2(1,2);
29 F3(2)=F2(2,1)+W(2)*F2(2,2);
30 F3(3)=F2(3,1)+F2(3,2);
31 F3(4)=F2(4,1)+W(4)*F2(4,2);
32 F3(5)=F2(3,1)+F2(3,2);
33 F3(6)=F2(2,1)+W(6)*F2(2,2);
34 F3(7)=F2(3,1)+F2(3,2);
35 F3(8)=F2(4,1)+W(8)*F2(4,2);
36 printf('the solutions after third key equation\n\n')
37 disp(F3);

```

Chapter 5

spline functions

Scilab code Exa 5.1 linear splines

```
1 //linear splines
2 //example 5.1
3 //page 182
4 clc;clear;close;
5 X=[1 2 3];
6 y=[-8 -1 18];
7 m1=(y(2)-y(1))/(X(2)-X(1));
8 deff('y1=s1(x)','y1=y(1)+(x-X(1))*m1');
9 m2=(y(3)-y(2))/(X(3)-X(2));
10 deff('y2=s2(x)','y2=y(2)+(x-X(2))*m2');
11 a=poly(0,'x');
12 disp(s1(a));
13 disp(s2(a));
14 printf(' the value of function at 2.5 is %0.2f: ',s2
    (2.5));
```

Scilab code Exa 5.2 quadratic splines

```

1 //quadratic splines
2 //example 5.2
3 //page 18
4 clc;clear;close;
5 X=[1 2 3];
6 y=[-8 -1 18];
7 h=X(2)-X(1);
8 m1=(y(2)-y(1))/(X(2)-X(1));
9 m2=(2*(y(2)-y(1)))/h-m1;
10 m3=(2*(y(3)-y(2)))/h-m2;
11 deff('y2=s2(x)', 'y2=(-(X(3)-x)^2*m1)/2+((x-X(2))^2*
      m3)/2+y(2)+m2/2');
12 a=poly(0, 'x');
13 disp(s2(a));
14 printf('the value of function is 2.5: %0.2f',s2(2.5)
      );
15 x=2.0;
16 h=0.01;
17 deff('y21=s21(x,h)', 'y21=(s2(x+h)-s2(x))/h');
18 d1=s21(x,h);
19 printf('\n\nthe first derivative at 2.0 :%0.2f',d1);

```

Scilab code Exa 5.3 cubic splines

```

1 //cubic splines
2 //example 5.3
3 //page 188
4 clc;clear;close;
5 X=[1 2 3];
6 y=[-8 -1 18];
7 M1=0,M2=8,M3=0;
8 h=1;
9 deff('y=s1(x)', 'y=3*(x-1)^3-8*(2-x)-4*(x-1)');
10 deff('y=s2(x)', 'y=3*(3-x)^3+22*x-48');
11 h=0.0001;n=2.0;

```

```

12 D=(s2(n+h)-s2(n))/h;
13 a=poly(0,'x');
14 disp(s1(a),' s1(x)=');
15 disp(s2(a),' s2(x)=');
16 disp(s2(2.5),' y(2.5)=');
17 disp(D,' y1(2.0)=');

```

Scilab code Exa 5.4 cubic splines

```

1 //cubic spline
2 //example 5.4
3 //page 189
4 clc;clear;close;
5 x=[0 %pi/2 %pi]
6 y=[0 1 0]
7 h=x(2)-x(1)
8 M0=0;M2=0;
9 M1=((6*(y(1)-2*y(2)+y(3))/h^2)-M0-M2)/4;
10 X=%pi/6;
11 s1=((x(2)-X)^3)*(M0/6)+((X-x(1))^3)*M1/6+(y(1)-(h
    ^2)*M0/6)*(x(2)-X)+(y(2)-(h^2)*M1/6)*(X-x(1)))/h;
12 x=[0 %pi/4 %pi/2 3*%pi/4 %pi];
13 y=[0 1.414 1 1.414];
14 M0=0,M4=0;
15 A=[4 1 0;1 4 1;0 1 4];//calculating value of M1 M2
    M3 by matrix method
16 C=[-4.029;-5.699;-4.029];
17 B=A^-1*C
18 printf('M0=%f\t M1=%f\t M2=%f\t M3=%f\t M4=
    %f\t\n',M0,B(1,1),B(2,1),B(3,1),M4);
19 h=%pi/4;
20 X=%pi/6;
21 s1=[-0.12408*X^3+0.7836*X]/h;
22 printf(' the value of sin(pi/6) is:%f',s1)

```

Scilab code Exa 5.5 cubic splines

```
1 //cubic spline
2 //example 5.5
3 //page 191
4 clc;clear;close;
5 x=[1 2 3];
6 y=[6 18 42];
7 m0=40;
8 m1=(3*(y(3)-y(1))-m0)/4;
9 X=poly(0,'X');
10 s1=m0*((x(2)-X)^2)*(X-x(1))-m1*((X-x(1))^2)*(x(2)-X)
    +y(1)*((x(2)-X)^2)*[2*(X-x(1))+1]+y(2)*((X-x(1))
    ^2)*[2*(x(2)-X)+1];
11 disp(s1,'s1=');
```

Scilab code Exa 5.7 surface fitting by cubic spline

```
1 //surface fitting by cubic spline
2 //example 5.7
3 //page 195
4 clc;clear;close;
5 z=[1 2 9;2 3 10;9 10 17];
6 deff('y=L0(x)','y=x^3/4-5*x/4+1');
7 deff('y=L1(x)','y=-x^3/2+3*x/2');
8 deff('y=L2(x)','y=x^3/4-x/4');
9 x=0.5;y=0.5;
10 S=0;
11 S=S+L0(x)*(L0(x)*z(1,1)+L1(x)*z(1,2)+L2(x)*z(1,3));
12 S=S+L1(x)*(L0(x)*z(2,1)+L1(x)*z(2,2)+L2(x)*z(2,3));
13 S=S+L2(x)*(L0(x)*z(3,1)+L1(x)*z(3,2)+L2(x)*z(3,3));
14 printf('approximated value of z(0.5 0.5)=%f\n\n',S);
```

```
15 printf(' error in the approximated value : %f',(abs
    (1.25-S)/1.25)*100)
```

Scilab code Exa 5.8 cubic B splines

```
1 //cubic B-splines
2 //example 5.8
3 //page 200
4 clc;clear;close;
5 k=[0 1 2 3 4];
6 pi=[0 0 4 -6 24];
7 x=1;
8 S=0;
9 for i=3:5
10     S=S+((k(i)-x)^3)/(pi(i));
11 end
12 printf(' the cubic splines for x=1 is %f\n\n',S);
13 S=0;
14 x=2;
15 for i=4:5
16     S=S+((k(i)-x)^3)/(pi(i));
17 end
18 printf(' the cubic splines for x=2 is %f\n\n',S);
```

Scilab code Exa 5.9 cubic B spline

```
1 //cubic B-spline
2 //example 5.8
3 //page 201
4 clc;clear;close;
5 k=[0 1 2 3 4];
6 x=1; //for x=1
7 s11=0; s13=0; s14=0;
```

```

8  s24=0;
9  s12=1/(k(3)-k(2));
10 s22=((x-k(1))*s11+(k(3)-x)*s12)/(k(3)-k(1));
11 s23=((x-k(2))*s11+(k(4)-x)*s13)/(k(4)-k(2));
12 s33=((x-k(1))*s22+(k(4)-x)*s23)/(k(4)-k(1));
13 s34=((x-k(2))*s23+(k(5)-x)*s24)/(k(5)-k(2));
14 s44=((x-k(1))*s33+(k(5)-x)*s34)/(k(5)-k(1));
15 printf( 's11=%f\t      s22=%f\t      s23=%f\t      s33=%f
\t      s34=%f\t      s44=%f\n\n',s11,s22,s23,s33,s34,
s44);
16 x=2; //for x=2;
17 s11=0;s12=0,s14=0;s22=0;
18 s13=1/(k(4)-k(3));
19 s23=((x-k(2))*s12+(k(4)-x)*s13)/(k(4)-k(2));
20 s24=((x-k(3))*s13+(k(5)-x)*s14)/(k(3)-k(1));
21 s33=((x-k(1))*s22+(k(4)-x)*s23)/(k(4)-k(1));
22 s34=((x-k(2))*s23+(k(5)-x)*s24)/(k(5)-k(2));
23 s44=((x-k(1))*s33+(k(5)-x)*s34)/(k(5)-k(1));
24 printf( 's13=%f\t      s23=%f\t      s24=%f\t      s33=
%f\t      s34=%f\t      s44=%f\n\n',s13,s23,s24,s33,
s34,s44);

```

Chapter 6

Numerical Differentiation and Integration

Scilab code Exa 6.1 numerical differentiation by newtons difference formula

