# Scilab Textbook Companion for Electronics Instrumentation and Measurements
# by U. S. Shah[1]

Created by
Vivek Maindola
B.TECH
Electronics Engineering
Uttrakhand Technical University
College Teacher
Arshad Khan
Cross-Checked by
Lavitha Pereira

July 11, 2017

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

# Book Description

**Title:** Electronics Instrumentation and Measurements

**Author:** U. S. Shah

**Publisher:** Tech-max Publication, Pune

**Edition:** 2

**Year:** 2011

**ISBN:** 978-81-8492-334-6

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 2

# Measurement Errors

**Scilab code Exa 2.3.1** Precision of the 5th measurement

```
//Example 2.3.1: precision of the 5th measurement
clc;
clear;
close;
//given data :
format('v',6)
X1=98;
X2=101;
X3=102;
X4=97;
X5=101;
X6=100;
X7=103;
X8=98;
X9=106;
X10=99;
Xn_bar=(X1+X2+X3+X4+X5+X6+X7+X8+X9+X10)/10;
Xn=101;// value of 5th measurement
P=(1-abs((Xn-Xn_bar)/Xn_bar))*100;
disp(P,"precision of the 5th measurement,P(%) = ")
```

**Scilab code Exa 2.3.2.a** Absolute Error

```
//Example 2.3.2.a: absolute error
clc;
clear;
close;
//given data :
Ae=80;// in V
Am=79;// in V
e=Ae-Am;
disp(e,"absolute error,e(V) = ")
```

**Scilab code Exa 2.3.2.b** Percentage Error

```
//Example 2.3.2.b: error
clc;
clear;
close;
//given data :
Ae=80;// in V
Am=79;// in V
e=Ae-Am;
error1=(e/Ae)*100;
disp(error1,"error(%) = ")
```

**Scilab code Exa 2.3.2.c** Relative Accuracy

```
//Example 2.3.2.c: relative accuracy
clc;
```

```
clear;
close;
//given data :
format('v',7)
Ae=80;// in V
Am=79;// in V
e=Ae-Am;
error1=(e/Ae)*100;
A=(1-abs(e/Ae));
disp(A,"relative accuracy ,A = ")
```

**Scilab code Exa 2.3.2.d** Percentage Accuracy

```
//Example 2.3.2.d: % accuracy
clc;
clear;
close;
//given data :
Ae=80;// in V
Am=79;// in V
e=Ae-Am;
error1=(e/Ae)*100;
A=(1-abs(e/Ae));
accuracy=A*100;
disp(accuracy,"accuracy(%) = ")
```

**Scilab code Exa 2.3.2.e** Percentage error of full scale reading

```
//Example 2.3.2.e: % error
clc;
clear;
close;
//given data :
```

```
Ae=80;// in V
Am=79;// in V
e=Ae-Am;
f=100;//full scale deflection
error1=(e/Ae)*100;
A=(1-abs(e/Ae));
accuracy=A*100;
P_error=(e/f)*100;
disp(P_error,"% error(%) = ")
```

**Scilab code Exa 2.3.3** Maximum Error

```
//Example 2.3.3: maximum error
clc;
clear;
close;
//given data :
V1=100;// in volts
V2=200;//in volts
V=V2-V1;
A=.25;//may be    in %
max_error=(A/100)*V;
disp(max_error,"maximum error(V) =   ")
```

**Scilab code Exa 2.3.4** Sesitivity and Deflection Factor

```
//Example 2.3.4: sensitivity and deflection error
clc;
clear;
close;
//given data :
C=4;// change in output in mm
M=8;// magnitude of input in ohm
```

```
S=C/M;
disp(S,"sensitivity ,S(mm/ohm) = ")
D=M/C;
disp(D,"deflection factor ,D(ohm/mm) = ")
```

**Scilab code Exa 2.3.5** Resolution

```
//Example 2.3.5: resolution
clc;
clear;
close;
//given data :
V=200;// full scale reading in volts
N=100;// number of divisions
Scale_div=V/N;
R=(1/10)*Scale_div;
disp(R,"resolution ,R(V) = ")
```

**Scilab code Exa 2.3.6** Resolution

```
//Example 2.3.6: resolution
clc;
clear;
close;
//given data :
V=9.999;// full scale read out in volt
c=9999;// range from 0 to 9999
R=(1/c)*V*10^3;
disp(R,"resolution ,R(mV) = ")
```

**Scilab code Exa 2.6.1** Relative Error

```
//Example 2.6.1: magnitude and relative error
clc;
clear;
close;
//given data :
format('v',5)
R1=15;//ohm
E1=R1*5/100;// limiting error for R1
R2=33;//ohm
E2=R2*2/100;// limiting error for R2
R3=75;//ohm
E3=R3*5/100;// limiting error for R3
RT=R1+R2+R3;//ohm(in series)
ET=E1+E2+E3;// limiting error for RT
disp("For series connection, magnitude is "+string(
    RT)+" ohm & limiting error is   "+string(ET)+"
    ohm.");
Epr=ET/RT*100;//%
disp(Epr,"Percent relative error( % ) : ");
```

---

**Scilab code Exa 2.6.2** Limiting Error and Relative Error

```
//Example 2.6.2: magnitude and relative error
clc;
clear;
close;
//given data :
R1=36;//ohm
E1=5;// limiting error for R1
R2=75;//ohm
E2=5;// limiting error for R2
RT=(R1*R2)/(R1+R2);//ohm(in parallel)
EP1=E1+E2;// limiting error
```

```
EP2=((R1*E1)/(R1+R2))+((R2*E2)/(R1+R2));
ET=EP1+EP2;
etm=(ET/100)*RT;//
disp(etm,"magnitude of limiting error is in ohms ( )")
disp(ET,"percentage relative error is (%) ")
```

**Scilab code Exa 2.6.3** Limiting Error

```
//Example 2.6.3:limiting error
clc;
clear;
close;
vr=40;//reading of voltmeter in volts
v=50;//rane in volts
va=50;//ammeeter reading in mA
i=125;//range in mA
fsd=2;//accurace in percentage in
dv=(2/100)*v;//limiting error of voltmeter
da=(2/100)*i;//liming error of the ammeter in mA
erv=dv/vr;//relative limiting error in voltmeter reading
eri=da/i;//relative limiting error in ammeter reading
et=erv+eri;//
pet=et*100;//percentage limiting error of the power calcultaed
disp(pet,"percentage limiting error of the power calcultaed ( )")
```

**Scilab code Exa 2.6.4** Limiting Error

```
//Example 2.6.4:limiting error
```

```
clc;
clear;
close;
format('v',6)
r1=120;//in ohms
er1=0.5;//limiting error in resistance 1 in ohms
r2=2;//in amperes
er2=0.02;//limiting error in amperes
e1=er2/r2;//limiting error in current
e2=er1/r1;//limiting eror in resistance
et=(2*e1+e2);//totak error
etp=et*100;//percentage limtimg error
disp(etp,"percentage limiting error in the value of
    power dissipation in   ")
```

**Scilab code Exa 2.6.5** Magnitude and Limiting Error

```
//Example 2.6.5:magnitude and limiting error
clc;
clear;
close;
format('v',10)
r1=120;//in ohms
er1=0.1;//limiting error in resistance 1 in ohms
r2=2700;//in ohms
er2=0.5;//limiting error in resistance 2 in ohms
r3=470;//in ohms
er3=0.5;//limiting error in resistance 3 in ohms
rxm=(r2*r3)/r1;//magnitude of unknown resistance in
    ohms
rxe=(er1+er2+er3);//error
er=(rxe*rxm)/100;//relative error
disp(rxm*10^-3,"magnitude of unknown resistance in
    kilo ohms")
disp(er,"relative limiting error in ohms is (   )")
```

```
disp("guranteed value of resistance is between "+
   string(rxm-er)+" ohms to "+string(rxm+er)+" ohms
   ")
```

**Scilab code Exa 2.6.6** Error

```
//Example 2.6.6. // absolute error , % error ,
   relative error , % accuracy and % error of full
   scale reading
clc;
clear;
close;
//given data :
Ae=80;// in volt
Am=79;// in volt
fsd=100;//full scale reading in volt
e=Ae-Am;
disp(e,"absolute error,e(V) = ")
error1=(e/Ae)*100;
disp(error1,"% error (%) = ")
A=1-abs(e/Ae);
disp(A,"relative accuracy,A = ")
p_accuracy=A*100;
disp(p_accuracy,"% accuracy (%)= ")
error2=(e/fsd)*100;
disp(error2,"% error expressed as percentage of full
    scale reading,(%) = ")
```

**Scilab code Exa 2.6.7** Limiting Error

```
//Example 2.6.7. // limiting error
clc;
clear;
```

```
close;
//given data :
format('v',7)
fsd=100;// in volts
A=1;// (+ve or -ve) in %
del_A=(A/100)*fsd;
As=15;//in volts
e1=del_A/As;
e=e1*100;
disp(e,"limiting error,e(%) = ")
```

