Scilab Textbook Companion for A Course In Mechanical Measurements And Instrumentation by A. K. Sawhney And P. Sawhney[1]

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Book Description

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

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

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

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

Contents

List of Scilab Codes

Chapter 2

Static Characteristics of Instruments and Measurement systems

Scilab code Exa 2.1 calculating static error and static correction

```
// calculating static error and static correction
clc;
disp('calculating static error and static correction
   ')
Am = 127.50;
At = 127.43;
e=Am-At;
disp(e,'Static error(V)=');
Sc=-e;
disp(Sc,'Static Correction(V)=');
```

Scilab code Exa 2.2 calculating true value of the temperature

```
// calculating true value of the temperature
```

```
clc;
disp('calculating true value of the temperature')
Am = 95.45;
Sc=-0.08;
At=Am+Sc;
disp(At,'True Temperature(Degree C)=');
```

Scilab code Exa 2.3 `calculating Relative error expressed as a percentage of f s d`

```
// calculating Relative error (expressed as a
   percentage of f.s.d)
clc;
disp('calculating Relative error (expressed as a
   percentage of f.s.d)')
Am = 1.46;
At=1.50;
e=Am-At;
disp(e,'Absolute error(V)=');
Sc=-e;
disp(Sc,'Absolute Correction(V)=');
RE=(e/At)*100;
disp(RE,'Relative Error in terms of true value(in
   percentage)=');
REF=(e/2.5)*100;
disp(REF,'Relative Error in terms of true value(in
   percentage)=');
```

Scilab code Exa 2.4 `calculating static error and static correction`

```
// calculating static error and static correction
clc;
disp('calculating static error and static correction
   ')
```

```
Am = 0.000161;
At = 0.159*10^-3;
e=Am-At;
disp(e,'Static error(m3/s)=');
Sc=-e;
disp(Sc,'Static Correction(m3/s)=');
```

Scilab code Exa 2.5 `calculating maximum static error Span of the thermometer degre`

```
//calculating maximum static error
disp('calculating maximum static error');
//Span of the thermometer(degree C)
S=200-150;
//Accuracy of the thermometer(in terms of percentage
    of span)
A=0.0025;
e= A*S;
disp(e,'Maximum Static error(degree C)=');
```

Scilab code Exa 2.6 `calculating the pressure for a dial reading of 100`

```
// calculating the pressure for a dial reading of
   100
clc;
disp('calculating the pressure for a dial reading of
    100')
P=((27.58-6.895)/150)*100+6.895;

disp(P,'pressure for a dial reading of 100(kN/m2)=')
   ;
```

Scilab code Exa 2.7 calculating the noise output voltage of the amplifier

```
// calculating the noise output voltage of the
   amplifier
clc;
disp('calculating the noise output voltage of the
   amplifier')
Bw=100*10^3;
Sn=7*10^-21;
R=50*10^3;
A=(Sn*R*Bw)^0.5;
En=2*A;
disp(En,'Noise voltage at input(V)=');
Ga=100;
Eno=En*Ga;
disp(Eno,'Noise voltage at output(V)=');
```

Scilab code Exa 2.8 calculating the noise voltage

```
// calculating the noise voltage
clc;
disp('calculating the noise voltage')
Sn=20;
Vs=3;
Vn=Vs/(Sn)^0.5;
disp(Vn,'noise Voltage(mV)=')
```

Scilab code Exa 2.9 calculating the signal to noise ratio at input calculating the

```
// calculating the signal to noise ratio at input
// calculating the signal to noise ratio at output
//calculating the noise factor and noise figure
clc;
```

```
disp('signal to noise ratio at input')
Sni=(3*10^-6/(1*10^-6))^2;
disp(Sni,'signal to noise ratio at input=')
disp('signal to noise ratio at output')
Sno=(60*10^-6/(20*10^-6))^2;
disp(Sno,'signal to noise ratio at output=')
disp('New signal to noise ratio at output')
Snno=(60*10^-6/(25*10^-6))^2;
disp(Snno,'signal to noise ratio at output=')
F=Sni/Snno;
disp(F,'noise Factor=')
nf=10*log10(F);
disp(nf,'noise Figure(dB)=')
```

Scilab code Exa 2.10 calculating the ratio of output signal to noise signal

```
// calculating the ratio of output signal to noise
   signal
clc;
disp('The noise voltage is')
Bw=100*10^3;
K=1.38*10^-23;
T=300;
R=120;
A=(K*T*R*Bw)^0.5;
En=2*A;
disp(En,'Noise voltage (V)=');
Eno=0.12*10^-3;
disp(Eno,'Noise voltage at output(V)=');
Ra=Eno/En;
disp(Ra,'Ratio of signal votage to Noise voltage =')
   ;
```

Scilab code Exa 2.12 calculating the average force and range of error

```
//calculating the average force and range of error
clc;
F1=10.03;
F2=10.10;
F3=10.11;
F4=10.08;
Fav=(F1+F2+F3+F4)/4;
disp(Fav,'Average Force(N) =');
Fmax=F3;
MaxR=Fmax-Fav;
Fmin=F1;
MinR=Fav-Fmin;
AvgR=(MaxR+MinR)/2;
disp(AvgR,'Average range of error (N)=')
```

Scilab code Exa 2.13 calculating the sum of resistances connected in series with u

```
//calculating the sum of resistances connected in
   series with uncertainity of one unit
clc;
R1=72.3;
R2=2.73;
R3=0.612;
R=(R1+R2+R3);
disp(R,'sum of resistances(ohm) =');

disp('the resultant resistance is 75.6 ohm with 6 as
    first doutful figure')
```

Scilab code Exa 2.14 calculating the power with uncertainity of one unit in voltag

```
//calculating the power with uncertainity of one
   unit in voltage and current
clc;
V=12.16;
I=1.34;
P=V*I;
disp(P,'Power(W) =');

disp('the resultant  is 16.2 W with 2 as first
   doutful figure')
```

Scilab code Exa 2.15 calculating the sum of resistances connected in series with a

```
//calculating the sum of resistances connected in
   series with appropriate number of significant
   figure
clc;
R1=28.7;
R2=3.624;

R=(R1+R2);
disp(R,'sum of resistances(ohm) =');

disp('the resultant resistance is 32.3 ohm as one of
    the resistance is accurate to three significant
   figure')
```

Scilab code Exa 2.16 calculating the voltage drop with appropriate number of signi

```
//calculating the voltage drop with appropriate
   number of significant figure
clc;
R=31.27;
```

```
I=4.37;

E=I*R;
disp(E,'voltage drop(V) =');

disp('the voltage drop is 137 V as one of the
   resistance is accurate to three significant
   figure')
```

Scilab code Exa 2.17 calculating the sensitivity and deflection factor of wheatsto

```
//calculating the sensitivity and deflection factor
   of wheatstone bridge
clc;
Mo=3;
Mi=7;
Sen=Mo/Mi;
disp(Sen,'sensitivity(mm per ohm) =');
Df=Mi/Mo;
disp(Df,'deflection factor( ohm per mm) =');
```

Scilab code Exa 2.18 calculating the volume of the mercury thermometer

```
//calculating the volume of the mercury thermometer
clc;
Ac=(%pi/4)*0.25^2;
disp(Ac,'Area of mercury thermometer')
Lc=13.8*10^3;
Vc=Ac*Lc;
disp(Vc,'Volume of mercury thermometer(mm3)')
```

Scilab code Exa 2.19 `calculating the maximum position deviation resistance deviati`

```
//calculating the maximum position deviation ,
   resistance deviation
clc;
Pl=0.001;
FSD=320;
R=10000;
MDD=(Pl*FSD);
disp(MDD,'Maximum displacement deviation(degree)=');
MRD=Pl*R;
disp(MRD,'Maximum displacement deviation(ohm)=');
```

Scilab code Exa 2.20 `calculating the dead zone`

```
//calculating the dead zone
clc;
disp('span s=')
s=600;
Dz=0.00125*s;
disp(Dz,'Dead zone(degree C)=');
```

Scilab code Exa 2.22 `calculating the Resolution`

```
//calculating the Resolution
clc;
Fs=200;
D=100;
SD=Fs/D;
R=SD/10;
disp(R,'resolution (V)=')
```

Scilab code Exa 2.23 calculating the Resolution

```
//calculating the Resolution
clc;
Fs=9.999;
D=9999;
SD=Fs/D;
R=SD;
disp(R,'resolution (V)=')
```

Scilab code Exa 2.24 calculating the reading of the multimeter and percentage erro

```
//calculating the reading of the multimeter and
    percentage error
clc;
Zl=20000;
Zo=10000;
Eo=6;
El=Eo/(1+Zo/Zl);
disp(El,'Reading of the multimeter (V)=')
PE=((El-Eo)/Eo)*100;
disp(PE,'Percentage error=')
```

Scilab code Exa 2.25 calculating the reading of the multimeter and percentage erro

```
//calculating the reading of the multimeter and
    percentage error
clc;
Zl=20000;
```

```
Zo=1000;
Eo=6;
El=Eo/(1+Zo/Zl);
disp(El,'Reading of the multimeter (V)=')
PE=((El-Eo)/Eo)*100;
disp(PE,'Percentage error=')
```

Scilab code Exa 2.26 calculating the loading error

```
//calculating the loading error
clc;
Zl=1000;
Zo=200*200/400;
Eo=100*200/400;
El=Eo/(1+Zo/Zl);
disp(El,'Reading of the multimeter (V)=')
PE=((El-Eo)/Eo)*100;
disp(PE,'Percentage loading error=')
Ac=100+PE;
disp(Ac,'Accuracy=')
```

Scilab code Exa 2.27 calculating the voltage across the oscilloscope

```
//calculating the voltage across the oscilloscope
clc;
C=50*10^-6;
f=100000;
disp(f,'frequency=')
Xc=1/(2*%pi*f*C);
R=10^6;
Zl=(R*-%i*Xc)/(R-%i*Xc);
Eo=1;
Zo=10*10^3;
```

```
El=Eo/(1+Zo/Zl);
disp(El,'Reading of the multimeter (V)=')
```

Scilab code Exa 2.28 calculating the actual value of current measured value of cur

```
//calculating the actual value of current, measured value of current and percentage error
clc;

Eo=10-((10*1000)/(1000+1000));
Zo=((1000*1000)/(1000+1000))+500;
Io=Eo/Zo;
disp(Io,'Actual value of current (A)=')
Zl=100;
Il=Eo/(Zo+Zl);
disp(Il,'Measured value of current (A)=')
PE=((Il-Io)/Io)*100;
disp(PE,'Percentage loading error=')
```

Scilab code Exa 2.29 calculating the maximum available power

```
//calculating the maximum available power
clc;

Eo=80*10^-3;
Il=5*10^-9;
Rl=6*10^6;
Ro=(Eo/Il)-Rl;
Pmax=(Eo^2)/(4*Ro);

disp(Pmax,'Maximum available Power(W)=')
```

Chapter 3

Errors in Measurements and Their Statistical Analysis

Scilab code Exa 3.1 calculating guarantee value of capacitance

```
// calculating guarantee value of capacitance
clc;
As = 1;
Er=0.05;
Aau=As*(1+Er);
disp(Aau,'Upper limit(micro F)=');
Aal=As*(1-Er);
disp(Aal,'Lower limit(micro F)=');
```

Scilab code Exa 3.2 calculating percentage limiting error

```
// calculating percentage limiting error
clc;
As = 150;
Er=0.01;
dA=As*Er;
```

```
As1=75;
Er=(dA/As1)*100;
disp(Er,'Percentage limiting error =');
```

Scilab code Exa 3.3 Calculate the range of readings

```
// Calculate the range of readings
clc;
fsd=1000;
TP=100;
Efsd=(1/100)*1000;
disp(Efsd,'magnitude of Error when specified in
    terms of full scale deflection (w)=')
disp('Thus the meter will read between 90W and 110W'
    )
Etv=(1/100)*100;
disp(Etv,'magnitude of Error when specified in terms
     of true value (w)=')
disp('Thus the meter will read between 99W and 101W'
    )
```

Scilab code Exa 3.4 Calculate the limiting error in percent

```
// Calculate the limiting error in percent
clc;
dA=0.05*5*10^-6;
As=2.5*10^-6;
Er=(dA/As)*100;
disp(Er,'percemtage limiting error =+/-')
```