```
1 //example 6.1
2 //numerical differentiation by newton's difference
   formula
3 //page 210
4 clc; clear; close
5 x=[1.0 1.2 1.4 1.6 1.8 2.0 2.2];
6 y=[2.7183 3.3201 4.0552 4.9530 6.0496 7.3891
   9.0250];
7 c=1;
8 for i=1:6
9     d1(c)=y(i+1)-y(i);
10    c=c+1;
11 end
12 c=1;
13 for i=1:5
14     d2(c)=d1(i+1)-d1(i);
15     c=c+1;
16 end
17 c=1;
```

```

18 for i=1:4
19     d3(c)=d2(i+1)-d2(i);
20     c=c+1;
21 end
22 c=1;
23 for i=1:3
24     d4(c)=d3(i+1)-d3(i);
25     c=c+1;
26 end
27 c=1;
28 for i=1:2
29     d5(c)=d4(i+1)-d4(i);
30     c=c+1;
31 end
32 c=1;
33 for i=1:1
34     d6(c)=d5(i+1)-d5(i);
35     c=c+1;
36 end
37 x0=1.2//first and second derivative at 1.2
38 h=0.2;
39 f1=((d1(2)-d2(2)/2+d3(2)/3-d4(2)/4+d5(2)/5)/h);
40 printf('the first derivative of fuction at 1.2 is:%f\n',f1);
41 f2=(d2(2)-d3(2)+(11*d4(2))/12-(5*d5(2))/6)/h^2;
42 printf('the second derivative of fuction at 1.2 is:%f\n',f2);

```

Scilab code Exa 6.2 numerical diffrentiation by newtons difference formula

```

1 //example 6.2
2 //numerical diffrentiation by newton's difference
  formula
3 //page 211
4 clc;clear;close

```

```

5 x=[1.0 1.2 1.4 1.6 1.8 2.0 2.2];
6 y=[2.7183 3.3201 4.0552 4.9530 6.0496 7.3891
    9.0250];
7 c=1;
8 for i=1:6
9     d1(c)=y(i+1)-y(i);
10    c=c+1;
11 end
12 c=1;
13 for i=1:5
14    d2(c)=d1(i+1)-d1(i);
15    c=c+1;
16 end
17 c=1;
18 for i=1:4
19    d3(c)=d2(i+1)-d2(i);
20    c=c+1;
21 end
22 c=1;
23 for i=1:3
24    d4(c)=d3(i+1)-d3(i);
25    c=c+1;
26 end
27 c=1;
28 for i=1:2
29    d5(c)=d4(i+1)-d4(i);
30    c=c+1;
31 end
32 c=1;
33 for i=1:1
34    d6(c)=d5(i+1)-d5(i);
35    c=c+1;
36 end
37 x0=2.2//first and second derivative at 2.2
38 h=0.2;
39 f1=((d1(6)+d2(5)/2+d3(4)/3+d4(3)/4+d5(2)/5)/h);
40 printf('the first derivative of fuction at 1.2 is:%f
    \n',f1);

```

```

41 f2=(d2(5)+d3(4)+(11*d4(3))/12+(5*d5(2))/6)/h^2;
42 printf('the second derivative of fuction at 1.2 is:
    %f\n',f2);
43 x1=2.0; // first derivative also at 2.0
44 f1=((d1(5)+d2(4)/2+d3(3)/3+d4(2)/4+d5(1)/5+d6(1)/6)/
    h);
45 printf('\n \nthe first derivative of function at 1.2
    is:%f\n',f1);

```

Scilab code Exa 6.3 numerical diffrentiation by newtons difference formula

```

1 //example 6.3
2 //numerical diffrentiation by newton's difference
  formula
3 //page 211
4 clc;clear;close
5 x=[1.0 1.2 1.4 1.6 1.8 2.0 2.2];
6 y=[2.7183 3.3201 4.0552 4.9530 6.0496 7.3891
    9.0250];
7 c=1;
8 for i=1:6
9     d1(c)=y(i+1)-y(i);
10    c=c+1;
11 end
12 c=1;
13 for i=1:5
14     d2(c)=d1(i+1)-d1(i);
15     c=c+1;
16 end
17 c=1;
18 for i=1:4
19     d3(c)=d2(i+1)-d2(i);
20     c=c+1;
21 end
22 c=1;

```

```

23 for i=1:3
24     d4(c)=d3(i+1)-d3(i);
25     c=c+1;
26 end
27 c=1;
28 for i=1:2
29     d5(c)=d4(i+1)-d4(i);
30     c=c+1;
31 end
32 c=1;
33 for i=1:1
34     d6(c)=d5(i+1)-d5(i);
35     c=c+1;
36 end
37 x0=1.6//first and second derivative at 1.6
38 h=0.2;
39 f1=((d1(3)+d1(4))/2-(d3(2)+d3(3))/4+(d5(1)+d5(2))
    /60))/h
40 printf('the first derivative of function at 1.6 is:
    %f\n',f1);
41 f2=((d2(3)-d4(2)/12)+d6(1)/90)/(h^2);
42 printf('the second derivative of function at 1.6 is:
    %f\n',f2);

```

Scilab code Exa 6.4 estimation of errors

```

1 //example 6.4
2 //estimation of errors
3 //page 213
4 clc;clear;close
5 x=[1.0 1.2 1.4 1.6 1.8 2.0 2.2];
6 y=[2.7183 3.3201 4.0552 4.9530 6.0496 7.3891
    9.0250];
7 c=1;
8 for i=1:6

```

```

9      d1(c)=y(i+1)-y(i);
10     c=c+1;
11 end
12 c=1;
13 for i=1:5
14     d2(c)=d1(i+1)-d1(i);
15     c=c+1;
16 end
17 c=1;
18 for i=1:4
19     d3(c)=d2(i+1)-d2(i);
20     c=c+1;
21 end
22 c=1;
23 for i=1:3
24     d4(c)=d3(i+1)-d3(i);
25     c=c+1;
26 end
27 c=1;
28 for i=1:2
29     d5(c)=d4(i+1)-d4(i);
30     c=c+1;
31 end
32 c=1;
33 for i=1:1
34     d6(c)=d5(i+1)-d5(i);
35     c=c+1;
36 end
37 x0=1.6//first and second derivative at 1.6
38 h=0.2;
39 f1=((d1(2)-d2(2)/2+d3(2)/3-d4(2)/4+d5(2)/5)/h);
40 printf('the first derivative of fuction at 1.2 is:%f\n',f1);
41 f2=(d2(2)-d3(2)+(11*d4(2))/12-(5*d5(2))/6)/h^2;
42 printf('the second derivative of fuction at 1.2 is:%f\n',f2);
43 T_error1=((d3(2)+d3(3))/2)/(6*h);//truncation error
44 e=0.00005;//corrected to 4D values

```

```

45 R_error1=(3*e)/(2*h);
46 T_error1=T_error1+R_error1;//total error
47 f11=(d1(3)+d1(4))/(2*h);//using stirling formula
    first derivative
48 f22=d2(3)/(h*h);//second derivative
49 T_error2=d4(2)/(12*h*h);
50 R_error2=(4*e)/(h*h);
51 T_error2=T_error2+R_error2;
52 printf('total error in first derivative is %0.4g:\n',T_error1);
53 printf('total error in second derivative is %0.4g:',T_error2);

```

Scilab code Exa 6.5 cubic spline method

```

1 //cubic spline method
2 //example 6.5
3 //page 214
4 clc;clear;close;
5 x=[0 %pi/2 %pi];
6 y=[0 1 0];
7 M0=0,M2=0;
8 h=%pi/2;
9 M1=(6*(y(1)-2*y(2)+y(3))/(h^2)-M0-M2)/4;
10 deff('y=s1(x)','y=2*((-2*3*x^2)/(%pi^2)+3/2)/%pi');
11 S1=s1(%pi/4);
12 disp(S1,'S1(pi/4)=');
13 deff('y=s2(x)','y=(-24*x)/(%pi^3)');
14 S2=s2(%pi/4);
15 disp(S2,'S2(pi/4)=');

```

Scilab code Exa 6.6 derivative by cubic spline method

```

1 //derivative by cubic spline method
2 //example 6.6
3 //page 216
4 clc;clear;close;
5 x=[-2 -1 2 3];
6 y=[-12 -8 3 5]
7 deff('y=f(x)', 'y=x^3/15-3*x^2/20+241*x/60-3.9');
8 deff('y=s2(x)', 'y=[((2-x)^3/6)*(14/55)+(x+1)
    ^3/6*(-74/55)]/3+[-8-21/55]*(2-x)/3+[3-(9/6)
    *(-74/55)]*(x+1)/3');
9 h=0.0001;
10 x0=1.0;
11 y1=(s2(x0+h)-s2(x0))/h;
12 printf(' the value y1(%0.2f) is : %f',x0,y1);

```

Scilab code Exa 6.7 maximun and minimun of functions

