Scilab Textbook Companion for Electrical Measurements And Measuring Instruments by J. B. Gupta[1]

Created by
Gundla Keerthi Vani
Mba
Others
Princeton P.g College
College Teacher
None
Cross-Checked by
None

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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

Measurements and Measurement systems

Scilab code Exa 1.1 calculate the static sensitivity and deflection factor

```
//==================================================================
//chapter 1 example 1

clc;
clear all;

//variable declaration
d    =2.4;                    //magnitude of output
    response in mm
R    = 6;                     //magnitude of input in

//calculations
S    = d/(R);           //static sensitivity in mm/
D    = R/(d);           //deflection factor in    /mm

//result
mprintf("static sensitivity = %3.2f mm/   ",S);
```

```
mprintf("\n deflection factor = %3.2f    /mm",D);

//
```

Scilab code Exa 1.2 determine the efficiency of the instrument

```
//

//chapter 1 example 2

clc;
clear all;

//variable declarations
If      = 5;        //full-scale reading of instrument
    in A
Ra      = 0.01;     //ammeter resistance in ohm


//calculations
Pf      = ((If)^2)*(Ra);                //power
   sonsumption for full-scale deflection is W
n       = (If)/(Pf);                 //instrument
   efficiency in A per watts

//result
mprintf("power sonsumption for full-scale deflection
    = %3.2f W",Pf);
mprintf("\ninstrument efficiency = %3.0f A per watts
   ",n);


```

```
//
```

Scilab code Exa 1.3 Find the range of the instrument and scale range

```
//

//chapter 1 example 3

clc;
clear all;

//variable declaration
n      = 100;                  //highest mutiplier switch
    in mA
N      = 100;                  //number of divisions


//calculations
R      = (N*10^-3)*n;                    //Range of
   instrument in A
S      = 0-n;                  //scale range

//result
mprintf("Range of instrument = %3.2f A",R);
mprintf("\nScale Range  = 0%3.2f",S);

//
```

Scilab code Exa 1.4 determine the measurement sensitivity of the instrument

```
//
    ============================================================

//chapter 1 example 4

clc;
clear all;

//variable declaration
T1    = 200;              //Tempperature in  C
T2    = 225;              //Tempperature in  C
R1    = 305;             //Resistance in
R2    = 310;              //Resistance in

//calculations
S   = (R2-R1)/(T2-T1);    //dr/dt in per  C

//result
mprintf("measurement sensitivity S = %3.2f     per
    C ",S);


//
    ============================================================
```

Scilab code Exa 1.5 Calculate the non linearity as a percent of full scale deflect

```
//
    ============================================================

//chapter 1 example 5

```

```
clc;
clear all;

//variable declaration
R0      = 100;                         //resistance in
R100    = 138.50;                       //resistance in

R200    = 175.83;                      //resistance in
T1      = 0;                           //Tempperature in
    C
T2      = 200;                         //Tempperature in
    C
T3      = 100;                         //Tempperature in
    C

//calculations
T       = ((T2-T1)/(R200-R0))*(R100-R0);  //change
   in temperatre in  C
D       = T-T3;                                    //
   deviation in  C  at T3 temperature
p       = (D/(T2))*100;                         //per cent
   full scale deflection non linearity in %

//result
mprintf("per cent full scale deflection %3.4f
   percent",p);



//
```

Scilab code Exa 1.6 Determine the maximum error

```
//
```

```
//chapter 1 example 6

clc;
clear all;

//variable declaration
l     = 0.2;            //percent liearity
r     = 300;            //full-scale readng
R     = 20;             //resistance in  k
V     = 2;              //voltage in V

//calculations
d     = (l*r)/(100);       //maximum displacement deviatio in
R1     = (l*R)/(100);        //maximum resistance displacement in
//a displacement of 300 corresponds to 2V  ,therfore 0.6 corresponds to a voltage of (0.6/300)*2
ev     = (d/(r))*V;         //maximum voltage error in mV

//result
mprintf("maximum displacement deviation =%3.1f     ",d);
mprintf("\nmaximum resistance displacement %3.2f  k",R1);
mprintf("\n maximum voltage error  %3.2f mV",(ev*10^3));

//
```

Scilab code Exa 1.7 `Determine the temperature`

```
//

//chapter 1 example 7

clc;
clear all;

//variable declaration
t1      =500;        //temperature in  C
t2      =1250;        //temperature in  C
r       = 0.12;       //dead space in pyrometer in per
    cent of span

//calculations
S      = t2-t1;                  //span the algebric
   diffeerence between the upper and lower range
   values
d      = (r/(100))*S;     //dead space in  C

//result
mprintf(" a change of %3.2f  C  must occur before it
    is detected",d);

//
```

Scilab code Exa 1.8 `Find the error in measurment`

```
//
```

```
//chapter 1 example 8

clc;
clear all;

//variable declaration
E0     = 12;         //open -circuit voltage in V
R0     = 1;          //output resistance in k
RL     = 25;          //output resistance in k


//calculations
EL      = E0/(1+(R0/RL));    //measured value of
   voltage in V
Er      = EL-E0;                          //errorin
   measurement in V
p       = ((EL-E0)/(E0))*100;             //percentage
    error in %

//result
mprintf("measured value of voltage  = %3.3f V",EL);
mprintf("\nerror in measurement= %3.3f V",Er);
mprintf("\npercentage error = %3.3f  percent low",p)
   ;


//
```

Scilab code Exa 1.9 `Also find the percentage error`

```
//
```

```
//chapter 1 example 9


clc;
clear all;

//variable declaration
s    = 4000;      //instrument sensitivity in k
R    = 10;        //range of scale
R0   = 20;        //output resistance in k
E0   = 7.5;        //open circuit voltage

//calculations
RL      =s*R;         //instrument resistance in k
RL1     = RL*10^-3;
EL      = E0/(1+(R0/(RL1)));    //measured value of voltage in V
p       = ((EL-E0)/(E0))*100;              //percentage error in %

//result
mprintf("measured value of voltage = %3.2f V",EL);
mprintf("\npercentage error = %3.2f V  percentage low",p);
```

Scilab code Exa 1.10 calculate the resistance of voltage measuring device

```
//

//chapter 1 example 10

clc;
clear all;

```

```
//variable declaration
E0     = 50;        //internal voltage source in V
R0     = 100;       //resitance in k
r      = 99;        //accuracy in %

//calculations
//Em = E0/(1+(R0/RL))
//Em  = E0*(r in %)
//E0/(1+(R0/RL)) = E0*(r in %)
Em    = (E0*r)/(100);
x     =E0/(Em);
y     = x-1;
Rm    = R0/(y);          //resistance of voltage in k

//result
mprintf("resistance of voltage  = %3.2f  k  ",Rm);
```

Scilab code Exa 1.11 Determine actual value of current measured value of current a

```
//
   ====================================================================

//chapter 1 example 11


clc;
clear all;

//variable declaration
E      = 20;         //voltage in V
R1     = 2;          //resistance in k
R2     = 2;          //resistance in k
R3     = 1;          //resistance in k
R      = 200;        //resistance whe current is
   connected to terminals in
```

```
//calculations
Io      = (E/(R1+((R2*R3)/(R2+R3))))*(R2/(R2+R3));        //nortons equivalent current in k
Rout    = R3+((1/(R1))+(1/(R2)));              //output resistance in k
IL      = Io*((R1*1000)/((R1*1000)+R));          //measured value of current in mA
e       = ((IL-Io)/(Io))*100;                        //percentage error in %
A       = 100+e;                //accuracy of measurement in %

//result
//mprintf("resistance of voltage  = %3.2f  k  ",Rm);

mprintf("actual value of current flowing through 1000    is %3.2f mA",Io');
mprintf("\nmeasured value of current when 200    is connected is %3.2f mA",IL);
mprintf("\npercentage error = %3.1f percentage(low)",e);
mprintf("\naccuracy of measurement = %3.1f percentage ",A);
```

Chapter 3

Error in Measurement and Their Analysis

Scilab code Exa 3.1 Determine the absolute error of measurement

```
//
==================================================================

//chapter 3 example 1

clc;
clear all;

//variable declaration
Am      = 10.25;                    //measured value in

A       = 10.22;                    //True value in

//calculations
dA      = Am-A;                     //absolute error in


//result
mprintf("abslotue error = %3.2f   ",dA);
```

Scilab code Exa 3.2 Determine the true value of power

```
clc;
clear all;

//variable declaration
Am      = 25.34;                    //measured value in
    watts
dA      = -0.11;                    //absolute error in
    watts


//calculations
A       = Am-dA;                    //True value in
   wtts

//result
mprintf("abslotue error = %3.2f watts",A);
```

Scilab code Exa 3.3 Determine the relative error

```
//
   ================================================================

//chapter 3 example 2

clc;clear all;


//variable declaration
Am      = 205.3*10**-6;                   //measured
   value in
```

```
A        = 201.4*10**-6;                    //True value
    in

//calculations
e0       = Am-A;                    //absolute error in

r        = (e0/(A))*100;            //relative error in
     %

//result
mprintf("abslotue error = %3.2e F ",e0);
mprintf("\nrelative error = %3.2f percentage",r);
```

Scilab code Exa 3.4 Determine the limits of inductance

```
//
    ==========================================================================

//chapter 3 example 4
clc;
clear all;

//variable declaration
ep      =  5;               //percentage error
Am      = 20;               //measuredd value in H

//calculations
er      = ep/(100);      //relative error
//A = Am+dA
//dA  = er*Am
A      = Am*(1+er);              //limiting value of
    inductance in H
A1     = Am*(1-er);              //limiting value of
    inductance in H

```

```
//result
mprintf("limits of inductance =%3.2f H",A);
mprintf("\n and  = %3.2f H",A1);
```

Scilab code Exa 3.5 calculate the limiting value of current

```
//
//chapter 3 example 5
clc;
clear all;

//variable declaration
er      = 1.5*10^-2;                           //accuracy
A1       = 10;                                   //current in A
A2      = 2.5;                                  //current in A

//calculations
dA      = er*A1;                                //magnitude of limiting error of the instrument
er1      = dA/(A2);                         //magnitude of current
A11      = A2*(1+er1);                           //current in A
A12      = A2*(1-er1);                           //current in A
er2      = (dA/(A2))*100;                        //limiting error in %

//result
mprintf("limiting values of current  =%3.2f A and %3.2f",A11,A12);
```

```
mprintf("\nlimiting error = %3.1f percentage',er2);
```

Scilab code Exa 3.6 Determine the limiting error in per cent

```
//
    ============================================================

//chapter 3 example 6

clc;clear all;

//variable declaration
e       = 0.01;              //acuuracy
v       = 150;               //voltage in V
v1      = 83;                // measured voltage  in V

//calculations
dV      = e*v;                          //magnitude of the
    limiting error of the instrument in V
er      = (dV/(v1))*100;      //percentage  limiting
    error at v1 voltage in %

//result
mprintf("limmiting error in case of 83V is = %3.2f
    percentage',er);
```

Scilab code Exa 3.7 calculate the limiting error

```
//
    ============================================================

//chapter 3 example 7

```

```
clc;clear all;

//variable declaration
er      = 0.01;                 // limiting error
P       = 1000;                 //power in watts
P1      = 100;                  // true power in watts

//calculations
dP      = er*P;                 //magnitude of instrument error of the instrument watts
eP      = (dP/(P1))*100;        //percentage limiting error at 100 W power in %

//result
mprintf("percentage limiting error at 100 W power = %3.2f percentage',eP);;
```

Scilab code Exa 3.9 Calculate the power dissipated in the resistor and the uncerta

```
//==========================================================================

//chapter 3 example 9

clc;clear all;

//variable declaration
v       = 110.2;            //voltage drop in V
i       = 5.3;              //current in A
v1      = 0.2;              //uncertainity in measurements in V
i1      = 0.6;              //uncertanity in measurments in A

```

```
//calculations
erv     =  (v1/(v))*100;     //limiting error to voltage drop in %(ranging + to -)
eri     = (i1/(i))*100;      //limitng error in currrent in %(ranging + to -)
P       = v*i;                   //power dissipated in the resistor in W
eP      = (erv+eri);             //limting error in the power dissipation in %(ranging + to -)
p       = eP*P*10^-2;                  //power with limiting error in W
e       = erv+eri;                     //limiting error in power dissipation
P1      = P+p;                   //power dissipation is given in W
P11     = P-p;                   //power dissipation is given in W

//result
mprintf("power dissipated = %3.2f W",P);
mprintf("\nlimiting error in the power dissipation = %3.1f percentage",e)
mprintf("\nuncertanity in power ranging in %3.2f W to %3.2f",P11,P1);
```

Scilab code Exa 3.10 calculate the limiting error in the computed value of power d

```
//

//chapter 3 example 10

clc;clear all;

//variable declaration
```

```
R       = 100;          //resistance in
dR      = 0.2;          //resistancce error in    (ranging + to −)
I       = 2;            //current in A
dI      = 0.01;         //error in current in A(ranging + to −)

//calaculatons
eR      = (dR/(R))*100;     //percentage limiting error to resistance in %(ranging + to −)
eI      = (dI/(I))*100;     //percentage limiting error to current in %(ranging + to −)
P       = (I^2)*R;                 //power dissioation in W
eP      = (2*eI)+eR;                //worst ossible combination of errors the limiting error in the power dissipation in %
p       = (eP*10^-2)*P;                     //error in power in watts
P1      = P+p;                      //power dissipation in W
P2      =P-p;                      //power dissipation in W

//result
mprintf("limiting error = %3.2f percentage',eP);
mprintf("\npower dissipation %3.2f W %3.2f W",P2,P1);
```

Scilab code Exa 3.11 Determine the resolution in the instrument in volt

```
//
//chapter 3 example 11
```

```

clc;clear all;

//variable declaration
V       = 200;          //full-scale reading i V
n       = 100;          //number of divivsions of scale

//calculations
n1      = V/(n);        //1 scale division in V
R       = n1/(5);       //1/5 th of scale division in V

//result
mprintf("resolution = %3.2f V",R);
```

Scilab code Exa 3.12 Determine the limiting error of the resultant capacitance

```
//
//chapter 3 example 12

clc;clear all;

//variable declaration
u     = 150;            //capacitance in uF
du    = 2.4;            //capacitance in uF
v     = 120;            //capacitance in uF
dv    = 1.5;            //capacitance in uF

//calculations
y     = u+v;            //resultant capacitance when capacitors are connectedd in parallel in uF
dy    = du+dv;          //limiting error in uF(ranging + to -)
er    = (dy/(y))*100;   //relative limiting error in %
```

```
   (ranging + to -)

//result
mprintf("limiting error of the resultant capacitance
     = %3.2f percentage',er);
```

Scilab code Exa 3.13 calculate the uncertainty in the combined resistance

```
//

//chapter 3 example 13
clc;clear all;

//variable declaration
R1    = 1000;          //resistance in
R2    = 500;           //resistance in
eR1   = 1;          //error resistance
eR2   = 1;          //error resistance

//calculations
R    = (R1*R2)/(R1+R2);        //resistance in
X    = R1*R2;
Y    = R1+R2;
dX   = (eR1+eR2);            //error in X
//dY   = (dR1/Y)+(dR2/Y);
//dY   = (R1/Y)*(dR1/R1)+((R2/Y)*(dR2/R2)
dY   = ((R1/(Y))*(eR1))+((R2/(Y))*(eR2));      //
   error in Y
eP   = dX+dY;                                  //
   percentage error in equivaent parallel resistance
    in %
e    = R*(eP/(100));                          //error(
   maximum ossible) in equivalent parallel
   resistance in
```

```
//result
mprintf("percentage error  = %3.2f percentage",eP);
mprintf("\nerror in equivalent parallel resistance =
    %3.2f  ",e);
```

Scilab code Exa 3.14 find the resistance in series and parallel

```
//
    ====================================================================

//chapter 3 example 14

clc;clear all;

//variable declaration
R1     = 200;                    //resistancce in
R2     = 100;                    //resistancce in
R3     = 50;                     //resistancce in
dR1     = 5;                    //change in
    resistancce(dR1/R1) in %
dR2     = 5;                    //change in
    resistancce(dR2/R2) in %
dR3     = 5;                     //change in
    resistancce(dR3/R3) in %
y1      = 20000;
y2      = 5000;
y3      = 10000;


//calculations
Rse    = R1+R2+R3;               //equivalent
    resistance in
R      = ((R1/(Rse))*(dR1))+((R2/(Rse))*(dR2))+((R3
```

```
/(Rse))*(dR3));
e       =  Rse*(R/(100));                        //relative limiting error  of series equivalent in

X       = R1*R2*R3;
Y       = (R2*R3)+(R1*R3)+(R1*R2);
RP      = X/(Y);                                 //equivalent resistance in
eX      = dR1+dR2+dR3;                           //error in X in %
dy1      = dR1+dR2;                              //error(dy1/y1) n y1 in %
dy2      = dR2+dR3;                              //error(dy2/y2) in y2 in %
dy3      = dR3+dR1;                              //error(dy3/y3) in y3 in %
eY       = ((y1/(Y))*(dy1))+((y2/(Y))*(dy2))+((y3/(Y))*(dy3));       //percentage error in %
pemax       = eX+eY;                             //percentage error (maximum possible) in equivalent parallel resistance in %
emax       = RP*(pemax/(100));                   //error maximum possible in equivalent parallel resistance in

//result
mprintf("equivalent resistance = %3.2f   ",Rse);
mprintf("\nrelative limiting error of series resistance  = %3.2f percentage",R);
mprintf("\nrelative limiting error  of series equivalent = %3.2f   ",e);
mprintf("\npercentage error (maximum possible) in equivalent parallel resistance= %3.2f percetage",pemax);
mprintf("\nerror maximum possible in equivalent parallel resistance =%3.4f   ',emax);
```

Scilab code Exa 3.15 power and limiting error of the power

```
//
//chapter 3 example 15

clc;clear all;

//variable decelaration
er      = 0.015;                        //limiting error
V     = 100;                            //range of
   voltmeter in V
I    = 150;                             //range of ammeter
   in mA
V1      = 70;                           //magnitude of
   voltage being measured in V
I1      = 80;                           //magnitude of
   current being measured in mA

//calculations
dV    = er*V;                          //magnitude(dV/V of
   limiting error of the voltmeter in V
eV      = (dV/(V1))*100;     //percentage(dI/I)
   limitng error at this voltage in %
dI      = er*I;                        //magnitude of
   limitng error off the ammeter  in mA
eI      = (dI/(I1))*100;     //percentage limitng
   error at this current in %
P       = V1*(I1/(1000));                        //power in
   W
dPx     = eV+eI;             //relative limiting error(
   dPx/Px) in power measurement in %

```

```
//result
mprintf("relative limitng error in power measurement
    = %3.4f percentage",dPx);
```

Scilab code Exa 3.16 calculate the nominal power and limiting error of power

```

//

//chapter 3 example 16

clc;clear all;

//variable declaration
E      =200;           //limiting voltage in V
R      = 1000;         //resistance in
eE     = 1;            //relative limiting error(dE/E)
     in %
eR     = 5;            //relative limting error(dR/R)
    in %

//calculations
P      = (E**2)/(R);       //normal power consumed in
    W
eP     = ((2*eE)+eR);              //relative limiting
    error(dP/P) in measurement of power in %
dP     = P*(eP/(100));                     //limitng
    error of power in watts

//result
mprintf("Normal power consumed = %3.2f W",P);
mprintf("\nrelative limitng error in power
    measurement= %3.2f percentage rangng +eP to -eP",
    eP);
```

```
mprintf("\nlimitng error of power = %3.2f percentage
   ",dP);
```

Scilab code Exa 3.17 calculate the nominal value of unknown resistance and error i

```
//
   ================================================================

//chapter 3 example 17
clc;
clear all;

//variable declaration
R1      = 500;        //resistance in
R2      = 615;        //resistance in
R3      = 100;        //resistance in
dR1     = 1;          //limiting error(dR1/R1) in %
dR2     = 1;          //limiting error(dR1/R1) in %
dR3     = 0.5;          //limiting error(dR1/R1) in %

//calculations
R4     = (R1*R2)/(R3);     //unknown resistance in
dR4    =dR1+dR2+dR3;             //relative error of
   unknown resistance in % ranging - to +
e      = R4*(dR4/(100));    //limitng error in

//result
mprintf("unknown resistance = %.2f    ",R4);
mprintf("\nrelative error of unknown resistance
   ranging - to + = %3.2f percentage ",dR4);
mprintf("\nlimitng error = %3.2f    ",e);
```

Scilab code Exa 3.18 calculate the absolute error

```
//==============================================================================

//chapter 3 example 18

clc;clear all;

//variable declartaion
r    = 0.5*10^-3;          //in mm
p1    = 200;          //in Pa
p2    = 150;          //in Pa
Q     = 4*10^-7;          //in m**3/s
l     = 1;                //length in m
dr     = 0.01;
dp1    = 3;
dp2     = 2
dQ     =0
dl     =0;

//calculations
u    = ((%pi)*((r^4)*((p1*10^3)-(p2*10^3)))/((8*Q*l))
    );     //absolute error inkr/m-s
er    = (dr/((r/(10^-3))))*100;                          //
    dr/r in %
ep1    = (dp1/(p1))*100;                          //dp1/p1
    in %
ep2    = (dp2/(p2))*100;                          //dp2/p2
    in %
eQ    = (dQ/(Q))*100;                          //dQ/Q in %
el    = (dl/(l))*100;                          //dl/l in %
p     = p1-p2;                    //dp/p in Pa
ep    = (((p1/(p))*(ep1))+(p2/(p))*(ep2));      //
    percentage error in % anging - to +
eu     = (4*er)+(ep+eQ+el);                //percentage
    error in % ranging - to +
ua      = u*(eu/100);                    //absolute
    error in kg/m-s

```

```
//result

mprintf("absolute error = %3.3e kg/m-s",u);
mprintf("\nxabsolute error = %3.2e kg/m-s",ua);
```

Scilab code Exa 3.19 determine the magnitude of unknown inductance

```
//

//chapter 3 example 19

clc;clear all;

//variable declaration
C    = 1*10^-6;         //capacitance in F
dC   = 1;        //error capacitance in %
P    = 1000;     //resistance in
dP   = 0.4;      //error in resistance in %
Q    = 2000;     //resistance in
dQ   = 1;      //error in resistance in %
S    = 2000;     //resistance in
dS   = 0.5;      //error in resistance in %
r    = 200;     //resistance in
dr   = 0.5;     //error in resistance in %

//calcukations
Lx     = ((C*P)*((r*(Q+S))+(Q*S)))/(S);       //unknown inductance in Henry
u      =Q+S;                          //in
du     = ((Q/(u))*(dQ))+((S/(u))*(dS));     //percentage error in %
v      = r*(Q+S);
dv     = dr+du;          //percentage error of v in %
x      = Q*S;
```

```
dx      = dQ+dS;          //percentage error of x in %
y       = (r*(Q+S))+(Q*S);
dy      = ((v/(y))*(dQ))+((x/(y))*(dx));     //percentage error in %
dLx      = dC+dP+dS+dy;

//result
mprintf("unknown inductance = %3.2f henry",Lx);
mprintf("\npercentage error on inductance = %3.1f percentage",dLx);
```

Scilab code Exa 3.20 determine the uncertainty in the measurement of Z

```
//

//chapter 3 example 20

clc;clear all;

//variable declaration
R     = 100;       //resistance in
dR    = 5;        // error (dR/R) in %
L    = 2;       //inductance
r      = 50;
dL    = 10;        // error (dl/L) in %

//calculations
u     = R**2;
du     = 2*dR;      //percentage error(du/u) in %
v      = ((2*(%pi)*(r))**2)*(L**2);
dv     =2*dL;      //percentage error(dv/v) in %
x      = u+v;
dx     =((u/(x))*(du))+((v/(x))*(dv));     //percentage error(dx/x)in %
```

```
Z      = sqrt(x);
dZ     = dx/(2);          //uncertanity (dZ/Z) in %

//result
mprintf("uncertanity in the measurement = %3.3f
   percentage",dZ);
```