Scilab code Exa 3.5 Calculate the range of readings specified interms of fsd and t

```
// Calculate the range of readings specified interms of f.s.d. and true value
clc;
disp('Range when specified interms of f.s.d.')
Error_fsd=1*1000/100'
Range_lower_value=100-Error_fsd;
disp(Range_lower_value,'Lower value of range (kN/m2)')
Range_upper_value=100+Error_fsd;
disp(Range_upper_value,'Upper value of range (kN/m2)')
disp('Range when specified interms of True value')
Error_true=1*100/100'
Range_lower_value=100-Error_true;
disp(Range_lower_value,'Lower value of range (kN/m2)')
Range_upper_value=100+Error_true;
disp(Range_upper_value,'Upper value of range (kN/m2)')
```

Scilab code Exa 3.6 Calculate the magnitude and limiting error in ohm and in perce

```
// Calculate the magnitude and limiting error in ohm and in percentage of the resistance
clc;
R1=37;
R1_le=5*R1/100;
R2=75;
R2_le=5*R2/100;
R3=50;
R3_le=5*R3/100;
R=R1+R2+R3;
disp(R,'Value of resistance (ohm)=')
```

```
R_le=R1_le+R2_le+R3_le;
disp(R_le,'Limiting Value of resistance (ohm)=')
Limiting_error_percentage=R_le*100/R;
disp(Limiting_error_percentage,'Limiting Value of
   resistance (percentage)=+/-')
```

Scilab code Exa 3.7 calculate the value of relative limiting error in resistance

```
// calculate the value of  relative limiting error
   in resistance
clc;
Re_P=1.5;
Re_I=1;
Re_resistance=(Re_P+2*Re_I);
disp(Re_resistance,'the value of  relative limiting
   error of resistance in percentage(+/-)=')
```

Scilab code Exa 3.8 Calculate the guaranteed values of the resistance

```
// Calculate the guaranteed values of the resistance
clc;
R1=100;
R1_le_perunit=0.5; // R1_le_perunit indicates dR1/R1
    = 0.5%
R2=1000;
R2_le_perunit=0.5;
R3=842;
R3_le_perunit=0.5;
Rx=R2*R3/R1;
disp(Rx,'Value of resistance (ohm)=')
Rx_le_perunit=R1_le_perunit+R2_le_perunit+
   R3_le_perunit;

```

```
disp(Rx_le_perunit,'Limiting Value of resistance per
    unit (dRx/Rx)=')
Er_Le=Rx_le_perunit*Rx/100;
disp(Er_Le,'Limiting Value of resistance (ohm)=+/-')
disp('Guarantee value of the resistance (ohm)=')
G1=Rx+Er_Le;
G2=Rx-Er_Le;
disp(G1,G2,'')
```

Scilab code Exa 3.9 Calculate the percentage limiting error and range of resistanc

```
// Calculate the percentage limiting error and range
    of resistance values
clc;
disp('decade a is set at 4000 ohm, so,error in
   decade a=')
Er_a=4000*0.1/100;
disp(Er_a)
disp('decade b is set at 600 ohm, so,error in decade
    b=')
Er_b=600*0.1/100;
disp(Er_b)
disp('decade c is set at 30 ohm, so,error in decade
   c=')
Er_c=30*0.1/100;
disp(Er_c)
disp('decade d is set at 9 ohm, so,error in decade d
   =')
Er_d=9*0.1/100;
disp(Er_d)
Er_total=Er_a+Er_b+Er_c+Er_d;
Re_le_percentage=Er_total*100/4639;
disp(Re_le_percentage,'Percentage Relative limiting
   error=')
Range_lower=4639-Er_total;
```

```
disp(Range_lower,'Lower value of range (ohm)=')
Range_upper=4639+Er_total;
disp(Range_upper,'upper value of range (ohm)=')
```

Scilab code Exa 3.10 Calculate the magnitude of power and limiting error

```
// Calculate the magnitude of power and limiting
   error
clc;
F=4.58;
L=397;
R=1202*10^-9;
t=60;
P=(2*%pi*9.81*F*L*R)/(t*10^6);
disp(P,'Magnitude of power (W)=')
dF_pu=0.02/F; // per unit error in force
dL_pu=1.3/L; // per unit error in Length
dR_pu=1/R; // per unit error in revolution
dt_pu=0.5/t; // per unit error in time
dP_pu= dF_pu+dL_pu+dR_pu+dt_pu;
dP_le=dP_pu*P;
disp(dP_le,'Magnitude of limiting error in power (W)
   ')
```

Scilab code Exa 3.11 Calculate the magnitude of Force and limiting error

```
// Calculate the magnitude of Force and limiting
   error
clc;
E=200*10^9;
L=25*10^-3;
b=4.75*10^-3;
d=0.9*10^-3;
```

```
I=(b*d^3)/12;
x=2.5*10^-3;
F=(3*E*I*x)/(L^3);
disp(F,'Magnitude of Force (N)=')
dE_pu=0/E; // per unit error in E
db_pu=0.0075/b;
dd_pu=0.0075/d;
dx_pu=0.025/x;
dL_pu=0.025/L;
dF_pu= (dE_pu+db_pu+3*dd_pu+dx_pu+3*dL_pu)*10^-3;

disp(dF_pu,'limiting error in force (N)=+/-')
```

Scilab code Exa 3.12 calculate the power loss and relative error

```
// calculate the power loss and relative error
clc;
I=64*10^-3;
R=3200;
P=(I^2)*R;
disp(P,'Power(W)=')
Re=2*0.75+0.2;
disp(Re,'Relative error (%)=')
```

Scilab code Exa 3.13 Calculate the true power as a percentage of measured power

```
// Calculate the true power as a percentage of
   measured power
clc;
I=30.4;
R=0.015;
I_true=I*(1+0.012);
R_true=R*(1-0.003);
```

```
P_true=(I_true^2)*R_true;
P_measured=(I^2)*R;
R=P_true*100/P_measured;
disp(R,'true power as a percentage of measured power
   (%)=' )
```

Scilab code Exa 3.14 calculate the total resistance error of each register and fra

```
//calculate the total resistance , error of each
   register and fractional error of total resistance
clc;
R1=250;
R2=500;
R3=375;
R_true=1/((1/R1)+(1/R2)+(1/R3));
disp(R_true, 'True value of resistance(ohm)=')
dR1= 0.025*R1;
dR2=-0.36*R2;
dR3=0.014*R3;
R1_effective=R1+dR1;
R2_effective=R2+dR2;
R3_effective=R3+dR3;
R_effective=1/((1/R1_effective)+(1/R2_effective)+(1/
   R3_effective));
disp(R_effective, 'Effective value of resistance(ohm
   )=')
Fractional_error=(R_true-R_effective)/R_true;
disp(Fractional_error,'Fractional_error')
```

Scilab code Exa 3.15 find the error

```
//
clc;
```

```
disp('When all the components have 0% error then
   resonant frequency (Hz)')
L=160*10^-6;
C=160*10^-12;
fr=[1/(2*%pi)]*[1/(L*C)]^0.5;
disp(fr)
disp('When all the components have +10% error then
   resonant frequency (Hz)')
L_new=(160*10^-6)+0.1*L;
C_new=(160*10^-12)+0.1*C;
fr_new=[1/(2*%pi)]*[1/(L_new*C_new)]^0.5;
disp(fr_new)
error=(fr_new-fr)/fr;
disp(error,'error=')
disp('When all the components have -10% error then
   resonant frequency (Hz)')
L_new=(160*10^-6)-0.1*L;
C_new=(160*10^-12)-0.1*C;
fr_new=[1/(2*%pi)]*[1/(L_new*C_new)]^0.5;
disp(fr_new)
error=(fr_new-fr)/fr;
disp(error,'error=')
```

Scilab code Exa 3.16 calculate the Volume and relative error

```
// calculate the Volume and relative error
clc;
L=250;
d=50;
V=((%pi/4)*d^2)*L;
disp(V,'Volume(mm3)=')
Re=2*0.2-0.5;
disp(Re,'Relative error (%)=')
```

Scilab code Exa 3.17 calculate the per unit change in the value of spring for diff

```
// calculate the per unit change in the value of
   spring for different temperature ranges
clc;
dG_pu=-240*10^-6;
dD_pu=11.8*10^-6;
disp('for temperature change of 20 degree C to 50
   degree C (%) =')
d_th=30;
dK_pu=(dG_pu+dD_pu)*d_th*100;
disp(dK_pu)
disp('for temperature change of 20 degree C to -50
   degree C (%) =')
d_th=-70;
dK_pu=(dG_pu+dD_pu)*d_th*100;
disp(dK_pu)
```

Scilab code Exa 3.18 Calculate apparent resistance actual resistance and error

```
// Calculate apparent resistance, actual resistance
   and error
clc;
Et=100;
It=5*10^-3;
Rt=Et/It;
disp(Rt,'apparent value of resistance (ohm)=')
Rv=1000*150;
Rx=Rt*Rv/(Rv-Rt);
disp(Rx,'true value of resistance(ohm)')
Er_percentage=[(Rt-Rx)/Rx]*100;
disp(Er_percentage,'percentage error=')
```

Scilab code Exa 3.19 Calculate apparent resistance actual resistance and error

```
// Calculate apparent resistance , actual resistance
   and error
clc;
Et=40;
It=800*10^-3;
Rt=Et/It;
disp(Rt,'apparent value of resistance (ohm)=')
Rv=1000*150;
Rx=Rt*Rv/(Rv-Rt);
disp(Rx,'true value of resistance(ohm)')
Er_percentage=[(Rt-Rx)/Rx]*100;
disp(Er_percentage,'percentage error=')
```

Scilab code Exa 3.20 Calculate the error and percentage error in the measurement o

```
//Calculate the error and percentage error in the
   measurement of deflection
clc;
l=0.2;
E=200*10^9;
b=20*10^-3;
d=5*10^-3;
D=(4*l^3)/(E*b*d^3);
F=1*9.81;
x_true= D*F;
disp(x_true,'True value of deflection')
x_indicated=D*10.31/(1+.1*D);
disp(x_indicated,'Indicated value of deflection')
Er=x_indicated-x_true;
```

```
disp(Er,'error=')
Er_percentage=Er*100/x_true;
disp(Er_percentage,'Percentage error=')
```

Scilab code Exa 3.21 to find the mean deviations from the mean Average deviation s

```
//to find the mean,deviations from the mean, Average
   deviation , standard deviation and variance

clc;
x=[532 548 543 535 546 531 543 536];
X=sum(x);
n=8;
a=0;
Mean=X/n;
disp(X/n,'mean (kHZ)');
for i=1:n,
d(i)=x(i)-Mean
    disp(d(i),'deviations =')
  a=a+(abs(d(i)))
   end
   d_average=a/n;
disp(d_average,'Average deviation (kHz)=')
d_2=sum(d^2);
s=sqrt(d_2/(n-1))
disp(s,'standard deviation(kHz)');
V=s^2;
disp(V,'varaince (kHZ)2=')
```

Scilab code Exa 3.22 to find the mean standard deviation probable error and range

```
//to find the mean,standard deviation , probable
   error and range
```

```

clc;
x=[41.7 42 41.8 42 42.1 41.9 42 41.9 42.5 41.8];
X=sum(x); disp(X);
d=[-.27 .03 -.17 .03 .13 -.07 .03 -.07 .53 -.17];
d_2=sum(d^2);
n=10;
disp(X/n,'mean length(deg C)');
disp(sqrt(d_2/n),'standard deviation(if data is infinite)(deg C)');
disp(sqrt(d_2/(n-1)),'standard deviation(deg C)');
r1=.6745*sqrt(d_2/(n-1));
disp(r1,'probable error of 1 reading(deg C)');
disp(r1/sqrt(n-1),'probable error of mean(deg C)');
disp(max(x)-min(x),'range(deg C)');
```

Scilab code Exa 3.23 to find the arithematic mean maen deviation standard deviatio

```
//to find the arithematic mean, maen deviation , standard deviation , prpobable error of 1 reading , standard deviation and probable error of mean, standard deviation of standard deviation

clc;
T=[397 398 399 400 401 402 403 404 405];
f=[1 3 12 23 37 16 4 2 2];
Tf=sum(abs(T.*f));
disp(Tf/sum(f),'mean temp(deg C)');
d=[-3.78 -2.78 -1.78 -.78 .22 1.22 2.22 3.22 4.22];
disp(sum(f.*d)/sum(f),'mean deviation(deg C)');
disp(sqrt(sum(f.*d^2)/sum(f)),'standard deviation(deg C)');
disp(.6745*sqrt(sum(f.*d^2)/sum(f)),'probable error of 1 reading(deg C)');
disp((.6745*sqrt(sum(f.*d^2)/sum(f)))/sqrt(sum(f)),'
```

```
probable error of mean(deg C)');
disp((sqrt(sum(f.*d^2)/sum(f)))/sqrt(sum(f)),'standard deviation of mean(deg C)');
disp((sqrt(sum(f.*d^2)/sum(f)))/sqrt(sum(f)*2),'standard deviation of standard deviation(deg C)');
```

