Scilab Textbook Companion for Electronic Measurements and Instrumentation by R. K. Rajput[1]

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Book Description

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

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

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

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

Contents

List of Scilab Codes

Chapter 1

concepts of measurements and electromechanical instruments

Scilab code Exa 1.1.a static error

```

// Example 1.a : static error
clc, clear
// given :
vm=112.68; // voltmeter in volts
vt=112.6; // voltage in volts
Es=vm-vt;
disp(Es,"static error,Es = (V)")
```

Scilab code Exa 1.1.b static correction for the voltmeter

```

// Example 1.b : static correction
clc, clear
// given :
vm=112.68; // voltmeter in volts
```

```
vt=112.6; // voltage in volts
Es=vm-vt;
Cs=-Es;
disp(Cs,"static corection,Cs = (V)")
```

Scilab code Exa 1.2 temperature

```

// Example 2. : true value of temperature
clc, clear
// given :
vm=92.35; // in celcius
cs=-0.07; // in celcius
Vt=vm+cs;
disp(Vt,"true value of temperature Vt = (degree
   celcius)")
```

Scilab code Exa 1.3.a absolute error and corrections

```

// Example 1.3.a : absolute error and correction
clc, clear
// given :
vm=2.65; // in volts
vt=2.70; // in volts
Es=vm-vt;
Cs=-Es;
disp(Es,"absolute error,Es = (V)")
disp(Cs,"correction,Cs = (V)")
```

Scilab code Exa 1.3.b express the error as the function of true value and full scale deflection

```

// Example 1.3.b : relative error
clc, clear
// given :
vm=2.65; // in volts
vt=2.70; // in volts
v=5;// full scale range of voltage
Es=vm-vt;
Er1=Es/vt;
Er2=Es/v;
disp("relative error as a function of true value is "+string(Er1)+" or "+string(100*Er1)+" %")
disp("relative error as a function of full scale deflection is "+string(Er2)+" or "+string(100*Er2)+" %")
```

Scilab code Exa 1.4.a static errors

```
// Example 1.4.a :static error
clc, clear
// given :
vm=42; // pressure in bar
vt=41.4; // pressure in bar
Es=vm-vt;
disp(Es,"static error,Es = (bar)")
```

Scilab code Exa 1.4.b static corrections

```

// Example 1.4.b :correction
```

```
clc, clear
// given :
vm=42; // pressure in bar
vt=41.4; // pressure in bar
Es=vm-vt;
Cs=-Es;
disp(Cs,"static corrction,Cs = (bar)")
```

Scilab code Exa 1.4.c relative static error

```

// Example 1.4.c :relative error
clc, clear
// given :
vm=42; // pressure in bar
vt=41.4; // pressure in bar
Es=vm-vt;
Er=Es/vt;
disp("relative error  is "+string(Er)+" or "+string
   (100*Er)+" %")
```

Scilab code Exa 1.5.a percentage error

```
//Example 1.5.a // the percentage error on the basis
    of maximum scale value
clc;
clear;
close;
//given data :
P=50; // pressure range in bar
E=0.15; // may be +ve or -ve in bar
Pe=(E/P)*100;
disp(Pe,"the percentage error,Pe(%)=   ");
```

Scilab code Exa 1.5.b possible error

```
//Example 1.5.b // the percentage error on the basis
    of indicated value of 10 bar pressure
clc;
clear;
close;
//given data :
P=10; // pressure range in bar
E=0.15; // may be +ve or -ve in bar
Pe=(E/P)*100;
disp(Pe,"the percentage error,Pe(%)=   ");
```

Scilab code Exa 1.6 maximum possible error and root square accuracy

```
//Example 1.6// maximum possible error and root
   square accuracy
clc;
clear;
close;
//given data :
a=.3; // accuracy limits for transmitter
b=1.4; // accuracy limits for relay
c=0.9; // accuracy limits for receiver
Me=a+b+c;
Rs=sqrt((a^2)+(b^2)+(c^2));
disp(Me,"maximum possible error,Me(%) =   ")
disp(Rs,"root sqare accuracy,Rs(%) =   ")
```

Scilab code Exa 1.7 maximum static error

```

//Example 1.7// maximum static error
clc;
clear;
close;
//given data :
s=.20; // in %
a=60; // pressure gauge in bar
b=5; // pressure gauge in bar
Pg=a-b;
Se=(s*Pg)/100;
disp(Se,"maximum static error,Se(bar)=   ")
```

Scilab code Exa 1.8 sensivity

```
// Example 1.8.sensitivity of gauge
clc, clear
// given :
C=60; // calibration pressure
F=(300*%pi)/180; //full scale deflection
L=F*90; // length of scale
S=L/C;
disp(S,"sensitivity,S = (mm/pa)")
//answer is calculated in the form of pi in the
   textbook
```

Scilab code Exa 1.9.a sensivity

```
// Example 1.9.a.sensitivity
clc, clear
// given :
```

```
Mo=2.4; // magnitude of output response in mm
Mi=6; // magnitude of input in ohm
S=Mo/Mi;
disp(S,"sensitivity ,S = (mm/ohm)")
```

Scilab code Exa 1.9.b deflection factor

```
// Example 1.9.b. deflection factor
clc, clear
// given :
Mo=2.4; // magnitude of output response in mm
Mi=6; // magnitude of input in ohm
D=Mi/Mo;
disp(D,"deflection factor = (ohm/mm)")
```

Scilab code Exa 1.10 deflection

```
//Example 1.10// deflection
clc;
clear;
close;
S1=6.8;//sensivity of the piezoelectric transducer
   in pC/bar
S2=0.0032;//sensivity of the piezoelectric
   transducer in V/bar
S3=16;//sensivity of the piezoelectric transducer in
    mm/V
OS= S1*S2*S3;// overall sensivity in mm/bar
CI=20;//changeb in input pressure
CO=OS*CI;//change in out put signal
DC= CO;//deflection on the chart mm
disp(DC,"deflection on the chart in mm")
```

Scilab code Exa 1.11 smallest change which can measured by transducer

```
// Example 1.11. smallest change which can be
   measured by this transducer
clc, clear
// given :
F=200; // range of force in N
R=.15/100; // resolution of full scale
Sc=R*F;
disp(Sc,"smallest change,Sc = (N)")
```

Scilab code Exa 1.12 resolution

```
//Example 1.12// resolution
clc;
clear;
close;
//given data :
a=50; // uniform scale
b=50; // full scale reading in volts
c=1/10;
O=a/b;
R=O*c;
disp(O,"one scale division,O = (v)")
disp(R,"resolution,R = (v)")
```

Scilab code Exa 1.13 resolution

```
//Example 1.13// resolution
```

```
clc;
clear;
close;
//given data :
D=1/9999;
F=9.999;
R=D*F;
disp(R*10^3,"resolution ,R(mv) = ")
```

Scilab code Exa 1.14 temperature change

```

//Example 1.14// temperature range
clc;
clear;
close;
//given data :
a=800; // calibration range in celcius
b=300; // calibration range in celcius
c=.11; // percentage of span
S=a-b;
D=(.11/100)*500;
disp(S,"span of pyrometer ,S(degree celcius) = ")
disp(D,"dead zone ,D(degree celcius) = ")
```

Scilab code Exa 1.15.b.i voltmeter and milliameter readings

```
//Example 1.15.b.i// loading error
clc;
clear;
close;
//given data :
Rv=125; // internal resistance in kilo-ohm
```

```
V=180; // in volts
I=6; // im mili−ampere
Rt=V/I;
Ra=Rt;
Rat=(Rt*Rv)/(Rv-Rt);
Le=((Rat-Ra)/Rat)*100;
disp(Le,"percentage loading error,Le(%) = ")
```

Scilab code Exa 1.15.b.ii voltmeter and milliameter readings

```
//Example 1.15.b.ii// loading error
clc;
clear;
close;
//given data :
Rv=125; // internal resistance in kilo−ohm
V=60; // in volts
I=1.2; // ampere
Rt=V/I;
Ra=Rt;
Rat=((Rt/1000)*Rv)/(Rv-(Rt/1000));
Le=((Rat-(Ra/1000))/Rat)*100;
disp(Le,"percentage loading error,Le(%) = ")
```

Scilab code Exa 1.18.a thermometer reading

```

//Example 1.18.a// what will be the reading of the
   thermometer after 1.2 seconds.
clc;
clear;
close;
//given data :
```

```
Iin=160; // in celcius
t1=1.2; // in seconds
t2=2.2;// in seconds
I=20; // in celcius
Io=Iin*(1-(exp(-t1/t2)));
disp(Io,"thermometer reading ,Io(degree celcius) = ")
```

Scilab code Exa 1.18.b thermometer reading

```

//Example 1.18.b// determine its reading
clc;
clear;
close;
//given data :
Iin=160; // in celcius
t1=1.2; // in seconds
t2=2.2;// in seconds
I=20; // in celcius
Io=Iin+(I-Iin)*exp(-t1/t2);
disp(Io,"thermometer reading ,Io(degree celcius) = ")
```

Scilab code Exa 1.19 temperature indicated

```
//Example 1.19.// calculate the temperature
    indicated
clc;
clear;
close;
//given data :
Iin=160; // in celcius
t1=10; // in seconds
t2=5;// in seconds
```

```
I=30; // in celcius
Io=Iin+(I-Iin)*exp(-t1/t2);
disp(Io,"thermometer reading,Io(celcius) = ")
```

Scilab code Exa 1.20 time taken by the transducer

```
//Example 1.20.// calculate the time taken by the
   transducer to read half of the temperature
   difference
clc;
clear;
close;
//given data :
t1=3; // in seconds
I=0.5; // in celcius
T=(-t1)*(log (I));
disp(T,"the time taken,T (second) = ")
```

Scilab code Exa 1.21 time domain equation and its value

```
//Example 1.21.// resistance
clc;
clear;
close;
//given data :
R1=90; // stable resistance
t1=12; // in seconds
t2=4.8; // in seconds
G=.296; // steady stage gain
T=80; // change of temperature
R=G*T;
Rt=R*(1-exp(-t1/t2))+R1;
disp(Rt,"resistance,Rt(ohm) = ")
```

Scilab code Exa 1.22.a time constant

```
//Example 1.22.a // the time contant for the thermometer
clc;
clear;
close;
//given data :
Iin=140; // in celcius
t1=4; // in seconds
I=15; // in celcius
Io=75; // in celcius
a=(Io-Iin)/(I-Iin);
t2=-t1/(log(a));
disp(t2,"time constant in seconds")
```

Scilab code Exa 1.22.b indicated temperature

```

//Example 1.22.b// indicated temperature
clc;
clear;
close;
//given data :
Iin=140; // in celcius
t1=5; // in seconds
t2=1; // in celcius
I=15; // in celcius
Io=75; // in celcius
Io=Iin+(I-Iin)*exp(-t1/t2);
disp(Io,"thermometer reading,Io(degree celcius) = ")
```

Scilab code Exa 1.23 time constant

```
//Example 1.23.// calculate the time constant
clc;
clear;
close;
//given data :
Ed=3.9; // dynamic error
Si=0.2; // slope in celcius/seconds
T=Ed/Si;
disp(T,"time constant,T(seconds) = ")
```

Scilab code Exa 1.24 time altitude

```
//Example 1.24.// calculate the time altitude
clc;
clear;
close;
//given data :
h=2500; // height in meter
t1=8; // in seconds
a=5; // rate of rise balloon in m/s
b=30; // temprerature indicated at an altiude of
    2500 m in celcius
c=.011; // rate of temperature variation with
    altitude in celcius/meter
y=c*a;
Ed=y*t1;
E=Ed/c;
A=h-E;
disp(A,"actual altitude,A(meter) = ")
```

Scilab code Exa 1.25.a ratio of output to input

```
//Example 1.25.a // the ratio of output to input
clc;
clear;
close;
//given data :
t1=50; // in seconds
t2=500; // in seconds
w=2*%pi/t2;
I=1/sqrt(1+(w*t1)^2);
disp(I,"ratio of output to input,I = ")
```

Scilab code Exa 1.25.b time lag

```
//Example 1.25.b // the time lag
clc;
clear;
close;
//given data :
t1=50; // in seconds
t2=500; // in seconds
w=2*%pi/t2;
P=atan(w*t1)
T=(1/w)*P
disp(T,"the time lag,T(seconds) = ")
```

Scilab code Exa 1.26.a variation in the indicated temperature

```
//Example 1.26.a // the variation in the indicated
   temerature
clc;
clear;
close;
//given data :
Iin=25; // may be +ve or -ve
t1=20; // in seconds
t2=4; // in minutes
f=1/(t2*60); // cycles/sec
w=2*%pi*f; // rad/sec
pi=atand(w*t1);
A=sin(w*t2-pi);
Io=(Iin/sqrt(1+(w*t1)^2));
disp(Io,"the variation in the indiacated temperature
   ,Io(degree celcius) =  ")
```

