Scilab Textbook Companion for Electronic Instrumentation and Measurements by J. B. Gupta[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

Chapter 1

Units Dimensions and Standards

Scilab code Exa 1.1 `Unit of resistance capacitance and inductance`

```
// Exa 1.1
clc;
clear;
close;
// Given data
V_desh= 100;// in V
I_desh= 10;// in amp
R_desh= V_desh/I_desh;// in
disp(R_desh,"New unit of resistance will be equal to
    ( in    ) is : ")
C_desh= I_desh/V_desh;// in F
disp(C_desh,"New unit of capacitance will be equal
   to (in Farad) is : ")
L_desh= V_desh/I_desh;// in L
disp(L_desh,"New unit of inductance will be equal to
    (in Henrys) is : ")
```

Chapter 2

Measurement Errors

Scilab code Exa 2.1 Absolute error of measurement

```
// Exa 2.1
clc;
clear;
close;
// Given data
Am= 10.25;// in ohm
A= 10.22;// in ohm
del_A= Am-A;// in ohm
disp(del_A,"Absolute error in ohm")
```

Scilab code Exa 2.2 Error and correction

```
// Exa 2.2
clc;
clear;
close;
// Given data
Am= 6.7;// in A
```

```
A= 6.54;// in A
del_A= Am-A;// in A
disp(del_A,"Absolute error in A")
disp(-del_A,"Correction in A")
```

Scilab code Exa 2.3 True value of power

```
// Exa 2.3
clc;
clear;
close;
// Given data
Am= 25.34;// in watt
del_A= -0.11;// in watt
A= Am-del_A;
disp(A,"True value in watt")
```

Scilab code Exa 2.4 Relative Error

```
// Exa 2.4
clc;
clear;
close;
// Given data
Am= 205.3*10^-6;// in F
A=  201.4*10^-6;// in F
epsilon_o= Am-A;
epsilon_r= epsilon_o/A*100;// in %
disp(epsilon_r,"Percentage relative error")
```

Scilab code Exa 2.5 Limit of inductance

```
// Exa 2.5
clc;
clear;
close;
// Given data
PerError= 5;// in %
epsilon_r= PerError/100;
Am=20;// in H
del_A= Am*epsilon_r;
// A= Am+del_A and A= Am-del_A
disp("Limiting value of inductance is : "+string(Am)+" + "+string(del_A)+" to "+string(Am)+" - "+string(del_A)+" in Henry")
```

Scilab code Exa 2.6 Limiting error

```
// Exa 2.6
clc;
clear;
close;
// Given data
V=600;// in volt
A= 400;//in volt
epsilon_r= 2.5/100;
del_V= epsilon_r*V;
PerLimitError= del_V/A*100;// in %
disp(PerLimitError,"The percentage limiting error at 400 volt (in positive and negetive)");
```

Scilab code Exa 2.7 Range of the reading

```
// Exa 2.7
clc;
clear;
close;
// Given data
Am= 500;// in watt
epsilon_r= 1.5/100;// in neg and pos
// for positive value of epsilon_r
A1= Am*(1+epsilon_r);// in watt
// for positive value of epsilon_r
A2= Am*(1-epsilon_r);// in watt
disp("Range of reading of wattmeter is "+string(A2)+
    " watt to "+string(A1)+" watt")
```

Scilab code Exa 2.8 Limiting error

```
// Exa 2.8
clc;
clear;
close;
// Given data
epsilon_r= 1.5/100;// in neg and pos
A= 10;// in amp
del_A= epsilon_r*A;//in amp
// The magnitude of current being measured is 2.5 A.
     The relative error at this current is
A= 2.5;// in amp
epsilon_r= del_A/A;
// Hence, the current under measurement is between
    the limits of
Am= 2.5;//in amp
// for positive value of epsilon_r
A1= Am*(1+epsilon_r);// in amp
// for positive value of epsilon_r
A2= Am*(1-epsilon_r);// in amp
```

```
disp("Limiting values of current under measurement
   are "+string(A2)+" amp to "+string(A1)+" amp")
LimitingError= del_A/A*100;// in %
disp(LimitingError,"Limiting Error in %")
```

Scilab code Exa 2.9 Limiting error

```
// Exa 2.9
clc;
clear;
close;
// Given data
epsilon_r= 1/100;
P=1000;// in watt
del_P= epsilon_r*P;// in watt
// The magnitude of the power being measured is 100
   watts.
PerLimitError= del_P/100*100;// in %
disp(PerLimitError,"The percentage limiting error at
    1000 watt ")
```

Scilab code Exa 2.10 Addition of resistance

```
// Exa 2.10
clc;
clear;
close;
// Given data
// For positive value of error
R1= 100+100*2/100;//in ohm
R2= 200+200*2.5/100;// in ohm
AddR1R2_pos= R1+R2;// in ohm
// For negative value of error
```

```
R1= 100-100*2/100;//in ohm
R2= 200-200*2.5/100;// in ohm
AddR1R2_neg= R1+R2;// in ohm
disp("Values of R1+R2 in ohm are "+string(
    AddR1R2_neg)+" ohm to "+string(AddR1R2_pos)+" ohm
    ")
```

Scilab code Exa 2.12 `Power dissipated`

```
// Exa 2.12
clc;
clear;
close;
// Given data
AV= 110.2;// true value of voltage in volt
AI= 5.3;// true value of current in amp
v= 0.2;// uncertainties in voltage in volt
i= 0.6;// uncertainties in current in amp
PLV= v/AV*100;// percentage limiting error to
    voltage drop
PLC= i/AI*100;// percentage limiting error to
    current
P= AV*AI;// in watt
disp(P,"The power dissipated in the resistor in watt
    ")
LE_P= (PLV+PLC);// limiting error in the power
    dissipation in pos and neg
disp(LE_P,"The limiting error in the power
    dissipation with pos and neg")
disp("Power dissipation")
disp(string(P-P*LE_P/100)+" to "+string(P+P*LE_P
    /100))
```

Scilab code Exa 2.13 Limiting error and power dissipation

```
// Exa 2.13
clc;
clear;
close;
// Given data
AR= 100;// true value of resistance in ohm
AI= 2;// true value of current in amp
R= 0.2;// uncertainties in resistance in ohm
I= 0.01;// uncertainties in current in amp
PLR= R/AR*100;// percentage limiting error to
    resistance
PLC= I/AI*100;// percentage limiting error to
    current
P=AI^2*AR;// in watt
LE_P= 2*PLC+PLR;// limiting error in the power
    dissipation
disp("Power dissipation")
disp(string(P-P*LE_P/100)+" to "+string(P+P*LE_P
    /100))
```

Scilab code Exa 2.14 Resolution of instrument

```
// Exa 2.14
clc;
clear;
close;
// Given data
FullScaleReading= 200;// in V
N= 100;// Number of division of scale
SD= FullScaleReading/N;// 1 scale division
Resolution = 1/5*SD;// in v
disp(Resolution,"Resolution in volt")
```

Scilab code Exa 2.15 Limiting error of the resulting capacitance

```
// Exa 2.15
clc;
clear;
close;
// Given data
// u= 150+2.4 miu F and 150-2.4 miu F
// v= 120+1.5 miu F and 120-1.5 miu F
y=150+120;
del_y = 2.4+1.5;// Pos and neg
disp(del_y,"Limiting error with pos and neg in miu F")
RelLimError= del_y/y*100;// in %
disp(RelLimError,"Relative limiting error with pos and neg");
```

Scilab code Exa 2.16 Uncertainly in the combined resistance

```
// Exa 2.16
clc;
clear;
close;
// Given data
R1= 1;//in kohm
R1=R1*10^3;//in ohm
del_R1ByR1= 1;
del_R2ByR2= 1;
R2= 500;//in kohm
R= R1*R2/(R1+R2);//in ohm
// Let R= X/Y
X= R1*R2;
```

```
Y=R1+R2;
ErrorX= del_R1ByR1+del_R2ByR2;// with pos and neg
// ErrorY= del_R1/Y + del_R2/Y = R1/Y*del_R1ByR1 + R2/Y*del_R2ByR2
ErrorY= R1/Y*del_R1ByR1 + R2/Y*del_R2ByR2;// with pos and neg
PerError= ErrorX+ErrorY;// in % with pos and neg
disp(PerError,"Percentage error (maximum posible) in equivalent parallel resistance with pos and neg")
Error= 333.33*PerError/100;
Error=ceil(Error);
disp(Error,"Error (maximum possible) in equivalent parallel resistance in ohm")
```

Scilab code Exa 2.17 Magnitude of the resultant resistance

```
// Exa 2.17
clc;
clear;
close;
// Given data
R1= 200;//in ohm
R2= 100;//in ohm
R3= 50;//in ohm
del_R1ByR1= 5;
del_R2ByR2= 5;
del_R3ByR3= 5;
// Part (i) when the resistance are connected in series
Rse= R1+R2+R3;// in ohm
disp(Rse,"Equivalent resistance when connected in seried in ohm");
LimError= R1/Rse*del_R1ByR1 + R2/Rse*del_R2ByR2 + R3/Rse*del_R3ByR3;
```

```
disp(LimError,"Relative limiting error of series resistances in percentage (with pos and neg)") ;
LimError= Rse*LimError/100;//relative limiting error of series equivalent resistance in ohm
disp(LimError,"Relative limiting error of series equivalent resistance in ohm")

// Part(ii) when the resistance are connected in parallel
Rp= R1*R2*R3/(R1*R2+R2*R3+R3*R1);
disp(Rp,"Equivalent resistance when connected in parallel in ohm")
// Let Rp= X/Y
X= R1*R2*R3;
Y=R1*R2+R2*R3+R3*R1;
y1= R1*R2;
y2= R2*R3;
y3= R3*R1;
ErrorX= del_R1ByR1 + del_R2ByR2 + del_R3ByR3;
Errory1= del_R1ByR1 + del_R2ByR2 ;
Errory2= del_R2ByR2 + del_R3ByR3 ;
Errory3= del_R3ByR3 + del_R1ByR1 ;
ErrorY= [ y1/Y*Errory1 + y2/Y*Errory2 + y3/Y*Errory3 ];
LimError= ErrorX+ErrorY;
disp(LimError,"Percentage error (maximum possible) in equivalent parallel resistance in percentage")
LimError= Rp*LimError/100;
disp(LimError,"Error (maximum possible) in equivalent parallel resistance in ohm")
```

Scilab code Exa 2.18 Power and limiting error of power

```
// Exa 2.18
clc;
```

```
clear;
close;
// Given data
epsilon_r= 1.5/100;
V=100;// in volt
I=150;// in mA
del_V= epsilon_r*V;// in volt
Vm= 70;// magnitude of voltage being measured in
    volt
PerLimError_V= del_V/Vm*100;// in %
del_I= epsilon_r*I;// in mA
Im= 80;//in mA
PerLimError_C= del_I/Im*100;// in %
P= Vm*Im/1000;// in watt
RelLImError_P= (PerLimError_V+PerLimError_C);// in %
disp(RelLImError_P,"Relative limiting error in power
     measurement in percentage")
```

Scilab code Exa 2.19 Nominal power consumed and limiting error of power

```
// Exa 2.19
clc;
clear;
close;
// Given data
E= 200;// in V
del_E_by_E= 1;
R=1000;// in ohm
del_R_by_R= 5;
P=E^2/R;// in watt
disp(P,"Normal power consumed in watt")
LimError= 2*del_E_by_E+del_R_by_R;// in %
disp(LimError,"Relative limiting error in
    measurement of power in percentage")
LimError= LimError*P/100;//in watt
```

```
disp(LimError,"Limiting error of power in watt")
```

