Scilab Textbook Companion for Electronic Instrumentation and Measurements by U. A. Bakshi, A. V. Bakshi and K. A. Bakshi[1]

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Book Description

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

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

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

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

Contents

List of Scilab Codes 4

2 Basic Of Measurement And Error Analysis 5

3 Analog and Electronics Instruments 22

4 Digital Instruments 44

5 Measurement of Resistance 49

6 A C Bridges 60

7 Oscilloscopes 92

8 Instrument Calibration 98

List of Scilab Codes

Exa 2.1	Calculate the precision of the 3rd measurement	5
Exa 2.2	Absolute error	6
Exa 2.3	Sensitivity and deflection factor	6
Exa 2.4	Resolution of the scale	7
Exa 2.5	Mean value median value and variance	7
Exa 2.6	Mean and probable error	8
Exa 2.7	Limiting error	9
Exa 2.8	Limiting error	9
Exa 2.9	Percentage relative limiting error	10
Exa 2.10	Uncertainly in combined resistance	10
Exa 2.11	Absolute error	11
Exa 2.12	True value of the voltage	11
Exa 2.13	Resolution of the meter	12
Exa 2.14	New reading	12
Exa 2.15	Apparent resistance	13
Exa 2.16	Magnitude of the resultant resistance	14
Exa 2.17	Magnitude of the limiting error	15
Exa 2.18	Limiting error	15
Exa 2.19	Magnitude of unknown resistance	16
Exa 2.20	Mean and probable error	17
Exa 2.21	Mean and standard deviation	18
Exa 2.22	Mean and range	19
Exa 2.23	Limiting error	20
Exa 2.24	The error	20
Exa 2.25	Range of reading	20
Exa 3.1	Deflecting torque	22
Exa 3.2	Deflection of galvanometer	23
Exa 3.3	Logarithmic decrement	23

Exa 3.4 Shunt resistance 25
Exa 3.5 Current through shunt 25
Exa 3.6 Multirange dc milliammeter 26
Exa 3.7 Value of Current 27
Exa 3.8 Required multiplier resistance 27
Exa 3.9 Required shunt 28
Exa 3.10 Series string of multipliers 28
Exa 3.11 Sensitivity method 29
Exa 3.12 Multiplier resistance 30
Exa 3.13 Sensitivity of the meter 31
Exa 3.14 Accuracy of the meter 31
Exa 3.15 Percentage accuracy 32
Exa 3.16 Multiplier resistance 34
Exa 3.17 Multiplier resistance 34
Exa 3.18 Error in meter reading 35
Exa 3.19 Percentage error in reading 35
Exa 3.20 Series resistance 36
Exa 3.21 Required resistance 36
Exa 3.22 Relative damping 37
Exa 3.23 Error 38
Exa 3.24 Required multiplier to be connected in series 39
Exa 3.25 Values of multiplier 39
Exa 3.26 Universal shunt for a PMMC instrument 40
Exa 3.27 Value of the resistance 41
Exa 3.28 Shunt resistance 41
Exa 3.29 Required shunt 42
Exa 3.30 Magnitude of current 43
Exa 4.1 Resolution and digital output 44
Exa 4.2 Quantizing error 44
Exa 4.3 The value of t2 45
Exa 4.4 Digital output 45
Exa 4.5 Conversion time 46
Exa 4.6 Maximum frequency 46
Exa 4.7 Resolution 47
Exa 4.8 Resolution 47
Exa 5.1 Value of R1 and R2 49
Exa 5.2 Unknown resistance 49
Exa 5.3 Current through galvanometer 50

Exa 5.4	Unknown resistance	51
Exa 5.5	Deflection of galvanometer	51
Exa 5.6	Deflection of galvanometer	52
Exa 5.7	Current through galvanometer	53
Exa 5.8	Unknown resistance	53
Exa 5.9	Temperature	54
Exa 5.10	Required supply voltage	54
Exa 5.11	Maximum unknown resistance	55
Exa 5.12	Required series resistance	56
Exa 5.13	Unknown resistance	56
Exa 5.14	Value of R	57
Exa 5.15	Unknown resistance	58
Exa 5.16	Smallest change in resistance	59
Exa 6.1	Constant of unknown impedence	60
Exa 6.2	Whether or not the bridge is complete balance	61
Exa 6.3	Equivalent series circuit of unknown impedance	62
Exa 6.4	Equivalent series circuit of unknown impedance	62
Exa 6.5	Component of branch BC	63
Exa 6.6	Value of Rx and Lx	64
Exa 6.7	Unknown inductance and resistance	64
Exa 6.8	Unknown capacitance and its dissipation factor	65
Exa 6.9	Equivalent parallel resistance and capacitance	66
Exa 6.10	Distributed capacitance and inductance	66
Exa 6.11	Percentage error in reading	67
Exa 6.12	Self capacitance	68
Exa 6.13	Percentage error	68
Exa 6.14	Self capacitance	69
Exa 6.15	Inductance and self capacitance	69
Exa 6.16	Inductance and self capacitance	70
Exa 6.17	Constant of arm CD	71
Exa 6.18	Equivalent series circuit of unknown impedance	72
Exa 6.19	Constant of arm CD	72
Exa 6.20	Unknown impedence	73
Exa 6.21	Constant of Zx	74
Exa 6.22	Constant of Zx	75
Exa 6.23	Inductance of Rx and Lx at balance	75
Exa 6.24	Unknown parameters in arm AB	76
Exa 6.25	Resistance and inductance of coil	77

Exa 6.26	Resistance and inductance of coil	77
Exa 6.27	Whether or not the bridge is complete balance	78
Exa 6.28	Whether or not the bridge is complete balance	79
Exa 6.29	R L and C constant of arm CD	81
Exa 6.30	Resistance and inductance	82
Exa 6.31	Value of C1 and r1	82
Exa 6.32	Effective impedance of the specimen	83
Exa 6.33	Largest value of Rx and Lx	84
Exa 6.34	Value of R1 and L1	84
Exa 6.35	Capacitance power factor and permittivity	85
Exa 6.36	Capacitance and dielectric loss angle of capacitor	86
Exa 6.37	Self capacitance	87
Exa 6.38	Resistance and inductance of choke coil	87
Exa 6.39	Value of R and C	88
Exa 6.40	Effective impedance of the specimen	89
Exa 6.41	Resistance and inductance of coil	90
Exa 6.42	Value of R and L	90
Exa 7.1	Rise time of the signal	92
Exa 7.2	Bandwidth of CRO	92
Exa 7.3	Amplitude and rms value of sinusoidal voltage	93
Exa 7.4	rms value of voltage	94
Exa 7.5	Phase difference	94
Exa 7.6	Unknown frequency of vertical signal	95
Exa 7.7	Compansating capacitance	95
Exa 7.8	Sampling rate	95
Exa 7.9	Minimum rise time of the pulse	96
Exa 7.10	Frequency of signal	96
Exa 7.11	Parameter of a high impedance probe	97
Exa 8.1	Accuracy	98

Chapter 2

Basic Of Measurement And Error Analysis

Scilab code Exa 2.1 Calculate the precision of the 3rd measurement

```
// Exa 2.1
format('v',6);clc;clear;close;
// Given data
// Values of measurements
x1 = 49;
x2 = 51;
x3 = 52;
x4 = 50;
x5 = 49;
n = 5;// numbers of reading
Xn_bar = (x1+x2+x3+x4+x5)/n;// average value for the
     set of measurements
// For n = 3
P = 1 - abs( (x3-Xn_bar)/x3);// the value of third
   measurement
P = P * 100;// in %
disp(P,"The precision of the 3rd measurement in % is
   ");
```

Scilab code Exa 2.2 Absolute error

```
// Exa 2.2
format('v',6);clc;clear;close;
// Given data
At = 150;// in V
Am = 149;// in V
e = At-Am;//absolute error in V
disp(e,"The absolute error in V is");
e_r = ((At-Am)/At)*100;// e_r stands for %e_r in %
disp(e_r,"The percentage error in % is");
A = 1 - abs( (At-Am)/At );// relative accuracy
disp(A,"The Relative accuracy is");
a = A*100;//Relative accuracy  in %
disp(a,"The percentage accuracy in % is");
fsd = 200;//full scale reading in V
// Percentage error
PerError = ((At-Am)/fsd)*100;// in %
disp(PerError,"Percentage error expressed as
    percentage of full scale reading  in % is");
```

Scilab code Exa 2.3 Sensitivity and deflection factor

```
// Exa 2.4
format('v',7);clc;clear;close;
// Given data
Fullscaledeflection = 30;//full scale deflection in
    cm
n = 30;// number of divisions
scaledivision = Fullscaledeflection/n;//scale
    division in cm
scaledivision = scaledivision * 10;// in mm
```

```
Resolution = (1/20)*scaledivision;// in mm
disp(Resolution,"The Resolution of the scale in mm
    is");
```

Scilab code Exa 2.4 Resolution of the scale

```
// Exa 2.4
format('v',7);clc;clear;close;
// Given data
Fullscaledeflection = 30;//full scale deflection in
    cm
n = 30;// number of divisions
scaledivision = Fullscaledeflection/n;//scale
    division in cm
scaledivision = scaledivision * 10;// in mm
Resolution = (1/20)*scaledivision;// in mm
disp(Resolution,"The Resolution of the scale in mm
    is");
```

Scilab code Exa 2.5 Mean value median value and variance

```
// Exa 2.5
format('v',7);clc;clear;close;
// Given data
// Reported values for average petrol consumption
x= [25.5 30.3 31.1 29.6 32.4 39.4 28.9 30.0 33.3
    31.4 29.5 30.5 31.7 33.0 29.2];
n = 15;// number of reading
sigma_x=0;// initialization of variable
for i=1:1:15
    sigma_x= sigma_x+x(i);// sum of reading
end
Mean =sigma_x/n;// mean value
```

```
disp(Mean,"The mean value is");
sorted_x= gsort(x);
Xmedian = sorted_x((n+1)/2);// median value
disp(Xmedian,"The median value is");
sigma_d_sq=0;
for i=1:1:15
    d(i)=x(i)-Mean
    sigma_d_sq= sigma_d_sq+d(i)*d(i);
end
sigma = round(sqrt( sigma_d_sq/(n-1) ));// standard deviation
disp(sigma,"The standard deviation is");
V = sigma^2;// variance
disp(V,"The variance is");
```

Scilab code Exa 2.6 Mean and probable error

```
// Exa 2.6
format('v',7);clc;clear;close;
// Given data
// Value of readings
x=[147.2 147.4 147.9 148.1 147.7 147.5 147.6 147.4 147.6 147.5]
n = 10;// number of reading
sigma_x=0;// initialization of variable
for i=1:1:n
    sigma_x= sigma_x+x(i);// sum of readings
end
x_bar= sigma_x/n;// mean value
disp(x_bar,"The arthmatic mean is");
sigma_d_sq=0;
for i=1:1:n
    d(i)=x(i)-x_bar;
    sigma_d_sq= sigma_d_sq+d(i)*d(i);
end
```

```
sigma = sqrt( sigma_d_sq/(n-1) );// standard
    deviation
disp(sigma,"The standard deviation is");
// probable error of average of the ten reading
e_m = 0.6745 * ( sigma/(sqrt(n-1)) );
disp(e_m,"The probable error of average of the ten
    reading is");
```

Scilab code Exa 2.7 Limiting error

```
// Exa 2.7
format('v',5);clc;clear;close;
// Given data
Vrange=50;//range of voltmeter in V
V= 15;//instrument reading in V
// Limiting error at full scale
del_A= Vrange*1/100;// in V
// limiting error
PerE= del_A/V*100;// in %
disp(PerE,"The limiting error in % is : ")
```

Scilab code Exa 2.8 Limiting error

```
// Exa 2.8
format('v',6);clc;clear;close;
// Given data
del_a1 = 0.02;// limiting error in current
del_a2 = 0.5;// limiting error in resistor
A1 = 2;
A2 = 120;
e1 = del_a1/A1;
e2 = del_a2/A2;
n = 2;
```

```
// limiting error
e_T = (n*e1)+e2;
e_T_Per= e_T*100;// limiting error in percentage
disp("The limiting error is    "+string(e_T)+" or
    "+string(e_T_Per)+" %")
```

Scilab code Exa 2.9 Percentage relative limiting error

```
// Exa 2.9
format('v',5);clc;clear;close;
// Given data
R1= 15;//value of resistance in
Re1= R1*5/100;//error in resistance in
R2= 33;//value of resistance in
Re2= R2*2/100;//error in resistance in
R3= 75;//value of resistance in
Re3= R3*5/100;//error in resistance in
R_T= R1+R2+R3;//resultant resistance in
R_T_e= Re1+Re2+Re3;//limiting error in resistance in

disp("The resultant is "+string(R_T)+"    with the
    limiting error of "+string(R_T_e)+"   ")
e_T= R_T_e/R_T*100;// in %
disp("The percentage relative limiting error in
    resultant is    "+string(e_T)+" %")
```

Scilab code Exa 2.10 Uncertainly in combined resistance

```
// Exa 2.10
format('v',7);clc;clear;close;
// Given data
R1= 100;//resistance in
Re1= 0.1;//error in
```

```
R2= 50;//resistance in
Re2= 0.03;//error in
R= R1+R2;//resistance in
w= sqrt(Re1^2+Re2^2);
disp("For Series connection , R= "+string(R)+"     "+string(w)+"   ")
R= R1*R2/(R1+R2);// in
del_RbyR1= ((R1+R2)*R2-R1*R2)/(R1+R2)^2;
del_RbyR2= ((R1+R2)*R1-R1*R2)/(R1+R2)^2;
w= sqrt(del_RbyR1^2*Re1^2+del_RbyR2^2*Re2^2);
disp("For Parallel connection , R= "+string(R)+"     "+string(w)+"   ")
```

Scilab code Exa 2.11 Absolute error

```
// Exa 2.11
format('v',5);clc;clear;close;
// Given data
At = 8.5;//true value in A
Am = 8.3;//measured value in A
Absoluteerror = At - Am;//absolute error in A
disp(Absoluteerror,"The Absolute error in A is");
// Relative percentage error
Per_Error = ((At-Am)/At)*100;// %e in %
disp(Per_Error,"The relative percentage error in % is");
```

Scilab code Exa 2.12 True value of the voltage

```
// Exa 2.12
format('v',7);clc;clear;close;
// Given data
Am = 111.5;//measured value in V
```

```
Per_Error = 5.3;// %e in %
// Per_Error = ((At-Am)/At)*100;
At = Am/(1 - (Per_Error/100));//true value of voltage in V
disp(At,"The true value of voltage in V is");
```