Scilab code Exa 1.26.b time

```
//Example 1.26.b // the lag
clc;
clear;
close;
//given data :
Iin=25; // may be +ve or -ve
t1=20; // in seconds
t2=4; // in minutes
f=1/(t2*60); // cycles/sec
w=2*%pi*f; // rad/sec
pi=atan(w*t1); // in rad
L=(1/w)*pi
disp(L,"the lag,L(seconds)= ")
```

Scilab code Exa 1.27 time constant and time lag

```
//Example 1.27 // maximum time constant
clc;
clear;
close;
//given data :
f1=90;//cycles per seconds
f=120; // frequency response in cylcle per second
w=2*%pi*f; // rad/sec
I=0.96
a=(1/I)^2;
b=sqrt(a)
t=(b-1)/w;
tl=atan(2*(%pi)*f1*t);//
tla=(1/(2*%pi*f1))*tl;// time lag in seconds
disp(t,"maximum time constant,t(sec) = ")
disp(tla,"time lag at 90 cycles per seconds in
    seconds")
```

Scilab code Exa 1.28.a maximum and minimum values indicated by thermometer

```
//Example 1.28.a // maximum and minimum value
clc;
clear;
close;
//given data :
Iin=30; // in celcius
t1=50; // in seconds
t2=10; // in seconds
T1=520; // starting range variation of temerature
T2=580; // range variation of temperature
T=(T1+T2)/2; // mean value in celcius
w=2*%pi*(1/t1); // angular frequency of oscillation
```

```
   rad/sec
a=1/sqrt(1+(w*t2)^2);
Io=Iin*a;
Tmax=T+Io;
Tmin=T-Io;
disp(Tmax,"maximum temperature,Tmax(celcius) = ")
disp(Tmin,"minimum temperature,Tmin(celcius) = ")
```

Scilab code Exa 1.28.b phase shift and time lag

```
//Example 1.28.b // phase shift and time
clc;
clear;
close;
//given data :
Iin=30; // in celcius
t1=50; // in seconds
t2=10; // in seconds
T1=520; // starting range variation of temerature
T2=580; // range variation of temperature
T=(T1+T2)/2; // mean value in celcius
w=2*%pi*(1/t1); // angular frequency of oscillation
   rad/sec
pi=atan(w*t2);
L=(1/w)*pi;
disp(L,"the time lag,L(seconds) = ")
```

Scilab code Exa 1.29 expression

```
//Example 1.29 // output
clc;
clear;
close;
```

```
//given data :
Iin=0.35; // sinusoidl input relation
t=0.3; // sec
w=25; // rad/sec
a=1/sqrt(1+(w*t)^2);
Io=Iin*a;
pi=atand(w*t);
disp(pi,"the phase shift ,pi(celcius)")
disp("the output expression ,Io = 0.0462sin(25t-82.4)
   ")
```

Scilab code Exa 1.30.a maximum value of temperature

```
//Example 1.30.a // determine the maximum value of
   temperature
clc;
clear;
close;
//given data :
T=20; // rate change of temperature may be +ve or -
   ve in celcius
t=120; // in seconds
t1=18; // time constant for the bulb in seconds
t2=36; // time constant for the well in seconds
w=2*%pi*(1/t);
a=1/sqrt(1+(w*t1)^2);
b=1/sqrt(1+(w*t2)^2);
I=a*b;
Tmax=T*I;
disp(Tmax,"the maximum indicated temperature ,Tmax(
   celcius) =  ")
```

Scilab code Exa 1.30.b time lag

```
//Example 1.30.b // determine the maximum value of
    temperature
clc;
clear;
close;
//given data :
T=20; // rate change of temperature may be +ve or −
    ve in celcius
t=120; // in seconds
t1=18; // time constant for the bulb in seconds
t2=36; // time constant for the well in seconds
w=2*%pi*(1/t);
A=atan(w*t1)+atan(w*t2); // angle of lag
L=(1/w)*A;
disp(L,"the time lag,L(seconds) = ")
```

Scilab code Exa 1.31 output

```
//Example 1.31// output
clc;
clear;
close;
t=1;//assume
I1= 2*sin(2*t)+0.5*sin(10*t);// input current
    equation
t1=0.3;//time constant in seconds
Io= ((sin(2*t)- atan(2*t1))/(sqrt(1+(2*t1)^2))+ ((
    sin(10*t)- atan(10*t1))/(sqrt(1+(10*t1)^2));//
    output current equation
disp(" output current equation is  0.857sin(2t
    −30.96)+0.316sin(10t−71.56)")
```

Scilab code Exa 1.32 expression of output

```
//Example 1.32// expression of output
clc;
clear;
close;
//I1=2*sin(2*t)+0.2*cos(8*t);//
//I1=2*sin(2*t)-0.2*sin(8*t+%pi);//
w=2;//
t=0.15;//secomds
r=1/(sqrt(1+(w*t)^2));//
mo=w*r;//magnitude
pf=atand(w*t);//degree
//Io=mo*sin(2*t-16.7);//output
x=0.2
w1=8;//
t=0.15;//secomds
r1=1/(sqrt(1+(w1*t)^2));//
mo1=x*r;//magnitude
pf1=atand(w1*t);//degree
//Io=mo1*sin(8*t+%pi-50.19);//output
disp("Overall output is 1.956sin(2t-16.7)-0.128sin(8
    t+%pi-50.19)")
```

Scilab code Exa 1.34.b percentage reduction in mass

```
//Example 1.34.b// percentage reduction in mass
clc;
clear;
close;
m=4.5;//mass in grams
PM=1.15;//percentage increase in mass
m2= m/(PM^2);//new mass
PCM=  (m-m2)/(m);//PERCENTAGE CHANGE IN MASS
disp(PCM*100,"percentage change in mass is")
```

Scilab code Exa 1.35.a damping ratio damped natural frequency static sensivity anf time constant

```
//Example 1.35// damping ration ,damped natural
   frequency ,static sensivity and time constant
clc;
clear;
close;
k=1;//static sensivity
wn=sqrt(30);//natural frequency in rad/s
y=(0.1*wn)/2;//damping ratio
wd=wn*sqrt(1-y^2);//damped natural frequency in rad/
   s
t=(1/wn);//time constant in seconds
disp(y,"damping ratio is")
disp(wd,"damped natural frequency in rad/s is")
disp(k,"static sensivity is")
disp(t,"time constant in seconds is")
```

Scilab code Exa 1.36 natural frequency damping ratio damped natural frequency and time constant

```
//Example 1.36// damping ration ,damped natural
   frequency ,natural frequency and time constant
clc;
clear;
close;
q=1.22;//in Nm/rad
j=0.14;//in kg meter square
w=1.95;//frequency in rad/s
wn=sqrt(q/j);//natural frequency in rad/s
y=(w/wn);//damping ratio
```

```
y1=0.555;//damping ratio corresponding to maximum
   possible error of 8%
wd=wn*sqrt(1-y1^2);//damped natural frequency in rad
   /s
t=(1/wn);//time constant in seconds
disp(wn,"natural frequency in rad/s")
disp(y1,"damping ratio is")
disp(wd,"damped natural frequency in rad/s is")
disp(t,"time constant in seconds is")
```

Scilab code Exa 1.37 effective damping ratio and undamped natural frequency

```

//Example 1.37:// damping ratio and undamped natural
    frequency
clc;
clear;
PO=12;//percentage overshhot
Rt=0.22;//rise time in seconds
y=0.56;//damping ration
wd=(%pi/Rt);//damped natural frequency
wn=(wd/(sqrt(1-y^2)));//
fn=(wn/(2*%pi));//undamped natural frequency in Hz
disp(y,"damping ratio is")
disp(fn,"undamped natural frequency in Hz is")
```

Scilab code Exa 1.38 determine the error

```
//Example 1.38:// percentage error
clc;
clear;
fn=5;// natural frequency in kHz
```

```
f=7;//excitation frequency in kHz
r=f/fn;//ratio
y=0.62;//damping ratio
M= (1/(sqrt((1-r^2)^2+(2*y*r)^2)));//amplitude ratio
E=(1-M)*100;//error due to proximity of excitation
   frequency with the natural frequency of the
   system
disp(E,"percentage error due to proximity of
   excitation frequency with the natural frequency
   of the system ")
```

Scilab code Exa 1.39 frequency range

```
//Example 1.39://frequency range
clc;
clear;
fn=800;// natural frequency in cps
MD=12;//maximum amount of deviation in amplitude
   ratio
M1=1.12;//
M2=0.88
r=0.904;//ratio
y=0.62;//damping ratio
f=fn*r;//excitation frequency in cps
//When M=1.12 THE SOLUTION WILL HAVE IMAGINARY ROOTS
    AND THIS IMLIES THE OUTPUT WOULD NEVER BE 1.12
   TIMES THE OUTPUT FOR ANY FREQUENCY
disp(f,"excitation frequency in cps")
//the deviation remains with in 12 percent of output
    for the frequency range 0-723cps
```

Scilab code Exa 1.40 expression output amplitude output frequency and phase lag

```
//Example 1.40://output amlitude,output frequency
   and phase lag
clc;
clear;
f=0.6;//frequency in hertz
w=2*%pi*f;//frequency in rad/s
t=1;//
I1=sin(w*t);//current
r= ((8/((%i*w)^2+(4*%i*w)+20)));//ratio of out put
   current to input current
rm=sqrt(0.724^2+1.885^2);//magnitude
rp=atand(1.885/0.724);//pahse lag
Mo= 1/rm;//magnitude of output
disp(w,"output frequency in rad/s")
disp(Mo,"magnitude of amplitude is")
disp(rp,"pahse lag in degree is")
```

Scilab code Exa 1.41 range of readings

```
//Example 1.41 // range
clc;
clear;
close;
//given data :
w=500; // in watt
E=1.5; // may be +ve or -ve in %
Qs=50; // in watt
Le=(E/100)*w; // may be +ve or -ve
Er=(Le/Qs)*100;
Me=(E/100)*Qs; // may be +ve or -ve
w1=Qs-Me;
w2=Qs+Me;
disp(w1,"strating range,w1(watt) = ")
disp(w2,"last range,w2(watt) = ")
```

Scilab code Exa 1.42 limiting error

```
//Example 1.42:// limitting error
clc;
clear;
Er= 3;//full scale reading
Qs=2.5*10^-6;//full scale reading
Fm=1.25*10^-3;//flow measured by the meter in meter
    cuber per seconds
dQs= Er*Qs;//magnitude limiting errr
Er1= dQs/Qs;//relative error at flow
PEr= dQs/(Fm*10^-3);//percentage limiting error
disp(PEr," peercentage limiting error in percentage
    in   ")
```

Scilab code Exa 1.43 limiting value and percent limiting error

```

//Example 1.43:// limitting values and limiting error
clc;
clear;
R1=25;//in ohms
ER1=4;//percentage error
R2=65;//in ohms
ER2=4;//percentage error
R3=45;//in ohms
ER3=4;//percentage error
er= (ER1/100)*(R1+R2+R3);//magnitude of resultant
    resistance limiting error
r= (R1+R2+R3);//magnitude of resultant resistance
lr= (er/r)*100;//limiting error
disp(r,"magnitude of resultant resistance in ohms")
```

```
disp(er,"resultane error in percentage is  ")
disp(lr," percentage limiting error in percentage is  ")
```

Scilab code Exa 1.44 limiting error

```
//Example 1.44:// limiting error
clc;
clear;
lp=1.2;//limiting error in the measurement of power
ll=0.8;//limiting error in the measurement of current
lr=lp+2*ll;//limting error in meaurement of resistance
disp(lr," peercentage limiting error in percentage is  ")
```

Scilab code Exa 1.45 magnitude and limiting error of resistance

```
//Example 1.45:// resistance and limiting error
clc;
clear;
R1=50;//in ohms
ER1=0.5;//percentage error
R2=500;//in ohms
ER2=0.5;//percentage error
R3=440;//in ohms
ER3=0.5;//percentage error
R4= (R2*R3)/R1;//unknown resistance in ohms
dR4=(ER1+ER2+ER3);//relative limiting error in unknown resistance
lr= (dR4*R4)/100;//limiting error in ohms
R41= R4+lr;//
```

```
R42=R4-lr;//
disp(R41,"VALUE OF RESISTANCE IN OHMS")
disp(R42,"VALUE OF RESISTANCE IN OHMS")
disp(lr," limiting error in OHMS is ")
```

Scilab code Exa 1.46 error

```
//Example 1.46:// limiting error
clc;
clear;
dE=0.2;//erroe in modulus of elesticity
d1=0.01;//change in width
b=4.5;//width
dB=d1/b;//error in width
d2=0.01;//change in width
D=0.9;//width
dD=d2/D;//error in width
d3=0.01;//change in beam
L=45;//BEAM
dL=d3/L;//error in beam
d4=0.1;//change in deflection
y=1.8;//deflectrion
dy=d2/D;//error in deflection
lr= (dE+dB+3*dD+3*dL+dy);//percentage limiting error
disp(lr," peercentage limiting error in percentage
   is ")
// answer is wrong in the textbook
```