Scilab code Exa 3.21 calculate the standard deviation

```
//

//chapter 3 example 21
clc;clear all;

//variable declaration
x1    = 49.7;       //voltage in V
x2    = 50.1;       //voltage in V
x3    = 50.2;       //voltage in V
x4    = 49.6;       //voltage in V
x5    = 49.7;       //voltage in V
n      =5;

//ccalculations
x   =(x1+x2+x3+x4+x5)/(5);     //arthimetic mean
d1    =x-x1;        //deviation
d2    =x-x2;        //deviation
d3    =x-x3;        //deviation
d4    =x-x4;        //deviation
d5    =x-x5;        //deviation
d      = (d1**2)+(d2**2)+(d3**2)+(d4**2)+(d5**2);
sigma   = sqrt(d/(n-1));        //standard devation

//result
mprintf("arthimetic mean = %3.2f ",x);
```

```
mprintf("\nstandard deviation = %3.3f",sigma);
```

Scilab code Exa 3.22 find mean and standard deviation and probable error

```
//
//chapter 3 example 22
clc;clear all;

//variable declaration
x1   = 41.7;      //voltage in V
x2   = 42;      //voltage in V
x3   = 41.8;      //voltage in V
x4   = 42;      //voltage in V
x5   = 42.1;      //voltage in V
x6   = 41.9;      //voltage in V
x7   = 42.5;      //voltage in V
x8   = 42;      //voltage in V
x9   = 41.9;      //voltage in V
x10   = 41.8;      //voltage in V
n     =10;

//ccalculations
x   =(x1+x2+x3+x4+x5+x6+x7+x8+x9+x10)/(10);     //
    arthimetic mean
d1   =x-x1;       //deviation
d2   =x-x2;       //deviation
d3   =x-x3;       //deviation
d4   =x-x4;       //deviation
d5   =x-x5;       //deviation
d6   =x-x6;       //deviation
d7   =x-x7;       //deviation
d8   =x-x8;       //deviation
d9   =x-x9;       //deviation
```

```
d10    =x-x10;        //deviation
d      = (d1^2)+(d2^2)+(d3^2)+(d4^2)+(d5^2)+(d6^2)+(d7^2)+(d8^2)+(d9^2)+(d10^2);
sigma  = sqrt(d/(n-1));        //standard devation
r      = 0.6745*sigma;        //probable error of one reading

//result
mprintf("arthimetic mean = %3.2f ",x);
mprintf("\nstandard deviation = %3.3f",sigma);
mprintf("\nprobable error of ne reading = %3.3f",r);
```

Scilab code Exa 3.23 `find mean and standard deviation and probable error and proba`

```
//

//chapter 3 example 23

clc;clear all;

//variable declaration
x1    = 41.7;       //voltage in V
x2    = 42;       //voltage in V
x3    = 41.8;       //voltage in V
x4    = 42;       //voltage in V
x5    = 42.1;       //voltage in V
x6    = 41.9;       //voltage in V
x7    = 42.5;       //voltage in V
x8    = 42;       //voltage in V
x9    = 41.9;       //voltage in V
x10    = 41.8;       //voltage in V
n      =10;

//ccalculations
```

```
x    =(x1+x2+x3+x4+x5+x6+x7+x8+x9+x10)/(10);      //arthimetic mean
d1    =x-x1;        //deviation
d2    =x-x2;        //deviation
d3    =x-x3;        //deviation
d4    =x-x4;        //deviation
d5    =x-x5;        //deviation
d6    =x-x6;        //deviation
d7    =x-x7;        //deviation
d8    =x-x8;        //deviation
d9    =x-x9;        //deviation
d10    =x-x10;        //deviation
d     = (d1**2)+(d2**2)+(d3**2)+(d4**2)+(d5**2)+(d6**2)+(d7**2)+(d8**2)+(d9**2)+(d10**2);
sigma   = sqrt(d/(n-1));        //standard devation
r       = 0.6745*sigma;        //probable error of one reading
rm      = r/(sqrt(n-1));      //probable error of mean in V
R       = x7-x1;          //range in V
//result
mprintf("arthimetic mean = %3.2f",x);
mprintf("\nstandard deviation = %3.3f",sigma);
mprintf("\nprobable error of one reading = %3.3f",r);
mprintf("\nprobable error of mean = %3.5f V',rm);
mprintf("\nRange = %3.2f V',R);
```

Scilab code Exa 3.24 determine arithmetic mean and average deviation and variance

```
//
//chapter 3 example 24
clc;clear all;
```

```
//variable declaration
x1   = 1.570;       //voltage in V
x2   = 1.597;       //voltage in V
x3   = 1.591;       //voltage in V
x4   =1.562;       //voltage in V
x5   =1.577;       //voltage in V
x6   = 1.580;       //voltage in V
x7   = 1.564;       //voltage in V
x8   = 1.586;       //voltage in V
x9   = 1.550;       //voltage in V
x10   = 1.575;       //voltage in V
n     =10;

//ccalculations
x   =(x1+x2+x3+x4+x5+x6+x7+x8+x9+x10)/(10);     //
    arthimetic mean
d1   =x1-x;       //deviation
d2   =x2-x;       //deviation
d3   =x3-x;       //deviation
d4   =x4-x;       //deviation
d5   =x5-x;       //deviation
d6   =x6-x;       //deviation
d7   =x7-x;       //deviation
d8   =x8-x;       //deviation
d9   =x9-x;       //deviation
d10   =x10-x;       //deviation
D     =(abs(d1)+abs(d2)+abs(d3)+abs(d4)+abs(d5)+abs(
   d6)+abs(d7)+abs(d8)+abs(d9)+abs(d10))/(n);
d     = ((d1^2)+(d2^2)+(d3^2)+(d4^2)+(d5^2)+(d6^2)+(
   d7^2)+(d8^2)+(d9^2)+(d10^2));
sigma  = sqrt(d/(n-1));       //standard devation
r      = 0.6745*sigma;       //probable error of one
     reading
v      = sigma^2;
rm     = r/(sqrt(n-1));      //probable error of mean
     in V

```

```
//result
mprintf("arthimetic mean = %3.3f",x);
mprintf("\naverage deviation = %3.3f gramme",D);
mprintf("\nstandard deviation = %3.5f gramme*2",
    sigma);
mprintf("\nprobable error of one reading = %3.5f
    gramme",r);
mprintf("\n variance= %3.3e gramme^2",v);
mprintf("\nprobable error of mean = %3.4f gramme",rm
    );
```

Chapter 4

Measuring system fundamentals

Scilab code Exa 4.1 `find the torque`

```
//

//chapter 4 example 1
clc;
clear all;


//variable decalartion
L     =0.4;               //length of the strip in m
W   = 0.0005;       //width of the strip in m
t     = 0.00008     //thickness in m
E    = 1.2*10^10;   //young's modulus  in kg/m**2
d   = 90;                       //deflection in degrees

//calucaltions
theta    = %pi/(2);         //deflection in radians
T        = ((E*W*(t^3))/(12*L*2))*(%pi);        //
```

```
    torque exerted in Kg-m

//result

mprintf("torque exerted  T = %3.2e Kg-m",T);
```

Scilab code Exa 4.2 determine deflection

```
//
    ==========================================================================

//chapter 4 example 2
clc;
clear all;


//variable decalartion
W       = 0.005;                //controlling weight
    in Kg
L       = 0.024;               //length in m
Td      = 1.05*10**-4;         //deflecting Torque in
    kg-m

//calculations
x       = Td/(W*L);
//Td = W*L*sin(theta)
theta   = asin(x);
theta1   =  (theta*180)/(%pi);

//result
mprintf("deflection = %3.0f   ",theta1);
```

Scilab code Exa 4.3 determine the suitable dimensions for spring

```
//==================================================================
//chapter 4 example 3

clc;
clear all;


//variable decalartion
Smax     = 3.0*10^6;      //maximum stress in kg/m**2
E        = 1.2*10^10;              //young's modulus in kg/m**2
w        = 0.0006;            //width of spring in m
Td       = 1.2*10^-4;         //deflecting torque in kg-m
d        = 90;                         //deflection in degrees

//calucaltions
theta = %pi/(2);          //deflection in radians
//since T        = ((E*W*(t*3))/(12*L))*theta
//t^3/l     = (12*Tc)/(E*W*theta)
Tc             = Td/(2);              //controlling torque of each spring in kg-m
//x   = t**3/l
x          = (12*Tc)/((E*w*theta));          //equqation 1
//y      =l/t
y    = (E*theta)/(2*Smax);            //equation 2
//by multiplying equations 1 and 2 (x*y =t**2 =z)
z     = x*y;
t     = sqrt(z);              //thickness of spring strip in mm
l    = y*t;                   //length on m

//result
mprintf("thickness of spring strip = %3.2f mm",(t
```

```
*10^3));
mprintf("\nlength in  = %3.2f m",l);
```

Scilab code Exa 4.4 determine the deflection

```
//
//chapter 4 example 4
clc;
clear all;

//variable declaration
theta1   = 90;        //deflection in
x              = 0.5;       //I2/I1

//calculations
//Td  proprtional to I
//theta   proprtional to I
theta2    = theta1*(x);      //deflection for the current equal to the half of the current in spring controlled instrument in
//Tc  proprtional to sin(theta)
//sin(theta) proprtional to I
y    = sin((%pi/(2)))
theta21     = asin(x*y);     //deflection for the current equal to the half of the current in gravity  controlled instrument in
theta22  =  (theta21*180)/(%pi);

//result
mprintf("deflection for the current equal to the half of the current in spring controlled instrument = %3.2f   ",theta2);
mprintf("\ndeflection for the current equal to the
```

```
half of the current in gravity controlled
instrument = %3.2f ",theta22);
```

Scilab code Exa 4.5 find the deflection when spring controlled and gravity control

```
//
//chapter 4 example 5
clc;
clear all;


//variable decelaration
theta1   = 90;        //deflection in
I1          = 10;
I2          =5;

//calculations
//Td  proprtional to I^2
//Theta   proprtional to I^2
theta2     = theta1*((I2/(I1))^2);                //
   deflection for I1 A  spring controlled instrument
    in
//Tc  proprtional to sin(theta)
//sin(theta) proprtional to I**2

x   =     (I2/((I1)))
theta21     = asin(x**2)*(sin(%pi/(2)));    //
   deflection for I1 A  Gravity  controlled
   instrument in
theta22  =  (theta21*180)/(%pi);

//result
mprintf("deflection for I1 A  spring controlled
```

```
instrument = %3.2f ",theta2);
mprintf("\ndeflection for I1 A Gravity controlled instrument = %3.1f ",theta22);
```

Scilab code Exa 4.6 determine the value of current when spring controlled and grav

```
//
//chapter 4 example 6

clc;
clear all;

//Variable declaration
I1      = 10;        //current in A
theta1  = 60;           //deflection in
theta2  = 40;           //deflection in


//calculations
I2     = (I1)*(theta2/(theta1));         //current in case spring controlled ammeter in A
x      = sin(((theta2*%pi)/(180)));
y      = sin((theta1*%pi)/(180));
I21     = (I1)*(x/y);        //current in case gravity controlled ammeter in A


//result
mprintf("current in case spring controlled ammeter = %3.2f A",I2);
mprintf("\ncurrent in case gravity controlled ammeter = %3.2f A",I21);
```

Scilab code Exa 4.7 find the deflecting torque

```
//
//chapter 4 example 7

clc;
clear all;


//variable declaration
Td     = 1.13*10^-3;       //defelecting torque in
    Nm
m      = 5*10^-3;                                          //
    weight in kg
g      = 9.81;          //gravity
theta   = 60;       //deflection in

//calculations
d      = Td/(m*g*sin(((theta*%pi)/(180))));      //
    distance of the controlling weight from spindle
    in mm

//result
mprintf("distance of the controlling weight from
    spindle = %3.1f mm",(d*10^3));
```

Chapter 5

Analog ammeters and voltmeters

Scilab code Exa 5.1 calculate the deflection

```
//
=====================================================================

//chapter 5 example 1

clc;clear all;

//variable declaration
K      = 24*10^-6;         //spring constant in Nm/
    radian
I       = 5;           //current in A

//calculations
//L      = 20+10*theta - 2*(theta^2)
//partial differentiate w.r.t to theta
//dL/dtheta = x = 10- 4*theta
//dL/dtheta = 2*K*theta/(I^2)
//x              = 10-4*theta
//y          = theta/x
```

```
y     = ((I^2)/(2*K))*10^-6;
theta  = (10*y)/(1+(4*y));        //defelction for
   current in radians
theta1  =  ((theta*180)/(%pi));

//result

mprintf("deflection = %3.1f    ',theta1);
```

Scilab code Exa 5.2 Determine the spring constant

```
//
   ==========================================================================

//chapter 5 example 2

clc;clear all;

//Variable declaration
I      = 5;           //current in A
d    = 30;                                   //
   deflection
I2     = 10;

//calculations
//L      = 10+5*theta - 2*(theta^2)        //
   inductancein uH
//partial differentiate w.r.t to theta
//dL/dtheta = x = 5- 4*theta
//dL/dtheta = 2*K*theta/(I^2)
//x              = 10-4*theta
theta  = %pi/(6);
K          = (((5-(4*theta))*10^-6)*(I^2))/(2*theta)
        //spring constant in Nm/radian
x          = ((2*K)/(I2^2))*10^6;
```

```
theta2   = (5)/(x+4);

//result

mprintf("spring constant = %3.4e Nm/radian",K);
mprintf("\ndeflection for 10 A current = %3.3f radian",theta2);
```

Scilab code Exa 5.3 find the reading of the voltmeter

```
//
//chapter 5 example 3
clc;
clear all;

//variable declaration
R    = 500;     //resistance in
r    = 2000;            //non inductive resistance in
V   = 250;       //voltage in V
f     = 50;             //frequency in Hz
L    = 1;          //inductance in H


//calculations
x       = (r+R)^2;
W     = (2*%pi*f*L)^2;
Z     =sqrt(x+W);       //impedance of the instrument circuit
I    = V/(Z);           //current drawn by instrument in A
I2   = V/(R+r);         //since voltmeter reads correctly on dc supply on 250 V,corresponding
```

```
    current in A
V1    = V*(I/(I2));                 //voltmeter reading
    when connected to 250V ,50Hz  supply

//result
mprintf("voltmeter reading = %3.1d V",V1);
```

Scilab code Exa 5.4 find the effect of the inductance of the meter

```
//
    ============================================================

//chapter 5 example 4
clc;clear all;

//variable declaration
Vac     = 500;    //voltage in V
Iac     = 0.1;        //current in A
f      = 50;          //frequency in Hz
L     = 0.8;              //inductance in H
Vdc    = 300;             //voltage in V
Z      =5000;

//calculations
W     = 2*(%pi)*f*L;
R        = (sqrt((Z^2)-(W^2)));   //resistance in
Idc    = Vdc/(R);              //instrument current in
    A
V      = (Vac/(Iac))*(Idc);       //Reading of
    instrument when connected to 300V in V

//result
mprintf("Reading of instrument when connected to 300
    V = %3.1f V",V);
```

Scilab code Exa 5.5 find the percentage error

```
//
    ===================================================

//chapter 5 example 5
clc;clear all;

//variable decalaration
Iac      = 0.1;                //current in A
f      = 50;                //frequency in Hz
L     = 0.8;            //inductance in H
Vac    = 300;      //voltage in V
V       = 200;         //true value in V

//calculations
XL   = 2*%pi*f*L;          //instrument reactance in
Z      = Vac/(Iac);        //instrument impedance in
R1     = sqrt((Z^2)-(XL^2)); //instrument resistance(
    R+r) in
Idc    = V/(R1);           //instrument current when
    connected to 200V dc supply
V1      = (Idc*Vac)/(Iac);       //reading of the
    instrument when connected to 200V dc supply
e     = ((V1-V)/(V))*100;

//result
mprintf("percentage error = %3.2f percentage",e);
```

Scilab code Exa 5.6 Find the value of capacitance

```
//
//Chapter 5 example 6

clc;clear all;

//variable declaration
R       = 50;                 //resistance of the magnetic coil in
Rt     = 500;                 //resistance in
L       = 0.09;               //inductance of the voltmeter in H
f       = 50;
I       = 1;


//calculations
r        = Rt-R;             //swamping resistance in
X       = (2*%pi*f*r)^2;
Y        = L*X;
Y1          = I*L;
//L            = C*r^2/(I+w^2*C^2*r^2)
//C*r^2        = L*I+L*w^2*C^2*r^2
//C*r^2      =y1+x*(C^2)
//x*(C^2)-C*r^2+y1;
a    = X;
b       = -r^2;
c        = Y1;
x        = (-b-sqrt((b^2)-(4*a*c)))/(2*a);  //we consider the positive value



//result
mprintf("swamping resistance = %3.2e",x);
```

Scilab code Exa 5.7 find the capacitance

```
//
//chapter 5 example 7
clc;clear all;

//variable declaration
R       = 50;              //resistance of the magnetic coil in
Rt     = 500;          //resistance in
L       = 0.09;            //inductance of the voltmeter in H

//calculations
r       =Rt-R;
C       = (L/(r^2));                 //capacitance to be placed in u F

//result
mprintf("capacitance to be placed  to make the instrument read correctly bot dc as well as ac = %3.3fe uF",(C*10^6));
```

Scilab code Exa 5.8 estimate the rate of change of self deflection

```
//
//chapter 5 example 8
clc;clear all;
```

```

//variable decalaration
Td       = 4*10^-5;       //full-scale defelcting
    torque in N-m
I          = 10;               //full-scale current in
    A

//calculations
//Td      = (1/2)*(I^2)*(dL/dtheta);
//dL/dtheta   = x
x       = (2*Td)/(I^2);

//result
mprintf('rate of change of selfinductance = %3.1f uH
    /rad",(x*10^6));
```

Scilab code Exa 5.9 determine the current passing in a moving iron instrument

```
//
    ================================================================

//chapter 5 example 9
clc;clear all;

//variable declaration
//dL/dtheta   = x
y      = 2.3*10^-6;
Td1     = 5*10**-7;
t        = 52;

//calculations
x      = y*(180/%pi);
Td      = Td1*t;
//Td      = (1/2)*(I**2)*(dL/dtheta);
I             = sqrt((Td*2)/(x));      //current in A
```

```
//result
mprintf("current = %3.2f A",I);
```

Scilab code Exa 5.10 calculate the percentage increase of resistance

```
//

//chapter 5 example 10

clc;clear all;

//variable declaration
R       = 400;        //resistance in
V     = 150;      //voltmeter reading in V
I       = 0.05;       //current in A
alphac    = 0.004;  //temperature coefficient of
   copper
alphas    = 0.00001;    //temperature coefficient of
    eureka
f           = 100;       //frequency in Hz
L         = 0.75;     //inductance in H


//calculations
//R1    = R+r;
R1      = V/(I);      //total reistance in
r         = R1-R;         //swamping resistancein
R11    = (R*(1+alphac))+(r*(1+alphas));      //total
   resistance for 1  C  rise in temperature in
e        = ((R11-R1)/(R1))*100;          //percentage
    rise in resistance per degree rise in
   temperature
W     = 2*%pi*f*L;                     //inductive
```

```
   reactance in
Z       = sqrt((R1^2)+(W^2));        //impedance in

v       = V*(R1/(Z));        //reading indicated on
   100 Hz in V


//result
mprintf("R1 =%3.0f",W);
mprintf("percentage rise in resistance per degree
   rise in  temperature = %3.4f percentage",e);
mprintf("\nreading indicated on 100 Hz= %3.1f V",v);
```

Scilab code Exa 5.11 find the deflection

```
//

//chapter 5 example 11
clc;clear all;

//variable declaration
V      = 300;        //voltage in V
R      = 12000;  //coil resistance in
B      = 6*10^-2;     //flux density in Wb/m**2
l        = 0.04; //length in m
r       = 0.03;       //width in m
N     = 100;
Tc     = 25*10^-7;        //torque in Nm per degree

//calculations
i     = V/(R);        //current in A
Td    = N*B*i*l*r;        //deflecting Torque in Nm
//Tc=Td;
//Tc =(25*10^-7)*theta
```

```
theta = Td/(Tc);          //defelction in

//result
mprintf('defelction = %3.0f    ",theta);
```

Scilab code Exa 5.12 determine the control constant of spring

```
//

//chapter 5 example 12
clc;clear all;

//variable declaration
V      = 0.1;             //voltage in V
R      = 200;             //coil resistance in
B      = 0.2;             //flux density in Wb/m^2
l        = 0.03;          //length in m
r       = 0.025;          //width in m
N     = 100;
Tc     = 25*10^-7;    //torque in Nm per degree
theta = 100;              //deflaction in
p           = 1.7*10^-8;  //specific resistance of
   coil in  -m
d        = 30;
d1        = 25;


//calculations
i     = V/(R);                  //current in A
Td    = N*B*i*l*r;              //deflecting Torque
   in Nm
K     = Td/(theta);             //control constant
   of spring in N-m
l      = (d+d1)*2*100*10^-3;     //length of copper
```

```
    coil in m
R1      = (R*20)/(100);
a      = (p*l)/(R1);          //area of x-section of
    copper wire inm^2
D      = sqrt((4*a)/(%pi));          //diameter of
    wire in mm

//result

mprintf("diameter fo wire = %3.3f mm",(D*10^3));
```

Scilab code Exa 5.13 calculate the value of current in the wire

```
//
    ====================================================================

//chapter 5 example 13

clc;clear all;

//variable declaration
V1   = 50*10^-3;           //voltage in V
I1    = 5;                 //current in A
I2   = 10;                 //current  in A
v1     =4;
v2     =4.2;

//calculations
//v1      = (r+R1)*I1
//v1      = (r+R1)*I2
//since potential difference is same in both cases
//v1= v2
R1     = V1/(I1);
R2     = V1/(I2);
r       = ((v2*R2)-(v1*R1))/(v1-v2);
```

```
v       = (r+R1)*v1;          //potential difference
    in V
I        = v/(r);             //current when neither
    meter in the circuit in A

//result
mprintf("current when neither meter in the circuit =
     %3.2f A",I);
```

Scilab code Exa 5.14 Finding the minimum resistance

```
//
    ================================================

//chapter 5 example 14
clc;clear all;

//variable declaration
V       =   250;      //voltage in V
RA     = 100;              //resistance in
RB     = 400;              //resistance in
x      = 0.005;          //error in measuring voltage
    in


//calculations
I      = V/(RA+RB);      //current flowing through
    resistance in A
VB     = I*RB;                //potential drop acreoss
    resitance in V
//Req    = RA+((r*RB)/(r+RB))
//Ieq     =V/Req   = V/ RA+((r*RB)/(r+RB))
//Ieq    = (V*(r+RB))/((RA*(r+RB))+(r*RB))
//V1 = Ieq*(r*RB)/(r+RB)
// V1  = (V*(r+RB))*(r*RB))/((r+RB)*((RA*(r+RB))+(r*
```

```
RB)))
//V1    = (V*r*RB)/((r+RB)*((RA*(r+RB))+(r*RB)))
//V1    = (200*r)/(80+r)
V1    = VB*(1-x);      //voltage measured with 0.5% error
r      = (V1*80)/(200-V1);        //solving equations we get minimum resistance in

//result
mprintf("minimum resistance = %3.2f    ",r);
```