Scilab code Exa 2.13 Resolution of the meter

```
// Exa 2.13
format('v',7);clc;clear;close;
// Given data
fullscaledivision = 100;//full scale division in V
n = 200;//number of divisions
scaledivision = fullscaledivision/n;//scale division in V
Resolution = 1/2*scaledivision;// in V
disp(Resolution,"The Resolution of meter in V is");
```

Scilab code Exa 2.14 New reading

```
// Exa 2.14
format('v',6);clc;clear;close;
// Given data
V = 150;//voltage in V
R1 = 50;//resistance in k ohm
R2 = 100;//resistance in k ohm
V_AB = R1 * (V/(R1+R2));// in V
sensitivity = 1;// in k ohm/V
R = sensitivity*V_AB;// in  k ohm
V_AB1 = ((R1*R)/(R1+R))*( V/(R2+(R1*R)/(R1+R)) );//voltage reading on the voltmeter  in V
disp("Part (i) When voltmeter sensitivity is 1 k  / volt : ")
```

```
disp(V_AB1,"The voltage reading on the voltmeter in
   V is : ")
Per_Error= ((V_AB-V_AB1)/V_AB)*100;// %e in %
disp(Per_Error,"The percentage error in % is : ")
sensitivity = 25;// in  k ohm/V
R = sensitivity*V_AB;// in k ohm
Rnet = (R1*R)/(R1+R);// assumed for calculation
V_AB2 = Rnet*( V/(R2+Rnet) );// in V
disp("Part (ii) When voltmeter sensitivity is 25 k
   /volt : ")
disp(V_AB2,"The voltage reading on the voltmeter in
   V is : ")
Per_Error = ((V_AB-V_AB2)/V_AB)*100;// %e in %
disp(Per_Error,"The percentage error in % is : ")
disp("Thus the voltmeter with low sensitivity shows
   more error");
disp(" while voltmeter with high sensitivity shows
   less error.")
```

Scilab code Exa 2.15 Apparent resistance

```
// Exa 2.15
format('v',6);clc;clear;close;
// Given data
V = 80;// in V
I = 15;// in mA
I = I * 10^-3;// in A
R_T = V/I;// in ohm
R_T = R_T * 10^-3;//apparent resistance in k ohm
Rapp = R_T;// in k ohm
disp(Rapp,"The apparent resistance in k  is");
sensitivity = 1.5;// in k ohm
f_s_reading = 150;//full scale reading in V
Rv = sensitivity*f_s_reading;// in k ohm
//R_T = (Rx*Rv)/(Rx+Rv);
```

```
Rx = (R_T*Rv)/(Rv-R_T);//Actual resistance of
    unknown resistor in k ohm
disp(Rx,"Actual resistance of unknown resistor in
    k  is");
At = Rx;// in k ohm
Am = Rapp;// in k ohm
PerError = ((At-Am)/At)*100;//Error due to loading
    effect of voltmeter  in %
disp(PerError,"Error due to loading effect of
    voltmeter in % is");
PerAccu = (1-abs(PerError*10^-2))*100;//Percentage
    relative accuracy  in %
disp(PerAccu,"Percentage relative accuracy in % is")
    ;
```

Scilab code Exa 2.16 Magnitude of the resultant resistance

```
// Exa 2.16
format('v',7);clc;clear;close;
// Given data
// Values of resistance
R1 = 200;// in ohm
R2 = 100;// in  ohm
R3 = 50;// in ohm
R_T = R1+R2+R3;//resultant resistance in ohm
// Error in resistance
e1 = 5;// in %
e2 = e1;// in %
e3 = e1;// in %
a1 = R1;// in ohm
a2 = R2;// in ohm
a3 = R3;// in ohm
Per_e_T = ( ((R1/R_T)*e1) + ((R2/R_T)*e2) + ((R3/R_T
    )*e3) );// in %
// Per_e_T= del_R_T/R_T*100;
```

```
del_R_T= Per_e_T*R_T/100;// in
disp(R_T,"The magnitude of the resultant resistance in    is : ")
disp("The limiting error (in percentage) is :    "+string(Per_e_T)+" %")
disp("The limiting error (in ohm) is :    "+string(del_R_T)+"   ")
```

Scilab code Exa 2.17 Magnitude of the limiting error

```
// Exa 2.17
format('v',7);clc;clear;close;
// Given data
// Values of resistances
R1 = 36;// in ohm
R2 = 75;// in ohm
R_T = (R1*R2)/(R1+R2);// in ohm
// Error in resistance
e1 = 5;// in %
e_1 = e1+e1;// in %      assumed
e2 = ( ((R1/(R1+R2))*e1) + ((R2/(R1+R2))*e1) );// in %
e_T = e_1+e2;//limiting error  in %
// Per_e_T= del_R_T/R_T*100;
del_R_T= e_T*R_T/100;//limiting error in
disp("The limiting error (in percentage) is :    "+string(e_T)+" %")
disp("The limiting error (in ohm) is :    "+string(del_R_T)+"   ")
```

Scilab code Exa 2.18 Limiting error

```
// Exa 2.18
```

```
format('v',7);clc;clear;close;
// Given data
Error = 2/100;
Voltmeterrange = 50;//voltmeter range in V
Ammeterrange = 125;//ammeter range in mA
A1 = 40;//voltmeter reading in V
A2 = 125;//ammeter reading in mA
del_a1 = Error*Voltmeterrange;// in V
del_a2 = Error*Ammeterrange;// in mA
e1 =  del_a1/A1;// error in voltage
e2 = del_a2/A2;// error in current
e_T= (e1+e2)*100;//limiting error of the power
    calculated  in %
disp("The limiting error of the power calculated is
    :    "+string(e_T)+" %")
```

Scilab code Exa 2.19 Magnitude of unknown resistance

```
// Exa 2.19
format('v',7);clc;clear;close;
// Given data
R1 = 120;//resistance in ohm
e1= 0.1;//error in %
R2 = 2700;//resistance in ohm
e2= 0.5;//error in %
R3 = 470;//resistance in ohm
e3= 0.5;//error in %
Rx = (R2*R3)/R1;//magnitude of the unknown
    resistance in ohm
disp(Rx,"The magnitude of the unknown resistance in
       is : ")
e_T= e1+e2+e3;//limiting error  in %
// Per_e_T= del_R_T/R_T*100;
del_Rx= e_T*Rx/100;//limiting error  in
disp("The limiting error (in percentage) is :    "+
```

```
string(e_T)+" %")
disp("The limiting error (in ohm) is :    "+string(
    del_Rx)+"    ")
disp("Hence the guaranteed values of the resistance
    is between")
disp(string(Rx-del_Rx)+"    to "+string(Rx+del_Rx)+"
    ")
```

Scilab code Exa 2.20 Mean and probable error

```
// Exa 2.20
format('v',7);clc;clear;close;
// Given data
x=[101.2 101.4 101.7 101.3 101.3 101.2 101.0 101.3
    101.5 101.1];// measured value
n = 10;// number of reading
sigma_x= 0;// initialization of variable
for i=1:1:n
    sigma_x= sigma_x+x(i);// sum of readings
end
x_bar=sigma_x/n;// mean value
disp(x_bar,"The arithmatic mean is");
sigma_d_sq=0;// initialization of variable
sigma_d=0;// initialization of variable
for i=1:1:n
    d(i)=x(i)-x_bar
    sigma_d= sigma_d+abs(d(i));
    sigma_d_sq= sigma_d_sq+d(i)*d(i);
end
DevFrommean =sigma_d/n;// Deviation from mean
disp(DevFrommean,"The Deviation from mean is");
sigma = sqrt( sigma_d_sq/(n-1) );//standard
    deviation in V
disp(sigma,"The standard deviation in V is");
ProError= 0.6745*sigma;//probable error of one
```

```
reading in V
disp(ProError,"The probable error of one reading in V is : ")
ProError = 0.6745*sigma;// in V
e_m = ProError/( sqrt(n-1) );// probable error of mean
disp(e_m,"The probable error of mean is : ");
```

Scilab code Exa 2.21 Mean and standard deviation

```
// Exa 2.21
format('v',7);clc;clear;close;
// Given data
x= [29.6 32.4 39.4 28.9 30.0 33.3 31.4 29.5 30.5 31.7 33.0 29.2];// measured value
n = 12;// number of reading
sigma_x= 0;// initialization of variable
for i=1:1:n
    sigma_x= sigma_x+x(i);// sum of readings
end
x_bar=sigma_x/n;// mean value
disp(x_bar,"The mean value is");
sorted_x= gsort(x);
x_median= (sorted_x(n/2)+sorted_x(n/2+1))/2;// median value
disp(x_median,"The median value is : ")
sigma_d_sq=0;
for i=1:1:n
    d(i)=x(i)-x_bar
    sigma_d_sq= sigma_d_sq+d(i)*d(i);
end
sigma = sqrt( sigma_d_sq/(n-1) );//standard deviation in V
disp(sigma,"The standard deviation in V is");
```

Scilab code Exa 2.22 Mean and range

```
// Exa 2.22
format('v',7);clc;clear;close;
// Given data
x= [41.7 42.0 41.8 42.0 42.1 41.9 42.0 41.9 42.5
   41.8];// measured value
n = 10;// number of reading
sigma_x= 0;// initialization of variable
for i=1:1:n
    sigma_x= sigma_x+x(i);// sum of reading
end
x_bar=sigma_x/n;// mean
disp(x_bar,"The mean is");
sigma_d_sq=0;
for i=1:1:n
    d(i)=x(i)-x_bar
    sigma_d_sq= sigma_d_sq+d(i)*d(i);
end
sigma = sqrt( sigma_d_sq/(n-1) );//standard
   deviation in V
disp(sigma,"The standard deviation in V is");
ProError= 0.6745*sigma;//probable error of one
   reading in V
disp(ProError,"The probable error of one reading in
   V is : ")
ProError = 0.6745*sigma;// in V
e_m = ProError/( sqrt(n-1) );// probable error of
   mean
disp(e_m,"The probable error of mean is : ");
sorted_x= gsort(x);
Range= sorted_x(1)-sorted_x(n);// range
disp("Range = "+string(sorted_x(n))+" to "+string(
   sorted_x(1))+" = "+string(Range))
```

Scilab code Exa 2.23 Limiting error

```
// Exa 2.23
format('v',7);clc;clear;close;
// Given data
Vrange= 600;//range in V
del_A= 2.5*Vrange/100;//limiting error at full scale in V
V= 400;//voltage in V
PerError= del_A/V*100;//percentage error in %
disp("The limiting error is :    "+string(PerError)+" %")
```

Scilab code Exa 2.24 The error

```
// Exa 2.24
format('v',7);clc;clear;close;
// Given data
At = 6.54;//true value in A
Am = 6.7;//measured value in A
AbsError = At-Am;// absolute error
PerError= ((At-Am)/At)*100;// percentage error
disp(PerError,"The error in % is");
```

Scilab code Exa 2.25 Range of reading

```
// Exa 2.25
format('v',7);clc;clear;close;
// Given data
```

```
Wrange= 500;//wattmeter range in W
del_A= 1.5*Wrange/100;//limiting error at full scale
    in W
P= 50;//power in W
Pmin= P-del_A;// minimum power in W
Pmax= P+del_A;// maximum power in W
disp("The range of the reading is : "+string(Pmin)+"
    watts to "+string(Pmax)+" watts");
```

Chapter 3

Analog and Electronics Instruments

Scilab code Exa 3.1 Deflecting torque

```
// Exa 3.1
format('v',7);clc;clear;close;
// Given data
N = 100;// number o turns
B = 0.15;//air gap in Wb/m^2
I = 5;//current in mA
I = I * 10^-3;// in A
l= 10;//length in mm
b = 8;//width in mm
A = l*b;//area in mm^2
A = A * 10^-6;// in m^2
Td = N*B*A*I;//deflecting torque in Nm
K = 0.2*10^-6;// in Nm/degree
// Td = Tc= K*theta;
theta = Td/K;//deflecting in degrees
disp(theta,"The deflecting in degrees is");
```

Scilab code Exa 3.2 Deflection of galvanometer

```
// Exa 3.2
format('v',7);clc;clear;close;
// Given data
B = 8*10^-3;//flux density in Wb/m^2
N = 300;// number of turns
l = 15;//length in mm
r = 30;//radius in mm
K = 2.5*10^-9;//spring constant in Nm/rad
J = 10*10^-9;// in kg-m^2
D = 2*10^-9;// in Nm/rads^-1
Rg = 80;// in ohm
A = l*r;// in mm^2
A = A * 10^-6;// in m^2
G = N*B*A;// in Nm/A
i = 1;// in  A
i = i * 10^-6;// in A
theta_f = (G*i)/K;// in rad
r = 1;// in m
r = r * 10^3;// in mm
d = 2*theta_f*r;//deflection of galvanometer  in mm
disp(d,"The deflection of galvanometer in mm is");
Si = d/i;// in mm/A
Si = Si * 10^-6;//Current sensitivity in mm/ A
disp(Si,"Current sensitivity in mm/ A is");
```

Scilab code Exa 3.3 Logarithmic decrement

```
// Exa 3.3
format('v',7);clc;clear;close;
// Given data
B = 10*10^-3;// in Wb/m^2
N = 200;// in turns
l = 16;// in mm
```

```
K = 12*10^-9;// in Nm/rad
J = 50*10^-9;// in kg-m^2
D = 5*10^-9;// in Nm/rads^-1
R = 120;// in ohm
A = 1^2;// in mm^2
A = A * 10^-6;// in m^2
G = N*B*A;// in Nm/A
i = 1;// in  A
i = i * 10^-6;// in A
theta_f = (G*i)/K;// in rad
r = 1;// in m
r = r * 10^3;// in mm
// deflection of the galvanometer
d = 2*theta_f*r;// in mm
disp(d,"The deflection of the galvanometer in mm is");
i = i * 10^6;// in  A
// Current sensitivity
Si = d/i;// in mm/ A
disp(Si,"The current sensitivity in mm/ A is");
// Voltage sensitivity
Sv = d/(i*R);// in mm/ V
disp(Sv,"The voltage sensitivity in mm/ V is");
So = d/(i*10^-6*10^6);//megaohm sensitivity in Mohm/mm
disp(So,"The megaohm sensitivity in Mohm/mm is");
omega_d = (sqrt((4*J*K) - ((D)^2)))/(2*J);// in rad/sec
f_d = omega_d/(2*%pi);//frequency of damped oscillation in Hz
disp(f_d,"The frequency of damped oscillation in Hz is");
omega_n = sqrt(K/J);
// period of free oscillation
To = (2*%pi)/omega_n;// in sec
disp(To,"The period of free oscillation in sec is");
Dc = 2*sqrt( J*K );
// The relative damping
```

```
Epsilon = D/Dc;
disp(Epsilon,"The relative damping is");
// The first maximum deflection
theta1 = theta_f * ( 1 + (%e^(-%pi*Epsilon)/(sqrt(1 - ((Epsilon)^2)))) );// in rad
theta1 = theta1*2*r;// in mm
disp(theta1,"The first maximum deflection in mm is");
// The logarithmic decrement
lembda = (%pi*Epsilon)/(sqrt(1 - ((Epsilon)^2)));
disp(lembda,"The logarithmic decrement is");
```