Scilab code Exa 3.24 `to find probable no of resistors`

```
//to find probable no of resistors

clc;
x=.15;     //deviation
o=.1;     //standard deviation
t=x/o;
A=.4432     //area under gaussian curve corresponding to t
n=2*A*1000;
disp(floor(n),'no of resistors');
```

Scilab code Exa 3.25 `to find no of 100 rsding exceed 30mm`

```
//to find no of 100 rsding exceed 30mm

clc;
x=30-26.3;     //mean value 26.3
r=2.5;
o=r/.6745;
t=x/o;
A=.3413;//area under gaussian curve corresponding to t
n=2*A*100;
nn=100-floor(n);
```

```
disp(nn/2,'no of readings exceed');
```

Scilab code Exa 3.26 to find no of rods of desired length

```
//to find no of rods of desired length

clc;
n=25000;      //no of rods
n1=12500;  //length >10mm
n2=2000;      //length >10.25
a=n1-n2;      //10<length <10.25
p=a/n;
t=1.41;     //using p
t1=t*2;
p1=.4975;
b=p1*n;     //9.5<length <10
disp(a+floor(b),'total no of rods');
```

Scilab code Exa 3.27 to find standard deviation and probability of error

```
//to find standard deviation and probability of
   error

clc;
p=.2;
x=.8;
t=.5025;
sd=x/t;
disp(sd,'stndard deviation');
x=1.2;
t=x/sd;
p=2*.2743;
disp(p,'probability of error');
```

Scilab code Exa 3.28 to find no of expected readings

```
//to find no of expected readings

clc;
x=20;
h=0.04;
sd=1/(sqrt(2)*h);
t=x/sd;

P=.3708;
disp(ceil(2*P*x),'no of expected readings');
```

Scilab code Exa 3.29 to calculate precision index of instrument

```
//to calculate precision index of instrument

clc;
t=.675;
x=2.4;
sd=x/t;
h=1/(sqrt(2)*sd);
disp(h,'precision index');
t=(50-44)/sd;
p=.45;
n=8*30;     //sept month no of measurements
a=((.5-p)*n);
disp(a,'no of false alarms');

rn=a/2;     //reduced no of false alarms
p1=rn/n;
```

```
P=.5-p1;
t=1.96;
sd=(50-44)/t;
h=1/(sqrt(2)*sd);
disp(h,'precision index');
```

Scilab code Exa 3.30 to find confidence interval for given confidence levels

```
//to find confidence interval for given confidence
   levels

clc;
cl=[.5 .9 .95 .99];
s=.22;
d=[.7 1.83 2.26 3.25];
function [a]=ci(b)
    a=s*b;
endfunction

CI(1)=ci(d(1));
CI(2)=ci(d(2));
CI(3)=ci(d(3));
CI(4)=ci(d(4));

disp(CI,'confidence interval');
```

Scilab code Exa 3.31 to point out the reading that can be rejected by chavenets cr

```
//to point out the reading that can be rejected by
   chavenets criterion

clc;
```

```
x=[5.3 5.73 6.77 5.26 4.33 5.45 6.09 5.64 5.81
   5.75]*10^-3;
d=[-.313 .117 1.157 -.353 -1.283 -.163 .477 .027
   .197 .137]*10^-3;
n=10;
X=sum(x)/n;
s=sqrt(sum(d^2)/(n-1));
a=abs(d)/s;disp(a);


for i=1:10,

if a(i)>1.96 then
    disp(x(i),'rejected value');
end
  end
```

Scilab code Exa 3.32 calculate standard deviation

```
//calculate standard deviation

clc;
x=[.9 2.3 3.3 4.5 5.7 6.7];
y=[1.1 1.6 2.6 3.2 4 5];
n=6;
a=((n*sum(x.*y)-(sum(x)*sum(y)))/((sum(x^2)*n)-sum(x
   )^2));
b=((sum(y)*sum(x^2)-(sum(x)*sum(x.*y)))/((sum(x^2)*n
   )-sum(x)^2));

sdy=sqrt((1/n)*sum((a*x+b-y)^2));
sdx=sdy/a;

sa=sqrt(n/(n*sum(x^2)-sum(x)^2))*sdy;
sb=sqrt(sum(x^2)/(n*sum(x^2)-sum(x)^2))*sdy;
```

```
disp(sa,'s_a');
disp(sb,'s_b');
```

Scilab code Exa 3.34 determine value of total current considering errors as limiti

```
//determine value of total current considering
   errors as limiting errors ans as standrd
   deviations

clc;
I1=200;
I2=100;
dI1=2;
dI2=5;
I=I1+I2;
dI=((I1/I)*(dI1/I1)+(I2/I)*(dI2/I2));
disp('error considered as limiting errors');
disp(I,'I');
disp(dI*I,'dI');
sdI=sqrt(dI1^2+dI2^2);
disp('error considered as standard deviations');
disp(I,'I');
disp(sdI,'sdI');
```

Scilab code Exa 3.35 determine probable error in the computed value of resistnce

```
//determine probable error in the computed value of
   resistnce

clc;
r_V=12;
I=10;
r_Rv=r_V/I;
```

```
V=100;
r1=2;
r_Ri=V*r1/I^2;
r_R=sqrt(r_Rv^2+r_Ri^2);
disp(r_R,'r_R');
```

Scilab code Exa 3.37 to find Cq and its possible errors

```
//to find Cq and its possible errors

clc;
d=12.5;
A=(%pi/4)*d^2*10^-6;
W=392;
t=600;
p=1000;
g=9.81;
h=3.66;
Cq=W/(t*p*A*sqrt(2*g*h));
disp(Cq,'Cq');
dW=.23/W;
dt=2/t;
dp=.1/100;
dA=2*.002;
dg=.1/100;
dh=.003/h;
dd=.002;
dCq=Cq*(dW+dt+dp+dA+dg/2+dh/2);
disp(dCq*100/Cq,'%age absolute error');

sdCq=Cq*sqrt(dW^2+dt^2+dp^2+4*dd^2+.25*(dg^2+dh^2));
disp(sdCq*100/Cq,'%age standard deviation error');
```

Scilab code Exa 3.38 calculate power disipated and uncertaainity in power

```
//calculate power disipated and uncertaainity in
   power

clc;
V=110.2;
I=5.3;
P=V*I;disp(P,'power(W) dissipated');
w_v=.2;
w_i=0.06;
dp=sqrt((w_v*I)^2+(w_i*V)^2);
disp(dp*100/P,'uncertainity in power(%)');
```

Scilab code Exa 3.39 to find uncertainity in combined resistance in both series an

```
//to find uncertainity in combined resistance in
   both series and in parrallel

clc;
R1=100;
R2=50;
wR1=.1;
wR2=0.03;
disp('series conn');
R=R1+R2;disp(R,'resistance(ohm)');
dR1=1;
dR2=1;
wR=sqrt((dR1*wR1)^2+(dR2*wR2)^2);disp(wR,'
   uncertainity in resistance(ohm)');

disp('parrallel conn');
R=R1*R2*(R1+R2)^-1;disp(R,'resistance(ohm)');
dR1=(R2/(R1+R2))-((R1*R2)/(R1+R2)^2);
dR2=(R1/(R1+R2))-((R1*R2)/(R1+R2)^2);
```

```
wR=sqrt((dR1*wR1)^2+(dR2*wR2)^2);disp(wR,'
    uncertainity in resistance(ohm)');
```

Scilab code Exa 3.40 to calculate uncertainity in measurement

```
//to calculate uncertainity in measurement

clc;
l=150;
dl=0.01;
b=50;
wA=l*dl;
disp('when no uncertainity in measurement of length'
    );
disp(wA,'uncertainity in measurement of area(m*m)');

disp('when no certainity in measurement of length');
wA=1.5*1.5;
wB=0.01;
wL=sqrt((wA^2-(l*wB)^2)/b^2);
disp(wL,'uncertainity in measurement of length(m)');
```

Scilab code Exa 3.41 to calculate uncertainity in power

```
//to calculate uncertainity in power

clc;
E=100;
dE=.01;
I=10;
dI=0.01;
R=10;
dR=.01;
```

```
dP=sqrt(4*dE^2+dR^2)*100;      //P=E^2/R
disp(dP,'%age uncertainity in power measurement');

dP=sqrt(dE^2+dI^2)*100;      //P=E*I
disp(dP,'%age uncertainity in power measurement');
```

Chapter 4

Dynamic Characteristics of Instruments and Measurement systems

Scilab code Exa 4.1 calculating the temperature

```
// calculating the temperature after 1.5 s
clc;
th0=100;
t=1.5;
tc=3.5;
th=th0*[1-exp(-t/tc)];
disp(th,'temperature after 1.5 s (degree C)')
```

Scilab code Exa 4.2 calculate time to read half of the temperature difference

```
// calculate time to read half of the temperature
   difference
clc;
tc=10/5;
```

```
th=1;
th0=2;
t=-tc*log(1-(th/th0));
disp(t,'Time to read half of the temperature
   difference (s)')
```

Scilab code Exa 4.4 Calculate the temperature after 10s

```
// Calculate the temperature after 10s
clc;
th0=25;
thi=150;
t=10;
tc=6;
th=th0+(thi-th0)*[exp(-t/tc)];
disp(th,'the temperature after 10s (degree C)')
```

Scilab code Exa 4.5 Calculate the value of resistance after 15s

```
// Calculate the value of resistance after 15s
clc;
R0=29.44;
Rs=100;
t=15;
tc=5.5;
R_15=Rs+R0*[1-exp(-t/tc)];
disp(R_15,'value of resistance after 15s(ohm)')
```

Scilab code Exa 4.6 Calculate the depth after one hour

```
// Calculate the depth after one hour
clc;
Qm=0.16*10^-3;
Hin=1.2;
K1=Qm/(Hin)^0.5;
Qo=0.2*10^-3;
Ho=(Qo/K1)^2;
R=Hin/Qm;
C=0.1;
tc=R*C;
t=3600;
H=Ho+(Hin-Ho)*exp(-t/tc);
disp(H,'the depth after one hour(m)')
```

Scilab code Exa 4.8 Calculate time constant

```
//Calculate time constant
clc;
S=3.5;
Ac=(%pi/4)*(0.25)^2;
alpha=0.18*10^-3;
Vb=S*Ac/alpha;
disp(Vb,'volume of bulb(mm2)')

Rb=[(Vb/%pi)*(3/4)]^(1/3);
Ab=4*%pi*Rb^2;
D=13.56*10^3;
s=139;
H=12;
tc=(D*s*Vb*10^-9)/(H*Ab*10^-6);
disp(tc,'time constant (s)')
```

Scilab code Exa 4.9 Calculate the temperature after 10s

```
// Calculate the time constant
ess=5;
A=0.1;
tc=ess/A;
disp(tc,'time constant(s)')
```

Scilab code Exa 4.10 Calculate the temperature at a depth of 1000 m

```
// Calculate the temperature at a depth of 1000 m
clc;
th0=20;
t=2000;
thr=th0-0.005*(t-50)-0.25*exp(-t/50);
disp(thr,'temperature at a depth of 1000 m (degree C
    )')
```

Scilab code Exa 4.11 Calculate the value of resistance at different values of time

```
// Calculate the value of resistance at different
    values of time
clc;
Gain=0.3925;
T=75;
p_duration=Gain*T;
tc=5.5;
Rin=100;
t=1;
Rt=p_duration*(1-exp(-t/tc))+Rin;
disp(Rt,'Value of resistance after 1s(ohm)=')
t=2;
Rt=p_duration*(1-exp(-t/tc))+Rin;
disp(Rt,'Value of resistance after 2s(ohm)=')
t=3;
```

```
Rt=p_duration*(1-exp(-t/tc))+Rin;
disp(Rt,'Value of resistance after 3s(ohm)=')
R_inc=Rt-Rin;
t=5;
Rt=(R_inc)*[exp(-(t-3)/(5.5))]+Rin;
disp(Rt,'Value of resistance after 5s(ohm)=')
t=10;
Rt=(R_inc)*[exp(-(t-3)/(5.5))]+Rin;
disp(Rt,'Value of resistance after 10s(ohm)=')
t=20;
Rt=(R_inc)*[exp(-(t-3)/(5.5))]+Rin;
disp(Rt,'Value of resistance after 20s(ohm)=')
t=30;
Rt=(R_inc)*[exp(-(t-3)/(5.5))]+Rin;
disp(Rt,'Value of resistance after 30s(ohm)=')
```