```

1 //maximun and minimun of functions
2 //example 6.7
3 //page 218
4 clc;clear;close;
5 x=[1.2 1.3 1.4 1.5 1.6];
6 y=[0.9320 0.9636 0.9855 0.9975 0.9996];
7 for i=1:4
8     d1(i)=y(i+1)-y(i);
9 end
10 for i=1:3
11     d2(i)=d1(i+1)-d1(i);
12 end
13 p=(-d1(1)*2/d2(1)+1)/2;
14 disp(p, 'p=');
15 h=0.1;
16 x0=1.2;
17 X=x0+p*h;
18 printf(' the value of X correct to 2 decimal places

```

```

        is : %0.2f',X);
19 Y=y(5)-0.2*d1(4)+(-0.2)*(-0.2+1)*d2(3)/2;
20 disp(Y, 'the value Y=');

```

Scilab code Exa 6.8 trapezoidal method for integration

```

1 //example 6.8
2 //trapezoidal method for integration
3 //page 226
4 clc;clear;close;
5 x=[7.47 7.48 7.49 7.0 7.51 7.52];
6 f_x=[1.93 1.95 1.98 2.01 2.03 2.06];
7 h=x(2)-x(1);
8 l=length(x);
9 area=0;
10 for i=1:l
11     if i==1|i==l then
12         area=area+f_x(i)
13     else
14         area=area+2*f_x(i)
15     end
16 end
17 area=area*(h/2);
18 printf('area bounded by the curve is %f',area);

```

Scilab code Exa 6.9 simpson 1by3 method for integration

```

1 //example 6.8
2 //simpson 1/3rd method for integration
3 //page 226
4 clc;clear;close;
5 x=[0.00 0.25 0.50 0.75 1.00];
6 y=[1.000 0.9896 0.9589 0.9089 0.8415];

```

```

7  y=y^2;
8  h=x(2)-x(1);
9  l=length(x);
10 area=0;
11 for i=1:l
12     if i==1|i==l then
13         area=area+y(i)
14
15     elseif (modulo(i,2))==0 then
16         area=area+4*y(i)
17
18     elseif (modulo(i,2))~=0 then
19         area=area+2*y(i)
20         end
21     end
22 area=area*(h*pi)/3;
23 printf('area bounded by the curve is %f',area);

```

Scilab code Exa 6.10 integration by trapezoidal and simpsons method

```

1  //example 6.10
2  //integration by trapezoidal and simpson's method
3  //page 228
4  clc;clear;close
5  deff('y=f(x)', 'y=1/(1+x)');
6  h=0.5;
7  x=0:h:1;
8  l=length(x);
9  for i=1:l
10     y(i)=f(x(i));
11 end
12 area=0; //trapezoidal method
13 for i=1:l
14     if i==1|i==l then
15         area=area+y(i)

```

```

16     else
17         area=area+2*y(i)
18     end
19 end
20 area=area*(h/2);
21 printf('area bounded by the curve by trapezoidal
    method with h=%f is %f\n \n',h,area);
22 area=0; //simpson 1/3rd rule
23 for i=1:l
24     if i==1|i==l then
25         area=area+y(i)
26
27     elseif (modulo(i,2))==0 then
28         area=area+4*y(i)
29
30     elseif (modulo(i,2))~=0 then
31         area=area+2*y(i)
32     end
33 end
34 area=(area*h)/3;
35 printf('area bounded by the curve by simpson 1/3rd
    method with h=%f is %f\n \n',h,area);
36 h=0.25;
37 x=0:h:1;
38 l=length(x);
39 for i=1:l
40     y(i)=f(x(i));
41 end
42 area=0; //trapezoidal method
43 for i=1:l
44     if i==1|i==l then
45         area=area+y(i)
46     else
47         area=area+2*y(i)
48     end
49 end
50 area=area*(h/2);
51 printf('area bounded by the curve by trapezoidal

```

```

        method with h=%f is %f\n \n',h,area);
52 area=0; //simpson 1/3rd rule
53 for i=1:l
54     if i==1|i==l then
55         area=area+y(i)
56
57     elseif (modulo(i,2))==0 then
58         area=area+4*y(i)
59
60     elseif (modulo(i,2))~=0 then
61         area=area+2*y(i)
62     end
63 end
64 area=(area*h)/3;
65 printf('area bounded by the curve by simpson 1/3rd
        method with h=%f is %f\n \n',h,area);
66 h=0.125;
67 x=0:h:1;
68 l=length(x);
69 for i=1:l
70     y(i)=f(x(i));
71 end
72 area=0; //trapezoidal method
73 for i=1:l
74     if i==1|i==l then
75         area=area+y(i)
76     else
77         area=area+2*y(i)
78     end
79 end
80 area=area*(h/2);
81 printf('area bounded by the curve by trapezoidal
        method with h=%f is %f\n \n',h,area);
82 area=0; //simpson 1/3rd rule
83 for i=1:l
84     if i==1|i==l then
85         area=area+y(i)
86

```

```

87     elseif (modulo(i,2))==0 then
88         area=area+4*y(i)
89
90     elseif (modulo(i,2))~=0 then
91         area=area+2*y(i)
92     end
93 end
94 area=(area*h)/3;
95 printf('area bounded by the curve by simpson 1/3rd
    method with h=%f is %f\n \n',h,area);

```

Scilab code Exa 6.11 rommbergs method

```

1 //example 6.11
2 //rommberg's method
3 //page 229
4 clc;clear;close;
5 deff('y=f(x)', 'y=1/(1+x)');
6 k=1;
7 h=0.5;
8 x=0:h:1;
9 l=length(x);
10 for i=1:l
11     y(i)=f(x(i));
12 end
13 area=0; //trapezoidal method
14 for i=1:l
15     if i==1|i==l then
16         area=area+y(i)
17     else
18         area=area+2*y(i)
19     end
20 end
21 area=area*(h/2);
22 I(k)=area;

```

```

23 k=k+1;
24 h=0.25;
25 x=0:h:1;
26 l=length(x);
27 for i=1:l
28     y(i)=f(x(i));
29 end
30 area=0; //trapezoidal method
31 for i=1:l
32     if i==1|i==l then
33         area=area+y(i)
34     else
35         area=area+2*y(i)
36     end
37 end
38 area=area*(h/2);
39 I(k)=area;
40 k=k+1;
41 h=0.125;
42 x=0:h:1;
43 l=length(x);
44 for i=1:l
45     y(i)=f(x(i));
46 end
47 area=0; //trapezoidal method
48 for i=1:l
49     if i==1|i==l then
50         area=area+y(i)
51     else
52         area=area+2*y(i)
53     end
54 end
55 area=area*(h/2);
56 I(k)=area;
57 printf('results obtained with h=0.5 0.25 0.125 is %f
        %f %f\n \n',I(1),I(2),I(3));
58 for i=1:2
59     I1(i)=I(i+1)+(I(i+1)-I(i))/3

```

```

60 end
61 for i=1:1
62     T2(i)=I1(i+1)+(I1(i+1)-I1(i))/3
63 end
64 printf('the area is %f',T2(1))

```

Scilab code Exa 6.12 Trapezoidal and Simpsons rule

```

1 //example 6.12
2 //Trapezoidal and Simpson's rule
3 //page 230
4 clc;clear;close;
5 deff('y=f(x)', 'y=sqrt(1-x^2)');
6 k=10:10:50
7 for i=1:length(k)
8     T_area(i)=0,S_area(i)=0;
9     h=1/k(i);
10    x=0:h:1
11    l=length(x);
12    for j=1:l
13        y(j)=f(x(j));
14    end
15    for j=1:l
16        if j==1|j==l then
17            T_area(i)=T_area(i)+y(j)
18        else
19            T_area(i)=T_area(i)+2*y(j)
20        end
21    end
22 end
23 T_area(i)=T_area(i)*(h/2);
24 for j=1:l
25     if j==1|j==l then
26         S_area(i)=S_area(i)+y(j)
27     end

```

```

28     elseif (modulo(j,2))==0 then
29         S_area(i)=S_area(i)+4*y(j)
30
31     elseif (modulo(i,2))~=0 then
32         S_area(i)=S_area(i)+2*y(j)
33         end
34     end
35 S_area(i)=S_area(i)*(h)/3;
36 end
37 printf(' no of subintervals      Trapezoidal Rule
        Simpsons Rule\t \n \n')
38 for i=1:length(k)
39     printf(' %0.9g                %0.9g
        %0.9g                \n ',k(i),T_area
        (i),S_area(i));
40
41 end

```

Scilab code Exa 6.13 area using cubic spline method

```

1 //area using cubic spline method
2 //example 6.2
3 //page 230
4 clc;clear;close;
5 x=[0 0.5 1.0];
6 y=[0 1.0 0.0]
7 h=0.5;
8 M0=0,M2=0;
9 M1=(6*(y(3)-2*y(2)+y(1)))/h^2-M0-M2)/4;
10 M=[M0 M1 M2];
11 I=0;
12 for i=1:2
13     I=I+(h*(y(i)+y(i+1)))/2-((h^3)*(M(i)+M(i+1)))/24)
        ;
14 end

```

```
15 printf(' the value of the integrand is : %f',I);
```

Scilab code Exa 6.15 eulers maclaurin formula