Scilab code Exa 1.47 magnitude of power and magnitude of limiting error

```
//Example 1.47:// magnitude and limiting error
clc;
clear;
```

```
F=4.26;//in KG
EF1=0.02;//percentage error
L=382;//in MM
EL2=1.2;//percentage error
R=1192;//in ohms
ER=1;//percentage error
T=60;//in seconds
Et=0.50;//percentage error
P= ((2*%pi*9.81*F*L*R)/(T*10^6));//power in kW
lr=((EF1/F)+(EL2/L)+(ER/R)+(Et/T))*P//limiting error in WATTS
disp(P,"magnitude of power in watts")
disp(lr,"  limiting error in watts is   ")
```

Scilab code Exa 1.48.b true power

```
//Example 1.48.b://true power is a percentage of the power
clc;
clear;
dI=(-0.011);//ERROR IN CURRENT MEASUREMENT
dR=0.0025;//ERROR IN RESISTANCE
dP= 2*dI+dR;//total relative error
RP= (1/(1+dP));//true power as a percentage of orignal power
disp(RP*100,"true power as a percentage of orignal power")
```

Scilab code Exa 1.49 arithemetic mean average deviation standard deviation and variance

```
//Example 1.49://ARITHEMATIC MEAN,AVERAGE DEVIATION,STANDARD DEVIATION AND VARAIANCE
```

```
clc;
clear;
q
   =[1.34,1.38,1.56,1.47,1.42,1.44,1.53,1.48,1.40,1.59];
   //length in mm
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)];//
AV=(-qb(1)-qb(2)+qb(3)+qb(4)-qb(5)-qb(6)+qb(7)+qb(8)
   -qb(9)+qb(10))/10;//
SD=stdev(Q);//standard deviation
V=SD^2;//variance
disp(AM,"arithematic mean in mm")
disp(AV,"average deviation")
disp(SD,"standard deviation in mm")
disp(V,"variance in mm square")
```

Scilab code Exa 1.50.a arithemetic mean

```
//Example 1.50.a // arithmetic deviation
clc;
clear;
close;
//given data :
n=8;
a=412;
b=428;
c=423;
d=415;
e=426;
f=411;
g=423;
```

```
h=416;
q=(a+b+c+d+e+f+g+h)/n;
disp(q,"the arithmetic mean,q(kHz) = ")
```

Scilab code Exa 1.50.b average deviation

```
//Example 1.50.b // average deviation
clc;
clear;
close;
//given data :
n=8;
a=412;
b=428;
c=423;
d=415;
e=426;
f=411;
g=423;
h=416;
q=(a+b+c+d+e+f+g+h)/n;
d1=a-q;
d2=b-q;
d3=c-q;
d4=d-q;
d5=e-q;
d6=f-q;
d7=g-q;
d8=h-q;
d=(abs(d1)+abs(d2)+abs(d3)+abs(d4)+abs(d5)+abs(d6)+
    abs(d7)+abs(d8))/n;
disp(d,"the average deviation,d(kHz) = ")
```

Scilab code Exa 1.50.c standard deviation

```
//Example 1.50.c // standard deviation
clc;
clear;
close;
//given data :
n=8;
a=412;
b=428;
c=423;
d=415;
e=426;
f=411;
g=423;
h=416;
q=(a+b+c+d+e+f+g+h)/n;
d1=a-q;
d2=b-q;
d3=c-q;
d4=d-q;
d5=e-q;
d6=f-q;
d7=g-q;
d8=h-q;
d=(abs(d1)+abs(d2)+abs(d3)+abs(d4)+abs(d5)+abs(d6)+
    abs(d7)+abs(d8))/n;
s=sqrt(((d1^2)+(d2^2)+(d3^2)+(d4^2)+(d5^2)+(d6^2)+(
    d7^2)+(d8^2))/(n-1));
disp(s,"the standard deviation(kHz) = ")
```

Scilab code Exa 1.50.d variance

```
//Example 1.50.d // variance
clc;
```

```
clear;
close;
//given data :
n=8;
a=412;
b=428;
c=423;
d=415;
e=426;
f=411;
g=423;
h=416;
q=(a+b+c+d+e+f+g+h)/n;
d1=a-q;
d2=b-q;
d3=c-q;
d4=d-q;
d5=e-q;
d6=f-q;
d7=g-q;
d8=h-q;
d=(abs(d1)+abs(d2)+abs(d3)+abs(d4)+abs(d5)+abs(d6)+
   abs(d7)+abs(d8))/n;
s=sqrt(((d1^2)+(d2^2)+(d3^2)+(d4^2)+(d5^2)+(d6^2)+(
   d7^2)+(d8^2))/(n-1));
V=s^2;
disp(V,"the variance,V (kHz)^2 = ")
```

Scilab code Exa 1.51 mean standard deviation probable error of one reading and mean

```

//Example 1.50.d // variance
clc;
clear;
```

```
close;
//given data :
n=10;
a=39.6;
b=39.9;
c=39.7;
d=39.9;
e=40;
f=39.8;
g=39.9;
h=39.8;
i=40.4;
j=39.7;
q=(a+b+c+d+e+f+g+h+i+j)/n;
d1=a-q;
d2=b-q;
d3=c-q;
d4=d-q;
d5=e-q;
d6=f-q;
d7=g-q;
d8=h-q;
d9=i-q;
d10=j-q;
d=(abs(d1)+abs(d2)+abs(d3)+abs(d4)+abs(d5)+abs(d6)+abs(d7)+abs(d8)+abs(d9)+abs(d10))/n;
s=sqrt(((d1^2)+(d2^2)+(d3^2)+(d4^2)+(d5^2)+(d6^2)+(d7^2)+(d8^2)+(d9^2)+(d10^2))/(n-1));
r1=0.6745*s;
rm=r1/sqrt(n-1);
R=i-a;
disp(q,"the arithmetic mean,q(degree celcius) = ")
disp(s,"the standard deviation(degree celcius) = ")
disp(r1,"probable error of one reading,r1(degree celcius) = ")
disp(rm,"probable error of mean,rm(degree celcius) = ")
disp(R,"range,R(degree celcius) = ")
```

Scilab code Exa 1.52 arithematic mean average deviation standard deviation variance and probable error

```
//Example 1.52://ARITHEMATIC MEAN,AVERAGE DEVIATION
    ,STANDARD DEVIATION AND VARAIANCE
clc;
clear;
T=[197,198,199,200,201,202,203,204,205];//
    temperature in degree celsius
f=[2,4,10,24,36,14,5,3,2];//frequency of occurence
q=[T(1)*f(1),T(2)*f(2),T(3)*f(3),T(4)*f(4),T(5)*f(5)
    ,T(6)*f(6),T(7)*f(7),T(8)*f(8),T(9)*f(9)];//
AM=(q(1)+q(2)+q(3)+q(4)+q(5)+q(6)+q(7)+q(8)+q(9))
    /100;//arithematic mean in mm
for i= 1:9
    qb(i)= T(i)-AM;
end
Q= [qb(1),qb(2),qb(3),qb(4),qb(5),qb(6),qb(7),qb(8),
    qb(9)];//
AV=(-qb(1)*f(1)-qb(2)*f(2)-qb(3)*f(3)-qb(4)*f(4)+qb
    (5)*f(5)+qb(6)*f(6)+qb(7)*f(7)+qb(8)*f(8)+qb(9)*f
    (9))/100;//
SD=sqrt(219.72/100);//standard deviation
V=SD^2;//variance
r1= 0.6745*SD;//PROBABLE ERROR OF ONE READING
rm= r1/(sqrt(100));//probable error of the mean
SGm= SD/10;//standard deviation of the mean
SDg= SGm/(sqrt(2));//standard deviation of the
    standard deviation
disp(AM,"arithematic mean in degreebcelsius")
disp(AV,"average deviation in degree celsius")
disp(SD,"standard deviation in degree celsius")
disp(V,"variance in degree celsius square")
```

```
disp(r1,"probable error of the one reading degree
   celsius")
disp(rm,"probable error of the mean in degree
   celsius")
disp(SDg,"standard deviation of the standard
   deviation")
```

Scilab code Exa 1.53 standard deviation and probability of error

```
//Example 1.53://STANDARD DEVIATION OF THE METER AND
    PROBABLITY OF ERROR
clc;
clear;
x=0.8;//in ampere
y=0.5248;//
SD=x/y;//standard deviation
x1=1.2;//in ampere
y1=x1/SD;//probability of error
disp(SD,"standard deviation is")
disp(2*0.2842*100,"probablity of an error for 1.2A
   in percentage is")
//thus 57% of the readings are with in 1.2A OF THE
   TRUE VALUE
```

Scilab code Exa 1.54 readings

```
//Example 1.54://readings
clc;
clear;
x=25-21.9;//in mm
r=2.1;//probable error
SD=r/0.6745;//standard deviation
y=x/SD;//ratio
```

```
NR=2*0.3413*100;//no. of readings having deviation with in 3.1mm
NR1=100-NR;//no. of readings EXCEEDING deviation OF 3.1mm
nor= round(NR1/2);// noumber of readings having deviation of 3.1mm
disp(nor,"number of readings having deviation of 3.1 mm")
```

Scilab code Exa 1.55 number of readings

```
//Example 1.55://NUMBER OF RODS
clc;
clear;
a=5000-1000;//NO. OF RODS WHERE LENGTH LIES BETWEEN 20MM AND 20.25MM
PY=0.4;//PROBABLITY THAT ROBABILITY THAT 4000 RODS HAVE A VLUE GREATER THAN 20MM AND LESS THAN 20.25 MM
SD=(20.25-20)/1.3;//standard deviation
y=(20-19.25)/SD;//
PY1=0.4953;//ROBABILITY THAT 4000 RODS HAVE A VLUE GREATER THAN 20MM AND LESS THAN 20.25MM
NR=10000*PY1//NO. OF RODS WHERE LENGTH LIES BETWEEN 19.25MM AND 20MM
tr=NR+a;//total number of rods whose length lie betweem specified limits of 19.5mm and 20.25mm
disp(tr,"total number of rods whose length lie betweem specified limits of 19.5mm and 20.25mm")
```

Scilab code Exa 1.56 probability of error and number of readings

```
//Example 1.56://probability error and readings
```

```
clc;
clear;
d=15;//deviation in r.p.m
h=0.04;//precision index
SD=(1/(sqrt(h)));//standard deviation
y=d/SD;//
py=0.3015;//probablity
pr= 2*py;//probablity of an error
r=0.6*20;//no. of readings lie between 1485 to 1515 r.p.m
disp(pr,"probability of an error  15 rpm is,=")
disp(r,"no. of readings lie between 1485 to 1515 r.p.m")
```

Scilab code Exa 1.57 prescribed range

```
//Example 1.57:// prescribed range
clc;
clear;
p1=(40-10)/40;//probablity of falling in particular range
py=p1/2;//probablity
h=9;//precision index
SD=(1/(sqrt(h)));//standard deviation
y=1.15;//
d= y*SD;//deviation
disp(d,"standard deviation is")
disp("75% of the depth measurement lie wtih the range of (15  0.0904)cm")
```

Scilab code Exa 1.58 precision index and false alarms

```
//Example 1.58:// precision index and false alarms
```

```
clc;
clear;
y=0.675;//
x=4.8;//
SD= x/y;//STANDARD DEVIATION
h=(1/(sqrt(2)*SD));//precision index
x1=100-88;//
y=x1/SD;//
py=0.45;//probablity
nm=30*4;//no. of measurements in the month of
    november
fa=nm*0.05;//expected no. of false alarms
rfa=fa/2;//reduced no. of false alarms
pfa=(rfa/nm)*100;//probablity of false alarms
py1=0.5-0.025;//probablity of data lie in the
    tolerant band
SD1=(100-88)/1.96;//
h1=((1/(sqrt(2)*SD1)));//PRCESION INDEX
disp(h,"precision index in part a")
disp(fa,"expected no. of false alarms")
disp(h1,"precision index in part b is")
```

Scilab code Exa 1.59 rejected reading

```
//Example 1.59://READING
clc;
clear;
q
    =[5.30,5.73,6.77,5.26,4.33,5.45,6.09,5.64,5.81,5.75];
    //length in mm
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)];//
AV=(-qb(1)-qb(2)+qb(3)+qb(4)-qb(5)-qb(6)+qb(7)+qb(8)-qb(9)+qb(10))/10;//
SD=stdev(Q);//standard deviation
for i=1:10
    B(i)= (qb(i))/SD;//
    disp(B(i))
end
V=SD^2;//variance
disp(AM,"arithematic mean in mm")
disp(SD,"standard deviation in mm")
disp("it is given that for 10 readings the ratio of deviation to standard deviation is not to exceed 1.96 and therefore reading no. 5 i.e. 4.33m should be rejected")
```