Scilab code Exa 2.20 Nominal value of unknown resistance

```
// Exa 2.20
clc;
clear;
close;
// Given data
R1= 500;// in ohm
R2= 615;// in ohm
R3= 100;// in ohm
delR1ByR1= 1;
delR2ByR2= 1;
delR3ByR3= 0.5;
// Part(i)
R4=R1*R2/R3;// in ohm
disp(R4,"Unknown resistance in ohm")
delR4ByR4= delR1ByR1+delR2ByR2+delR3ByR3;
disp(delR4ByR4,"Relative limiting error of unknown
    resistance in percentage")
LimError= R4*delR4ByR4/100;
disp(LimError,"Limiting error in ohms");
```

Scilab code Exa 2.21 Relative error in power factor

```
// Exa 2.21
clc;
clear;
close;
// Given data
del_PbyP=0.5;
del_CbyC=1;
```

```
del_VbyV=1;
del_PFbyPF=del_PbyP + del_CbyC + del_VbyV;
disp(del_PFbyPF,"Relative limiting error in
    percentage (with pos and neg)")
```

Scilab code Exa 2.22 Magnitude of unknown inductance

```
// Exa 2.22
clc;
clear;
close;
// Given data
C=1;// in miu F
C=C*10^-6;// in F
P=1000;// in ohm
Q=2000;// in ohm
r=200;// in ohm
S=2000;// in ohm
del_C_by_C= 1;
del_P_by_P= 0.4;
del_Q_by_Q= 1;
del_r_by_r= 0.5;
del_S_by_S= 0.5;
Lx= C*P/S*(r*(Q+S)+Q*S);// in Henry
disp(Lx,"Unknown inductance in Henry")
// Let
u=Q+S;// in ohm
Error_u= Q/u*del_Q_by_Q + S/u*del_S_by_S;// in %
// Let v= r*(Q+S) = r*u
v= r*(Q+S);
Error_v= del_r_by_r + Error_u;// in %
// Let
x=Q*S;
Error_x= del_Q_by_Q + del_S_by_S;// in %
// Let y= r*(Q+S)+Q*S = v+x
```

```
y=v+x;
Error_y= v/y*Error_v + x/y*Error_x;// in %
del_Lx_by_Lx= del_C_by_C + del_P_by_P + del_S_by_S +
    Error_y;// in %
disp(del_Lx_by_Lx,"Percentage error in inductance")
```

Scilab code Exa 2.23 Uncertainly in the measurement of Z

```
// Exa 2.23
clc;
clear;
close;
// Given data
R=100;// in ohm
del_R_by_R= 5;
L=2;// in Henry
del_L_by_L= 10;
omega= 2*%pi*50;
// Let
u=R^2;
Error_u= 2*del_R_by_R;
// Let
v= omega^2*L^2;
Error_v= 2*del_L_by_L;
// Let
x= u+v;
Error_x= u/x*Error_u + v/x*Error_v;// in %
// Now
Z= x^(1/2);
Error_Z= 1/2*Error_x;
disp(Error_Z,"The uncertainly in the measurement of
   Z in percentage")
```

Scilab code Exa 2.24 Standard Deviation

```
// Exa 2.24
clc;
clear;
close;
// Given data
x1= 49.7;
x2= 50.1;
x3= 50.2;
x4= 49.6;
x5= 49.7;
n=5;
x_bar= (x1+x2+x3+x4+x5)/5;
d1= x1-x_bar;
d2= x2-x_bar;
d3= x3-x_bar;
d4= x4-x_bar;
d5= x5-x_bar;
s= sqrt((d1^2+d2^2+d3^2+d4^2+d5^2)/(n-1));
disp(s,"Standard deviation")
```

Scilab code Exa 2.25 Mean standard deviation

```
// Exa 2.25
clc;
clear;
close;
// Given data
x1= 41.7;
x2= 42;
x3= 41.8;
x4= 42;
x5= 42.1;
x6= 41.9;
```

```
x7= 42.5;
x8= 42;
x9= 41.9;
x10=41.8;
n=10;
// (i)
x_bar= (x1+x2+x3+x4+x5+x6+x7+x8+x9+x10)/10;
disp(x_bar,"Arithmetic mean")
d1= x1-x_bar;
d2= x2-x_bar;
d3= x3-x_bar;
d4= x4-x_bar;
d5= x5-x_bar;
d6= x6-x_bar;
d7= x7-x_bar;
d8= x8-x_bar;
d9= x9-x_bar;
d10= x10-x_bar;
// (ii)
sigma= sqrt((d1^2+d2^2+d3^2+d4^2+d5^2+d6^2+d7^2+d8^2+d9^2+d10^2)/(n-1));
disp(sigma,"Standard deviation");

// (iii)
r= 0.6745*sigma;
disp(r,"Probable error of one reading")
```

Scilab code Exa 2.26 Arithmetic mean average deviation

```
// Exa 2.26
clc;
clear;
close;
// Given data
x1= 1.570;
```

```
x2= 1.597;
x3= 1.591;
x4= 1.562;
x5= 1.577;
x6= 1.580;
x7= 1.564;
x8= 1.586;
x9= 1.550;
x10=1.575;
n=10;
// (i)
x_bar= (x1+x2+x3+x4+x5+x6+x7+x8+x9+x10)/10;
disp(x_bar,"Arithmetic mean in gramme")
d1= x1-x_bar;
d2= x2-x_bar;
d3= x3-x_bar;
d4= x4-x_bar;
d5= x5-x_bar;
d6= x6-x_bar;
d7= x7-x_bar;
d8= x8-x_bar;
d9= x9-x_bar;
d10= x10-x_bar;

// (ii)
D= (abs(d1)+abs(d2)+abs(d3)+abs(d4)+abs(d5)+abs(d6)+abs(d7)+abs(d8)+abs(d9)+abs(d10))/n;// in gramme
disp(D,"Average deviation in gramme")

// (iii)
sigma= sqrt((d1^2+d2^2+d3^2+d4^2+d5^2+d6^2+d7^2+d8^2+d9^2+d10^2)/(n-1));// in gramme
disp(sigma,"Standard deviation in gramme");

// (iv)
V= sigma^2;// variance in gramme^2
disp(V,"Variance in gramme^2");

```

```
// (v)
r= 0.6745*sigma;// in gramme
disp(r,"Probable error gramme")

// (vi)
rm= r/sqrt(n-1);// in gramme
disp(rm,"Probable error of mean in gramme")
```

Chapter 3

PMMC Instruments

Scilab code Exa 3.1 Torque developed by the each coil

```
// Exa 3.1
clc;
clear;
close;
// Given data
N= 100;
A=4*3;// in cm^2
A=A*10^-4;// in m^2
i=20;// in mA
i=i*10^-3;// in A
B=0.05;// in T
T=N*i*B*A;//in Nm
disp(T,"Torque developed by the coil in Nm")
```

Scilab code Exa 3.2 Deflection

```
// Exa 3.2
clc;
```

```
clear;
close;
// Given data
N= 125;
A=4*2.5;// in cm^2
A=A*10^-4;// in m^2
i=25;// in mA
i=i*10^-3;// in A
B=0.06;// in T
Td=N*i*B*A;//in Nm
Tc_BY_theta= 25*10^-7;// in Nm/
// Formula Tc=Td
theta= Td/Tc_BY_theta;// in
disp(theta,"Deflection in degree")
```

Scilab code Exa 3.3 Deflection produced by the 300 V

```
// Exa 3.3
clc;
clear;
close;
// Given data
N= 100;
B=6*10^-2;// in Wb/m^2
A=3*4;// in cm^2
A=A*10^-4;// in m^2
V=300;// in volt
R=12000;// in ohm
i= V/R;// in amp
Td=N*i*B*A;//in Nm
Tc_BY_theta= 25*10^-7;// in Nm/
// Formula Tc=Td
theta= Td/Tc_BY_theta;// in
disp(theta,"Deflection in degree")
```

Scilab code Exa 3.4 Angle through which the coil turns

```
// Exa 3.4
clc;
clear;
close;
// Given data
d= 42;// in mm
d=d*10^-3;// in meter
r= 0.6;// in meter
// Formula d= 2*theta*r
theta= d/(2*r);// radian
theta= 180*theta/%pi;// in
disp(round(theta),"Angle through which coil turn in
    ");
```

Scilab code Exa 3.5 Number of turns

```
// Exa 3.5
clc;
clear;
close;
// Given data
B=1.8*10^-3;// in Wb/m^2
K= 1.4*10^-7;// in Nm/radian
theta= 90;// in
theta=theta*%pi/180;
Tc= K*theta;// in N-m
i=5;// in mA
i=i*10^-3;// in amp
A=1.5*1.2;// in cm^2
A=A*10^-4;// in m^2
```

```
// Formula Tc= Td= B*i*A*N;
N= Tc/(B*i*A);
N=ceil(N);
disp(N,"Number of turns is")
```

Scilab code Exa 3.6 Current in the coil

```
// Exa 3.6
clc;
clear;
close;
// Given data
B=0.1;// in T
C= 100*10^-7;// in Nm/radian
theta= 120;// in
theta=theta*%pi/180;
Tc= C*theta;// in N-m
N=200;// number of turns
A=2.5*2;// in cm^2
A=A*10^-4;// in m^2
// Formula Tc= Td= B*i*A*N;
i= Tc/(B*A*N);// in amp
disp(i*10^3,"Current in the coil in mA")
```

Scilab code Exa 3.7 Current sensitivity voltage sensitivity megohm sensitivity

```
// Exa 3.7
clc;
clear;
close;
// Given data
d=150;// in mm
i=2.5;// in micro amp
```

```
R=200;// in ohm
V= R*i;// in micro volt
r=2.5;// in meter
// Part(i)
Si= d/i;// in mm/micro amp
disp(Si,"Current sensitivity in mm/micro amp")

// Part(ii)
Sv= d/V;// in mm/micro volt
disp(Sv,"Voltage sensitivity in mm/micro volt")

// Part(iii)
So= 1/(1/60*10^-6);// in ohm/mm
So=So*10^-6;// in Mohm
disp(So,"Megohm sensitivity in Mohm/mm")

// Part(iv)
i=5;// in micro amp
d=60*i;// in mm
d=d*10^-3;// in meter
theta=d/(2*r);//in radian
disp(theta,"Deflection in radians")
```

Scilab code Exa 3.8 Value of the shunt resistance

```
// Exa 3.8
clc;
clear;
close;
// Given data
Im= 50*10^-6;// in amp
Rm= 1000;// in ohm
I=1;// in amp
Rs= Rm/(I/Im-1);// in ohm
disp(Rs,"Resistance of ammeter shunt required in ohm
```

```
")
```

Scilab code Exa 3.9 Current range of instrument

```
// Exa 3.9
clc;
clear;
close;
// Given data
Rm= 1.0;// in ohm
Rse= 4999;// in ohm
V=250;// full scale deflection voltage in volt
// Formula V= Im*(Rm+Rse)
Im= V/(Rm+Rse);// in amp

// Part(a)
Rs= 1/4999;// in ohm
Is= Im*Rm/Rs;//in amp
I= Im+Is;// in amp
disp(I,"Current range in amp")

// Part(b)
I=50;// in amp
N=I/Im;
Rs= Rm/(N-1);// in ohm
disp(Rs,"Required shunt resistance in ohm")
```