**Scilab code Exa 2.6.8** Limiting Error

```
//Example 2.6.8. // limiting value of current and %
   limiting error
clc;
clear;
close;
//given data :
As=2.5;// in A
fsd=10;//full scale reading in A
A=1.5/100;
del_A=A*fsd;
At1=As+del_A;
At2=As-del_A;
disp(At1,"limiting value of current,At1(A) = ")
disp(At2,"limiting value of current,At2(A) = ")
e=(del_A/As)*100;
disp(e,"percentage limiting error,e(%) = ")
```

**Scilab code Exa 2.7.1.a** Arithmetic mean

```
//Example 2.7.1.a://ARITHEMATIC MEAN
```

```
clc;
clear;
format('v',6)
q=[49.7,50.1,50.2,49.6,49.7];//
AM= mean(q);//arithematic mean in mm
for i= 1:5
    qb(i)= q(i)-AM;
end
Q= [qb(1),qb(2),qb(3),qb(4),qb(5)];//
AV=(-qb(1)-qb(2)+qb(3)+qb(4)-qb(5))/10;//
SD=stdev(Q);//standard deviation
V=SD^2;//variance
disp(AM,"arithematic mean is")
```

**Scilab code Exa 2.7.1.b** Deviation

```
//Example 2.7.1.b://deviation
clc;
clear;
q=[49.7,50.1,50.2,49.6,49.7];//
AM= mean(q);//arithematic mean in mm
for i= 1:5
    qb(i)= q(i)-AM;
    disp(qb(i),"deviation in "+string (q(i))+" is")
end
```

**Scilab code Exa 2.7.1.c** Algebric Sum of Deviation

```
//Example 2.7.1.c://algebric sum of deviation
clc;
clear;
format('v',2)
q=[49.7,50.1,50.2,49.6,49.7];//
```

```
AM= mean(q);//arithematic mean in mm
for i= 1:5
    qb(i)= q(i)-AM;
end
asm1=qb(1)+qb(4)+qb(5);//
asm2=qb(2)+qb(3);//
asm=asm1+asm2;
disp(asm,"algebric sum of deviation is")
```

**Scilab code Exa 2.7.1.d** Standard Deviation

```
//Example 2.7.1.d://standard deviation
clc;
clear;
format('v',5)
q=[49.7,50.1,50.2,49.6,49.7];//
AM= mean(q);//arithematic mean in mm
for i= 1:5
    qb(i)= q(i)-AM;
end
Q= [qb(1),qb(2),qb(3),qb(4),qb(5)];//
SD=stdev(Q);//standard deviation
disp(SD,"standard deviation is")
```

**Scilab code Exa 2.7.2.a** Arithmetic Mean

```
//Example 2.7.2.a://ARITHEMATIC MEAN
clc;
clear;
format('v',6)
q
   =[101.2,101.4,101.7,101.3,101.3,101.2,101.0,101.3,101.5,101.1];
   //
```

```
AM= mean(q);//arithematic mean in mm
for i= 1:10
    qb(i)= q(i)-AM;
end
Q= [qb(1),qb(2),qb(3),qb(4),qb(5)];//
AV=(-qb(1)-qb(2)+qb(3)+qb(4)-qb(5))/10;//
SD=stdev(Q);//standard deviation
V=SD^2;//variance
disp(AM,"arithematic mean is in volts")
```

**Scilab code Exa 2.7.2.b** Deviation

```
//Example 2.7.2.b://deviation from mean
clc;
clear;
format('v',6)
q
   =[101.2,101.4,101.7,101.3,101.3,101.2,101.0,101.3,101.5,101.1];
   //
AM= mean(q);//arithematic mean in mm
for i= 1:10
    qb(i)= q(i)-AM;
        disp(qb(i),"deviation in "+string (q(i))+"
           is")
end
```

**Scilab code Exa 2.7.2.c** Standard Deviation

```
//Example 2.7.2.c://standard deviation
clc;
clear;
format('v',6)
```

```
q
   =[101.2,101.4,101.7,101.3,101.3,101.2,101.0,101.3,101.5,101.1];
   //
AM= mean(q);//arithematic mean in mm
for i= 1:10
    qb(i)= q(i)-AM;

end
Q= [qb(1),qb(2),qb(3),qb(4),qb(5),qb(6),qb(7),qb(8),
   qb(9),qb(10)];//
SD=stdev(Q);//standard deviation
disp(SD,"standard deviation in volts")
```

**Scilab code Exa 2.7.2.d** Probable Error

```
//Example 2.7.2.d://probable error
clc;
clear;
n=10;//
format('v',7)
q
   =[101.2,101.4,101.7,101.3,101.3,101.2,101.0,101.3,101.5,101.1];
   //
AM= mean(q);//arithematic mean in mm
for i= 1:10
    qb(i)= q(i)-AM;

end
Q= [qb(1),qb(2),qb(3),qb(4),qb(5),qb(6),qb(7),qb(8),
   qb(9),qb(10)];//
SD=stdev(Q);//standard deviation
Pe1=0.6745*SD;// probable error of one reading
probable_error=Pe1/sqrt(n-1);
disp(Pe1,"probable error of one reading(V) = ")
disp(probable_error,"probable error of mean(V) = ")
```

**Scilab code Exa 2.7.3.a** Arithmetic Mean

```
//Example 2.7.3.a: Arithmetic mean
clc;
clear;
close;
//given data :
X1=147.2;// in nF
X2=147.4;// in nF
X3=147.9;// in nF
X4=148.1;// in nF
X5=148.1;// in nF
X6=147.5;// in nF
X7=147.6;// in nF
X8=147.4;// in nF
X9=147.6;// in nF
X10=147.5;// in nF
AM=(X1+X2+X3+X4+X5+X6+X7+X8+X9+X10)/10;
disp(AM,"Arithmetic mean,AM(nF) = ")
```

**Scilab code Exa 2.7.3.b** Average Deviation

```
//Example 2.7.3.b: Average deviation
clc;
clear;
close;
//given data :
n=10;
X1=147.2;// in nF
X2=147.4;// in nF
X3=147.9;// in nF
```

```
X4=148.1;// in nF
X5=148.1;// in nF
X6=147.5;// in nF
X7=147.6;// in nF
X8=147.4;// in nF
X9=147.6;// in nF
X10=147.5;// in nF
AM=(X1+X2+X3+X4+X5+X6+X7+X8+X9+X10)/n;
d1=X1-AM;
d2=X2-AM;
d3=X3-AM;
d4=X4-AM;
d5=X5-AM;
d6=X6-AM;
d7=X7-AM;
d8=X8-AM;
d9=X9-AM;
d10=X10-AM;
Average_deviation=(abs(d1)+abs(d2)+abs(d3)+abs(d4)+
    abs(d5)+abs(d5)+abs(d6)+abs(d7)+abs(d8)+abs(d9)+
    abs(d10))/n;
disp(Average_deviation,"Average deviation(nF) = ")
// answer is wrong in book
```

**Scilab code Exa 2.7.3.c** Standard Deviation

```
//Example 2.7.3.c: Standard deviation
clc;
clear;
close;
//given data :
n=10;
X1=147.2;// in nF
X2=147.4;// in nF
X3=147.9;// in nF
```

```
X4=148.1;// in nF
X5=148.1;// in nF
X6=147.5;// in nF
X7=147.6;// in nF
X8=147.4;// in nF
X9=147.6;// in nF
X10=147.5;// in nF
AM=(X1+X2+X3+X4+X5+X6+X7+X8+X9+X10)/n;
d1=X1-AM;
d2=X2-AM;
d3=X3-AM;
d4=X4-AM;
d5=X5-AM;
d6=X6-AM;
d7=X7-AM;
d8=X8-AM;
d9=X9-AM;
d10=X10-AM;
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(nF) = ")
```

**Scilab code Exa 2.7.3.d** Probable Error

```
//Example 2.7.3.d: Probable error
clc;
clear;
close;
//given data :
n=10;
X1=147.2;// in nF
X2=147.4;// in nF
X3=147.9;// in nF
X4=148.1;// in nF
X5=148.1;// in nF
```

```
X6=147.5;// in nF
X7=147.6;// in nF
X8=147.4;// in nF
X9=147.6;// in nF
X10=147.5;// in nF
AM=(X1+X2+X3+X4+X5+X6+X7+X8+X9+X10)/n;
d1=X1-AM;
d2=X2-AM;
d3=X3-AM;
d4=X4-AM;
d5=X5-AM;
d6=X6-AM;
d7=X7-AM;
d8=X8-AM;
d9=X9-AM;
d10=X10-AM;
sigma=sqrt((d1^2+d2^2+d3^2+d4^2+d5^2+d6^2+d7^2+d8^2+
    d9^2+d10^2)/(n-1));
Pe1=0.6745*sigma;// probable error of one reading
probable_error=Pe1/sqrt(n-1);
disp(Pe1,"probable error of one reading(nF) = ")
disp(probable_error,"probable error of mean(nF) = ")
```