Scilab code Exa 4.12 calculate the value of damping constant and frequency of damp

```
// calculate the value of damping constant and frequency of damped oscillations
clc;
M=8*10^-3;
K=1000;
wn=(K/M)^0.5;
disp('for critically damped system eta=1')
B=2*(K*M);
disp(B,'Damping constant for critically damped system (N/ms-1)=')
eta=0.6;
wd=wn*(1-eta^2)^0.5;
disp(wd,'frequency of damped oscillations (rad/s)=')
```

Scilab code Exa 4.13 Calculate damping ratio natural frequency frequency of damped

```
// Calculate damping ratio, natural frequency, frequency of damped oscillations, time constant
// and steady state error for ramp signal of 5V/s
clc;
K=(40*10^-6)/(%pi/2);
J=0.5*10^-6;
B=5*10^-6;
eta=B/(2*(K*J)^0.5);
disp(eta,'damping ratio=')
wn=(K/J)^0.5;
disp(wn,'natural frequency (rad/sec)')
wd=wn*(1-(eta)^2)^0.5;
disp(wd,'frequency of damped oscillations (rad/s)')
tc=1/wn;
disp(tc,'time constant (s)')
ess=2*eta/wn;
disp('for a ramp input of 5V, steady state error (V)=')
ess=5*2*eta/wn;
disp(ess,'')
T_lag=2*eta*tc;
disp(T_lag,'Time lag (s)')
```

Scilab code Exa 4.14 Calculate the natural frequency

```
// Calculate the natural  frequency
clc;
wn=2*%pi*30;
disp( 'for a frequency of 30 Hz  wn=(K/M+5*10^-3)^0.5.........(i)');
disp('But wn=(K/M)^0.5.........(ii)');
disp('for a frequency of 25 Hz  wn=(K/M+5*10^-3+5*10^-3)^0.5.........(iii) ')
disp('on solving (i), (ii) and (iii)')
M=6.36*10^-3;
```

```
K=403.6;
disp(M,'M=')
disp(K,'K=')
wn=(K/M)^0.5;
f=wn/(2*%pi);
disp(f,'natural frequency (Hz)')
```

Scilab code Exa 4.15 Calculate natural frequency and setteling time

```
// Calculate natural frequency and setteling time
clc;
K=60*10^3;
M=30;
wn=(K/M)^0.5;
disp(wn,'natural frequency (rad/sec)')
eta=0.7;
ts=4/(eta*wn);
disp(ts,'setteling time (s)')
```

Scilab code Exa 4.16 Calculate time lag and ratio of output and input

```
// Calculate time lag and ratio of output and input
clc;
disp('when time period is 600s')
w=2*%pi/600;
tc=60;
T_lag=(1/w)*atan(w*tc);
disp(T_lag,'time lag (s)=')
M=1/((1+(w*tc)^2)^0.5);
disp(M,'ratio of output and input=')
disp('when time period is 120s')
w=2*%pi/120;
tc=60;
```

```
T_lag=(1/w)*atan(w*tc);
disp(T_lag,'time lag (s)=')
M=1/((1+(w*tc)^2)^0.5);
disp(M,'ratio of output and input=')
```

Scilab code Exa 4.17 Calculate the maximum allowable time constant and phase shift

```
// Calculate the maximum allowable time constant and phase shift
clc;
M=1-0.05;
w=2*%pi*100;
tc={[(1/M^2)-1]/(w^2)}^0.5;
disp(tc,'maximum allowable time constant (s)')
disp('phase shift at 50 Hz (degree)=')
ph=[-atan(2*%pi*50*tc)]*(180/%pi);
disp(ph,'')
disp('phase shift at 100 Hz (degree)=')
ph=[-atan(2*%pi*100*tc)]*(180/%pi);
disp(ph,)
```

Scilab code Exa 4.18 Calculate maximum value of indicated temperature and delay ti

```
// Calculate maximum value of indicated temperature and delay time
clc;
T=120;
w=2*%pi/T;
tc1=40;
tc2=20;
M=[1/((1+(w*tc1)^2)^0.5)]*[1/((1+(w*tc2)^2)^0.5)];
M_temp=M*10;
```

```
disp(M_temp,'maximum value of indicated temperature
   (degree C)')
ph=[{atan(w*tc1)+atan(w*tc2)}];
T_lag=ph/w;
disp(T_lag,'Time lag (s)')
```

Scilab code Exa 4.19 Find the output

```
// Find the output
clc;
disp('when tc=0.2');
disp('output=1/(1+(2*0.2)^2)^0.5] sin[2t-atan(2*0.2)
   ]+3/(1+(2*0.2)^2)^0.5] sin[20t-atan(20*0.2)]')
disp('on solving   output=0.93 sin(2t-21.8)+0.073
   sin(20t-76)')
disp('when tc=0.002');
disp('output=1/(1+(2*0.002)^2)^0.5] sin[2t-atan
   (2*0.002)]+3/(1+(2*0.002)^2)^0.5] sin[20t-atan
   (20*0.002)]')
disp('on solving   output= 1sin(2t-0.23)+0.3 sin(20t
   -2.3)')
```

Scilab code Exa 4.20 Calculate maximum and minimum value of indicated temperature

```
//Calculate maximum and minimum value of indicated
   temperature, phase shift, time lag
clc;
T_max=640;
T_min=600;
T_mean=(T_max+T_min)/2;
Ai=T_mean-T_min;
w=2*%pi/80;
tc=10;
```

```
Ao=Ai/{(1+(w*tc)^2)}^0.5;
T_max_indicated=T_mean+Ao;
disp(T_max_indicated,'Maximum value of indicated
    temperature(degree C)=')
T_min_indicated=T_mean-Ao;
disp(T_min_indicated,'Minimum value of indicated
    temperature(degree C)=')
ph=-atan(w*tc);
Time_lag=-ph/w;
disp(Time_lag,'Time lag (s)')
```

Scilab code Exa 4.21 determine damping ratio

```
// determine damping ratio
clc;
w=2;
K=1.5;
J=200*10^-3;
wn=(K/J)^0.5;
u=w/wn;
M=1.1;
eta=[{[1/(M^2)]-[(1-u^2)^2]}/(2*u)^2]^0.5;
disp(eta,'damping ratio=')
```

Scilab code Exa 4.22 Calculate the frequency range

```
// Calculate the frequency range
clc;
eta=0.6;
fn=1000;
M=1.1;
disp('M=1/[[(1-u^2)^2]+(2*u*eta)^2]^0.5; ..........(
    i)')
```

```
disp('on solving u^4-0.5u^2+0.173=0')
disp('the above equation gives imaginary values for
   frequency so for eta=0.6 the output is not 1.1')
disp('Now let M=0.9, on solving equation (i) we have
   ')
disp('u^4-0.56u^2-0.234=0')
disp('on solving u=0.916')
u=0.916;
f=u*fn;
disp(f,'maximum value of range (Hz)=')
disp('So, the range of the frequency is from 0 to
   916 Hz')
```

Scilab code Exa 4.23 determine the error

```
// determine the error
clc;
w=6;
wn=4;
u=w/wn;
eta=0.66;
M=1/{[(1-u^2)^2]+(2*eta*u)^2}^0.5;
Error=(M-1)*100;
disp(Error,'error (%)=')
```

Chapter 5

Primary Sensing Elements and Transducers

Scilab code Exa 5.1 Calculate the deflection at center

```
// Calculate the deflection at center
clc;
D=15*10^-3;
P=300*10^3;
sm=300*10^6;
t=[3*D^2*P/(16*sm)]^0.5;
disp(t,' thickness(m)=')
P=150*10^3;
v=0.28;
E=200*10^9;
dm=3*(1-v^2)*D^4*P/(256*E*t^3);
disp(dm,' deflection at center for Pressure of 150
    kN/m2(m)=')
```

Scilab code Exa 5.2 Calculate the angle of twist

```
// Calculate the angle of twist
clc;
T=100;
G=80*10^9;
d=2*15*10^-3;
th=16*T/(%pi*G*d^3)
disp(th,' angle of twist(rad)=')
```

Scilab code Exa 5.3 Calculate the Torque

```
// Calculate the Torque
clc;

E=110*10^9;
t=0.073*10^-3;
b=0.51*10^-3;
l=370*10^-3;
th=%pi/2;
T=(E*b*t^3)*th/(12*l);
disp(T,' Controlling torque(Nm)=')
```

Scilab code Exa 5.4 Calculating the displacement and resolution of the potentiomet

```
//Calculating the displacement and resolution of the
    potentiometer
clc;
Rnormal=10000/2;
Rpl=10000/50;
Rc1=Rnormal-3850;
Dnormal=Rc1/Rpl;
disp(Dnormal,'Displacement(mm)=')
Rc2=Rnormal-7560;
Dnormal=Rc2/Rpl;
```

```
disp(Dnormal,'Displacement(mm)=')
disp('since one displacement is positive and other
   is negative so two displacements are in the
   opposite direction')
Re=10*1/200;
disp(Re,'Resolution (mm)=')
```

Scilab code Exa 5.5 plot the graph of error versus K

```
// plot the graph of error versus K
clc;
K=[0    0.25    0.5    0.75    1];
V=[0    -0.174    -0.454    -0.524    0];
plot(K,V)
```

Scilab code Exa 5.6 Calculating the output voltage

```
//Calculating the output voltage
clc;
RAB=125;
Rtotal=5000;
R2=75/125*Rtotal;
R4=2500;
ei=5;
eo=[(R2/Rtotal)-(R4/Rtotal)]*ei;
disp(eo,'output voltage (V)=')
```

Scilab code Exa 5.7 Calculating the maximum excitation voltage and the sensitivity

```
// Calculating the maximum excitation voltage and
   the sensitivity
clc;
Rm=10000;
Rp=Rm/15;
R=600;
P=5;
ei= (P*R)^0.5;
disp(ei,'Maximum excitation voltage (V)=')
S=ei/360;
disp(S,'Sensitivity (V/degree)=')
```

Scilab code Exa 5.8 Calculating the resolution of the potentiometer

```
// Calculating the resolution of the potentiometer
clc;
Rwga=1/400;
Re=Rwga/5;
disp(Re,'Resolution (mm)=')
```

Scilab code Exa 5.9 Checking the suitability of the potentiometer

```
// Checking the suitability of the potentiometer
clc;
mo=0.8;
sr=250;
sm=sr/mo;
R=sm*1;
disp(R,'resolution of 1mm movement')
Rq=300/1000;
disp(Rq,'resolution required=')
```

```
disp('since the resolution of potentiometer is
    higher than the resolution required so it is
    suitable for the application')
```

Scilab code Exa 5.10 Checking the suitability of the potentiometer

```
// Checking the suitability of the potentiometer
clc;
Pd=(10^2)/150;
disp(Pd,'Power dissipation (W)=')
th_pot=80+Pd*30*10^-3;
PDa=1-(10*10^-3)*(th_pot-35);
disp(PDa,'Power dissipation allowed(W)=')
disp('Since power dissipation is higher than the
    dissipation allowed so potentiometer is not
    suitable')
```

Scilab code Exa 5.11 Calculating the possion ratio

```
// Calculating the possion's ratio
clc;
Gf=4.2;
v=(Gf-1)/2;
disp(v,'Possion s ratio=')
```

Scilab code Exa 5.12 Calculating the value of the resistance of the gauges

```
// Calculating the value of the resistance of the
    gauges
clc;
```

```
strain=-5*10^-6;
Gf=-12.1;
R=120;
dR_nickel=Gf*R*strain;
disp(dR_nickel,'change in resistance of nickel(ohm)=
   ')
Gf=2;
R=120;
dR_nicrome=Gf*R*strain;
disp(dR_nicrome,'change in resistance of nicrome(ohm
   )=')
```

Scilab code Exa 5.13 calculate the percentage change in value of the gauge resista

```
// calculate the percentage change in value of the
   gauge resistance
clc;
s=100*10^6;
E=200*10^9;
strain=s/E;
Gf=2;
r_perunit=Gf*strain*100;
disp(r_perunit,'Percentage change in resistance=')
```

Scilab code Exa 5.14 Calculating the Gauge factor

```
//Calculating the Gauge factor
clc;
b=0.02;
d=0.003;
I=(b*d^3)/12;
E=200*10^9;
x=12.7*10^-3;
```

```
l=0.25;
F=3*E*I*x/l^3;
x=0.15;
M=F*x;
t=0.003;
s=(M*t)/(I*2);
strain=s/E;
dR=0.152;
R=120;
Gf=(dR/R)/strain;
disp(Gf,'Gauge factor=')
```

Scilab code Exa 5.15 Calculating the change in length and the force applied

```
// Calculating the change in length and the force
   applied
clc;
dR=0.013;
R=240;
l=0.1;
Gf=2.2;
dl=(dR/R)*l/Gf;
disp(dl,'change in length(m)=')
strain=dl/l;
E=207*10^9;
s=E*strain;
A=4*10^-4;
F=s*A;
disp(F,'Force(N)')
```