Scilab code Exa 3.10 Main circuit current

```
// Exa 3.10
clc;
clear;
close;
```

```
// Given data
Im= 50;// in micro amp
Im=Im*10^-6;// in amp
Rm= 49;// in ohm
Rs= 1;// in ohm
Is= Im*Rm/Rs;//in amp
I= Im+Is;// in amp
// (i)
I1= I;// in amp
I2= I*0.5;// in amp
I3= I*0.1;// in amp
disp(I1*10^3,"Main circuit current at FSD in mA")
disp(I2*10^3,"Main circuit current at 0.5 FSD in mA"
   )
disp(I3*10^3,"Main circuit current at 0.1 FSD in mA"
   )
```

Scilab code Exa 3.11 Necessary value of resistors

```
// Exa 3.11
clc;
clear;
close;
// Given data
Rm= 40;// in ohm
Im= 1;// in mA
// For switch at position 1 (lowest range of 10 mA)
I=10;// in mA
N1= I/Im;
R1= Rm/(N1-1);// in ohm
// For switch at position 2 (range of 20 mA)
I=20;// in mA
N2= I/Im;
R2= (R1+Rm)/N2;// in ohm
// For switch at position 3 (range of 30 mA)
```

```
I=30;// in mA
N3= I/Im;
R3= (R1+Rm)/N3;// in ohm
// For switch at position 4 (range of 40 mA)
I=40;// in mA
N4= I/Im;
R4= (R1+Rm)/N4;// in ohm
// For switch at position 5 (range of 50 mA)
I=50;// in mA
N5= I/Im;
R5= (R1+Rm)/N5;// in ohm
r1= R1-R2;// in ohm
r2= R2-R3;// in ohm
r3= R3-R4;// in ohm
r4= R4-R5;// in ohm
r5= R5;// in ohm
disp("Resistance of the various sections of the
    Ayrtons shunt in ohm are: ")
disp(r1);
disp(r2);
disp(r3);
disp(r4);
disp(r5);
```

Scilab code Exa 3.12 Three ranges of ammeter

```
// Exa 3.12
clc;
clear;
close;
// Given data
Rm= 1000;// in ohm
Im= 1;// in mA
Im=Im*10^-3;// in amp
r3=0.05;// in ohm
```

```
r2=0.45;// in ohm
r1=4.5;// in ohm
// For switch at contact 1
Rm1= Rm;// in ohm
Rs1= r1+r2+r3;// in ohm
I1= Im*(Rm1/Rs1+1);// in A
I1=I1*10^3;// in mA
I1=round((I1/10))*10;

disp(I1,"Ammeter range at contact 1 in mA")
// For switch at contact 2
Rm2= Rm+r1;// in ohm
Rs2= r2+r3;// in ohm
I2= Im*(Rm2/Rs2+1);// in A
I2=round(I2);
disp(I2,"Ammeter range at contact 2 in A")

// For switch at contact 3
Rm3= Rm+r1+r2;// in ohm
Rs3= r3;// in ohm
I3= Im*(Rm3/Rs3+1);// in A
I3=round(I3);
disp(I3,"Ammeter range at contact 3 in A")
```

Scilab code Exa 3.13 Shunt resistance required

```
// Exa 3.13
clc;
clear;
close;
// Given data
Rm= 10;// in ohm
Im= 50;// in mA
Im=Im*10^-3;// in amp
V=750;// in volt
```

```
R= V/Im-Rm;// in ohm
disp(R,"External resistance in ohm")
// Part(ii)
I=100;// in A
N=I/Im;
Rs= Rm/(N-1);// in ohm
disp(Rs,"Shunt resistance required in ohm")
```

Scilab code Exa 3.14 Estimate the resistance

```
// Exa 3.14
clc;
clear;
close;
// Given data
Tc= 120*10^-6;// in N-m
B= 0.5;// in wb/m^2
N=100;
A= 4*3;// in cm^2
A=A*10^-4// in m^2
Rm=0;
V= 100*1;
// Formula Tc= Td = B*I*N*A
I= Tc/(B*N*A);// in amp
R= V/I-Rm;// in ohm
disp(R,"External required resistance in ohm")
```

Scilab code Exa 3.15 Applied voltage

```
// Exa 3.15
clc;
clear;
close;
```

```
// Given data
Im= 0.2*10^-3;// in amp
Rm= 10;// in ohm
V=100;// in volt
R= V/Im-Rm;// in ohm
disp(R*10^-3,"External required resistance in kohm")
Im1= 0.75*Im;//in amp
V1= Im1*(R+Rm);// in volt
disp(V1,"Applied voltage at instrument current 0.75 FSD in volt");

Im2= 0.5*Im;//in amp
V2= Im2*(R+Rm);// in volt
disp(V2,"Applied voltage at instrument current 0.5 FSD in volt");

Im3= 0.25*Im;//in amp
V3= Im3*(R+Rm);// in volt
disp(V3,"Applied voltage at instrument current 0.25 FSD in volt");

Im4= 0.1*Im;//in amp
V4= Im4*(R+Rm);// in volt
disp(V4,"Applied voltage at instrument current 0.1 FSD in volt");
```

Scilab code Exa 3.16 `Additional resistance required`

```
// Exa 3.16
clc;
clear;
close;
// Given data
CS= 0.1*10^-3;// current sensitivity in amp
VS= 1/CS;// voltage sensitivity in ohm/volt
```

```
VS= VS*10^-3;// in kohm/volt
Rm=500;// in ohm
Rm=Rm*10^-3;// in kohm

// (i) 0-10 V range
V=10;// full scale delection voltage in volt
R_T= VS*V;// in kohm
R1= R_T-Rm;// in kohm
disp(R1,"Additional required resistance at 0-10 V
    range in kohm")

// (ii) 0-50 V range
V=50;// full scale delection voltage in volt
R_T= VS*V;// in kohm
R2= R_T-R1-Rm;// in kohm
disp(R2,"Additional required resistance at 0-50 V
    range in kohm")

// (i) 0-100 V range
V=100;// full scale delection voltage in volt
R_T= VS*V;// in kohm
R3= R_T-R1-R2-Rm;// in kohm
disp(R3,"Additional required resistance at 0-100 V
    range in kohm")

// (i) 0-500 V range
V=500;// full scale delection voltage in volt
R_T= VS*V;// in kohm
R4= R_T-R1-R2-R3-Rm;// in kohm
disp(R4,"Additional required resistance at 0-500 V
    range in kohm")
```

Scilab code Exa 3.17 `Instrument indication`

```
// Exa 3.17
```

```
clc;
clear;
close;
// Given data
E= 1.5;// in V
R1addRm= 10;// addition of R1 and Rm in kohm
Rx= 0;
R=R1addRm+Rx;// in kohm
R=R*10^3;// in ohm
I= E/R;//meter FSD current in amp

// At 0.8 FSD
Im= 0.8*I;// in amp
R= E/Im;// in ohm
R=R*10^-3;// in kohm
Rx= R-R1addRm;//in kohm
disp(Rx,"Unknown resistance at 0.8 FSD in k ")

// At 0.5 FSD
Im= 0.5*I;// in amp
R= E/Im;// in ohm
R=R*10^-3;// in kohm
Rx= R-R1addRm;//in kohm
disp(Rx,"Unknown resistance at 0.5 FSD in k ")

// At 0.25 FSD
Im= 0.25*I;// in amp
R= E/Im;// in ohm
R=R*10^-3;// in kohm
Rx= R-R1addRm;//in kohm
disp(Rx,"Unknown resistance at 0.25 FSD in k ")

// At 0.1 FSD
Im= 0.1*I;// in amp
R= E/Im;// in ohm
R=R*10^-3;// in kohm
Rx= R-R1addRm;//in kohm
disp(Rx,"Unknown resistance at 0.8 FSD in k ")
```

Scilab code Exa 3.18 New resistance value

```
// Exa 3.18
clc;
clear;
close;
// Given data
Rm= 50;// in ohm
R1= 10;// in kohm
R1=R1*10^3;// in ohm
R2= 50;// in ohm
Im_FSD= 100*10^-6;//meter FSD current in amp

// At 0.5 FSD , with 1.5 V
E=1.5;// in volt
Im= 0.5*Im_FSD;// in amp
Vm= Im*Rm;// in volt
I0= Vm/R2;//in amp
I=I0+Im;// in amp
Rx= E/I-R1;// in ohm
Rx=Rx*10^-3;//in kohm
disp(Rx,"Unknown resistance at 0.5 FSD with 1.5 V in
    kohm")
// With E= 1.25 V and Rx=0
E=1.25;// in volt
Rx=0;
I=E/(R1+Rx);// in amp
I0=I-Im_FSD;// in amp
Vm= Im_FSD*Rm;// in volt
R2= Vm/I0;// in ohm
disp(R2,"Zero adjuster resistance in ohm")

// At 0.5 FSD , with 1.25 V
E=1.25;// in volt
```

```
Im= 0.5*Im_FSD;// in amp
Vm= Im*Rm;// in volt
I0= Vm/R2;//in amp
I=I0+Im;// in amp
Rx= E/I-R1;// in ohm
Rx=Rx*10^-3;//in kohm
disp(Rx,"Unknown resistance at 0.5 FSD with 1.25 V
    in kohm")
```

Chapter 4

Digital Meters

Scilab code Exa 4.1 `Meter current voltmeter inpur`

```
// Exa 4.1
clc;
clear;
close;
// Given data
V_CC= 12;// in volt
V_BE=0.7;//in volt
Rsm=4.3;//value o Rs+Rm in kohm
I=1;//in mA

// Part (i)
V= 5;//in volt
V_E= V-V_BE;// in volt
Im= V_E/Rsm;// in mA
I_E=Im;// in mA
disp(Im,"Meter Current in mA")

// Part(ii)
h_FE= 100;
Im=Im*10^-3;//in amp
I_B= Im/h_FE;// in amp
```

```
Rin= V/I_B;// in ohm
disp(Rin*10^-3,"Input resistance with transistor in kohm")
// without transistor
Rin= Rsm;
disp(Rin,"Input resistance without transistor in kohm")

// Part(iii)
V=2.5;// in volt
V_E= V-V_BE;// in volt
Im= V_E/Rsm;// in mA
I_E=Im;// in mA
disp(Im,"Meter current when the dc input voltage is 2.5 volt in mA")
```

Scilab code Exa 4.2 `Meter circuit voltage`

```
// Exa 4.2
clc;
clear;
close;
// Given data
V_CC= 12;// in volt
V_BE=0.7;//in volt
R_E1=3.3;// in kohm
V_EE= -12;// in volt
// Part (a) when V=0
V= 0;//in volt
V_E1= V-V_BE-V_EE;// in volt
I_E1= V_E1/R_E1;// in mA
disp(I_E1,"emitter current when input voltage is zero volt , in mA")

// Part(b)
```

```
// Part (i) when V=2 volt
V= 2;//in volt
V_P=0;
V_E1= V-V_BE;// in volt
V_E2= V_P-V_BE;// in volt
Vm= V_E1-V_E2;// in volt
disp(Vm,"Meter circuit voltage when input voltage is
    2 volt , in volt")

// Part (ii) when V=1 volt
V= 1;//in volt
V_P=0;
V_E1= V-V_BE;// in volt
V_E2= V_P-V_BE;// in volt
Vm= V_E1-V_E2;// in volt
disp(Vm,"Meter circuit voltage when input voltage is
    1 volt , in volt")
```