Scilab code Exa 1.60 linear relation and standard deviation

```
//Example 1.60://standard deviation
clc;
clear;
u1=[1.8,4.6,6.6,9.0,11.4,13.4];//
v1=[2.2,3.2,5.2,6.4,8.0,10.0];//
for i= 1:6
    m(i)= u1(i)*v1(i)
    d(i)= u1(i)^2;//
end
su= u1(1)+u1(2)+u1(3)+u1(4)+u1(5)+u1(6);
sv= v1(1)+v1(2)+v1(3)+v1(4)+v1(5)+v1(6);
sm=m(1)+m(2)+m(3)+m(4)+m(5)+m(6);//
sd=d(1)+d(2)+d(3)+d(4)+d(5)+d(6);//
a= ((6*sm)-(su*sv))/((6*sd)-(su)^2);//
b=((sv*sd)-(sm*su))/((6*sd)-(su)^2);//
disp(a,"variable a is")
disp(b,"variable b is")
```

```
disp("best linear equation is 0.672u+0.591")
for i=1:6
    x(i)=a*u1(i)+b-v1(i)
    dx(i)=x(i)^2
end
sdx=dx(1)+dx(2)+dx(3)+dx(4)+dx(5)+dx(6);//
SD= sqrt(sdx/6);//
SDu=SD/a;//deviation of u
SDa= sqrt((6)/((6*sd)-(su^2)))*SD;//standard deviation in a
SDb= sqrt((sd)/((6*sd)-(su^2)))*SD;//standard deviation in b
disp(SD,"standard deviation is  ")
disp(SDu,"standard deviation in u is  ")
disp(SDa,"standard deviation in a is  ")
disp(SDb,"standard deviation in b is  ")
```

Scilab code Exa 1.61 constants and relationship

```
//Example 1.61://standard deviation
clc;
clear;
u1=[550,700,850,1000];//
v1=[0.04182,0.04429,0.05529,0.0610];//
for i= 1:4
    m(i)= u1(i)*v1(i)
    d(i)= u1(i)^2;//
end
su= u1(1)+u1(2)+u1(3)+u1(4);
sv= v1(1)+v1(2)+v1(3)+v1(4);
sm=m(1)+m(2)+m(3)+m(4);//
sd=d(1)+d(2)+d(3)+d(4);//
a= ((4*sm)-(su*sv))/((4*sd)-(su)^2);//
b=((sv*sd)-(sm*su))/((4*sd)-(su)^2);//
disp(a,"variable a is")
```

```
disp(b,"variable b is")
disp("best linear equation is 45.7*10^-6*f
    ^2+15.18*10^-3*f in mW")
//value of a and b is wrong in the book
```

Scilab code Exa 1.62 limiting error and standard deviation

```
// Example 1.62. limiting error and standard
    deviation
clc, clear
// given :
q1=50;
q2=100;
dq1=0.02; // may be +ve or -ve
dq2=0.01; // may be +ve or-ve
Le=(((q1/(q1+q2))*dq1)+((q2/(q1+q2))*dq2))*100;
Re=sqrt(1+1); // when individul error are standard
    deviation ,then errors in individual measurement
    are 2% of 50 and 1% of 100 ie., 1 and 1
Sd=(Re/(q1+q2))*100;
disp(Le,"limiting error,Le(%) = ")
disp(Sd,"standard deviation,Sd(%) = ")
```

Scilab code Exa 1.63 voltmeater and ammeter reading

```
// Example 1.63. resistance
clc, clear
// given :
Im=0.1; // maximum current in A
V=10; // voltage in volts
Rm=2.5; // resistance in ohm
Rs=(V/Im)-Rm;
I=10; // in A
```

```
Rsh=(Im*Rm)/(I-Im);
disp(Rs,"resistance in series,Rs(ohm) = ")
disp(Rsh,"resistance in parallel,Rsh(ohm) = ")
```

Scilab code Exa 1.64 current and voltage

```
// Example 1.64. resistance
clc, clear
// given :
Rm=10; // in ohm
Im=.005; // in A
I=1; // in A
V=5;
Rsh=(Im*Rm)/(I-Im);
Rs=(V-(Im*Rm))/Im;
disp(Rsh,"shunt resistance,Rsh(ohm) = ")
disp(Rs,"series resistance,Rs(ohm) = ")
```

Scilab code Exa 1.65 turning moment

```
// Example 1.65. turning moment
clc, clear
// given :
l=0.03; // in m
B=0.09; // in Wb/m^2
I=0.01; // in A
N=100; // number of turn
T=(N*B*I*l^2);
disp(T,"turning moment,T(N-m) = ")
```

Scilab code Exa 1.66 error

```

//Example 1.66// percentage error
clc;
clear;
close;
//given data :
alfa_c=.4/100; // in per degree celcius
alfa_m=0.015/100; //  in per degree celcius
Rm=5; // in ohm
Im=0.015; // in A
I=100; // in A
Ish=I-Im;
Vsh=Im*Rm;
Rsh=Vsh/Ish;
a=20; // in degree celcius
Rsh1=Rsh*(1+(a*alfa_m)); // the shunt resistance after a rise of 20 degree celcius
R1=5; // internal resistance in ohm
R2=1; // copper resistor in ohm
R3=4; // manganin swamping resistor in ohm
Ri=R1*(1+20*alfa_c);
// current through the instrument corresponding to 100 A
I1=(Rsh1/(Ri+Rsh1))*100;
Ii=(I1*I)/Im;
Pe1=I-Ii;
Ri1=(R2*(1+20*alfa_c))+(R3*(1+20*alfa_m));
 // instrument current with a line current of 100 A
Il=(Rsh1/(Ri1+Rsh1))*100;
Ir=Il*(100/Im);
Pe2=100-Ir;
disp(Pe1,"the percentage error,Pe1(low) = ")
disp(Pe2,"the percentage error,Pe2(low) = ")
```

Scilab code Exa 1.67 percentage error

```
//Example 1.67// percentage error
clc;
clear;
close;
//given data :
f=100; // in Hz
V1=250; // in volts
I1=0.05; // in A
L=1; // in H
R=V1/I1;
V=250; // in volts
XL=2*%pi*f*L;
Z=sqrt(R^2+XL^2);
Vr=(V1*R)/Z;
Ve=Vr-V;
Pe=abs(Ve/V)*100;
disp(Pe,"percentage error ,Pe = ")
```

Scilab code Exa 1.68 readings

```
//Example 1.68// voltmeter reading
clc;
clear;
close;
//given data :
f1=25; // in Hz
f2=100; // in Hz
R=300; // in ohm
L=0.12; // in H
XL1=2*%pi*f1*L;
```

```
V_ac=15; // in volts
Z1=sqrt(R^2+XL1^2);
Vr1=V_ac*(R/Z1);
XL2=2*%pi*f2*L;
Z2=sqrt(R^2+XL2^2);
Vr2=V_ac*(R/Z2)
disp(Vr1,"the voltmeter reading at f1,Vr1(V) = ")
disp(Vr2,"the volt meter reading at f2, Vr1(V) = ")
```

Scilab code Exa 1.69 power factor

```
//Example 1.69// power factor
clc;
clear;
close;
//given data :
W1=920; // in watt
W2=300; // in watt
fi=atand(sqrt(3)*(W1-W2)/(W1+W2));
cos_fi=cosd(fi)
disp(cos_fi,"the power factor,cos_fi(lag) = ")
```

Scilab code Exa 1.70 true power power factor and line current

```
//Example 1.70// power factor and line current
clc;
clear;
close;
//given data :
W1=14.2; // in k-watt
W2=-6.1; // in k-watt
El=440; // in volts
P=W1+W2;
```

```
fi=atand(sqrt(3)*(W1-W2)/(W1+W2));
cos_fi=cosd(fi);
IL=P*1000/(sqrt(3)*El*cos_fi);
disp(P,"true power,P(k-watt) = ")
disp(cos_fi,"the power factor,cos_fi(lag) = ")
disp(IL,"the line current,IL(A) = ")
```

Scilab code Exa 1.71 reading

```
//Example 1.71// READING
clc;
clear;
close;
Pi=25;//in kW
El=440;//line voltage in volts
pf=0.6;//power factor
ph=acosd(pf);//
tp=tan(ph);//
dw=(tp*Pi)/((3)^(1/3));//change in weights
W1=22.12;//IN kW
W2=25-W1;//
disp(W1,"reading in kW")
disp(W2,"reading in kW")
```

Scilab code Exa 1.72 percentage error

```

//Example 1.72// percentage error
clc;
clear;
I=5;//current in ampere
V=230;//volts
pf=1;//power factor
```

```
n=60;//no. of revolutions
t=360;//total time in seconds
nr=520;//normal disc no. of revolutions per kWh
E=((V*I*pf*360)/(3600*1000));//energy consumed in
   360 seconds in kWh
Er= n/nr;//energy recorded by the meter
Per=((Er-E)/E)*100;//percentage error
disp(Per,"percentage error is (fast)")
```

Scilab code Exa 1.73 percentage error

```
//Example 1.73// percentage error
clc;
clear;
I=4.5;//current in ampere
V=230;//volts
pf=1;//power factor
n=10;//no. of revolutions
t=360;//total time in seconds
nr=185;//normal disc no. of revolutions per kWh
E=((V*I*pf*190)/(3600*1000));//energy consumed in
   190 seconds in kWh
Er= n/nr;//energy recorded by the meter
Per=((Er-E)/E)*100;//percentage error
disp(-Per,"percentage error is (slow),(%)=")
//answer is calculated wrong in the textbook because
    in calculation of percentage error it is not
   divided by the actual value
```

Scilab code Exa 1.74 power

```
//Example 1.74// power
clc;
```

```
clear;
kwh1=15000;//in one kWh
n=150;//no. of revolutions in 45 seconds
Pm= (1*n)/kwh1;//power metered on 150 revolutions
P=(Pm*3600)/45;//POWER
disp(P*1000,"power in watts is")
```

Scilab code Exa 1.75 kWh registered by the meter and percentage error

```
//Example 1.74// kWh & percentage error
clc;
clear;
I= (40*225)/600;//current in amperes
I1=14;//current in ampere
V=230;//volts
pf=1;//power factor
n=225;//no. of revolutions
t=360;//total time in seconds
E=((V*I*pf*10)/(60*1000));//energy recorded in 1
   hour in kWh
Er=((V*I1*pf*10)/(60*1000));//energy consumed in 1
   hour in kWh;//energy recorded by the meter
Per=((Er-E)/E)*100;//percentage error
disp(-Per,"percentage error is")
```

Chapter 2

electronic instruments

Scilab code Exa 2.1 ammeter current

```

//Example 2.1. // ameter current
clc;
clear;
close;
//given data :
Rq1=100; // in kilo-ohm
Rq2=Rq1;
Rq=Rq2;
gm=0.005; // in siemens
Rm=50; // in ohm
Rd=10; // in kilo-ohm
V1=1; // in volts
i=((gm*Rq*10^2*Rd*10^2)/(Rq*10^2+Rd*10^2)*V1)/(((2*
   Rd*10^2*Rq*10^2)/(Rd*10^2+Rq*10^2))+Rm);
disp(i*10^3,"the ammeter current,i(mA) = ")
```

Scilab code Exa 2.2 error

```
//Example 2.2. // error
clc;
clear;
close;
//given data :
m=150;
T=3;
Kf_sin=1.11;//Form factor of sine wave
//e=50*t
Erms=sqrt(1/T*integrate('(50*t)^2','t',0,T));
Eav=(1/T*integrate('(50*t)','t',0,T));
kf=Erms/Eav;
R=Kf_sin/kf; // ratio of the two form factors
Pe=(R-1/1)*100;
disp(Pe,"the percentage error,Pe(%) = ")
```

Scilab code Exa 2.3 error

```
//Example 2.3. // error``
clc;
clear;
close;
//given data :
Kf_sin=1.11;//Form factor of sine wave
kf=1; // from interation Erms=Eav
R=Kf_sin/kf; // ratio of the two form factors
Pe=(R-1/1)*100;
disp(Pe,"the percentage error,Pe(%) = ")
```

Scilab code Exa 2.4 input voltage

```

//Example 2.4. // input voltage``
```

```
clc;
clear;
close;
//given data :
Va=2000; // in volts
ld=0.02; // in m
d=.005; // in m
L=.3; // in m
D=.03; // in m
Og=100; // overall gain
Vd=(2*d*Va*D)/(L*ld);
I=Vd/Og;
disp(I,"inout voltage,I(V) = ")
```