Scilab code Exa 3.4 Shunt resistance

```
// Exa 3.4
format('v',7);clc;clear;close;
// Given data
Rm = 100;//internal resistance in ohm
Im = 2;// in mA
Im = Im * 10^-3;// in A
I = 150;// in mA
I = I * 10^-3;// in A
Rsh = (Im*Rm)/(I-Im);//shunt resistance in ohm
disp(Rsh,"The value of shunt resistance in ohm is");
// Note: The calculation in the book is wrong.
```

Scilab code Exa 3.5 Current through shunt

```
// Exa 3.5
format('v',7);clc;clear;close;
// Given data
Rsh = 0.01;//shunt resistance in ohm
```

```
Rm = 750;//resistance in ohm
Vm= 400*10^-3;//voltage in V
Ish = 50;//current in A
// Ish*Rsh = voltagedrop;
Ish = Vm/Rsh;//current through shunt  in A
disp(Ish,"The current through shunt in A is");
Ish=50;// in A
Vsh = Ish*Rsh;// in V
Im = Vm/Rm;// in A
// Im*R_m = Vsh;
R_m = Vsh/Im;//resistance of meter in ohm
disp(R_m,"The resistance of meter in    is");
```

Scilab code Exa 3.6 Multirange dc milliammeter

```
// Exa 3.6
format('v',7);clc;clear;close;
// Given data
// The first range is 0-10 mA
I1 = 10;//in mA
Im = 2;// in mA
Rm = 75;// in ohm
R1 = (Im*Rm)/(I1-Im);// in ohm
disp(R1,"The value of R1 in ohm is");
// Second range is 0-50 mA
I2 = 50;// in mA
R2 = (Im*Rm)/(I2-Im);// in ohm
disp(R2,"The value of R2 in ohm is");
// The third range is 0-100 mA
I3 = 100;// in mA
R3 = (Im*Rm)/(I3-Im);// in ohm
disp(R3,"The value of R3 in ohm is");
```

Scilab code Exa 3.7 Value of Current

```
// Exa 3.7
format('v',7);clc;clear;close;
// Given data
I1 = 10;// in A
Im = 1*10^-3;// in A
Rm = 50;// in ohm
I2 = 5;// in A
I3 = 1;// in A
// I1*R1= Im*(R2+R3+Rm) or I1*R1 - Im*R2 - Im*R3 =
    Im*Rm          (i)
// I2*(R1+R2) = Im*(R3+Rm) or I2*R1 + I2*R2 - Im*R3
    = Im*Rm       (ii)
// I3*(R1+R2+R3) = Im*Rm or I3*R1 + I3*R2 + I3*R3 =
    Im*Rm                (iii)
// Solving eq (i),(ii) and (iii) by matrix method :
A= [I1 I2 I3;-Im I2 I3;-Im -Im I3];
B= [Im*Rm Im*Rm Im*Rm];
R= B*A^-1;
R1= R(1);//value of R1 in ohm
R2= R(2);//value of R2 in ohm
R3= R(3);//value of R3 in ohm
disp(R1,"The value of R1 in ohm is : ")
disp(R2,"The value of R2 in ohm is : ")
disp(R3,"The value of R3 in ohm is : ")
```

Scilab code Exa 3.8 Required multiplier resistance

```
// Exa 3.8
format('v',7);clc;clear;close;
// Given data
Rm = 500;//resistance of meter in ohm
Im = 40;//current in  A
Im = Im * 10^-6;// in A
```

```
V = 10;//voltage in V
// The required multiplier resistance
Rs = (V/Im)-Rm;// in ohm
Rs = Rs * 10^-3;// in k ohm
disp(Rs,"The required multiplier resistance in k is");
```

Scilab code Exa 3.9 Required shunt

```
// Exa 3.9
format('v',7);clc;clear;close;
// Given data
Im = 20;//current in mA
Vm = 200;//voltage in mV
// Vm = Im*Rm;
Rm = Vm/Im;//resistance in ohm
I = 200;// in A
Im = Im * 10^-3;// in A
Rsh = (Im*Rm)/(I-Im);//required shunt resistance in ohm
disp(Rsh,"The required shunt resistance in  is");
V = 500;// in V
Rs = (V/Im)-Rm;//required multiplier resistance in ohm
Rs = Rs * 10^-3;// in k ohm
disp(Rs,"The required multiplier resistance in k is");
```

Scilab code Exa 3.10 Series string of multipliers

```
// Exa 3.10
format('v',7);clc;clear;close;
// Given data
```

```
Rm = 50;//resistance of meter in ohm
Im = 2;//current in mA
Im = Im * 10^-3;// in A
V4 = 10;//voltage in V
R4 = (V4/Im) - Rm;// in ohm
R4= R4*10^-3;// in k ohm
disp(R4,"The value of R4 in k  is");
R4= R4*10^3;// in ohm
V3 = 50;// in V
// (R3+R4) = (V3/Im) - Rm;
R3 = (V3/Im) - Rm-R4;// in ohm
R3= R3*10^-3;// in k ohm
disp(R3,"The value of R3 in k  is");
R3= R3*10^3;// in ohm
V2 = 100;// in V
//(R2+R3+R4) = (V2/Im) - Rm;
R2 = (V2/Im) - Rm - R3 - R4;// in ohm
R2= R2*10^-3;// in k ohm
disp(R2,"The value of R2 in k  is");
R2= R2*10^3;// in ohm
V1 = 500;// in V
// (R1+R2+R3+R4) = (V1/Im) - Rm;
R1 = (V1/Im) - Rm - R4 - R3 - R2;// in ohm
R1= R1*10^-3;// in k ohm
disp(R1,"The value of R1 in k  is");
```

Scilab code Exa 3.11 Sensitivity method

```
// Exa 3.11
format('v',7);clc;clear;close;
// Given data
Rm = 50;//meter resistance in ohm
Im = 2;//current in mA
Im = Im * 10^-3;// in A
S = 1/Im;//sensitivity in ohm/V
```

```
// Voltage ranges
V1 = 500;// in V
V2 = 100;// in V
V3 = 50;// in V
V4 = 10;// in V
R4 = (S*V4) - Rm;// in ohm
R4= R4*10^-3;// in k ohm
disp(R4,"The value of R4 in k   is");
R4= R4*10^3;// in ohm
R3 = (S*V3) - (Rm+R4);// in ohm
R3= R3*10^-3;// in k ohm
disp(R3,"The value of R3 in k  is");
R3= R3*10^3;// in ohm
R2 = (S*V2) - (Rm+R4+R3);// in ohm
R2= R2*10^-3;// in k ohm
disp(R2,"The value of R2 in k  is");
R2= R2*10^3;// in ohm
R1 = (S*V1) - (Rm+R2+R3+R4);// in ohm
R1= R1*10^-3;// in k ohm
disp(R1,"The value of R1 in k  is");
```

Scilab code Exa 3.12 Multiplier resistance

```
// Exa 3.12
format('v',7);clc;clear;close;
// Given data
Im = 50;//current in  A
Im = Im * 10^-6;// in A
S = 1/Im;// in ohm/V
V = 500;// in V
Rm = 200;//internal resistance in ohm
Rs = (S*V) - Rm;//multiplier resistance in ohm
Rs = Rs * 10^-6;// in Mohm
disp(Rs,"The value of multiplier resistance in M
   is");
```

Scilab code Exa 3.13 Sensitivity of the meter

```
// Exa 3.13
format('v',7);clc;clear;close;
// Given data
Rs = 25;//resistance in k ohm
Rs = Rs * 10^3;// in ohm
Rm = 1;//meter resistance in k ohm
Rm = Rm * 10^3;// in k ohm
V = 100;//voltage in V
// Rs = (S*V) - Rm;
S = (Rs+Rm)/V;//sensitivity in ohm/V
disp("For meter A:  The value of S is : "+string(S)+
    "  /V")
Rs = 150;// in  k ohm
Rs = Rs * 10^3;// in ohm
V = 1000;// in V
// Rs = (S*V) - Rm;
S = (Rs+Rm)/V;// in ohm/V meter B
disp("For meter B:  The value of S is : "+string(S)+
    "  /V")
disp("The meter A is more sensitive than meter B")
```

Scilab code Exa 3.14 Accuracy of the meter

```
// Exa 3.14
format('v',7);clc;clear;close;
// Given data
// Case (i): When voltmeter having a sensitivity of
    500  /V
R1 = 20;// in k ohm
```

```
R2 = 25;// in k ohm
Vdc = 250;// in V
V = (Vdc/(R1+R2))*R2;// in V
Vrange = 150;// in V
S = 500;// in ohm/V
R_V = S*Vrange;// in ohm
R_V = R_V * 10^-3;// in k ohm
Req = (R2*R_V)/(R2+R_V);// in k ohm
V = (Req/(Req+R1))*Vdc;// in V voltmeter first
disp("Case (i): When voltmeter having a sensitivity of 500  /V")
disp("                    The voltmeter will reads : "+string(V)+" V");
// Case (ii): When voltmeter having a sensitivity of 1000  /V
S = 10000;// in ohm/V
R_V = S*Vrange;// in ohm
R_V = R_V * 10^-3;// in k ohm
Req = (R2*R_V)/(R2+R_V);// in k ohm
V = (Req/(Req+R1))*Vdc;// in V  Voltmeter second
disp("Case (ii): When voltmeter having a sensitivity of 1000  /V")
disp("                    The voltmeter will reads : "+string(V)+" V");
disp("Thus the second voltmeter reads more accurately.")
```

Scilab code Exa 3.15 Percentage accuracy

```
// Exa 3.15
format('v',6);clc;clear;close;
// Given data
Ra = 5;// in k ohm
Rb = 1;// in k ohm
V = 25;// in V
```

```
Vrange = 5;// in V
S = 1;// in k ohm/V
// True voltage across Rb
Vb = (Rb/(Ra+Rb))*V;// in V
disp(Vb,"The true voltage across Rb in V is");
R_V = S*Vrange;// in k ohm
Req = (Rb*R_V)/(Rb+R_V);// in k ohm
V1 = (Req/(Req+Ra))*V;//reading on the voltmeter 1 in V
disp(V1,"The reading on the voltmeter 1 in V is");
S = 20;// in k ohm/V
R_V = S*Vrange;// in k ohm
Req = (Rb*R_V)/(Rb+R_V);// in k ohm
V2 = (Req/(Ra+Req))*V;//reading on the voltmeter 2 in V
disp(V2,"The reading on the voltmeter 2 in V is");
PerError1 = ((Vb-V1)/Vb)*100;//percentage error in meter 1 in %
disp(PerError1,"The percentage error in meter 1 in % is");
PerError2 = ((Vb-V2)/Vb)*100;//percentage error in meter 2 in %
disp(PerError2,"The percentage error in meter 2 in % is");
PerAccuracy1 = 100 - PerError1;//percentage accuracy of meter 1 in %
disp(PerAccuracy1,"The percentage accuarcy of meter 1 in % is");
PerAccuracy2 = 100-PerError2;//percentage accuracy of meter 2 in %
disp(PerAccuracy2,"The percentage accuracy of meter 2 in % is");
disp("Thus voltmeter 2 is "+string(PerAccuracy2)+" % accurate while voltmeter 1 is "+string(PerAccuracy1)+" % accurate")
```

Scilab code Exa 3.16 Multiplier resistance

```
// Exa 3.16
format('v',7);clc;clear;close;
// Given data
Erms = 10;//r.m.s. range of the voltmeter in V
Ep = sqrt(2)*Erms;// in V
Eav = 0.6*Ep;// in V
Eav = 9;// in V
Eavoutput = (1/2)*Eav;// in V
Edc = 0.45*Erms;// in V
Idc = 1;// in mA
Idc = Idc * 10^-3;// in A
Rm = 200;// in W
Rs = (Edc/Idc) - Rm;//required multiplier resistance
    in ohm
Rs = Rs * 10^-3;// in k ohm
disp(Rs,"The required multiplier resistance in k
   is");
```

Scilab code Exa 3.17 Multiplier resistance

```
// Exa 3.17
format('v',7);clc;clear;close;
// Given data
Idc = 2;//dc current in mA
Idc = Idc * 10^-3;// in A
Rm = 500;//meter resistance in ohm
Erms = 10;//r.m.s value in v
Eav = 9;//average value in V
Edc = 0.9*Erms;//dc voltage in V
Rs = (Edc/Idc) - Rm;//multiplier resistance in ohm
```

```
Rs = Rs * 10^-3;// in k ohm
disp(Rs,"The multiplier resistance in k  is");
```

Scilab code Exa 3.18 Error in meter reading

```
// Exa 3.18
format('v',7);clc;clear;close;
// Given data
Kf_true = 1;// true value of form factor
Kf_measured= 1.11;// measured value of form factor
PerError = ((Kf_true-Kf_measured)/Kf_true)*100;//
    percentage error in the meter reading in %
disp(PerError,"The percentage error in the meter
    reading in % is");
```

Scilab code Exa 3.19 Percentage error in reading

```
// Exa 3.19
format('v',5);clc;clear;close;
// Given data
V1 = 100;// in V
V2 = 0;// in V
e1= 0;// in V
e2= 100;// in V
T=2;// in sec
T1 = 0;// in sec
T2 = 2;// in sec
// Slope of ramp
A= (e2-e1)/(T2-T1);// in V/sec
e= 'A*t';// in sec
Erms= sqrt(1/T*integrate('(A*t)^2','t',0,T));// in V
Eav= 1/T*integrate('(A*t)','t',0,T);// in V
Kf= Erms/Eav;// form factor
```

```
Kf_sine= 1.11;// form factor of sine wave
True_reading= 1;// true reading
Meas_reading= Kf_sine/Kf;// measured reading
PerError= (True_reading-Meas_reading)/True_reading
    *100;//percentage error in the reading in %
disp(PerError,"The percentage error in the reading
    in % is : ")
```