Scilab code Exa 5.15 Find the total inductance

```
//
2 //chapter 5 example 15
clc;clear all;

//variable decalartaion
C      = 1*10**-7;            //spring torsion constant in N-m/degree
I       = 10;               //current in A
theta    = 110;                //full-deflection in
L1         = 2*10**-6;        //initial inductance in uH

//calculations
Td         =C*theta;              //full-scale deflceting torque in N-m
//dM/dtheta   =x
x   = Td/(I^2);
theta1   = ((theta*%pi)/(180));    //converstion of radians to degrees
dM      = x*theta1;           //change in inductance
```

```
    in uH
M       = L1+dM;          //total inductance in uH

//result

mprintf("total inductance = %3.3f uH",(M*10^6));
```

Scilab code Exa 5.16 Find the difference in the readings

```
//

//chapter 5 example 16

clc;clear all;

//variable declaration
theta      = 90;          //full-deflection in
Td         = 0.4*10^-4;           //full-scale deflecting torque in Nm
I          = 0.05;        //current in A
M          = 0.25;            //initial inductance in H
V          = 50;          //voltage in V
I          = 0.05;            //current in A
f          =50;           //frequency in Hz
V2         = 25;
R         = 1000;


//calculations
//dM/dtheta = x
x      = (Td/(I^2));         //change in inductance in H
dM      = (Td/(I^2))*((theta*%pi)/(180));
```

```
//change in inductance in H
M1      = M+dM;           //total mutual inductance in H
R        = V/(I);            //the resistance of voltmeter in
Z        =sqrt((R**2)+((2*%pi*f*M1)**2));        //toatal impedance in
V1      = (V/(Z))*R;          //voltmeter reading in V
d        = V-V1;          //difference in reading in V
I1        = V2/(R);           //current through instrument in A
theta1     = ((theta*%pi)/(180))*((I1/(I))^2);          //defelction
M2      = M+(x*theta1);           //total mutual inductance in H
Z1     = sqrt((R**2)+((2*%pi*f*M2)**2));         //toatal impedance in
V21      = (V2*R)/(Z1);           //voltmeter reading in V
d1        = V2-V21;           //difference in voltmeter reading in V

//result
mprintf("impedancewhile measuring the voltage = %3.3f    ",Z1);
mprintf("\ndifference in reading = %3.1f V",d);
mprintf("\ndifference in reading  when 25v is used = %3.2f V",d1);
```

Scilab code Exa 5.17 Determine the range of the instrument and current and deflect

```
//
```

```
//chapter 5 example 17
clc;
clear all;

//variable declaration
theta1 =  90;        //defelction in
theta2 =  360;           //defelction in
theta3 =  180;               //defelction in
I1          = 30;            //current in A
I4          = 25;            //current in A

//T is proportional to I**2
//T is proportional to theta
//theta is proportional to math.sqrt (I)
//calculations
I2  = I1*sqrt((theta2/(theta1)));       //current
   corresponding to deflection of 360
I3  = I1*sqrt((theta3/(theta1)));       //current
   corresponding to deflection of 180
theta4  = theta1*((I4/I1)^2);       //defelction
   corresponding tocurrent  of 25 A

//result
mprintf("current corresponding to deflection of 360
      = %3.2f A",I2);
mprintf("\ncurrent corresponding to deflection of
   180    = %3.2f A",I3);
mprintf("\ndefelction  corresponding tocurrent  of
   25 A = %3.2f   ",theta4);
```

Scilab code Exa 5.18 Calculate the reading of an electro dynanometer

```
//
```

```
//Chapter 5 example 18

clc;
clear all;

//variable declaration
p        = 80;
q        = 60

//i      = 80-60*sqrt(2)*sin(theta+%pi/6)
//i^2         = x = (80)^2)-((2*80*60*sqrt*sin(theta+(%pi/6))0^2)+((80^2)*(sin(theta+(%pi/6))^2))
//x    =a-b*(sin(theta+(%pi/6))^2)+(c)*(sin(theta+(%pi/6))^2)
//x = (80)^2)-((2*80*60*sqrt*sin(theta+(%pi/6))0^2)+(((80^2)/2)*(1-(cos(theta+(%pi/6))^2))
//x      = a-(b*sin(theta+(%pi/6)))+(c/2)-cos(theta+((pi/6)^2))
 a       = p^2;
 b       =(2*(q^2)*(sqrt(2)));
 c       = (q*sqrt(2))^2;
 //x     = (1/2*%pi)*{(integral(x*dtheta))}(0-2*%pi)
 //applying integration
 y       =(a+(c/2));
 x       = (1/%pi)*y*(%pi);           //Irms^2
 Irms    =sqrt(x);        //reading in A


 //result
 mprintf("electrodynamometer instrument indicates the rms value of the current therefore the dreading will be equla ")
 mprintf("Irms  = %3.2f A",Irms);
```

Scilab code Exa 5.19 `Find the magnification`

```
//
//chapter 5 example 19
clc;
clear all;

//variable declaration
L       = 150;        //length of working wire  at room temperature in mm
alpha   = 16*10^-6;      //coefficient of linear expansion
T           = 85;          //temperature in     C
Si      =1;           //initial sag in mm
//calculations
dL      = alpha*L*T;      //increase in length of the wire when gets heated through 85    C in mm
M      = sqrt(L/(2*dL));      //magnification with no intial sag
S       = sqrt((L*dL)/(2));   //Sag in mm
Sn     = S-Si;            //net increase in Sag in mm
M1    = Sn/(dL);          //magnification with initial Sag of 1 mm

//result
mprintf("magnification with no intial sag  = %3.2f",M);
mprintf("\nSag = %3.2f mm",S);
mprintf("\nnet increase in Sag =%3.2f mm",Sn);
mprintf("\nmagnification with initial Sag of 1 mm = %3.2f",M1);
```

Scilab code Exa 5.20 `Determine the magnification`

```
//
```

```
//==========================================================================
//chapter 5 example 20
clc;
clear all;

//variable declaration
L   = 170;        //length of the wire in mm
dL      = 0.2;    //increase in length in mm
L1     =100;      //length of the  second wire in mm

//calculations
S        = sqrt((L*dL)/(2));              //Sag in mm
S1        = sqrt((L1*S)/(2));        //Sag in mm
M       = S1/(dL);             //magnification

//result
mprintf("magnification = %3.1f",M);
```

Scilab code Exa 5.21 Determine the current

```
//
//==========================================================================
//Chapter 5 example 21

clc;
clear all;

//variable declaration
I        = 10;             //current in A
//e       = (alpha*(dt))+(b(dt^2))= alpha*dt
//dt   = (K1*(I^2)*R)
//theta = K2*e
//theta      = K2*e   = K2*K1*alpha*dt    = K2*K1*alpha
```

```
    *(I^2)*R
//thetaF      = K3*(I^2)
//K3          = (thetaF)/(I^2);
x             = 1/(I^2);
mprintf("K3      = %3.2f *thetaf",x);
//K3          =thetaF*x
mprintf("\ntheta      = theatF/3");
//I           = sqrt((thetaF/3)*((K3)))
//I           = sqrt((thetaF/3)/K3)
I          =sqrt((1/3)*((1/x)))


//result
mprintf("\ncurrent = %3.2f A",I);
```

Scilab code Exa 5.22 Determine the form factor of the current wire

```
//

//chapter 5 example 22

clc;
clear all;

//variable declaration
 Irms              = 32;        //measured reading reading in A
 Ir           = 30;             //rectifier ammeter reading in A
Ks            = 1.11;      //form factor for sinusoidal wave

//calculations
Iav      = Ir/(Ks);       //average value of current
```

```
under measurement in A
e            = ((Irms)/(Iav));        //percentage errror in %

//result

mprintf("form factor = %3.3f ",e);
```

Scilab code Exa 5.23 Estimate the peak and rms values of current and calculate the

```
//

//chapter 5 example 23
clc;
clear all;

//variable declaration
 Ir             = 2.22;        //measured reading reading in A
Ks             = 1.11;      //form factor for sinusoidal wave

//calculations
Iav      = Ir/(Ks);       //average value of current under measurement in A
Imax     = 2*Iav;         //peak value of current in A
Irms     = Imax/(sqrt(3));       //RMS value of current in
e            = ((Ir-Irms)/(Irms))*100;        //percentage errror in %

//result
mprintf("peak value of current = %3.2f A",Imax);
mprintf("\nRMS value of current = %3.3f A",Irms);
```

```
mprintf("\npercentage error = %3.2f percentage(low)"
    ,e);
```

Scilab code Exa 5.24 Determine the capacitance

```
//

//chapter 5 example 24

clc;clear all;

//variable declaration
Iav     = 40*10^-3;        //average value of current
    in mA
Ks      = 1.11;  //assuming form factor for
    sinusoidal wave
f         = 50;        //frequency in Hz
V        = 10^5; //voltage in V

//calculations
Irms     = Iav*Ks;         //RMS value of current in A
//Irms    = V/Xc = 2*%pi*f*C*V
C              = Irms/(2*%pi*f*V);     //capacitance to
     be connected in pF

//result

mprintf("capacitance to be connected = %3.0f pF",(C
    *10^12));
```

Scilab code Exa 5.25 determine the reading of moving coil ammeter and moving iron

```
//
    ========================================================================

//chapter 5 example 25

clc;clear all;

//variable declaration
Emax     = 200;       //emf of peak value in V
R              = 10;       //resistance in

//calculations
Imax      = Emax/(R);         //peak value of current
    in A
Iav           = (2*Imax)/(%pi);    //reading of moving
   -coil ammeter in A
Irms     = Imax/(sqrt(2));         //reading of moving
   -iron  ammeter in A

//result
mprintf("reading of moving -coil ammeter = %3.2f A",
    Iav);
mprintf("\nreading of moving -iron  ammeter = %3.2f
   A",Irms);
mprintf("\nreading of hot-wire ammeter = %3.2f A",
    Irms);
```

Scilab code Exa 5.26 `find the reading on hot wire and moving coil in the circuit`

```
//
    ================================================================

//Chapter 5 example 26

clc;
```

```
clear all;

//variable declaration
Vmax          = 100;          //maximum value of applied voltage in V
R             = 2;            //resistance in


//calculations
Imax          = Vmax/R;            //maximum value of current flowing through instruments in A
mprintf("x  = (Imax^2)*((sin(theta))^2)");
//Irms        = sqrt((1/2*%pi)*{(integral(x*dtheta))}(0-%pi))
Irms          = sqrt(((Imax^2)/(2*%pi))*((%pi/2)));
mprintf("\n y  = (Imax*sin(theta))");
//Iav           = sqrt((1/2*%pi)*{(integral(y*dtheta))}(0-%pi)
Iav           = Imax/%pi;


//result
mprintf("\nthe hot-wire ammeter reads rms value = %3.2f A",Irms);
mprintf("\nmoving coil ammeter reads average value = %3.2f A",Iav);
```

Scilab code Exa 5.27 Determine the reading of the ammeter

```
//===========================================================================
//Chapter 5 example 27

clc;
```

```
clear all;


//variable declaration
//V    = (5*sin(theta))+(0.6*sin(3*theta))\

a        = 5;
b        = 0.6;
rd            = 35;        //resistance in
ra            = 30;        //resistance in

//calculations
R        = (3*rd)+ra;              //resitance in
//i        = v/R
//i           = (5*sin(theta)/R)+(0.6*(sin(3*theta)/R))
x1            = a/R;
y1            =b/R;
//i           = (x1*sin(theta))+(y1*sin(3*theta))
//Iav         = ((1/%pi)*{(integral(i*dtheta))}(0-%pi))
//Iav         = (1/%pi)*((0.5*sin(theta))-(0.006/3)*(cos(3*theta)))
//solving above equation we get (1/%pi)*(1)
p             = (-0.05*((cos((180*%pi/180))-cos(0))))-((0.002*((cos(3*180*%pi/180))-cos(3*0))));
z        = (1/%pi)*p;              //average value in mA


//result
mprintf("average value reading of PMMC ammeter = %3.1f mA",(z*10^3));
```

Scilab code Exa 5.28 Calculate the power dissipated in the rectifying device

```
//==========================================================================
//Chapter 5 example 28

clc;
clear all;


//variable declaration
V            = 230;          //RMS value of voltage applied in volts
r1           = 115;        //resistance in
r2           = 115;        //resistance in
r3           = 575;        //resistance in



//calculations
Vmax       =230*sqrt(2);
R1       =r1+r2;              //resiatance in one directions in
R2       =r2+r3;              //resiatance in other directions in
Imax1        = Vmax/R1;            //current(maximum value) in one direction in A
Imax2        = Vmax/R2;            //current(maximum value) in other direction in A
//Iav        = Iav1-Iav2
//x          = (Imax1*sin(theta))
//Iav        = ((1/2*%pi)*{(integral(x*dtheta))}(0-%pi)))
//y          = (Imax2*sin(theta))
//Iav        = ((1/2*%pi)*{(integral(y*dtheta))}(0-%pi)))
z1           =-((cos(180*%pi/180))-cos(0))
z2           = -((cos(180*%pi/180))-cos(0))
A          = ((Imax1*z1)-(Imax2*z2));
```

```
Iav       = A/(2*%pi);
//x1             = (Imax1*sin(theta))^2
//I1           = ((1/2*%pi)*{(integral(x1*dtheta))}(0-%pi)))
//y1             = (Imax2*sin(theta))^2
//I2           = ((1/2*%pi)*({(integral((1-cos(2*theta))/2*dtheta))}(0-%pi)))-{(integral((1-cos(2*theta))/2*dtheta))}(0-%pi)))
//Irms= I1+I2
//Irms    = ((1/2*%pi)*{(integral(y1*dtheta))}(0-%pi)))
Z1            =-((cos(2*180*%pi/180))-cos(180*%pi/180));
Z2            = -((cos(2*180*%pi/180))-cos(180*%pi/180));
Irms1         = (((Imax1^2)/(2*2*%pi))*(%pi-0))+(((Imax2^2)/(2*2*%pi))*(%pi-0))-Z1+Z2
Irms          =sqrt(Irms1);
P             = (1/2)*(((V^2)/R1)+((V^2)/R2));
Irms11        =   1;
Irms22        = 1/3;
Pd            = (((Irms11^2)*r2)+((Irms22^2)*r3))/2;


//result
mprintf("Iav    = %3.2f A",Irms1);
mprintf("\npower taken from the mains = %3.2f",P);
mprintf("\npower dissipated in rectifying device =%3.2f W",Pd);
```

Scilab code Exa 5.29 Determine the value of v

```
//
```

```
//Chapter 5 example 29

clc;
clear all;


//variable declaration
V1      = 1000;          //potential of vane in volts

//calculations
//v      = VA-VB
mprintf("theta 10 S D");
mprintf("\ntheta praportional to Tt praportional to 2*V1*V")
mprintf("\n10 praportional to 2 praportional to 1000");
mprintf("\ndividing above expressions ")
v       = (10/25)*(2500/2000);

//result
mprintf("v       = %3.2f volt",v);
```

Scilab code Exa 5.30 Find the potential difference

```
//==========================================================================

//chapter 5 example 30

clc;clear all;

//variable declaration
d      = 0.08;        //diameter in m
D      = 0.004;   //distance between plates in m
F       = 0.002; //force in Newton
```

```
//calculations
e0   = 8.85*10^-12; //permittivity in N
A      = (%pi/4)*(d^2);      //area of the plates in m**2
x      = (F*2*(D^2))/(e0*A);
V =       sqrt(x);             //potential diference in V

//result
mprintf("potential diference = %3.1f V",V);
mprintf("\nNote:final answer in textbook is wrong printed")
```

Scilab code Exa 5.31 Find the change in capacitance

```
//

//chapter 5 example 31

clc;
clear all;

//variable declaration
d      = 0.1;          //diameter in m
F       = 0.005; //force in Newton
V      = 10000;  //potential diference in V
e0   = 8.85*10^-12; //permittivity in N
d2      = 26.4*10^-3;   //distance between plates in mm
d1      = 25.4*10^-3;   //distance between plates in mm

//calculations
```

```
A       = (%pi/4)*(d^2);        //area of the plates in
    m**2
x       = sqrt((e0*A)/(2*F));
d2       = x*V;                 //distance between
    plates in mm
//C       = e0*A/d
x1      = 1/d1;
x2      = 1/d2;
C        = e0*A*(x1-x2);        //change in capacitance
    in uF

//result
mprintf("change in capacitance due to change in
    distance between plates from 26.4 to 25.4 mm = %3
    .2f  u uF",(C*10^12));
```

Scilab code Exa 5.32 Finding the capcaitance

```
//
    ================================================================

//chapter 5 example 32

clc;
clear all;

//variable declaration
K        = 0.0981*10^-6;
theta       = 80;               //full scale of
    deflection in
V             = 1000;           //voltage in V
C             = 10*10^-12;              //capacitance in
     F

```

```
//calculations
//x      =dC/dtheta = (2*K*theta)/V^2
x        = (2*K*theta)/V^2;           //rate of change
    of capacitance
dC       = x*(theta/180)*%pi;
C1       = C+dC;

//result
mprintf("capacitance when reading 1kV = %3.3e F",C1)
   ;
```

Scilab code Exa 5.33 Determine the pd for different deflections

```
//
   ===================================================================

//chapter 5 example 33

clc;
clear all;

//variable declaration
//x = dC/d(theta)
//Td         = (1/2)*(V^2)*(dC/d(theta))
x        = 0.5*10^-12;                //dC/d(theta) in
   pF/degree
y        = 1.5*10^-12;                //dC/d(theta) in
   pF/degree
T        = 8*10^-6;            //torison constant in Nm
N1        =100;
N2        =35;

//calculations
x1       = x*(180/%pi);              //dC/d(theta) in
   pF/radian
```

```
y1        = y*(180/%pi);              //dC/d(theta) in pF/radian
//Td          = Tc = T*N*(%pi/180)
Td            = T*N1*(%pi/180);            //deflecting torque in N-m
V1             = sqrt((2*Td)/x1);          //voltage required in V
Td1            = T*N2*(%pi/180);            //deflecting torque in N-m
V2             = sqrt((2*Td1)/y1);          //voltage required in V

//result
mprintf("voltage deflection at 100 = %3.0f V",V1);
mprintf("\nvoltage deflection at 100 = %3.0f V",V2);
```

Scilab code Exa 5.34 Determine the pd for required to pull the plate three quarter

```
//==========================================================================

//chapter 5 example 34

clc;
clear all;

//variable declaration
e0            =8.854*10^-12;
d             =0.05;
er            = 1;
a             = 0.25;
V1             = 12000;             //voltage in V
V2             = 32000;             //voltage in V


```

```
//calculations
//x−x0        = (1/2)*((V^2)/k)*(dc/dx)
//C       =(2*e0*er*A)/d
//dC      =(2*e0*er*a*x)/d
// y = dC/dx = (2*e0*er*a)/d
y         = (2*e0*er*a)/d;
X1         = 0.25/4;
// A =x1+x01        = (1/2)*((V1^2)/k)*(dc/dx)
X2         = 0.25/2;
//B = x2+x01        = (1/2)*((V2^2)/k)*(dc/dx)
//C     = B/A    =(V2/V1)^2
C         =   (V2/V1)^2;
x01        = (X2-(C*X1))/(1-C);
k            = ((1/2)*((V1^2))*(y))/(X1-x01);
X3        = (3/4)*0.25;
V         = sqrt(((X3-x01)*2*k)/y);            //
   voltage in V

//result
mprintf("voltage required to pull the plate three
   quarte way in = %3.3f KV",(V*10^-3));
```

Scilab code Exa 5.35 Calculate the spring constant

```
//
   ==================================================

//chapter 5 example 35

clc;
clear all;

//variable declaration
e            = 8.85*10^-12;
V            = 10000;             //voltage in V
```

```
r             = 40*10^-3;          //radius in m

//calcaulations
d        = (4/2)*10^-3;            //voltage in V
theta         = (100)*(%pi/180);
k            = (2.5*e*(r^2)*(V^2))/(d*theta);

//result
mprintf("spring constant = %3.3e Nm per radian",k);
```

Scilab code Exa 5.36 Determine the deflection of the instrument

```
//
    ========================================================================

//chapter 5 example 36

clc;
clear all;

//variable declaration
theta1        = 105;       //deflection in
I1            = 20;        //current in A
I2            = 20;        //current in A
f1            = 50;        //frequency in Hz
f2            = 75;        //frequency in Hz


//calculations
theta         = (theta1)*((I2/I1)^2)*(f2/f1);

//result
mprintf("deflection of the instrument while
   measuring  20 A = %3.1f    ",theta);
```

Scilab code Exa 5.37 Determine the voltage

```
//
//chapter 5 example 37
clc;
clear all;

//variable declaration
V1          = 240;      //voltage in V
theta1          = 300;          // defelection in
theta2          = 180;          // defelection in

//calculations
//T praportional to V^2/Z)*(f*cos(alpha)*(sin(beta)))
//T praportional V^2
//theta praportional to V^2
V2          = V1*sqrt(theta2/theta1);

//result
mprintf("voltage for deflection of 180   =%3.0f   ",V2);
```

Chapter 6

Extensions of instrument range

Scilab code Exa 6.1 Finding the value of shunt resistance

```
//
    ================================================================
//chapter 6 example 1

clc;
clear all;

//variable declaration
Im    = 50*10^-6;                  //full scale
   deflection current in A
Rm    = 1000;                //instrument resistance in

I     = 1;                         //total current to be
   measured in A

//calculations
Rs    = (Rm/((I/(Im))-1));         //resistance of
   ammeter in


```

```
//result
mprintf("resistance of ammeter shunt required Rs =
   %3.7f   ",Rs);
```

Scilab code Exa 6.2 Find the current range of instrument and the value of resistan

```
//

//chapter 6 example 2
clc;clear all;

//variable declaration
Rm     = 1;                                                  //
   instrument resistance in
Rse    = 4999;
   //series resistance in
V      = 250;                                               //full
   -scale deflection voltage in V
Rs     = 4999;                   //Shunt resistance in
     (Rs =1/(499))
I1     = 50;                                                 //
   full-scale defelction current in A

//calculations
Rs1    = 1/(Rs);
Im     = V/(Rm+Rse);                    //full-scale
   deflection current in A
I      = Im*(1+(Rm/Rs1));              //current in A
N      = I1/(Im);
Rsh    = Rm/(N-1);                          //shunt
   resistance in
```

```
mprintf("full-scale defelction current in Im = %3.2f A",Im);
mprintf("\ncurrent range of instrument when used as an ammeter with coil connected across shunt is I = %3.2f A",I);
mprintf("\nShunt resistance for the instrument to give a full-scale deflection of 50A is Rsh = %3.4f ",Rsh);
```

Scilab code Exa 6.3 Find the shunt resistance required

```
//

//result
```

```
//
//chapter 6 example 3

clc;clear all;

//variable declaration
Rm    = 10;                                   //instrument resistance in
Im    = 0.05;                    //full scale defelection current in A
I     =100;                                //current to be measured in A
V     = 750;                                  //voltage to be measured in V

//calculations
R     = (V/(Im))-Rm; //series resistance in
N     = I/(Im);                        //power
```

```
    of shunt
Rs    = Rm/(N-1);              //resistance in



//result
mprintf("resistance to be connected in series to enable the instrument to measure current upto 1A is %3.5f   ",R);
mprintf("\nshunt resistance required for full-scale defelction with 10v is %3.4f   ",Rs);
```