**Scilab code Exa 2.7.4.a** Arithmetic Mean

```
//Example 2.7.4.a://ARITHEMATIC MEAN
clc;
clear;
format('v',8)
q=[10.3,10.7,10.9,9.7,9.5,9.2,10.3,11.7];//
AM= mean(q);//arithematic mean in mm
for i= 1:8
    qb(i)= q(i)-AM;
end
Q= [qb(1),qb(2),qb(3),qb(4),qb(5)];//
```

```
AV=(-qb(1)-qb(2)+qb(3)+qb(4)-qb(5))/10;//
SD=stdev(Q);//standard deviation
V=SD^2;//variance
disp(AM,"arithematic mean is in kg/cm^2")
//answer is wrong in textbook
```

**Scilab code Exa 2.7.4.b** Average Deviation

```
//Example 2.7.4.b://average deviation
clc;
clear;
format('v',7)
n=8
q=[10.3,10.7,10.9,9.7,9.5,9.2,10.3,11.7];//
AM= mean(q);//arithematic mean in mm
for i= 1:8
    qb(i)= q(i)-AM;
    disp(qb(i),"deviation in "+string (q(i))+" is")
end
Q= [qb(1),qb(2),qb(3),qb(4),qb(5),qb(6),qb(7),qb(8)
   ];//
AV=(-qb(1)+qb(2)+qb(3)-qb(4)-qb(5)-qb(6)-qb(7)+qb(8)
   )/n;//
SD=stdev(Q);//standard deviation
V=SD^2;//variance
disp(AV,"average deviation in kg/cm^2")
//answer iswring in textbook
```

**Scilab code Exa 2.7.4.c** Standard Deviation

```
//Example 2.7.4.c://standard deviation
clc;
clear;
```

```
format('v',7)
n=8
q=[10.3,10.7,10.9,9.7,9.5,9.2,10.3,11.7];//
AM= mean(q);//arithematic mean in mm
for i= 1:8
    qb(i)= q(i)-AM;

end
Q= [qb(1),qb(2),qb(3),qb(4),qb(5),qb(6),qb(7),qb(8)];//
AV=(-qb(1)+qb(2)+qb(3)-qb(4)-qb(5)-qb(6)-qb(7)+qb(8))/n;//
SD=stdev(Q);//standard deviation
V=SD^2;//variance
disp(SD,"standard deviation in kg/cm^2")
//answer iswring in textbook
```

**Scilab code Exa 2.7.4.d** Probable Error

```
//Example 2.7.4.d://probable error
clc;
clear;
format('v',7)
n=8
q=[10.3,10.7,10.9,9.7,9.5,9.2,10.3,11.7];//
AM= mean(q);//arithematic mean in mm
for i= 1:8
    qb(i)= q(i)-AM;

end
Q= [qb(1),qb(2),qb(3),qb(4),qb(5),qb(6),qb(7),qb(8)];//
AV=(-qb(1)+qb(2)+qb(3)-qb(4)-qb(5)-qb(6)-qb(7)+qb(8))/n;//
SD=stdev(Q);//standard deviation
```

```
V=SD^2;//variance
Pe1=0.6745*SD;// probable error of one reading
probable_error=Pe1/sqrt(n-1);
disp(Pe1,"probable error of one reading(kg/cm^2) = ")
disp(probable_error,"probable error of mean(kg/cm^2) = ")
//answer iswring in textbook
```

**Scilab code Exa 2.8.1** Arithmetic mean and variance

```
//Example 2.8.1://ARITHEMATIC MEAN ,median value , standard deviation and variance
clc;
clear;
format('v',8)
q
 =[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.
 //
AM= mean(q);//arithematic mean in mm
for i= 1:15
    qb(i)= q(i)-AM;
end
Q= [qb(1),qb(2),qb(3),qb(4),qb(5),qb(6),qb(7),qb(8),qb(9),qb(10),qb(11),qb(12),qb(13),qb(14),qb(15)];//
AV=(-qb(1)-qb(2)+qb(3)+qb(4)-qb(5))/15;//
SD=stdev(Q);//standard deviation
V=SD^2;//variance
mv=q(12);//
disp(AM,"arithematic mean is in volts")
disp(mv,"median value is")
for i=1:15
      disp(qb(i),"deviation in "+string (q(i))+" is")
```

```
end
disp(round(SD),"standard deviation is")
disp(round(V),"variance is")
```

**Scilab code Exa 2.8.2** Arithmetic Mean and Standard Deviation

```
//Example 2.8.2://ARITHEMATIC MEAN
clc;
clear;
format('v',6)
v=[10,11,12,13,14];//
f=[03,12,18,12,03];//
q=[v(1)*f(1),v(2)*f(2),v(3)*f(3),v(4)*f(4),v(5)*f(5)
    ];
am=[q(1)+q(2)+q(3)+q(4)+q(5)];//
n=[f(1)+f(2)+f(3)+f(4)+f(5)];//
AM= am/n;//arithematic mean
for i= 1:5
    qb(i)= v(i)-AM;
    m(i)=f(i)*qb(i);//
end
sm=[-m(1)-m(2)+m(3)+m(4)+m(5)];//
md=sm/n;//
sm1=[f(1)*qb(1)^2,f(2)*qb(2)^2,f(3)*qb(3)^2,f(4)*qb
    (4)^2,f(5)*qb(5)^2];//
sm2=[sm1(1)+sm1(2)+sm1(3)+sm1(4)+sm1(5)];//
sd=sqrt(sm2/n);//standard deviation
disp(AM,"arithematic mean is in volts")
disp(md,"mean deviation is")
disp(sd,"standard deviation is")
```

**Scilab code Exa 2.8.3** Mean Value and Standard deviation

```
//Example 2.8.3://ARITHEMATIC MEAN ,median value ,
    standard deviation
clc;
clear;
format('v',6)
q
    =[29.2,29.5,29.6,30.0,30.5,31.4,31.7,32.4,33.0,33.3,39.4,28.9];
    //
AM= mean(q);//arithematic mean in mm
for i= 1:12
    qb(i)= q(i)-AM;
end
Q= [qb(1),qb(2),qb(3),qb(4),qb(5),qb(6),qb(7),qb(8),
    qb(9),qb(10),qb(11),qb(12)];//
AV=(-qb(1)-qb(2)+qb(3)+qb(4)-qb(5))/12;//
SD=stdev(Q);//standard deviation
V=SD^2;//variance
mv=q(5);//
disp(AM,"arithematic mean is ")
disp(mv,"median value is")
disp((SD),"standard deviation is")
```

**Scilab code Exa 2.8.4.a** Apparent Resistance

```
//Example 2.8.4.a // unknown resistor
clc;
clear;
close;
//given data :
V=100;//in volts
I=5*10^-3;// in A
R_app=(V/I)*10^-3;
disp(R_app,"apparent resistor,R_app(kilo-ohm) = ")
```

**Scilab code Exa 2.8.4.b** Actual Resistance

```
//Example 2.8.4.b //  resistance
clc;
clear;
close;
//given data :
V=100;//in volts
I=5*10^-3;// in A
S=1000;//in ohm/volts
R_app=(V/I)*10^-3;
V1=150;//in volts
Rv=S*V1*10^-3;
Rx=Rv/6.5;//actual resistance in kilo ohms
disp(Rx,"actual resistance in kilo ohms is")
```

**Scilab code Exa 2.8.4.c** Loading Effect

```
//Example 2.8.4.c //  error
clc;
clear;
close;
//given data :
format('v',5)
V=100;//in volts
I=5*10^-3;// in A
S=1000;//in ohm/volts
R_app=(V/I)*10^-3;
V1=150;//in volts
Rv=S*V1*10^-3;
Rx=Rv/6.5;//actual resistance in kilo ohms
per=(Rx-R_app)/Rx;//
```

```
disp(per*100,"percentage error due to loading effect
    of voltmeter is")
```

**Scilab code Exa 2.8.5** Limiting Error

```
//Example 2.8.5 // limiting error
clc;
clear;
close;
//given data :
del_A=2.5;// may be +ve or-ve in %
As=400;
FSD=600;// in volts
del_A1=(del_A/100)*600;
disp(del_A1,"del_A1 (V)=   ")
e=(del_A1/As)*100;
disp(e,"limiting error,e(%) = ")
```

# Chapter 3

# Electromechanical Instruments

**Scilab code Exa 3.2.1** Torque

```
//Example 3.2.1 // torque
clc;
clear;
close;
format("v",8)
//given data :
N=10;
L=1.5*10^-2;// in m
I=1;// in mA
B=0.5;
d=1*10^-2;// in m
Td=B*I*L*d*N;
disp(Td*10^-3,"torque,Td(Nm) = ")
```