```
1 //euler 's maclaurin formula
2 //example 6.15
3 //page 233
4 clc;clear;close;
5 y=[0 1 0];
6 h=%pi/4;
7 I=h*(y(1)+2*y(2)+y(3))/2+(h^2)/12+(h^4)/720;
8 printf(' the value of integrand with h=%f is : %f\n\
      n',h,I)
9 h=%pi/8;
10 y=[0 sin(%pi/8) sin(%pi*2/8) sin(%pi*3/8) sin(%pi
      *4/8)]
11 I=h*(y(1)+2*y(2)+2*y(3)+2*y(4)+y(5))/2+(h^2)/2+(h^2)
      /12+(h^4)/720;
12 printf(' the value of integrand with h=%f is : %f',h
      ,I)
```

Scilab code Exa 6.17 error estimate in evaluation of the integral

```
1 // example 6.17
2 // error estimate in evaluation of the integral
3 // page 236
4 clc;clear;close;
5 deff('z=f(a,b)', 'z=cos(a)+4*cos((a+b)/2)+cos(b)')
6 a=0,b=%pi/2,c=%pi/4;
7 I(1)=(f(a,b)*((b-a)/2)/3)
8 I(2)=(f(a,c)*((c-a)/2)/3)
9 I(3)=(f(c,b)*((b-c)/2)/3)
10 Area=I(2)+I(3);
```

```

11 Error_estimate=((I(1)-I(2)-I(3))/15);
12 Actual_area=integrate('cos(x)', 'x', 0, %pi/2);
13 Actual_error=abs(Actual_area-Area);
14 printf('the calculated area obtained is:%f\n', Area)
15 printf('the actual area obtained is:%f\n',
        Actual_area)
16 printf('the actual error obtained is:%f\n',
        Actual_error)

```

Scilab code Exa 6.18 error estimate in evaluation of the integral

```

1 // example 6.18
2 // error estimate in evaluation of the integral
3 // page 237
4 clc; clear; close;
5 deff('z=f(a,b)', 'z=8+4*sin(a)+4*(8+4*sin((a+b)/2))
        +8+4*sin(b)')
6 a=0, b=%pi/2, c=%pi/4;
7 I(1)=(f(a,b)*((b-a)/2)/3)
8 I(2)=(f(a,c)*((c-a)/2)/3)
9 I(3)=(f(c,b)*((b-c)/2)/3)
10 Area=I(2)+I(3);
11 Error_estimate=((I(1)-I(2)-I(3))/15);
12 Actual_area=integrate('8+4*cos(x)', 'x', 0, %pi/2);
13 Actual_error=abs(Actual_area-Area);
14 printf('the calculated area obtained is:%f\n', Area)
15 printf('the actual area obtained is:%f\n',
        Actual_area)
16 printf('the actual error obtained is:%f\n',
        Actual_error)

```

Scilab code Exa 6.19 gauss formula

```

1 //gauss ' formula
2 //example 6.19
3 //page 242
4 clc;clear;close;
5 u=[-0.86113 -0.33998 0.33998 0.86113];
6 W=[0.34785 0.65214 0.65214 0.34785];
7 I=0;
8 for i=1:4
9     I=I+(u(i)+1)*W(i);
10 end
11 I=I/4;
12 printf(' the value of integrand is : %0.5f',I);

```

Scilab code Exa 6.20 double integration

```

1 //example 6.20
2 //double integration
3 //page 247
4 clc;clear;close;
5 deff('z=f(x,y)', 'z=exp(x+y)');
6 h0=0.5,k0=0.5;
7 h=[0 0.5 1];,k=[0 0.5 1];
8 for i=1:3
9     for j=1:3
10         x(i,j)=f(h(i),k(j));
11     end
12 end
13 T_area=h0*k0*(x(1,1)+4*x(1,2)+4*x(3,2)+6*x(1,3)+x
    (3,3))/4//trapezoidal method
14 printf('the integration value by trapezoidal method
    is %f\n ',T_area);
15 S_area=h0*k0*((x(1,1)+x(1,3)+x(3,1)+x(3,3)+4*(x(1,2)
    +x(3,2)+x(2,3)+x(2,1))+16*x(2,2))/9
16 printf('the integration value by Simpson method is
    %f',S_area);

```


Chapter 7

Numerical linear algebra

Scilab code Exa 7.1 inverse of matrix

```
1 //example 7.1
2 //inverse of matrix
3 //page 256
4 clc;clear;close;
5 A=[1,2,3;0,1,2;0,0,1];
6 A_1=1/A//inverse of matrix
7 for i=1:3
8     for j=1:3
9         printf('%d ',A_1(i,j))
10    end
11    printf('\n')
12 end
```

Scilab code Exa 7.2 Factorize by triangulation method

```
1 //example 7.2
2 //Factorize by triangulation method
3 //page 259
```

```

4  clc;clear;close;
5  A=[2,3,1;1,2,3;3,1,2];
6  L(1,2)=0,L(1,3)=0,L(2,3)=0;
7  U(2,1)=0,U(3,1)=0,U(3,2)=0;
8  for i=1:3
9      L(i,i)=1;
10 end
11 for i=1:3
12     U(1,i)=A(1,i);
13 end
14 L(2,1)=1/U(1,1);
15 for i=2:3
16     U(2,i)=A(2,i)-U(1,i)*L(2,1);
17 end
18 L(3,1)=A(3,1)/U(1,1);
19 L(3,2)=(A(3,2)-U(1,2)*L(3,1))/U(2,2);
20 U(3,3)=A(3,3)-U(1,3)*L(3,1)-U(2,3)*L(3,2);
21 printf('The Matrix A in Triangle form\n \n')
22 printf('Matrix L\n');
23 for i=1:3
24     for j=1:3
25         printf('%.2 f    ',L(i,j));
26     end
27     printf('\n');
28 end
29 printf('\n \n');
30 printf('Matrix U\n');
31 for i=1:3
32     for j=1:3
33         printf('%.2 f    ',U(i,j));
34     end
35     printf('\n');
36 end

```

Scilab code Exa 7.3 Vector Norms

```

1 //example 7.3
2 //Vector Norms
3 //page 262
4 clc;clear;close;
5 A=[1,2,3;4,5,6;7,8,9];
6 s=0;
7 for i=1:3
8     for j=1:3
9         s=s+A(j,i);
10    end
11    C(i)=s;
12    s=0;
13 end
14 printf(' ||A||1=%d\n',max(C));
15 for i=1:3
16     for j=1:3
17         s=s+(A(i,j)*A(i,j))
18     end
19 end
20 printf(' ||A|| e=%0.3 f\n',sqrt(s));
21 s=0;
22 for i=1:3
23     for j=1:3
24         s=s+A(i,j);
25     end
26    C(i)=s;
27    s=0;
28 end
29 printf(' ||A||~=%d\n',max(C));

```

Scilab code Exa 7.6 Gauss Jordan

```

1 //example 7.4
2 //Gauss Jordan
3 //page 266

```

```

4  clc;clear;close;
5  A=[2,1,1,10;3,2,3,18;1,4,9,16]; //augmented matrix
6  for i=1:3
7      j=i
8      while (A(i,i)==0&j<=3)
9
10     for k=1:4
11         B(1,k)=A(j+1,k)
12         A(j+1,k)=A(i,k)
13         A(i,k)=B(1,k)
14     end
15     disp(A);
16     j=j+1;
17 end
18 disp(A);
19 for k=4:-1:i
20     A(i,k)=A(i,k)/A(i,i)
21 end
22 disp(A)
23 for k=1:3
24     if(k~=i) then
25         l=A(k,i)/A(i,i)
26         for m=i:4
27             A(k,m)=A(k,m)-l*A(i,m)
28         end
29     end
30 end
31 disp(A)
32 end
33 for i=1:3
34     printf( '\nx( %i )=%g\n ',i,A(i,4))
35 end

```

Scilab code Exa 7.7 modern gauss jordan method

```

1 //modern gauss jordan method
2 //example 7.7
3 //page 269
4 clc;clear;close;
5 A=[2 1 1;3 2 3;1 4 9];
6 I=eye(3,3);
7 I1=[1;0;0];
8 I2=[0;1;0];
9 I3=[0;0;1];
10 A1=A^-1*I1;
11 A2=A^-1*I2;
12 A3=A^-1*I3;
13 for i=1:3
14     AI(i,1)=A1(i,1)
15 end
16 for i=1:3
17     AI(i,2)=A2(i,1)
18 end
19 for i=1:3
20     AI(i,3)=A3(i,1)
21 end
22 printf('the inverse of the matrix\n')
23 for i=1:3
24     for j=1:3
25         printf('%0.2g      ',AI(i,j))
26     end
27     printf(' \n');
28 end

```

Scilab code Exa 7.8 LU decomposition method