Scilab code Exa 6.4 Calculate the resistance parallel and series

```
//
    =================================================================
//chapter 6 example 4
clc;clear all;

//variable declaration
Rm    = 5;                                          //instrument resistance in
Im    = 15*10^-3;                                   //full scale defelection current in A
I     =1;                                           //current to be measured in A
V     = 10;                                         //voltage to be measured in V

//calculations
N     = I/(Im);                                     //power of shunt
```

```
Rs    = Rm/(N-1);              //resistance in
R     = (V/(Im))-Rm; //series resistance in


//result
mprintf("resistance to be connected in parallel to
   enable the instrument to measure current upto 1A
   is %3.5f   ",Rs);
mprintf("\nshunt resistance required for full-scale
   defelction with 10v is %3.4f   ",R);
```

Scilab code Exa 6.5 Finding the current range of instrument

```
//
   ===========================================

//chapter 6 example 5
clc;clear all;

//variable declaration
Rm   = 2;                                              //
   instrument coil resistance in
V    = 250;                                            //
   full-scale reading in V
Rs   = 5000;                                           //
   series resistance in
Rsh = 2*10^-3;                                         //
   shunt resistance in


//calculations
```

```
Im    = V/((Rm+Rs));
   //current flowing through the instrument for full
   -scale deflection in A
Is    = (Im*Rm)/(Rsh);              //current through
   shunt resistance in A
I     = Im+Is;
                                                   //
   current range of instrument in A

//result
mprintf("current flowing through the instrument for
   full-scale deflection is %3.5fA",Im);
mprintf("\ncurrent through shunt resistance is %3.2f
    A",Is);
mprintf("\ncurrent range of instrumentis %3.1f A",I)
   ;
```

Scilab code Exa 6.6 Finding the shunt current and the value of R

```
//
   ===========================================================

//chapter 6 example 6
clc;clear all;

//variable declaration
Rsh   = 0.02;                          //shunt
   resistance in
V     = 0.5;                               //potential
    difference across the shunt in V
Rm    = 1000;                          //resistance in

I1    = 10;                                 //current
   in A
I2    = 75;                                 //current
```

```
in A
I     =  100;              //current in A
x   = 40;            //deflection %

//calculations
Is     = V/(Rs);                                //current through shunt in A
Im     = V/(Rm);                             //current through ammeter for full-scale defelction in A
V1     = I1*Rsh;         //voltage across shunt for 10A in V
R1     = V1/(Im);               //resistance for the ammeter for a current of 10 A for full-scale defelction in
V2     = I2*Rsh;         //voltage across shunt for 75A in V
R2     = V2/(Im);               //resistance for the ammeter for a current of 75 A for full-scale defelction in
I3      = I*(100/(x));              //full-scale defelction current when 100 A gives 40% defelction
V3     = I3*Rsh;         //voltage across shunt for  250 A in V
R3     = V3/(Im);               //resistance for the ammeter for a current of 250 A for full-scale defelction in


//result
mprintf("current through ammeter for full-scale defelction is %3.2f mA",(Im*10^3));
mprintf("\nResistance for the ammeter for a current of 10 A for full-scale defelction is %3.2f  ",R1);
mprintf("\nResistance for the ammeter for a current of 75 A for full-scale defelction is %3.2f  ",R2);
```

```
mprintf("\nResistance for the ammeter for a current of 250 A for full-scale defelction is %3.2f   ",R3);
```

Scilab code Exa 6.7 Finding the resistance that must put in series

```
//

//chapter 6 example 7

clc;clear all;

//variable declaration
B          = 0.5;           //flux density of the magnetic field in Wb/m**2
N          = 100;           //number of turns in coil
l           = 0.04;              //length in m
r           =0.03;               //width in m
Tc        = 120*10^-6;              //controlling torque in N-m
v         = 1;          //volts per division in V
n         = 100;            //number of division on full-scale
Rm   = 0;

//calculations
x      =B*N*l*r;
I      = Tc/(x);      //current for full-scale deflection in A
V      = n*v;               //full-scale reading of instrument in V
R      = (V/(I))-(Rm);              //External resistance required to be put in series with the coil in
```

```

//result
mprintf("current for full-scale deflection is %3.3f A",I);
mprintf("\nExternal resistance required to be put in series with the coil is %3.2f ",R);
```

Scilab code Exa 6.8 `Calculate the error`

```
//
//chapter 6 example 8
clc;clear all;


//variable decalaration
Rm       = 5;        //coil resistance in
Rm1        = 0.00075;         //coil resistance in
Im         = 0.015;       //full-scale defelction current in A
I             = 100;       //current to be measured in A
T1         =  0.004;      //temperature coeficient of copper in  /  / C
T2         =  0.00015;         //temperature coeficient of manganin in  /  / C
T           =10;          //rise in temperature in  C

//calculations
N        = I/(Im);         //multiplying power of shunt
Rs      = Rm/(N-1);  //resistance of manganin shunt in
Rc      = Rm*(1+(T1*T)); //coil resitance with 10 C in temperature in
```

```
Rsh     = Rm1*(1+(T2*T));     //shunt resitance with 10 C  in temperature in
In       = (Rsh/((Rc+Rsh)))*100; //new instrument current in A
r         = (In/(Im))*100;        //new instrument reading in A
e        = ((r-I)/(I))*100;       //percentage error in %


//result
mprintf('percentage error %3.3f percentage",e);
```

Scilab code Exa 6.9 Calculate the error

```
//

//chapter 6 example 9
clc;clear all;

//variable declaration
Rm     = 25;                  //instrument resistance in
V      = 25*10^-3;         //full-scale deflection voltage in V
V1     = 10;                 //voltage to be measured in V
t      = 10;
alphac  = 0.004;
alpham  = 0.00015;

//calculations
Im     = V/(Rm);       //full-scale deflection in mA
R      = (V1/(Im))-Rm;    //external resistance in
```

```
Rt     = Rm+R;
Rm1 = Rm*(1+(alphac*t));      //instrument resistance with 10 C   rise in temperature in
R1    = R*(1+(alpham*t));     //series resistance with 10 C   rise in temperature in
R2    = Rm1+R1;               //total resistance in the voltmeter circuit in
V2    = V1*(Rt/(R2));   //reading of voltmeter at 10 C  rise in temerature in V
er    = ((V2-V1)/(V1))*100;   //percentage error in %

//reult
mprintf('percentage error = %3.2f percentage",er);
```

Scilab code Exa 6.10 Determine the ratio of R and r

```
//
// ========================================================================

//chapter 6 example 10

clc;clear all;

//variable declaration
alpha0    = 0.0043;
t1        = 25;       //temperature in  C
t2        = 45;       //temperature in  C
e         = 1.1;      //percentage error in %

//calculations
R1     = ((1+(alpha0*t2))/(1+(alpha0*t2)));
//r1    = R1*r
//I2    = V/r1+R
//e     = (I1-I2)/100
//I2     = 0.989I1
```

```
//I2        = V/1.0776r+R
//I1        = V/R+r
//V/(1.0776r+R)   = 0.989V/R+r
//R/r        = 5.96
x          = 5.96;

//result
mprintf("R/r= %3.2f",x);
```

Scilab code Exa 6.11 Finding the reading of instruments

```
//
    ====================================================================

//chapter 6 example 11

clc;clear all;

//variable declaration
Rm1      = 1000;      //resistance of ammeter of A1 in

Rs1      = 0.05;      //resistance  of shunt connected
    across ammeter A1 in
Rm2      = 1500;      //resistance of ammeter of A2 in

Rs2      = 0.02;      //resistance  of shunt connected
    across ammeter A2 in
I       =10;          //current in A

//calculations
//in normal connecetion
I1    = (Rs1/(Rs1+Rm1))*I;        //current through in
    A
I2    = (Rs2/(Rs2+Rm2))*I;        //current through in
    A
```

```
//when shunts are interchanged
I11   = (Rs2/(Rs2+Rm1))*I;        //current through in A
I12   = (Rs1/(Rs1+Rm2))*I;        //current through in A
A1   = (I11/(I1))*I;             //current through ammeter in A
A2   = (I12/(I2))*I;             //current through ammeter in A

//calculations

mprintf("reading of ammeter A1 = %3.0d A",A1)
mprintf("\nreading of ammeter A2  = %3.0f A",A2);
```

Scilab code Exa 6.12 Finding the series resistance would be necessary to increase

```
//

//chapter 6 example 12

clc;clear all;

//variable declaration
Rv     = 2400;       //resistance in
L      =0.6;         //instrument inductace in H
f      = 60;        //frequency in Hz

//calculations
XL   = 2*%pi*f*L;             //instrument reactance in
Z    = sqrt((Rv^2)+(XL^2));      //instrument impedance in
//when the instrument range is extended from 120V to
```

```
    600V the impedance will have to be made 5 times
    in order to have the same current
//math.sqrt((RV**2)+XL^2) = 5*Z
x     = (5*Z)^2;
y     = XL^2;
z     = x-y;
a     = (sqrt(z));
R    = a-Rv;        //series resistance in

//result
mprintf("instrument reactance = %3.1f    ",XL);
mprintf("\nseries resistance = %3.2f    ",R);
```

Scilab code Exa 6.13 Determine the capacitance of the condenser multiplier require

```
//
    ===============================================================

//chapter 6 example 13
clc;clear all;

//variable declaration
Cv      = 70*10^-12;      //capacitance in F
V       =10000;              //electrostatic
    measurement in V
Vv      = 100;          //reading in V

//calculations
Vc     = V-Vv;     //voltage across series capacitor
    in V
//since the capacitors are connected in series ,te
    charge on each is same
//Vv*Cv   = Vc*C
C        = (Vv*Cv)/(Vc);       //capacitance in uuF

```

```
//result
mprintf("capacitance of the condenser = %3.4f uuF "
    ,(C*10^12));
```

Scilab code Exa 6.14 Calculating the necessary values of resistor

```
//
    ================================================

//chapter 6 example 14
clc;clear all;

//variable declaration
Rm     =40;       //resistance  in
Im     = 1;       //current in mA
I1     = 10;      //current in mA
I2     = 20;      //current in mA
I3     = 30;      //current in mA
I4     = 40;      //current in mA
I5     = 50;      //current in mA

//calculations
R1     = Rm/(((I1/(Im)))-1);
R2     = (R1+Rm)/(((I2/(Im))));
R3     = (R1+Rm)/(((I3/(Im))));
R4     = (R1+Rm)/(((I4/(Im))));
R5     = (R1+Rm)/(((I5/(Im))));
r1     = R1-R2;        //resistance  in
r2     = R2-R3;        //resistance  in
r3     = R3-R4;        //resistance  in
r4     = R4-R5;        //resistance  in
r5     = R5;        //resistance  in

//result
mprintf("resistance of various section of the
```

```
ayrtons shunt are = %3.4f    , %3.4f    , %3.4f
    , %3.4f    , %3.4f    ",r1,r2,r3,r4,r5);
```

Scilab code Exa 6.15 Explaining conversion of multi range voltmeter

```
//
    ==================================================================

//chapter 6 example 15
clc;clear all;

//variable declaration
Si   = 0.1*10^-3;       //current sensitivity in mA
Rm     = 500;              //meter resistance in
V1      = 10;               //full -scale voltage in V
V2      =50;               //volage range in V
V3      =100;              //volage range in V
V4      =500;              //volage range in V

//calculations
Sv    = (1/(Si))*10^-3;       //voltage sensitivity in
      /V
Rm1   =500*10**-3;        //Rm in  k
RT1    = Sv*V1;           //total resistance required
    in  k
R1     = RT1-Rm1;          //additional resistance in
    k
RT2    = Sv*V2;           //total resistance required
    in  k
R2     = RT2-Rm1-R1;         //additional resistance
    in  k
RT3    = Sv*V3;           //total resistance required
    in  k
R3     = RT3-Rm1-R2-R1;         //additional
    resistance in  k
```

```
RT4    = Sv*V4;          //total resistance required
   in  k
R4     = RT4-Rm1-R1-R2-R3;         //additional
   resistance in  k

//result
mprintf("additional resistance = %3.2f  k  ",R1);
mprintf("\nadditional resistance = %3.2f  k  ",R2);
mprintf("\nadditional resistance = %3.2f  k  ",R3);
mprintf("\nadditional resistance = %3.2f  k  ",R4);
```

Scilab code Exa 6.16 Calculate the flux density and current ratio and phase angle

```
//
   ==================================================

//chapter 6 example16

clc;clear all;

//variable declaration
Tp    = 1;      //numberof turns on primary
Ts    = 200;      //numberof turns on secondary
Is     = 5;        //secondary current in A
Zs     = 1;       // secondary burden in
f       = 50;     //frequency in Hz
a       = 0.0011;     //cross sectional area of core
   in m**2
S      = 0.91;       //stamping faactor
KT     =200;         //turns ratio
M       =80;        //ampere turns
Vs      =5;        //voltage

//calculations
Vs     = Is*Zs;       //secondary voltage in V
```

```
phimax    = Vs/(4.44*f*Ts);      //flux in the core in mWb
A         = a*S;         //net crss sectional area in m**2
Bmax      = phimax/(A);      //flux density in the core in T
Im        = M/(Tp);           //magnetising current in A
Ip        = sqrt(((KT*Is)^2)+(Im**2));      //primary current in A
Ir        = Ip/(Is);                  //current ratio
b         = ((180/(%pi))*(Im/(KT*Is)));      //phase angle in  (degrees)

//result
mprintf("flux density in the core = %3.4f T",Bmax);
mprintf("\ncurrent ratio = %3.2f",Ir);
mprintf("\nphase angle = %3.2f   ",b);
```

Scilab code Exa 6.17 Calculate the flux in the core and ratio error

```
//
==========================================================================

//chapter 6 example 17

clc;clear all;

//variable declaration
Tp     = 1;       //number of turns in primary
KT     = 200;     //turns ratio
Is     = 5;     //secondary current in A
Rs     = 1.5;   //secondary burden in
f      = 50;    //frequency in Hz
L       =1.5;   //iron loss in Watts
Ie      = 40;     //current in A
```

```

//calculaations
Ts     = KT*Tp;        //number of turns in secondary
Vs     = Is*Rs;        //secondary voltage in V
phimax   = Vs/(4.44*f*Ts);     //flux inn the core in mWb
Il       = L/(Vs);        //iron-loss in the secondary side in A
Ip       = KT*Il;        //iron-loss current in primary side in A
x        =(KT*Is)+Ie;
e         = ((-Ie/((x))))*100;     //ratio error  in %

//result
mprintf("flux in the core = %3.3e percentage mWb",(phimax*10^3));
mprintf("\nratio error = %3.4f percentage",e);
```

Scilab code Exa 6.18 Determine the ratio and phase angle errors

```
//==========================================================================
//chapter 6 example 18

clc;
clear all;

//variable declraration
Ts   = 300;  //number of turns in secondary winding
Tp   = 1;    //number of turns in primary winding
Is   =5; //current in A
Zs   =(1.5)+(%i*1)   //secondary impedance
MMF = 100;
```

```
Pi   = 1.2;        //iron loss in watts
KN   = 300;           //turn ratio


//calculations
KT   =Ts/Tp;       //turn ratio
Es   = Is*Zs;      //secondary voltage in volts
Es1      = sqrt(((real(Es))^2)+((imag(Es))^2));
Im   =MMF/Tp;                   //magnetising current in A
E    = Pi/Es1;                   //energy compnent of exciting current on secondary side in A
Ie   = KT*E;                    //energy compnent of exciting current on primary side in A
I0   = Im+%i*Ie;                //exciting current on primary side in A
I01     =sqrt(((real(I0))^2)+((imag(I0))^2));
alpha    = atan(Ie/Im);
alpha1   = (alpha*180)/%pi;
theta    = atan(imag(Zs)/real(Zs));
theta1   = (theta*180)/%pi;
KC   = KT+((I01*sin(((theta1+alpha1)*%pi)/180))/Is);    //actual current ratio
e    = ((KN-KC)/KC)*100;                 //percentage ratio error in %
b    = (I01*cos((((theta1+alpha1)*%pi)/180)))/(KT*Is);          //phase angle in radians
b1   = b*(180/%pi);


//result
mprintf("percentage ratio error =%3.2f    percentage ",e);
mprintf("\nphase angle = %3.2f    ",b1);
```

Scilab code Exa 6.19 Finding the primary current and ratio error and number of tur

```
//
//chapter 6 example 19
clc;
clear all;

//variable declraration
Ts  = 200;  //number of turns in secondary winding
Tp  = 1;    //number of turns in primary winding
Is  = 5;    //current in A
Zs  = (1.2+0.2)+(%i*(0.5+0.3)); //secondary impedance
MMF = 100;
Pi  = 1.2;      //iron loss in watts
Ie  = 50;       //energy component of eddy current in A



//calculations
KT  =Ts/Tp          //turn ratio
//Es    = Is*Zs           //secondary voltage in volts
Im  =MMF/Tp         //magnetising current in A
I0  = Im+%i*Ie      //exciting current on primary side in A
I01   =sqrt(((real(I0))^2)+((imag(I0))^2))
alpha   = atan(Ie/Im)
alpha1  = (alpha*180)/%pi

theta   = atan(imag(Zs)/real(Zs))
theta1  = (theta*180)/%pi
Ip  = (KT*Is)+(I01*sin(theta+alpha))          //primary current in A
e   = ((-I01*sin(((theta1+alpha1)*%pi)/180))/Ip)*100
```

```
            //ratio error
N   = (I01*sin(((theta1+alpha1)*%pi)/180))/Is
                //number of secondary turns to be
   reduced

//result
mprintf("ratio error = %3.1f percentage",e);
mprintf("\nnumber of secondary turns to be reduced
   = %3.0f ",N);
```

Scilab code Exa 6.20 Determine the primary current and phase angle of the transfor

```

//

//chapter 6 example 20

clc;
clear all;

//variable declraration
Ts  = 300;  //number of turns in secondary winding
Tp  = 3;    //number of turns in primary winding
Is  = 5;    //current in A
Zs  = (0.583)+%i*(0.25);    //secondary impedance

n1  =10;
n2  =5;

//calculations
KT  =Ts/Tp;     //turn ratio
Es  = Is*Zs;        //secondary voltage in volts
Nm  = n1*Es;        //total magnetising amp-turns
Ni  =n2*Es;     //total iron loss amp-turns
```

```
Im  =Nm/Tp;     //magnetising componenet of exciting current in A
Ie  = Ni/Tp;        //
I0  = Im+%i*Ie; //exciting current on primary side in A
I01    =sqrt(((real(I0))^2)+((imag(I0))^2))
alpha   = atan(Ie/Im);  //energy component of exciting current in A
alpha1  = (alpha*180)/%pi
theta   = atan(imag(Zs)/real(Zs));
theta1  = (theta*180)/%pi
x   = sin(((theta1+alpha1)*%pi)/180)
Ip  = (KT*Is)+(I01*x);  //primary current in A
y   = cos(((theta1+alpha1)*%pi)/180);
b   =(180/%pi)*((I01*y)/(KT*Is));       //phase angle


//result
mprintf("primary current  = %3.0d A",Ip);
mprintf("\nphase angle  = %3.3f    ",b);
```

Scilab code Exa 6.21 Calculate the ratio error and phase angle error

```
//==================================================================

//Chapter 6 Example 21


clc;
clear all;

//variable declaration
R       = 25;           //rate burden in VA
```

```
Is       = 5;              //current in A
r        = 6;              //Rs/Es ratio of resistance
   to reactance
IL       = 0.2;            //iron loss in W
Im          = 1.5;         //magnetising compnent of
   current in A


//calculations
KT       = 100/5;                //turn ratio
Es       = R/Is;                 // Secondary rated
   voltage in V
Zs       = Es/Is;                //total secondary
   impedance in
theta        = (atan(1/r))*180/%pi;         //angle in

Zs1           = (Zs*cos(theta*%pi/180))+(Zs*sin(theta
   *%pi/180))*%i;
Ie           = KT*0.04;            //energy component
   of exciting current on primary side
r            = (((Im*sin(theta*%pi/180))+(Ie*cos(
   theta*%pi/180)))/((KT*Is)+(Ie*cos(theta*%pi/180))
   +(Im*sin(theta*%pi/180))))*100;      //percentage
    ratio error in %
beta         = (180/%pi)*(((Im*cos(theta*%pi/180))-(
   Ie*sin(theta*%pi/180)))/(KT*Is));        //phase
   angle erro in

//result
mprintf("percentage ratio error  = -%3.1f percentage
   ",r);
mprintf("\nphase angle error = %3.4f   ",beta);
```

Scilab code Exa 6.22 Find the ratio and phase angle errors

```
//
//Chapter 6 Example 22


clc;
clear all;

//variable declaration
r        = 12.5;           //rate burden in VA
Is       = 5'              //secondary rated curret in A
f        = 50;             //frequency in Hz
L            = 0.96*10^-3;
Im           = 16;             //magnetising component of exciting current in A
Ie           = 12;             //energy component of exciting current in A
Is           = 5;              //secondary rated current in A


//calculations
KN       = 1000/5;             ///nominal ration
KT       = 196/1;              //turn ratio
Es       = r/Is;               //secondary rated voltage in V
Zs       = Es/Is;              //secondary impedance in
Xs       = 2*%pi*f*L;          //secondary reactance in
theta        = (asin(Xs/Zs))*180/%pi;        //secondary circuit phase angle in
KC           = KT+(((Ie*cos(theta*%pi/180))+(Im*sin(theta*%pi/180)))/Is);
e            = ((KN-KC)/KC)*100;        //ratio error
beta         = (180/%pi)*(((Im*cos(theta*%pi/180))-(
```

```
    Ie*sin(theta*%pi/180)))/(KT*Is));         //phase
    angle erro in

//result
mprintf("ratio error = %3.2f percentage ",e);
mprintf("\nphase angle error = %3.2f   ",beta);
```

Scilab code Exa 6.23 Estimate CT ratio and phase angle error

```
//
    ==================================================================

//chapter 6 example 23

clc;
clear all;

//variable declaration
KT   = 8;          //turn ratio
Ie   = 0;          //current in A
I0       = 0.08;
R1   = 1.5;        //resistance in
R2   = 0.4;        //resistance in
L1   =60*10^-3;    //inductance in H
L2   =0.7*10^-3;   //inductance in H
f    = 50;         //frequency in Hz
phi      = 0;          //angle in

//calculations
Im   = 0.01*KT;        //Im = 1% of primary current =
    0.01*Ip = 0.01*KT*Is
alpha    =atan(Ie/Im);    //phase angle in radians
R    = R1+R2;          //resistance of burden
L    = L1+L2;          //inductance in H
theta    = (atan((2*%pi*f*L)/R)*%pi/180);     //phase
```

```
   angle in
KC  = KT+((I0*sin(theta+alpha))/Is);
KC  = KT+((0.08*Is*sin(theta+alpha))/Is);
KC  = KT+(0.08*sin(theta+alpha));        //actual
   current ratio
b   = (I0*cos(theta+phi))/(KT*Is);

//result
mprintf("actual current ratio = %3.1f ",KC);
mprintf("\nphase angle error = %3.2d ",b);
```

Scilab code Exa 6.24 Find the ratio and phase angle errors

```
//

//chapter 6 example 24
clc;
clear all;

//variable declaration
KT  = 201;       //turn ration
Is  = 5;         //secondary current in A
Im  = 7;         //magnetising component of exciting
   current in A
Ie  = 3;         //cross-loss component of exciting
   current in A
delta   =0;

//calculations
Kn      = 1000/5;       //nominal ratio
alpha   =atan(Ie/Im);   //angle in
alpha1  = (alpha*180)/%pi;
theta   = delta-(((acos(0.8))*180)/%pi);        //
   from figure taken the value of gamma
```

```
z    = cos((theta*%pi)/180);
z1   = sin(((theta)*%pi)/180);
Kc   = KT+(((Ie*z)+(Im*z1))/Is);       //actual current in A
e    = ((Kn-Kc)/Kc)*100;//ratio error
b    =(180/%pi)*(((Im*z)-(Ie*z1))/(KT*Is));

//result
mprintf("ratio error = %3.3f percentage",e);
mprintf("\nphase angle error = %3.3f   ",b);
```