---

**Scilab code Exa 3.2.2** Number of Turns

```
//Example 3.2.2 // number of turns
clc;
```

```
clear;
close;
//given data :
theta=%pi/2;
I=5*10^-3;// in A
B=1.8*10^-3;// in Wb/m^2
C=0.14*10^-6;// in Nm/rad
L=15*10^-3;// in m
d=12*10^-3;// in m
N=(C*theta)/(B*I*L*d);
disp(round(N),"number of turns,N(turns) = ")
```

**Scilab code Exa 3.2.3** Resistance

```
//Example 3.2.3 // resistance
clc;
clear;
close;
//given data :
Tc=240*10^-6;//in Nm
N=100;
L=40*10^-3;
d=30*10^-3;
B=1;//in Wb/m^2
TdBYI=N*B*L*d;
I=Tc/TdBYI;
//voltage per division=I*(R/100)
R=100/I;
disp(R*10^-3,"resistance ,R(k-ohm) = ")
//UNIT IS TAKEN WRONG IN THE BOOK
```

**Scilab code Exa 3.2.4** Diameter

```
//Example 3.2.4 // flux density and diameter
clc;
clear;
close;
//given data :
format('v',5)
p=1.7*10^-8;//in ohm-m
V=100*10^-3;//in V
R=50;// in ohm
theta=120;//in degree
L=30;// in mm
d=25;// in mm
N=100;
C=0.375*10^-6;// in Nm/degree
I=V/R;
Td_By_B=I*L*10^-3*d*10^-3*N;
Tc=C*theta;
B=Tc/Td_By_B;
disp(B,"the flux density,B(Wb/m^2) = ")
Rc=0.3*R;
Lmt=2*(L+d);
a=(N*p*Lmt*10^-3*10^6)/Rc;
D=sqrt(4/(%pi*a));
disp(D,"diameter,D(m) = ")
```

**Scilab code Exa 3.4.1** Shunt Resistor

```
//Example 3.4.1 // shunt resistor
clc;
clear;
close;
im=3;//in mA
rm=100;//in ohms
i=150;//in mA
rsh=(im*10^-3*rm)/((i-im)*10^-3);//shunt resistance
```

```
   in ohms
disp(rsh,"shunt resistance in ohms is")
```

**Scilab code Exa 3.4.2** Multiplying power and Shunt Resistot

```
//Example 3.4.2 // shunt resistormultiplying factor
   and resistance
clc;
clear;
close;
//given data :
format('v',6)
Rsh=300;//in ohm
Rm=1500;//in ohm
m=1+(Rm/Rsh);
disp(m,"multiplying factor ,m = ")
m1=40;
Rsh1=Rm/(m1-1);
disp(Rsh1,"the shunt resistor ,Rsh1(ohm) = ")
```

**Scilab code Exa 3.5.1** Shunt Resistance

```
//Example 3.5.1 //
clc;
clear;
close;
//given data :
format('v',5)
Rm=100;// in ohm
Im=1;
//for range 0-20 mA
I1=20;
m=I1/Im;
```

```
Rsh1=Rm/(m-1);
disp(Rsh1,"the shunt resistor,Rsh1(ohm) = ")
//for the range of 0-100 mA
I2=100;
m=I2/Im;
Rsh2=Rm/(m-1);
disp(Rsh2,"the shunt resistor,Rsh2(ohm) = ")
//for the range 0-200 mA
I3=200;
m=I3/Im;
Rsh3=Rm/(m-1);
disp(Rsh3,"the shunt resistor,Rsh3(ohm) = ")
```

**Scilab code Exa 3.6.1** Resistance

```
//Example 3.6.1 //design
clc;
clear;
close;
format('v',8)
rm=50;//in ohms
im=2;//in mA
i1=2;//in amperes
i2=10;//in amperes
i3=15;//in amperes
x=(im*rm*10^-3)/i1;//
A=[1 1;1 -7500];//
B=[0.05;-50];
X=A\B;
z=X(2,1);//
R1=0.2167/10.002;//in ohms
R2=0.025-R1;// in ohms
disp(R1,"resistance (R1) in ohms")
disp(R2,"resistance (R2) in ohms")
disp(z,"resistance (R3) in ohms")
```

**Scilab code Exa 3.9.1** Multiplier

```
//Example 3.9.1// multiplier
clc;
clear;
close;
//given data :
Vin=20;//in volts
I_fsd=50*10^-6;//in Farad
Rm=200;// in ohm
Rs=(Vin/I_fsd)-Rm;
disp(Rs*10^-3,"the multiplier,Rs(k-ohm) = ")
```

**Scilab code Exa 3.9.2** Current

```
//Example 3.9.2// full scale deflection current
clc;
clear;
close;
//given data :
format('v',5)
Vin=10;// in volts
Rs=200;//in k-ohm
Rm=400;// in ohm
I_fsd=Vin/((Rs*10^3)+Rm);
disp(I_fsd*10^6,"full scale deflection current,I_fsd
    (micro-A) = ")
```

**Scilab code Exa 3.10.1** Multiplier

```
//Example 3.10.1// multiplier
clc;
clear;
close;
//given data :
V1=200;//in V
V2=100;//in V
V3=10;// in V
Rm=100;//in ohm
I_fsd=50*10^-3;
//for the range 0-10V
Rt3=V3/I_fsd;
Rs3=Rt3-Rm;
disp(Rs3," the multiplier ,Rs3(ohm) = ")
//for the range 0-100V
Rt2=V2/I_fsd;
Rs2=Rt2-(Rm+Rs3);
disp(Rs2,"the multiplier ,Rs2(ohm) = ")
Rt1=V1/I_fsd;
Rs1=Rt1-(Rm+Rs3+Rs2);
disp(Rs1,"the multiplier ,Rs1(ohm) = ")
```

**Scilab code Exa 3.11.1** Multiplier

```
//Example 3.11.1// multiplier
clc;
clear;
close;
//given data :
format('v',7)
Rm=200;//in ohm
I_fsd=150*10^-6;// in A
S=1/I_fsd;
V=50;//in V
Rs=(S*V)-Rm;
```

```
disp(Rs*10^-3,"multiplier,Rs(k-ohm) = ")
```

**Scilab code Exa 3.11.2** Accurate Value of Voltage

```
//Example 3.11.2//accurate voltmeter reading
clc;
clear;
close;
format('v',6)
r1=50;// in killo ohms
r2=50;//in killo ohms
v=100;//in volts
vr2=(r1/(r1+r2))*v;// voltage in volts
//case 1
s1=12000;//sensivity in ohms/volts
rm1=r1*s1*10^-3;//in killo ohms
req=((rm1*r1)/(rm1+r1));//equivalent resistance in ohms
v1=((req/(r1+req))*v;// voltmeter reading when sensivity is 12000 ohms /V
//case 2
s2=15000;//sensivity in ohms/volts
rm2=r1*s2*10^-3;//in killo ohms
req1=((rm2*r1)/(rm2+r1));//equivalent resistance in ohms
v2=((req1/(r1+req1))*v;// voltmeter reading when sensivity is 15000 ohms /V
disp(v1,"voltmeter reading when sensivity is 12000 ohms /V in volts")
disp(v2,"voltmeter reading when sensivity is 15000 ohms /V in volts, this voltmeter will measure the correct value")
```

**Scilab code Exa 3.15.1.a** Voltage

```
//Example 3.15.1.a//voltage
clc;
clear;
close;
format('v',6)
r1=25;// in kilo ohms
r2=5;//in kilo ohms
v=30;//in volts
vr2=(r2/(r1+r2))*v;// voltage in volts across 5 kilo
    ohms resistance
disp(vr2,"voltage in volts across 5 kilo ohms
   resistance")
```

---

**Scilab code Exa 3.15.1.b** Voltage

```
//Example 3.15.1.b//voltage
clc;
clear;
close;
format('v',5)
r1=25;// in kilo ohms
r2=5;//in kilo ohms
v=30;//in volts
vr2=(r1/(r1+r2))*v;// voltage in volts across 5 kilo
    ohms resistance
//case 1
s1=1;//sensivity in kilo ohms/volts
v1=10;// in volts
rm1=v1*s1;//in kilo ohms
req=((rm1*r2)/(rm1+r2));//equivalent resistance in
   ohms
vrb1=((req/(r1+req)))*v;// voltmeter reading when
   sensivity is 1 kilo ohms /V
```

```
disp(vrb1," voltmeter reading when sensivity is 1
    kilo ohms /V in volts")
```

**Scilab code Exa 3.15.1.c** Voltage

```
//Example 3.15.1.c//voltage
clc;
clear;
close;
format('v',5)
r1=25;// in kilo ohms
r2=5;//in kilo ohms
v=30;//in volts
vr2=(r1/(r1+r2))*v;// voltage in volts across 5 kilo
     ohms resistance
//case 2
s2=20;//sensivity in kilo ohms/volts
v1=10;// in volts
rm2=v1*s2;//in kilo ohms
req1=((rm2*r2)/(rm2+r2));//equivalent resistance in
    ohms
vrb2=((req1/(r1+req1)))*v;// voltmeter reading when
    sensivity is 1 kilo ohms /V
disp(vrb2," voltmeter reading when sensivity is 1
    kilo ohms /V in volts")
```