Scilab code Exa 5.2 Analog output voltage

```
// Exa 5.2
clc;
clear;
close;
// Given data
V_REF= -5;// in volt
V_A= -5;// in volt
V_C=V_A;// in volt
V_D=V_C;// in volt
V_B= 0;
Vout= -1*(V_A+V_B/2+V_C/4+V_D/8);
disp(Vout,"Output voltage in volt");
```

Scilab code Exa 4.4 `Suitable value of R1 and Rf`

```
// Exa 4.4
clc;
clear;
close;
// Given data
Im= 200;// in micro A
Im=Im*10^-6;// in amp
Rm= 5;// in kohm
Rm=Rm*10^3;// in ohm
I_B= 0.5;// in micro amp
I_B=I_B*10^-6;// in amp
V=25;// in mV
V=V*10^-3;// in volt
Vout= Im*Rm;// in volt
I= 500*I_B;// in amp
R1= V/I;// in ohm
disp(R1,"Resistor in ohm")
Rf= (Vout-V)/I;// in ohm
disp(Rf*10^-3,"Feedback resistor in kohm")
```

Scilab code Exa 4.5 `Value of R1`

```
// Exa 4.5
clc;
clear;
close;
// Given data
Im= 1;// in mA
Im=Im*10^-3;// in amp
Rm= 100;// in ohm
V=1.2;// in volt
R1= V/Im;// in ohm
disp(R1*10^-3,"Resistance in kohm")
```

```
Vout= Im*(Rm+R1);// in volt
disp(Vout,"Output voltage in volt")
```

Scilab code Exa 4.6 Value of R2 and meter deflection

```
// Exa 4.6
clc;
clear;
close;
// Given data
Vrms=120;// in mV
Iav= 1.25;// in mA
I_max= 1/0.318*Iav;// in mA
Vmax= sqrt(2)*Vrms;// in mV
R2= Vmax/I_max;// in ohm
disp(R2,"Value of R2 in ohm")
// when input voltage is 60 volt
Vrms=60;// in mV
Vmax= sqrt(2)*Vrms;// in mV
I_max= Vmax/R2;// in mA
Iav= I_max*0.318;// in mA
disp(Iav,"Average value of meter current in mA")
```

Chapter 5

Digital Meters

Scilab code Exa 5.1 Resolution and Full scale output

```
// Exa 5.1
clc;
clear;
close;
// Given data
V_REF= 10;// in volt
w2= V_REF/2;// The second MSB weight in volt
disp(w2,"The second MSB weight in volt")
w3= V_REF/4;// The third MSB weight in volt
disp(w3,"The third MSB weight in volt")
w4= V_REF/8;// The forth MSB weight in volt
disp(w4,"The forth MSB weight in volt")

// (i)
r_DAC= w4;// resolution of the DAC in volt
disp(r_DAC,"Resolutio of the DAC in volt");

//(ii)
FSO= V_REF+w2+w3+w4;//full scale output in volt
disp(FSO,"Full scale output in volt")

```

```
// (iii)
FSO_R= FSO/4;// full scale output when the feedback resistor is made one fourth of R in volt
disp(FSO_R,"The full scale output when the feedback resistor is made one fourth of R i volt")
```

Scilab code Exa 5.2 Analog output voltage

```
// Exa 5.2
clc;
clear;
close;
// Given data
V_REF= -5;// in volt
V_A= -5;// in volt
V_C=V_A;// in volt
V_D=V_C;// in volt
V_B= 0;
Vout= -1*(V_A+V_B/2+V_C/4+V_D/8);
disp(Vout,"Output voltage in volt");
```

Scilab code Exa 5.3 Resolution and full scale output

```
// Exa 5.3
clc;
clear;
close;
// Given data
D=16;
D1= D/2;// first MSB output in volt
disp(D1,"First MSB output in volt");
D2= D/4;// second MSB output in volt
disp(D2,"Second MSB output in volt");
```

```
D3= D/8;// third MSB output in volt
disp(D3,"Third MSB output in volt");
D4= D/16;// fourth MSB output in volt
disp(D4,"Fourth MSB output in volt");
D5= D/32;// fifth MSB output in volt
disp(D5,"Fifth MSB output in volt");
D6= D/64;// sixth MSB (LSB) output in volt
disp(D6,"Sixth MSB (LSB) output in volt");
disp(D6,"The resolution is equal to the weight of the LSB in volt. ")
// Full scale output occurs for a digital input of 111111
FSO= D1+D2+D3+D4+D5+D6;// in volt
disp(FSO,"Full scale output occurs for a digital input of 111111 in volt")
// The output voltage for a digital input of 101011
D0=16;
D1=16;
D2=0;
D3=16;
D4=0;
D5=16;
Vout= ( D0*2^0 + D1*2^1 + D2*2^2 + D3*2^3 + D4*2^4 + D5*2^5  )/64;// in volt
disp(Vout,"The output voltage for  digital input of 101011 in volt")
```

Scilab code Exa 5.4 Value of Vx

```
// Exa 5.4
clc;
clear;
close;
// Given data
R=100;// in kohm
```

```
R=R*10^3;//in ohm
C=1*10^-6;// in F
V_REF= 5;// in volt
t=0.2;// time taken to read unknown voltage in sec
T=R*C;// in sec
Vx= T/t*V_REF;// in volt
disp(Vx,"Unknown voltage in volt")
```

Scilab code Exa 5.5 Conversion time

```
// Exa 5.5
clc;
clear;
close;
// Given data
// For an 8-bit converter reference voltage V_REF be
    taken as 100 V
V_REF= 100;// in volt
f=75*10^6;// in Hz
// For setting
D7=1;
Vout1= V_REF*2^7/2^8;// in volt
disp(Vout1,"Output voltage in volt")
// since 180-100 = 80 > 50; set D7=1

// For setting
D6=1;
Vout2= V_REF*2^6/2^8;// in volt
disp(Vout2,"Output voltage in volt")
// Hence for setting D7=1 and D6=1 output voltage
Vout3= Vout1+Vout2;// in volt
disp(Vout3,"Output voltage in volt")
// since 80>75; set D6=1
// For setting D5=1, D6=1 and D7=1
Vout4   = V_REF*2^5/2^8 + Vout1+ Vout2;// in volt
```

```
disp(Vout4,"Output voltage in volt")
disp("All other digits will be set to zero or 1. Output will be accordingly indicated as a result of successive approximation. The Converted 8-bit digital form will be 1110010")
T=1/f;//in sec
disp(T*10^9,"Conversion time in ns")
```

Scilab code Exa 5.6 `Time of conversion`

```
// Exa 5.6
clc;
clear;
close;
// Given data
N=8;// Number of bits
f=1*10^6;// in Hz
T=1/f;
Tc= N*T;// in second
disp(Tc*10^6,"Time of conversion in micro second")
```

Scilab code Exa 5.7 `Maximum time upto which the reference voltage can be integrate`

```
// Exa 5.7
clc;
clear;
close;
// Given data
Vin= 2;// in volt
Vout= 10;// in volt
R=100;// kohm
R=R*10^3;// in ohm
C= 0.1;// in miu F
```

```
C=C*10^-6;// in F
//  Vout= -1/(R*C)*integrate('Vin','t',0,t) = -Vin*t
    /(R*C)
t= Vout*R*C/Vin;// in sec
disp(t*10^3,"The maximum time upto which the
    reference voltage can be integrated in ms");
```

Scilab code Exa 5.8 Possible error in volt

```
// Exa 5.8
clc;
clear;
close;
// Given data
n=3;
R=1/10^n;
fs1=1;// full scale range of 1 v
r1= fs1*R;// resolution for full scale range of 1 V
disp(r1,"Resolution for full scale range of 1 V")
fs2=10;// full scale range of 10 v
r2= fs2*R;// resolution for full scale range of 10 V
disp(r2,"Resolution for full scale range of 10 V")
// The display for 2 V reading on 10 V scale of
    3*1/2 digital meter would be 02.00 i.e
reading=2;
LSD= 5*R;// in volt
Total_pos_Error= reading*0.5/100+LSD;//in volt
disp(Total_pos_Error,"Total possible error in volt")
```

Scilab code Exa 5.9 Resolution of voltmeter

```
// Exa 5.9
clc;
```

```
clear;
close;
// Given data
R= 1/10^4;// resolution
disp(R,"Resolution of voltmeter is : ")
reading1= 16.58;
reading2= 0.7254;
disp("There are 5 digit places in 4  display , so "+string(reading1)+" would be displayed as 16.580 V on a 10V range ")
disp(reading2,"Any reading up to 4th decimal can be displayed. Hence "+string(reading2)+" will be displayed as ")
R= 10*R;// resolution on 10 V range
format('v',6);
disp("Resolution of 10 V range is "+string(R)+" So")
disp(reading2,"0.7254 will be displayed as ")
```

Scilab code Exa 5.10 Resolution of the instrument

```
// Exa 5.10
clc;
clear;
close;
// Given data
n=3;
R=1/10^n;
fs1=10;// full scale range of 10 v
r1= fs1*R;// resolution for full scale range of 10 V
disp(r1,"Resolution for full scale range of 10 V")
fs2=100;// full scale range of 100 v
r2= fs2*R;// resolution for full scale range of 100 V
disp(r2,"Resolution for full scale range of 100 V")
disp("The display of 14.53 V reading on 10 V scale
```

```
would be 14.53")
disp("The display of 14.53 V reading on 100 V scale
   would be 0145.3")
```

Scilab code Exa 5.11 `Time taken to read the unknown voltage`

```
// Exa 5.11
clc;
clear;
close;
// Given data
Vmax= 255;// in volt
Vx= 180;// in volt
f=10;// in kHz
f=f*10^3;// in Hz
t= (Vmax-Vx)/(2*%pi*f*Vmax);// time taken to read
   the unknown voltage in second
t=t*10^6;// in micro second
disp(t,"Time taken to read the unknown voltage in
   micro second");
```

Scilab code Exa 5.12 `Display indication`

```
// Exa 5.12
clc;
clear;
close;
// Given data
f=2.5;// in kHz
f=f*10^3;// in Hz
// Part (i) when
t=0.1;// in sec
count= f*t;
```

```
disp(count,"When GATE ENABLE time is 0.1 sec then
    the counter will count or display")
// Part (ii) when
t=1;// in sec
count= f*t;
disp(count,"When GATE ENABLE time is 1 sec then the
    counter will count or display")
// Part (iii) when
t=10;// in sec
count= f*t;
disp(count,"When GATE ENABLE time is 10 sec then the
    counter will count")
```

Scilab code Exa 5.13 Frequency of the system

```
// Exa 5.13
clc;
clear;
close;
// Given data
N=045;// unit less
t=10;// in ms
t=t*10^-3;// in sec
f=N/t;// Hz
f=f*10^-3;// in kHz
disp(f,"Frequency in kHz")
```

Scilab code Exa 5.14 Resolution of measurement

```
// Exa 5.14
clc;
clear;
close;
```

```
// Given data
totalPulse= 174;// unit less
t=100;//time period of total pulses in miu s
t=t*10^-6;// in sec
t1= t/totalPulse;// time period of one pulse in sec
f= 1/t1;// frequency in Hz
f=f*10^-6;// in MHz
disp(f,"Frequency in MHz");
resolution= totalPulse/t;// in sec
resolution=resolution*10^-6;// per micro sec
disp(resolution,"Resolution of measurement per micro
    sec")
```