Scilab code Exa 2.5 deflection voltage

```

//Example 2.5. // deflection voltage and deflection
    sensitivity`
clc;
clear;
close;
//given data :
Va=2500; // in volts
ld=0.025; // in m
d=.005; // in m
L=.2; // in m
D=.03; // in m
Vd=(2*d*Va*D)/(L*ld);
S=(D/Vd)*1000;
disp(Vd,"deflection voltage,Vd(V) = ")
disp(S,"deflection sensitivity,S(mm/V) = ")
```

Scilab code Exa 2.6 deflection sensivity

```

//Example 2.6 // deflection sensitivity
clc;
clear;
close;
//given data :
Va=2500; // in volts
ld=0.02; // in m
d=.005; // in m
L=.2; // in m
D=.03; // in m
Vd=(2*d*Va*D)/(L*ld);
S=(D/Vd)*1000;
disp(S,"deflection sensitivity ,S(mm/V) = ")
```

Scilab code Exa 2.7 beam speed

```

//Example 2.7 // the beem speed and the deflection
    sensitivity
clc;
clear;
close;
//given data :
Va=2500; // in volts
ld=.015; // in m
d=.005; // in m
L=.5; // in m
m=9.109*10^-31; // in kg
e=1.602*10^-19;
v=sqrt((2*e*Va)/m);
S=((L*ld)/(2*d*Va))*10^3;
disp(v,"the beem speed ,v(m/s)")
```

```
disp(S,"deflection sensitivity,S(mm/V) = ")
```

Scilab code Exa 2.8 density of the magnetic field

```
//Example 2.8 // the density of magnetic field
clc;
clear;
close;
//given data :
Va=6000; // in volts
l=.033; // in m
L=.22; // in m
D=0.044; // in m
m=9.109*10^-31; // in kg
e=1.602*10^-19;
A=sqrt(e/(2*m*Va));
C=(L*l*A);
B=(D/C)*10^3;
disp(B,"the density magnetic field,B(mWb/m^2) = ")
```

Scilab code Exa 2.9 voltage

```

//Example 2.9 // voltage
clc;
clear;
close;
//given data :
Va=800; // in volts
B=1.8*10^-4; // in Wb/m^2
d=.01; // in m
m=9.109*10^-31; // in kg
e=1.602*10^-19;
```

```
A=sqrt(e/(2*m*Va));
C=A*B;
F=1/(2*d*Va);
Vd=C/F;
disp(Vd,"voltage,Vd(V)")
```

Scilab code Exa 2.10 peak to peak value amplitude and rms value of signal

```
//Example 2.10 // peak to peak, amplitude and rms
    value
clc;
clear;
close;
//given data :
Va=3; // vertical attenuation in mV/div
S=0.2; // 1 subdivision
//From the figure given in question : Div=1 unit &
    subdiv=0.2 unit
Div=1;//unit
subdiv=0.2;//unit
Vpeak=2*Div+3*subdiv;//only for one peak
Vpp=Vpeak*2;//For peak to peak
Vpp1=(Va/Div)*Vpp;
Vmax=Vpp1/2;
Vrms=Vmax/sqrt(2);
disp(Vpp1,"peak to peak value,Vpp1(mV) = ")
disp(Vmax,"amplitude,Vmax(mV) = ")
disp(Vrms,"R.M.S value,Vrms(mV) = ")
```

Scilab code Exa 2.11 phase angles

```
//Example 2.11 // determine the possible phase angles
clc;
clear;
close;
//given data :
y1=1.25; // division
y2=2.5; // division
pi=asind(y1/y2);
disp("the possible angles,pi(degree) "+string(pi)+" or "+string(360-pi)+" = ")
```

Scilab code Exa 2.12 resistance

```

//Example 2.12 // calculate the unknown resistance
clc;
clear;
close;
//given data :
R1=20; // in kilo-ohm
R2=30; // in kilo-ohm
R3=80; // in kilo-ohm
Rx=(R2*R3)/R1;
disp(Rx,"the unknown resistance,Rx(killo-ohm) = ")
```

Scilab code Exa 2.13 resistance

```
//Example 2.13 // calculate the unknown resistance
clc;
clear;
close;
//given data :
```

```
R1=100.24; // in ohm
R2=200; // in ohm
R3=100.03; // in micro-ohm
l=100.31; // in ohm
m=200; // in ohm
Ry=680; // in micro-ohm
A=(R1*R3*10^-6)/R2;
B=(m*Ry*10^-6)/(l+m+Ry*10^-6);
C=((R1/R2)-(l/m));
Rx=(A+B*C)*10^6;
disp(Rx,"the unknown resistance,Rx(micro-ohm) = ")
```

Scilab code Exa 2.14 constants of unknown arm

```
//Example 2.14//unknown resistance
clc;
clear;
Z1=50//impedance of first arm(in ohm)
Za=80//phase angle of first arm(in degree)
Z2=125//impedance of second arm(in ohm)
Z3=200//impedane of third arm(in ohm)
Zc=30//phase angle of third arm(in degree)
Z4=(Z2*Z3)/Z1
disp(Z4,'magnitude of Z4 arm(in ohm)=')
Zd=Zc-Za
disp(Zd,'phase angle of Z4 arm(in degree)=')
```

Scilab code Exa 2.15 constants of arm CD

```

//Example 2.15//calculate the constants of arm CD
clc;
clear;
```

```
f=1;//frequency in kHz
R1=225;//in ohms
R2=150;//in ohms
C2=0.53;//capacitance in micro farad
R3=100;//in ohms
L=7.95;//in mH
oC2=(2*%pi*f*10^3*C2*10^-6);//IN OHMS
wL= (2*%pi*f*10^3*L*10^-3);//in ohms
Z1=225;//in ohms
Z2= R2-(%i*(1/oC2));
Z3=R3+(%i*wL);//
Z4= (Z2*Z3)/(Z1);//unknow resistance in ohms
R4=real(Z4);//
C4=1/(2*%pi*f*10^3*imag(-Z4));//capacitance in farad
disp(R4,"resistance in arm CD in ohms")
disp(C4*10^6,"capacitance in micro farads")
```

Scilab code Exa 2.16 resistance and capacitance

```

//Example 2.16//resistance and capacitance
clc;
clear;
w=7500;//in rad/s
R2=140;//in ohms
R3=1000;//in ohms
R4=R3;//in ohms
C2=0.0115;//capacitance in micro farad
oC2=(w*C2*10^-6);//IN OHMS
Z2= R2+(%i*(1/oC2));
Z3=R3;//
Z4=R4;//
Z1=(Z2*Z3)/(Z4);//
R1=real(Z1);//
C1=1/(w*imag(Z1));//capacitance in farad
```

```
disp(R1,"resistance in arm CD in ohms")
disp(C1*10^6,"capacitance in arm CD in micro farads")
```

Scilab code Exa 2.17 series euivalent of unknown impedence

```
//Example 2.17//series equivalent of unknown impedence
clc;
clear;
R1=235;//in killo ohms
C1=0.012;//capacitance in micro farads
R2=2.5;//in killo ohms
R3=50;// in kilo ohms
Rx=(R2*R3)/(R1);//in killo ohms
Lx=C1*10^-6*R2*R3*10^6;//in henry
disp(Rx,"unknown resistance in killo ohms")
disp(Lx,"inductance in henry")
```

Scilab code Exa 2.18 series euivalent of unknown inductance and resistance

```

//Example 2.18//series equivalent of unknown impedence
clc;
clear;
w=3000;//in rad/s
R1=1.8;//in killo ohms
C1=0.9;//capacitance in micro farads
R2=9;//in killo ohms
R3=0.9;// in kilo ohms
```

```
Rx= ((w^2*(C1*10^-6)^2*R1*10^3*R2*10^3*R3*10^3)/(1+w
    ^2*(R1*10^3)^2*(C1*10^-6)^2));//
Lx=((R2*10^3*R3*10^3*C1*10^-6)/(1+w^2*(R1*10^3)^2*(
    C1*10^-6)^2));//in henry
disp(Rx*10^-3,"unknown resistance in killo ohms")
disp(Lx,"inductance in henry")
//answer is wrong in the textbook
```

Scilab code Exa 2.19 resistance capacitance and dissioation factor

```
//Example 2.19//unknown resistance ,capacitance and
    dissipation factor
clc;
clear;
f=1;//frequency in kHz
R1=1.5;//in killo ohms
C1=0.4;//in micro farads
R2=3;//in killo ohms
C3=0.4;//in micro farads
Rx=(R2*C1)/(C3);//unknown resistance in killo ohms
Cx=(R1*C3)/(R2);//UNKNOWN CAPACITANCE IN MICRO
    FARADS
D= 2*%pi*f*Cx*10^-6*Rx*10^3*10^3;//DISSIPATION
    FACTPR
disp(Rx,"unknown resistance in killo ohms")
disp(Cx,"unknown capacitance in micro farads")
disp(D,"dissipation factor is")
```

Scilab code Exa 2.20 equivalent parralel resistance and capacitance

```
//Example 2.20//unknown resistance ,capacitance
clc;
clear;
```

```
f=2;//frequency in kHz
R1=2.8;//in killo ohms
C1=4.8;//in micro farads
R2=20;//in killo ohms
R4=80;//in killo ohms
R3=((R4/R2)*(R1*10^3+(1/((2*%pi*f*10^3)^2*(C1*10^-6)
    ^2*R1*10^3))));//
C3=(1/((2*%pi*f*10^3)^2*C1*10^-6*R1*10^3*R3));//
    capaciatnce
disp(R3*10^-3,"unknown resistance in killo ohms")
disp(C3*10^12,"CAPACITANCE IN PICO FARAD IS")
```

Scilab code Exa 2.21 resistance and capacitance

```
//Example 2.21//RESISTANCE AND INDUCTANCE
clc;
clear;
L1=52.6;//in mH
R2=1.68;//in ohms
r1=28.5;//internal resistance in ohms
r2=r1-R2;//resistance in ohms
L2=L1;//inductance in mH
disp(r2,"resistance in ohms")
disp(L2,"inductance in mH")
```

Scilab code Exa 2.22 constants of arm CD

```

//Example 2.22//calculate the constants of arm CD
clc;
clear;
f=1;//frequency in kHz
C1=0.2;//in micro farad
```

```
R2=500; //in ohms
R3=300; //in ohms
C3=0.1; //in micro frads
Z1=0-%i*(1/(2*%pi*f*10^3*C1*10^-6)); //
Z2=R2; //
Y3= ((1/R3)+(%i*2*%pi*f*10^3*C3*10^-6)); //
Z4=(Z2)/(Z1*Y3); //
Rx= real(Z4); //
Lx=(imag(Z4))/(2*%pi*f); //
disp(Rx,"unknown resistance in ohms")
disp(round(Lx),"unknow capacitance in mH")
```

Scilab code Exa 2.23 constant of Zx

```

//Example 2.23//calculate the constants zX
clc;
clear;
R1=200; //IN OHMS
f=1; //frequency in kHz
C2=5; //in micro farad
R2=200; //in ohms
R3=500; //in ohms
C3=0.2; //in micro frads
Z1=R1; //
Z2=R2-(%i*(1/(2*%pi*f*10^3*C2*10^-6))); //
Z3=R3-(%i*(1/(2*%pi*f*10^3*C3*10^-6))); //
Zx=(Z2*Z3)/Z1;
Rx=real(Zx);
Cx=((1/(2*%pi*f*10^3*imag(-Zx)))); //
disp(Rx,"unknown resistance in ohms")
disp(Cx*10^6,"unknown capacitance in micro farads")
```

Scilab code Exa 2.24 resistance and inductance

```
//Example 2.24//find unknow resistance and
   inductance
clc;
clear;
R1=600;//in ohms
f=1;//frequency in kHz
C1=1;//in micro farad
R2=100;//in ohms
R3=1000;//in ohms
Y1=((1/R1)+(%i*2*%pi*f*10^3*C1*10^-6));//
Z2=R2;//
Z3=R3;//
Z4=Z2*Z3*Y1;//
Rx= real(Z4);//
Lx=(imag(Z4))/(2*%pi*f);//
disp(round(Rx),"unknown resistance in ohms")
disp(Lx*10^-3,"unknow capacitance in Henry")
```

Scilab code Exa 2.25 capacitance power factor and relative permittivity

```
//Example 2.25//capacitance ,power factor and
   relative permittivity
clc;
clear;
f=50;//in hertz
C2=106;//capacitance in pico farad
R4=(1000/%pi);//IN OHMS
C4=0.055;//in micro farads
R3=270;//in ohms
R1= (R3*C4*10^-6)/(C2*10^-12);// IN OHMS
C1=(R4*C2*10^-12)/(R3);//in farads
pf=2*%pi*f*R1*C1*10^-12;//
```

```
Eo=8.854*10^-12;//
a= (%pi*12^2)/(4*100^2);//in meter square
t=0.005;//THICKNESS IN METER
Er= ((C1*t)/(Eo*a));//relative permittivity
disp(C1*10^12,"capacitance in pico farad ")
disp(pf*10^13,"power factor is")
disp(Er,"realtive permittivity is")
```