**Scilab code Exa 3.15.1.d** Error

```
//Example 3.15.1.d//error
clc;
clear;
close;
format('v',5)
```

```
r1=25;// in kilo ohms
r2=5;//in kilo ohms
v=30;//in volts
vr2=(r2/(r1+r2))*v;// voltage in volts across 5 kilo
    ohms resistance
//case 1
s1=1;//sensivity in kilo ohms/volts
v1=10;// in volts
rm1=v1*s1;//in kilo ohms
req=((rm1*r2)/(rm1+r2));//equivalent resistance in
    ohms
vrb1=((req/(r1+req)))*v;// voltmeter reading when
    sensivity is 1 kilo ohms /V
//case 2
s2=20;//sensivity in kilo ohms/volts
v1=10;// in volts
rm2=v1*s2;//in kilo ohms
req1=((rm2*r2)/(rm2+r2));//equivalent resistance in
    ohms
vrb2=((req1/(r1+req1)))*v;// voltmeter reading when
    sensivity is 1 kilo ohms /V
er1=(vr2-vrb1)/vr2;//voltmeter 1 error
er2=(vr2-vrb2)/vr2;//voltmeter 2 error
disp(er1*100,"voltmeter 1 error in percentage")
disp(er2*100,"voltmeter 2 error in percentage")
//answer is wrong in the textbook
```

**Scilab code Exa 3.15.2** Shunt Resistance

```
//Example 3.15.2: shunt resistance
clc;
clear;
close;
//given data :
Im=1;// in mA
```

```
Rm=100;// in ohm
I=100;// in mA
Rsh=(Im*10^-3*Rm)/((I-Im)*10^-3);
disp(Rsh,"shunt resistance,Rsh(ohm) = ")
```

**Scilab code Exa 3.15.3** Shunt Resistance

```
//Example 3.15.3: shunt resistance
clc;
clear;
close;
//given data :
Im=1;// in mA
P=100;// in kilo-watt
I=100;// in mA
Rm=(P)/(Im)^2;
Rsh=((Im*10^-3*Rm*10^3)/((I-Im)*10^-3))*10^-3;
disp(Rsh,"shunt resistance,Rsh(kilo-ohm) = ")
```

**Scilab code Exa 3.15.4** Shunt Resistance

```
//Example 3.15.4: shunt resistance
clc;
clear;
close;
//given data :
Rsh=200;// in ohm
Rm=100;// in ohm
m=50;
Rsh=Rm/(m-1);
disp(Rsh,"the shunt resistance,Rsh(ohm) = ")
```

**Scilab code Exa 3.15.5** Shunt Resistance

```
//Example 3.15.5: shunt resistance
clc;
clear;
close;
//given data :
Im=1;// in mA
Rm=100;// in ohm
I=100;// in mA
Rsh=(Im*10^-3*Rm)/((I-Im)*10^-3);
disp(Rsh,"shunt resistance,Rsh(kilo-ohm) = ")
```

# Chapter 4

# Analog Electronic Volt Ohm Milliammeter

**Scilab code Exa 4.2.1** Peak Amplitude

```
//Example 4.2.1: peak amplitude
clc;
clear;
close;
//given data :
format('v',7)
E_rms=230;//in V
Ep=sqrt(2)*E_rms;
disp(Ep,"peak amplitude,Ep(V) = ")
```

---

**Scilab code Exa 4.12.1** Resistance

```
//Example 4.12.1: resistance
clc;
clear;
close;
```

```
//given data :
format('v',5)
Rm=500;//in ohm
E_rms=50;// in V
E_dc=(sqrt(2)*E_rms)/(%pi/2);
Im=1*10^-3;//in A
R=E_dc/Im;
Rs=(R-Rm)*10^-3;
disp(Rs,"the resistance,Rs(kilo-ohm) = ")
```

**Scilab code Exa 4.14.1** form factor and error

```
//Example 4.14.1: form factor and percentage error
clc;
clear;
close;
ff1=1;//form factor
r=1.11;//sine wave form factor
per=((r-ff1)/ff1)*100;//percentage error
disp(ff1,"form factor is")
disp(per,"percentage error is")
```

**Scilab code Exa 4.14.2.a** Form Factor of The Voltage

```
//Example 4.14.2.a:form factor
clc;
clear;
close;
format('v',6)
T1=3;//
T=0:3;
Vrms=200*(sqrt((1/T1)*(intsplin(T,T^2))));//in volts
Vav=200*(1/T1)*(intsplin(T,T));// in volts
```

```
ff=Vrms/Vav;//
disp(ff,"form factor is")
```

**Scilab code Exa 4.14.2.b** Error

```
//Example 4.14.2.b:error
clc;
clear;
close;
format('v',6)
T1=3;//
T=0:3;
Vrms=200*(sqrt((1/T1)*(intsplin(T,T^2))));//in volts
Vav=200*(1/T1)*(intsplin(T,T));// in volts
ff=Vrms/Vav;//
ff1=1.11;//form factor of sine wave
per=((ff1/ff)-1)*100;//percentage errpr
disp(per,"percentage error in meter indication is")
```

**Scilab code Exa 4.19.1** Current

```
//Example 4.19.1: current
clc;
clear;
close;
//given data :
gm=0.005;//in mho
V1=1.5//in V
rd=200*10^3;// in Ohm
Rd=15*10^3;//in ohm
Rm=75;//in ohm
I=(gm*V1*((Rd*rd)/(rd+Rd)))/((2*((Rd*rd)/(rd+Rd)))+
    Rm);
```

```
disp(I*10^3,"current ,I(mA) = ")
```

**Scilab code Exa 4.19.2** Current

```
//Example 4.19.2: current
clc;
clear;
close;
//given data :
gm=0.005;//in mho
V1=1//in V
rd=200*10^3;// in Ohm
Rd=15*10^3;//in ohm
Rm=75;//in ohm
V=[0.2,0.4,0.6,0.8,1];// IN VOLTS
for i=1:5
    I(i)=(gm*V(i)*((Rd*rd)/(rd+Rd)))/((2*((Rd*rd)/(
       rd+Rd)))+Rm);
    disp(I(i)*10^3,"current in mA for voltage "+
       string(V(i))+" volts")
end
```

**Scilab code Exa 4.19.3** Resistance

```
//Example 4.19.3: design
clc;
clear;
close;
format('v',6)
v1=100;// in volts
v2=30;//in volts
v3=103;// in volts
v4=1;//in volts
```

```
x=9;//assume input resistance in mega ohms
r4=(v4/v3)*x*10^3;//in kllo ohms
r3=(((v4/v1)*x*10^6)-(r4*10^3))*10^-3;//in kilo ohms
r2=(((v4/v2)*x*10^6)-((r4+r3)*10^3))*10^-3;// in
    kilo ohms
r1=9*10^6-((r2+r3+r4)*10^3);// in ohms
disp(r4,"resistance (R4) in kilo ohms is")
disp(r3,"resistance (R3) in kilo ohms is")
disp(r2,"resistance (R2) in kilo ohms is")
disp(r1*10^-6,"resistance (R1) in mega ohms is")
```

**Scilab code Exa 4.19.4** Current

```
//Example 4.19.4: current
clc;
clear;
close;
//given data :
format('v',4)
rd=150*10^3;// in ohm
Rm=50;// in ohm
Rs=1000*10^3;// in ohm
gm=0.0052;//in mho
rd1=rd/((gm*rd)+1);
V0=gm*((rd1*Rs)/(rd1+Rs))
R0=(2*Rs*rd1)/(Rs+rd1)
I=V0/(R0+Rm);
disp(I*10^3,"curent ,I(mA) = ")
```

**Scilab code Exa 4.19.5** Resistance

```
//Example 4.19.5: resistance
clc;
```

```
clear;
close;
//given data :
V1=1;//in V
I=1.5*10^-3;//in A
rd=200*10^3;// in ohm
Rm=50;// in ohm
Rs=600*10^3;// in ohm
gm=0.005;//in mho
rd1=rd/((gm*rd)+1);
V0=gm*((rd1*Rs)/(rd1+Rs))*V1
R0=(2*Rs*rd1)/(Rs+rd1)
R_cal=(V0/I)-Rm-R0;
disp(R_cal,"resistance ,R_cal(ohm) = ")
// answer is wrong in book
```

**Scilab code Exa 4.26.3** Shunt Resistance and Current

```
//Example q.3: current and voltae
clc;
clear;
close;
format('v',5)
rm=10;//in ohms
im=5;// in mA
i=1;// in amperes
v=5;//in volts
ish=i-(im*10^-3);// in amperes
m=i/(im*10^-3);//ratio
rsh=rm/(m-1);//in ohms
vo=v/i;//in volts
rsh1=vo/(im);//in kilo ohms
disp(rsh,"shunt resistance in ohms to measure
    current upto 1 A")
disp(rsh1,"shunt resistance in kilo to measure
```

```
voltage upto 5 V")
```