Scilab code Exa 5.15 Frequency of input signal

```
// Exa 5.15
clc;
clear;
close;
// Given data
t=1/(2*10^6); // time of one cycle o 2MHz clock in
   sec
N=500;// number of cycle
t1= N*t;// time of 1 cycle by the electronic counter
    in sec
f= 1/t1;// in Hz
f=f*10^-3;// in kHz
disp(f,"Frequency of input signal in kHz")
```

Chapter 6

Resistance Measurements

Scilab code Exa 6.1 Apparant resistance of the unknown resistor

```
// Exa 6.1
clc;
clear;
close;
// Given data
V= 100;// in volt
I=5;// in mA
I=I*10^-3;// in amp
VS= 1000;// sensitivity of voltmeter in ohm
VR= 150;// voltmeter range in volt
Rv= VS*VR;// in ohm
// Part (i)
Rm= V/I;// in ohm
Rm= Rm*10^-3;// in kohm
disp(Rm,"Apparent value of unknown resistor in kohm"
    );

// Part (ii)
Rx= V/(I*(1-V/(I*Rv)));// in ohm
Rx= Rx*10^-3;/// in kohm
disp(Rx,"Actual value of unknown resistor in kohm")
```

```

// Part (iii)
epsilon_r= (Rm-Rx)/Rx*100;// in %
disp(epsilon_r,"Error percentage due to loading effect of voltmeter");
```

Scilab code Exa 6.2 Resulting error

```
// Exa 6.2
clc;
clear;
close;
// Given data
V=38.4;// in volt
I=0.4;// in amp
ammeterRange= 1;// in amp
voltmeterRange= 50;// in volt
inst_acc= 1/2;// instrument accurcy in %
R= 100;// resistance in ohm

R_A= 2.5;// in ohm
R_V= 6000;// in ohm
Rx= sqrt(R_A*R_V);// in ohm
disp(Rx,"Value of unknown resistance in ohm")
disp("Since the unknown resistance is of value smaller than "+string(Rx)+" ohm, the voltmeter should be connected directly across the unknown resistance as it will give more accurate result")
Rm= V/I;// in ohm
Rx= V/(I*(1-V/(I*R_V)));// in ohm
ErrorAmmeter= inst_acc*ammeterRange/R;// Error in ammeter reading in amp
ErrorVoltmeter= inst_acc*voltmeterRange/R;// Error in voltmeter reading in volt
// Percentage error at 0.4 A reading
```

```
E1= ErrorAmmeter/0.4*100;//in %
// Percentage error at 38.4 V reading
E2= ErrorVoltmeter/38.4*100;//in %
//Error due to ammeter and voltmeter
E= sqrt(E1^2+E2^2);
//Absolute error due to ammeter and voltmeter
Error_ammeter_voltmeter= E/R*Rx;// in pos and neg
disp(Error_ammeter_voltmeter,"Absolute error due to ammeter and voltmeter in ohm")
disp("So the resistance is specified as "+string(Rx-Error_ammeter_voltmeter)+" to "+string(Rx+Error_ammeter_voltmeter));
```

Scilab code Exa 6.3 `Value of unknown resistance and limits of possible error`

```
// Exa 6.3
clc;
clear;
close;
// Given data
V=120;// in volt
I=8;// in amp
R_A= 0.3;// in ohm
ammeterReading= 0.01;// in A
voltmeterReading= 0.1;// in V
AmmeterRange= 10;//in A
VoltmeterRange= 150;//in V
EA= 0.25;// constructional error of the ammeter in %
EV= 0.5;// constructional error of the voltmeter in %

Rm= V/I;// in ohm
Rx= Rm-R_A;// in ohm
ErrorAmmeter= ammeterReading/AmmeterRange*100;// in %
```

```
ErrorVoltmeter= voltmeterReading/VoltmeterRange*100;
    // in %
del_I= ErrorAmmeter+EA;// in %
del_V= ErrorVoltmeter+EV;// in %
// since R=V/I
TotalError= del_I+del_V;// in % in neg and pos
disp(TotalError,"Total systematic error in
    measurement in % (neg and pos)")
disp("So the value of Rx is specified as "+string(Rx
    -Rx*TotalError/100)+" ohm to "+string(Rx+Rx*
    TotalError/100) +" ohm")
```

Scilab code Exa 6.4 Value of unknown resistance

```
// Exa 6.4
clc;
clear;
close;
// Given data
P=100;// in ohm
Q=10;// in ohm
S=46;// in ohm
R= P*S/Q;//in ohm
disp(R,"Unknown resistance in ohm")
```

Scilab code Exa 6.5 Value of unknown resistance

```
// Exa 6.5
clc;
clear;
close;
// Given data
S=6;// in ohm
```

```
AB= 25;// in cm
BC= 75;// in cm
R= S*AB/BC;// in ohm
disp(R,"Unknown resistance in ohm")
```

Scilab code Exa 6.6 `Dials required`

```
// Exa 6.6
clc;
clear;
close;
// Given data
resistor= 5000;// in ohm
LVR1= resistor-resistor*0.1/100;// Limiting value of 5000 ohm resistor in negative error
LVR2= resistor+resistor*0.1/100; //Limiting value of 5000 ohm resistor in positve error
disp("Limiting value of 5000 ohm resistance is "+string(LVR1)+" ohm to "+string(LVR2)+" ohm")
disp("Thus dials of 1000 , 100 , 10 and 1 ohm would to be adjusted");
```

Scilab code Exa 6.7 `Limiting values of unknown resistance`

```
// Exa 6.7
clc;
clear;
close;
// Given data
P=100;// in ohm
Q=100;// in ohm
S=230;// in ohm
R=P*S/Q;// in ohm
```

```
del_P_BY_P= 0.02;// in %
del_Q_BY_Q= 0.02;// in %
del_S_BY_S= 0.01;// in %
del_R_BY_R= del_P_BY_P + del_Q_BY_Q + del_S_BY_S;//
    in %
disp(del_R_BY_R,"Relative limiting error of unknown
    resistance in percentage")
disp("So limiting values of unknown resistance "+
    string(R-R*del_R_BY_R/100)+" ohm to "+string(R+R*
    del_R_BY_R/100)+" ohm")
```

Scilab code Exa 6.8 Magnitude and direction of current

```
// Exa 6.8
clc;
clear;
close;
// Given data
P=1000;// in ohm
Q=1000;// in ohm
S=100;// in ohm
E=2;// in volt
Rg=50;// in ohm
R_desh= 101;// in ohm
R=Q*S/P;// in ohm
del_R= R_desh-R;// in ohm
E_Th= E*[(R+del_R)/(R+del_R+S)- P/(P+Q)];// in volt
R_Th= [(R+del_R)*S/(R+del_R+S)+ P*Q/(P+Q)];//in ohm
Ig= E_Th/(R_Th+Rg);// in amp
Ig=Ig*10^+6;// in micro amp
disp(Ig,"The galvanometer current in micro amp")
```

Scilab code Exa 6.9 Sensitivity of the bridge

```
// Exa 6.9
clc;
clear;
close;
// Given data
P=100;// in ohm
Q=1000;// in ohm
S=2000;// in ohm
E=5;// in volt
Si= 5;// in mm/miuA
Rg=200;// in ohm
R_desh= 202;// in ohm
R=P*S/Q;// in ohm
del_R= R_desh-R;// in ohm
E_Th= E*[(R+del_R)/(R+del_R+S)- P/(P+Q)];// in volt
R_Th= [(R+del_R)*S/(R+del_R+S)+ P*Q/(P+Q)];//in ohm
Ig= E_Th/(R_Th+Rg);// in amp
Ig=Ig*10^+6;// in micro amp
theta= Si*Ig;// in mm
disp(theta,"Deflection of the galvanometer in mm")
S_B= theta/del_R;// in mm/ohm
disp(S_B,"Sensitivity of the bridge in mm/ohm")
```

Scilab code Exa 6.10 Ratio of galvanometer sensitivities

```
// Exa 6.10
clc;
clear;
close;
// Given data
P=1000;// in ohm
Q=100;// in ohm
R=200;// in ohm
E=5;// in volt
Si1= 10;// in mm/miuA
```

```
Si2= 5;// in mm/miuA
Rg1= 400;// in ohm
Rg2= 100;// in ohm
S=R*Q/P;// in ohm
R_Th= R*S/(R+S)+ P*Q/(P+Q);// in ohm
// theta=Si1*E*S*del_R/((R+S)^2*(R_Th+Rg))
// RatioTheta21= theta2/theta1
RatioTheta21= Si2/Si1*(R_Th+Rg1)/(R_Th+Rg2);
disp(RatioTheta21,"Ratio of deflection on two
    galvanometers ")
```

Scilab code Exa 6.11 Smallest change in resistance

```
// Exa 6.11
clc;
clear;
close;
// Given data
P=500;// in ohm
S=P;
Q=S;
R=P;
R_Th=R;// in ohm
Rg=100;// in ohm
E=10;// in volt
Ig= 1;// in nA
Ig=Ig*10^-9;//in amp
// Formula Ig= E_Th/(R_Th+Rg) and E_Th= E*del_R/(4*R
    ) so
// Ig= (E*del_R/(4*R))/(R_Th+Rg) and
del_R= Ig*(R_Th+Rg)*4*R/E;// in ohm
del_R= del_R*10^3;//in mohm
disp(del_R,"The smallest change in resistance in
    mohm")
```

Scilab code Exa 6.12 `Series resistance`

```
// Exa 6.12
clc;
clear;
close;
// Given data
R=200;// in ohm
S=R;
P=S;
Q=P;
r=2;// in ohm
E=24;// in volt
Power= 0.5;// in W
// Formula Power= I^2/R
I= sqrt(Power/R);// in A
disp(I,"Maximum power dissipation in amp")
V=I*2*R;// in volt
// Formula E= V+2*I*(r+R)
R= (E-V)/(2*I)-r;// in ohm
disp(R,"Series resistance in ohm")
```

Scilab code Exa 6.13 `Maximum value of resistance`

```
// Exa 6.13
clc;
clear;
close;
// Given data
P=10000;// in ohm
Q=10;// in ohm
S=5;// in kohm
```

```
S=S*10^3;// in ohm
E=12;// in volt
R=P*S/Q;// in ohm
disp(R*10^-6,"The maximum value of resistance that
    can be measurement with the given argument in
    Mohm")
R_Th= R*S/(R+S)+ P*Q/(P+Q);// in ohm

// Part (ii)
theta= 2.5;// in mm
Rg=100;// in ohm
Si=100;// in mm/miuA
Si=Si*10^6;// in mm/amp
del_R= theta*(R_Th+Rg)*(R+S)^2/(Si*E*S);// in ohm
disp(del_R*10^-3,"Change in resistance  in kohm")
```

Scilab code Exa 6.14 Unknown resistance

```
// Exa 6.14
clc;
clear;
close;
// Given data
p=200.62;// in ohm
q=400;// in ohm
P=200.48;// in ohm
Q=400;// in ohm
S=100.03;// in micro ohm
S=S*10^-6;// in ohm
r=700;// in micro ohm
r=r*10^-6;// in ohm
X= P*S/Q+q*r/(p+q)*(P/Q-p/q);// in ohm
disp(X*10^+6,"Unknown resistance in micro ohm")
```