Scilab code Exa 2.26 distributed capacitance

```
//Example 2.26 // self capacitance
clc;
clear;
close;
//given data :
C1=420; // in pico-farad
C2=90; // inpico-farad
Cd=(C1-4*C2)/3;
disp(Cd,"the self capacitance,Cd(pico-farad) = ")
```

Scilab code Exa 2.27 distributed capacitance

```
//Example 2.27 // distributed capacitance
clc;
clear;
close;
//given data :
C1=410; // in pico-farad
C2=50; // inpico-farad
f1=2; // in MHz
f2=5; // in MHz
F=f2/f1;
Cd=(C1-F^2*C2)/5.25;
```

```
disp(Cd,"the self capacitance,Cd(pico-farad) = ")
```

Scilab code Exa 2.28 resistive and reactive components of unknow impedence

```
//Example 2.28 //resistive and reactive component
clc;
clear;
close;
//given data :
C1=190*10^-12; // in farad
C2=170*10^-12; // in farad
Q1=75;
Q2=45;
f=200; // in kilo-Hz
w=2*%pi*f*1000;
Rx=((C1*Q1)-(C2*Q2))/(w*C1*C2*Q1*Q2);
Xx=(C1-C2)/(w*C1*C2);
disp(Rx,"the resistive,Rx(ohm) = ")
disp(Xx,"the reactive component,Xx(ohm) = ")
```

Scilab code Exa 2.29 percentage error

```
//Example 2.29 //percentage error
clc;
clear;
close;
//given data :
R=4; // in ohm
f=500; // in kilo-Hz
C=120; // in pico-farad
O=0.02; // in ohm
w=2*%pi*f*10^3;
```

```
Qt=1/(w*C*10^-12*R);
Qi=1/(w*C*10^-12*(R+0));
Pe=((Qt-Qi)/Qt)*100;
disp(Pe,"the percentage error,Pe(%) = ")
```

Scilab code Exa 2.30 self capacitance

```
//Example 2.30 //self capacitance
clc;
clear;
close;
//given data :
C1=100; // in pico-farad
f1=600;// in kilo-Hz
f2=2; // in M-Hz
Cd=(f1*1000)^2*C1/((f2*10^6)^2-(f1*1000)^2)
disp(Cd,"the self capacitance,Cd(pico-farad) = ")
```

Scilab code Exa 2.31 resistance and inductance

```

//Example 2.31 //inductance and resistance
clc;
clear;
close;
//given data :
C=220; // in pico-farad
f1=400;// in kilo-Hz
Rsh=0.8; // in ohm
Q=110;
w=2*%pi*f1*1000;
L=(1/(w^2*C*10^-12));
R=((w*L)/Q);
```

```
disp(L*10^6,"inductance,L(micro-H) = ")
disp(R,"resistance,R(ohm) = ")
```

Scilab code Exa 2.32 inductance and capacitance

```
//Example 2.32 //inductance and capacitance
clc;
clear;
close;
//given data :
f=2*10^6; // resonant freqencies in Hz
Cs=210*10^-12; // resonant capacitor in farad
Cv=6*10^-12; // capacitance of voltmeter in farad
L=1/((Cs+Cv)*4^2*(%pi)^2*f^2);
C=((1/(4*L*(%pi)^2*f^2*10^-12))-6);//
disp(L*10^6,"inductance,L(micro henry) = ")
disp(C,"capacitance in pF is")
```

Scilab code Exa 2.33 inductance and resistance

```
//Example 2.33 //inductance and resistance
clc;
clear;
close;
//given data :
C1=40; // in pico-farad
C2=48; // in pico-farad
f=4; // in MHz
R1=60; // additional series resistance in ohm
C0=(C1+C2)/2;
w=2*%pi*f*10^6;
L=(1/(4*%pi^2*(f*10^6)^2*(C0*10^-6)));//
X= ((w*L*10^6)-(1/(w*C2*10^-12)))^2;//
```

```
R= (X-R1^2)/120;// unknown resistance in ohms
disp(L*10^12,"inductance in MH")
disp(R,"unknown resistance in ohms")
//resistance is calculated wrong in the textbbok
```

Scilab code Exa 2.34 Q factor and effective resistance

```
//Example 2.31 //inductance and resistance
clc;
clear;
close;
//given data :
fo=1.2*10^6; // in Hz
C=160*10^-12; // in farad
f=6*10^3; // resonant frequency in Hz
f1=fo+f;
f2=fo-f;
F=f1-f2;
Q=fo/F;
R=F/((2*%pi*(fo)^2*C));
disp(Q,"Q factor ,Q = ")
disp(R,"resistance ,R(ohm) = ")
```

Scilab code Exa 2.35 self capacitance and inductance

```
//Example 2.35 //self capacitance and inductance
clc;
clear;
close;
C1=200;//in pico farads
f1=(2/%pi)*10^6;//in hertz
C2=40;// in pico fards
f2=2*f1;//
```

```
CD= ((f1^2*C1*10^-12)-(f2^2*C2*10^-12))/(f2^2-f1^2);
    //
L=1/(4^2*(C1+CD*10^12));//
disp(CD*10^12,"capacitance in pico farad")
disp(L*10^6,"inductance in micro henry")
```

Chapter 5

Digital Instruments

Scilab code Exa 5.1 frequency of the system

```
//Example 5.1 // frequency
clc;
clear;
close;
//given data :
N=45; // count
t=10; // gate period in ms
f=(N/(t*10^-3))*10^-3;
disp(f,"frequency ,f(k-Hz) = ")
```

Scilab code Exa 5.2 possible error

```
//Example 5.2 // possible error
clc;
clear;
close;
//given data :
n=3;
```

```
R=1/10^n;
v=2; // in v
r=0.5/100;
R1=1*R; // full scale range of 1 V
R2=10*R; // full scale range of 10 V
Lsd=5*R;
Pe=(r*v)+Lsd;
disp(Pe,"the possible error,Pe(V) = ")
```

Scilab code Exa 5.3 resolution

```
//Example 5.3 // resolution
clc;
clear;
close;
//given data :
n=4;
R=1/10^n;
disp(R,"resolution,R = ")
```

Chapter 6

instrument transformers

Scilab code Exa 6.1 actual transformation ratio phase angle and maximum flux density

```
//Example 6.1// actual transformer ratio ,phase
   angle and maximum flux density
clc;
clear;
Np=1;//no. of primary turns
Ns=240;//no. of secondary turns
Is=5;//SECONDARY WINDING CURRENT IN AMPERE
Re=1.2;//external burden in ohms
mmf=96;//magneromotive force in AT
Ac=1200;//CROSS SECTIONAL AREA IN MM sqaure
f=50;//suplly frequency in hertz
Kt=Ns/Np;//turn ratio
Es=Is*Re;//voltage induced in secondary winding
Im= mmf/Np;//magnetising component of current in
   ampere
Rs=Kt*Is;//reflected secondary winding current in
   ampere
Ip=sqrt(Rs^2+Im^2);//primary current in ampere
Kact= Ip/Is ;//actual turn ratio
Theta= atand(Im/(Kt*Is));//
```

```
Phm= ((Es/(4.44*f*Ns)));//flux in Wb
Bm= Phm/(Ac*10^-6);//maximum flux density in Wb/Meter squre
temp=Theta-floor(Theta)
disp(Kact,"actual transformation ratio is")
disp("the phase angle is "+string(floor(Theta))+" degree and "+string(round(temp*60))+"min");
disp(Bm,"maximum flux density in Wb/meter square")
```

Scilab code Exa 6.2 ratio error and phase angle

```
//Example 6.2// ratio error and phase angle
clc;
clear;
dv=0;//as secondary winding power factor is unity
Io=1;//in ampere
Knom=200;//nominal ratio
Re=1.1;//external burden in ohms
Pf=0.45;//power factor
d= acosd(Pf);//
alpha=90-d;//in degrees
Is=5;//in ampere
Rs=Knom*Is;//
Kact= Knom+((Io/Is)*sind(dv+alpha));//actual transformation ratio
Re= ((Knom-Kact)/Kact)*100;//ratio error in percentage
pa=((180/%pi)*(Io*cosd(dv+alpha))/Rs);//phase angle in degree
pa1=pa-round(pa);
pa2=pa*3600;//
pa3= round(pa2);
pa4= pa3-180;//
pa5=pa2-pa4;//
disp(Re,"ratio error in percentage is")
```

```
disp("the phase angle is "+string(round(pa5/60))+"
   min and "+string(pa4)+" seconds" );
```

Scilab code Exa 6.3 flux and ratio error

```
//Example 6.3// aflux ,ratio error
clc;
clear;
f=50;//frequency in hertz
Np=1;//no. of primary turns
Il=1.4;//iron loss in watts
Is=5;//SECONDARY WINDING CURRENT IN AMPERE
Re=1.4;//external burden in ohms
mmf=80;//magneromotive force in AT
Kt=200;//turn ratio
Ns=Kt*Np;//no. of secondary turns
Es=Is*Il;//voltage induced in secondary winding
Ep=Es/Kt;//primary voltage
Iw= Il/Ep;//loss component in ampere
Im= mmf/Np;//magnetising component of current in
   ampere
Kact= Kt+((Iw/Is));//actual ratio
Re= ((Kt-Kact)/Kact)*100;//ratio error in percentage
Phm= ((Es/(4.44*f*Ns)));//flux in Wb
disp(Phm,"maximum flux density in Wb")
disp(Re,"ratio error in percentage is")
```

Scilab code Exa 6.4 ratio error and phase angle error

```
//Example 6.4// ratio error and phase angle error
clc;
clear;
Ns=250;//no. of secondary turns
```

```
Rp=1.4;//in ohms
f=50;//frequency in hertz
Np=1;//no. of primary turns
Is=5;//SECONDARY WINDING CURRENT IN AMPERE
Re=1.1;//external burden in ohms
mmf=80;//magneromotive force in AT
Il=1.1;//IRON LOSS IN WATTS
Kt=Ns/Np;//turn ratio
Se=sqrt(Rp^2+Re^2);//secomdary circuit impedance in
    ohms
csd=Rp/Se;//cos angle
sd=Il/Se;//SIN ANGLE

Es=Is*Se;//voltage induced in secondary winding
Ep=Es/Kt;//primary voltage
Iw= Il/Ep;//loss component in ampere
Im= mmf/Np;//magnetising component of current in
    ampere
Kact= Kt+((Im*sd)+(Iw*csd))/Is;//actual ratio
Re= ((Kt-Kact)/Kact)*100;//ratio error in percentage
Pa=((180/%pi)*(Im*csd-Iw*sd)/(Kt*Is));//phase angle
    in degree
disp(Re,"ratio error in percentage is")
disp(Pa,"phase angle in degree is")
```

Scilab code Exa 6.5 primary winding current actual transformation ratio and number of turns

```
//Example 6.5// primary winding current ,actual
    transformation ratio and no. of turns
clc;
clear;
Ns=300;//no. of secondary turns
Xe=0.55;//in ohms
Xs=0.25;//in ohms
```

```
f=50;//frequency in hertz
Np=1;//no. of primary turns
Is=5;//SECONDARY WINDING CURRENT IN AMPERE
Re=1.0;//external burden in ohms
Rs=0.3;//in ohms
mmf=90;//magneromotive force in AT
mmfc=45;//mmf for core loss in AT
ts=Rs+Re;//total secondary circuit resistance
tr=Xe+Xs;//total secondary circuit reactance
d= atand(tr/ts);//secondady phase angle in degree
csd= cosd(d);
sd=sind(d);
Kt=300;//
Iw= mmfc/Np;//loss component in ampere
Im= mmf/Np;//magnetising component of current in
    ampere
Kact= Kt+((Im*sd)+(Iw*csd))/Is;//actual ratio
Ip=Kact*Is;//primary current in amperes
Knom=300;//NOMINAL TRANSFORMATION RATIO
Ktd= Knom-((Im*sd)+(Iw*csd))/Is;//for zero ratio
    error
Nsd=Ktd*Np
Rtr=round(Knom-Nsd);//reduction in secondary winding
     turns
disp(Ip,"primary current in ampere")
disp(Kact,"actual transformation ratio")
disp(Rtr,"reduction in secondary winding turns")
```

Scilab code Exa 6.6 actual ratio and phase angle

```
//Example 6.6// actual ratio and phase angle
clc;
clear;
Ns=100;//no. of secondary turns
f=50;//frequency in hertz
```

```
Np=1;//no. of primary turns
Knom=100
Io=1.8;//amperes
Is=1;//SECONDARY WINDING CURRENT IN AMPERE
Re=1.45;//external burden in ohms
Rs=0.25;//in ohms
La=38.4;//lagging angle in degree
Kt=Ns/Np;//actual ratio
ts=Rs+Re;//total secondary circuit resistance
alpha=90-La;// PHASE ANGLE
Kact= Kt+((Io/Is)*sind(alpha));//actual transformation ratio
Pa=((180/%pi)*(Io*cosd(alpha))/(Kt*Is));//phase angle in degree
disp(Pa,"phase angle in degree is")
disp(Kact,"actual transformation ratio")
```