# Chapter 5

# Digital Voltmeters

**Scilab code Exa 5.10.1** Resolution

```
//Example 5.10.1: resolution
clc;
clear;
close;
format('v',8)
//given data :
n=4
R=1/10^n;
disp(R,"resolution ,R = ")
```

**Scilab code Exa 5.10.2** Resolution

```
//Example 5.10.2: resolution
clc;
clear;
close;
format('v',9)
//given data :
```

```
n=5
R=1/10^n;
disp(R,"resolution ,R = ")
```

**Scilab code Exa 5.10.3** Resolution

```
//Example 5.10.3: resolution
clc;
clear;
close;
format('v',8)
//given data :
n=4
R=1/10^n;
disp(R,"resolution ,R = ")
```

**Scilab code Exa 5.10.4** Time Interval

```
//Example 5.10.4: voltage and time interval
clc;
clear;
close;
//given data :
t1=1;//sec
R=100;//k-ohm
C=1;//micro F
Vin=1;//V
Vref=5;//V
Vout=1/(R*1000)/(C*10^-6)*integrate('Vin*1','t',0,t1
   );//V
disp(Vout,"Output vltage after 1 sec in Volt : ");
//Vout=Vref*t2/R/C & Vout=Vin*t1/R/C
t2=t1*Vin/Vref;//sec
```

```
disp(t2,"Time interval t2 in sec : ");
```

# Chapter 6

# Digital Frequency Meter

**Scilab code Exa 6.17.1** Gate Time

```
//Example 6.17.1 // desired gate time
clc;
clear;
close;
//given data :
r=0.1;//in Hz
D=1/r;
disp(D,"the desired gate time,D(sec) = ")
```

**Scilab code Exa 6.17.2** Error

```
//Example 6.17.2 // error
clc;
clear;
close;
f1=1;// in Mhz
f2=200;//in kHz
per=(200*10^-3)*100;// percentage error that display
    may indicate 4 micro seconds or 6 micro seconds
```

```
per1=(1/50)*100;//percentage error after 10 times
   improvement
disp(per,"percentage error that display may indicate
    4 micro seconds or 6 micro seconds")
disp(per1,"percentage error after 10 times
   improvement")
```

**Scilab code Exa 6.17.3** Accuracy

```
//Example 6.17.3 //  Accuracy
clc;
clear;
close;
//given data :
format('v',9)
f=400;//Hz
time_accuracy=10^-8;//sec
display_accuracy=1;//(+ve or -Ve)
t=10;//sec
period=1/f ;//ms
Accuracy= 1+((period*10^3)/10);//ms
disp(Accuracy,"accuracy in ms (   )")
```

# Chapter 7

# Low High and Precise Resistance Measurement

**Scilab code Exa 7.5.1** Resistance

```
//Example 7.5.1: resistance
clc;
clear;
close;
//given data :
R1=5;// in kilo-ohm
R2=7;// in kilo-ohm
R3=10; // in kilo-ohm
Rx=(R2*R3)/R1;
disp(Rx,"unknown resistance ,Rx(k-ohm) = ")
```

**Scilab code Exa 7.5.2** Current

```
//Example 7.5.2: current
clc;
clear;
```

```
close;
//given data :
R1=1.5;// in kilo-ohm
R2=3;// in kilo-ohm
R3=5; // in kilo-ohm
R4=14;//in kilo-ohm
Rg=250;//in ohm
E=10;//in V
Vd=(E*R4)/(R2+R4);
Vc=(E*R3)/(R1+R3);
E_th=E*((R4/(R2+R4))-(R3/(R1+R3)));
R_th=((R1*R3)/(R1+R3))+((R2*R4)/(R2+R4));
Ig=(E_th/((R_th*10^3)+Rg))*10^6;
disp(Ig,"current,Ig(micro-A) = ")
// answer is wrong in book
```

**Scilab code Exa 7.5.3** Deflection

```
//Example 7.5.3: deflection
clc;
clear;
close;
//given data :
format('v',4)
s=8;//sensivity in mm/micro amperes
R1=1;// in kilo-ohm
R2=5;// in kilo-ohm
R3=2; // in kilo-ohm
R4=10;//in kilo-ohm
Rg=150;//in ohm
E=6;//in V
r=10;// unbalance resistance in ohm
del_r=10;// in kilo-ohm
R4_1=((R4*10^3)+r)*10^-3;
Vd=(E*R4_1)/(R2+R4_1);
```

```
Vc=(E*R3)/(R1+R3);
E_th=E*((R4_1/(R2+R4_1))-(R3/(R1+R3)));
R_th=((R1*R3)/(R1+R3))+((R2*R4)/(R2+R4));
Ig=(E_th/((R_th*10^3)+Rg))*10^6;
d=Ig*s;//deflection in mm
disp(d,"deflection in mm")
//answer is wrong in the textbook
```

**Scilab code Exa 7.5.4** Current

```
//Example 7.5.4: current
clc;
clear;
close;
//given data :
format('v',7)
R=500;//in ohm
Rg=150;// in ohm
del_r=10;// in ohm
E=6;//in V
E_th=(E*del_r)/(4*R);
R_th=R;
Ig=(E_th/(R_th+Rg))*10^6;
disp(Ig,"current,Ig(micro-A) = ")
```

**Scilab code Exa 7.5.5** voltage

```
//Example 7.5.5: supply voltage
clc;
clear;
close;
//given data :
R=120;//in ohm
```

```
del_r=1;// in ohm
E_th=10*10^-3;//in V
E=(E_th*4*R)/del_r;
disp(E,"supply voltage,E(volts) = ")
```

**Scilab code Exa 7.5.6** Resistance

```
//Example 7.5.6: resistance
clc;
clear;
close;
//given data :
A=100.24;// in ohm
B=200;// in ohm
a=100.31;// in ohm
b=200;// in ohm
S=100.03;// in micro-ohm
r=700;// in micro-ohm
X=((A/b)*S)+(((r*b)/(r+a+b))*((A/B)-(a/b)));
disp(X,"the unknown resistance,X(micro-ohm) = ")
```

**Scilab code Exa 7.5.7** Deflection

```
//Example 7.5.7: deflection
clc;
clear;
close;
//given data :
format('v',6)
R_ab=100;// in ohm
R_bc=500;// in ohm
R_cd=1000;// in ohm
R_da=200;// in ohm
```

```
V=10;
VRg=200;// in ohm
del_CD=10;// in ohm
V_bd=V*((R_ab/(R_ab+R_bc))-(R_da/(R_da+R_cd+del_CD))
    );
R_bd=(((R_ab*R_bc)/(R_ab+R_bc))+((VRg*(R_cd+del_CD))
    /(VRg+R_cd+del_CD)));
I_G=(V_bd/(R_bd+VRg));
s=5;//sensivity in micro ampere /mm
dg=I_G*10^6*s;//deflection in mm
disp(dg,"deflection in mm")
//answer is wrong in the textbook
```

**Scilab code Exa 7.5.8** Resistance and Limiting Error

```
//Example 7.5.8: LIMITING VALUE OF RESISTANCE
clc;
clear;
close;
format('v',8)
P=100;//OHMS
Q=P;//
S=230;//IN OHMS
DP=0.02;//ERROR IN PERCENTAGE
DS=0.01;//IN PERCENTAGE
R=(P/Q)*S;//unkow resistance in ohms
dr=(DP+DP+DS);//relative limiting error in unknow
    resistance in percentage
drm=(dr/100)*R;//magnitude of error
R1=R+drm;//in ohms
R2=R-drm;//in ohms
disp("limiting value of unknown resistance is "+
    string(R1)+" ohms to "+string(R2)+" ohms")
```

**Scilab code Exa 7.5.9** Resistance

```
//Example 7.5.9: insulation resistance of cable
clc;
clear;
close;
format('v',6)
t=120;//in seconds
v1=300;//in volts
v2=100;//in volts
c=300;//capacitance in pf
r=((t)/(c*10^-12*log(v1/v2)));//resistance in ohms
disp(r*10^-12,"resistance of cable in mega ohms is")
```

**Scilab code Exa 7.5.10** Resistance

```
//Example 7.5.10: resistance
clc;
clear;
close;
format('v',9)
g=2000;//in ohms
s=10;//in kilo ohms
q1=40;//divisions
q2=46;//divisions
r=((q1/q2)*((s*10^3)+(g)))-g;//in ohms
disp(r,"unknown resistance in ohms is")
//answer is wrong in the textbook
```

**Scilab code Exa 7.5.11** Resistance

```
//Example 7.5.11: resistance
clc;
clear;
close;
t=200;// in volts
i=0.5;//in amperes
ra=10;//in ohms
x=t/i;//in ohms
r=x-ra;//in ohms
disp(r,"unknown resistance in ohms is")
```