Scilab code Exa 6.25 Determine the phase angle and ratio error

```

//==================================================================
//chapter 6 example 25

clc;
clear all;

//variable declaration
KT   = 201;        //turn ration
Ie   = 3;          //cross loss  current in A
Im   = 7;          //magnetising component of exciting current in A
delta    =0;
Kn      = 200;

//calculations

theta    = delta+(((acos(0.8))*180)/%pi);     //from figure taken the value of gamma
z    = cos((theta*%pi)/180);
```

```
z1   = sin(((theta)*%pi)/180);
Kc   = KT+(((Ie*z)+(Im*z1))/Is);       //actual current in A
e    = ((Kn-Kc)/Kc)*100;      //ratio error
b    =(180/%pi)*(((Im*z)-(Ie*z1))/(KT*Is));

//result
mprintf("ratio error = %3.3f percentage",e);
mprintf("\nphase angle error = %3.4f   ",b);
```

Scilab code Exa 6.26 Determine the phase angle and ratio error

```

//
//chapter 6 example 26
clc;
clear all;

//variable declaration
KT   = 199;       //turn ration
Is   = 5;         //secondary current in A
Im   = 7;         //magnetising component of exciting current in A
Ie   = 4;         //cross-loss component of exciting current in A
delta   =0;

//calculations
KN   = 1000/5              //nominal ratio
alpha   =atan(Ie/Im)     //angle in
alpha1  = (alpha*180)/%pi
theta   = delta+(((acos(0.8))*180)/%pi)      //from figure taken the value of gamma
```

```
z    = cos((theta*%pi)/180)
z1   = sin(((theta)*%pi)/180)
Kc   = KT+(((Ie*z)+(Im*z1))/Ie)   //actual current in
    A
e    = ((KN-Kc)/Kc)*100   //ratio error
b    =(180/%pi)*(((Im*z)-(Ie*z1))/(KT*Is))
theta1  = delta-(((acos(0.8))*180)/%pi)    //from
    figure taken the value of gamma
z11    = cos((theta1*%pi)/180)
z12   = sin(((theta1*%pi)/180))
Kc1 = KT+(((Ie*z11)+(Im*z12))/Is)   //actual current
     in A
e1   = ((KN-Kc1)/Kc1)*100     //ratio error
b1   =(180/%pi)*(((Im*z11)-(Ie*z12))/(KT*Is))


//result
mprintf("ratio error = %3.2f  percentage",e);
mprintf("\nphase angle error = %3.1f   ",b);
mprintf("\nratio error = %3.2f percentage",e1);
mprintf("\nphase angle error = %3.2f   ",b1);
```

Scilab code Exa 6.27 Estimate the iron loss

```
//
    ====================================================================

//chapter 6 example 27

clc;
clear all;

//variable declaration
KT   = 198;   //turn ratio
e    =0; //ratio error
```

```
Is   = 5;     // secondary current in A
P    = 5;     //load in VA
Rs   = 0.02;  //resistance in
KN   = 200;   //KN=KC since e=0
KC   = 200;

//calculations
V2   = P/Is; //secondary voltage in V
Es   = V2+(Is*Rs);    //secondary induced emf in V
Ep   = Es/KT;         //primary induced emf
Ie   = (KC-KT)*Is;    //eddy current loss in A
IL   = Ep*Ie;         //iron loss in W

//result
mprintf("iron loss = %3.3f mW",(IL*10^3));
```

Scilab code Exa 6.28 Find the phase angle error at no load and load in VA at unity

```
//
    ====================================================================

//Chapter 6 Example 28


clc;
clear all;

//variable declaration
Vs           = 100+0*%i;          //secondary terminal
    voltage in V
Rp           = 97.5;              //primary resistance
    in
Xp           = 67.4;              //primary reactance
   in
X1           = 110;               // total equivalent
```

```
    reactance in
K            =1000/100;



//calculations
//Es             = Vs+(Is*(Rs+Xs*%i);
Es           = Vs;
Ep           = 10*(100+0*%i);        //induced emf in primary winding in V
I0           = 0.02*(0.4-0.9165*%i);          //no load current in A
Zp           = Rp+Xp*%i;
Vd           = I0*Zp;
Vp           = Ep+Vd;
beta         = (atan((imag(Vp))/real(Vp)))*180/%pi;                //phase angle between primary and secondary voltage in
Xs1          = X1-Xp;               //reactance of secondary winding in
//Es             = Vs+(Is*Zs);               //induced emf in secondary winding
//IP             = (Is/10)+I0;
//V            = Ip*Zp = (IS/10)+0.008-0.01833*i
//V            = (9.75*Is)+2.015)-((1.2478-6.74*Is)*%i) .....equation 1
//Vp           = K*(ES+IP*ZP)
//VP           =(1002.015+18.35*%i)-(1.2478-11*Is)*%i ....equation 2
//comparing equation 1 and 2 we get
//1.2478-11*Is   =0;
Is       = 1.2478/11;              //secondary current in A
v            = Vs*Is;

//result
mprintf("phase angle between primary and secondary voltage = %3.2f    lagging",beta);
```

```
mprintf("\nvolt ampere rating for zero phase angle = %3.2f",v);
mprintf("\nnote:Is values is taken as 0.114 wchich is approximate when answer is 0.1134");
```

Scilab code Exa 6.29 Calculate the ratio and phase angle errors

```
//

//Chapter 6 Example 29


clc;
clear all;

//variable declaration
Vs      = 63+0*%i;          //secondary terminal voltage in V
Zs1     = 2+1*%i;           //equivalent mpedance referred to prmary in
Zb      = 100+200*%i;           //secondary burden in
KN      =60.5;



//calculations
KT      = 3810/63;          //turn ratio
Ep      = KT*Vs;            //primary induced emf in V
Zp1     = (KT^2)*Zs1;           //equivalent impedance
Zs12     = sqrt(((real(Zp1))^2)+((imag(Zp1))^2));
Is          = Vs/Zb;            //secondary current
```

```
   in A
Is1     = sqrt(((real(Is))^2)+((imag(Is))^2));
Ip           = Is/KT;                //primary current in A
Ip1     = sqrt(((real(Ip))^2)+((imag(Ip))^2));
Vp           = Ep+(Ip*Zp1);          //applied voltage to primary in V
Vp1     = sqrt(((real(Vp))^2)+((imag(Vp))^2));
beta         = (atan((imag(Vp))/real(Vp)))*180/%pi;
                   //phase angle  error in
e            = (((KN*Vs)-Vp)/Vp)*100;              //ratio error in percentage
//beta         = (atan((imag(Zp1))/real(Zp1)))*180/%pi;

//result
mprintf("phase angle  error = %3.2f   ",beta);
mprintf("ratio error = %3.1f percentage ",e);
```

Chapter 7

Analog measurement of power and wattmeters

Scilab code Exa 7.1 Calculate the power

```
//
===========================================================

//chapter 7 example 1

clc;clear all;


//variable declaration
P    = 250;        //wattmeter reading in watts
Rp   = 2000;       //pressure coil circuit resistance
   in
VL   = 200;        //load voltage in V

//calculations
p    = (VL^2)/Rp;     //power lost in pressure coil in
    watts
P1   = P-p;        //power lost in the pressure coil
   circuit in watts
```

```
//result
mprintf("power lost in the pressure coil circuit =
   %3.2f watts",P1);
```

Scilab code Exa 7.2 Calculate the percentage error

```
//
   ==========================================================================

//chapter 7 example 2

clc;clear all;

//variable declaration
x   = 0.004;
y   = 0.707;        //power factor lagging
y1  = 0.5;      //power factor lagging

//calculaitons
theta   = atan(x)       //theta in degrees
a   = cos(theta)
b   = sin(theta)
phi = acos(y)
c   = cos(phi)/(a*cos(theta-phi))   //correction
   factor
A      = cos(phi)/sin(phi);
e   = (b/(A+b))*100 //percentage error in %
phi1    = acos(y1)
c1  = cos(phi1)/(a*cos(theta-phi1)) //correction
   factor
B     = cos(phi1)/sin(phi1);
e1  = (b/(B+b))*100     //percentage error in %

```

```
//result
mprintf("correction factor  when 0.707 pf lagging = %3.3f",c);
mprintf("\npercentage error =%3.2f percentage ",e);
mprintf("\ncorrection factor  when 0.707 pf lagging = %3.3f",c1);
mprintf("\npercentage error =%3.1f percentage ",e1)
```

Scilab code Exa 7.3 Estimate the percentage error in the wattmeter

```
//
//chapter 7 example 3

clc;clear all;

//variable declaration
V    = 240;       //voltage in V
I    = 8;         //current in A
x    = 0.1;       //pf lagging
Rp   = 8000;      //resistance in
f    = 50;        //frequency in Hz
L    = 63.6*10^-3     //inductance

//calculations
phi      = acos(x);
phi1     =(phi*180)/%pi;
P    = V*I*x;          //load power
Pl   = (V^2)/Rp; //power lost in the pressure coil circuit in watts
Pt   = P+Pl;      //neglecting inductance of the voltage coil the reading of wattmeter would be in watts
Xp   = 2*%pi*f*L;     //reactance in
```

```
theta    = atan(Xp/Rp);
theta1   = (theta*180)/%pi;
A = cos(theta1);
B        =cos(phi1-theta1);
C    = cos(phi1);
w    = Pt*(A)*(B/C); //wattmeter reading
e    = ((w-P)/P)*100;        //percentage error in %

//result
mprintf("phi value in textbook is taken wrong
   correct is 84  .16 but value is 84  .26 so
   textbook answer is coming wrong")
mprintf("\npercentage error in %3.2f percentage ",e)
   ;
```

Scilab code Exa 7.4 Calculate the percentage error in wattmeter reading

```
//
  ====================================================================

//chapter 7 example 4

clc;clear all;

//variable declaration
w    = 23;          //wattmeter reading in watts
Rp   = 2000;        //resistance in
f    = 100;         //frequency in Hz
L    = 10*10^-3     //inductance
V    = 240;         //voltage in V
I    = 4.5;         //current in A

//calculations
Xp   = 2*%pi*f*L;      //reactance in
theta    = atan(Xp/Rp);
```

```
theta1  =(theta*180)/(%pi)
//cos(phi)=P/V*I
//phi    = acos(P/V*I)
//w = Pt*(cos(theta))*(cos(phi-theta))/cos(phi);
    //wattmeter reading
W1       = V*I;          //V*I in watts
//phi    = acos(P/W) = acos(P/1080)
//W      = P*cos(theta)*(cos(phi-theta))/cos(phi)
//W      =23 =P*cos(0.18)*cos((acos(P/1080))-0.18)/(P
    /V*I)
//let cos(acos(P/1080)-0.18) =A
//B = cos(0.18)
//W=23   = (P*B*A)/(P/(V*I))
// W= B*A*V*I
//A      = W/(B*V*I)
B       = cos((theta1*%pi)/180);
A        = w/(B*V*I);
//cos(acos(P/1080)-0.18) =A
//C  =acos(P/1080)    = acos(A)+0.18
A1       =(acos(A))*(180/%pi);
C        = A1+0.18
D        = cos(C*%pi/180)
P        =1080*D;
e    = ((w-P)/P)*100;        //percentage error in %

//result
mprintf("percentage error in %3.2f percentage ",e);
```

Scilab code Exa 7.5 Finding the error in wattmeter

```
//

//chapter 7 example 5
clc;clear all;
```

```

//variable declaration
f   = 50;        //frequency in Hz
L   = 5*10^-3    //inductance
V   = 100;       //voltage in V
I   = 10;        //current in A
R1  = 3000;      //resistance in

//calculations
x        = ((2*%pi*f*L)/R1);             //tan(theta)
theta    = atan(x);  //the angle by which the current
    in pressure coil lags behind the voltage
//W = V*I*sin(90+theta) = V*I*cos(theta) = V*I*tan(
   theta)
//W=V*I*theta        //since theta is small
W   = V*I*x;     //reading of wattmeter in watt

//result
mprintf("error = %3.2f watts",W);
```

Scilab code Exa 7.6 Find the actual reading reading on the wattmeter

```
//
    ====================================================================

//chapter 7 example 6
clc;clear all;

//variable declaration
RL  = 2;     //resistance in
f   =50;     //frequency in Hz
L   = 0.25;  //inductance in H
V   = 200;   //voltage in V
LP  = 5.6*10^-3;     //inductance in H
RP  =1000;
```

```
//calculations
XL  = 2*%pi*f*L;    //load reactance in
ZL  = RL+XL*%i; //load impedance
IL  = V/ZL;     //load current in A
XLP = 2*%pi*f*LP;   //reactance in
ZP  = RP+XLP*%i;    //pressure coil circuit
    impedance in
IP  = V/ZP;     //pressure coil current in A
theta   = (atan(imag(IP)/real(IP)))*180/%pi;
Ic  = IL+IP;
Ic1     = sqrt(((imag(Ic))^2)+((real(Ic))^2))
phi     = (atan(imag(Ic)/real(Ic)))*180/%pi;
A       = (phi-theta);
x   = cos((A*%pi)/180);
y   =cos((theta*%pi)/180);
W   = V*Ic1*y*x;    //actual reading of wattmeter in
     watts

//result
mprintf("actual reading of wattmeter = %3.4f  watts"
    ,W);
```

Scilab code Exa 7.7 Calculate the percentage errors

```
//
    ==================================================

//chapter 7 example 7
clc;clear all;

//variable declaration
V   = 250;      //load voltage in V
I   = 12;       //load current in A
Rc  = 0.1;      //resistance in
```

```
Rp  =6500;      //resistance in
x   = 1;        //pf cos(phi)
y   = 0.4;      //pf cos(phi)

//calculations
P   = V*I*x;        //power input to the apparatus
    in W
PL  = (I^2)*Rc;     //power lost in current coil in
    W
e   = (PL/P)*100;   //percentage error in %
Pc  = (V^2)/Rp; //power lost in presuure coil in W
e   = (Pc/P)*100;   //percentage error in %
P1  = V*I*y;        //power input to the apparatus
    in W
PL1 = (I^2)*Rc;     //power lost in current coil in
    W
e1  = (PL1/P1)*100; //percentage error in %
Pc1 = (V^2)/Rp; //power lost in presuure coil in W
e1  = (Pc1/P1)*100; //percentage error in %

//result
mprintf("percentage error when pf 1  lagging  %3.2f
    percentage",e);
mprintf("\npercentage error when pf 0.4  lagging  %3
    .2f percentage",e1);
```

Scilab code Exa 7.8 Calculate the actual power and current

```
//

//Chapter 7 Example 8


clc;
```

```
clear all;

//variable declaration
theta1      =1;          //pressure coil phase angle in
theta2      =2;          //pressure coil phase angle in
P1          = 700;           //wattmeter reading in W
P2          = 620;           //wattmeter reading in W
V           = 240;           //voltage in V


//calculations
x       = P1/P2;
//P1          =P*cos(theta2)*cos(phi-theta2)/cos(phi)
//P2           = P*cos(theta1)*cos(phi-theta1)/cos(phi)
//P1/P2       = cos(theta2)*cos(phi-theta2)/cos(phi)/cos(theta1)*cos(phi-theta1)/cos(phi)
//x          = cos(theta2)*cos(phi-theta2)/cos(phi)/cos(theta1)*cos(phi-theta1)/cos(phi)
//x           = (cos(theta2)/cos(theta1))*(cos(phi-theta2)/cos(phi-theta1))
//x           = y*(cos(phi-theta2)/cos(phi-theta1))
//(cos(phi-theta2)/cos(phi-theta1))      = x/y
y           = (cos(theta2*%pi/180)/cos(theta1*%pi/180));
z           = x/y;
//(cos(phi-theta2)/cos(phi-theta1))   = ((cos(thet2*%pi/180))*cos(phi))+(sin(thet2*%pi/180))*sin(phi))/((cos(theta1*%pi/180))*cos(phi))+(sin(thet1*%pi/180))*sin(phi))
//z      = ((cos(thet2*%pi/180))*cos(phi))+(sin(thet2*%pi/180))*sin(phi))/((cos(theta1*%pi/180))*cos(phi))+(sin(thet1*%pi/180))*sin(phi))
t           = ((z*cos(theta1*%pi/180))-(cos(theta2*%pi/180)))/((sin(theta2*%pi/180))-(z*sin(theta1*%pi/180)));
```

```
phi           = (atan(t))*180/%pi;
pf            = cos(phi*%pi/180);
C             = (phi-theta2)
c                = cos(C*%pi/180);
a             = (cos(theta2*%pi/180));
b             = a*c;
B             = P1*pf;
P             = B/b;
I             = P/(V*pf);

//result
mprintf("actual power = %3.3f W",P);
mprintf("\ncurrent drawn = %3.2f A",I);
```

Scilab code Exa 7.9 Estimate the torque

```
//
   ====================================================================

//chapter 7 example 9
clc;clear all;

//variable declaration
Np            = 500;          //number of turns on
   moving coil
Ip            = 0.05;         //current through moving
    coil in A
B             = 0.012;            // flux density in
   the air gap in T
d             = 0.03;             //diameter in m
theta1        = 30;
theta2        = 90;
x             = 0.866;                //power factor
   cos(phi)

```

```
//calculations

A        = (%pi/4)*(d^2);            //area  of x-section of moving coilin m^2
phimax      = B*A;                //maximum flux through moving coil in Wb
//Mmax          = (phimax*Np)/Ic
//Mmax*Ic         = X       = phimax*Np
X         = (phimax*Np);
//T            = Ip*Ic*Mmax*cos(phi)*sin(theta)
//T            = Ip*Ic*(X/Ic)*cos(phi)*sin(theta)
//T            = Ip*(X)*cos(phi)*sin(theta)
T1              = Ip*X*x*sin(theta1*%pi/180);
T2              = Ip*X*x*sin(theta2*%pi/180);

//result
mprintf("torque in when 30    = %3.4e   N-m",T1);
mprintf("\ntorque in when 90    = %3.4e   N-m",T2);
```

Scilab code Exa 7.10 `Calculate the power factor of inductive load`

```
//==================================================================================

//chapter 7 example 10

clc;clear all;

//variable declaration
V1   = 200;       //voltage across an inductive load in volts
V2   = 180;       //voltage across an nono- inductive resistor in volts
V3   = 300;       //voltage across the two in series in volts
```

```
//calculations
x   = ((V3^2)-(V1^2)-(V2^2))/(2*V1*V2); //cos(phi)

//result
mprintf("power factor cos (phi) = %3.3f lagging",x);
```

Scilab code Exa 7.11 `Calculate the power absorbed by the load and load impedance a`

```
//
//chapter 7 example 11

clc;clear all;

//variable declaration
I1  = 2.5;       //current across an inductive load in A
I2  = 2.4;       //current across an non- inductive resistor in A
I3  = 4.5;       //current across the two in series in A
V   = 250;       //supply voltage in V


//calculations
R   = V/I2; // non- inductive resistance in
P   = ((I3^2)-(I1^2)-(I2^2))*(R/2); //power absorbed by the load in watts
Z   = V/I1;          //load impedance in
x   = ((I3^2)-(I1^2)-(I2^2))/(2*I1*I2); //cos(phi)

//result
mprintf("power absorbed by the load = %3.2f watts",P
```

```
    );
mprintf("\nload impedance = %3.2f   ",Z);
mprintf("\npower factor cos (phi) = %3.4f lagging",x
    );
```

Scilab code Exa 7.12 Write the suitable transformation ratio7

```
//
    ============================================================

//chapter 7 example 12
clc;clear all;

//variable declaration
V1  = 6600;     //primary voltage in V
V2  = 110;      //secondary voltage in V
I1  = 50;       //primary current in A
I2  = 5;        //secondary voltage in A

//calculations
r   = V1/V2;        //hence transformation ratio of
    PT
r1  = I1/I2;        //transformation ratio of CT

//result
mprintf("transformation ratio of CT = %3.2f ",r1);
```

Scilab code Exa 7.13 Calculate the new multiplying factor of wattmeter

```
//
    ============================================================

//chapter 7 example 13
```

```
clc;clear all;

//variable declaration
m   = 10;       //wattmeter multiplying factor

//calculations
x   = 100/5;        //CT ratio
y   = 1000/100; //PT ratio
W   = x*y*m;        //new multiplying factor of wattmeter

//result
mprintf("new multiplying factor of wattmeter = %3.2f",W);
```

Scilab code Exa 7.14 `Calculate the percentage error`

```
//==========================================================================

//chapter 7 example 14
clc;
clear all;

//variable declaration

V   = 6000;     //load voltage in V
I   = 100;      //load current in A
p   = 0.5;      //power factor cos(phi) lagging
theta   = 0;        //since wattmeter reads correctly
x1      = 20;           // current transformers nominal ratio
x2      = 60;           // potenetial transformers nominal ratio
```

```
e1       =-0.005;            // ration error
e2       = 0.01;           // ratio error

//calculations
P    = V*I*p;         //actual power consumed in W
phi =acos(p);
phi1     = (phi*180)/%pi;
d    = -1;        //phase angle in
b    = 2;         //phase angle in
g    = phi1+d-theta1-b;  //phase angle in
theta1       =theta*180/%pi
g1       = g*180/%pi;
A        =cos(phi1)
K    = (cos(phi1*%pi/180))/((cos(theta1*%pi/180))*(cos(g*%pi/180)));
CT       =  x1*(1+e1);             //actual transformation ratio of CT
PT             = x2*(1+e2);          //actual transformation ratio of PT
P1             = P/(K*CT*PT);        //power indicated by wattmeter in kW
T              = P/(x1*x2);          //true reading of wattmeter in kW
e              = ((P1-T)/T)*100;      //percentage errror in %
//result
mprintf("phase angle between the currents in CC and PC of wattmeter %3.2f    ",K);
mprintf("\npercentage error = %3.0f percentage ",e);
```

Scilab code Exa 7.15 Calculate the input power and power factort

```
//
```

```
//chapter 7 example 15
clc;
clear all;

//variable declaration
W1  = 300;      //wattmeter reading in kW
W2  = 100;      //wattmeter reading in kW

//calculations
P   = W1+W2;          //input power in kW
phi = atan(((W1-W2)/(W1+W2))*sqrt(3));      //phase
    angle in radians
phi1    = (phi*180)/%pi;
pf  =cos((phi1*%pi)/180);       //power factor
    lagging


//result
mprintf("input power = %3.2f kW",P);
mprintf("power factor  = %3.3f lagging",pf);
```

Scilab code Exa 7.16 Calculate the power and power factor of the load

```
//
    ================================================

//chapter 7 example 16

clc;clear all;

//variable declaration
W1  = 20;       //wattmeter reading in kW
W2  = -5;       //wattmeter reading in kW

//calculations
```

```
P   = W1+W2;          //input power in kW
phi = atan(((W1-W2)/(W1+W2))*sqrt(3));       //phase angle in
pf  =cos(phi);        //power factor lagging

//result
mprintf("input power = %3.2f kW",P);
mprintf("\npower factor  = %3.4f lagging",pf);
```