Scilab code Exa 3.20 Series resistance

```
// Exa 3.20
format('v',7);clc;clear;close;
// Given data
Erms = 200;//r.m.s value in V
Rm = 100;//meter resistance in ohm
Idc = 25;//dc current in mA
Idc= Idc*10^-3;// in A
Rf = 500;// in ohm
R_D = 2*Rf;// in ohm
Edc = 0.9*Erms;// in V
Rs = (Edc/Idc) - Rm;// in ohm
R_m = Rm+R_D;// in ohm
Rs = (Edc/Idc) - R_m;//required series resistance in
     ohm
disp(Rs,"The required series resistance in    is");
```

Scilab code Exa 3.21 Required resistance

```
// Exa 3.21
format('v',7);clc;clear;close;
// Given data
r = 2;//radius in m
r = r * 10^3;// in mm
```

```
d = 200;//deflection in mm
To = 3.1415;// in sec
J = 2*10^-6;// in kg-m^2
i = 1;// in  A
i = i * 10^-6;// in A
// d = 2*r*theta_f;
theta_f = d/(2*r);// in rad
// To = 2*%pi * (sqrt( J/K ));
K = 4*%pi^2*J/To^2;// in Nm/A
// theta_f = (G*i)/K;
G = (theta_f*K)/i;// in Nm/A
// The required resistance to obtain critical
   damping
Rc = G^2/( 2*sqrt(J*K));// in ohm
Rc = Rc * 10^-3;// in k ohm
disp(Rc,"The required resistance to obtain critical
   damping in k  is");
```

Scilab code Exa 3.22 Relative damping

```
// Exa 3.22
format('v',6);clc;clear;close;
// Given data
theta1 = 128;//first maximum deflection in mm
theta3 = 90;//second maximum deflection in mm
theta_f = 70;// in mm
i = 6.2;// in  A
// The current sensitivity
Si = theta_f/i;// in mm/ A
disp(Si,"The current sensitivity in mm/ A is");
// The logarithmic decrement
// Formula %e^(2*lambda)= (theta1-thetaf)/(theta3-
   thetaf)
lembda = log((theta1-theta_f)/(theta3-theta_f) )
   *(1/2);
```

```
disp(lembda,"The logarithmic decrement is");
// lembda = (%pi*sie)/(sqrt( 1-((sie)^2) ));
// ((lembda/%pi)^2) = ((sie)^2)/(sqrt( 1-((sie)^2) ));
sie = lembda/sqrt(lembda^2+%pi^2);// the relative damping
disp(sie,"The relative damping is");
```

Scilab code Exa 3.23 Error

```
// Exa 3.23
format('v',5);clc;clear;close;
// Given data
I = 100;// in mA
Im = 1;// in mA
Rm = 25;// in ohm
// m = I/Im = 1 + Rm/Rsh;
Rsh = Rm/((I/Im) - 1);// in ohm
del_t = 10;// in  C
Alpha_c = 0.004;
Alpha_m = 0.00015;
// When temperature increase by 10  C
R_m = Rm * ( 1 + (Alpha_c*del_t) );// in ohm
R_sh = Rsh * (1 + (Alpha_m*del_t));// in ohm
// When I= 100 mA then
I_m = (R_sh/(R_sh+R_m))*I;// in mA
// But Im required for full scale deflection
PerEerror= ((I_m-Im)/Im)*100;// in %
disp("Part (i) ");
disp(PerEerror,"The percentage error in % is");
Rx = 75;// in ohm
Rtotal = Rm+Rx;// in ohm
Rsh = Rtotal/((I/Im) - 1);// in ohm
//R_total =R_m+R_x;
R_total = R_m + (Rx*(1+(Alpha_m*del_t)));// in ohm
```

```
R_sh = Rsh * (1+( Alpha_m*del_t ));// in ohm
I_m = (R_sh/(R_sh+R_total))*I;// in mA
PerEerror = ((I_m-Im)/Im)*100;//percentage error in
    %
disp("Part (ii) ");
disp(PerEerror,"The percentage error in % is");
```

Scilab code Exa 3.24 Required multiplier to be connected in series

```
// Exa 3.24
format('v',7);clc;clear;close;
// Given data
Im =25;//current in mA
Im = Im * 10^-3;// in A
Rm = 10;//resistance in ohm
I = 20;// in A
Rsh = (Im*Rm)/(I-Im);//shunt resistance in ohm
disp(Rsh,"The value of Rsh in    is");
V = 120;// in V
Rs = (V/Im)-Rm;// in ohm
disp(Rs,"The value of Rs in    is");
```

Scilab code Exa 3.25 Values of multiplier

```
// Exa 3.25
format('v',7);clc;clear;close;
// Given data
Vm = 10;// in mV
Vm = Vm * 10^-3;// in V
Rm = 1;// in k ohm
Rm = Rm * 10^3;// in ohm
Im = Vm/Rm;// in A
// Part (i) : For the range of 100 mV
```

```
Vrange = 100;// in mV
Vrange = Vrange * 10^-3;// in V
Rs = (Vrange/Im) - Rm;// in ohm
Rs= Rs*10^-3;// in kohm
disp("Part (i) For the range of 100 mV")
// Part (ii) : For the range of 1 V
disp(Rs,"The value of Rs in k  is");
Vrange = 1;// in V
Rs = (Vrange/Im) - Rm;// in ohm
Rs= Rs*10^-3;// in kohm
disp("Part (i) For the range of 1V")
disp(Rs,"The value of Rs in k  is");
```

Scilab code Exa 3.26 Universal shunt for a PMMC instrument

```
// Exa 3.26
format('v',7);clc;clear;close;
// Given data
Vm = 0.1;//full scale deflection voltage in V
Rm = 20;//meter resistance in ohm
Im = Vm/Rm;//current in A
I1= 10;// in A
I2= 1;// in A
I3= 100*10^-3;// in A
// I1*R1 = Im*(R2+R3+Rm) or   I1*R1 - Im*R2 - Im*R3
    = Im*Rm        (i)
// I2*(R1+R2) = Im*(R3+Rm) or I2*R1 + I2*R2 -Im*R3 =
     Im*Rm       (ii)
// I3*(R1+R2+R3) = Im*Rm or   I3*R1 + I3*R2 + I3*R3
    = Im*Rm      (iii)
A= [I1 I2 I3;-Im I2 I3;-Im -Im I3];
B= [Im*Rm Im*Rm Im*Rm];
R= B*A^-1;// Solving equation (i), (ii) and (iii) by
     matrix method
R1= R(1);// in ohm
```

```
R2= R(2);// in ohm
R3= R(3);// in ohm
disp(R1,"The value of R1 in ohm is : ")
disp(R2,"The value of R2 in ohm is : ")
disp(R3,"The value of R3 in ohm is : ")
```

Scilab code Exa 3.27 Value of the resistance

```
// Exa 3.27
format('v',7);clc;clear;close;
// Given data
Im = 10;//current in mA
Im = Im * 10^-3;// in A
Rm = 50;//meter resistance in ohm
I = 5;// in A
// Value of resistance to be connected in parallel
Rsh = (Im*Rm)/(I-Im);// in ohm
disp(Rsh,"The value of resistance to be connected in
    parallel in    is");
V = 250;// in V
// The value of resistance to be connected in series
Rs = (V/Im) - Rm;// in ohm
disp(Rs,"The value of resistance to be connected in
   series in    is");
```

Scilab code Exa 3.28 Shunt resistance

```
// Exa 3.28
format('v',6);clc;clear;close;
// Given data
Im = 1;// in mA
Im = Im * 10^-3;// in A
Rm = 100;// in ohm
```

```
I = 100;// in mA
I = I * 10^-3;// in A
// For 100 mA range, the value of Rsh to be connected in parallel
Rsh = (Im*Rm)/(I-Im);// in ohm
disp(Rsh,"For 100 mA range, the value of Rsh to be connected in parallel in   is");
I = 1;// in A
// For 1 A range, the value of Rsh to be connected in parallel
Rsh = (Im*Rm)/(I-Im);// in ohm
disp(Rsh,"For 1A range, the value of Rsh to be connected in parallel in   is");
V = 1;// in V
// For 1V range, the value of Rs to be connected in series
Rs = (V/Im)-Rm;// in ohm
disp(Rs,"For 1V range, the value of Rs to be connected in series in   is");
V = 100;// in V
// For 100 V range, the value of Rs to be connected in series
Rs = (V/Im)-Rm;// in ohm
Rs= Rs*10^-3;// in k ohm
disp(Rs,"For 100V range, the value of Rs to be connected in series in k  is");
```

Scilab code Exa 3.29 Required shunt

```
// Exa 3.29
format('v',7);clc;clear;close;
// Given data
Rm = 100;//meter resistance in ohm
Im = 2;//current in mA
Im = Im * 10^-3;// in A
```

```
I = 150;// in mA
I = I * 10^-3;// in A
m = I/Im;
Rsh = Rm/(m-1);//required shunt resistance in ohm
disp(Rsh,"The value of required shunt resistance in
    is");
Pm = ((Im)^2)*Rm;// in W
Psh = ((I-Im)^2)*Rsh;// in W
P = Pm+Psh;//power consumption  in W
P = P * 10^3;// in mW
disp(P,"The power consumption in mW is");
```

Scilab code Exa 3.30 Magnitude of current

```
// Exa 3.30
format('v',7);clc;clear;close;
// Given data
std_cell_emf = 1.45;//e.m.f. of standard cell in V
l = 50;//length in cm
Vdrop = std_cell_emf /l;//voltage drop per unit
    length in V/cm
Vstdresistor = Vdrop*75;//voltage across standard
    resistor in V
Stdresistor = 0.1;//standard resistor in ohm
I = Vstdresistor/Stdresistor;//magnitude of current
    in A
disp(I,"The magnitude of current in A is");
```

Chapter 4

Digital Instruments

Scilab code Exa 4.1 Resolution and digital output

```
// Exa 4.1
format('v',7);clc;clear;close;
// Given data
Vi = 5.1;//input voltage in V
n = 8;// number of bit
Resolution = 2^n;
Resolution = Vi/(Resolution-1);// in V/LSB
Resolution= Resolution*10^3;// in mV/LSB
disp(Resolution,"The Resolution in mV/LSB is");
Resolution= Resolution*10^-3;// in V/LSB
Vi = 1.28;// in V
D = Vi/Resolution;//digital output in LSBs
DigitalOutput= dec2bin(round(D));// digital output
    in binary
disp(DigitalOutput,"The digital output in binary is
    :")
```

Scilab code Exa 4.2 Quantizing error

```
// Exa 4.2
format('v',7);clc;clear;close;
// Given data
n = 12;//number of bit
Vi = 4.095;//input voltage in V
Q_E = Vi/(((2^n)-1)*2);//quantizing error in V
Q_E = Q_E * 10^3;// in mV
disp(Q_E,"The quantizing error in mV is");
```

Scilab code Exa 4.3 The value of t2

```
// Exa 4.3
format('v',7);clc;clear;close;
// Given data
// When Vi=100 mV
Vi = 100;// in mV
V_R = 100;// in mV
t1 = 83.33;// in ms
t2 = (Vi/V_R)*t1;// in ms
disp(t2,"When Vi=100 mV, the value of t2 in ms is");
// When Vi=200 mV
Vi = 200;// in mV
t2 = (Vi/V_R)*t1;// in ms
disp(t2,"When Vi=200 mV, the value of t2 in ms is");
```

Scilab code Exa 4.4 Digital output

```
// Exa 4.4
format('v',7);clc;clear;close;
// Given data
t1 = 83.33;// in ms
V_R = 100;// in mV
Vi = 100;// in mV
```

```
fc = 12;//clock frequency in kHz
fc = fc* 10^3;// in Hz
Digitaloutput = round(fc*t1*(Vi/V_R)*10^-3);// digital output in counts
disp(Digitaloutput,"The Digital output in counts is");
```

Scilab code Exa 4.5 Conversion time

```
// Exa 4.5
format('v',7);clc;clear;close;
// Given data
f = 1;// in MHz
f = f * 10^6;// in Hz
T = 1/f;// in sec
T = T * 10^6;// in  sec
n = 8;
// Conversion time
T_C = T*(n+1);// in  sec
disp(T_C,"The conversion time in  sec is");
```

Scilab code Exa 4.6 Maximum frequency

```
// Exa 4.6
format('v',7);clc;clear;close;
// Given data
n = 8;// number of bit
T_C = 9;//conversion time in  s
T_C = T_C * 10^-6;// in s
// The maximum frequency
f_max = 1/(2*%pi*T_C*(2^n));// in Hz
disp(f_max,"The maximum frequency in Hz is");
```

Scilab code Exa 4.7 Resolution

```
// Exa 4.7
format('v',7);clc;clear;close;
// Given data
n = 3;// number of bit
R = 1/(10^n);
V = 1;// in V
// For 1V range,
Resolution = V*R;// in V
disp(Resolution,"For 1 V range, the resolution in V
   is");
// For 50 V range,
V = 50;// in V
Resolution = V*R;// in V
disp(Resolution,"For 50 V range, the resolution in V
    is");
```

Scilab code Exa 4.8 Resolution

```
// Exa 4.8
clc;clear;close;
// Given data
format('v',8)
n = 4;// number of bit
R = 1/(10^n);
disp(R,"Part (i) : The resolution is");
// There are 5 digit places in 4 1/2 digits, so
disp("Part (ii) : 11.87 would be displayed as 11.870
   ")
Reading= 0.5573;
format('v',7)
```

```
disp(Reading,"Part (iii) : On 1 V range, 0.5573 will
    be displayed as : ")
format('v',6)
disp(Reading,"On 10 V range, 0.5573 will be
   displayed as : ")
```

Chapter 5

Measurement of Resistance

Scilab code Exa 5.1 Value of R1 and R2

```
// Exa 5.1
format('v',7);clc;clear;close;
// Given data
Rh = 1000;// in ohm
Rm = 50;// in ohm
V = 3;// in V
Ifsd = 1;// in mA
Ifsd = Ifsd * 10^-3;// in A
R1 = Rh - ( (Ifsd*Rm*Rh)/V );// in ohm
disp(R1,"The value of R1 in    is");
R2 = (Ifsd*Rm*Rh)/(V-(Ifsd*Rh));// in ohm
disp(R2,"The value of R2 in    is");
// Due to 5 % drop in battery voltage, the voltage
   becomes
V = V - (0.05*V);// in V
R2 = (Ifsd*Rm*Rh)/(V-(Ifsd*Rh));// in ohm
disp(R2,"Maximum value of R2 in    is");
```