Scilab code Exa 6.7 actual ratio and phase angle error

```

//Example 6.7// ratio
clc;
clear;
Is=5;//in amperes
Ns=200;//no. of secondary turns
f=50;//frequency in hertz
Np=1;//no. of primary turns
Iw=5;//in amperes
Im=8;//amperss
Kt=Ns/Np;//turn ratio
csd1=0.8;//
sd1= sqrt(1-csd1^2);//
Kact1= Kt+((Im*sd1)+(Iw*csd1))/Is;//actual ratio when 0.8 p.f. lagging
Re1= ((Kt-Kact1)/Kact1)*100;//ratio error in
```

```
percentage when 0.8 p.f. lagging
Pa1=((180/%pi)*(Im*csd1-Iw*sd1))/(Kt*Is);//phase angle in degree when 0.8 pf lagging
csd2=0.8;//
sd2=-0.6;//
Kact2= Kt+((Im*sd2)+(Iw*csd2))/Is;//actual ratio when 0.8 p.f. leading
Re2= ((Kt-Kact2)/Kact2)*100;//ratio error in percentage when 0.8 p.f. leading
Pa2=((180/%pi)*(Im*csd2-Iw*sd2))/(Kt*Is);//phase angle in degree when 0.8 pf leading
disp(Kact1,"actual ratio when 0.8 p.f. lagging")
disp(Re1,"percentage ratio error when 0.8 p.f. lagging")
disp(Pa1,"phase angle when 0.8 p.f. lagging in degree ")
disp(Kact2,"actual ratio when 0.8 p.f. leading")
disp(Re2,"percentage ratio error when 0.8 p.f. leading")
disp(Pa2,"phase angle when 0.8 p.f. leading in degree")
```

Scilab code Exa 6.8 current nd phase angle error

```
//Example 6.8// current and phase angle errors
clc;
clear;
Ns=99;//no. of secondary turns
Xe=0.55;//in ohms
Xs=0.35;//in ohms
f=50;//frequency in hertz
Np=1;//no. of primary turns
Is=5;//SECONDARY WINDING CURRENT IN AMPERE
Rs=0.4;//in ohms
Re= (20)/(Is^2);//innohms
```

```
Xe=0;//
mmf=6;//magneromotive force in AT
mmfc=8;//mmf for core loss in AT
ts=Rs+Re;//total secondary circuit resistance
tr=Xe+Xs;//total secondary circuit reactance
d= atand(tr/ts);//secondady phase angle in degree
csd= cosd(d);
sd=sind(d);
Kt=99;//
Knom=100
Iw= mmfc/Np;//loss component in ampere
Im= mmf/Np;//magnetising component of current in
    ampere
Kact= Kt+((Im*sd)+(Iw*csd))/Is;//actual ratio
Re=((Knom-Kact)/Kact)*100;//current error in
    percentage
Pa=((180/%pi)*(Im*csd-Iw*sd))/(Kt*Is);//phase error
disp(Re,"current error in percentage is")
disp(Pa,"phase error in degree is")
```

Scilab code Exa 6.9 ratio error and phase angle

```
//Example 6.9// current and phase angle errors
clc;
clear;
Is=5;//IN AMPERES
Ip=100;//primary current in amperes
VA=20;//BURDEN
xr=4;//
mmfc=0.18;//mmf for core loss in AT
Ep=VA/Ip;//voltage across primary winding
d= atand(1/xr);//secondady phase angle in degree
csd= cosd(d);
sd=sind(d);
Kt=20;//
```

```
Knom=20
Iw= mmfc/Ep;//loss component in ampere
Im= 1.4;//magnetising component of current in ampere
Kact= Kt+((Im*sd)+(Iw*csd))/Is;//actual ratio
Re=((Knom-Kact)/Kact)*100;//current error in
    percentage
Pa=((180/%pi)*(Im*csd-Iw*sd))/(Kt*Is);//phase error
disp(Re,"current error in percentage is")
disp(Pa,"phase error in degree is")
//answer is wrong in the book
```

Scilab code Exa 6.10 phase angle error and burden in VA

```

//Example 6.10// phase errors and burden
clc;
clear;
Vs=100;//IN VOLTS
Kt=10;//TRANSFORMATION RATIO
Rp=86.4;//primry resistance IN OHMS
Xp=62.5;//primary reactance in ohms
Rs=0/78;//secondary resistance in ohms
Xe=102;//reactance in ohms
Io=0.03;//in amperes
pf=0.42
csd1=0.42;//
sd=sqrt(1-csd1^2);//
Iw=Io*csd1;//in amperes
Im=Io*sd;//in amperes
pa= ((Iw*Xp)-(Im*Rp))/(Kt*Vs);//phase angle in
    radians AT NO LOAD
csd2=1;//AT BURDEN
sd2=0;//
Is= 1.5632/10.2;//in amperes
B=Vs*Is;//BURDEM IN VA
```

```
disp(pa,"phase angle in radians at no load")
//phase angle is calulated wrong in the textbook
disp(B,"burden in VA is")
```

Scilab code Exa 6.11 ratio and phase angle error

```
//Example 6.11//ratio and phase errors
clc;
clear;
Kt=60.476;//TRANSFORMATION RATIO
Knom=Kt;//
Vs=63;//in volts
Rs=2;//in ohms
Xs=1;//IN OHMS
va=100+%i*200;//burden in VA
y=atand((imag(va)/(real(va))));//in degree
Zs= sqrt((imag(va)^2+real(va)^2));//magnitude
Kact=Kt+((Kt*(Rs*cosd(y)+Xs*sind(y))))/Zs;//actual turn ratio
Pr=(Knom-Kact)/Kact;//percentage ration error
pa=((Xs*cosd(y)-Rs*sind(y))/Zs)*(180/%pi);//change in phase angle error in degree
disp(Pr*100,"percetage ratio error is")
disp(pa,"phase error in degree is")
```

Chapter 7

sensors and transducers

Scilab code Exa 7.2 displacement and resolution

```
//Example 7.2 // resolution
clc;
clear;
close;
//given data :
l=50; // a linear resistance potentiometer lenth in
   mm
r=10000; // resistance in ohm
rmin=10; // minimum measurable resistance in ohm
r1=3850; //  ‘case 1 in ohm
r2=7560; // case 2 in ohm
R1=r/2; // in ohm
R2=r/l; // in ohm/mm
Rc=R1-r1;
D1=Rc/R2;
Rd=r2-R1; // opposite direction in ohm
D2=Rd/R2;
R=rmin/R2;
disp(D1,"displacement in case 1 ,D1(mm) = ")
disp(D2,"displacement in case 2,D2(mm) = ")
disp(R,"resolution ,R(mm) = ")
```

Scilab code Exa 7.3 resistance

```
//Example 7.3 // resistance
clc;
clear;
close;
//given data :
R25=100; // in ohm
alfa=-5/100;
T1=35; // in degree celcius
T2=25; // in degree celcius
R35=R25*(1+alfa*(T1-T2));
disp(R35,"resistance R35(ohm) = ")
```

Scilab code Exa 7.4 inductance

```
//Example 7.4 // inductance
clc;
clear;
close;
//given data :
l=1; // air gap lenth in mm
L1=2; // in mH
D1=0.02; // when a displacement is applied
l1=l-D1;
dL=(L1*(l/l1))-L1;
L=dL/L1;
D=D1/l;
disp(L*10^2," inductance ,L(mH) = ")
```

```
disp(dL,"inductance,dL(mH) = ")
disp(D,"the ratio of displacement to original gap length,D = ")
```

Scilab code Exa 7.5 linearity

```
//Example 7.5 // LINEARITY
clc;
clear;
close;
//given data :
V=1.8; // the output voltage
D=.0045; // the deviation from a straight line through the origin may be +ve or-ve
A=(D/V)*100;
disp(A,"age linearity,A(%) =    ")
```

Scilab code Exa 7.6 sensivity and resolution

```
//Example 7.6 // the sensitivity and resolution
clc;
clear;
close;
//given data :
Vo=1.8; // output voltage
D=0.6; // displacement
S=Vo/D;
Af=500; // amplification factor
Sm=Af*S; // in mV/mm
V=4000; // in mili-volts
Sd=V/100; // one scale division
Vmin=(1/4)*Sd; // scale can be read to 1/4 of a division
```

```
R=Vmin*(1/Sm);
disp(S,"sensitivity of LVDT,S(mV/mm) = ")
disp(R,"resolution ,R(mm) = ")
```

Scilab code Exa 7.7.a capacitance

```
//Example 7.7.a // determine the value of
   capacitance
clc;
clear;
close;
//given data :
A=300; // plates of area in mm^2
eo=8.85*10^-12; // in F/m
er1=1;
er2=8; //  dielectric contant of mica
d=0.2; //
C=((eo*er1*10^-6*A)/(d*10^-3))*10^12;
disp(C,"capacitance ,C(pF) = ")
```

Scilab code Exa 7.7.b change in capacitance

```
//Example 7.7. // change in capacitance
clc;
clear;
close;
//given data :
A=300; // plates of area in mm^2
eo=8.85*10^-12; // in F/m
er1=1;
er2=8; //  dielectric contant of mica
d1=0.18; //
d=0.2; //
```

```
D=d-d1;
C=((eo*er1*10^-6*A)/(d*10^-3))*10^12;
C1=((eo*er1*10^-6*A)/(d1*10^-3))*10^12;
dC=C1-C;
a=dC/C;
b=D/d;
R=a/b;
disp(dC,"capacitance ,dC(pF) = ")
disp(R,"ratio of per unit cahnge of capacitance to
   per unit change of displacement ,R = ")
```

Scilab code Exa 7.7.c original capacitance and change in capacitance

```
//Example 7.7.c // ratio
clc;
clear;
close;
//given data :
A=300; // plates of area in mm^2
eo=8.85*10^-12; // in F/m
er1=1;
er2=8; //  dielectric contant of mica
d1=0.01; // thickness of mica
d2=0.02; // when a displacement is applied
d=0.2; //
D=d-d1;
D1=D-d2;
C=((eo*A*10^-6)/(((D/er1)+(d1/er2))*10^-3))*10^12;
C1=((eo*A*10^-6)/(((D1/er1)+(d1/er2))*10^-3))*10^12;
dC=C1-C;
a=dC/C;
b=d2/d;
R=a/b;
disp(C,"Capacitance ,C(pF)=")
disp(dC,"capacitance ,dC(pF) = ")
```

```
disp(R,"ratio of per unit cahnge of capacitance to
    per unit change of displacement ,R = ")
```

Scilab code Exa 7.8 voltage output and charge sensivity

```

//Example 7.8 // voltage output and charge
    sensitivity
clc;
clear;
close;
//given data :
t=2.5*10^-3; // thick quartz in mm
g=0.055; // in Vm/N
p=1.4; // MN/m^2
e=40.6*10^-12; // in F
E=g*t*p*10^6;
C=e*g*10^12;
disp(E,"voltage output ,E(V) = ")
disp(C,"charge sensitivity ,C(pC/N) = ")
```

Scilab code Exa 7.9 force

```
//Example 7.9 // force
clc;
clear;
close;
//given data :
A=6*6*10^-6; // in m^2
t=1.8*10^-3; // in m
g=0.055; // in Vm/N
E=120; // in volts
p=E/(g*t);
```

```
F=p*A;
disp(F,"force ,F(N) = ")
```

Scilab code Exa 7.10 strain charge and capacitance

```

//Example 7.10 // strain charge and capacitance
clc;
clear;
close;
//given data :
A=6*6*10^-6; // in m^2
t=1.5*10^-3; // in m
e=12.5*10^-9; // in F/m
F=6; // in N
d=150*10^-12; // in F
E=12*10^6; // in N/m^2
p=F/A;
S=p/E;
g=d/e;
E1=g*t*p;
Q=d*F*10^12;
C=Q/E1;
disp(S,"strain ,S = ")
disp(Q,"charge ,Q(pC) = ")
disp(C,"capacitance ,C(pF) = ")
```

Scilab code Exa 7.11 hall angle

```
//Example 7.11 // the hall angle
clc;
clear;
close;
```

```
//given data :
p=0.00912; // resistivity of semiconductor material
   in ohm-m
B=0.48; // in Wb/m^2
Rh=3.55*10^-4; //  in m^3/C
Jx=1;
Ex=p*Jx;
Ey=Rh*B*Jx;
t=Ey/Ex;
Theta=atand(t)
temp=Theta-round(Theta)
disp("the hall angle is "+string(round(Theta))+"
   degree and "+string(round(temp*60))+"min");
```