**Scilab code Exa 7.5.12** Ammeter and Voltmeter

```
//Example 7.5.12: ammeter and voltmeter readings
clc;
clear;
close;
format('v',7)
t=200;// in volts
i=0.5;//in amperes
ra=10;//in ohms
x=t/i;//in ohms
r=x-ra;//in ohms
sv=10;//sensivity in killo ohms / V
v=1000;//in volts
rv=v*sv *10^-6;// in mega ohms
rp=((rv*10^6)*r)/(rv*10^6+r);//in ohms
vr=((t*rp)/(ra+rp));//voltmeter reading in volts
vi=vr/rp;//ammeter rading in amperes
disp(vr,"voltmeter reading in volts")
disp(vi,"ammeter rading in amperes")
```

# Chapter 8

# Inductance and Capacitance Measurements

**Scilab code Exa 8.5.1** Error

```
//Example 8.5.1:percentage errpr
clc;
clear;
close;
format('v',4)
r=10;//in ohms
f=1;//in  MHz
c=65;//capacitance in pF
rsh=0.02;//in ohms
qact=((1/(2*%pi*f*10^6*c*10^-12*r)));//actual q
   factor
qm=(1/(2*%pi*c*10^-12*f*10^6*(r+rsh)));//measured q
   factor
per=((qact-qm)/qact)*100;//percentage error
disp(per,"percentage error is")
```

**Scilab code Exa 8.5.2** Capacitance and Inductance

```
//Example 8.5.2:self capacitance and inductance
clc;
clear;
close;
format('v',6)
f1=2;//in MHz
c1=460;//in pF
f2=4;//in MHz
c2=100;//in pF
cd1=((c1-(4*c2))/3);//self capacitance in pF
x=((1/(2*%pi*f1*10^6)))^2;//
l=x/((c1+cd1)*10^-12);//
disp(cd1,"self capacitance in pF")
disp(l*10^6,"inductance in micro Henry")
```

**Scilab code Exa 8.6.1** Resistance and Capacitance

```
//Example 8.6.1: Lx and Rx
clc;
clear;
close;
//given data :
R1=560;// in kilo-ohm
R2=6.3;// in kilo-ohm
R3=120; // in kilo-ohm
Ci=0.01;// in micro-farad
Sensitivity=10;// in mm/micro-A
del_r=1;// in ohm
Rx=(R2*R3)/R1;
disp(Rx,"unknown resistance,Rx(k-ohm) = ")
Lx=R2*10^3*R3*10^3*Ci*10^-6;
disp(Lx,"unknown inductanceLx(H) = ")
```

**Scilab code Exa 8.6.2** Capacitance and Dissipation Factor

```
//Example 8.6.2: Cx,Rx and D
clc;
clear;
close;
//given data :
f=1000;//in Hz
R1=1.1;// in kilo-ohm
R2=2.2;// in kilo-ohm
C1=0.47;// in micro-farad
C3=0.5;// in micro-farad
Rx=(R2*C1)/C3;
disp(Rx,"unknown resistance,Rx(k-ohm) = ")
Cx=(R1*C3)/R2;
disp(Cx,"unknown capacitance,Cx(micro-farad) = ")
w=2*f*%pi;
D=w*Cx*10^-6*Rx*10^3;
disp(D,"dissipation factor,D = ")
//answer is wrong in the textbook
```

**Scilab code Exa 8.6.3** Resistance and Capacitance

```
//Example 8.6.3: unknown resistance and capacitance
clc;
clear;
close;
r1=10;//in kilo ohms
r2=50;//in kilo ohms
r3=100;//in kilo ohms
c3=100;//in micro farads
```

```
rx=((r2*10^3*r3*10^3)/(r1*10^3))*10^-3;//unknown
    resistance in killo ohms
cx=((r1*10^3*c3*10^-6)/(r2*10^3))*10^6;// unknown
    capacitance in micro farads
disp(rx,"unknown resistance in kilo ohms")
disp(cx,"unknown capacitance in micro farads")
```

**Scilab code Exa 8.6.4** Inductance and Resistance

```
//Example 8.6.4: Lx and Rx
clc;
clear;
close;
//given data :
R1=600;// in ohm
R2=1000;// in ohm
R3=100;// in ohm
C1=1;// in micro-farad
Rx=(R2*R3)/R1;
disp(Rx,"resistance,Rx(ohm) = ")
Lx=C1*10^-6*R2*R3;
disp(Lx,"inductance,Lx(henry) = ")
```

**Scilab code Exa 8.6.5** Resistance and Inductance

```
//Example 8.6.5: L3 and R3
clc;
clear;
close;
format('v',5)
//given data :
R1=10;// in kilo-ohm
R2=2;// in kilo-ohm
```

```
R4=1;// in kilo-ohm
C2=1*10^-6;// in micro-farad
w=3000;// in rad/sec
L3=(R1*10^3*R4*10^3*C2)/(1+((R2*10^3)^2*(C2^2)*w^2))
R3=R2*10^3*L3*C2*w^2;//
disp(R3,"unknown resistance in ohms")
disp(L3,"inductance in henry ")
//resistance is calculated wrong in the textbook
```

**Scilab code Exa 8.6.6** Capacitance Resistance and Dissipation Factor

```
//Example 8.6.6: Cx,Rx and D
clc;
clear;
close;
format('v',9)
//given data :
f=1000;//in Hz
R2=20000;// in ohm
R3=1.2*10^3;// in ohm
C3=300*10^-12;// in farad
C4=0.05*10^-6;// in farad
Rx=(R2*C3)/C4;
disp(Rx,"unknown resistance ,Rx(k-ohm) = ")
Cx=((R3*C4)/R2)*10^6;
disp(Cx,"unknown capacitance ,Cx(micro-farad) = ")
w=2*f*%pi;
D=w*Cx*10^-6*Rx*10^3;
disp(D*10^-3,"dissipation factor ,D = ")
```

**Scilab code Exa 8.6.7** Resistance and Relative Permittivity

```
//Example 8.6.7: resistance and capacitance
```

```
clc;
clear;
close;
//given data :
format('v',8)
C2=106*10^-12;// in farad
C4=0.6*10^-6;// in farad
R4=1000/%pi;// in ohm
R3=250;// in ohm
R1=(C4/C2)*R3*10^-6;
disp(R1*10^6,"resistance ,R1(ohm) = ")
C1=(R4/R3)*C2*10^6;
disp(round(C1*10^6),"capacitance ,C1(micro-farad) = "
  )
```

**Scilab code Exa 8.6.8** Resistance and Capacitance

```
//Example 8.6.8: resistance and capacitance
clc;
clear;
close;
//given data :
R1=3.1;// in kilo-ohm
C1=5.2;//in micro-ohm
R2=25;//in kilo-ohm
R4=100;//in kilo-ohm
f=2.5*10^3;//in Hz
w=2*%pi*f*10^-3;
R3=(R4/R2)*(R1+(1/(w^2*R1*C1^2)));
disp(R3,"resistance ,R3(kilo-ohm) = ")
C3=((R4/R2)-(R1/R3))*C1;
disp(C3,"capacitance ,C3(micro-farad) = ")
// answer is wrong in book
```

**Scilab code Exa 8.6.9** Capacitance and Inductance

```
//Example 8.6.9: inductance and capacitance
clc;
clear;
close;
format('v',6)
//given data :
F1=1.5;//in MHz
C1=650;//in pF
F2=3;//in MHz
C2=150;//in pF
Cd=(C1-(4*C2))/3;
disp(Cd,"capacitance ,Cd(pico-farad) = ")
L=(1/(4*%pi^2*F1^2*((C1*10^-12)+(C2*10^-12))))
   *10^-6;
disp(L,"inductance ,L(micro-henry) = ")
```

---

**Scilab code Exa 8.6.10** Error

```
//Example 8.6.10 // Q
clc;
clear;
close;
//given data
format('v',5)
rsh=0.02;//:
r=10;// in ohm
f=1;//in MHz
c=65;//in pico-farad
L=(1/((2*%pi*f*10^6)^2*c*10^-12))*10^3;
```

```
qact=((1/(2*%pi*f*10^6*c*10^-12*r)));//actual q
   factor
qm=(1/(2*%pi*c*10^-12*f*10^6*(r+rsh)));//measured q
   factor
per=((qact-qm)/qact)*100;//percentage error
disp(per,"percentage error is")
```

**Scilab code Exa 8.6.11** Capacitance

```
//Example 8.6.11 // capacitance
clc;
clear;
close;
//given data :
F1=3;//in MHz
C1=400;//in pico-farad
F2=6;//in MHz
C2=120;//in pico-farad
Cd=(C1-(4*C2))/3;
disp(-Cd,"self capacitance,Cd(pico-farad) = ")
```