Scilab code Exa 7.17 Find the reading of the each instrument

```
//

//chapter 7 example 17

clc;clear all;

//variable declaration
P   = 30000;     //total power in kW
pf  = 0.4;   //power factor assuming lagging

//calculations
phi = acos(pf); //phase angle in radians
phi1     = (phi*180)/%pi;
y        = sqrt(3);
z        =y*pf;
x   = P/(y*pf); //VL*IL in VA

//W = VL*IL*cos(30-phi)
//VL*IL      = x;
W1  = x*cos((30*%pi/180)-(phi1*%pi/180));   //reading of wattemeter in W
W2  =  x*cos((30*%pi/180)+(phi1*%pi/180));  //reading of wattemeter in W
```

```

//result
mprintf("reading of wattemeter %3.2f W %3.0f W",W1,W2);
mprintf("\nNote:x value is taken approximate value, so the w1 and w2 differing ")
mprintf("\nif power factor is leading the readings of wattmeters interchange ");
```

Scilab code Exa 7.18 Find the reading OF TWO wattmeters

```
//
//chapter 7 example 18


clc;clear all;

//variable declaration
VL  =400;        //voltage in V
IL  = 10;        //current in A
//r = W1/W2
//tan(phi)       = sqrt(3)*((W1-W2)/(W1+W2))
//tan(phi)       = sqrt(3)*((1-(W2/W1))/(1+(W2/W1)))
//tan(phi)       = sqrt(3)*((1-r)/(1+r))
//cos(phi)       = 1/sec(phi) =  1/sqrt(1+(tan(phi)^2) = 1/sqrt(1+(3*((1-r)/(1+r))^2)
r   = 0.5;
z      = ((1-r)/(1+r))^2;
pf  = 1/sqrt(1+(3*z));
phi = (acos(pf)*180/%pi);
W1  = VL*IL*cos((30*%pi/180)-(phi*%pi/180));   //wattmeter reading in W
W2  = VL*IL*cos((30*%pi/180)+(phi*%pi/180));
```

```
    //wattmeter reading in W

//result
mprintf("wattmeter reading = %3.2f W",  W1);
mprintf("\nwattmeter reading = %3.2f W",W2);
```

Scilab code Exa 7.19 Determine the values of Rand L connected in the phase

```
//

//chapter 7 example 19

clc;
clear all;

//variable declaration
W1  = 3000;     //wattmeter reading in W
W2  = 1000;     //wattmeter reading in W
f   = 50;       //frequency in HZ
V   = 400;      //voltage in V


//calculations
VP  = V/sqrt(3);                    //voltage in V
P         = W1+W2;                        //input power in kW
phi     = atan(((W1-W2)/(W1+W2))*sqrt(3));             //phase angle in radians
phi1    = phi*180/%pi;    //phase angle in degrees
pf       =cos(phi1*%pi/180);                   //power factor lagging
IL       = P/((sqrt(3))*V*pf);
```

```
                                //line current in A
ZP        =VP/IL;   //impedance of the circuit per phase in
R          = ZP*pf;                       //resistance per phase
XL        = sqrt((ZP^2 )-(R^2));                 //reactance per phase in
L          = XL/(2*%pi*f);                        //inducatance per phase in H

//result
mprintf("resistance per phase = %3.2f    ",R);
mprintf("\ninducatance per phase in = %3.3f H",L);
```

Scilab code Exa 7.20 Find the wattage shown by three wattmeters and power taken by

```
//
========================================================================

//chapter 7 example 20

clc;
clear all;

//variable declaration
IPR = 8;    //current in line R in A
IPY = 10;   //current in line Y in A
IPB = 6;    //current in line B in A
VP  =120;   //voltage in V
pf  = 1;    //power factor

//calculations
W1  = VP*IPR*pf;    //wattage shown by wattmeter having current coil in line R in watts
W2  = VP*IPY*pf;    //wattage shown by wattmeter
```

```
having current coil in line Y in watts
W3  = VP*IPB*pf;    //wattage shown by wattmeter having current coil in line B in watts
p   = W1+W2+W3; //power taken by lighting load in watts

//result
mprintf("wattage shown by wattmeter having current coil in line R = %3.2f watts",W1);
mprintf("\nwattage shown by wattmeter having current coil in line Y = %3.2f watts",W2);
mprintf("\nwattage shown by wattmeter having current coil in line B = %3.2f watts",W3);
mprintf("\npower taken by lighting load = %3.2f watts",p);
```

Scilab code Exa 7.21 Find the current and reading of two wattmeters connected to m

```
//
// ==========================================================

//chapter 7 example 21

clc;
clear all;

//variable declaration
R   = 10;   //resistance in
XL  = 10;   //reactance  in
VL  = 440;  //load voltage in V

//calculations
Z   = sqrt((R^2)+(XL^2));       //impedance of each choking coil in
VP  = VL/sqrt(3);       //phase voltage in V
```

```
IP   = VP/Z;      //phase current in A
IL   = IP;        //line current in A
phi      = atan(XL/R);    //phase angle in
phi1        = phi*180/%pi;

W1   = VL*IL*cos((30*%pi/180)-(phi1*%pi/180));  //wattmeter reading in W
W2   = VL*IL*cos((30*%pi/180)+(phi1*%pi/180));  //wattmeter reading in W

//result
mprintf("line current = %3.2f A",IL);
mprintf("\nwattmeter reading = %3.2f W",W1);
mprintf("\nwattmeter reading = %3.2f W",W2);
```

Scilab code Exa 7.22 Find the power factor of the system and the value of capacita

```
//

//chapter 7 example 22

clc;
clear all;

//variable declaration
W1   = 5000;      //wattmeter reading in W
W2   = -1000;         //wattmeter reading in W
VL   = 440;       //load voltage in V
f    = 50;        //frequency in Hz
VP       = 440;

//calculations
P    = W1+W2;         //total power in the load circuit in W
```

```
phi = atan(((W1-W2)/(W1+W2))*sqrt(3));      //phase angle in
phi1          = phi*180/%pi;
pf  = cos(phi);     //power factor
IP  = P/((sqrt(3)*VL*pf));  //load current per phase in A
IP1     = IP/sqrt(3);
ZP  = VP/IP1;             //load impedance per phase
RP  = ZP*pf;              //load resistance per phase in
XP  =ZP*sin(phi);         //load reactance per phase in
pf1 = 0.5;            //power factor
phi2    = (acos(pf1))*180/%pi;
//reading of wattmeter will be zero
XP1 = RP*tan((phi2)*%pi/180);       //reactnace in circuit per phase in
XC  =XP-XP1;              //value of capacitive reactance in troduced in each phase in
C   = 1/(2*%pi*f*XC);       //value of capacitive reactance introduced in each phase of delta connected in uF

//result
mprintf("value of capacitive reactance introduced in each phase of delta connected  = %3.0f uF",(C*10^6));
```

Scilab code Exa 7.23 Find the line currents and reading on wattmeters whose curren

```
//
//chapter 7 example 23

```

```
clc;
clear all;

//variable declaration
VAB1      = 400+0*%i;      //voltage in V
VBC1     = -200-346.41*%i;      //voltage in V
VCA1      = -200+346.41*%i;      //voltage in V
VAB          =400;
VBC          = 400;
VCA          = 400;
TVAB         = 0;
TVBC         = -120;
TVCA         =120;
PAB          = 20000;        //Wwattmetr readig VA
PBC          = 30000;        //Wwattmetr readig VA
PCA          = 20000;        //Wwattmetr readig VA


//calculations
IAB         = PAB/VAB;          //magnitude of IABC
IBC         = PBC/VAB;          //magnitude of IABC
ICA         = PCA/VAB;          //magnitude of IABC
c1           = 0;
c2           = (acos(0.8)*180/%pi);
c3           = -(acos(0.6)*180/%pi);
angle1       = c1-TVAB;
angle2       = c2-TVBC;
angle3       = c3-TVCA;
IAB1          = (IAB*cos(angle1))+(IAB*sin(angle1))*
   %i;
IBC1          = (IBC*cos(angle2*%pi/180))+(IBC*sin(-
   angle2*%pi/180))*%i;
ICA1          = (ICA*cos(angle3*%pi/180))+(ICA*sin(-
   angle3*%pi/180))*%i;
IA           = IAB1-ICA1;
IB           = IBC1-IAB1;
IC           = ICA1-IBC1;
W1           = -(VBC1)*IA;
```

```
W2          = VCA1*IB;



//result
mprintf("line current IA    = %3.2f %3.2f *j A",real
   (IA),imag(IA));
mprintf("\nline current IA    = %3.2f%3.2f*j A",real
   (IB),imag(IB));
mprintf("\nline current IA    = %3.2f + %3.2f*j A",
   real(IC),imag(IC));
mprintf("\nreading of wattmeter W1    = %3.2f W",W1
   );
mprintf("\nreading of wattmeter W2    = %3.2f W",W2
   );
```

Scilab code Exa 7.24 Find the power of the network

```
//
   ==========================================================

//chapter 7 example 24
clc;
clear all;

//variable declaration
W1  = 2000;     //reading of wattmeter in watts
W2  = 1000;     //reading of wattmeter in watts

//calculations
Q   = sqrt(3)*(W1-W2);      //reactive power of the
   network in V A
P   = Q/(sqrt(3));      //wattmeter reading when
   current coil is connected in one phase and the
   potential coil across the two phases in VA
```

```

//result
mprintf("Wattmeter reading = %3.2f  reactive volt amperes",P);
```

Scilab code Exa 7.25 `Calculate the wattmeter reading`

```
//
//chapter 7 example 25
clc;
clear all;

//variable declaration
VL  = 415;      //voltage in V
IL  = 20;       //current in A
pf  = 0.8;      //phase angle

//calculations
phi =acos(pf)       //phase angle in
phi1    = (phi*180)/%pi
x   = cos((30-phi1)*%pi/180)
W1  = VL*IL*x       //wattmeter reading in W
W2  = VL*IL*cos((30+phi1)*%pi/180)  //wattmeter reading in W
//total KVAR = sqrt(3))*(W1-W2)
// W    = totalKVAR/sqrt(3)
//W = (sqrt(3))*(W1-W2))/sqrt(3);       //wattmeter reading
W   = W1-W2             //wattmeter reading

//result
mprintf("reading on wattmeter 1 = %3.2d  W",W1);
mprintf("\nreading on wattmeter 2 = %3.2d  W",W2);
```

```
mprintf("\nreading on wattmeter = %3.2f W",W);
```

Chapter 8

Measurement of energy and energy meters

Scilab code Exa 8.1 Determine the meter constant in revolution

```
//
====================================================================
//chapter 8 example 1

clc;clear all;

//variable declaration
P       = 360;      //power in W
t        = 100;      //time in seconds
n       = 10;           //revolutions

//calculations
E      = (P*(t/(3600)))/(1000);     //energy
   consumed in kWh
M    = n/(E);            //meter constant in
   revolutions/KWh

//result
```

```
mprintf("meter constant in revolutions/KWh = %3.2f ",M);
```

Scilab code Exa 8.2 Calculate the power

```
//
//chapter 8 example 2


clc;clear all;

//variable declaration
V       = 220;      //voltage in V
I        = 5;           //current in A
Rp    = 8800;       //resistance of pressure in
V1     = 6;         //voltage excited in V

//calculations
P1      = V*I;                      //power consumed in current coil circuit in W
P2      = (V^2)/(Rp);                   //power consumed in pressure coil circuit in W
P        = P1+P2;                       //total power consumed in W
P11      = V1*I;                    //power consumed in current coil circuit in W
P21      = (V^2)/(Rp);                 //power consumed in pressure coil circuit in W
PP        = P11+P21;                //total power consumed in W

//result
mprintf("total power consumed for direct load
```

```
    arrangement = %3.2f W",P);
mprintf("\ntotal power consumed for phanton loading
    with current circuit = %3.1f W",PP);
```

Scilab code Exa 8.3 Calculate the error and state whether the meter is fast or slo

```
//
//chapter 8 example 3

clc;clear all;

//variable declaration
T      = 0.5;               //time in hours
V        = 220;       //voltage in V
I         = 5;              //current in A
P       = 525;              //consumption registered in
    Wh
P1       =0.525;            //consumption registered in
    kWh

//calculations

E       = ((V*I)/(1000))*T;       //energy consumed in
     kWh
e       = ((P1-E)/(E))*100;       //percentage error
    in %

//result
mprintf("percentage error  = %3.2f percentage(slow)
    ",e);
```

Scilab code Exa 8.4 Calculate the full load speed of the meter

```
//
    ====================================================================
//chapter 8 example 4


clc;clear all;

//variable declaration
M1      = 5;      //meter constant in A-s/rev
V        = 250;   //voltage in V
t          = 60;       //time in minute

//calculations
M2      = M1*V;       //meter constant in W-s/rev with
     rated voltage of 250V
M3         = M2/(1000*3600);       //meter constant in
   kWh/rev
M          = 1/(M3);            //meter constant in rev/
   kWh
E           = (M2/(t*1000));       //energy consumed in
     1 minute at full-load
S           = M*E;             //full-load speed in rpm

//result
mprintf("meter constant in revolutions per kWh = %3
   .2d",M);
mprintf("\nfull-load speed = %3.2d rpm",S);
```

Scilab code Exa 8.5 Determine the load in kWh

```
//
    ====================================================================
```

```
//chapter 8 example 5

clc;clear all;

//variable declaration
n      = 15;        //number of revolutions made
M     = 750;        //meter constant in revolutions
   per kWh
T       = 30;       //time in seconds

//calculations
E      = n/(M);     //Energy consumed in 30 seconds
L      = (E*3600)/T;    //load in kW

//result
mprintf("Energy consumed in 30 seconds = %3.2f kWh",
   E);
mprintf("\nLoad = %3.2f kW",L);
```

Scilab code Exa 8.6 Find out the percentage error

```
//
   ================================================================

//chapter 8 example 6


clc;clear all;

//variable declaration
M     = 500;        //meter constant in revolutions
   per kWh
n      = 40;        //number of revolutions made
T1     = 58.1;   //time in seconds
```

```
P       = 5;      //power in kW

//calculations
x     =P*T1;
E       =(x/3600);        //Energy consumed in 58.1
    seconds
E1    = n/(M);            //energy consumption
    registeredin kWh
e      = ((E1-E)/E)*100;      //percentage error in %

//result
mprintf("percentage error = %3.2f percentage",e);
```

Scilab code Exa 8.7 Calculate the percentage error

```
//
    ====================================================================

//chapter 8 example 7
clc;clear all;

//variable declaration
V       = 230;    //voltage in V
I       = 4.4;        //current in A
T       = 3;      //time in minutes
x       =1;       //cos(0)=1
n       = 10;         //number of revolutions made
M       = 200;        //meter constant in revolutions
    per kWh

//calculations
E      = (V*I*(T/(60))*x)/(1000);         //Energy
    consumed i3 minutes
E1    = n/(M);            //energy consumption
    registeredin kWh
```

```
e      = ((E1-E)/(E))*100;        //percentage error
    in %

//result
mprintf("percentage error = %3.3f percentage",e);
```

Scilab code Exa 8.8 Calculate how many units are recorded as error

```
//
    ================================================================

//chapter 8 example 8

clc;clear all;

//variable declaration
L      = 1;       //Load in kW
S      = 10.2;        //speed of the disc in rpm
T1        = 12;       //time in hours
M     = 600;      //meter constant in revolutions per
    kWh

//calculations
T2      = T1*60; //time in minutes
E       = L*T1;  //actual energy consumed in 12 hours
     in kWh
N      = S*T2;   //Revolutions made by the disc in 12
     hours
E1      = N/(M); //Energy consumption recorded by the
     meter
e     = E1-E;         //error in kWh

//result
mprintf("error = %3.2f kWh more",e);
```

Scilab code Exa 8.9 `Determine the speed of the disc`

```
//==========================================================================================================

//chapter 8 example 9

clc;clear all;

//variable declaration

V       = 240;  //voltage in V
I        = 8;       //current in A
T       = 1;        //time in minutes
x      =0.6;        //power factor
M     = 600;      //meter constant in revolutions per kWh

//calculations
E     = (V*I*(T/(60))*x)/(1000);        //Energy consumed 1 minute
S     = E*M;                    //speed of the disc in rev/minute

//result
mprintf("speed of the disc = %3.2f rev/minute",S);
```

Scilab code Exa 8.10 `Find out the error in registration and error in rpm of the me`

```
//==========================================================================================================
```

```
//chapter 8 example 10

clc;clear all;

//variable declaration
V        = 230;  //voltage in V
I          = 10;       //current in A
T        = 30;         //time in minutes
x        =0.8;         //power factor
n        = 890;        //number of revolutions made
M      = 1200;         //meter constant in revolutions per kWh
E        = 58.25;      //dial reading at the end of test
E1       = 57.35;          //dial reading at the start of test

//calculations
Ea       = (V*I*(T/(60))*x)/(1000);       //Energy consumed 1 minute
Em     = E-E1;              //energy consumption recorded by the meter in kWh
e          = Em-Ea;              //error in registration in kWh
N          = M*Em;               //actual revolutions required to be made by the  meter for an energy consumption of 0.90kWh
e        = (n-N)/(T);                //error in rpm

//result
mprintf("error = %3.2f rpm",e);
```

Scilab code Exa 8.11 `Calculate the power factor`

```
//
```

```
//chapter 8 example 11

clc;clear all;

 //variable declaration
V   = 230;             //voltage in volts
I   = 4;             //current in A
I1   = 5;             //current in A
cosphi   = 1;        //power factor
h        = 6;         //hours
R        = 2208;     //revolutios made by meter
R1        = 1472;     //revolutios made by meter
E1       = 400;       //energy consumption
h1        =4;

//calculations
E    = (V*I*cosphi*h)/(1000);     //energy
   consumption in kWh
M     = R/(E);                    //meter constant in
    rev/kWh
cosphi2    = (R1/(E1)*(1000/(V*I1*h1)));    //power
   factor of the load is cosphi2 for second
   measuremnet

//result
mprintf("meter constant = %3.2f revolutions/kWhr",M)
   ;
mprintf("\npower factor of the load is cosphi2 for
   second measuremnet = %3.2f",cosphi2);
```

Chapter 9

Measurement of Speed and Frequency and Power factor

Scilab code Exa 9.1 Determine the frequency of output pulses

```
//

//chapter 9 example 1

clc;clear all;

//variable declaration
N    = 1500;   //speed of shaft in rm
T    =120;      //number of teeth on rotator

//calculatins
f    = (N/60)*T;    //frequency of output pulses in pulses per second

//result
mprintf("frequency of output pulses in pulses = %3.2f pulses per second",f);
```

Scilab code Exa 9.2 Determine the speed of the shaft

```
//
=====================================================================

//chapter 9 example 2

clc;clear all;

//variable declaration
R   = 4;      //digital counter reading
G    = 0.001;     //gatting period in s
T     = 150;      //number of teeth on rotor

//calculations
f   = R/(G);    //number of pulses per second
N    = (f/T)*60;      //rotational speed in rpm

//result
mprintf("rotational speed = %3.2f rpm",N);
```

Scilab code Exa 9.3 Determine the speed of the shaft

```
//
=====================================================================

//chapter 9 example 3

clc;clear all;

//variable declaration
```

```
H     = 120;     //number of holes on the rotating disc
f     = 5400;    //frequency of output pulses in per second

//calculations
N     = (f/(H))*60;      //rotational speed in rpm

//result
mprintf("rotational speed = %3.2f rpm",N);
```

Scilab code Exa 9.4 Find the frquency

```
//

//chapter 9 example 4
clc;
clear all;

//variable declaration
f1   = 60;        //frequency in Hz
f2   = 50;        //frequency in Hz
C1   = 10^-6;         //inductance of circuit
R1   = 100;       //resistance in
C2   = 1.5*10^-6;         //capacitance

//calculations
L1   = 1/(4*((%pi)^2)*((f1)^2)*C1);  //inductance of circuit in H
w    = 2*%pi*f2;
Z1   = R1+(%i)*((w*L1)-(1/(w*C1)));       //impedance of circuit at 50 Hz
//Z2    = R1+(%i)*((w*L2)-(1/(w*C2)));       //impedance of circuit at 50 Hz
```

```
//real(Z2)     = real(Z1)
//((w*L2)-(1/(w*C2))) = real(Z1)=963
x        =abs((w*L1)-(1/(w*C1)))
y        = 1/(w*C2);
L2       =(x+y)/w;
z        = sqrt(1/(L2*C2));
f2  = (1/(2*%pi))*(z);

//result
mprintf("resonant frequency of circuit = %3.1f  Hz",
   f2);
```

Chapter 10

Measurement of Resistance

Scilab code Exa 10.1 Calculate the apparent resistance and actual resistance and t

```
//====================================================================
//chapter 10 example 1


clc;
clear all;

//variable declaration
V      = 100;          //voltmeter reading in V
I      =0.005;         //ammeter reading in A
S      = 1000;         //sensitivity of voltmeter in per volt
v      = 150;           //voltmeter range in V

//calculations
Rv      = S*v;              //voltmeter resistance in
Rm      = V/I;              //apparent value of unknown resistor in
y       = V/(I*Rv);
```

```
x       = I*(1-y);
Rx      = V/x;                    //actual value of unknown resistor in
er       = ((Rm-Rx)/Rx)*100;              //error due to loading effect of voltmeter in %

//result
mprintf("apparent value of unknown resistor = %3.2f",Rm);
mprintf("\nactual value of unknown resistor = %3.2f",Rx);
mprintf("\nerror due to loading effect of voltmeter = %3.2f percentage",er);
```

Scilab code Exa 10.2 Determine the resulting error

```
//
//chapter 10 example 2


clc;clear all;

//variable declaration
RA       = 2.5;       //resistance of ammeter
RV       = 6000;      //resistance of voltmeter
V        = 38.4;      //voltage in V
I        = 0.4;       //current in A

//calculations
Rx            = sqrt(RA*RV);   //value of unknown resisitance in
Rm            = V/I;       //measured value of unknown resistance in
```

```
Rx1          = V/(I*(1-(V/(I*RV))));      //true value of unknown resistance in
EA           = (1/2)*(1/100)*1;           //error on ammeter reading in A
EV           = (1/2)*(50/100);            //error on voltmeter  reading in V
PEA          = (EA/I)*100;            //percentage error at 0.4 A reading in %
PEV          = (EV/V)*100;            //percentage error at 38.4 A reading in %
E            = sqrt((PEA^2)+(PEV^2));         //error due to ammeter and voltmeter in %
AE           = (E/100)*Rx1;           //absolute error due to ammeter and voltmeter in
R1           =Rx1+AE;                 //resistance in

R2           = Rx1-AE;                //resistance in


//result
mprintf("resistance is specified as %3.3f and %3.3f ",R1,R2);
```

Scilab code Exa 10.3 Determine the value of unknown resistance

```
//

//chapter 10 example 3

clc;
clear all;


//variable declaration
```

```
V    = 120;         //voltage in V
I    = 8;           //current in A
RA   = 0.3;         //resistance in
AR   = 0.01;        //maximum reading of ammeter in A
VR   = 0.1;         //maximum reading of voltmeter in V
AR1  = 10;          //ammeter rane 0−10 A
AV1  = 150;         //voltmeter range in 0−150 V
EA   = 0.25;        //constructional error of ammeter in %
EV   = 0.5;         //constructional error of voltmeter in %


//calculations
Rm       = V/I;       //measured value of unknown resistance in
Rx       = Rm-RA;         //true value of unknown resistance in
EA1      =  (AR/AR1)*100;     //reading error of ammeter in %
EV1      = (VR/AV1)*100; //reading of voltmeter in %
dI       = EA+EA1;         //error in ammeter reading in %
dv       = EV+EV1;         //error in voltmeter reading in %
d        =dI+dv;      //total error in % ranging − to +
R1       = Rx+d;      //Value of Rx is specified as
R2       = Rx-d;      //Value of Rx is specified as

//result
mprintf("Value of Rx is specified = %3.3f,%3.3f   ", R1,R2);
```