Chapter 7

Inductance And Capacitance Measurements

Scilab code Exa 7.1 Balance the bridge under condition

```
// Exa 7.1
clc;
clear;
close;
// Given data
Z1= 100;// in
theta1= 30;// in
Z2= 50;// in
theta2= 0;// in
Z3= 200;// in
theta3= -90;// in
Z4= 100;// in
theta4= 30;// in
if Z1*Z4 = = Z2*Z3 then
    disp("The first condition is satisfied")
end
if theta1+theta4 = = theta2+theta3 then
    disp("The second condiiton is also satisfied , So
        it is possible to balance the bridge under
```

```
        the given condition")
else
    disp("The second condition is not satisfied.")
    disp("So balance is not possible under given condition")
end
```

Scilab code Exa 7.2 Whether or not the bridge is complete balance

```
// Exa 7.2
clc;
clear;
close;
// Given data
Z1= 1000;// in
theta1= -90;// in
Z2= 500;// in
theta2= 0;// in
Z3= 1000;// in
theta3= 0;// in
R4= 100;// in
XL4= 500;// in
Z4=abs(R4+%i*XL4);// in
theta4= atand(imag(R4+%i*XL4),real(R4+%i*XL4));// in

if theta1+theta4 == theta2+theta3 then
    disp("The first condiiton is satisfied.")
else
disp("Balance is not possible with given configuration")
end
// 1/Z1=1/R1+j*omega*C1       (i)
// According to figure  1/Z1= R4/(Z2*Z3)+%i*XL4/(Z2*Z3)          (ii)
// Comparing real and j-components of Eqn (i) and (
```

```
    ii)
R1= Z2*Z3/R4;// in
OmegaC1= Z2*Z3/XL4;// in
disp("Since X_C1 is already equal to "+string(
    OmegaC1)+"    , the bridge can be balanced simply
    by placing a")
disp("resistance of "+string(R1)+"     across the
    capacitor arm 1")
// Z3= R3-j*X_C3          (iii)
Z3= Z1*expm(%i*theta1*%pi/180)*Z4*expm(%i*theta4*%pi
    /180)/(Z2*expm(%i*theta2*%pi/180));//        (iv)
// Comparing real and j-components of Eqn (iii) and
    (iv)
R3= 1000;// in
XC3= 200;// in
disp("Since R3 is already of "+string(R3)+"    , the
    bridge can be balanced simply by adding a")
disp("capacitor of reactance X_C3 of "+string(XC3)+"
        in series with the resistor R3 in arm 3.")
```

Scilab code Exa 7.3 Range of measurements of unknown capacitance

```
// Exa 7.3
clc;
clear;
close;
// Given data
C2= 0.2;// in micro F
Ratio21= 10/1;// resistance ratio R2/R1
C1= C2*Ratio21;// in micro F
Ratio21_desh= 1/10;
C1_desh= C2*Ratio21_desh;// in micro F
disp("So range of measurement of unknown capacitance
     is "+string(C1_desh)+" micro F to "+string(C1)+"
     micro F")
```

Scilab code Exa 7.4 Dissipation Factor

```
// Exa 7.4
clc;
clear;
close;
// Given data
R2= 5;// in ohm
R3= 2000;// in ohm
R4= 2950;// in ohm
C2= 0.5;// in micro F
C2=C2*10^-6;// in F
r2=0.4;// in  ohm
f=450;// in Hz
omega= 2*%pi*f;
// Under Balace Condition Z1*Z4=Z2*Z3
// [r1+1/(j*omega*C1)]*R4= [r2+R2+1/(j*omega*C2)]*R3
// Equating the real parts we have, r1*R4= (r2+R2)*
   R3
r1= (r2+R2)*R3/R4;// in ohm
disp(r1,"Value of r1 in ohm")
// Equating imaginary parts we have R4/(j*omega*C1)=
   R3/(j*omega*C2)
C1= R4/R3*C2;// in F
disp(C1*10^6,"Value of C1 in micro F");
Tan_toh= omega*C1*r1;
disp(Tan_toh,"Dissipation Factor is")
```

Scilab code Exa 7.5 Phase angle errors and unknown capacitance

```
// Exa 7.5
```

```
clc;
clear;
close;
// Given data
f=1000;//in Hz
R1=1000;//in ohm
R2=1000;// in ohm
R3=2000;//in ohm
R4=2000;//in ohm
C1=1*10^-6;//in F
r1= 10;// in ohm
omega=2*%pi*f;
C2=C1*R1/R2;//in F
disp(C2*10^6,"Unknown capacitance in micro F ");

r2=(R2*(R3+r1)-R1*R4)/R1;//in ohm
del_1=omega*r1*C1;//in radian
del_1=del_1*180/%pi;// in
disp(del_1,"Phase angle error1 in degree");
del_2=omega*r2*C2;//in radian
del_2=del_2*180/%pi;// in degree
disp(del_2, "Phase angle error2 in degree");
```

Scilab code Exa 7.6 Values of C1 and r1 and dissipation factor

```
// Exa 7.6
clc;
clear;
close;
// Given data
f=500;//in Hz
R2=4.8;//in ohm
R3=2*10^3;// in ohm
R4=2.85*10^3;//in ohm
C2=0.5*10^-6;//in F
```

```
r2= 0.4;// in ohm
omega=2*%pi*f;
C1=C2*R4/R3;//in F
disp(C1*10^6,"Unknown capacitance in micro F ");
r1=(R3*(R2+r2))/R4;//in ohm
disp(r1,"Resistance of unknown capacitance in ohm")
Tan_del_1= omega*C1*r1;
disp(Tan_del_1,"Dissipation factor is ")
```

Scilab code Exa 7.7 Resistive and capacitive component of unknown capacitor and di

```
// Exa 7.7
clc;
clear;
close;
// Given data
f=50;//in Hz
R2=330*10^3;//in ohm
R3=15*10^3;// in ohm
R4=22*10^3;//in ohm
C2=0.12*10^-6;//in F
omega=2*%pi*f;
R1= R2*R3/R4;// in ohm
disp(R1*10^-3,"Resistive component of unknown
    resistance in kohm")
C1= C2*R4/R3;// in F
disp(C1*10^6,"Capacitive component of unknown
    capacitor in micro F")
D=1/(omega*C1*R1);
disp(D,"Dissipation factor is ")
```

Scilab code Exa 7.8 Power factor of the specimen

```
// Exa 7.8
clc;
clear;
close;
// Given data
f=50;//in Hz
R4=309;//in ohm
R2=100;// in ohm
C3=109*10^-12;//in F
C4=0.5*10^-6;//in F
omega=2*%pi*f;
Cx= C3*R4/R2;// in F
disp(Cx*10^12,"Equivalent series capacitance in
    F ");
Rx= C4*R2/C3;// in ohm
// Power factor of the specimen
Tan_delta= omega*Cx*Rx;
disp(Tan_delta,"Power factor of the specimen is ")
```

Scilab code Exa 7.9 Variable capacitor and resistor required

```
// Exa 7.9
clc;
clear;
close;
// Given data
f=50;//in Hz
R4=1000;//in ohm
C3=50*10^-12;//in F
delta=9;// in
epsilon_r= 2.3;
epsilon_0= 8.854*10^-12;
d= 0.3*10^-2;// in meter
A=314;// area of each electrode in square cm
A=A*10^-4;// in square meter
```

```
omega=2*%pi*f;
C1= epsilon_r*epsilon_0*A/d;// in F
// Formula tan (delta)= 1/(omega*C1*R1)
R1= 1/(omega*C1*tand(delta));// in ohm
C4= 1/(omega^2*C1*R1*R4);// in F
disp(C4*10^6,"Variable capacitor in micro F")
R2= C3*R4*(cosd(delta))^2/C1;// in ohm
disp(R2,"Variable resistance in ohm")

// Note: Calculation of R2 in the book is wrong
```

Scilab code Exa 7.10 Equivalent parallel resistance and capacitance

```
// Exa 7.10
clc;
clear;
close;
format('v',7);
// Given data
f=25;//in kHz
f=f*10^3;// in Hz
R1=3.1*10^3;//in ohm
R2=25*10^3;//in ohm
R4=100*10^3;//in ohm
C1=5.2*10^-6;//in F
omega= 2*%pi*f;
// From C3/C1= R2/R4-R1/R3
// C3= C1*(R2/R4-R1/R3)            (i)
// and omega= 1/sqrt(R1*R3*C1*C3)
// R3= 1/(omega^2*R1*C1*C3), putting this value in (
   i)
C3= C1*R2/(R4*(1+R1^2*C1^2*omega^2));// in F
disp(C3*10^12,"Equivalent capacitance in    F   ")
R3= 1/(omega^2*R1*C1*C3);// in ohm
disp(R3*10^-3,"Equivalent parallel resistance in
```

```
kohm")


// Note Evaluating the value of C3 in the book is wrong.
```

Scilab code Exa 7.11 `Values of C1 and r1 and dissipation factor`

```
// Exa 7.11
clc;
clear;
close;
// Given data
format('v',9);
R2= 5;// in ohm
R3= 2000;// in ohm
R4= 2950;// in ohm
C2= 0.5;// in miu F
C2=C2*10^-6;// in F
r2=0.4;// in  ohm
f=450;// in Hz
omega= 2*%pi*f;
// Under Balace Condition Z1*Z4=Z2*Z3
// [r1+1/(j*omega*C1)]*R4= [r2+R2+1/(j*omega*C2)]*R3
// Equating the real parts we have, r1*R4= (r2+R2)*R3
r1= (r2+R2)*R3/R4;// in ohm
disp(r1,"Value of r1 in ohm")
// Equating imaginary parts we have R4/(j*omega*C1)= R3/(j*omega*C2)
C1= R4/R3*C2;// in F
disp(C1*10^6,"Value of C1 in micro F");
Tan_toh= omega*C1*r1;
disp(Tan_toh,"Dissipation Factor is")
```

Scilab code Exa 7.12 Resistance and inductance of coil

```
// Exa 7.12
clc;
clear;
close;
// Given data
L1= 52.6;// in mH
r1= 28.5;// in ohm
R2= 1.68;// in ohm
R3= 80;// resistance in ohm
R4= 80;// resistance in ohm
r2= r1*R3/R4-R2;// in ohm
disp(r2,"Resistance of coil in ohm")
L2=L1*R3/R4;// in mH
disp(L2,"Inductance of coil in mH");
```

Scilab code Exa 7.13 Resistance and inductance of coil

```
// Exa 7.13
clc;
clear;
close;
// Given data
L= 47.8;// in mH
R= 1.36;// in ohm
R2= 100;// in ohm
R3= 32.7;//in ohm
R4= 100;//in ohm
R1= R2*R3/R4-R;// in ohm
disp(R1,"Resistance of coil in ohm");
L1= R2/R4*L;// in mH
```

```
disp(L1,"Inductance of coil in mH")
```

Scilab code Exa 7.14 Resistance and inductance of inductor

```
// Exa 7.14
clc;
clear;
close;
// Given data
R2= 1000;// in ohm
R3= 1000;//in ohm
R4= 1000;//in ohm
C4= 0.5;// in miu F
C4= C4*10^-6;// in F
R1= R2*R3/R4;// in ohm
disp(R1,"Resistance of inductor in ohm")
 L1= C4*R2*R3;// in H
 disp(L1,"Inductance of inductor in H")
```