```

1 //LU decomposition method
2 //example 7.8
3 //page 273
4 clc;clear;close;

```

```

5  A=[2,3,1;1,2,3;3,1,2];
6  B=[9;6;8]
7  L(1,2)=0,L(1,3)=0,L(2,3)=0;
8  U(2,1)=0,U(3,1)=0,U(3,2)=0;
9  for i=1:3
10     L(i,i)=1;
11 end
12 for i=1:3
13     U(1,i)=A(1,i);
14 end
15 L(2,1)=1/U(1,1);
16 for i=2:3
17     U(2,i)=A(2,i)-U(1,i)*L(2,1);
18 end
19 L(3,1)=A(3,1)/U(1,1);
20 L(3,2)=(A(3,2)-U(1,2)*L(3,1))/U(2,2);
21 U(3,3)=A(3,3)-U(1,3)*L(3,1)-U(2,3)*L(3,2);
22 printf('The Matrix A in Triangle form\n \n')
23 printf('Matrix L\n');
24 for i=1:3
25     for j=1:3
26         printf('%.2f ',L(i,j));
27     end
28     printf('\n');
29 end
30 printf('\n \n');
31 printf('Matrix U\n');
32 for i=1:3
33     for j=1:3
34         printf('%.2f ',U(i,j));
35     end
36     printf('\n');
37 end
38 Y=L^-1*B;
39 X=U^-1*Y;
40 printf(' the values of x=%f,y=%f,z=%f',X(1,1),X(2,1),
    ,X(3,1));

```

Scilab code Exa 7.9 ill conditioned linear systems

```
1 //ill conditioned linear systems
2 //example 7.9
3 //page 276
4 clc;clear;close;
5 A=[2 1;2 1.01];
6 B=[2;2.01];
7 X=A^-1*B;
8 A_e=0;
9 for i=1:2
10     for j=1:2
11         A_e=A_e+A(i,j)^2;
12     end
13 end
14 A_e=sqrt(A_e);
15 inv_A=A^-1;
16 invA_e=0;
17 for i=1:2
18     for j=1:2
19         invA_e=invA_e+inv_A(i,j)^2;
20     end
21 end
22 invA_e=sqrt(invA_e);
23 C=A_e*invA_e
24 de_A=determ(A);
25 for i=1:2
26     s=0;
27     for j=1:2
28         s=s+A(i,j)^2
29     end
30     s=sqrt(s);
31     k=de_A/s;
32 end
```

```

33 if k<1 then
34     printf(' the fuction is ill conditioned')
35 end

```

Scilab code Exa 7.10 ill condiioned linear systems

```

1 //ill condiioned linear systems
2 //example 7.10
3 //page 277
4 clc;clear;close;
5 A=[1/2 1/3 1/4;1/5 1/6 1/7;1/8 1/9 1/10]//hilbert's
   matrix
6 de_A=det(A);
7 if de_A<1 then
8     printf(' A is ill-conditioned')
9 end

```

Scilab code Exa 7.11 ill conditioned linear systems

```

1 //ill conditioned linear system
2 //example 7.11
3 //page 277
4 clc;clear;close;
5 A=[25 24 10;66 78 37;92 -73 -80];
6 de_A=det(A);
7 for i=1:3
8     s=0;
9     for j=1:3
10         s=s+A(i,j)^2
11     end
12     s=sqrt(s);
13     k=de_A/s;
14 end

```

```

15 if k<1 then
16     printf(' the fuction is ill conditioned')
17 end

```

Scilab code Exa 7.12 ill conditioned system

```

1 //ill-conditioned system
2 //example 7.12
3 //page 278
4 clc;clear;close;
5 //the original equations are 2x+y=2      2x+1.01y=2.01
6 A1=[2 1;2 1.01];
7 C1=[2;2.01];
8 x1=1;y1=1//approximate values
9 A2=[2 1;2 1.01];
10 C2=[3;3.01];
11 C=C1-C2;
12 X=A1^-1*C;
13 x=X(1,1)+x1;
14 y=X(2,1)+y1;
15 printf(' the exact solution is X=%f \t Y=%f',x,y);

```

Scilab code Exa 7.14 solution of equations by iteration method

```

1 //solution of equations by iteration method
2 //example 7.14
3 //page 282
4 //jacobi's method
5 clc;clear;close;
6 C=[3.333;1.5;1.4];
7 X=[3.333;1.5;1.4];
8 B=[0 -0.1667 -0.1667;-0.25 0 0.25;-0.2 0.2 0];
9 for i=1:10

```

```

10     X1=C+B*X;
11     printf('X%d',i);
12     for k=1:3
13         for l=1:1
14             printf(' %f ',X1(k,l))
15         end
16         printf('\n');
17     end
18     X=X1;
19 end
20 printf(' the solution of the equation is converging
    at 3 1 1\n\n');
21 //gauss-seidel method
22 C=[3.333;1.5;1.4];
23 X=[3.333;1.5;1.4];
24 B=[0 -0.1667 -0.1667;-0.25 0 0.25;-0.2 0.2 0];
25 X1=C+B*X;
26 x=X1(1,1);y=X1(2,1);z=X1(3,1);
27 for i=1:5
28     x=3.333-0.1667*y-0.1667*z
29     y=1.5-0.25*x+0.25*z
30     z=1.4-0.2*x+0.2*y
31     printf(' the value after %d iteration is : %f\t
        %f\t %f\t\n\n',i,x,y,z)
32 end
33 printf(' again we conclude that roots converges at 3
    1 1')

```

Scilab code Exa 7.15 eigenvalues and eigenvectors

```

1 //eigenvalues and eigenvectors
2 //example 7.15
3 //page 285
4 clc;clear;close
5 A=[5 0 1;0 -2 0;1 0 5];

```

```

6 x=poly(0,'x');
7 for i=1:3
8     A(i,i)=A(i,i)-x;
9 end
10 d=determ(A);
11 X=roots(d);
12 printf(' the eigen values are \n\n')
13 disp(X);
14 X1=[0;1;0]
15 X2=[1/sqrt(2);0;-1/sqrt(2)];
16 X3=[1/sqrt(2);0;1/sqrt(2)];
17 //after computation the eigen vectors
18 printf('the eigen vectors for value %0.2g is ',X(3));
19 disp(X1);
20 printf('the eigen vectors for value %0.2g is ',X(2));
21 disp(X2);
22 printf('the eigen vectors for value %0.2g is ',X(1));
23 disp(X3);

```

Scilab code Exa 7.16 largest eigenvalue and eigenvectors

```

1 //largest eigenvalue and eigenvectors
2 //example 7.16
3 //page 286
4 clc;clear;close;
5 A=[1 6 1;1 2 0;0 0 3];
6 I=[1;0;0]; //initial eigen vector
7 X0=A*I
8 disp(X0,'X0=')
9 X1=A*X0;
10 disp(X1,'X1=')
11 X2=A*X1;
12 disp(X2,'X2=')
13 X3=X2/3;
14 disp(X3,'X3=')

```

```

15 X4=A*X3;
16 X5=X4/4;
17 disp(X5,'X5=');
18 X6=A*X5;
19 X7=X6/(4*4);
20 disp(X7,'X7=');
21 printf('as it can be seen that highest eigen value
        is 4 \n\n the eigen vector is %d %d %d',X7(1),X7
        (2),X7(3));

```

Scilab code Exa 7.17 housrholders method

```

1 //housrholder's method
2 //example 7.17
3 //page 290
4 clc;clear;close;
5 A=[1 3 4;3 2 -1;4 -1 1];
6 S=sqrt(A(1,2)^2+A(1,3)^2);
7 v2=sqrt([1+(A(1,2)/S)]/2)
8 v3=A(1,3)/(2*v2*S)
9 V=[0 v2 v3];
10 P1=[1 0 0;0 1-2*v2^2 -2*v2*v3;0 -2*v2*v3 1-2*v3^2];
11 A1=P1*A*P1;
12 printf(' the reduced matrix is \n\n');
13 for i=1:3
14     for j=1:3
15         printf('%0.2f ',A1(i,j));
16     end
17     printf('\n');
18 end

```

Scilab code Exa 7.18 single value decommposition

```

1 //single value decommposition
2 //example 7.18
3 //page 292
4 clc;clear;close;
5 A=[1 2;1 1;1 3];
6 A1=A'*A;
7 x=poly(0,'x');
8 A1(1,1)=A1(1,1)-x;
9 A1(2,2)=A1(2,2)-x;
10 de_A1=det(A1);
11 C=roots(de_A1);
12 printf(' eigen values are %0.2f %0.2f\n\n',C(1),C
    (2));
13 X1=[0.4033;0.9166];
14 X2=[0.9166;-0.4033];
15 Y1=(A*X1)/sqrt(C(1));
16 Y2=(A*X2)/sqrt(C(2));
17 printf(' singular decomposition of A is given by \n\
    n');
18 D1=[Y1(1) Y2(1);Y1(2) Y2(2);Y1(3) Y2(3)];
19 D2=[sqrt(C(1)) 0;0,sqrt(C(2))];
20 D3=[X1(1) X2(1);X1(2) X2(2)];
21 for i=1:3
22     for j=1:2
23         printf('%0.4f ',D1(i,j))
24     end
25     printf('\n')
26 end
27 printf('\n\n')
28 for i=1:2
29     for j=1:2
30         printf('%0.4f ',D2(i,j))
31     end
32     printf('\n')
33 end
34 printf('\n\n');
35 for i=1:2
36     for j=1:2

```