Scilab code Exa 5.16 Calculate the linear approximation

```
// Calculate the linear approximation
```

```
clc;
th1=30;
th2=60;
th0=th1+th2/2;
Rth1=4.8;
Rth2=6.2;
Rth0=5.5;
ath0=(1/Rth0)*(Rth2-Rth1)/(th2-th1);
disp(ath0,'alpha at o degree(/degree C)=')
disp('5.5[1+0.0085(th-45)]')
```

Scilab code Exa 5.17 Calculate the linear approximation

```
// Calculate the linear approximation
clc;
th1=100;
th2=130;
th0=th1+th2/2;
Rth1=573.40;
Rth2=605.52;
Rth0=589.48;
ath0=(1/Rth0)*(Rth2-Rth1)/(th2-th1);
disp(ath0,'alpha at o degree(/degree C)=')
disp('Linear approximation is: Rth=
    589.48[1+0.00182(th-115)]')
```

Scilab code Exa 5.18 Calculate the resistance and the temperature

```
// Calculate the resistance and the temperature
clc;
Rth0=100;
ath0=0.00392;
dth=65-25;
```

```
R65=Rth0*[1+ath0*dth];
disp(R65,'resistance at 65 degree C(ohm)=')

th={[(150/100)-1]/ath0}+25;
disp(th,'Temperature (degree C)')
```

Scilab code Exa 5.19 Calculate the resistance

```
// Calculate the resistance
clc;
Rth0=10;
ath0=0.00393;
dth=150-20;
R150=Rth0*[1+ath0*dth];
disp(R150,'resistance at 150 degree C(ohm)=')
```

Scilab code Exa 5.20 Calculate the time

```
// Calculate the time
clc;
th=30;
th0=50;
tc=120;
t=-120*[log(1-(th/th0))];
disp(t,'time(s)=')
```

Scilab code Exa 5.21 Calculate the resistance

```
// Calculate the resistance
clc;
```

```
R25=100;
ath=-0.05;
dth=35-25;
R35=R25*[1+ath*dth];
disp(R35,'resistance at 35 degree C(ohm)=')
```

Scilab code Exa 5.22 find resistance

```
//
clc;
Ro=3980;
Ta=273;
disp('3980= a*3980*exp(b/273)')
Rt50=794;
Ta50=273+50;
disp('794= a*3980*exp(b/323)')
disp('on solving')
disp('a=30*10^-6', 'b=2843')
Ta40=273+40;
Rt40=(30*10^-6)*3980*exp(2843/313);
disp(Rt40,'Resistance at 40 degree C (ohm)')
Rt100=(30*10^-6)*3980*exp(2843/373);
disp(Rt100,'Resistance at 100 degree C (ohm)')
```

Scilab code Exa 5.23 calculating the change in temperature

```
// calculating the change in temperature
clc;
th=((1-1800/2000)/0.05)+70;
dth=th-70;
disp(dth,'change in temperature (degree C)')
```

Scilab code Exa 5.24 calculating the frequencies of oscillation

```
// calculating the frequencies of oscillation
clc;
C=500*10^-12;
R20=10000*(1-0.05*(20-25));
f20=1/(2*%pi*R20*C);
disp(f20,'Frequency of oscillation at 20 degree C (
    Hz)')
R25=10000*(1-0.05*(25-25));
f25=1/(2*%pi*R25*C);
disp(f25,'Frequency of oscillation at 25 degree C (
    Hz)')
R30=10000*(1-0.05*(30-25));
f30=1/(2*%pi*R30*C);
disp(f30,'Frequency of oscillation at 30 degree C (
    Hz)')
```

Scilab code Exa 5.25 Calculating the sensitivity and maximum output voltage

```
// Calculating the sensitivity and maximum output
    voltage
clc;
Se_thermocouple=500-(-72);
disp(Se_thermocouple,'Sensitivity of thermocouple (
    micro V/degree C)=')
Vo=Se_thermocouple*100*10^-6;
disp(Vo,'maximum output voltage(V)=')
```

Scilab code Exa 5.26 `Calculating the temperature`

```
// Calculating the temperature
clc;
ET=27.07+0.8;
disp(ET,'Required e.m.f.(mV)')
disp('temperature corresponding to 27.87 mV is 620
   degree C')
```

Scilab code Exa 5.27 `Calcating the series resistance and approximate error`

```
// Calcating the series resistance and approximate
   error
clc;
Rm=50;
Re=12;
E=33.3*10^-3;
i=0.1*10^-3;
Rs=(E/i)-Rm-Re;
disp(Rs,'series resistance (ohm)=')
Re=13;
i1=E/(Rs+Re+Rm);
AE=[(i1-i)/i]*800;
disp(AE,'approximate error due to rise in resistance
    of 1 ohm in Re (degree C)=')
R_change=50*0.00426*10;
i1=E/(Rs+Re+Rm+R_change);
AE=[(i1-i)/i]*800;
disp(AE,'approximate error due to rise in Temp. of
   10 (degree C)=')
```

Scilab code Exa 5.28 `Calculate the values of resistance R1 and R2`

```
// Calculate the values of resistance R1 and R2
clc;
E_20=0.112*10^-3;// emf at 20degree C
E_900=8.446*10^-3;
E_1200=11.946*10^-3;
E1=E_900-E_20;
E2=E_1200-E_20;
disp('E1=1.08*R1/(R1+2.5+R2);        (i)')
disp('E2=1.08*(R1+2.5)/(R1+2.5+R2);        (ii)')
disp('on solving (i) and (ii)')
R1=5.95;
R2=762.6;
disp(R1,'value of resistance R1 (ohm)=')
disp(R2,'value of resistance R2 (ohm)=')
```

Scilab code Exa 5.29 Calculate the percentage linearity

```
// Calculate the percentage linearity
clc;
linearity_percentage=(0.003/1.5)*100;
disp(linearity_percentage,'percentage linearity=')
```

Scilab code Exa 5.30 Calculate senstivity of the LVDT

```
// Calculate senstivity of the LVDT, Instrument and
   resolution of instrument in mm
clc;
displacement=0.5;
Vo=2*10^-3;
Se_LVDT=Vo/displacement;
disp(Se_LVDT,'senstivity of the LVDT (V/mm)')
Af=250;
Se_instrument=Se_LVDT*Af;
```

```
disp(Se_instrument,'senstivity of instrument (V/mm)'
   )
sd=5/100;
Vo_min=50/5;
Re_instrument=1*1/1000;
disp(Re_instrument,'resolution of instrument in mm')
```

Scilab code Exa 5.31 calculate the deflection maximum and minimum force

```
// calculate the deflection , maximum and minimum
   force
clc;
b=0.02;
t=0.004;
I=(1/12)*b*t^3;
F=25;
l=0.25;
E=200*10^9;
x=(F*l^3)/(3*E*I);
disp(x,'deflection (m)')
DpF=x/F;
Se=DpF*0.5*1000;
Re=(10/1000)*(2/10);
F_min=Re/Se;
F_max=10/Se;
disp(F_min,'minimum force (N)')
disp(F_max,'maximum force (N)')
disp(Se,'')
```

Scilab code Exa 5.32 calculating the sensitivity of the transducer

```
// calculating the sensitivity of the transducer
clc;
```

```
disp('permittivity of the air e0=8.85*10^-12')
e0=8.85*10^-12;
w=25*10^-3;
d=0.25*10^-3;
Se=-4*e0*w/d;
disp(Se,'sensitivity of the transducer (F/m)=')
```

Scilab code Exa 5.33 Calculate the value of the capacitance afte the application o

```
// Calculate the value of the capacitance afte the
   application of pressure
clc;
C1=370*10^-12;
d1=3.5*10^-3;
d2=2.9*10^-3;
C2=C1*d1/d2;
disp(C2,'the value of the capacitance afte the
   application of pressure (F)=')
```

Scilab code Exa 5.34 Calculate the change in frequency of the oscillator

```
// Calculate the change in frequency of the
   oscillator
clc;
fo1=100*10^3;
d1=4;
d2=3.7;
fo2=[(d2/d1)^0.5]*fo1;
dfo=fo1-fo2;
disp(dfo,'change in frequency of the oscillator (Hz)
   ')
```

Scilab code Exa 5.35 Calculate the dielectric stress change in value of capacitanc

```
// Calculate the dielectric stress , change in value
   of capacitance
clc;
L_air=(3.1-3)/2;
D_stress=100/L_air;
e0=8.85*10^-12;
l=20*10^-3;
D2=3.1;
D1=3;
C=(2*%pi)*e0*l/(log(D2/D1));
disp(C,'Capacitance(F)=')
l=(20*10^-3)-(2*10^-3);
C_new=(2*%pi)*e0*l/(log(D2/D1));
C_change=C-C_new;
disp(C_change,'change in Capacitance(F)=')
```

Scilab code Exa 5.36 Calculate the value of time constant phase shift series resis

```
//Calculate the value of time constant ,phase shift ,
   series resistance , amplitude ratio and voltage
   sensitivity
clc;
M=0.95;
w=2*%pi*20;
tc=(1/w)*[(M^2)/(1-M^2)]^0.5;
disp(tc,'time constant (s)')
ph={(%pi/2)-[atan(w*tc)]}*(180/%pi);
disp(ph,'phase shift(deg)')
C=(8.85*10^-12*300*10^-6)/(0.125*10^-3);
R=tc/C;
```

```
disp(R,'series resistance (ohm)')
M=1/(1+(1/(2*%pi*5*tc)^2))^0.5;
disp(M,'amplitude ratio=')
Eb=100;
x=0.125*10^-3;
Vs=Eb/x;
disp(Vs,'voltage sensitivity (V/m)')
```

Scilab code Exa 5.37 Calculate the change in capacitance and ratio

```
//Calculate the change in capacitance and ratio
clc;
e0=8.85*10^-12;
A=500*10^-6;
d=0.2*10^-3;
C=e0*A/d;
d1=0.18*10^-3;
C_new=e0*A/d1;
C_change=C_new-C;
Ratio=(C_change/C)/(0.02/0.2);
disp(Ratio,'ratio of per unit change of capacitance
   to per unit change of diaplacement')
d1=0.19*10^-3;
e1=1;
d2=0.01*10^-3;
e2=8;
C=(e0*A)/((d1/e1)+(d2/e2));
d1_new=0.17*10^-3;
C_new=(e0*A)/((d1_new/e1)+(d2/e2));
C_change=C_new-C;
Ratio=(C_change/C)/(0.02/0.2);
disp(Ratio,'ratio of per unit change of capacitance
   to per unit change of diaplacement')
```

Scilab code Exa 5.40 Calculate the output voltage and charge sensitivity

```
// Calculate the output voltage and charge
   sensitivity
clc;
g=0.055;
t=2*10^-3;
P=1.5*10^6;
Eo=g*t*P;
disp(Eo,'output voltage(V)=')
e=40.6*10^-12;
d=e*g;
disp(d,'charge sensitivity (C/N)=')
```

Scilab code Exa 5.41 Calculate the force

```
// Calculate the force
clc;
g=0.055;
t=1.5*10^-3;
Eo=100;
P= Eo/(g*t);
A=25*10^-6;
F=P*A;
disp(F,'Force(N)=')
```

Scilab code Exa 5.42 Calculate the strain charge and capacitance clc

```
// Calculate the strain , charge and capacitance
```

```
clc;
A=25*10^-6;
F=5;
P=F/A;
d=150*10^-12;
e=12.5*10^-9;
g=d/(e);
t=1.25*10^-3;
Eo=(g*t*P);
strain=P/(12*10^6);
Q=d*F;
C=Q/Eo;
disp(strain,'strain=')
disp(Q,'charge(C)=')
disp(C,'Capacitance(F)=')
```

Scilab code Exa 5.43 calculate peak to peak voltage swing under open and loaded co

```
// calculate peak to peak voltage swing under open
   and loaded conditions
// calculate maximum change in crystal thickness
clc;
d=2*10^-12;
t=1*10^-3;
Fmax=0.01;
e0=8.85*10^-12;
er=5;
A=100*10^-6;
Eo_peak_to_peak=2*d*t*Fmax/(e0*er*A);
disp(Eo_peak_to_peak,'peak voltage swing under open
   conditions')
Rl=100*10^6;
Cl=20*10^-12;
d1=1*10^-3;
Cp=e0*er*A/d1;
```

```
C=Cp+Cl;
w=1000;
m=[w*Cp*Rl/[1+(w*C*Rl)^2]^0.5];
El_peak_to_peak=[2*d*t*Fmax/(e0*er*A)]*m;

disp(El_peak_to_peak,'peak voltage swing under loaded conditions')
E=90*10^9;
dt=2*Fmax*t/(A*E);
disp(dt,'maximum change in crystal thickness (m)')
```