Scilab code Exa 7.15 Resistance and inductance of unknown inductor

```
// Exa 7.15
clc;
clear;
close;
// Given data
r= 469;// in ohm
R2= 1000;// in ohm
R3= 218;//in ohm
R4= 1000;//in ohm
C= 10;// in miu F
C= C*10^-6;// in F
R1= R2*R3/R4;// in ohm
```

```
disp(R1,"Resistance of inductor in ohm")
 L1= C*R2/R4*(r*(R3+R4)+R3*R4);// in H
 disp(L1,"Inductance of inductor in H")
```

Scilab code Exa 7.16 Resistance and inductance of AB

```
// Exa 7.16
clc;
clear;
close;
// Given data
r= 500;// in ohm
R2= 400;// in ohm
R3= 400;//in ohm
R4= 400;//in ohm
C= 2;// in miu F
C= C*10^-6;// in F
R= R2*R3/R4;// in ohm
disp(R,"Resistance of AB in ohm")
 L= C*R2/R4*(r*(R3+R4)+R3*R4);// in H
 disp(L,"Inductance of AB in H")
```

Scilab code Exa 7.17 Resistance and inductance of unknown inductor

```
// Exa 7.17
clc;
clear;
close;
// Given data
r= 100;// in ohm
R2= 1000;// in ohm
R3= 500;//in ohm
R4= 1000;//in ohm
```

```
C= 3;// in micro F
C= C*10^-6;// in F
Rx= R2*R3/R4;// in ohm
disp(Rx,"Value of Rx in ohm")
 Lx= C*R2/R4*(r*(R3+R4)+R3*R4);// in H
 disp(Lx,"Value of Lx in H")
```

Scilab code Exa 7.18 Resistance and inductance at balance condition

```
// Exa 7.18
clc;
clear;
close;
// Given data
R2= 1000;// in ohm
R3= 16800;//in ohm
R4= 833;//in ohm
C4= 0.38;// in miu F
C4= C4*10^-6;// in F
f= 50;// in Hz
omega=2*%pi*f;
L1= R2*R3*C4/(1+(omega*C4*R4)^2);// in H
disp(L1,"Unknown inductance in H");
R1= R2*R3*R4*omega^2*C4^2/(1+(omega*C4*R4)^2);// in
    ohm
disp(R1,"Unknown resistance in ohm")
```

Scilab code Exa 7.19 Value of R and C

```
// Exa 7.19
clc;
clear;
close;
```

```
// Given data
R1= 500;//in ohm
R2= 1000;// in ohm
R3= R2;//in ohm
L1= 0.18;// in H
f= 5000/(2*%pi);// in Hz
omega= 2*%pi*f;
// L1= R2*R3*C4/(1+(omega*C4*R4)^2)       (i)
// and  R1= R2*R3*R4*omega^2*C4^2/(1+(omega*C4*R4)^2) or R1= omega^2*R4*C4*L1
R4C4= R1/(omega^2*L1);
// From eq (i)
C4= L1*(1+(omega*R4C4)^2)/(R2*R3);// in F
disp(C4*10^6,"Value of C in micro F");
R4= R4C4/C4;// in ohm
disp(round(R4),"Value of R4 in ohm")
```

Scilab code Exa 7.20 `Series equivalent inductance and resistance`

```
// Exa 7.20
clc;
clear;
close;
// Given data
R2= 1000;//in ohm
R3= 10000;// in ohm
R4= 2000;//in ohm
C4= 1*10^-6;// in F
omega= 3000;// radians/sec
L1= R2*R3*C4/(1+(omega*C4*R4)^2);// in H
disp(L1,"Equivalent inductance of the network in H")
R1= R2*R3*R4*omega^2*C4^2/(1+(omega*C4*R4)^2);// in ohm
disp(R1*10^-3,"Equivalent resistance of the network in kohm")
```

Scilab code Exa 7.21 Resistance and inductance of choke coil

```
// Exa 7.21
clc;
clear;
close;
// Given data
R2= 2410;//in ohm
R3= 750;// in ohm
R4= 64.5;//in ohm
C4= 0.35*10^-6;// in F
r4= 0.4;// series resistance of capacitor in ohm
f=500;/// in Hz
omega= 2*%pi*f;// radians/sec
R4= R4+r4;// in ohm
R1= R2*R3*R4*omega^2*C4^2/(1+(omega*C4*R4)^2);// in
    ohm
disp(R1,"Resistance of the choke coil in ohm")
L1= R2*R3*C4/(1+(omega*C4*R4)^2);// in H
disp(L1,"Inductance of the choke coil in H")

// Note: Calculation of finding the value of L1 in
    the book is wrong
```

Scilab code Exa 7.22 Effective impedance of the specimen

```
// Exa 7.22
clc;
clear;
close;
// Given data
```

```
R2= 834;// in
R3= 100;// in
C2= 0.124;// in  F
C2= C2*10^-6;// in F
C4= 0.1;// in  F
C4= C4*10^-6;// in F
L1= R2*R3*C4;// in H
f= 2;// in kHz
f= f*10^3;// in kHz
disp(L1*10^3,"The value of L1 in mH is :  ")
R1= R3*C4/C2;// in
disp(R1,"The value of R1 in    is : ")
Z= R1+%i*2*%pi*f*L1;// in
disp(abs(Z),"The magnitude of effective impedence in
        is : ")
disp(atand(imag(Z),real(Z)),"The angle of effective
   impedence in    is : ")
```

Scilab code Exa 7.23 `Value of L and C`

```
// Exa 7.23
clc;
clear;
close;
// Given data
fr= 2;// in MHz
fr=fr*10^6;// in Hz
C=230+8;// in pF
C=C*10^-12;// in F
// Formula fr= 1/(2*%pi*sqrt(L*C))
L= 1/((2*%pi*fr)^2*C);// in H
disp(L*10^6,"Value of L in  H ")
// From the first set of data
fr= 1;// in MHz
fr=fr*10^6;// in Hz\
```

```
C= 1/((2*%pi*fr)^2*L);// in F
disp(C*10^12,"Value of C in pF")
```

Scilab code Exa 7.24 Resistive and reactive component of unknown impedence

```
// Exa 7.24
clc;
clear;
close;
// Given data
C1= 208;// in pF
C1=C1*10^-12;// in F
Q1= 80;
C2= 184;// in pF
C2=C2*10^-12;// in F
Q2= 50;
f=165;// in kHz
f=f*10^3;// in Hz
omega= 2*%pi*f;// in radians/sec
// Part (i)
Rm= 1/omega*(1/(C2*Q2)-1/(C1*Q1));// in ohm
disp(Rm,"Resistive component of unknown impedence in ohm")
// Part(ii)
Xm= 1/omega*(1/C2-1/C1);// in ohm
disp(round(Xm),"Reactive component of unknown impedence in ohm")
```

Scilab code Exa 7.25 Self capacitance and inductance of the coil

```
// Exa 7.25
clc;
clear;
```

```
close;
// Given data
C1= 160*10^-12;// in F
C2= 36*10^-12;// in F
f1=250;// in kHz
f1=f1*10^3;// in Hz
f2=500;// in kHz
f2=f2*10^3;// in Hz
Cd= (C1-4*C2)/3;// in F
disp(Cd*10^12,"Self Capacitance of the coil in  F")
// Formula f1= 1/(2*%pi*sqrt(L*(C1+Cd)))
L= 1/((2*%pi*f1)^2*(C1+Cd));// in H
disp(round(L*10^6),"Self inductance of the coil in  H");
```

Scilab code Exa 7.26 `Self capacitance of the coil`

```
// Exa 7.26
clc;
clear;
close;
// Given data
C1= 251*10^-12;// in F
C2= 50*10^-12;// in F
f1=3;// in MHz
f1=f1*10^6;// in Hz
f2=6;// in MHz
f2=f2*10^6;// in Hz
Cd= (C1-4*C2)/3;// in F
disp(Cd*10^12,"Self Capacitance of the coil in pF")
```

Scilab code Exa 7.27 `Value of self capacitance`

```
// Exa 7.27
clc;
clear;
close;
// Given data
C1= 1530;// in pF
C2= 162;// in pF
f1=1;// in MHz
f1=f1*10^6;// in Hz
f2=3;// in MHz
f2=f2*10^6;// in Hz
// f1= 1/(2*%pi*sqrt(L*(C1+Cd)))
//  f1= 1/(2*%pi*sqrt(L*(C2+Cd))) and f2= 3*f1 so
Cd= (C1-9*C2)/8;// in pF
disp(Cd,"Self capacitance of the coil in pF")
```

Scilab code Exa 7.28 Effective inductance and resistance of unknown coil

```
// Exa 7.28
clc;
clear;
close;
// Given data
f= 450;// in kHz
f=f*10^3;// in Hz
C=250;// in pF
C=C*10^-12;// in F
Rsh= 0.75;// in ohm
Q= 105;
omega= 2*%pi*f;// in radians/sec
// Formula f= 1/(2*%pi*sqrt(L*C))
L= 1/((2*%pi*f)^2*C);// in H
disp(round(L*10^6),"Inductance of the coil in  H ")
R= omega*L/Q-Rsh;// in ohm
disp(R,"Resistance of the coil in ohm")
```

Scilab code Exa 7.29 Percentage error introduced in the calculated value of Q

```
// Exa 7.29
clc;
clear;
close;
// Given data
f= 500;// in kHz
f=f*10^3;// in Hz
C=120;// in pF
C=C*10^-12;// in F
R= 5;// in ohm
r=0.02;// resistance used across the oscillatory circuit in ohm
omega= 2*%pi*f;// in radians/sec
Q_True= 1/(omega*C*R);
Q_indicated= 1/(omega*C*(R+r));
PerError= (Q_True-Q_indicated)*100/Q_True;// in %
disp(PerError,"Percentage Error is ")
```

Scilab code Exa 7.30 Self capacitance of the radio coil

```
// Exa 7.30
clc;
clear;
close;
// Given data
f1= 800;// in kHz
f1=f1*10^3;// in Hz
f2= 2.5;// in MHz
f2=f2*10^6;// in Hz
```

```
C1=95;// in pF
C1=C1*10^-12;// in F
// L= 1/(omega1^2*(C1+Cd))          (i)
// L= 1/(omega2^2*Cd)                    (ii)
// From eq(i) and eq(ii)
Cd= f1^2*C1/(f2^2-f1^2);// in F
disp(Cd*10^12,"Self capacitance of the radio coil in
    pF");
```

Scilab code Exa 7.31 `Self capacitance of the coil and true and indicated values of`

```
// Exa 7.31
clc;
clear;
close;
// Given data
f1= 1;// in MHz
f1=f1*10^6;// in Hz
f2= 2;// in MHz
f2=f2*10^6;// in Hz
C1=480;// in pF
C1=C1*10^-12;// in F
C2=90;// in pF
C2=C2*10^-12;// in F
R=10;// in ohm
omega1= 2*%pi*f1;// in radians/sec
omega2= 2*%pi*f2;// in radians/sec

// Part (i)
Cd= (C1-4*C2)/3;// in F
disp(Cd*10^12,"Self capacitance of the coil in pF")

// Part(ii)
Q_indicated1= 1/(omega1*(C1+Cd)*R);
disp(Q_indicated1,"Indicated or effective Q for
```

```
    first measurement")
Q_True1=  1/(omega1*C1*R);
disp(Q_True1,"True Q for first measurement is ");
Q_indicated2= 1/(omega2*(C2+Cd)*R);
disp(Q_indicated2,"Indicated or effective Q for
    second measurement")
Q_True2=  1/(omega2*C2*R);
disp(Q_True2,"True Q for second measurement is ");
```