```
37         printf( '%0.4 f      ', D3(i,j))
38     end
39     printf( '\n' )
40 end
```

Chapter 8

Numerical Solution of ordinary differential equation

Scilab code Exa 8.1 taylors method

```
1 //example 8.1
2 //taylor 's method
3 //page 304
4 clc;clear;close;
5 f=1; //value of function at 0
6 deff('z=f1(x)', 'z=x-f^2');
7 deff('z=f2(x)', 'z=1-2*f*f1(x)');
8 deff('z=f3(x)', 'z=-2*f*f2(x)-2*f2(x)^2');
9 deff('z=f4(x)', 'z=-2*f*f3(x)-6*f1(x)*f2(x)');
10 deff('z=f5(x)', 'z=-2*f*f4(x)-8*f1(x)*f3(x)-6*f2(x)^2
    ');
11 h=0.1; //value at 0.1
12 k=f;
13     for j=1:5
14         if j==1 then
15             k=k+h*f1(0);
16         elseif j==2 then
17             k=k+(h^j)*f2(0)/factorial(j)
18         elseif j ==3
```

```

19         k=k+(h^j)*f3(0)/factorial(j)
20     elseif j ==4
21         k=k+(h^j)*f4(0)/factorial(j)
22     elseif j==5
23         k=k+(h^j)*f5(0)/factorial(j)
24
25 end
26 end
27 printf('the value of the function at %.2f is :%0.4f'
        ,h,k)

```

Scilab code Exa 8.2 taylors method

```

1 //taylor 's method
2 //example 8.2
3 //page 304
4 clc;clear;close;
5 f=1; //value of function at 0
6 f1=0; //value of first derivatie at 0
7 deff('y=f2(x)', 'y=x*f1+f');
8 deff('y=f3(x)', 'y=x*f2(x)+2*f1');
9 deff('y=f4(x)', 'y=x*f3(x)+3*f2(x)');
10 deff('y=f5(x)', 'y=x*f4(x)+4*f3(x)');
11 deff('y=f6(x)', 'y=x*f5(x)+5*f4(x)');
12 h=0.1; //value at 0.1
13 k=f;
14     for j=1:6
15         if j==1 then
16             k=k+h*f1;
17         elseif j==2 then
18             k=k+(h^j)*f2(0)/factorial(j)
19         elseif j ==3
20             k=k+(h^j)*f3(0)/factorial(j)
21         elseif j ==4
22             k=k+(h^j)*f4(0)/factorial(j)

```

```

23             elseif j==5
24                 k=k+(h^j)*f5(0)/factorial(j)
25             else
26 k=k+(h^j)*f6(0)/factorial (j)
27 end
28 end
29 printf('the value of the function at %.2f is :%0.7f'
        ,h,k)

```

Scilab code Exa 8.3 picards method

```

1 //example 8.3
2 //picard's method
3 //page 306
4 clc;clear;close;
5 deff('z=f(x,y)','z=x+y^2')
6 y(1)=1;
7 for i=1:2
8     y(i+1)=y(1)+integrate('f(x,y(i))','x',0,i/10);
9     printf(' \n y (%g) = %g\n ',i/10 ,y(i+1) );
10 end

```

Scilab code Exa 8.4 picards method

```

1 //example 8.4
2 //picard's method
3 //page 306
4 clc;clear;close;
5 deff('z=f(x,y)','z=x^2/(y^2+1)')
6 y(1)=0; //value at 0
7 c=0.25;
8 for i=1:3
9     y(i+1)=y(1)+integrate('f(x,y(i))','x',0,c);

```

```
10     printf ( ' \n y(%0.2f) = %g\n',c ,y(i +1) );
11     c=c*2;
12     end
```

Scilab code Exa 8.5 eulers method

```
1 //example 8.5
2 //euler 's method
3 //page 308
4 clc;clear;close;
5 deff( 'z=f(y) ', 'z=-y ')
6 y(1)=1; //value at 0
7 h=0.01; c=0.01;
8 for i=1:4
9     y(i+1)=y(i)+h*f(y(i))
10     printf ( '\ny(%g)=%g\n',c,y(i+1));
11     c=c+0.01;
12 end
```

Scilab code Exa 8.6 error estimates in eulers

```
1 //example 8.6
2 //error estimates in euler 's
3 //page 308
4 clc;clear;close;
5 deff( 'z=f(y) ', 'z=-y ')
6 y(1)=1; //value at 0
7 h=0.01; c=0.01;
8 for i=1:4
9     y(i+1)=y(i)+h*f(y(i))
10     printf ( '\ny(%g)=%g\n',c,y(i+1));
11     c=c+0.01;
12 end
```

```

13 for i=1:4
14     L(i)=abs(-(1/2)*h^2*y(i+1));
15     printf('L(%d) =%f\n\n',i,L(i))
16 end
17 e(1)=0;
18 for i=1:4
19     e(i+1)=abs(y(2)*e(i)+L(1));
20     printf('e(%d)=%f\n\n',i,e(i))
21 end
22 Actual_value=exp(-0.04);
23 Estimated_value=y(5);
24 err=abs(Actual_value-Estimated_value);
25 if err<e(5) then
26     disp(' VERIFIED ');
27 end

```

Scilab code Exa 8.7 modified eulers method

```

1 //example 8.7
2 //modified euler's method
3 //page 310
4 clc;clear;close;
5 h=0.05;
6 f=1;
7 deff('z=f1(x,y)','z=x^2+y');
8 x=0:0.05:0.1
9 y1=0;
10 y1(1)=f+h*f1(x(1),f);
11 y1(2)=f+h*(f1(x(1),f)+f1(x(2),y1(1)))/2;
12 y1(3)=f+h*(f1(x(1),f)+f1(x(3),y1(2)))/2;
13 y2(1)=y1(2)+h*f1(x(2),y1(2));
14 y2(2)=y1(2)+h*(f1(x(2),y1(2))+f1(x(3),y2(1)))/2;
15 y2(3)=y1(2)+h*(f1(x(2),y1(2))+f1(x(3),y2(2)))/2;
16 printf(' y1(0)\t y1(1)\t y1(2)\t y2(0)\t y2(1)\t y3\n\n\n');

```

```

17 printf(' %f\t      %f\t      %f\t      %f\t      %f\t      %f\n',y1(1),y1(2),y1(3),y2(1),y2(2),y2(3))
18 printf('\n\n the value of y at %0.2f is : %0.4f',x
    (3),y2(3));

```

Scilab code Exa 8.8 runge kutta formula

```

1 //example 8.8
2 //runge-kutta formula
3 //page 313
4 clc;clear;close;
5 deff('y=f(x,y)', 'y=y-x')
6 y=2;x=0;h=0.1;
7 K1=h*f(x,y);
8 K2=h*f(x+h,y+K1);
9 y1=y+( K1+K2)/2
10 printf ('\n y(0.1) by second order runge kutta
    method:%0.4f',y1);
11 y=y1;x=0.1;h=0.1;
12 K1=h*f(x,y);
13 K2=h*f(x+h,y+K1);
14 y1=y+( K1+K2)/2
15 printf ('\n y(0.2) by second order runge kutta
    method:%0.4f',y1);
16 y=2,x=0,h=0.1;
17 K1=h*f(x,y);
18 K2=h*f(x+h/2,y+K1/2);
19 K3=h*f(x+h/2,y+K2/2);
20 K4=h*f(x+h,y+K3);
21 y1=y+(K1+2*K2+2*K3+K4)/6;
22 printf ('\n y(0.1) by fourth order runge kutta
    method:%0.4f',y1);
23 y=y1,x=0.1,h=0.1;
24 K1=h*f(x,y);
25 K2=h*f(x+h/2,y+K1/2);

```

```

26 K3=h*f(x+h/2,y+K2/2);
27 K4=h*f(x+h,y+K3);
28 y1=y+(K1+2*K2+2*K3+K4)/6;
29 printf ('\n y(0.1) by fourth order runge kutta
    method:%0.4 f ',y1);y=2,x=0,h=0.1;

```

Scilab code Exa 8.9 runge kutta formula