Scilab code Exa 5.2 Unknown resistance

```
// Exa 5.2
format('v',7);clc;clear;close;
// Given data
R1 = 10;//resistance in k ohm
R2 = 2;//resistance in k ohm
R3 = 5;//resistance in k ohm
Rx = (R1/R2)*R3;//value of unknown resistance in  k ohm
disp(Rx,"The value of unknown resistance in k  is");
```

Scilab code Exa 5.3 Current through galvanometer

```
// Exa 5.3
format('v',7);clc;clear;close;
// Given data
// Values of resistances of the circuit
R1 = 7;// in k ohm
R2 = 2;// in k ohm
R3 = 4;// in k ohm
R4 = 20;// in k ohm
Rg = 300;// in ohm
E = 8;// in V
//Use Thevenin's equivalent for Ig,  V_TH=V_BD=V_AD-V_AB=( ((E/(R3+R4))*R4) - ((E/(R1+R2))*R1) );
V_TH = ( ((E/(R3+R4))*R4) - ((E/(R1+R2))*R1) );// in V
Req = ((R1*R2)/(R1+R2)) + ((R3*R4)/(R3+R4));// in k ohm
// Current through galvanometer
Ig = V_TH/((Req*10^3)+Rg);// in A
Ig = Ig * 10^6;// in  A
disp(Ig,"The current through galvanometer in  A is");
```

Scilab code Exa 5.4 Unknown resistance

```
// Exa 5.4
format('v',7);clc;clear;close;
// Given data
R3 = 100.03;//standard resistance in  ohm
R3 = R3 * 10^-6;// in ohm
R2 = 100.24;//outer ratio arms resistance in ohm
R1 = 200;//outer ratio arms resistance in ohm
b = 100.31;// in ohm
a = 200;// in ohm
Ry = 700;// in  ohm
Ry = Ry * 10^-6;// in ohm
Rx = ((R1*R3)/R2) + ( ((b*Ry)/(Ry+a+b)) * ((R1/R2) - (a/b)) );// in ohm
Rx = Rx * 10^6;//unknown resistance in  ohm
disp(Rx,"The unknown resistance in      is");
```

Scilab code Exa 5.5 Deflection of galvanometer

```
// Exa 5.5
format('v',7);clc;clear;close;
// Given data'
R1 = 100;// in ohm
R2 = 1000;// in ohm
R3 = 200;// in ohm
R4 = 2000;// in ohm
Rg = 200;// in ohm
S = 12;// in mm/  A
R = 5;// in ohm
R4 = R4 + R;// in ohm
E = 10;// in V
```

```
// By Thevenin's equivalent
V_TH = E*( (R3/(R1+R3)) - (R4/(R2+R4)) );// in V
Req = ((R1*R3)/(R1+R3)) + ((R2*R4)/(R2+R4));// in ohm
Ig = abs(V_TH)/(Req+Rg);// in A
Ig = Ig * 10^6;// in  A
// S =D/I;
D = S*Ig;//deflection of the galvanomter  in mm
disp(D,"The deflection of the galvanomter in mm is");

// Note:In the book the calculated value of V_TH is not correct. Correct value of V_TH is -5.546312 mV not -5.213 mV, So there is some difference between coding and the answer of the book.
```

Scilab code Exa 5.6 Deflection of galvanometer

```
// Exa 5.6
format('v',7);clc;clear;close;
// Given data
R1 = 1000;// in ohm
R2 = 1000;// in ohm
R3 = 121;// in ohm
R4 = 119;// in ohm
Rg = 200;// in ohm
E = 5;// in V
S = 1;// in mm/  A
// Calculation of Thevenin's equivalent due to change in R3 and R4
V_TH = E*( (R3/(R3+R1)) - (R4/(R4+R2)) );// in V
Req = ((R1*R3)/(R1+R3)) + ((R2*R4)/(R2+R4));// in ohm
Ig = V_TH/(Req+Rg);// in A
Ig = Ig * 10^6;// in  A
```

```
// S = D/I;
D = S*Ig;//deflection of the galvanometer in mm
disp(D,"The deflection of the galvanometer in mm is"
    );
```

Scilab code Exa 5.7 Current through galvanometer

```
// Exa 5.7
format('v',7);clc;clear;close;
// Given data
R = 500;// in ohm
del_r = 20;// in ohm
E = 10;// in V
Rg = 125;// in ohm
V_TH = (E*del_r)/(4*R);// in V
Req = R;// in ohm
// The current through the galvanometer
Ig = V_TH/(Req+Rg);// in A
Ig = Ig * 10^6;// in  A
disp(Ig,"The current through the galvanometer in  A
    is");
```

Scilab code Exa 5.8 Unknown resistance

```
// Exa 5.8
format('v',7);clc;clear;close;
// Given data
// Rx/R2 = Rb/Ra = 1/1200;
R1 = 10;// in ohm
// Rx/R2= Rb/Ra= 1/1200
R2 = R1/0.5;// in ohm
Rx = R2/1200;//unknown resistance in ohm
disp(Rx,"The value of unknown resistance in  is");
```

Scilab code Exa 5.9 Temperature

```
// Exa 5.9
format('v',7);clc;clear;close;
// Given data
//format()
R1 = 10;// in k ohm
R2 = 10;// in k ohm
R3 = 10;// in k ohm
E = 10;// in V
// R2/R_V = R1/R3;
R_V = (R2*R3)/R1;// in k ohm
T=80;// in  C
Rv=9;// in  k
// Evaluation of error voltage by Thevenin's equivalent voltage
e = E*( (R3/(R1+R3)) - (Rv/(R2+Rv)) );// in V
// Evaluation of error voltage by approximation of slightly unbalanced bridge
del_r = R_V-Rv;// in k ohm
errorVoltage = (E*del_r)/(4*R1);// in V
disp(T,"The temperature at which the bridge is balanced in  C is : ");
disp(e,"The error voltage at 60  C by Thevenin''s voltage in volts is : ")
disp(errorVoltage,"The error voltage at 60  C by approximation of slightly unbalanced bridge in Volts is ");
```

Scilab code Exa 5.10 Required supply voltage

```
// Exa 5.10
format('v',7);clc;clear;close;
// Given data
R1 = 120;// in ohm
R2 = 120;// in ohm
R3 = 120;// in ohm
R_V = 121;// in ohm
E_TH = 10;// in mV
E_TH = E_TH * 10^-3;// in V
// E_TH = E * ( (R3/(R3+R1)) - (R_V/(R_V+R2)) );
E = E_TH/((R3/(R3+R1)) - (R_V/(R_V+R2)));//required
    supply voltage in V
disp(E,"The required supply voltage in V is");
R = 120;// in ohm
del_r = R_V-R;// in ohm
// E_TH = (E*del_r)/(4*R);
E = E_TH*4*R;//The approximation of slightly
    unbalanced bridge in V
disp(E,"The approximation of slightly unbalanced
    bridge in V is");
```

Scilab code Exa 5.11 Maximum unknown resistance

```
// Exa 5.11
format('v',7);clc;clear;close;
// Given data
R1 = 1000;// in ohm
R2 = 100;// in ohm
R3 = 4;// in k ohm
R3 = R3*10^3;// in ohm
//At bridge balance, R1*R3 = R2*R4;
R4 = (R1*R3)/R2;// in ohm
R4= R4*10^-3;//maximum unknown resistance in k ohm
disp(R4,"The maximum unknown resistance in k  is");
R4= R4*10^3;// in ohm
```

```
R_TH = ((R1*R2)/(R1+R2)) + ((R3*R4)/(R3+R4));// in
   ohm
Si = 70;// in mm/ A
Si = Si * 10^6;// in mm/A
theta = 3;// in mm
E = 10;// in V
Rg = 80;// in ohm
// theta = (Si*E*R3*del_R)/((R_TH+Rg)*((R3+R4)^2));
del_R = (theta*((R_TH+Rg)*((R3+R4)^2)))/(Si*E*R3);//
    in ohm
disp(del_R,"The value of del_R in   is : ")
disp("This much unbalance is necessary to cause the
   deflection of 3 mm")
```

Scilab code Exa 5.12 Required series resistance

```
// Exa 5.12
format('v',7);clc;clear;close;
// Given data
P = 0.4;//power dissipation in each arm in W
Rarm = 150;// in ohm
//P = (I^2)*Rarm;
I = sqrt(P/Rarm);// in A
//Apply KVL to the loop ABCEFA, (-I*Rarm) - (I*Rarm
   ) - (2*I) + 25 - (2*I*R) = 0;
R = ((-I*Rarm) - (I*Rarm) - (2*I) + 25)/(2*I);//
   required series resistance in ohm
disp(R,"The required series resistance in   is");
```

Scilab code Exa 5.13 Unknown resistance

```
// Exa 5.13
format('v',7);clc;clear;close;
```

```
// Given data
R1 = 100;// in ohm
R2 = 1000;// in ohm
R3 = 0.00377;//standard resistance in ohm
a = 99.92;// in ohm
b = 1000.6;// in ohm
Ry = 0.1;//resistance of link in ohm
Rx =R1*R3/R2+b*Ry/(Ry+a+b)*(R1/R2-a/b);//unknown resistance in ohm
Rx = Rx * 10^3;// in mohm
disp(Rx,"The value of unknown resistance in m  is");

// Note: The answer will be in m  not M .
```

Scilab code Exa 5.14 Value of R

```
// Exa 5.14
format('v',7);clc;clear;close;
// Given data
P = 10;// in ohm
Q = 10;// in ohm
S = 10;// in ohm
// For first balance
p = 30000;// in ohm
q = 25000;// in ohm
R_AB = (P*p)/(P+p);// in ohm
R_BC = (Q*q)/(Q+q);// in ohm
// R_AB*R = R_BC*S;
R = (R_BC/R_AB)*S;// in ohm
disp(R,"The value of R for first balance in   is");
// For second balance
p = 15000;// in ohm
q = 40000;// in ohm
R_AB = (P*p)/(P+p);// in ohm
```

```
R_BC = (Q*q)/(Q+q);// in ohm
// R_AB*S = R_BC*R;
R = (R_AB/R_BC)*S;// in ohm
disp(R,"The value of R for second balance in   is");
```

Scilab code Exa 5.15 Unknown resistance

```
// Exa 5.15
format('v',7);clc;clear;close;
// Given data
P = 1000;// in ohm
Q = 1000;// in ohm
p = 1000;// in ohm
q = 1000;// in ohm
S = 0.001;// in ohm
R = (P/Q)*S;// in ohm
disp(R,"The value of unknown resistance in   is");
Rb = 5;// in ohm
V = 100;// in V
I = V/(Rb+R+S);// in A
disp(I,"The current through the unknown resistance in A is");
R = R*0.1;// in ohm
// Vac = ( (R+r+S)/(Rb+R+r+S) )*V;
Vac = ((R+S)/(Rb+R+S))*V;// in V .. correction
Vab = (P/(P+Q))*Vac;// in V
Vab = Vab * 10^3;// in mV
// Vamd = (R + (Pr/(p+q+r)))/(R+S+(((p+q)*r)/(p+q+r)));
Vamd = (R/(R+S))*Vab*10^-3;// in V
Vamd = Vamd * 10^3;// in mV
Vout = Vab - Vamd;//output voltage in mV
Vout = Vout*10^-3;// in V
disp(Vout,"The output voltage in V is");
```

Scilab code Exa 5.16 Smallest change in resistance

```
// Exa 5.16
format('v',7);clc;clear;close;
// Given data
R = 1000;// in ohm
E = 20;// in V
Ig = 0.1;// in nA
Ig = Ig * 10^-9;// in A
Req = R;// in ohm
//For small change in resistance, Thevenin's voltage
    , V_TH = (E*del_r)/(4*R);
// Ig = V_TH/Req;
del_r =  (Ig*4*R*R)/E;//smallest change in
    resistance in ohm
del_r= del_r*10^6;// in
disp(del_r,"The smallest change in resistance in
        is");
```

Chapter 6

A C Bridges

Scilab code Exa 6.1 Constant of unknown impedence

```
// Exa 6.1
format('v',7);clc;clear;close;
// Given data
Z1 = 50;// in ohm
Z2 = 250;// in ohm
Z3 = 200;// in ohm
theta1 = 80;// in degree
theta2 = 0;// in degree
theta3 = 30;// in degree
//bridge balance equation , Z1*Z4 = Z2*Z3;
Z4 = (Z2*Z3)/Z1;// in ohm
//phase angle condition , theta1+theta4 = theta2+
   theta3;
theta4 = theta2+theta3-theta1;// in degree
Z4=Z4*expm(%i*theta4*%pi/180);
disp("The resistance part of Z4 is "+string(real(Z4)
   )+"   while ")
disp(" it is in series with capacitive reactance of
   "+string(abs(imag(Z4)))+"   ")
```

Scilab code Exa 6.2 Whether or not the bridge is complete balance

```
// Exa 6.2
format('v',7);clc;clear;close;
// Given data
Z1 = 50;// in ohm
Z2 = 100;// in ohm
Z3 = 15;// in ohm
Z4 = 30;// in ohm
theta1 = 40;// in degree
theta2 = -90;// in degree
theta3 = 45;// in degree
theta4 = 30;// in degree
if abs(Z1*Z4)== abs(Z3*Z2) then
    flag1=1;
    disp("The condition of balance for magnitude is
        satisfied")
else
    flag1=0
    disp("The condition of balance for magnitude is
        not satisfied")
end
if theta1+theta4==theta2+theta3 then
    flag2=1
    disp("The condition of balance for phase is also
         satisfied")
else
    flag2=0
    disp("But the condition of balance for phase is
        not satisfied")
end
if flag1==1 then
    if flag2==1 then
        disp("Hence the bridge is under balanced
```

```
            condition")
    else
        disp("Hence the bridge is not under balanced condition")
    end
else
        disp("Hence the bridge is not under balanced condition")
end
```

Scilab code Exa 6.3 Equivalent series circuit of unknown impedance

```
// Exa 6.3
format('v',7);clc;clear;close;
// Given data
C3 = 10;// in  F
C3 = C3*10^-6;// in F
R1 = 1.2;// in k ohm
R1 = R1 * 10^3;// in ohm
R2 = 100;// in k ohm
R2 = R2 * 10^3;// in ohm
R3 = 120;// in k ohm
R3 = R3 * 10^3;// in ohm
Rx = (R2*R3)/R1;//unknown resistance in ohm
Rx = Rx * 10^-6;// in M ohm
disp(Rx,"The value of Rx in M  is");
Cx = (R1*C3)/R2;// in F
Cx = Cx * 10^6;//unknown capacitance in  F
disp(Cx,"The value of Cx in  F is");
```