Scilab code Exa 5.44 Calculate the minimum frequency and phase shift

```
// Calculate the minimum frequency and phase shift
clc;
M=0.95;
tc=1.5*10^-3;
w=(1/tc)*[(M^2)/(1-M^2)]^0.5;
disp(w,'minimum frequency (rad/s)')
ph={(%pi/2)-[atan(w*tc)]}*(180/%pi);
disp(ph,'phase shift(deg)')
```

Scilab code Exa 5.45 calculate sensitivity of the transducer high frequency sensit

```
//calculate sensitivity of the transducer, high frequency sensitivity, Lowest frequency
// Calculate external shunt capacitance and high frequency sensitivity after connecting the external shunt capacitance
clc;
Kq=40*10^-3;
Cp=1000*10^-12;
K=Kq/Cp;
```

```
disp(K,'sensitivity of the transducer(V/m)')
Cc=300*10^-12;
Ca=50*10^-12;
C=Cp+Cc+Ca;
Hf=Kq/C;
disp(Hf,'high frequency sensitivity (V/m)')
R=1*10^6;
tc=R*C;
M=0.95;
w=(1/tc)*[(M^2)/(1-M^2)]^0.5;
f=w/(2*%pi);
disp(w,'minimum frequency (s)')
disp('now f=10Hz')
f=10;
w=2*%pi*f;
tc=(1/w)*[(M^2)/(1-M^2)]^0.5;
C_new=tc/R;
Ce=C_new-C;
disp(Ce,'external shunt capacitance(F)')
Hf_new=Kq/C_new;
disp(Hf_new,'new value of high frequency sensitivity
    (V/m)')
```

Scilab code Exa 5.46 calculate op volatge

```
//
clc;
R=10^6;
C=2500*10^-12;
tc=R*C;
t=2*10^-3;
d=100*10^-12;
F=0.1;
el=10^3*{d*F*[exp(-t/tc)]/C};
disp(el,'voltage just before t=2ms (mV)')
```

```
el_after=10^3*{d*F*[exp(-t/tc)-1]/C};
disp(el_after,'voltage just after t=2ms (mV)')
disp('when t=10ms')
t=10*10^-3;
T=2*10
e_10=10^3*{d*F*[exp((-T/tc)-1)]*{exp(-(t-T))/tc}/C}
disp(e_10,'output voltage 10 ms after the
    application of impulse(mV) ')
```

Scilab code Exa 5.47 to prove time constant should be approximately 20T

```
// to prove time constant should be approximately 20
   T to keep undershoot within 5%
clc;
disp('Let T=1');
T=1;
el=0.95;
tc=-T/log(el);
disp(tc,'time constant')
disp('as T=1 so time constant should be
    approximately equal to 20T')
```

Scilab code Exa 5.48 calculate op volatge

```
//
clc;
Kh=-1*10^-6;
I=3;
B=0.5;
t=2*10^-3;
Eh=Kh*I*B/t;
disp(Eh,'output voltage (V)')
```

Scilab code Exa 5.49 Calculate the threshold wavelength

```
// Calculate the threshold wavelength
clc;
Th_wavelength=1.24*10^-6/1.8'
disp(Th_wavelength,'Threshold wavelength (m)')
```

Scilab code Exa 5.50 Calculate maximum velocity of emitted photo electrons

```
// Calculate maximum velocity of emitted photo
   electrons
clc;
E_imparted=(1.24*10^-6)/(0.2537*10^-6);
B_energy=E_imparted-4.30;
em_ratio=0.176*10^12;
v=(2*B_energy*em_ratio)^0.5;
disp(v,'maximum velocity of emitted photo electrons
   (m/s)')
```

Scilab code Exa 5.51 Calculate the resistance of the cell

```
// Calculate the resistance of the cell
clc;
Ri=30;
Rf=100;
t=10;
tc=72;
Rt=Ri+(Rf-Ri)*[1-exp(-t/tc)];
disp(Rt,'resistance of the cell (K ohm)')
```

Scilab code Exa 5.52 Calculate incident power and cut off frequency

```
//Calculate incident power and cut off frequency
clc;
I_power=250*0.2*10^-6;
disp(I_power,'incident power (W)')
Rl=10*10^3;
C=2*10^-12;
fc=1/(2*%pi*Rl*C);
disp(fc,'cut off frequency (Hz)')
```

Scilab code Exa 5.53 Calculate the internal resistance of cell and open circuit vo

```
// Calculate the internal resistance of cell and open circuit voltage
clc;
I=2.2*10^-3;
Eo=0.33;
Rl=100;
Ri=(Eo/I)-100;
disp(Ri,'internal resistance of cell (ohm)')
Vo=0.33*[log(25)/log(10)];
disp(Vo,'open circuit voltage for a radiant incidence of 25 W/m2 (V)=')
```

Scilab code Exa 5.54 Find the value of current

```
// Find the value of current
clc;
```

```
A=1935*10^-6;
r=0.914;
S_angle=A/r^2;
I=180;
L_flux=I*S_angle;
disp(L_flux,'lumnious flux=')
disp('Corresponding to lumnious flux o.417 lm and a
    load resistance of 800 ohm the current is 120
    micro Ampere')
```

Chapter 6

Signal Conditioning

Scilab code Exa 6.1 calculating feedback resistance

```
// calculating feedback resistance
clc;
A=100;
R1=1*10^3;
Rf=-A*R1;
disp(Rf,'feedback resistance (ohm)=');
```

Scilab code Exa 6.2 calculating the closed loop gain

```
// calculating the closed loop gain
clc;
Rf=10;
R1=1;
Avol=200000;
A=-(Rf/R1)*(1/[1+(1/Avol)*((R1+Rf)/R1)]);
disp(A,'closed loop gain=')
```

Scilab code Exa 6.3 `calculating the maximum output voltage`

```
// calculating the maximum output voltage
clc;
Sa=10;
disp(Sa, 'saturation voltage=')
Vom=Sa;
disp(Vom,'maximum output voltage')
```

Scilab code Exa 6.4 `calculating output voltage due to offset voltage`

```
// calculating output voltage due to offset voltage
clc;
Vos=5*10^-3;
Rf=10;
R1=1;
Vo=-Vos*(1+Rf/R1);
disp(Vo,'output voltage due to offset voltage (V)=')
```

Scilab code Exa 6.5 `calculating Amplification factor`

```
// calculating Amplification factor
clc;

Rf=10;
R1=1;
A=Rf/R1;
disp(A,'Amplification Factor=')
```

Scilab code Exa 6.6 `calculating output voltage due to offset voltage`

```
// calculating output voltage due to offset voltage
clc;
V1=1;
V2=-2;
Rf=500;
R1=250;
R2=100;
Vo=-{[(Rf/R1)*V1]+[(Rf/R2)*V2]};
disp(Vo,'output voltage(V)=')
```

Scilab code Exa 6.7 calculating gain and feedback resistance

```
// calculating gain and feedback resistance
clc;

Rf=100*10^3;
R1=1*10^3;
A=Rf/R1;
disp(A,'Gain=')
disp('If multiplier is 10')
A=10;
Rf=A*R1;
disp(Rf, 'feedback resistance (Ohm)=')
```

Scilab code Exa 6.8 Calculating the values of resistances

```
// Calculating the values of resistances
clc;
g=10;
Rf=10;
R1=Rf/g;
disp(R1,'resistance R1(Kilo-ohms)=')
R2=Rf/(0.5*g);
```

```
disp(R2,'resistance R1(Kilo-ohms)=')
R3=Rf/(0.333*g);
disp(R3,'resistance R1(Kilo-ohms)=')
```

Scilab code Exa 6.9 Calculating the value of resistance and capacitance

```
// Calculating the value of resistance and
   capacitance
clc;
Voramp=-10;
disp('if voltage source is 10V then RC= 1 ms and if
   C=1 micro-F')
C=1;
R=1*10^-3*10^6;
disp(R,'value of resistance (ohm)= ')
```

Scilab code Exa 6.10 Calculating Difference mode gain and output voltage

```
// Calculating Difference mode gain and output
   voltage
clc;
V2=5*10^-3;
V1=3*10^-3;
Vo=300*10^-3;
Vd=V2-V1;
Ad=Vo/Vd;
disp(Ad,'difference mode gain=')
V2=155*10^-3;
V1=153*10^-3;
Vo=Ad*(V2-V1);
disp(Vo,'output voltage (V)=')
```

Scilab code Exa 6.11 Calculating Difference mode Common mode gain and CMRR

```
// Calculating Difference mode, Common mode gain and
   CMRR
clc;
Vo=3;
Vd=30*10^-3;
Ad=Vo/Vd;
disp(Ad,'difference mode gain=')
Vo=5*10^-3;
Vc=500*10^-3;
Ac=Vo/Vc;
disp(Ac,'Common mode gain=')
CMRR=Ad/Ac;
disp(CMRR,'Common mode rejection ratio=')
```

Scilab code Exa 6.12 Calculating Signal to noise ratio and CMRR

```
// Calculating Signal to noise ratio and CMRR
clc;
V2=30*10^-3;
V1=-30*10^-3;
Vd=V2-V1;
Ad=150;
Vos=Ad*Vd;
Ac=0.04;
Vc=600*10^-3;
Von=Ac*Vc;
SNR=Vos/Von;
CMRR=Ad/Ac;
disp(SNR,'Signal to Noise Ratio=')

```

```
disp(CMRR,'CMRR=')
```

Scilab code Exa 6.13 Calculating sensitivity and output voltage

```
// Calculating sensitivity and output voltage
clc;
Ci=10*10^-12;
Vi=10;
Eo=8.85*10^-12;
A=200*10^-6;
K=-Ci*Vi/(Eo*A);
disp(K,'sensitivity (V/mm)=')
d=1*10^-6;
Vo=K*d;
disp(Vo,'output voltage (V)=')
```

Scilab code Exa 6.14 calculating minimum maximum time constants and value of frequ

```
// calculating minimum, maximum time constants and
   value of frequencies
clc;
MXtc= 10^10*1000*10^-12;
disp(MXtc,'Maximum time constant (s)');
MNtc= 10^8*10*10^-12;
disp(MNtc,'Minimum time constant (s)');
AR=0.95;
fmin=(AR)/[2*%pi*MXtc*(1-AR^2)^0.5];
disp(fmin,'minimum frequency (Hz)')
fmax=(AR)/[2*%pi*MNtc*(1-AR^2)^0.5];
disp(fmax,'Maximum frequency (Hz)')
```

Scilab code Exa 6.15 calculating time constant and value of capacitance

```
// calculating  time constant and value of
   capacitance
clc;
g=0.501;
f=50;
w=2*%pi*f;
tc=(1-g^2)^0.5/(w*g);
disp(tc,'time constant (s)')
R=10000;
C=(tc/R)*10^6;
disp(C,'capacitance (micro-F)')
```

Scilab code Exa 6.16 calcuating the passband gain and upper and lower cut off freq

```
// calcuating the passband gain and upper & lower
   cut off frequencies
clc;
R1=10*10^3;
R2=1*10^6;
A=R2/(R1+R2);
disp(A,'gain=')
C2=(0.01)*10^-6;
C1=100*10^-12;
fcl=1/(2*%pi*C2*R2);
disp(fcl,'lower cut off frequency (Hz)')
fcu=1/(2*%pi*R1*C1);
disp(fcu,'upper cut off frequency (Hz)')
```

Scilab code Exa 6.17 calcuating the value of C

```
// calcuating the value of C
```

```
clc;
R=1*10^6;
fo=10*10^3;
C=1/(2*%pi*fo*R);
disp(C,'the value of C (F)')
```

Scilab code Exa 6.19 calculate the output voltage and sensitivity

```
// calculate the output voltage and sensitivity
clc;
Rt=100;
K=1;
Rb=K*Rt;
ei=10;
disp('When K=1')
eo=[(K*Rt/Rb)/(1+(K*Rt/Rb))]*ei;
disp(eo,'output voltage (V)= ')
Se=(ei*Rb)/[(Rb+K*Rt)^2];
disp(Se,'sensitivity (V/ohm)= ')
K=0.95;
disp('When K=0.95')
eo=[(K*Rt/Rb)/(1+(K*Rt/Rb))]*ei;
disp(eo,'output voltage (V)= ')
Se=(ei*Rb)/[(Rb+K*Rt)^2];
disp(Se,'sensitivity (V/ohm)= ')
```

