Scilab Textbook Companion for Electronics Instrumentation and Measurements
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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.

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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) = ")
```