Scilab code Exa 6.4 Equivalent series circuit of unknown impedance

```
// Exa 6.4
```

```
format('v',7);clc;clear;close;
// Given data
L3 = 8;// in mH
L3 = L3 * 10^-3;// in H
R1 = 1;// in k ohm
R1 = R1 * 10^3;// in ohm
R2 = 25;// in k ohm
R2 = R2 * 10^3;// in ohm
R3 = 50;// in  k ohm
R3 = R3 * 10^3;// in ohm
Rx = (R2*R3)/R1;//unknown resistance in ohm
Rx = Rx * 10^-6;// in M ohm
disp(Rx,"The value of Rx in M  is");
Lx = (R2*L3)/R1;//unknown inductance in H
Lx = Lx * 10^3;// in mH
disp(Lx,"The value of Lx in mH is");
```

Scilab code Exa 6.5 Component of branch BC

```
// Exa 6.5
format('v',7);clc;clear;close;
// Given data
C1 = 0.5;// in  F
C1 = C1 * 10^-6;// in  F
R1 = 1200;// in ohm
R2 = 700;// in ohm
R3 = 300;// in ohm
// From bridge balance equation
Rx = (R2*R3)/R1;// in ohm
disp("Component of the brach BC :")
disp("Rx = "+string(Rx)+"  ");
Lx = R2*R3*C1;// in H
Lx = Lx * 10^3;// in mH
disp("Lx = "+string(Lx)+" mH");
```

Scilab code Exa 6.6 Value of Rx and Lx

```
// Exa 6.6
format('v',7);clc;clear;close;
// Given data
R2 = 1000;//resistance in ohm
R3 = 500;// resistance in ohm
R4 = 1000;// resistance in ohm
C = 3;//capacitance in  F
C = C * 10^-6;// in F
r = 100;// in ohm
Rx = (R2*R3)/R4;//value of Rx in ohm
disp(Rx,"The value of Rx in   is");
Lx = ((C*R2)/R4)*( (R3*r) + (R4*r) + (R3*R4) );//
   value of Lx in H
disp(Lx,"The value of Lx in H is");
```

Scilab code Exa 6.7 Unknown inductance and resistance

```
// Exa 6.7
format('v',7);clc;clear;close;
// Given data
R1 = 5.1;// in k ohm
R1 = R1 * 10^3;// in ohm
R2 = 7.9;// in k ohm
R2 = R2 * 10^3;// in ohm
R3 = 790;// in ohm
C1 = 2;// in  F
C1 = C1 * 10^-6;// in F
omega = 1000;// in rad/sec
Rx = (((omega)^2)*R1*((C1)^2)*R2*R3)/( 1+(((omega)
   ^2) * ((R1)^2)* ((C1)^2)) );// unknown resistance
```

```
in ohm
Rx = Rx * 10^-3;// in k ohm
disp(Rx,"The value of unknown resistance in k  is");
Lx = (R2*R3*C1)/( 1+(((omega)^2) * ((R1)^2)* ((C1)^2)) );// unknown inductance in H
Lx = Lx * 10^3;// in mH
disp(Lx,"The value of unknown inductance in mH is");
```

Scilab code Exa 6.8 Unknown capacitance and its dissipation factor

```
// Exa 6.8
format('v',7);clc;clear;close;
// Given data
R1 = 1.2;// in k ohm
R1 = R1 * 10^3;// in ohm
R2 = 4.7;// in k ohm
R2 = R2 * 10^3;// in ohm
C1 = 1;// in  F
C1 = C1 * 10^-6;// in F
C3 = 1;// in  F
C3 = C3 * 10^-6;// in F
Rx = (R2*C1)/C3;// unknown resistance in ohm
Rx = Rx * 10^-3;// in k ohm
Cx = (R1*C3)/R2;// unknown capacitance in F
Cx = Cx * 10^6;// in  F
disp(Rx,"The unknown resistance in k  is ")
disp(Cx,"The unknown capacitance in  F is");
f = 0.5;// in kHz
f = f * 10^3;// in Hz
// omega = 2*%pi*f;
D = 2*%pi*f*Cx*10^-6*Rx*10^3;// dissipation factor
disp(D,"The dissipation factor is");
```

Scilab code Exa 6.9 Equivalent parallel resistance and capacitance

```
// Exa 6.9
format('v',7);clc;clear;close;
// Given data
R1 = 2.7;// in k ohm
R1 = R1 * 10^3;// in ohm
R2 = 22;// in k ohm
R2 = R2 * 10^3;// in ohm
R4 = 100;// in k ohm
R4 = R4 * 10^3;// in ohm
C1 = 5;// in  F
C1 = C1 * 10^-6;// in F
f = 2.2;// in kHz
f = f * 10^3;// in Hz
//From omega^2 = 1/(R1*C1*R3*C3);
// C3 = 1/(R1*C1*R3*(omega^2));      (i)
// R2/R4 = R1/R3 + C3/C1                       (ii)
// From eq(i) and (ii)
R3 = (R4/R2) * (R1 + 1/( ((2*%pi*f)^2)*R1*(C1^2) ));// equivalent parallel resistance in ohm
R3= R3*10^-3;// in k ohm
disp(R3,"The equivalent parallel resistance in k is");
R3= R3*10^3;// in ohm
C3 = 1/(R1*C1*R3*((2*%pi*f)^2));// equivalent parallel capacitance in F
C3 = C3 * 10^12;// in pF
disp(C3,"The equivalent parallel capacitance in pF is");
```

Scilab code Exa 6.10 Distributed capacitance and inductance

```
// Exa 6.10
format('v',7);clc;clear;close;
// Given data
C1 = 550;// in pF
C2 = 110;// in pF
Cd = (C1-(4*C2))/3;// distributed capacitance in pF
disp(Cd,"The distributed capacitance in pF is");
Cd = Cd * 10^-12;// in F
C1 = C1 * 10^-12;// in F
f1 = 1.5;// in MHz
f1 = f1 * 10^6;// in Hz
// f1 = 1/(2*%pi*(sqrt( L*(C1+Cd))));
L = ((1/(2*%pi*f1))^2) * (1/(C1+Cd));// distributed inductance in H
L = L * 10^6;// in  H
disp(L,"The distributed inductance in  H is");
```

Scilab code Exa 6.11 Percentage error in reading

```
// Exa 6.11
format('v',7);clc;clear;close;
// Given data
f = 1.5;//frequency in MHz
f = f * 10^6;// in Hz
C = 60;// in pF
C = C * 10^-12;// in F
R = 8;// in ohm
R_SH = 0.02;// in ohm
omega = 2*%pi*f;
Qactual = 1/(omega*C*R);// true value of Q
Qobserved = 1/(omega*C*(R+R_SH));// observed value of Q
PerError = ((Qactual-Qobserved)/Qactual) * 100;// Percentage error in %
disp(PerError,"The Percentage error in % is");
```

Scilab code Exa 6.12 Self capacitance

```
// Exa 6.12
format('v',7);clc;clear;close;
// Given data
f1 = 2;//frequency in MHz
f1 = f1 * 10^6;// in Hz
C1 = 500;// in pF
C2 = 60;// in pF
// f1 = 1/(2*%pi*sqrrt(L*(C1+Cd)))   (i)
// f2 = 1/(2*%pi*sqrrt(L*(C2+Cd)))   (ii)
// and f2 = 2.5*f1        (iii)
//From eq(i),(ii) and (iii)
Cd = (C1 - (6.25*C2))/5.25;// value of self
    capacitance in pF
disp(Cd,"The value of self capacitance in pF is");
```

Scilab code Exa 6.13 Percentage error

```
// Exa 6.13
format('v',7);clc;clear;close;
// Given data
f = 1;// in MHz
f = f * 10^6;// in Hz
omega = 2*%pi*f;// in rad/sec
C = 65;// in pF
C = C * 10^-12;// in F
R = 10;// in ohm
R_SH = 0.02;// in ohm
// Q = X_L/R = X_C/R = 1/(omega*C*R);
Qactual = 1/(omega*C*R);// True value of Q
```

```
Qmeasured = 1/(omega*C*(R+R_SH));// measured value of Q
PerError = ((Qactual-Qmeasured)/Qactual)*100;// percentage error in %
disp(PerError ,"The Percentage error in % is");
```

Scilab code Exa 6.14 Self capacitance

```
// Exa 6.14
format('v',7);clc;clear;close;
// Given data
C1 = 450;//capacitance in pF
C1 = C1 * 10^-12;// in F
C2 = 60;//capacitance in pF
C2 = C2 * 10^-12;// in F
// f1 = 1/(2*%pi*(sqrt(L*(C1+Cd))))       (i)
// f2 = 1/(2*%pi*(sqrt(L*(C2+Cd))))       (ii)
// and f2 = 2.5*f1        (iii)
// from eq(i),(ii) and (iii)
Cd = (C1 - (6.25*C2))/5.25;// value of self capacitance in F
Cd = Cd * 10^12;// in pF
disp(Cd,"The value of self capacitance in pF is");
```

Scilab code Exa 6.15 Inductance and self capacitance

```
// Exa 6.15
format('v',7);clc;clear;close;
// Given data
f1 = 8;//frequency in MHz
f1= f1*10^6;// in Hz
f2 = 12;//frequency in MHz
f2= f2*10^6;// in Hz
```

```
C1 = 120;//capacitance in pF
C1 = C1 * 10^-12;// in F
C2 = 40;//capacitance in pF
C2 = C2 * 10^-12;// in F
// f1 = 1/(2*%pi*(sqrt(L*(C1+Cd))))      (i)
// f2 = 1/(2*%pi*(sqrt(L*(C2+Cd))))      (ii)
// From eq(i) and (ii)
Cd= (f2^2*C2-f1^2*C1)/(f1^2-f2^2);// in F
// From eq(i)
C=C1+Cd;
L=1/((C1+Cd)*(2*%pi*f1)^2);// inductance in H
L= L*10^6;// in  H
Cd= Cd*10^12;// self capacitance in pF
disp(Cd,"The self capacitance in pF is");
disp(L,"The inductance in  H is : ")
```

Scilab code Exa 6.16 Inductance and self capacitance

```
// Exa 6.16
format('v',7);clc;clear;close;
// Given data
f1 = 1;//frequency in MHz
f1= f1*10^6;// in Hz
f2 = 2;//frequency in MHz
f2= f2*10^6;// in Hz
C1 = 500;//capacitance in pF
C1 = C1 * 10^-12;// in F
C2 = 110;//capacitance in pF
C2 = C2 * 10^-12;// in F
// f1 = 1/(2*%pi*(sqrt(L*(C1+Cd))))      (i)
// f2 = 1/(2*%pi*(sqrt(L*(C2+Cd))))      (ii)
// From eq(i) and (ii)
Cd= (f2^2*C2-f1^2*C1)/(f1^2-f2^2);// in F
// From eq(i)
C=C1+Cd;
```

```
L=1/((C1+Cd)*(2*%pi*f1)^2);// in H
L= L*10^6;//inductance in  H
Cd= Cd*10^12;// self capacitance in pF
disp(Cd,"The self capacitance in pF is");
disp(L,"The inductance in  H is : ")
```

Scilab code Exa 6.17 Constant of arm CD

```
// Exa 6.17
format('v',7);clc;clear;close;
// Given data
f = 1;//frequency in kHz
f = f * 10^3;// in Hz
R1 = 400;//resistance in ohm
R2 = 150;//resistance in ohm
C2 = 0.2;//capacitance in  F
C2 = C2 * 10^-6;// in F
XC2= 1/(2*%pi*f*C2);
R3 = 100;//resistance in ohm
L3 = 10;//inductance in mH
L3 = L3 * 10^-3;// in H
XL3= 2*%pi*f*L3;
Z1= R1+%i*0;// in
Z2= R2-%i*XC2;// in
Z3= R3+%i*XL3;// in
Z4= Z2*Z3/Z1;// in
R4= real(Z4);//resistance in
XC4= abs(imag(Z4));// in
C4= 1/(2*%pi*f*XC4);// in F
C4= C4*10^6;// in  F
disp("The components of branch CD : ")
disp("R4= "+string(R4)+"   ")
disp("C4= "+string(C4)+"   F")
```

Scilab code Exa 6.18 Equivalent series circuit of unknown impedance

```
// Exa 6.18
format('v',7);clc;clear;close;
// Given data
C3 = 10;//capacitance in  F
C3 = C3 * 10^-6;// in F
R1 = 1.2;//resistance in  k ohm
R1 = R1 * 10^3;// in ohm
R2 = 100;//resistance in k ohm
R2 = R2 * 10^3;// in ohm
R3 = 120;//resistance in k ohm
R3 = R3 * 10^3;// in ohm
Rx = (R2*R3)/R1;//resistance of unknown impedance in ohm
Rx = Rx * 10^-6;// in M ohm
disp(Rx,"The resistance of unknown impedance in M is");
Cx = (R1*C3)/R2;//capacitance of unknown impedance in F
Cx = Cx * 10^6;// in  F
disp(Cx,"The capacitance of unknown impedance in  F is");
```

Scilab code Exa 6.19 Constant of arm CD

```
// Exa 6.19
format('v',7);clc;clear;close;
// Given data
f = 1000;//frequency in Hz
C1 = 0.2;//capacitance in  F
C1 = C1 * 10^-6;// in F
```

```
XC1= 1/(2*%pi*f*C1);
R2= 500;// in
R3= 300;// in
C3= 0.1*10^-6;// in F
XC3= 1/(2*%pi*f*C3);
omega = 2*%pi*f;// in rad/sec
Z1= 0-%i*XC1;// in
Z2= R2;// in
Y3= 1/R3+%i*1/XC3;// in
Z3= R3*XC3/(R3+XC3);// in
Z4= Z2/(Z1*Y3);// in
R4= real(Z4);// in
XL4= abs(imag(Z4));// in
L4= XL4/(2*%pi*f);// in F
L4= L4*10^3;// in mH
disp("The components of branch CD : ")
disp("Rx= "+string(R4)+"    ")
disp("Lx= "+string(L4)+" mH")
```