Scilab code Exa 10.4 Determine the value of resistor under test

```
//
    ==========================================================================================
//chapter 10 example 4
clc;
clear all;

//variable declaration
S   = 0.02;      //resistance of standard resistor in

Vs  = 0.98;      //voltage drop across standard
    resistor in V
Vx  = 0.735;         //voltage drop across resistor
   under test in V

//calculations
X   = (S*Vx)/Vs;     //Resistance of resistor under
    test in

//result
mprintf("Resistance of resistor under test= %3.3f
      ",X);
```

Scilab code Exa 10.5 Determine the value of resistor under test

```
//
    ==========================================================================================
//chapter 10 example 5
clc;clear all;

//variable declaration
Vx1 = 0.835;         //indicated calue of voltage
   drop across the unknown resistance in V
emf = -25*10^-6;     //thermal emf with unknown
```

```
resistance in V
S   = 0.10025;      //resistance of standard resistor in
Vs  = 0.984;        //voltage drop across standard resistor in V

//calculations
Vx  = Vx1-emf;
X   = (S*Vx)/Vs;    //Resistance of resistor under test in

//result
mprintf("unknown resistor = %3.5f    ",X);
```

Scilab code Exa 10.6 Calculate the unknown resistance

```
//

//chapter 10 example 6

clc;clear all;

//variable decalartion
p   = 200.62;       //resistance in
q   = 400;      //resistance in
P   = 200.48;       //resistance in
Q   = 400;      //resistance in
S   = 100.03;       //resistance in
r   = 700;      //resistance in

//calculations
X       = ((P/Q)*S)+((q*r)/(p+q))*((P/Q)-(p/q));

//result
```

```
mprintf("unknown resistance = %3.4f u ",X);
```

Scilab code Exa 10.7 Determine the value of unknown resistacne

```
//
    =========================================================

//chapter 10 example 7


clc;clear all;


//variable declaration
P    = 100;       //resistance in
Q    = 10;        //resistance in
S    = 46;        //resistance in

//calculations
R    = (P/Q)*S;       //unknown reistance in

//result
mprintf("unknown resistance  = %3.2f    ",R);
```

Scilab code Exa 10.8 Determine the value of unknown resistance

```
//
    =========================================================

//chapter 10 example 8

clc;clear all;

```

```
//variable declaration
S    = 6;          //resistance in
AB   = 25;         //length of AB in cm
BC   = 75;         //length of BC in cm

//calculations
R    = (AB/BC)*S;          //unknown reistance in

//result
mprintf("unknown resistance  = %3.0f    ",R);
```

Scilab code Exa 10.9 Determine the dials required to adjusted for obtaining the re

```
//

//chapter 10 example 9

clc;clear all;

//variable decalartion
R    =5000;       //a resistance of apporximately required to balance a bridge in
E    = 0.1;       //in per cent

//calculations
R2   = R+(R*(E/100));     //limiting value in
R1   = R-(R*(E/100));     //limiting value in

//result
mprintf("limiting value %3.0f     to %3.0f   ",R1,R2);
mprintf("\nThus dials of 1000,100,10,1    would have to be adjusted");
```

Scilab code Exa 10.10 `Calculate the limiting values of unknown resistance`

```
//

//chapter 10 example 10


clc;
clear all;

//variable declaration
P   = 100;      //resistance in
Q   = 100;      //resistance in
S   = 230;      //resistance in
dP  = 0.02;     //limiting error(dP/P) in  %
dQ  = 0.02;     //limiting error(dQ/Q) in  %
dS  = 0.01;     //limiting error(dS/S) in  %

//calculations
R   = (P/Q)*S;        //unknown reistance in
dR  =dP+dQ+dS;  //limiting error(dR/R) in %
dR1 = (dR*R)/100;
R1  = R-dR1;          //limitng values of unknown resistance in
R2  = R+dR1;          //limitng values of unknown resistance in

//result
mprintf("unknown resistance  = %3.0f    ",R);
mprintf("limitng values of unknown resistance %3.3f to %3.3f    ",R1,R2);
```

Scilab code Exa 10.11 Find the magnitude and direction of the current flowing thro

```
//
=====================================================

//chapter 10 example 11

clc;clear all;

//variable declaration
P   = 1000;     //resistance in arm AC in
Q   = 1000;     //resistance in arm AD in
S   = 100;      //resistance in  arm CB in
R   = 101;      //resistance in arm BD in
Rg  = 50;       //galvanometer resistance in
E   = 2;        //voltage in V

//calculations
R1  = (Q*S)/P;      //resistance required in arm BD
    for balance bridge
dR  = R-R1;     //the deviation from balanced
    condition in
Eth = E*(((R1+dR)/(R1+dR+S))-(P/(P+Q)));    //
    thevenin's open circuit voltage in V
Rth = (((R1+dR)*S)/(R1+dR+S))+((P*Q)/(P+Q));    //
    thevenin's equivalent resistance of bridge in
Ig  = Eth/(Rth+Rg);         //galvanometer current
    in A

//result
mprintf("galvanometer current = %3.3f uA",(Ig*10^6))
    ;
mprintf("\nsince the point B is at higher potential
    with respect to point A ,current will floe from
```

terminal A");

Scilab code Exa 10.12 Determine the sensitivity of the bridge

```
//
// ==================================================
//chapter 10 example 12
clc;clear all;

//variable declaration
P    = 100;       //resistance in arm AB in
Q    = 1000;      //resistance in arm BC in
S    = 2000;      //resistance in  arm CD in
R    = 202;       //resistance in arm BD in
Rg   = 200;       //galvanometer resistance in
E    = 5;         //voltage in V
Si   = 5;         //current sensitivity of the
   galavanometer in mm/uA

//calculations
Si1 = 5*10^9;         //current sensitivity of the
   galvanometer in mm
R1   = (P*S)/Q;       //resistance required in arm BD
   for balance bridge
dR   = R-R1;      //the deviation from balanced
   condition in
Eth = E*(((R1+dR)/(R1+dR+S))-(P/(P+Q)));     //
   thevenin's open circuit voltage in V
Rth = (((R1+dR)*S)/(R1+dR+S))+((P*Q)/(P+Q));     //
   thevenin's equivalent resistance of bridge in
Ig   = Eth/(Rth+Rg);          //galvanometer current
   in A
d    = Si1*Ig;                //deflection of the
   galvanometre theta in mm
```

```
S   = d/dR;                //sensitivity of the bridge in mm/

//result
mprintf("galvanometer current = %3.2e A",Ig);
mprintf("\ndeflection of the galvanometre theta = %3.1f mm",(d*10^-3));
mprintf("\nsensitivity of the bridge = %3.2f mm/ ",(S*10^-3));
```

Scilab code Exa 10.13 Determine the ratio of galvanometer sensitivities

```
//
//chapter 10 example 13
clc;
clear all;

//variable declaration
P   = 1000;     //resistance in arm AB in
Q   = 100;      //resistance in arm BC in
R   = 200;      //resistance in arm BD in
Si1 = 10;       //sensitivity
Si2 = 5;        //sensitivity
Rg1 =400;
Rg2 =100;

//calculations
S   = R*Q/P;         //resistance required in arm CD in
Rth = ((R*S/(R+S))+(P*Q/(P+Q)));        //thevenin's equivalent resistance of bridge in
//theta = (Si*E*S*dR)/((R+S)^2)*(Rth+Rg1))
//theta2/theta1  = (Si*E*S*dR)/((R+S)^2)*(Rth+Rg1))
```

```
   *(((R+S)^2)*(Rth+Rg1)/(Si*E*S*dR))
r        = (Si2/Si1)*((Rth+Rg1)/(Rth+Rg2));  //ratio
   deflection of  two galvanometer

//result
mprintf("ratio deflection of  two galvanometer   =
   %3.3f    ",r);
mprintf("\nthe first galvanometer (internal
   resistance 400    and sensitivity 10 mm/uA) is
   less sensitive to a small unbalance on the given
   bridge ,through on its own it is more sensitive
   than the other galavanometer")
```

Scilab code Exa 10.14 Determine the smallest change in the resistance

```
//

//chapter 10 example 14

clc;
clear all;

//variable declaration
P   = 500;      //resistance in arm AB in
Q   = 500;      //resistance in arm BC in
S   = 500;      //resistance in  arm CD in
R   = 500;      //resistance in arm BD in
Rg  = 100;      //galvanometer in
E   = 10;       //battery voltage in V
Rth = 500;      //thevenin's equivalent resistanceof
    bridge
Ig  = 10^-9;          //galavanometer capable of
   detecting Ig current in A

```

```
//calculations
//Eth    = (E*dR)/(4*R);
x    = E/(4*R);        //thevenin or open -circuit
    voltage in dR
//Ig     = Eth/(Rth+Rg)
y    = x/(Rth+Rg);    //current through galvanometer
dR   = (Ig*(Rth+Rg))/x;        //the smallest change in
     resistance that can be detected in

//result
mprintf("the smallest change in resistance that can
    be detected = %3.2f m   ",(dR*10^3));
```

Scilab code Exa 10.15 Determine the value of resistance

```
//
   ================================================================

//chapter 10 example 15
clc;clear all;

//variable declaration
P    = 200;        //resistance in arm  in
Q    = 200;        //resistance in arm  in
S    = 200;        //resistance in  arm in

R    = 200;        //resistance in arm  in
p    = 0.5;        //power in W
r    = 2;          //r is internal resistance of
    battery in
E    = 24;         //voltage in V

//calculations
//P = (I^2)*R;       power disiipation in W
I    = sqrt(p/R);
```

```
V   = I*2*R;         //the maximum voltage ,that can
   be appliedto the bridge in V
I1  = 2*I;       //current through series resistor in
    A
//E = V+(2*I*(r+R)  battery emf E
R1  = ((E-V)/I1)-r; //series resistance in

//result
mprintf("current = %3.2f A",I);
mprintf("\nseries resistance = %3.2f    ",R1);
```

Scilab code Exa 10.16 Determine the maximum value of the resistance and internal r

```
//

//chapter 10 example 16

clc;clear all;

//variable declaration
P   = 10000;         //resistance in arm AB in
Q   = 10;        //resistance in arm BC in
S   = 5000;      //resistance in arm BD in
Si  = 10^8;      //sensitivity
Rg  =100;        //galvanometer resistance in
E   = 12;        //voltage in V
d   = 2.5;       //deflection in mm



//calculations
R   = P*S/Q;         //resistance required  in  arm
   CD in
Rth = ((R*S/(R+S))+(P*Q/(P+Q)));        //thevenin's
```

```
equivalent resistance of bridge in
dR  = ((d*(Rth+Rg)*((R+S)^2))/(Si*E*S));         //change in defelection in

//result
mprintf("the maximum value of resistance that can be measured with the given arrangement = %3.2f   ",R);
mprintf("\nchange in defelction = %3.2f k   ",(dR*10^-3));
```

Scilab code Exa 10.17 Calculating how far are the balance positions

```
//====================================================================================
//Chapter 10 Example 17


clc;clear all;

//variable declaration
r    = 0.0250;         //resistance in
R    = 1.0125;         //resistance in
S    = 1         //sensitivity
P1    = 10;         //resistance in
Q1    = 10;         //resistamce in
P2    = 9.95;         //resistance in
Q2    = 10.05;         //resistamce in
l   = 100;

//calculations
r1    = r/100;         //resistance in     per scale division
x1    = P1/Q1;
```

```
x2     = P2/Q2;
//P/Q     = (R+(l1*r))/(S+(l-l1)*r)
//(s*x)+((l-l1)*r) = R+(l1*r)
//(S*x)+(l*r)-(l1*r) = R+(L1*r)
//(S*x)+(l*r)-R = (l1*r)+(l1*r)
l1      = ((S*x1)+(l*r1)-R)/(r1+r1);          //scale
   divisions
l12     = ((S*x2)+(l*r1)-R)/(r1+r1);          //scale
   divisions

//result
mprintf("hence the balance is obtainde at %3.0f and
   75 scale divisions",l1);
mprintf("\nhence the balance is obtainde at %3.0f
   and 95 scale divisions",l12);
```

Scilab code Exa 10.18 Calculate the insulation resistance of the cable

```
//
   ==========================================================================

//chapter 10 example 18

clc;clear all;

//variable declaration
V1   = 250;       //voltage in V
V2    = 92;       //voltage in V
t    = 60;        //time in seconds
C    = 600*10^-12;    //capacitance in F

//calculations
//V2     = V1*e^(t/C*R)
R    = t/(C*log(V1/V2))

```

```
//result
mprintf("insulation resistance = %3.0f M    ",(R
   *10^-6));
```

Scilab code Exa 10.19 Calculate the insulation resistance of the cable

```
//
   ==================================================================
//chapter 10 example 19

clc;clear all;

//variable declaration
V1  = 100;       //voltage in V
V2   = 80;       //voltage in V
t   = 20;        //time in seconds
C   = 300*10^-12;    //capacitance in F

//calculations
//V2    = V1*e^(t/C*R)
R   = t/(C*log(V1/V2))

//result
mprintf("insulation resistance = %3.2e M   ",(R
   *10^-6));
```

Scilab code Exa 10.20 Calculate the insulation resistance of the cable

```
//
   ==================================================================
//chapter 10 example 20
```

```
clc;clear all;
//variable declaration
V1  = 200;        //voltage in V
V2   = 126;       //voltage in V
t   = 30;         //time in seconds
V12 = 200;        //voltage in V
V22  = 100;       //voltage in V

//calculations
//let CR = a
//V2     = V1*e^(t/C*R)
a        = t/log(V1/V2);      //C*R
//R1     = (10*R)/(10+R)
a1        = t/log(V12/V22);       //C*R1
//a1/a   =R1/R=x
x   = a1/a;
//since R1       =  (10*R)/(10+R)
//x*(10+R)*R = 10*R
//(x*10)+R*x = 10
R = (10-(x*10))/x;       //Resistance in

//result
mprintf("resistance = %3.2f M   ",R);
```

Scilab code Exa 10.21 Calculate the value of R

```
//
//chapter 10 example 21
clc;clear all;

//variable declaration
V1  = 450;        //voltage in V
V2   = 280;       //voltage in V
```

```
t    = 15.2;       //time in minutes
t1   = 10.8;       //time in minutes
C    = 2.5*10^-6;      //capacitance in F

//calculations
t12 = t*60;       //time in seconds
t22 = t1*60;           //time in seconds
//V2     = V1*e^(t/C*R)
x     = V1/V2;
y     = log(x);
R    = t12/(C*y);
R1   =t22/(C*y);
//R1     = t1/(C*log(V1/V2));
//1/R`   = (1/R1)-(1/R)
R11 = (R1*R)/(R-R1);         //unknown resistance in


//result
mprintf("unknown resistance= %3.2d M   ",(R11*10^-6)
   );
```

Scilab code Exa 10.22 Calculate the insulation resistance of the cable

```
//
   ==================================================================

//chapter 10 example 22
clc;
clear all;

//variable declaration
r    = 250;       //number of scale divisions
   galvanometer can read
s    = 2.5;       //universal shunt multiplier
r1   = 350;       //number of scale reading
```

```
s1   = 1000;      //universal shunt multiplier when standard resistor is connecter
S    = 1000000;

//calculations
//IR praportional to galvanometer*universal shunt multiplier
IR   = r*s;  //current through the circuit with unknown resistance Rconnected
Is   = r1*s1;    //current through the circuit with standard resistance in S
R1   = (Is/IR)*S;    //insulation resistance of cable in

//result
mprintf("insulation resistance of cable = %3.2f M "
,(R1*10^-6));
```

Scilab code Exa 10.23 Determine Rsh AND Rse AND maximum value of Rsh and scale err

```
//
=====================================================================

//chapter 10 example 23
clc
clear all

//variable declaration
V     = 3;        //battery voltage in volts
Rm     = 60;        //resistance in
Ifm     = 1.2;        //full-scale deflection meter current in mA
Rh     = 1500;        //half-scale deflection resistance in
V1     = 0.3;        //at 10 % drop in battery
```

```
   voltage in V

//calculations
If     = V/Rh;     //battery current for full-scale deflection in A
If1      = If*10^3;           //battery current for full-scale deflection in mA
Ish     = If1-Ifm;          //current through zero adjuster resistor i.e,shunt resistor in mA
Rsh     = (Ifm*Rm)/Ish;     //resistance in
Rse     = Rh-((Rsh*Rm)/(Rsh+Rm));     //current limiting resistor i.e,series resistor
V3     = V-V1;          //voltage in V
If2     = V3/Rh;          //battery current at full-scale deflection in A
If21     = If2*10^3;          //battery current at full-scale deflection in mA
Ish1     =If21-Ifm;          //current through shunt resistor in mA
Rsh1     = (Ifm*Rm)/Ish1;     //shunt resistor in
Rh1     = Rse+((Rm*Rsh1)/(Rm+Rsh1));          //total internal circuit resistance in
e     =((Rh-Rh1)/(Rh1))*100;          //percentage error in %

//calculation
mprintf("resistance = %3.2f     ",Rsh);
mprintf("\ncurrent limiting resistor = %3.2f     ",Rse);
mprintf("\nshunt resistor = %3.2f     ",Rsh1);
mprintf("\npercentage error = %3.3f percentage ",e);
```

Scilab code Exa 10.24 Determine the value of current

```
//
```

```
//chapter 10 example 24

clc;
clear all;

//variable declaration
V = 3;  //battery voltage in volts
Rm = 2;  //meter resistance in
Ifm = 10;  //full scale deflection meter current in mA
Rh = 0.5;  //half scale deflection resistance in

//calculations
Im = 0.5*Ifm;              //half-scale deflection of the movement
Vm = Im*Rm;                //voltage across movement in mV
Ix = (Vm*10^-3)/Rh;            //current through resistor in A
Ix1  = Ix*10^3;              //urrent through resistor in mA
IB = Im+Ix1;               //total battery current in mA
V1 = V-(Vm*10^-3);            //voltage drop across current lo V
Rse = V1/(IB*10^-3);           //current limiting resistor in

//result
mprintf("current limiting resistor = %3.1f  ",Rse);
```

Chapter 11

Potentiometers

Scilab code Exa 11.1 Determine emf and current and voltage and percentage error in

```
//
===============================================================================

//chapter 11 example 1

clc;clear all;

//variable declartion
v    = 1.0186;        //emf of standard cell in volts
l    = 60;        //length in cm
l1   = 75;        //length in cm
l2   = 66;        //length in cm
l3   = 84;        //length in cm
l4   = 40;        //length in cm
l5   = 72;        //length in cm
S    = 2;         //resistance in
r    = 100;       //ratio of volt ratio box
S1   = 2.5;       //resistance in
I    = 0.28;      //ammeter reading in ampere
v1   =1.25;       //voltmeter reading in volts

```

```
//calculations
v0  = v/l;      //the voltage drop per cm length of
    potentiometer wire in volt
V1  = v0*l1;        //emf of cell which balances at
    75 cm  in volts
V2  =  v0*l2;       //emf of cell which balances at
    66 cm  in volts
I1  = v/S;      //current flowing through 2
    resistance in A
V3  =  v0*l3;       //emf of cell which balances at
    84 cm  in volts
v31 = V3*r;     //voltage of supply main in volts
V4  =  v0*l4;       //emf of cell which balances at
    40 cm  in volts
I4  =V4/S1;     //current flowing through 2.5
    resistance in A
e   = ((I-I4)/I4)*100;  //percentage error in the
    ammeter reading in %
V5  =  v0*l5;       //emf of cell which balances at
    72 cm  in volts
e1  = ((v1-V5)/V5)*100; //percentage error in the
    voltmeter reading in %

//result
mprintf("emf of cell which balances at 75 cm  = %3.5
    f volts",V1);
mprintf("\ncurrent flowing through 2    resistance =
    %3.5f A",I1);
mprintf("\nvoltage of supply main in volts = %3.5f
    volts",v31);
mprintf("\npercentage error in the ammeter reading =
    %3.1d percentage high",e);
mprintf("\npercentage error in the voltmeter reading
    = %3.2f percentage ",e1);
```

Scilab code Exa 11.2 Calculate the resolution of potenetiometer

```
//
=============================================================

//chapter 11 example 2
clc;
clear all;

//variable declaration
R    = 10;        //resistance of slide wire in
n    = 15;        //number of steps of dial
r    = 10;        //resistance of each dial in
I    = 0.01;      //working current in A
N    = 100;       //number of divisions of slide
a    = 0.2;       //each division of slide can read
   upto a accurately of its span

//calculations
R1   = (n*r)+R;       //total resistance of
   potentiometer in
V    = I*R1;      //voltage range of the potentiometer
    V
v    = R*I;       //voltage drop across slide wire V
x    = v/N;       //each division represents in V
y    = x*a;       //resolution of potentiometer in V

//result
mprintf("resolution of potentiometer = %3.4f V",y);
```

Scilab code Exa 11.3 Calculate the working current and resistance and measurement

```
//
=============================================================
```

```
//chapter 11 example 3
clc;
clear all;

//variable declaration
R    = 400;       //total resistance of slide-wire of 200 cmin
L1   = 101.8;         //length of slide wire in cm
L    = 200;       //length of wire in cm
v1   = 1.018;         //voltage drop across 101.8cm length of slide wire in V
v    = 3;         //battery voltage in V
a    = 0.2;       //it is possible to read a of 1 mm

//calculations
R1   = (R/L)*L1;      //resistance of slide wire of 101.8 cm in
I1   = v1/R1;         //working current in A
RT   = v/I1;      //total resistance of battery circuit in
RR   = RT-R;      //resistance of series rheostat in

r    = I1*R;      //measuring range in V
//since 200cm length represents 2 V
//1 mm length represents = z
z    = (r/L)*(1/10); //voltage represented for 1mm length
Ri   = z*a;       //resolution of instrument in mV

//result
mprintf("working current = %3.1e A",(I1*10^3));
mprintf("\nresistance of series rheostat = %3.2f    ",RR);
mprintf("\nmeasuring range = %3.2f  V",r);
mprintf("\nresolution of the instrument = %3.2f mV",(Ri*10^3));
```

Scilab code Exa 11.4 Calculate the inductance of the coil

```
//
    ========================================================================
//chapter 11 example 4

clc;
clear all;

//variable declaration
R1    = 0.1;          //standard resistance in
V2    = 0.613;          //voltage drop across standard
    resistance in V
a    = 100;
r    = 0.781;          //volt ration box
theta    = 50.48;
theta1    = 12.6;
f         = 50;            //frequency in in HZ

//calculations
I    = V2/R1;          //current through coil in A
V1    = a*r;          //voltage drop across inductive
   coil in V
theta2 = theta -theta1;
L    = V1*sin(theta2*180/%pi)/(2*%pi*f*I);    //
   inducatance of coil in H

//result
mprintf("inductance of coil =%3.2f H",L);
```

Scilab code Exa 11.5 Calculate the resistance and reactance of the coil

```
//
//chapter 11 example 5

clc;clear all;

//variable declaration
R1  = 1;         //standard resistance in
V3  = 0.952-0.340*%i;    //voltage  through the coil in A
a   = 10;        //multiplying power of potential divider
V2  = 1.35+1.28*%i; //voltage  across potential in A

//calculations
x  = complex([0.952,-0.342])
y  = complex([1.35,1.28])
I   = x/R1;,         //current through coil in A
I   = x/R1       //current through coil in A
I1   = 0.952-0.340*%i;
V1  = a*y        //voltage across coil in V
V11 = 13.5+12.8*%i;
Z   = V11/I1
R   = real(Z)        //resistance of coil in
X   = imag(Z)        //reactance of coil

//result
mprintf("%g + %gi\n",R,X);
mprintf("resistance of coil  = %3.4f   ",R);
mprintf("\nreactance of coil = %3.2f   ",X);
```