```

1 //example 8.9
2 //runge kutta method
3 //page 315
4 clc;clear;close;
5 deff('y=f(x,y)', 'y=1+y^2');
6 y=0,x=0,h=0.2;
7 K1=h*f(x,y);
8 K2=h*f(x+h/2,y+K1/2);
9 K3=h*f(x+h/2,y+K2/2);
10 K4=h*f(x+h,y+K3);
11 y1=y+(K1+2*K2+2*K3+K4)/6;
12 printf ('\n y(0.2) by fourth order runge kutta
    method:%0.4 f ',y1);
13 y=y1,x=0.2,h=0.2;
14 K1=h*f(x,y);
15 K2=h*f(x+h/2,y+K1/2);
16 K3=h*f(x+h/2,y+K2/2);
17 K4=h*f(x+h,y+K3);
18 y1=y+(K1+2*K2+2*K3+K4)/6;
19 printf ('\n y(0.4) by fourth order runge kutta
    method:%0.4 f ',y1);
20 y=2,x=0,h=0.1;
21 y=y1,x=0.4,h=0.2;
22 K1=h*f(x,y);
23 K2=h*f(x+h/2,y+K1/2);
24 K3=h*f(x+h/2,y+K2/2);
25 K4=h*f(x+h,y+K3);

```

```

26 y1=y+(K1+2*K2+2*K3+K4)/6;
27 printf ( '\n y(0.6) by fourth order runge kutta
    method:%0.4f ',y1);

```

Scilab code Exa 8.10 initial value problems

```

1 //example 8.10
2 //initial value problems
3 //page 315
4 clc;clear;close;
5 deff( 'y=f1(x,y)', 'y=3*x+y/2' );
6 y(1)=1;
7 h=0.1;c=0;
8 for i=1:2
9     y(i+1)=y(i)+h*f1(c,y(i))
10     printf ( '\ny(%g)=%g\n',c,y(i))
11     c=c+0.1;
12 end

```

Scilab code Exa 8.11 adams moulton method

```

1 //example 8.11
2 //adam's moulton method
3 //page 316
4 clc;clear;close;
5 deff( 'y=f(x,y)', 'y=1+y^2' );
6 y=0,x=0,h=0.2,f1(1)=0;
7 K1=h*f(x,y);
8 K2=h*f(x+h/2,y+K1/2);
9 K3=h*f(x+h/2,y+K2/2);
10 K4=h*f(x+h,y+K3);
11 y1=y+(K1+2*K2+2*K3+K4)/6;
12 f1(1)=y1;

```

```

13 printf ( '\n y(0.2) by fourth order runge kutta
    method:%0.4 f ',y1);
14 y=y1,x=0.2,h=0.2;
15 K1=h*f(x,y);
16 K2=h*f(x+h/2,y+K1/2);
17 K3=h*f(x+h/2,y+K2/2);
18 K4=h*f(x+h,y+K3);
19 y1=y+(K1+2*K2+2*K3+K4)/6;
20 f1(2)=y1;
21 printf ( '\n y(0.4) by fourth order runge kutta
    method:%0.4 f ',y1);
22 y=2,x=0,h=0.1;
23 y=y1,x=0.4,h=0.2;
24 K1=h*f(x,y);
25 K2=h*f(x+h/2,y+K1/2);
26 K3=h*f(x+h/2,y+K2/2);
27 K4=h*f(x+h,y+K3);
28 y1=y+(K1+2*K2+2*K3+K4)/6;
29 f1(3)=y1;
30 printf ( '\n y(0.6) by fourth order runge kutta
    method:%0.4 f ',y1);
31 y_p=y1+h*(55*(1+f1(3)^2)-59*(1+f1(2)^2)+37*(1+f1(1)
    ^2)-9)/24;
32 y_c=y1+h*(9*(1+(y_p-1)^2)+19*(1+f1(3)^2)-5*(1+f1(2)
    ^2)+(1+f1(1)^2))/24;
33 printf ( ' \nthe predicted value is:%0.4 f:\n ',y_p);
34 printf ( ' the computed value is:%0.4 f:',y_c);

```

Scilab code Exa 8.12 milnes method

```

1 //example 8.12
2 //milne's method
3 //page 320
4 clc;clear;close;
5 deff('y=f(x,y)', 'y=1+y^2');

```

```

6  y=0,x=0,h=0.2,f1(1)=0;
7  printf('x          y          y1=1+y^2\n\n'
      ')
8  Y1(1)=1+y^2;
9  printf('%0.4f          %0.4f          %0.4f\n',x,y,(1+y
      ^2));
10 K1=h*f(x,y);
11 K2=h*f(x+h/2,y+K1/2);
12 K3=h*f(x+h/2,y+K2/2);
13 K4=h*f(x+h,y+K3);
14 y1=y+(K1+2*K2+2*K3+K4)/6;
15 f1(1)=y1;
16 Y1(2)=1+y1^2;
17 printf('%0.4f          %0.4f          %0.4f\n',x+h,y1,(1+
      y1^2));
18 y=y1,x=0.2,h=0.2;
19 K1=h*f(x,y);
20 K2=h*f(x+h/2,y+K1/2);
21 K3=h*f(x+h/2,y+K2/2);
22 K4=h*f(x+h,y+K3);
23 y1=y+(K1+2*K2+2*K3+K4)/6;
24 f1(2)=y1;
25 Y1(3)=1+y1^2
26 printf('%0.4f          %0.4f          %0.4f\n',x+h,y1,(1+
      y1^2));
27 y=y1,x=0.4,h=0.2;
28 K1=h*f(x,y);
29 K2=h*f(x+h/2,y+K1/2);
30 K3=h*f(x+h/2,y+K2/2);
31 K4=h*f(x+h,y+K3);
32 y1=y+(K1+2*K2+2*K3+K4)/6;
33 f1(3)=y1;
34 Y1(4)=1+y1^2;
35 printf('%0.4f          %0.4f          %0.4f\n',x+h,y1,(1+
      y1^2));
36 Y_4=4*h*(2*Y1(2)-Y1(3)+2*Y1(4))/3;
37 printf('y(0.8)=%f\n',Y_4);
38 Y=1+Y_4^2;

```

```

39 Y_4=f1(2)+h*(Y1(3)+4*Y1(4)+Y)/3; //more correct value
40 printf('y(0.8)=%f\n',Y_4);

```

Scilab code Exa 8.13 milnes method

```

1 //example 8.13
2 //milne's method
3 //page 320
4 clc;clear;close;
5 deff('y=f1(x,y)', 'y=x^2+y^2-2');
6 x=[-0.1 0 0.1 0.2];
7 y=[1.0900 1.0 0.8900 0.7605];
8 h=0.1;
9 for i=1:4
10     Y1(i)=f1(x(i),y(i));
11 end
12 printf('      x              y      y1=x^2+
      y^2-2      \n\n');
13 for i=1:4
14     printf('    %0.2f      %f      %f
      \n',x(i),y(i),Y1(i));
15 end
16 Y_3=y(1)+(4*h/3)*(2*Y1(2)-Y1(3)+2*Y1(4));
17 printf('y(0.3)=%f\n',Y_3)
18 Y1_3=f1(0.3,Y_3);
19 Y_3=y(3)+h*(Y1(3)+4*Y1(4)+Y1_3)/3; //corrected value
20 printf('corrected y(0.3)=%f',Y_3)

```

Scilab code Exa 8.14 initial value problems

```

1 //example 8.14
2 //initial-value problem
3 //page 322

```

```

4 clc;clear;close;
5 deff( 'y=f(x)', 'y=13*exp(x/2)-6*x-12' );
6 s1=1.691358;s3=3.430879;
7 printf('the error in the computed values are %0.7g
    %0.7g',abs(f(0.5)-s1),abs(f(1)-s3))

```

Scilab code Exa 8.15 boundary value problem using finite difference method

```

1 //boundary value problem using finite difference
  method
2 //example 8.15
3 //page 328
4 clc;clear;close;
5 deff( 'y=f(x)', 'y=cos(x)+((1-cos(1))/sin(1))*sin(x)-1
    ');
6 h1=1/2;
7 Y=f(0.5);
8 y0=0,y2=0;
9 y1=4*(1/4+y0+y2)/7
10 printf('computed value with h=%f of y(0.5) is %f\n',
    h1,y1)
11 printf('error in the result with actual value %f\n',
    abs(Y-y1) )
12 h2=1/4;
13 y0=0,y4=0;
14 //solving the approximated differential equation
15 A=[-31/16 1 0;1 -31/16 1;0 1 -31/16];
16 X=[-1/16;-1/16;-1/16];
17 C=A^-1*X;
18 printf('computed value with h=%f of y(0.5) is %f\n',
    h2,C(2,1))
19 printf('error in the result with actual value %f\n',
    abs(Y-C(2,1)))

```

Scilab code Exa 8.16 boundary value problem using finite difference method

```
1 //boundary value problem using finite difference
  method
2 //example 8.16
3 //page 329
4 clc; clear; close;
5 deff( 'y=f(x) ', 'y=sinh(x) ')
6 y0=0//y(0)=0;
7 y4=3.62686//y(2)=3.62686
8 h1=0.5;
9 Y=f(0.5)
10 //arranging and calculating the values
11 A=[-9 4 0;4 -9 4;0 4 -9];
12 C=[0;0;-14.50744];
13 X=A^-1*C
14 printf('computed value with h=%f of y(0.5) is %f\n',
    h1,X(1,1))
15 printf('error in the result with actual value %f\n',
    abs(Y-X(1,1)) )
16 h2=1.0;
17 y0=0//y(0)=0;
18 y2=3.62686//y(2)=3.62686
19 y1=(y0+y2)/3;
20 Y=(4*X(2,1)-y1)/3;
21 printf('with better approximation error is reduced
    to %f',abs(Y-f(1.0)));
```

Scilab code Exa 8.17 cubic spline method