Scilab code Exa 6.20 Unknown impedence

```
// Exa 6.20
format('v',7);clc;clear;close;
// Given data
f = 2;// in kHz
f = f * 10^3;// in Hz
omega = 2*%pi*f;// in rad/sec
Z1 = 10;// in k ohm
Z2 = 50;// in k ohm
R3 = 100;// in k ohm
C3 = 100;// in   F
C3 = C3 * 10^-6;// in F
XC3= 1/(2*%pi*f*C3);
Z3= R3-%i*XC3;// in
// From balance equation , Z1*Z4= Z2*Z3
```

```
Z4= Z2*Z3/Z1;// in
R4= real(Z4);// in k
XC4= abs(imag(Z4));// in k
C4= 1/(2*%pi*f*XC4);// in F
C4= C4*10^6;// in  F
disp("The components of branch DC : ")
disp("Rx= "+string(R4)+" k ")
disp("Cx= "+string(C4)+"  F")
```

Scilab code Exa 6.21 Constant of Zx

```
// Exa 6.21
format('v',7);clc;clear;close;
// Given data
f = 1;// in kHz
f = f * 10^3;// in Hz
omega = 2*%pi*f;// in rad/sec
Z1 = 200;// in ohm
R2 = 200;// in ohm
C2 = 5;// in  F
C2 = C2 * 10^-6;// in F
XC2= 1/(2*%pi*f*C2);
Z2= R2-%i*XC2;// in
R3 = 500;// in ohm
C3 = 0.2;// in  F
C3 = C3 * 10^-6;// in F
XC3= 1/(2*%pi*f*C3);
Z3= R3-%i*XC3;// in
// From balance equation, Z1*Z4= Z2*Z3
Z4= Z2*Z3/Z1;// in
R4= real(Z4);// in
XC4= abs(imag(Z4));// in
C4= 1/(2*%pi*f*XC4);// in F
C4= C4*10^6;// in  F
disp("The components of Zx : ")
```

```
disp("Rx= "+string(R4)+"    ")
disp("Cx= "+string(C4)+" nF")
```

Scilab code Exa 6.22 Constant of Zx

```
// Exa 6.22
format('v',7);clc;clear;close;
// Given data
f = 1;// in kHz
f = f * 10^3;// in Hz
omega = 2*%pi*f;// in rad/sec
Z1 = 1.65;// in k ohm
Z2 = 15.3;// in k ohm
R3 = 2.5;// in k ohm
C3 = 10;// in   F
C3 = C3 * 10^-6;// in F
XC3= 1/(2*%pi*f*C3);
Z3= R3-%i*XC3;// in
// From balance equation , Z1*Z4= Z2*Z3
Z4= Z2*Z3/Z1;// in
R4= real(Z4);// in  k
XC4= abs(imag(Z4));// in  k
C4= 1/(2*%pi*f*XC4);// in F
C4= C4*10^6;// in   F
disp("The components of branch DC : ")
disp("Rx= "+string(R4)+" k  ")
disp("Cx= "+string(C4)+"   F ")
```

Scilab code Exa 6.23 Inductance of Rx and Lx at balance

```
// Exa 6.23
format('v',7);clc;clear;close;
// Given data
```

```
f = 1;// in kHz
f = f * 10^3;// in Hz
R1 = 600;// in ohm
C1 = 1;// in  F
C1 = C1 * 10^-6;// in F
XC1= 1/(2*%pi*f*C1);
R2 = 100;// in ohm
R3 = 1;// in k ohm
R3 = R3 * 10^3;// in ohm
omega = 2*%pi*f;// in rad/sec
Y1= 1/R1+%i*1/XC1;// in
Z2=R2;// in
Z3= R3;// in
// From balance equation , Z1*Z4= Z2*Z3
Z4= Z2*(Z3*Y1);// in
R4= real(Z4);// in
XL4= abs(imag(Z4));// in
L4= XL4/(2*%pi*f);// in F
disp("Rx= "+string(R4)+"   ")
disp("Lx= "+string(L4)+" H")
```

Scilab code Exa 6.24 Unknown parameters in arm AB

```
// Exa 6.24
format('v',7);clc;clear;close;
// Given data
R2 = 842;//resistance in ohm
C2 = 0.135;//capacitance in  F
C2 = C2 * 10^-6;// in F
f=1000;//frequency in Hz
XC2= 1/(2*%pi*f*C2);
R3= 10;//resistance in ohm
C4= 1*10^-6;//capacitance in F
XC4= 1/(2*%pi*f*C4);
Z2= R2-%i*XC2;//impedance in ohm
```

```
Z3= R3;//impedance in ohm
Z4= -%i*XC4;//impedance in ohm
// From balance equation
Z1= Z2*Z3/Z4;// in
R1= real(Z1);// in
XL1= abs(imag(Z1));// in
L1= XL1/(2*%pi*f);// in F
L1= L1*10^3;// in mH
disp(R1,"The value of R1 in  is : ")
disp(L1,"The value of L1 in mH is : ")
```

Scilab code Exa 6.25 Resistance and inductance of coil

```
// Exa 6.25
format('v',7);clc;clear;close;
// Given data
L2 = 47.8;//inductance in mH
R2 = 1.36;//resistance in ohm
r1 = 32.7;//resistance in ohm
R1 = 1.36;//resistance in ohm
//At balance, 100*(r1+J*oemga*L1) = 100*((R2+r2)+(J*
   omega*L2));
 L1 = L2;// in mH (equating imaginary terms)
disp(L1,"The inductance of coil in mH is");
// R2+r2 = r1 (equating real terms)
r2 = r1-R1;//resistance of coil in ohm
disp(r2,"The resistance of coil in ohm is");

// Note: In the book the value of L1 is wrong.
```

Scilab code Exa 6.26 Resistance and inductance of coil

```
// Exa 6.26
```

```
format('v',7);clc;clear;close;
// Given data
R=1.36;//resistance in ohm
r2= 32.7;//resistance in ohm
L2= 47.8;//inductance in mH
L2= L2*10^-3;// in H
f=1000;//frequency in Hz
XL2=2*%pi*f*L2;// in
Z3 = 100;// in ohm
Z4 = 100;// in ohm
Z2= r2+%i*XL2;// in ohm
// Under balance condition
Z1= Z2*Z3/Z4;// in ohm
R1= real(Z1);
r1= R1-R;//resistance of the coil in ohm
XL1= imag(Z1);// in ohm
L1= XL1/(2*%pi*f);//inductance of the coil in F
L1= L1*10^3;// in mH
disp(r1,"The resistance of the coil in    is : ")
disp(L1,"The inductance of the coil in mH is : ")
```

Scilab code Exa 6.27 Whether or not the bridge is complete balance

```
// Exa 6.27
format('v',7);clc;clear;close;
// Given data
Z1 = 400;// in ohm
Z2 = 200;// in ohm
Z3 = 800;// in ohm
Z4 = 400;// in ohm
theta1 = 50;// in degree
theta2 = 40;// in degree
theta3 = -50;// in degree
theta4 = 20;// in degree
if abs(Z1*Z4)== abs(Z3*Z2) then // Applying the
```

```
condition of balance for magnitude
    flag1=1;
    disp("The condition of balance for magnitude is satisfied")
else
    flag1=0
    disp("The condition of balance for magnitude is not satisfied")
end
if theta1+theta4==theta2+theta3 then // Applying the condition of balance for phases
    flag2=1
    disp("The condition of balance for phase is also satisfied")
else
    flag2=0
    disp("But the condition of balance for phase is not satisfied")
end
if flag1==1 then
    if flag2==1 then
        disp("Hence the bridge is under balanced condition")
    else
        disp("Hence the bridge is not under balanced condition")
    end
else
        disp("Hence the bridge is not under balanced condition")
end
```

Scilab code Exa 6.28 Whether or not the bridge is complete balance

```
// Exa 6.28
```

```
format('v',7);clc;clear;close;
// Given data
Z1 = 200;// in ohm
Z2 = 400;// in ohm
Z3 = 300;// in ohm
Z4 = 600;// in ohm
theta1 = 60;// in degree
theta2 = -60;// in degree
theta3 = 0;// in degree
theta4 = 30;// in degree
if abs(Z1*Z4)== abs(Z3*Z2) then // Applying the
   condition of balance for magnitude
    flag1=1;
    disp("The condition of balance for magnitude is
       satisfied")
else
    flag1=0
    disp("The condition of balance for magnitude is
       not satisfied")
end
if theta1+theta4==theta2+theta3 then // Applying the
    condition of balance for phases
    flag2=1
    disp("The condition of balance for phase is also
        satisfied")
else
    flag2=0
    disp("But the condition of balance for phase is
       not satisfied")
end
if flag1==1 then
    if flag2==1 then
        disp("Hence the bridge is under balanced
           condition")
    else
        disp("Hence the bridge is not under balanced
            condition")
    end
```

```
else
        disp("Hence the bridge is not under balanced condition")
end
```

Scilab code Exa 6.29 R L and C constant of arm CD

```
// Exa 6.29
format('v',7);clc;clear;close;
// Given data
f = 1;//frequency in kHz
f = f * 10^3;// in Hz
C1 = 0.2;// in  F
C1 = C1 * 10^-6;// in F
XC1= 1/(2*%pi*f*C1);// in
C2 = 0.1;// in  F
C2 = C2 * 10^-6;// in F
XC2= 1/(2*%pi*f*C2);// in
R2= 300;// in
R3= 500;// in
Z1= 0-%i*XC1;// in
Z2= R2*-%i*XC2/(R2-%i*XC2);// in
Z3=R3;// in
// For balanced condition
Z4= Z2*Z3/Z1;// in
R4= real(Z4);// in
XL4= imag(Z4);// in
L4= XL4/(2*%pi*f);// in H
L4= L4*10^3;// in mH
disp("Components of arm CD : ")
disp("L4= "+string(L4)+" mH")
disp("R4= "+string(R4)+"  ")
```

Scilab code Exa 6.30 Resistance and inductance

```
// Exa 6.30
format('v',7);clc;clear;close;
// Given data
R3 = 100;// in ohm
R4 = 200;// in ohm
R2 = 250;// in ohm
C = 1;// in  F
C = C * 10^-6;// in F
r = 229.7;// in ohm
r1 = 43.1;// in ohm
// Value of unknown resistance for Anderson's bridge
R1 = ((R2*R3)/R4) - r1;//resistance in ohm
disp(R1,"The resistance in ohm is");
L1 = ((C*R3)/R4) * ( ((R2+R4)*r) + (R2*R4) );// inductance in H
L1 = L1 * 10^3;// in mH
disp(L1,"The inductance in mH is");
```

Scilab code Exa 6.31 Value of C1 and r1

```
// Exa 6.31
format('v',7);clc;clear;close;
// Given data
f = 450;//frequency in Hz
omega = 2*%pi*f;// in rad/sec
R2 = 4.8;// in ohm
R3 = 200;// in ohm
R4 = 2850;// in ohm
C2 = 0.5;// in  F
C2 = C2*10^-6;// in F
XC2= 1/(2*%pi*f*C2);// in
r2 = 0.4;// in ohm
Z2= (R2+r2)-%i*XC2;// in
```

```
Z3= R3;// in
Z4= R4;// in
// For balanced condition
Z1= Z2*Z3/Z4;// in
r1= real(Z1);// in
XC1= abs(imag(Z1));// in
C1= 1/(2*%pi*f*XC1);// in F
Df= 2*%pi*f*C1*r1;// dissipating factor
C1= C1*10^6;// in  F
disp(r1,"The value of r1 in   is : ")
disp(C1,"The value of C1 in  F is : ")
disp(Df,"The dissipating factor is : ")
```

Scilab code Exa 6.32 Effective impedance of the specimen

```
// Exa 6.32
format('v',7);clc;clear;close;
// Given data
f = 2;//frequency in kHz
f = f * 10^3;// in Hz
omega = 2*%pi*f;// in rad/sec
R2 = 834;//resistance in ohm
C2 = 0.124;//capacitance in  F
C2 = C2 * 10^-6;// in F
XC2= 1/(2*%pi*f*C2);// in
R3= 100;//resistane in
C4= 0.1*10^-6;//capacitance in F
XC4= 1/(2*%pi*f*C4);// in
Z2= R2-%i*XC2;// in
Z3=R3;// in
Z4= 0-%i*XC4;// in
// For balanced condition, effective impedance
Z1= Z2*Z3/Z4;//in
disp(Z1,"The effective impedance in   is : ")
```

Scilab code Exa 6.33 Largest value of Rx and Lx

```
// Exa 6.33
format('v',7);clc;clear;close;
// Given data
R1= 20*10^3;//resistance in ohm
R2= 50*10^3;//resistance in ohm
C2= 0.003*10^-6;//capacitance in F
R4= 10*10^3;//resistance in ohm
C1= 150*10^-12;//capacitance in F
omega= 10^6;// in rad/sec
Z1= R1/(1+%i*omega*C1*R1);// in ohm
Z2= (1+%i*omega*C2*R2)/(%i*omega*C2);// in ohm
// At balance condition : Z1*R4 = Z2*(Rx+%i*omega*Lx) or
// R4= omega^2*R1*C2*(R1*R4*C1-Lx)          (i)
// R4= R1*(Rx*C2-R4*C1)/(R2*C2)             (ii)
Rx= R4*(R1*C1+R2*C2)/(R1*C2);// in   from eq(ii)
Lx= R4*(R2*C1-1/(omega^2*R1*C2));// in H from eq (i)
Rx= Rx*10^-3;// in k ohm
Lx= Lx*10^3;// in mH
disp(Rx,"The value of Rx in k  is : ")
disp(Lx,"The value of Lx in mH is : ")

// Note: The calculated value of Rx will be as in k  not in only  , so the answer in the book is wrong.
```

Scilab code Exa 6.34 Value of R1 and L1

```
// Exa 6.34
format('v',7);clc;clear;close;
```

```
// Given data
R2 = 1000;//resistance in
R3 = 1000;//resistance in
R4 = 1000;//resistance in
C4 = 0.5;//capacitance in   F
C4 = C4 * 10^-6;// in F
//At balance, (R1+(%i*omega*L1))*(R4/( 1+(%i*omega*
   C4*R4) )) = R2*R3;
// R1*R4 + (%i*omega*L1*R4) = (R2*R3) + (%i*omega*R2
   *R4*C4);
R1 = (R2*R3)/R4;// in    (equating real terms)
L1 = R2*R3*C4;// in H (equating imaginary terms)
disp(R1,"The value of R1 in ohm is");
disp(L1,"The value of L1 in H is");
```