**Scilab code Exa 8.6.12** Capacitance

```
//Example 8.6.12 // capacitance
clc;
clear;
close;
//given data :
format('v',6)
F1=2;//in MHz
C1=450;//in pico-farad
F2=5;//in MHz
C2=60;//in pico-farad
```

```
ratio=F2/F1;
//1/sqrt(C2+Cd)=ratio/sqrt(C1+Cd)
Cd=(C1-(ratio^2*C2))/5.25;
disp(Cd,"self capacitance,Cd(pico-farad) = ")
```

**Scilab code Exa 8.6.13** Capacitance

```
//Example 8.6.13 // capacitance
clc;
clear;
close;
//given data :
F1=8;//in MHz
C1=120;//in pico-farad
F2=12;//in MHz
C2=40;//in pico-farad
ratio=F1/F2;
//1/sqrt(C2+Cd)=ratio/sqrt(C1+Cd)
Cd=((4*C1-9*C2)/5);//
disp(Cd,"self capacitance,Cd(pico-farad) = ")
```

**Scilab code Exa 8.7.5** Resistance and Inductance

```
//Example Q.5: Lx and Rx
clc;
clear;
close;
//given data :
r1=28.5;//in ohms
L1=52.6;//in mH
R2=1.68;//in ohms
R3=80;//in ohms
R4=R3;// in ohms
```

```
Lx=(R3/R4)*L1;//inductance in mH
Rx=r1*(R3/R4)-R2;//in ohms
disp(Rx,"unknown resistance ,Rx(ohm) = ")
disp(Lx,"unknown inductanceLx(mH) = ")
```

# Chapter 9

# Cathode Ray Oscilloscope

**Scilab code Exa 9.14.1** Peak to Peak Amplitude and rms Value

```
//Example 9.14.1 // peak to peak voltage and rms
   voltage
clc;
clear;
close;
format('v',7)
vdv=1;//volts per division in V/div
n=6.8;//no. of divisions
Vpp=vdv*n;//peak to peak voltage in volts
vrms=Vpp/(2*sqrt(2));//rms voltage in volts
disp(Vpp,"peak to peak voltage in volts")
disp(vrms,"rms voltage in volts")
```

---

**Scilab code Exa 9.14.2** Time Interval

```
//Example 9.14.2 // time interval
clc;
clear;
```

```
close;
format('v',7)
vdv=2;//volts per division in micro seconds/div
n=2;//no. of divisions
Tint=vdv*n;//peak to peak voltage in volts
disp(Tint,"time interval in micro seconds is")
```

**Scilab code Exa 9.14.3** Period and Frequency

```
//Example 9.14.3 // period and frequency
clc;
clear;
close;
format('v',6)
vdv=2;//volts per division in micro seconds/div
n=12;//no. of divisions
Tp=vdv*n;// period in micro seconds
f=1/(Tp*10^-3);//frequency in kHz
disp(Tp,"period in micro seconds")
disp(f,"frequency in kHz")
```

**Scilab code Exa 9.14.4** Frequency

```
//Example 9.14.4 // peak to peak voltage and
   frequency
clc;
clear;
close;
format('v',7)
vdv1=0.5;//volts per division in V/div
nv=3;//no. of divisions
nh=4;//numbers of horizontal divisions
Vpp=vdv1*nv;//peak to peak voltage in volts
```

```
vdv2=2;// time division in micro seconds per
   divisions
Tp=vdv2*nh;// period in micro seconds
f=1/(Tp*10^-3);//frequency in kHz
disp(Vpp,"peak to peak voltage in volts")
disp(Tp,"period in micro seconds")
disp(f,"frequency in kHz")
```

**Scilab code Exa 9.17.1** Bandwidth

```
//Example 9.17.1 // bandwidth
clc;
clear;
close;
format('v',6)
//given data :
Trs=12;//in micro-sec
Trd=15;//in micro-sec
Tro=sqrt(Trd^2-Trs^2);
K=0.35;// constant
BW=(K/Tro)*10^3;
disp(BW,"bandwidth ,BW(KHz) =")
```

**Scilab code Exa 9.17.2** Rise Time

```
//Example 9.17.2 // rise time
clc;
clear;
close;
//given data :
BW=10*10^6;// in Hz
tr=(0.35/BW)*10^9;
disp(tr,"rise time,tr(ns) = ")
```

**Scilab code Exa 9.17.3** Rise Time

```
//Example 9.17.3 // rise time
clc;
clear;
close;
//given data :
Tro=10;//in micro-sec
Trd=13;//in micro-sec
Trs=sqrt(Trd^2-Tro^2);
disp(Trs,"actual rise time,Trs(n-sec) = ")
```

**Scilab code Exa 9.17.4** rise time

```
//Example 9.17.3 // rise time
clc;
clear;
close;
//given data :
Tro=10;//in micro-sec
Trd=15;//in micro-sec
Trs=sqrt(Trd^2-Tro^2);
disp(Trs,"actual rise time,Trs(n-sec) = ")
```

**Scilab code Exa 9.17.5** rise time

```
//Example 9.17.5 // rise time
clc;
clear;
```

```
close;
//given data :
Trs=12;//in micro-sec
Trd=30;//in micro-sec
BW=20*10^6;// in Hz
K=0.35;// constant
Tro=(K/BW)*10^9;
Trs=sqrt(Trd^2-Tro^2);
disp(Trs,"actual rise time,Trs(n-sec) = ")
```

**Scilab code Exa 9.17.6** capacitance

```
//Example 9.17.5 // capacitance
clc;
clear;
close;
//given data :
K=10;// constant
C2=35*10^-12;
C1=(C2/(K-1))*10^12;
disp(C1,"capacitance,C1(pico-farad) = ")
```

**Scilab code Exa 9.17.7** input impedence

```
//Example 9.17.7 // impedance of CRO
clear;
close;
clc;
K=10;//
vin=1;//vpp
vout=0.1;//in vpp
c1=2;// in pF
c2=c1*(K-1);//CAPACITANCE IN Pf
```

```
disp(c2,"capacitance in pF")
```

**Scilab code Exa 9.17.8** minimum time division sensivity

```
//Example 9.17.8 // sensivity
clear;
close;
clc;
n=2;//divisions
f=50;//in MHz
t=(1/f)*10^3;//time in nanao seconds
mdv=t/4;//in ns/div
mtds=mdv*n;// in ns/div
disp(mdv,"minimum time/div in ns/div")
disp(mtds,"minimum time/div setting in ns/div")
```

**Scilab code Exa 9.17.9** rise time

```
//Example 9.17.9 // rise time
clc;
clear;
close;
//given data :
format('v',4)
Trs=21;//in micro-sec
K=0.35;// constant
BW=50*10^6;// in Hz
Tro=(K/BW)*10^9;
Trd=sqrt(Trs^2+Tro^2);
disp(Trd,"rise time,Tro(n-sec) = ")
```

# Chapter 10

# special oscilloscopes

**Scilab code Exa 10.11.1** sampling rate

```
//Example 10.11.1 // sampling rate
clc;
clear;
close;
//given data :
format('v',6)
N=10;//number of cycles
f1=1*10^3;//in Hz
f2=100*10^3;// in Hz
sampling_period1=N/f1;
sampling_frequency1=1/sampling_period1;
disp(sampling_frequency1,"sampling frequency of 1
   kHz signal in samples per second")
sampling_period2=N/f2;
sampling_frequency2=1/sampling_period2;
disp(sampling_frequency2,"sampling frequency of 100
   kHz signal in samples per second")
```

**Scilab code Exa 10.13.1** sampling rate

```
//Example 10.13.1 // sampling rate
clc;
clear;
close;
//given data :
N=10;//number of cycles
f=1*10^3;//in Hz
sampling_period=N/f;
sampling_rate=1/sampling_period;
disp(sampling_rate,"sampling rate in samples per
    second")
```

# Chapter 11

# Instrument Callibration

**Scilab code Exa 11.3.1** error

```
//Example 11.3.1 // percentage of the reading and percentage of full scale
clc;
clear;
close;
//given data :
a=10;//scale reading
b=70;// full scale
error1=-(0.5/10)*100;
disp("step 1")
disp(error1,"error of reading in %")
error2=-(0.5/100)*100;
disp(error2,"error of full scale in %")
disp("step 2")
error3=(2.5/70)*100;
disp(error3,"error of reading in %")
error4=(2.5/100)*100;
disp(error4,"error of full scale in %")
```

**Scilab code Exa 11.3.2** error

```
//Example 11.3.2 // wattmeter error and correction
   figure
clc;
clear;
close;
//given data :
P1=120;// in watt
V=114;//in volts
I=1;//in A
P=V*I;
error1=P-P1;
disp(error1,"correction figure in (W)")
error2=(error1/P1)*100;
disp(error2,"wattmeter error in %")
```

# Chapter 12

# Recorders

**Scilab code Exa 12.5.1** chart speed

```
//Example 12.5.1 // chart speed
clc;
clear;
close;
//given data :
f=50;// frequency in Hz
period=1/f;
t=5;//in mm/cycle
chart_speed=t/period;;
disp(chart_speed,"chart speed(mm/s) = ")
```