Scilab code Exa 6.20 calculate the output voltage for different values of K

```
// calculate the output voltage for different values
   of K
clc;
ei=100;
K=0.25;
```

```
disp('When K=0.25')
eo=[(K/6)/(1+(K/6))]*ei;
disp(eo,'output voltage (V)= ')
K=0.5;
disp('When K=0.5')
eo=[(K/6)/(1+(K/6))]*ei;
disp(eo,'output voltage (V)= ')
K=0.6;
disp('When K=0.6')
eo=[(K/6)/(1+(K/6))]*ei;
disp(eo,'output voltage (V)= ')
K=0.8;
disp('When K=0.8')
eo=[(K/6)/(1+(K/6))]*ei;
disp(eo,'output voltage (V)= ')
```

Scilab code Exa 6.21 calculating the resistance and output voltage

```
// calculating the resistance and output voltage
clc;
R2=119;
R3=119.7;
R1=120.4;
R4=R2*R3/R1;
R4=121.2;
ei=12;
eo=[(R1*R4-R2*R3)/((R1+R3)*(R2+R4))]*ei;
disp(eo, 'output voltage (V)=')
```

Scilab code Exa 6.22 Calculating the bridge output

```
// Calculating the bridge output
clc;
```

```
ei=6;
R=10000;
disp('if dR=0.05R')
dR=0.05*R;
eo=[(dR/R)/(4+2*(dR/R))]*ei;
disp(eo,'output voltage (V)')
disp('if dR=-0.05R')
dR=-0.05*R;
eo=[(dR/R)/(4+2*(dR/R))]*ei;
disp(eo,'output voltage (V)')
```

Scilab code Exa 6.23 Calculating the resistance of unknown resistance

```
// Calculating the resistance of unknown resistance
clc;
R2=800;
R3=800;
R4=800;
Rm=100;
R=800;
ei=4;
im=0.8*10^-6;
dR=(im*R^2)*(4*(1+Rm/R))/ei;
R1=R+dR;
disp(R1,'Resistance of unknown resistor (ohm)=')
```

Scilab code Exa 6.24 calculating the current

```
// calculating the current
clc;
R2=1000;
R3=1000;
R1=1010;
```

```
R4=1000;
ei=100;
eo=[(R1*R4-R2*R3)/((R1+R3)*(R2+R4))]*ei;
disp(eo, 'open circuit voltage (V)=')
Ro=[R1*R4/(R1+R4)]+[R2*R3/(R2+R3)];
Rm=4000;
im=eo/(Ro+Rm);
disp(im,'current (A)=')
```

Scilab code Exa 6.25 `Calculating maximum permissible current through strain gauge`

```
// Calculating maximum permissible current through strain gauge, supply voltage
// and Power dissipation in series resistance
clc;
R=100;
P=250*10^-3;
i=(P/R)^0.5;
disp(i,'maximum permissible current (A)=')
ei=2*i*R;
disp(ei,'maximum supply voltage (V)=')
Rs=100;
Ps=10^2/Rs;
disp(Ps,'Power dissipation in series resistance (W)')
```

Scilab code Exa 6.26 `Calculating the maximum voltage sensitivity of the bridge`

```
// Calculating  the maximum voltage sensitivity of the bridge
clc;
P=(0.1/0.2)*10^-3;
R=1000;
```

```
eim=2*(P*R)^0.5;
dth=0.1;
dR=(4.5/100)*dth*R;
eom=(dR/(4*R))*eim;
Sem=eom/dth;
disp(Sem,'maximum voltage sensitivity of the bridge
   (V)=')
```

Scilab code Exa 6.27 Calculating the resolution of the instrument quantization err

```
// Calculating the resolution of the instrument ,
   quantization error and decesion levels
clc;
Reso=10*10^-3/10;
disp (Reso,'resolution of the instrument=')
n=10;
Q=10/2^n;
Eq=Q/(2*3^0.5);
disp (Eq,'quantization error=')
D=(2^n)-1;
disp (D,'decesion levels=')
```

Scilab code Exa 6.28 Calculating the weight of MSB and LSB

```
// Calculating the weight of MSB and LSB
clc;
Ra=10;
b=5;
Wmsb=Ra/2;
disp(Wmsb,'weight of MSB (V)=')
Wlsb=Ra/2^b;
disp(Wlsb,'weight of LSB (V)=')
```

Scilab code Exa 6.29 Calculating reference voltage and percentage change

```
// Calculating reference voltage and percentage
   change
clc;
E=10;
ER=E*256/255;
disp(ER,'Reference voltage (V)=')
n=8;
CVlsb=(2^-n)*ER;
PC=CVlsb*100/E;
disp(PC,'Percentage change =')
```

Scilab code Exa 6.30 Calculating the number of bits Value of LSB Quantization erro

```
// Calculating the number of bits, Value of LSB,
   Quantization error ,minimum sampling rate
   Aperature time and dynamic range
clc;
n=14;
disp(n,'number of bits =')
E=10;
Q=10;
LSB=E/2^n;
disp(LSB,'Value of LSB (V) =')
Eq=Q/(2*(3^0.5));
disp(Eq,'Quantization error (V) =')
fh=1000;
fs=5*fh;
disp(fs,'minimum sampling rate (Hz) =')
a=1/16384;
ta=1/(2*%pi*fh)*a;
```

```
disp(ta,'Aperature time (s) =')
Dr=6*n;
disp(Dr,'dynamic range (db) =')
```

Scilab code Exa 6.31 Calculating the value of resistance and smallest output curre

```
// Calculating the value of resistance and smallest output current
clc;
ER=10;
n=6;
Imax=10*10^-3;
R=ER*((2^n)-1)/[(2^(n-2))*Imax];
disp(R,'resistance (ohm)=')
LSB=ER/[(2^(n-1))*R];
disp(LSB,'smallest output current (A)')
```

Scilab code Exa 6.32 Calculating the output voltage

```
// Calculating the output voltage
clc;
n=6;
R=10000;
Io= (10/10*10^3)*{1*1+1*0.5+1*0.25+0*0.125+1*0.0625}*10^-6;
Rf=5000;
Eo=-Io*Rf;
disp(Eo,'Output voltage (V)=')
```

Scilab code Exa 6.33 Calculate the output of successive approximation A to D

```
// Calculate the output of successive approximation
   A/D
clc;
disp('Set d3=1')
Output=5/2^1;
disp('since 3.217>2.5  so d3=1')
disp('Set d2=1')
Output=(5/2^1)+(5/2^2);
disp('since 3.217< 3.75  so d2=0')
disp('Set d1=1')
Output=(5/2^1)+(5/2^3);
disp('since 3.217>3.125  so d1=1')
disp('Set d0=1')
Output=(5/2^1)+(5/2^3)+(5/2^4);
disp('since 3.217<3.4375  so d0=0')
disp('Output of successive approximation A/D = 1010'
   )
```

Scilab code Exa 6.34 to calculate op dc voltage

```
//to calculate o/p dc voltage

clc;
t=400;
T=t/4;
C=1*10^-6;
v=20;
i=C*100*v/(T);
R=1*10^3;
e_o=i*R;
disp(e_o,'output voltage(V)');
```

Chapter 7

Display Devices and recorders

Scilab code Exa 7.1 `calculating resolution`

```
// calculating resolution
clc;
N = 4;
R=1/10^N;
disp(R,'Resolution of the meter=');
VR=1;
R1=VR*R;
disp(R1,'Resolution of the meter for voltage range 1
   V=');
VR1=10;
R2=VR1*R;
disp(R2,'Resolution of the meter for voltage range
   10V=');
```

Scilab code Exa 7.2 `calculating resolution`

```
// calculating resolution
clc;
```

```
N = 3;
R=1/10^N;
disp(R,'Resolution of the meter=');
disp('12.98 will be displayed as 12.980 on 10V scale
    ')
VR=1;
R1=VR*R;
disp(R1,'Resolution of the meter for voltage range 1
    V=');
disp('0.6973 will be displayed as 0.6973 on 1V scale
    ')
VR1=10;
R2=VR1*R;
disp(R2,'Resolution of the meter for voltage range
    10V=');
disp('0.6973 will be displayed as 00.697 on 10V
    scale')
```

Scilab code Exa 7.3 `calculating Total possible error and percentage error`

```
// calculating Total possible error and percentage
    error
clc;
R=5;
V=0.005*R;
disp(V,'0.5 percent of the reading')
TPE=V+0.01;
disp(TPE,'Total possible error (V)=')
R1=0.10;
V1=0.005*R1;
TPE1=V1+0.01;
disp(TPE1,'Total possible error (V)=')
PE=(TPE1/0.1)*100;
disp(PE,'Percentage error=')
```

Scilab code Exa 7.4 calculating frequency

```
// calculating frequency
clc;
N=034;
t=10*10^-3;
f=N/t;
disp(f,'frequency(Hz)=')
```

Scilab code Exa 7.5 calculating maximum error

```
// calculating maximum error
clc;
R=5*10^6;
V=0.00005*R;
disp(V,'0.005 percent of the reading(micro sec)=');
LSD=1;
ME=V+1;
disp(ME,'Maximum error (micro sec)=')
R=500;
V=0.00005*R;
disp(V,'0.005 percent of the reading(sec)=');
LSD=1;
ME=V+1;
disp(ME,'Maximum error (sec)=')
```

Scilab code Exa 7.6 calculating number of turns and current

```
// calculating number of turns and current
```

```
clc;
D=8*10^-3;
A=D^2;
disp(A,'A=')
J=8*10^-3;
K=16*10^-3;
B=4*J*K;
disp (B,'B=')
disp('since A<B so the instrument is underdanped')
th=(100*%pi)/180;
i=10*10^-3;
F=0.2*10^-6;
G=(K*th+F)/i;
l=65*10^-3;
d=25*10^-3;
N=G/(B*l*d);
disp(N,'number of turns=')
i=F/G;
disp(i,'current required to overcome friction (A)')
```

Scilab code Exa 7.7 calculating speed of the tape

```
// calculating speed of the tape
clc;
Lam=2.5*6.25;
f=50000;
S=Lam*10^-6*f;
disp(S,'speed(m/s)=')
```

Scilab code Exa 7.8 calculating number density of the tape

```
// calculating number density of the tape
clc;
```

```
ND=12000/1.5;
disp(ND,'Number density (numbers/mm)')
```

Scilab code Exa 7.9 Calculating possible phase angles

```
// Calculating possible phase angles
clc;
Y1=1.25;
Y2=2.5;
PA=asind(Y1/Y2);
disp(PA,'phase angle (degree)')
disp('possible angle are 30 degree and 330 degree')
```

Scilab code Exa 7.10 Calculating possible phase angles

```
// Calculating possible phase angles
clc;
disp ('if spot generating pattern moves in the
    clockwise direction')
Y1=0;
Y2=5;
PA=asind(Y1/Y2);
disp(PA,'phase angle (degree)')
Y1=2.5;
Y2=5;
PA=asind(Y1/Y2);
disp(PA,'phase angle (degree)')
Y1=3.5;
Y2=5;
PA=asind(Y1/Y2);
disp(PA,'phase angle (degree)')
Y1=2.5;
Y2=5;
```

```
PA=180-[asind(Y1/Y2)];
disp(PA,'phase angle (degree)')
```

Chapter 8

Metrology

Scilab code Exa 8.1 calculate the arrangement of slip gauges

```
// calculate the arrangement of slip gauges
clc;
Dd=52.215;
disp(Dd,'desired value=')
Pb=4;
disp(Pb,'Protected block=')
R=Dd-Pb;
disp(R,'Reminder=')
Tp=1.005;
disp(Tp,'thousand  block=')
R=R-Tp;
disp(R,'Reminder=')
Hp=1.010;
disp(Hp,'Hunderths block=')
R=R-Hp;
disp(R,'Reminder=')
Ttp=2.20;
disp(Ttp,'tenths block=')
R=R-Ttp;
disp(R,'Reminder=')
Up=4;
```

```
disp(Up,'unit block=')
R=R-Up;
disp(R,'Reminder=')
Tp=40;
disp(Tp,'Tens block=')
R=R-Tp;
disp(R,'Reminder=')
```

Scilab code Exa 8.2 calculate the sensitivity

```
// calculate the sensitivity
clc;
Ps=200*10^3;
r=0.6;
d2=0.5;
d1=0.5;
a=(d2/d1^2);
x1=(1.1-r)/(2*a);
disp(x1,'x1=')
r=0.8;
d2=0.5;
d1=0.5;
a=(d2/d1^2);
x2=(1.1-r)/(2*a);
disp(x2,'x2=')
x=x1-x2;
disp(x,'so the range is x (mm)')
hS=%pi*d2*10^-3;
A2=%pi*d2*10^-6*(x1+x2)/2;
pS=-0.4*Ps/A2;
pgS=25*10^-3/1000;
S=hS*pS*pgS;
disp(S,'sensitivity=')
```