Scilab code Exa 6.35 Capacitance power factor and permittivity

```
// Exa 6.35
format('v',7);clc;clear;close;
// Given data
R3 = 260;//resistance in ohm
C4 = 0.5;// in   F
C4 = C4 * 10^-6;// in F
C2 = 106;// in pF
C2 = C2 * 10^-12;// in F
R4 = 1000/%pi;//resistance in ohm
r1 = (C4/C2)*R3;//resistance in ohm
C1 = (R4/R3)*C2;// in F
Epsilon_o = 8.854*10^-12;
d = 4.5// in mm
d = d * 10^-3;// in m
D= 0.12;// in m
A= %pi*D^2/4;// in m^2
disp(r1,"The resistance in     is :")
C1= C1*10^12;// in pF
```

```
disp(C1,"The capacitance in pF is");
C1= C1*10^-12;// in F
f = 50;// in Hz
omega = 2*%pi*f;// in rad/sec
Pf= omega*C1*r1;// power factor
disp(Pf,"The power factor is");
// C1 = Epsilon_r*Epsilon_o*(A/d);
Epsilon_r = (C1*d)/(Epsilon_o*A);// the relative permittivity
disp(Epsilon_r,"The relative permittivity is");

// Note: The calculation of evaluating the value of C1 is wrong, so the answer of C1 in the book is wrong. But they putted the correct value of C1 to find the value of relative permittivity
```

Scilab code Exa 6.36 Capacitance and dielectric loss angle of capacitor

```
// Exa 6.36
format('v',7);clc;clear;close;
// Given data
C2 = 500;// capacitance in nF
C2 = C2 * 10^-9;// in F
f = 50;//frequency in Hz
omega = 2*%pi*f;// in rad/sec
C4 = 0.148;//capacitance in   F
C4 = C4 * 10^-6;// in F
R4 = 72.6;//resistance in ohm
R3 = 300;//resistance in ohm
C1 = C2*(R4/R3);// capacitance in F
C1 = C1 * 10^6;// in   F
disp(C1,"The capacitance in   F is");
delta = atand(omega*C4*R4);//dielectric loss angle of capacitance in degree
disp(delta,"The dielectric loss angle of capacitance
```

```
    in degree is");

// Note: The calculation in the book is wrong, so
   the answer in the book is wrong.
```

Scilab code Exa 6.37 Self capacitance

```
// Exa 6.37
format('v',7);clc;clear;close;
// Given data
f1 = 3;//frequency in MHz
f1 = f1 * 10^6;// in Hz
C1 = 251;//capacitance in pF
C1 = C1  * 10^-12;// in F
f2 = 6;//frequency in MHz
f2 = f2 * 10^6;// in Hz
C2 = 50;//capacitance in pF
C2 = C2 * 10^-12;// in F
// f1 = 1/(2*%pi*(sqrt(L*(C1+Cd))) )     (i)
// f2 = 1/(2*%pi*(sqrt(L*(C2+Cd))) )     (ii)
// From eq(i) and (ii)
Cd = (C1 - (4*C2))/3;// self capacitance of the coil
    in F
Cd = Cd * 10^12;// in pF
disp(Cd,"The self capacitance of the coil in pF is")
   ;
```

Scilab code Exa 6.38 Resistance and inductance of choke coil

```
// Exa 6.38
format('v',7);clc;clear;close;
// Given data
f=500;//frequency in Hz
```

```
R2 = 2410;//resistance in ohm
R3 = 750;//resistance in ohm
R4 = 64.5;//resistance in ohm
R_C4 = 0.4;//resistance in ohm
C4 = 0.35;//capacitance in  F
C4 = C4 * 10^-6;// in F
XC4= 1/(2*%pi*f*C4);// in
Z4= R4+R_C4-%i*XC4;// in
Z2= R2;// in
Z3= R3;// in
Z1= Z2*Z3/Z4;// in
R1= real(Z1);//resistance of choke coil  in
XL1= imag(Z1);// in
L1= XL1/(2*%pi*f);//inductance of choke coil  in H
disp(R1,"The resistance of choke coil in    is : ")
disp(L1,"The inductance of choke coil in H is : ")
```

Scilab code Exa 6.39 Value of R and C

```
// Exa 6.39
format('v',7);clc;clear;close;
// Given data
f = 50;// in Hz
omega = 2*%pi*f;// in rad/sec
R1 = 50;// in ohm
L1 = 0.1;// in H
XL1= 2*%pi*f*L1;// in
R2= 100;// in
R3= 1000;// in
Z1= R1+%i*XL1;// in
Z2= R2;// in
Z3= R3;// in
// The bridge balance condition
Zx= Z2*Z3/Z1;// in
// Comparing real part
```

```
Rx= real(Zx);// in
// Comparing imaginary part
XCx= abs(imag(Zx));// in
Cx= 1/(2*%pi*f*XCx);// in F
disp(Rx,"The value of Rx in    is : ")
disp(Cx*10^6,"The value of Cx in   F is : ")
```

Scilab code Exa 6.40 Effective impedance of the specimen

```
// Exa 6.40
format('v',7);clc;clear;close;
// Given data
f = 2;// in kHz
f = f * 10^3;// in Hz
R2= 834;// in
C2= 0.124*10^-6;// in F
XC2= 1/(2*%pi*f*C2);// in
R3= 100;// in
C4 = 0.1;// in   F
C4 = C4*10^-6;// in F
XC4= 1/(2*%pi*f*C4);// in
Z2= R2+%i*XC2;// in
Z3= R3;// in
Z4= -%i*XC4;// in
// The bridge balance condition
Z1= Z2*Z3/Z4;// in
mag= abs(Z1);// magnitude of effective impedence in

theta= atand(imag(Z1),real(Z1));// phase angle of
   effective impedence in
disp(mag,"The magnitude of effective impedence in
    is : ")
disp(theta,"The phase angle of effective impedence
   in    is")
```

Scilab code Exa 6.41 Resistance and inductance of coil

```
// Exa 6.41
format('v',7);clc;clear;close;
// Given data
L1 = 52.6;//inductance in mH
R2 = 1.68;//resistance in ohm
// 80*(r1+(J*omega*L1)) = 80*( (R2+r2) + (J*omega*L2) );
L2 = L1;//inductance of the coil in mH
disp(L2,"The inductance of the coil in mH is");
r1 = 28.5;// in ohm
r2 = r1-R2;//resistance of the coil in ohm
disp(r2,"The resistance of the coil in ohm is");
```

Scilab code Exa 6.42 Value of R and L

```
// Exa 6.42
format('v',7);clc;clear;close;
// Given data
Q = 1;// in k ohm
Q = Q * 10^3;// in  ohm
S = Q;// in ohm
P = 500;// in ohm
r = 100;// in ohm
C = 0.5;// in  F
C = C * 10^-6;// in F
//Using standard condition , Rx = (R2*R3)/R4;
Rx = (P*Q)/S;// in ohm
disp(Rx,"The value of Rx in   is");
//Lx = ((C*R2)/R4) * ( (R3*r) + (R4*r) + (R3*R4) );
Lx = ((C*P)/S) * ( (Q*r) + (S*r) + (Q*S) );// in H
```

```
disp(Lx,"The value of Lx in H is");
```

Chapter 7

Oscilloscopes

Scilab code Exa 7.1 Rise time of the signal

```
// Exa 7.1
format('v',7);clc;clear;close;
// Given data
BW = 25;//bandwidth in MHz
Trd = 20;//rise time in ns
Trd = Trd * 10^-9;// in s
// BW = 0.35/Tro;
Tro = 0.35/(BW*10^6);// in s
// Trd = sqrt( (Trs^2) + (Tro^2) );
Trs = sqrt( (Trd^2)-(Tro^2) );// rise time of signal
    in sec
Trs = Trs * 10^9;// in ns
disp(Trs,"The rise time of signal in ns is");
```

Scilab code Exa 7.2 Bandwidth of CRO

```
// Exa 7.2
format('v',7);clc;clear;close;
```

```
// Given data
Trs = 17;//rise time in   s
Trs = Trs * 10^-6;// in s
Trd = 21;// in   s
Trd = Trd * 10^-6;// in s
// Trd = sqrt( (Trs^2) + (Tro^2) );
Tro = sqrt( (Trd^2)- (Trs^2) );// in sec
BW = 0.35/Tro;//band width  in Hz
BW = BW * 10^-3;// in kHz
disp(BW,"The band width in kHz is");
```

Scilab code Exa 7.3 Amplitude and rms value of sinusoidal voltage

```
// Exa 7.3
format('v',7);clc;clear;close;
// Given data
subdivision = 1/5;//sub division in units
positivepeak = 2.6;//positive peak in units
Vpp = positivepeak + positivepeak;//peak to peak in
   divisions
verticalattenuation = 2;//vertical attenuation in mV
   /div
verticalattenuation = verticalattenuation * 10^-3;//
    in V/div
Vpp = Vpp * verticalattenuation;// in V
Vpp = Vpp * 10^3;// in mV
Vm = Vpp/2;;//amplitude of the sinusoidal voltage
   in mV
disp(Vm,"The amplitude of the sinusoidal voltage in
   mV is");
V_RMS = Vm/sqrt(2);//r.m.s. value of the sinusoidal
   voltage in mV
disp(V_RMS,"The r.m.s. value of the sinusoidal
   voltage in mV is");
```

Scilab code Exa 7.4 rms value of voltage

```
// Exa 7.4
format('v',7);clc;clear;close;
// Given data
voltsBYdiv = 2;//volts per division in V/div
Timebase = 2;//base time in ms/div
Verticaloccupancy = 3;//Vertical occupancy in cm
Vpp = voltsBYdiv*Verticaloccupancy;//peak to peak voltage in V
Vm = Vpp/2;// in V
V_RMS = Vm/sqrt(2);//r.m.s. value of the voltage in V
disp(V_RMS,"The r.m.s. value of the voltage in V is");
Horizontaloccupancy = 2;//Horizontal occupancy in cm
timeBYdiv = 2;//time per division in mV
timeBYdiv = timeBYdiv*10^-3;// in V
T = timeBYdiv*Horizontaloccupancy;// in sec
f = 1/T;// in Hz
disp(f,"The frequency in Hz is");
```

Scilab code Exa 7.5 Phase difference

```
// Exa 7.5
format('v',7);clc;clear;close;
// Given data
y1 = 8;// in units
y2 = 10;// in units
phi = asind(y1/y2);// phase difference in degree
disp(phi,"The phase difference in degree is");
```

Scilab code Exa 7.6 Unknown frequency of vertical signal

```
// Exa 7.6
format('v',7);clc;clear;close;
// Given data
verticaltangencies = 2;// vertical tangencies
horizontaltangencies = 5;// horizontal tangencies
f_H = 1;// frequency in kHz
// f_V/f_H = horizontaltangencies/verticaltangencies;
f_V = (horizontaltangencies/verticaltangencies)*f_H; //unknown frequency of vertical signal in kHz
disp(f_V,"The unknown frequency of vertical signal in kHz is");
```

Scilab code Exa 7.7 Compansating capacitance

```
// Exa 7.7
format('v',6);clc;clear;close;
// Given data
Cin = 35;// in pF
// (R1+Rin)/Rin = 10;
RinBYR1= 1/9;
//while balance equation with compensating capacitor
//  R1*C1 = Rin*(C2+Cin);
C1= Cin*RinBYR1;//compansating capacitor  in pF
disp(C1,"The compansating capacitor in pF is");
```

Scilab code Exa 7.8 Sampling rate

```
// Exa 7.8
format('v',7);clc;clear;close;
// Given data
n = 10;// number of cycle
fs = 1;//signal frequency in kHz
fs = fs * 10^3;// in Hz
Timeperiod = n/fs;//time period in sec
Samplingfrequency = 1/Timeperiod;//Sampling
    frequency in samples/sec
disp(Samplingfrequency,"The sampling rate for 1 kHz
    in samples/sec is");
fs = 10;// in kHz
fs = fs * 10^3;// in Hz
Samplingperiod = n/fs;//Sampling period in sec
Samplingfrequency = 1/Samplingperiod;//sampling rate
     for 10 kHz in samples/sec
disp(Samplingfrequency,"The sampling rate for 10 kHz
     in samples/sec is");
```

Scilab code Exa 7.9 Minimum rise time of the pulse

```
// Exa 7.9
format('v',7);clc;clear;close;
// Given data
Samplingrate = 200;//Sampling rate in MS/s
Samplingrate = Samplingrate * 10^6;// in S/s
t_r = 1/Samplingrate;//minimum rise time of pulse in
     s
t_r = t_r * 10^9;// in ns
disp(t_r,"The minimum rise time of pulse in ns is");
```

Scilab code Exa 7.10 Frequency of signal

```
// Exa 7.10
format('v',7);clc;clear;close;
// Given data
Vd = 4;// vertical division
Va = 0.5;//Vertical attenuation in V/Div
App = Vd*Va;//peak to peak amplitude in V
disp(App ,"The peak to peak amplitude of the signal in V is");
TimebyDiv = 2;//time per division in  s/Div
Hd = 4;// horizontal division
Time = Hd*TimebyDiv;// in  s
f = 1/(Time*10^-6);// frequency of signal in Hz
f = f * 10^-3;// in kHz
disp(f,"The frequency of signal in kHz is");
```

Scilab code Exa 7.11 Parameter of a high impedance probe

```
// exa 7.11
format('v',5);clc;clear;close;
// Given data
Rin = 2;//resistance in Mohm
Cin = 50;//capacitance in pF
Cin = Cin * 10^-12;// in F
// (R1+Rin)/Rin = 10;
R1 = 9*Rin;//resistance in Mohm
disp(R1,"The value of R1 in M  is");
R1 = R1*10^6;// in ohm
Rin = Rin * 10^6;// in ohm
// While balance equation with compensating capacitor
// R1*C1 = Rin*(C2+Cin)
C1 = (Rin*Cin)/R1;// in F(neglecting C2)
C1 = C1 * 10^12;// in pF
disp(C1,"The value of C1 in pF is");
```

Chapter 8

Instrument Calibration

Scilab code Exa 8.1 Accuracy

```
// Exa 7.1
format('v',7);clc;clear;close;
// Given data
BW = 25;//bandwidth in MHz
Trd = 20;//rise time in ns
Trd = Trd * 10^-9;// in s
// BW = 0.35/Tro;
Tro = 0.35/(BW*10^6);// in s
// Trd = sqrt( (Trs^2) + (Tro^2) );
Trs = sqrt( (Trd^2)-(Tro^2) );// rise time of signal
    in sec
Trs = Trs * 10^9;// in ns
disp(Trs,"The rise time of signal in ns is");
```