Scilab code Exa 7.12 voltage

```

//Example 7.12 // voltage
clc;
clear;
close;
//given data :
Rh=3.55*10^-4; // hall coefficient in m^3/C
I=0.015; // current in A
A=15*10^-6; // area in m^2
B=0.48; // flux density in Wb/m^2
Jx=I/A;
Ey=Rh*B*Jx;
V=Ey*A*10^3;
disp(V,"voltage between contact,V(V) = ")
```

Scilab code Exa 7.13 poissons ratio

```
//Example 7.13 // poisson's ratio
clc;
clear;
close;
//given data :
Gf=4.2;
mu=(Gf-1)/2;
disp(mu,"poissons ratio,mu = ")
```

Scilab code Exa 7.14 change in resistance

```
//Example 7.14 // resistance
clc;
clear;
close;
//given data :
alfa=20*10^-6; //resistance temperature coefficient
    in per degree celcius
R=120; // in ohm
E=400; // in MN/m^2
Gf=2;
Me=200*10^9; // modulus of elasticity in N/m^2
Cs=(1/10)*E*10^6; // in N/m^2
e=Cs/Me;
dR=R*Gf*e*10^3; //
t=20; // temerature in degree celcius
dR1=R*alfa*t*10^3;
disp(dR,"resistance due to change in stress,dR(m-ohm
    ) = ")
disp(dR1,"resistance due to change of temperature,
    dR1(m-ohm) = ")
//ANSWER IS WRONG IN THE TEXTBOOK
```

Scilab code Exa 7.15 change in length and amount of force

```
//Example 7.15 // change in length and force
clc;
clear;
close;
//given data :
E=207*10^9; // strain gauge in N/m^2
L=0.12; // im m
A=3.8*10^-4; // in m^2
R=220; // in ohm
Gf=2.2;
dR=0.015;  // in ohm
dL=(((dR/R)*L)/Gf);
a=E*(dL/L);
F=a*A/1000;
disp(dL,"change in length,L(m) = ")
disp(F,"the force,F(kN) = ")
```

Scilab code Exa 7.16 strain

```
//Example 7.16 // strain
clc;
clear;
close;
//given data :
Rg=100; // in ohm
Rsh=80000; // in ohm
Gf=2.1; //
e=(1/Gf)*(Rg/(Rg+Rsh))*10^6;
disp(e,"the strain,e(microstrain) = ")
```

Scilab code Exa 7.17 axial strain

```
//Example 7.17 // strain
clc;
clear;
close;
//given data :
n=4;
Rg=200; // in ohm
Rsh=100*10^3; // in ohm
Gf=2; // gauge factor
e=Rg/(n*Gf*(Rg+Rsh));
// case 1 -when the calibration switch is closed,
    the read out gives a reading of 140 division
D=e/140;
//case 2 - when the strain gauge is loaded, the
    strain
S=D*220*10^6;
disp(S,"the strain,S(microstrain) = ")
```

Scilab code Exa 7.18 longitudinal and hoop stresses

```
//Example 7.18 // the longitudinal and hoop stress
clc;
clear;
close;
//given data :
ex=0.00016;
ey=0.00064;
E=200*10^9; // in N/m^2]
mu=0.26;
a=(E*(ex+(mu*ey))/(1-(mu)^2))*10^-6;
b=(E*(ey+(mu*ex))/(1-(mu)^2))*10^-6;
disp(a,"longitudinal,a(MN/m^2) = ")
disp(b,"hoop stress,b(MN/m^2) = ")
```

Scilab code Exa 7.19 modulus of elesticity and poissons ratio

```
//Example 7.18 // the longitudinal and hoop stress
clc;
clear;
close;
//given data :
ex=1540;
ey=-420;
A=110*10^-6; // in m^2
P=25*10^3; // load in N
ax=P/A;
by=0;
E=(ax/ex);
mu=(ey*E)/ax;
disp(E*10^-3,"modulus of elasticity ,E(GN/m^2) = ")
disp(-mu,"poisson ratio ,ey = " )
```

Scilab code Exa 7.21 principa strains principal stresses maximum shrea stress and princiole planes

```

// Example 7.21 : principle strains , principal
    stess ,maximum shreat stress and location of
    principle planes
clc, clear
// given :
e1=60; // in microstrain
e2=48; // in microstrain
e3=-12; // in microstrain
E=200*10^9; // in N/m^2
mu=0.3;
```

```
e_max=((e1+e3)/2)+(1/sqrt(2))*sqrt((e1-e2)^2+(e2-e3)^2);
e_min=((e1+e3)/2)-(1/sqrt(2))*sqrt((e1-e2)^2+(e2-e3)^2);
a_max=E*(e1+e3)/(2*(1-mu))+((E/(sqrt(2)*(1+mu)))*sqrt((e1-e2)^2+(e2-e3)^2));
a_min=E*(e1+e3)/(2*(1-mu))-((E/(sqrt(2)*(1+mu)))*sqrt((e1-e2)^2+(e2-e3)^2));
tau_max=(E/(sqrt(2)*(1+mu)))*sqrt((e1-e2)^2+(e2-e3)^2);
A=atand((2*e2-e1-e3)/(e1-e3));
B=A/2;
disp(e_max*10^-6,"principle strain (e_max)")
disp(e_min*10^-6,"principle strain (e_min)")
disp(a_max*10^-12,"principle stresses (a_max) in MN/m^2")
disp(a_min*10^-12,"principle stresses (a_min)in MN/m^2")
disp(tau_max*10^-12,"maximm shear stress (tau_max) in MN/m^2")
disp(B,"location of the princinple planes (B)  in degree")
```

Scilab code Exa 7.22 sensivity

```
//Example 7.22 // sensitivity
clc;
clear;
close;
//given data :
d=0.06; // in mm
Rg=120; // in ohm
Gf=2; // gauge factor
v=6; // im volts
E=200; // GN/m^2
```

```
mu=0.3; // poisson's ratio
l=1000; // consider a load applied in N
Si=l/((%pi/4)*(d)^2)
e=Si/(E*10^9);
R=Gf*e;
dVo=2*(1+mu)*R*(v/4)*10^-6;
S=dVo/(l*1000);
disp(S*10^18,"the sesitivity ,S(microvolt/kN) = ")
```

Chapter 8

signal conditioning

Scilab code Exa 8.1 total voltage gain

```
//Example 8.1 //total voltage gain
clc;
clear;
g1=100;//FIRST STAGE GAIN
g1db=20*(log10(g1));//first stage gain in db
g2=200;//second stage gain
g2db=20*(log10(g2));//second stage gain in db
g3=400;//third stage gain
g3db=20*(log10(g3));//third stage gain in db
Tdb=g1db+g2db+g3db;//
disp(Tdb,"total gain in dB")
```

Scilab code Exa 8.2 total gain and resultant gain

```
//Example 8.2 //POWER GAIN AND RESULTANTT POWER GAIN
clc;
clear;
g1=30;//ABSOLUTE GAIN FOR EACH STAGE
```

```
N=5;// no. of stages
Pdb=10*(log10(g1));//power gain in db
Ndb= Pdb*N;//power gai of 5 stages in db
Nfb=10;//NEGATIVE FEEDBACK IN DB
Rpg=Ndb-Nfb;//RESULTANT POWER GAIN IN db
disp(Ndb,"power gain in db")
disp(Rpg,"resultant power gain in db")
```

Chapter 12

measurement of non electrical quantities

Scilab code Exa 12.1.b percentage change

```
//Example 12.1.b // percentage
clc;
clear;
close;
//given data :
Gf=2; // gauge factor
a=100; // stress in MN/m^2
E=200; // modulus of elasticity in GN/m^2
S=(a*10^6)/(E*10^9);
R=Gf*S;
P=R*100;
disp(P,"percentange change in resistance ,P(%) = ")
```

Scilab code Exa 12.4 water flow rate

```
//Example 12.4 // the water flow rate
```

```
clc;
clear;
close;
//given data :
D1=0.2; // in m
D2=0.1; // in m
h=220; // in mm
Cd=0.98;
ph=13.6;
pw=1; // in Kg/m^3
g=9.81;
P=g*h*10^-3*(ph-pw)*1000;
M=1/sqrt(1-(D2/D1)^4)
A2=(%pi/4)*D2^2;
Q=(Cd*M*A2*sqrt((2*g/g*1000)*P))*10^-3;
disp(Q,"water flow rate,Q(m^3/s) = ")
```

Scilab code Exa 12.5 rate of flow

```
//Example 12.5 //rate of flow oin pipe line
clc;
clear;
D1=0.4;//diameter of pipe at inlet
A1= (%pi/4)*D1^2;//area of inlet in meter square
D2=0.2;//throat diameter in meter
A2=(%pi/4)*D2^2;//area of throat in meter square
y=0.05;//reading of the differntial manometer in
    meter
Shl=13.6;//SPECIFIC GRAVITY OF HEAVY LIQUID
Sp=0.7;//SPECIFIC GRAVITY OF OIL FLOWING THE
    PIPELINE
h=y*((Shl/Sp)-1);//differntial pressure head in
    meter
g=9.81;//assume
V2=sqrt(h/((1/(2*g))-(1/(32*g))));//
```

```
V1=(A2*V2)/A1;//
Q=A2*V2;//
disp(Q,"rate of flow of oil in m^3/s is")
```

Scilab code Exa 12.6 differecne in pressure head

```

//Example 12.6 // difference
clc;
clear;
close;
//given data :
Q=0.015; // in m^3/s
D0=0.1; // in m
D1=0.2; // in m
Cc=0.6;
Cd=0.6;
g=9.81;
A0=((%pi/4)*D0^2);//in m^2
A1=((%pi/4)*D1^2);//in m^2
K=Cd/sqrt(1-(Cc*(A0/A1))^2);
S=sqrt((2*g)/(g*1000));
DP=((Q/(K*A0*S)))^2;//
disp("difference in thr pressure head is "+string(DP
    )+" N/m^2 or "+string(DP/9739.45)+" m of water")
```

Scilab code Exa 12.7 flow rate

```
//Example 12.7 // flow rate
clc;
clear;
close;
//given data :
```

```
Qv=1.2; // m^3/s
C0=0.6; // discharge coeficient of orifice
Cv=0.97; // discharge coeficient
Q0=(C0/Cv)*Qv;
disp(Q0,"the flow rate,Q0(m^3/s) = ")
```

Scilab code Exa 12.8 speed of sub marine

```

//Example 12.8 // speed
clc;
clear;
close;
//given data :
g=9.81; // gravity og earth
Sh=13.6; // gravity of mercury
Sl=1.025; // gravity of sea water
y=0.2; // reading of the manometer in m
h=y*((Sh/Sl)-1);
V=sqrt(2*g*h);
disp("velocity of sub-marine,V(m/s) "+string(V)+" or
    "+string(V*(3.6))+" km/h")
```

Chapter 13

Additional or supplement topics

Scilab code Exa 13.1 resistance and inductance

```
//Example 13.1 // resistance and inductance
clc;
clear;
close;
//given data :
Q=1000; // in ohm
S=Q;
P=500; // in ohm
r=100; // in ohm
C=0.5; // in micro-farad
R=(P*Q)/S;
L=((C*10^-6*P)/S)*(r*(Q+S)+(Q*S));
disp(R,"resistance ,R(ohm) = ")
disp(L,"inductance ,L(H) = ")
```

Scilab code Exa 13.2 resistance and inductance

```
//Example 13.2 // resistance and inductance
clc;
clear;
close;
//given data :
R2=1000; // in ohm
R3=500; // in ohm
R4=1000; // in ohm
r=100; // in ohm
C=3; // in micro-farad
R=(R2*R3)/R4;
L=((C*10^-6*R2)/R4)*(r*(R3+R4)+(R3*R4));
disp(R,"resistance ,R(ohm) = ")
disp(L,"inductance ,L(H) = ")
```

Scilab code Exa 13.3 effective impedence

```

//Example 13.3 // impedance
clc;
clear;
close;
//given data :
C3=0.124; // in micro-farad
R3=834; // in ohm
C4=0.1; // in micro-farad
f=2000; // in Hz
R2=100; // in ohm
L1=R2*R3*C4*10^-6;
R1=R2*(C4/C3);
X1=2*%pi*f*L1;
Z1=sqrt(R1^2+X1^2);
disp(R1,"resistance in ohms is")
disp(Z1,"impedance of the specimen ,Z1(ohm) = ")
```

Scilab code Exa 13.4 capacitance and equivalent series

```
//Example 13.4 // capacitance and series resistance
clc;
clear;
close;
//given data :
M=18.35; // in m-H
R1=200; // in ohm
L1=40.6; // in m-H
R2_1=119.5; // in ohm
R4=100; // in ohm
C2=((M*10^-3)/(R1*R4))*10^6;
R2=(R4*(L1-M))/M;
Rs=R2-R2_1;
disp(C2,"capacitance,C(micro-farad) = ")
disp(Rs,"the series resistance,Rs(ohm) = ")
```