Scilab code Exa 8.3 calculate uncertainity in displacement

```
// calculate uncertainity in displacement
Pi=70*10^3;
r=0.4;
d2=1.6;
d1=0.75;
a=(d2/d1^2);
x1=(1.1-r)/(2*a);
disp(x1,'x1=')
r=0.9;
x2=(1.1-r)/(2*a);
disp(x2,'x2=')
x=x1-x2;
disp(x,'so the range is x (mm)')
d=-2*a;
Wr=12.5/Pi;
Wx=Wr/d;
disp(Wx,'uncertainity in displacement (mm)')
```

Scilab code Exa 8.4 calculate difference between height of workpieces and pile of

```
// calculate difference between height of workpieces
    and pile of slip gauges
clc;
N=12;
lem=0.644;
d=N*lem/2;
disp(d,'difference between height of workpieces and
   pile of slip gauges (micro-meter)')
```

Scilab code Exa 8.5 calculate seperation distance between two surfaces and angle o

```
// calculate seperation distance between two
   surfaces and angle of tilt
clc;
N=5;
lem=546*10^-9;
d=[(2*N-1)*lem*10^6]/4;
disp(d,'seperation distance between two surfaces(
   micro-meter)')
x=75;
th=atan(d/x);
disp(th,'angle of tilt')
```

Scilab code Exa 8.6 Calculate the difference in two diameters

```
// Calculate the difference in two diameters
clc;
x=20/12;
L=50-10;
lem=0.6;
d=(L*lem)/(2*x);
disp(d,'difference in diameters of the rollers(micro
   -meter)')
```

Scilab code Exa 8.7 Calculate the change in thickness along its length

```
// Calculate the change in thickness along its
   length
```

```
clc;
d=4.5-2.5;
Tg=2*(0.5)*0.509;
disp(Tg,'change in thickness along its length(micro-
    meter)')
```

Chapter 9

Pressure Measurements

Scilab code Exa 9.1 calculating the length of mean free path

```
// calculating the length of mean free path
clc;
T=273+20;
P=101.3*10^3;
mfp=22.7*10^-6*T/P;
disp(mfp,'length of mean free path when pressure is
    one atmospheric pressure(m)')
P=133;
mfp=22.7*10^-6*T/P;
disp(mfp,'length of mean free path when pressure is
    one torr(m)')
P=133*10^-3;
mfp=22.7*10^-6*T/P;
disp(mfp,'length of mean free path when pressure is
    one micrometer of Hg(m)')
P=249.1;
mfp=22.7*10^-6*T/P;
disp(mfp,'length of mean free path when pressure is
    one inch of water(m)')
P=133*10^-6;
mfp=22.7*10^-6*T/P;
```

```
disp(mfp,'length of mean free path when pressure is
    10^-3 micrometer of Hg(m)')
```

Scilab code Exa 9.2 Calculate Pressure of air source

```
//Calculate Pressure of air source
clc;
T=273+25;
P=99.22*10^3;
R=288;
df=P/(R*T);
dm=0.82*996;
g=9.81;
h=200*10^-6;
P1=g*h*(dm-df)*10^3;
Pa=P+P1;
disp(Pa,'Pressure of air source(N/m2)')
```

Scilab code Exa 9.3 Calculate Pressure head

```
//Calculate Pressure head
clc;
df=1*10^3;
dm=13.56*10^3;
g=9.81;
h=130*10^-3;
P=g*h*(dm-df);
Ph=P/9.81;
disp(Ph,'Pressure head(mm of water)')
```

Scilab code Exa 9.4 calculate height

```
// calculate hight
clc;
hn =250;
d=5;
D=25;
h=hn*(1+(d/D)^2);
disp(h,'height')
```

Scilab code Exa 9.6 calculate error interms of pressure

```
// calculate error interms of pressure
clc;
P=8*133;
h=P/(800*9.81);
d=2;
D=50;
hn=h/(1+(d/D)^2);
e=(hn-h)/h*100;
eP=0.8*1000*9.81*(hn-h);
disp(eP,'error interms of pressure(N/m2)')
```

Scilab code Exa 9.7 calculate angle to which tube is incliend to vertical

```
// calculate angle to which tube is incliend to
   vertical
clc;
P=133;
g=9.81;
dm=13.56*10^3;
R=10^-3;
d=4;
```

```
D=20;
th=asind(P/(g*dm*R*(1+(d/D)^2)));
thV=90-th;
disp(thV,'angle to which tube is incliend to vertical(degree)')
```

Scilab code Exa 9.8 calculate angle to which tube is incliend to horizontal

```
// calculate angle to which tube is incliend to horizontal
clc;
P=9.81;
g=9.81;
dm=0.864*10^3;
R=4*10^-3;
d=2;
D=20;
th=asind(P/(g*dm*R*(1+(d/D)^2)));
disp(th,'angle to which tube is incliend to horizontal(degree)')
```

Scilab code Exa 9.9 calculate Length of scale angle to which tube is incliend to h

```
// calculate Length of scale angle to which tube is incliend to horizontal
clc;
P=500*9.81;
g=9.81;
d=8;
a= (%pi/4)*d^2;
A=1200;
dm=0.8*10^3;
hn=P/(g*dm*(1+(a/A)));
```

```
disp(hn,'Length of scale(m)')
R=0.6;
P1=50*9.81;
th=asind(P1/(g*dm*R*[1+(a/A)]));
disp(th,'angle to which tube isincliend to
   horizontal(degree)')
```

Scilab code Exa 9.10 calculate diameter of the tube

```
// calculate diameter of the tube
clc;
P=100*10^3;
g=9.81;
di=10*10^-3;
D=40*10^-3;
A= (%pi/4)*D^2;
dm=13.6*10^3;
a=A/[P/(dm*g*di)-1];
d=(4*a/%pi)^0.5*10^3;
disp(d,'diameter of the tube(mm)')
```

Scilab code Exa 9.11 calculate amplification ratio and percentage error

```
// calculate amplification ratio and percentage
   error
clc;
AR=1/(0.83-0.8);
disp(AR,'Amplification ratio')
D=50*10^-3;
A= (%pi/4)*D^2;
d=6*10^-3;
a= (%pi/4)*d^2;
PR=(a/A)*100;
```

```
disp(PR,'percentage error')
```

Scilab code Exa 9.12 calculate value of counter weight required

```
// calculate value of counter weight required
clc;
P=981;
g=9.81;
d=500*10^-3;
A= (%pi/4)*(10*10^-3)^2;
R=275*10^-3;
th=30;
W=A*d*P/(2*g*R*sind(th));
disp(W,'value of counter weight required(kg)')
```

Scilab code Exa 9.13 calculate damping factor time constant error and time lag cal

```
// calculate damping factor, time constant, error
   and time lag
// calculate damping factor, natural frequency, time
    constant, error and time lag
clc;
Mp1=20/40;
Mp2=10/40;
Mp3=5/40;
Eta=0.225;
disp(Eta,'damping factor')
Td=1.2;
wd=2*%pi/Td;
wn=wd/[(1-Eta^2)^0.5];
tc=1/wn;
disp(tc,'time constant(s)')
ess=2*Eta/wn;
```

```
ess5=5*ess;
disp(ess5,'error for 5mm/s ramp(mm)')
Tlag=2*Eta*tc;
disp(Tlag,'time lag(s)')
Eta1=Eta*(0.5)^0.5;
disp(Eta1,'New damping factor')
Td=1.2;
wn1 = wn*(0.5)^0.5;
disp(wn1,'New natural frequency(rad/s)')
tc1=1/wn;
disp(tc1,'New time constant(s)')
ess51=ess5;
disp(ess51,'new error for 5mm/s ramp(mm)')
Tlag1=Tlag;
disp(Tlag1,'new time lag(s)');
```

Scilab code Exa 9.14 calculate thickness of diaphram and natural frequency

```
// calculate thickness of diaphram and natural
   frequency
clc;
P=7*10^6;
R=6.25*10^-3;
v=0.28;
E=200*10^9;
t={[9*P*R^4*(1-v^2)/(16*E)]^0.25}*10^3;
disp(t,'thickness of diaphram(mm)')
ds=7800;
fn=[2.5*t/(%pi*R^2)]*[E/(3*ds*(1-v^2))]^0.5;
disp(fn,'natural frequency(Hz)')
```

Scilab code Exa 9.15 calculate the natural length of the spring and dispacement

```
// calculate the natural length of the spring and
   dispacement
clc;
P=100*10^3;
A=1500*10^-6;
F=P*A;
Cs=F/3;
Ls=Cs+40;
disp(Ls,'natural length of spring(mm)')
P1=10*10^3;
F1=P1*A;
Ss=3+2*.5;
D=F1/Ss;
disp(D,'displacement (mm)')
```

Scilab code Exa 9.16 calculate the open circuit voltage

```
// calculate the open circuit voltage
clc;
P=200*10^3;
R=70*10^-3;
v=0.25;
t=1*10^-3;
r=60*10^-3;
E=200*10^9;
Sr=[3*P*R^2*v/(8*t^2)]*{(1/v+1)-(3/v+1)*(r/R)^2};
St=[3*P*R^2*v/(8*t^2)]*{(1/v+1)-(1/v+3)*(r/R)^2};
Sta2=(Sr-v*St)/E;
Sta3=(Sr-v*St)/E;
r0=10*10^-3;
Sr1=[3*P*R^2*v/(8*t^2)]*{(1/v+1)-(3/v+1)*(r0/R)^2};
St1=[3*P*R^2*v/(8*t^2)]*{(1/v+1)-(1/v+3)*(r0/R)^2};
Sta1=(Sr1-v*St1)/E;
Sta4=(Sr1-v*St1)/E;
Gf=1.8;
```

```
ei=12;
eo=(Sta1+Sta4-Sta2-Sta3)*Gf*ei/4;
disp(eo,'output voltage (V)')
```

Scilab code Exa 9.17 calculate the optimum setting

```
// calculate the optimum setting
clc;
Aou=700*25*1/100;
Aol=100*25*1/100;
AouPtP= 2*Aou;
AolPtP= 2*Aol;
Se1=1;
D1=AouPtP/Se1;
disp(D1,'deflection of screen corresponding to
    maximum pressure for sensitivity of 1mV/mm (mm)')
disp('sinch the length of the screen is 100mm so
    waveform is out of range and hence sensitivity
    setting of 1mV/mm should not be used')
Se2=5;
D2=AouPtP/Se2;
disp(D2,'deflection of screen corresponding to
    maximum pressure for sensitivity of 5mV/mm (mm)')
disp('delection is within the range')
Se3=20;
D3=AouPtP/Se3;
disp(D3,'deflection of screen corresponding to
    maximum pressure for sensitivity of 20mV/mm (mm)'
    )
disp('delection is within the range')
Se4=100;
D4=AouPtP/Se4;
disp(D4,'deflection of screen corresponding to
    maximum pressure for sensitivity of 100mV/mm (mm)
    ')
```

```
disp('delection is within the range')
Se5=500;
D5=AouPtP/Se5;
disp(D5,'deflection of screen corresponding to
   maximum pressure for sensitivity of 500mV/mm (mm)
   ')
disp('delection is within the range')
disp('since the sensitivity of 5mV/mm gives higher
   deflection so it is the optimum sensitivity')
```

Scilab code Exa 9.18 calculate the output voltage of bridge

```
// calculate the output voltage of bridge
clc;
dP=(7000*10^3)-(100*10^3);
b=25*10^-12;
R1=100;
dR=R1*b*dP;
ei=5;
deo=dR*ei/(4*R1)
disp(deo,'output voltage of bridge(V)')
```

Scilab code Exa 9.19 calculate attenuation

```
// calculate attenuation
clc;
T=273+20;
P=101.3*10^3;
R=287;
de=P/(R*T);
C=20.04*T^0.5;
r=6.25*10^-3;
L=0.6;
```

```
V=%pi*[(12.5*10^-3)^2]*(12.5*10^-3);
wn=C*r*(%pi/(V*(L+0.5*%pi*r)))^0.5;
fn=wn/(2*%pi);
f=1000;
u=f/fn;
mu=19.1*10^-6;
eta=[2*mu/(de*C*r^3)]*[3*L*V/%pi]^0.5;
M=1/{[(1-u^2)^2]+[(2*eta*u)^2]}^0.5;
%M=M*100;
disp(%M,'attenuation=')
```

Scilab code Exa 9.20 calculate error

```
// calculate error
clc;
d=1;
At=(%pi*d^2)*10^-6/4;
V=100*10^-6;
h=30*10^-3;
P1=(At*h^2)/V;
P2=(At*h^2)/(V-At*h);
e=P2-P1;
disp(e,'error=' )
```