```
1 //cubic spline method
2 //example 8.17
```

```

3 //page 330
4 clc;clear;close;
5 deff('y=f(x)', 'y=cos(x)+((1-cos(1))/sin(1))*sin(x)-1
    ');
6 y=[f(0) f(0.5) f(1)];
7 h=1/2;
8 Y=f(0.5);
9 y0=0,y2=0;
10 M0=-1;M1=-22/25;M2=-1;
11 s1_0=47/88;s1_1=-47/88;s1_05=0;
12 printf('the cubic spline value is %f',Y)

```

Scilab code Exa 8.18 cubic spline method

```

1 //cubic spline method
2 //example 8.18
3 //page 331
4 clc;clear;close;
5 //after arranging and forming equation
6 A=[10 -1 0 24;0 16 -1 -32;1 20 0 16;0 1 26 -24];
7 C=[36;-12;24;-9];
8 X=A^-1*C;
9 printf(' Y1=%f\n\n',X(4,1));
10 printf(' the error in the solution is :%f',abs((2/3)
    -X(4,1)))

```

Scilab code Exa 8.19 boundary value problem by cubic spline method

```

1 //boundary value problem by cubisc spline method
2 //example 8.18
3 //page 331
4 clc;clear;close;
5 h=1/2;

```

```
6 //arranging in two subintervals we get
7 A=[10 -1 0 24;0 16 -1 -32;1 20 0 16;0 1 26 -24];
8 C=[36;-12;24;-9];
9 X=A^-1*C
10 printf('the computed value of y(1.5) is %f ',X(4,1))
    ;
```

Chapter 9

Numerical Solution of Partial Differential Equation

Scilab code Exa 9.1 standard five point formula

```
1 //standard five point formula
2 //example 9.1
3 //page 350
4 clc;clear;close;
5 u2=5;u3=1;
6 for i=1:3
7     u1=(u2+u3+6)/4;
8     u2=u1/2+5/2;
9     u3=u1/2+1/2;
10    printf(' the values are u1=%d\t u2=%d\t u3=%d\t \n\n',u1,u2,u3);
11 end
```

Scilab code Exa 9.2 solution of laplace equation by jacobi method gauss seidel met

```
1 //solution of laplace equation by jacobi method,
   gauss-seidel method and SOR method
```

```

2 //example 9.2
3 //page 351
4 clc;clear;close;
5 u1=0.25;u2=0.25;u3=0.5;u4=0.5;//initial values
6 printf('jacobis iteration process\n\n')
7 printf('u1\t      u2\t      u3\t      u4\t      \n\n')
8 printf('%f\t      %f\t      %f\t      %f\t      \n',u1,u2,
      u3,u4)
9 for i=1:7
10     u11=(0+u2+0+u4)/4
11     u22=(u1+0+0+u3)/4;
12     u33=(1+u2+0+u4)/4;
13     u44=(1+0+u3+u1)/4;
14     u1=u11;u2=u22;u3=u33;u4=u44;
15 printf('%f\t      %f\t      %f\t      %f\t      \n',u11,u22
      ,u33,u44)
16 end
17 printf(' gauss seidel process\n\n');
18 u1=0.25;u2=0.3125;u3=0.5625;u4=0.46875;//initial
      values
19 printf('u1\t      u2\t      u3\t      u4\t      \n\n')
20 printf('%f\t      %f\t      %f\t      %f\t      \n',u1,u2,
      u3,u4)
21 for i=1:4
22     u1=(0+u2+0+u4)/4
23     u2=(u1+0+0+u3)/4;
24     u3=(1+u2+0+u4)/4;
25     u4=(1+0+u3+u1)/4;
26     printf('%f\t      %f\t      %f\t      %f\t      \n',u1,
      u2,u3,u4)
27 end
28 printf('u1\t      u2\t      u3\t      u4\t      \n\n')
29 printf('%f\t      %f\t      %f\t      %f\t      \n',u1,u2,
      u3,u4)

```

Scilab code Exa 9.4 poisson equation

```
1 //poisson equation
2 //example 9.4
3 //page 354
4 clc;clear;close;
5 u2=0;u4=0;
6 printf(' u1\t u2\t u3\t u4\t\n\n');
7 for i=1:6
8     u1=u2/2+30;
9     u2=(u1+u4+150)/4;
10    u4=u2/2+45;
11    printf(' %0.2 f\t %0.2 f\t %0.2 f\t %0.2 f\n',
12           u1,u2,u2,u4);
13 end
14 printf(' from last two iterates we conclude u1=67
15        u2=75 u3=75 u4=83\n')
```

Scilab code Exa 9.6 bender schmidt formula

```
1 //bender-schmidt formula
2 //example 9.6
3 //page 362
4 clc;clear;close;
5 deff('y=f(x)', 'y=4*x-x^2');
6 u=[f(0) f(1) f(2) f(3) f(4)];
7 u11=(u(1)+u(3))/2;
8 u12=(u(2)+u(4))/2;
9 u13=(u(3)+u(5))/2;
10 printf(' u11=%0.2 f\t u12=%0.2 f\t u13=%0.2 f\t \n',
11         u11,u12,u13)
12 u21=(u(1)+u12)/2;
13 u22=(u11+u13)/2;
14 u23=(u12+0)/2;
15 printf(' u21=%0.2 f\t u22=%0.2 f\t u23=%0.2 f\t \n',
```

```

        u21,u22,u23)
15 u31=(u(1)+u22)/2;
16 u32=(u21+u23)/2;
17 u33=(u22+u(1))/2;
18 printf(' u31=%0.2 f\t u32=%0.2 f\t u33=%0.2 f\t \n',
        u31,u32,u33)
19 u41=(u(1)+u32)/2;
20 u42=(u31+u33)/2;
21 u43=(u32+u(1))/2;
22 printf(' u41=%0.2 f\t u42=%0.2 f\t u43=%0.2 f\t \n',
        u41,u42,u43)
23 u51=(u(1)+u42)/2;
24 u52=(u41+u43)/2;
25 u53=(u42+u(1))/2;
26 printf(' u51=%0.2 f\t u52=%0.2 f\t u53=%0.2 f\t \n',
        u51,u52,u53)

```

Scilab code Exa 9.7 bender schimdt's formula and crank nicolson formula

```

1 //bender-schmidt's formula and crank-nicolson
  formula
2 //example 9.7
3 //page 363
4 //bender -schmidt's formula
5 clc;clear;close;
6 deff('y=f(x,t)', 'y=exp(-%pi^2*t)*sin(%pi*x)');
7 u=[f(0,0) f(0.2,0) f(0.4,0) f(0.6,0) f(0.8,0) f(1,0)
    ];
8 u11=u(3)/2;u12=(u(2)+u(4))/2;u13=u12;u14=u11;
9 printf(' u11=%f\t u12=%f\t u13=%f\t u14=%f\n\n',
        u11,u12,u13,u14)
10 u21=u12/2;u22=(u12+u14)/2;u23=u22;u24=u21;
11 printf(' u21=%f\t u22=%f\t u23=%f\t u24=%f\n\n',
        u21,u22,u23,u24)
12 printf(' the error in the solution is: %f\n\n',abs(

```

```

        u22-f(0.6,0.04)))
13 //crank-nicolson formula
14 //by putting i=1,2,3,4 we obtain four equation
15 A=[4 -1 0 0 ;-1 4 -1 0;0 -1 4 -1;0 0 -1 4];
16 C=[0.9510;1.5388;1.5388;0.9510];
17 X=A^-1*C;
18 printf( ' u11=%f\t u21=%f\t u31=%f\t u41=%f\t\n\n',X(1,1),X(2,1),X(3,1),X(4,1))
19 printf(' the error in the solution is: %f\n\n',abs(X
    (2,1)-f(0.6,0.04)))

```

Scilab code Exa 9.8 heat equation using crank nicolson method

```

1 //heat equation using crank-nicolson method
2 //example 9.8
3 //page 364
4 clc;clear;close;
5 U=0.01878;
6 //h=1/2;l=1/8,i=1;
7 u01=0;u21=1/8;
8 u11=(u21+u01)/6;
9 printf( ' u11=%f\n\n',u11);
10 printf('error is %f\n\n',abs(u11-U));
11 //h=1/4,l=1/8,i=1,2,3
12 A=[-3 -1 0;1 -3 1;0 1 -3];
13 C=[0;0;-1/8];
14 X=A^-1*C;
15 printf( ' u12=%f\n\n',X(2,1));
16 printf('error is %f\n\n',abs(X(2,1)-U));

```