Chapter 8

Cathode Ray Oscilloscopes

Scilab code Exa 8.1 Deflection sensitivity

```
// Exa 8.1
clc;
clear;
close;
// Given data
l=25;// in mm
l=l*10^-3;// in meter
d=5;// in mm
d=d*10^-3;// in meter
S= 20;// in cm
S= S*10^-2;// in meter
Va= 3000;// in volts
TraceLength= 10;// in cm
TraceLength=TraceLength*10^-2;// in meter
y=TraceLength/2;
Vd= 2*d*Va*y/(l*S);// in volts
Vrms= Vd/sqrt(2);// in volts
Vrms= floor(Vrms);
disp(Vrms,"RMS value of the sinusoidal voltage
    applied to the X-deflecting plates in volt");
DeflectionSensitivity= l*S/(2*d*Va);// in m/V
```

```
disp(DeflectionSensitivity*10^3,"Deflection
   Sensitivity in mm/V");
```

Scilab code Exa 8.2 Maximum velocity of electrons

```
// Exa 8.2
clc;
clear;
close;
// Given data
Va= 1000;// in volts
e= 1.6*10^-19;// in C
m= 9.1*10^-31;// in kg
MaxVel= sqrt(2*Va*e/m);// maximum velocity of
   electrons in m/s
disp(MaxVel,"Maximum velocity of electrons in m/s")
```

Scilab code Exa 8.3 Deflection sensitivity

```
// Exa 8.3
clc;
clear;
close;
// Given data
l=20;// in mm
l=l*10^-3;// in meter
d=5;// in mm
d=d*10^-3;// in meter
S= 0.20;// in meter
Va= 2500;// in volts
DeflectionSensitivity= l*S/(2*d*Va);// in m/V
disp(DeflectionSensitivity*10^3,"Deflection
   Sensitivity in mm/V");
```

Scilab code Exa 8.4 Required voltage

```
// Exa 8.4
clc;
clear;
close;
// Given data
l=2.5;// in cm
l=l*10^-2;// in meter
d=1;// in cm
d=d*10^-2;// in meter
Va= 1000;// in volts
theta= 1;// in degree
// Formula tand(theta) = l*Vd/(2*d*Va)
Vd= 2*d*Va/l*tand(theta);// in volts
disp(Vd,"Voltage required across the deflection
   plates in volts")
```

Scilab code Exa 8.5 Required deflecting voltage

```
// Exa 8.5
clc;
clear;
close;
// Given data
l=2.5;// in cm
l=l*10^-2;// in meter
d=.5;// in cm
d=d*10^-2;// in meter
S= 20;// in cm
S= S*10^-2;// in meter
```

```
Va= 2500;// in volts
// Formula y = OC*AB/OB = (S*d/2)/(l/2)
y = (S*d/2)/(l/2);// in meter
disp(y*10^2,"Deflection in cm")
```

Scilab code Exa 8.6 Charging current and time period

```
// Exa 8.6
clc;
clear;
close;
// Given data
R_E1= 5.6;// in kohm
C1= 0.2;// in miu F
V_B1= 6.3;// in volt
V_BE= 0.7;// in volt
TL= 2.5;// trigger level for the Schmitt trigger (
   UTP,LTP) in volt
del_V1= 2*TL;// in volt
I_C1= (V_B1-V_BE)/R_E1;// in mA
disp(I_C1,"Charging current in mA");
toh= del_V1*C1/I_C1;// in ms
disp(toh,"Time period in ms")
```

Scilab code Exa 8.7 RMS value of unknown ac voltage

```
// Exa 8.7
clc;
clear;
close;
// Given data
L=10;// trace length in cm
DS= 5;// deflection sensitivity in V/cm
```

```
V_peakTOpeak= L*DS;// in volt
V_peak= V_peakTOpeak/2;// in volt
RMS= V_peak/sqrt(2);// RMS value of unknown as
    voltage in volt
disp(RMS,"AC voltage in volt")
```

Scilab code Exa 8.8 Ratio of frequencies of vertical and horizontal signals

```
// Exa 8.8
clc;
clear;
close;
// Given data
Y= 3;// Positive Y-peaks in pattern
X= 2;// Positive X-peaks in pattern
// Ratio of frequencies of vertical and horizontal
    signals
// f_y/f_x= omega_y/omega_x = Y/X
R= Y/X;//Ratio of frequencies
disp(R,"Ratio of frequencies of vertical and
    horizontal signals");
```

Scilab code Exa 8.9 Frequency of vertical signal

```
// Exa 8.9
clc;
clear;
close;
// Given data
Y= 2+1/2;// Positive Y-peaks in pattern
X= 1/2+1/2;// Positive X-peaks in pattern
f_h= 3// frequency of horizontal voltage signal in
    kHz
```

```
f_yBYf_x= Y/X;
// frequency of vertical voltage signal= f_yBYf_x *
    f_h
f_v= f_yBYf_x * f_h;// frequency of vertical voltage
     signal in kHz
disp(f_v,"frequency of vertical voltage signal in
    kHz");
```

Scilab code Exa 8.10 Frequency of vertical signal

```
// Exa 8.10
clc;
clear;
close;
// Given data
f_x= 1000;// in Hz
Y= 2;// points of tangency to vertical line
X= 5;// points of tangency to horizontal line
f_y= f_x*X/Y;// in Hz
disp(f_y,"Frequency of vertical input in Hz")
```

Scilab code Exa 8.11 Mark to space ratio

```
// Exa 8.11
clc;
clear;
close;
// Given data
// Taking 1div= 1 cm for CRO wave displays
Mark= 0.4;// cm
Space= 1.6;// cm
SAC= 0.2;// signal amplitude control in V/div
TBS= 10;// time base control in micro/div
```

```
Amplitude= 2.15;// in cm
M_S_ratio= Mark/Space;// Mark to Space raio
disp(M_S_ratio,"Mark to Space raio ")
T= (Mark+Space)*TBS;// in micro sec
T=T*10^-6;// in sec
f=1/T;// in Hz
disp(f*10^-3,"Pulse frequency in kHz")
Mag= Amplitude*SAC;// Magnitude of pulse voltage in
    volt
disp(Mag,"Magnitude of pulse voltage in volt")
```

Scilab code Exa 8.12 Phase angle for each trace

```
// Exa 8.12
clc;
clear;
close;
// Given data
// Part (a)
d_v0= 0;
Dv=6;
fie= asind(d_v0/Dv);
disp(fie,"Phase angle of first figure in degree")
// Part (b)
d_v0= 3;
Dv=6;
fie= asind(d_v0/Dv);
disp(fie,"Phase angle of second figure in degree")
// Part (c)
d_v0= 5;
Dv=5;
fie= asind(d_v0/Dv);
disp(fie,"Phase angle of third figure in degree")
// Part (d)
d_v0= 3;
```

```
Dv=5;
fie= asind(d_v0/Dv);
// since ellipse is in 2nd and fourth quartes so the
    valid value of phase angle
fie= 180-fie
disp(fie,"Phase angle of forth figure in degree")
```

Scilab code Exa 8.13 Pulse duration

```
// Exa 8.13
clc;
clear;
close;
// Given data
f=2000;// in Hz
T=1/f;// in sec
D=0.2;
PulseDuration= D*T;// in sec
disp(PulseDuration*10^3,"Pulse duration in ms")
```

Scilab code Exa 8.14 Peak to peak amplitude of the signal and signal frequency

```
// Exa 8.14
clc;
clear;
close;
// Given data
vertical_attenuation= 0.5;// in V/Div
TPD= 2;// time/Div control in micro sec
P= 4*vertical_attenuation;// peak-to-peak amplitude
   of the signal in V;
disp(P,"Peak-to-Peak amplitude of the signal in V")
T= 4*TPD;// in micro sec
```

```
T=T*10^-6;// in sec
f=1/T;// in Hz
disp(f*10^-3,"Frequency in kHz")
```

Scilab code Exa 8.15 Value of C1 and input capacitance

```
// Exa 8.15
clc;
clear;
close;
// Given data
C_1N= 36;// in pF
C_2= 150;// in pF
R_1N= 1;// in M ohm
R_1= 10;// in M ohm
// R_1/(omega*(C_2+C_1N)) = R_1N/(omega*C_1)
C_1= R_1N*(C_2+C_1N)/R_1;// in pF
disp(C_1,"Value of C_1 in pF")
C_T= 1/(1/C_1+1/(C_2+C_1N));// in pF
disp(C_T,"Value of C_T in pF")
```

Scilab code Exa 8.16 Signal frequency

```
// Exa 8.16
clc;
clear;
close;
// Given data
C_1N= 36;// in pF
C_2= 150;// in pF
R_1N= 1;// in M ohm
R_1= 10;// in M ohm
R_source= 500;// in ohm
```

```
// R_1/(omega*(C_2+C_1N)) = R_1N/(omega*C_1)
C_1= R_1N*(C_2+C_1N)/R_1;// in pF
C_T= 1/(1/C_1+1/(C_2+C_1N));// in pF
C_T= C_T*10^-12;// in F
f= 1/(2*%pi*C_T*R_source);
disp(f*10^-6,"Signal Frequency in MHz")
```

Scilab code Exa 8.17 Minimum time division

```
// Exa 8.17
clc;
clear;
close;
// Given data
f= 20;// in MHz
f=f*10^6;// in Hz
toh= 1/f;// in sec
toh=toh*10^9;// in ns
// For one cycle occupying 4 horizontal divisions,
MTD= toh/4;// Minimum time/division in ns/division
// Using the 10 times magnifier to provide MTD
MTD_setting= 10*MTD;// minimum time/division setting
    in ns/division
disp(MTD_setting,"Minimum time/division setting in
   ns/division")
```

Chapter 10

Instrument Calibration And Recorders

Scilab code Exa 10.1 Instrument accuracy

```
// Exa 10.1
clc;
clear;
close;
// Given data
FullScale= 25;// in volt

VR= 5;// voltmeter reading in volt
Error= -0.25;// in volt
Error_Reading= Error/VR*100;// % of reading
disp(Error_Reading,"Error percentage of reading");
Error_FullScale= Error/FullScale*100;// % of full scale
disp(Error_FullScale,"Error percentage of full scale")

VR= 10;// voltmeter reading in volt
Error= 0.25;// in volt
Error_Reading= Error/VR*100;// % of reading
```

```
disp(Error_Reading,"Error percentage of reading");
Error_FullScale= Error/FullScale*100;// % of full
   scale
disp(Error_FullScale,"Error percentage of full scale
   ")

VR= 20;// voltmeter reading in volt
Error= -0.4;// in volt
Error_Reading= Error/VR*100;// % of reading
disp(Error_Reading,"Error percentage of reading");
Error_FullScale= Error/FullScale*100;// % of full
   scale
disp(Error_FullScale,"Error percentage of full scale
   ")
```

Scilab code Exa 10.2 `Wattmeter error`

```
// Exa 10.2
clc;
clear;
close;
// Given data
Pm=1250;// in watt
V=255;// in volt
I=4.8;// in amp
P=V*I;/// in watt
AbsoluteError= Pm-P;// in watt
disp(AbsoluteError,"Absolute Error in watt");
PerError= AbsoluteError/Pm*100;// in %
disp(PerError,"Percentage Error")
```