Scilab code Exa 11.6 Calculate the resistance and reactance of the coil

```
//
```

```
//chapter 11 example 6

clc;
clear all;

//variable declaration
R        = 1;                  //resistace in
V2       = 0.238-%i*0.085;               //voltage across
    standard resistor in V
P        = 10;                 //multiplying ower of
   potential divider
V1       = 0.3375+%i*0.232;       //voltage across
   potential divider in V



//calculations
I        = V2/R;               //current through coil
   in A
V2       = P*V1;                //voltage acrossthe
   coil in V
Z        = V2/I;               //impedance of coil in

R1        = real(Z);               // resistance of
   coil in
X1        =imag(Z);            //reactance of coil in


//result
mprintf("resistance = %3.2f   ",R1);
mprintf("\nreactance = %3.3f   ",X1);
```

Scilab code Exa 11.7 Determine the core loss in the choke coil

```
//
//chapter 11 example 7

clc;
clear all;

//variable declaration
R1           = 1.0;      //resistace in
V1           = 0.8-%i*0.75;      //voltage drop across the resistance in volt
V2           = 1.2+%i*0.3;      //voltage across the coil in volt

//calculations
I        = V1/R1;         //current through coil in A
x        = (atan(imag(V1)/real(V1)))*180/%pi;
y        = (atan(imag(V2)/real(V2)))*180/%pi;
phi      = y-x;
a        =sqrt(((real(V2))^2)+((imag(V2))^2));
b        =sqrt(((real(I))^2)+((imag(I))^2));
V3       = a*cos(phi*%pi/180);          //resistive drop the coil in V
P        = a*b*cos(phi*%pi/180);          //power loss in the coil in W


//result
mprintf("iron loss in the coil =%3.3f watt",P);
```

Scilab code Exa 11.8 Determine the true reading of the wattmeter and the load powr

```
//
```

```
//chapter 11 example 8

clc;
clear all;

//variable declaration
R1    = 0.1;          //standard resistance in
V1  = 0.35-%i*0.1;       //voltage drop across
   resistance in V
V2  = 0.8-%i*0.15;        //voltage  across coil in V

//calculations
I     = V1/R1;,         //current through coil in A
V      = 300*V2;        //apply voltage V
x1    = real(I);
y1    = abs(imag(I));
V1    = sqrt((x1^2)+(y1^22));
x    = real(V);
y    = imag(V);
I1    = sqrt((x^2)+(y^2));
P     = (x1*x)+(y1*y);
//pf     = P/(V1*I);          //power factor of the
   load circuit in lagging
pf       = P/(V1*I1);              //power factor of
   the load circuit in cos(phi)

//result
mprintf("power factor of the load circuit = %3.3f
   lagging",pf);
```

Chapter 12

AC bridges

Scilab code Exa 12.1 Determine whether to balance the bridge

```
//
   ==============================================================
//Chapter 12 example 1
clc;clear all;

//variable declaration
Z1          =  100;         //resistance of arm  in

Z2          =  50;          //resistance of arm  in

Z3          =  200;         //resistance of arm  in

Z4          =  100;         //resistance of arm  in

theta1        = 30;         //phase angle in
theta2        = 0;          //phase angle in
theta3        = -90;            //phase angle in
theta4        = 30;         //phase angle in

//calculations
```

```
x       = Z1*Z4;      //magnitude
y       = Z2*Z3;      //magnitude
thetax    = theta1+theta4;
thetay    = theta2+theta3;

//result
mprintf("x    = %3.2f",x)
mprintf("\nx    = %3.2f",y);
mprintf("\nsince x =y\n');
mprintf("\nthe first condition is satisfied');
mprintf("\nthetax = %3.2f",thetax);
mprintf("\nthetay    = %3.2f",thetay);
mprintf("\nsecond condition is not saatisfied ');
mprintf("\nIt means bridge is unbalancedthrough first condition for equality of magnitude product satisfied,obviously balance is not possible under above conditions");
```

Scilab code Exa 12.2 Determne whether or not the bidge is complete balance

```
//==========================================================================

//Chapter 12 Example 2

clc;
clear all;

//variable declaration
Z1           = 1000;          //resistance of arm in

Z2           = 500;           //resistance of arm in

Z3           = 1000;          //resistance of arm in
```

```
Z4           = 509.9;            //resistance of arm in
ZX4          =100+500*%i;
theta1       = -90;          //angle in
theta2       = 0;          //angle in
theta3       = 0;          //angle in
theta4       = -90;          //angle in
theta41      = 78.69;

//calculations

thetax        = theta1+theta41;
thetay          = theta2+theta3;
x            = Z2*Z3;
//Z1*Z4  =Z2*Z3
//1/Z1       = A      = Z4/Z2*Z3    = Z4/x
A            = ZX4/x;
//1/Z1       = 1/R1 +(w*C1)*%i
Zx3          = (Z1*Z4)/Z2;
thetax3          = theta1+theta41-theta2;
Z3           = (Zx3*cos(thetax3*%pi/180))+(Zx3*sin(thetax3*%pi/180));



//result
mprintf("thetax          = %3.2f   ",thetax);
mprintf("\nthetax          = %3.2f   ",thetay);
mprintf("\nbalance can be restored by modifying the circuit so asto satisfy the phase angle condition");
mprintf("\ncomparing equations  1 and 2 R1      = %3.2f",1/real(A));
mprintf("\ncomparing equations  1 and 2  1/w*C1    = %3.2e",imag(A));
mprintf("\n1/w*C1 is already equal to 1000      so the bridge can be easily balanced by adding 5000     accross capacitor in arm 1");
mprintf("\nsince R3 is already of 1000    so the
```

```
bridge can be easily balanced by adding capacitance 200    in series across in arm 3");
mprintf("Note:there was a possibility that with the addition of resistance R1 in armm 1 as first option or with teh addition of capacitance  C3 in arm 3");
```

Scilab code Exa 12.3 Find the resistance and inductance of the coil

```
//==============================================================

//Chapter 12 Example 3


clc;clear all;

//variable declaration
R2          = 100;       //resistance of arm  in
R3          = 32.7;      //resistance of arm  in
R4          = 100;       //resistance of arm  in
R          = 1.36;       //resistance of arm  in
L        = 47.8;         //inducatance in mH


//calculations
R1    = ((R2*R3)/(R4))-R;        //resistance of coil in
L1     = (R2/(R4))*L;        //in case of balanced position of bridge in mH

//result
mprintf("Resistance pf the coil = %3.2f    ",R1);
mprintf("\ninductance in case of balanced bridge = %3.2f mH",L1);
```

Scilab code Exa 12.4 Find the resistance and inductance

```
//
    ===================================================

//Chapter 12 Example 4

clc;clear all;

//variable declaration
R2         = 1000;      //resistance of arm  in
R3         = 1000;      //resistance of arm  in
R4         = 1000;      //resistance of arm  in
C4        = 0.5*10^-6;      //capacitance in F

//calculations
R1    = ((R2*R3)/(R4));      //resistance of coil in

L1     = C4*R2*R3;           //inductance of inductor
    in H

//result
mprintf("resistance of coil  = %3.2f   ",R1);
mprintf("\ninductance of inductor = %3.2f H",L1);
```

Scilab code Exa 12.5 Find the resistance and inductance of the unknown resistance

```
//
    ===================================================

//Chapter 12 Example 5
```

```

clc;clear all;

//variable declaration
R2          = 1000;       //resistance of arm  in
R3          = 218;        //resistance of arm  in
R4          = 1000;       //resistance of arm  in
C4         =  10*10^-6;       //capacitance in F
r            = 469;

//calculations
R1    = ((R2*R3)/(R4));      //resistance of coil in

x      = (r*(R3+R4))+(R3*R4)
L1     = (C4*R2*x)/(R2);             //inductance of
   inductor in H

//result
mprintf("resistance of coil  = %3.2f   ",R1);
mprintf("\ninductance of inductor = %3.2f H",L1);
```

Scilab code Exa 12.6 Find the resistance and inductance

```
//
   ====================================================================

//Chapter 12 Example 6

clc;clear all;

//variable declaration
R2          = 400;        //resistance of arm  in
R3          = 400;        //resistance of arm  in
R4          = 400;        //resistance of arm  in
C4         =  2*10^-6;        //capacitance in F
```

```
r            = 500;      //resistance in

//calculations
R1     = ((R2*R3)/(R4));      //resistance of coil in

x       = (r*(R3+R4))+(R3*R4)
L1      = (C4*R2*x)/(R3);            //inductance of
   inductor in H

//result
mprintf("resistance of coil   = %3.2f    ",R1);
mprintf("\ninductance of inductor = %3.2f Henry",L1)
   ;
```

Scilab code Exa 12.7 Find the resistance and inductance

```
//
   ===================================================

//Chapter 12 Example 7

clc;clear all;

//variable declaration
R2           = 1000;      //resistance of arm  in
R3           = 500;       //resistance of arm  in
R4           = 1000;      //resistance of arm  in
C4          =  3*10**-6;      //capacitance in F
r            = 100;

//calculations
R1     = ((R2*R3)/(R4));      //resistance of coil in

x       = (r*(R3+R4))+(R3*R4)
L1      = (C4*R2*x)/(R4);            //inductance of
```

```
inductor in H

//result
mprintf("resistance of coil  = %3.2f  ",R1);
mprintf("\ninductance of inductor = %3.2fHenry",L1);
```

Scilab code Exa 12.8 Find the resistance and inductance

```
//
==========================================================

//Chapter 12 Example 8

clc;clear all;

//variable declaration
R2          = 1000;       //resistance of arm  in
R3          = 16800;          //resistance of arm  in

R4          = 833;        //resistance of arm  in
C4         = 0.38*10^-6;      //capacitance in F
f            = 50;        //frequency in Hz

//calculations
w        = 2*(%pi)*f;
L1      = (R2*R3*C4)/(1+((w^2)*(R4^2)*(C4^2)));
   //inductance in H
R1      = (R2*R3*R4*(w^2)*(C4^2))/(1+((w^2)*(R4^2)*(
   C4^2)));      //resistance in


//result
mprintf("inductance of inductor = %3.2fHenry",L1);
mprintf("\nresistance of coil  = %3.2f  ",R1);
```

Scilab code Exa 12.9 Find the Resistance and Capacitance

```
//
//Chapter 12 Example 9

clc;clear all;

//variable declaration
R2          = 1000;       //resistance of arm  in
R3          = 1000;       //resistance of arm  in
R1          = 500;        //resistance of arm  in
L1          = 0.18;       //inductance in H

//calculations
f            = 5000/(2*(%pi));        //frequency in
    Hz
w           = 2*(%pi)*f;
x      =    R1/((w^2)*L1);         //R4*C4 be x
z   = ((w^2)*(x^2));
a     = (1+z);
C4       = (L1*a)/(R2*R3);
//from 1 and 2 equations
//R4    = R4*C4/C4 = x/C4
R4       = (x)/(C4);      //resistance  in

//result
mprintf("resistance = %3.2f    ",R4);
```

Scilab code Exa 12.10 Find the series equivalent inductance and resistance of the

```
//
=====================================================================
//Chapter 12 Example 10

clc;clear all;

//variable declaration
R2          = 1000;       //resistance of arm  in
R3          = 10000;          //resistance of arm  in

R4          = 2000;       //resistance of arm  in
C4         = 1*10**-6;        //capacitance in F
w        = 3000;      //radian per second

//calculations

L1      = (R2*R3*C4)/(1+((w^2)*(R4^2)*(C4^2)));
   //inductance in H
R1      = (R2*R3*R4*(w^2)*(C4^2))/(1+((w^2)*(R4^2)*(
   C4^2)));      //resistance in

//result
mprintf("\ninductance of inductor = %3.2f H",L1);
mprintf("resistance of coil  = %3.2f   ",R1);
```

Scilab code Exa 12.11 Find the resistance and inductance of the choke coil

```
//
=====================================================================
//Chapter 12 Example 11

clc;clear all;

```

```
//variable declaration
R2          = 2410;      //resistance of arm  in
R3          = 750;       //resistance of arm  in
R4          = 64.9;      //resistance of arm  in
R          = 0.4;        //resistance in
C4         = 0.35*10^-6;     //capacitance in F
f          = 500;            //frequency in Hz

//calculations
w        = 2*(%pi)*f;        //radian per second
R41    = R4+R;           //resistance in
L1      = (R2*R3*C4)/(1+((w)*(R4^2)*(C4^2)));
   //inductance in H
R1      = (R2*R3*R41*(w^2)*(C4^2))/(1+((w^2)*(R41^2)
   *(C4^2)));        //resistance in

//result
mprintf("resistance of coil  = %3.2f   ",R1);
mprintf("\ninductance of inductor = %3.4f Henry",L1)
   ;
```

Scilab code Exa 12.12 Derive the balance condition and calculate the effective imp

```
//
   ================================================================

//Chapter 12 example 12

clc;
clear all;

//variable declaration
R2          = 834;       //resistance of arm  in
R3          = 100;       //resistance of arm  in
R4          = 64.9;      //resistance of arm  in
```

```
R           = 0.4;          //resistance in
C4          = 0.1*10^-6;        //capacitance in F
C2          = 0.124*10^-6;          //capacitance in F
f           = 2000;             //frequency in Hz

//calculations
L1       = R2*R3*C4;                //inductance in H
R1       = (R3*C4/C2);              // resistance in
Z            = R1+(2*%pi*f*L1)*%i;          // effective impedance
Z1           = sqrt(((real(Z))^2)+(((imag(Z))^2)));
angle            = (atan((imag(Z))/real(Z)))*180/%pi;

//result
mprintf("L1      = %3.2e",L1);
mprintf("\nR1          = %3.2f",R1);
mprintf("\neffective impedance of test specimen  =%3.2f    angle %3.2f    ",Z1,angle);
```

Scilab code Exa 12.13 Find out the phase angle error and unknown capacitance

```
//
==================================================

//Chapter 12 example 13

clc;clear all;

//variable declaration
R1           = 1000;        //resistance of arm  in
R2           = 1000;        //resistance of arm  in
R3           = 2000;        //resistance of arm  in
R4           = 2000;        //resistance of arm  in
C1          = 1*10^-6;          //capacitance in F
f             = 1000;
```

```
r1          =10;           //resistance  in

//calculations
W          = 2*%pi*f;
C2       = (C1*R1)/(R2);      //capacitance in F
r2        =  ((R2*(R3+r1))-(R1*R4))/(R1);        //Resistance in
d1      = (W*r1*C1)*(180/%pi);           //phase angle error in
d2      = (W*r2*C2)*(180/%pi);           //phase angle error in

//calculations
mprintf("phase angle error  = %3.1f   ",d1);
mprintf("\nphase angle error  = %3.1f   ",d2);
```

Scilab code Exa 12.14 Calculate the resistance and capacitance and also the dissip

```
//==========================================================================

//Chapter 12 example 14

clc;clear all;

//variable declaration

R2           = 4.8;       //resistance of arm  in
R3           = 2000;      //resistance of arm  in
R4           = 2850;      //resistance of arm  in
C2          = 0.5*10^-6;      //capacitance in F
f             = 500;      //frequency in Hz
r2          =0.4;         //resistance  in

//calculations
```

```
w          = 2*(%pi)*f;
C1        = C2*(R4/(R3));       //unknown capacitance in
     F
x         =R2+r2
r1         = (R3/R4)*(x);       //resistance  in
D          = w*C1*r1;           //dissipation factor

//result
mprintf("unknown capacitance = %3.2e uF",(C1*10^6));
mprintf("\nresistance = %x3.2f    ",x);
mprintf("\ndissipation factor = %3.5f",D);
```

Scilab code Exa 12.15 Calculate the power factor

```
//
   ===================================================================

//Chapter 12 example 15

clc;clear all;

//variable declaration
R2           = 100;        //resistance of arm  in
R4           = 309;        //resistance of arm  in
C4          = 0.5*10^-6;       //capacitance in F
C3          = 109*10^-12;      //capacitance in F
f          = 50;                  //frequency in Hz

//calculations
w          =2*(%pi)*f;
Cx          = (R4*C3)/(R2);          //equivalent series
    capacitance in F
Rx          = (C4*R2)/(C3);          //series resistance
    in
p           = w*Rx*Cx;               //power factor of
```

```
    the specimen (sind =tand)


//result
mprintf("power factor of the specimen = %3.5f",p);
```

Scilab code Exa 12.16 Derive the variable resistance

```
clc;clear all;

//variable decalaration
R4    = 1000;         //resistance in
C3     = 50*10^-12;      //capacitance in F
A        = 314*10^-4;        //area in m**2
D       = 0.3*10^-2;        //thickness in m
er     = 2.3;             //dielectric constant
e0    = 8.854*10^-12;       //dielectric constant
d       = 9;              //loss angle in
f           = 50;

//calculations
//calculations
C1     = (er*e0*A)/D;        //capacitance in F
w       = 2*%pi*f;
x           = tan(d*%pi/180);
R1     = 1/(w*C1*x);     //resistance in
C4     = 1/((w^2)*C1*R1*R4);        //variable capacitor in F
R2     = (C3*R4*((cos(d*%pi/180))^2))/(C1); //variable resistance in

//result
mprintf("Variable capacitor = %3.1f M   ",(R1*10^-6));
```

```
mprintf("\nvariable resistance = %3.0f    ",R2);
```

Scilab code Exa 12.17 Find the equivalent resistance

```
//
//chapter 12 example 17



clc;
clear all;

//variable declaration
R1          = 3100;          //resistance of arm  in

R2          = 25000;          //resistance of arm  in

R4          = 100000;          //resistance of arm  in

C1         = 5.2*10^-6;          //capacitance in F
f            = 25000;         //frequency in Hz

//calculations
//C3       = C1*((R2/R4)-(R1/R3))
//X      = C1*(R2/R4)
//Y        = C1*(R1/R3)
w            = 2*%pi*f;
x            =1/((w^2)*R1*C1);
//R3          = x/C3
A        = (C1*R2)/R4;
B        = 1+(C1*R1/x);
C3       = A/B;                //capcitance in uuF
R3       = x/C3;               //equivalent parallel
```

```
   resistance in

//result
mprintf("equivalent parallel resistance = %3.2f K
   ",(R3*10^-3));
```

Scilab code Exa 12.18 Find the dissipation factor

```
//

//Chapter 12 example 18

clc;clear all;

//variable declaration
R3          = 2000;      //resistance of arm  in
R4          = 2950;      //resistance of arm  in
R2          = 5;         //resistance of arm  in
r2          = 0.4;           //resistance   in
C2         = 0.5*10^-6;      //capacitance in F
f            = 450;      //frequency in Hz

//calculations
r1     = (R3*(r2+R2))/R4     //resistance   in
C1     = ((R4/R3)*C2)    //capacitance in F
tand    = 2*(%pi)*f*C1*r1    //dissipation power ,C1
   in uF

//result
mprintf("resistace = %3.2f    ",r1);
mprintf("\ncapacitance = %3.2e uF",(C1*10^6));
mprintf("\ndissipation factor = %3.2e ",(tand));
```

Scilab code Exa 12.19 Calculate the capacitance and dielectric loss angle of bushi

```
//
    ==================================================

//Chapter 12 example 19

clc;clear all;

//variable declaration
R3          = 300;       //resistance of arm  in
R4          = 72.6;      //resistance of arm  in
C2         = 500*10^-12;     //capacitance in F
C4         = 0.148*10^-6;        //capacitance in F
f            = 50;       //frequency in Hz

//calculations
Cx     = (R4*C2)/(R3);       //capacitance in F
Rx     = (R3*C4)/(C2);       //resistance   in
x      = 2*(%pi)*f*Cx*Rx;
d     = atan(x);          //dielectric loss angle of
   bushing in
d1   = (d*180)/%pi;
//result

mprintf("\ncapacitance = %3.2e uF",(Cx));
mprintf("resistace = %3.2f   K  ",(Rx*10^-3));
mprintf("\ndielectric loss angle of bushing  = %3.3f
      ",d1);
```

Scilab code Exa 12.20 Calculate the power factor and equivalent series resistance

```
//
===========================================================================

//Chapter 12 example 20

clc;clear all;

//variable declaration
R3          = 130;        //resistance of arm  in
R4          = 318;        //resistance of arm  in
C2         = 106*10**-12;         //capacitance in F
C4         = 0.35*10**-6;         //capacitance in F
f            = 50;        //frequency in Hz

//calculations
Cx     = (R4*C2)/(R3);        //capacitance in F
Rx     = (R3*C4)/(C2);        //resistance   in
x      = 2*(%pi)*f*Cx*Rx;     //power factor


//result

mprintf("capacitance = %3.2e uF",(Cx));
mprintf("\nresistace = %3.2f   K  ",(Rx*10^-3));
mprintf("\npower factor   = %3.3f ",x);
```

Scilab code Exa 12.21 Find the resistance and inductance of the coil

```

//
===========================================================================

//Chapter 12 example 21

clc;clear all;
```

```
//variable declaration
M1     = 15.9;        //mutual inductance in mH
M2     = 0.1;             //mutual inductance in mH
r1       = 25.9;      //resistance   in
r2       = 12.63;         //resistance   in

//calculations
L1      = 2*(M1-M2);      //self inductance in mH
R1     = r1-r2;       //resistance   in

//result
mprintf("self inductance = %3.2f mH",L1);
mprintf("\nresistance = %3.2f   ",R1);
```

Scilab code Exa 12.22 Calculate the value of L and C

```
//
    ====================================================================

//Chapter 12 example 22

clc;clear all;

//variable declaration
f1     = 2*10^6;      //frequency from second data in
    Hz
f2     = 1*10^6;      //frequency from first data in
    Hz
C1         = 230*10^-12;      //capacitance in F
C2         = 8*10^-12;        //capacitance in F

//calculations
C      = C1+C2;
L    = 1/((((2*(%pi)*f1)^2)*C));        //inductance
```

```
    in uH
Cx      = 1/(((2*(%pi)*f2)^2)*L);          //
   capacitance in pF

//result
mprintf("inductance = %3.2f uH",(L*10^6));
mprintf("\ncapacitance = %3.2f pF",(Cx*10^12));
```

Scilab code Exa 12.23 Determine the resistive and reactive component of unknown im

```
//
   ================================================================

//Chapter 12 example 23

clc;clear all;

//variable declaration
f     = 165*10^3;          //frequency in Hz
C1          = 208*10^-12;     //capacitance in F
C2          = 184*10^-12;     //capacitance in F
Q1       = 80;               //Q-factor
Q2       = 50;               //Q-factor

//calculations
x     = C2*Q2;
y     = C1*Q1;
w     = 2*(%pi)*f;
Rm     = (1/(w))*((1/(x))-(1/(y)));       //resistive
   component of unknown impedance in
Xm     = (1/(w))*((1/C2)-(1/C1));         //reactive
   component of unknown impedance in


//result
```

```
mprintf("resistive component of unknown impedance =
    %3.2f   ",Rm);
mprintf("\nreactive component of unknown impedance =
    %3.0f   ",Xm);
```

Scilab code Exa 12.24 Determine the self capacitance and inductance of the coil

```

//

//Chapter 12 example 21

clc;clear all;

//variable declaration
M1    = 15.9;        //mutual inductance in mH
M2    = 0.1;             //mutual inductance in mH
r1       = 25.9;      //resistance   in
r2       = 12.63;         //resistance    in

//calculations
L1      = 2*(M1-M2);      //self inductance in mH
R1    = r1-r2;       //resistance   in

//result
mprintf("self inductance = %3.2f mH",L1);
mprintf("\nresistance = %3.2f   ",R1);
```

Scilab code Exa 12.25 Determine the self capacitance

```
//
    ================================================================
//Chapter 12 example 25
clc;clear all;

//variable declaration
f1    = 3;       //frequency in MHz
f2   =6;         //frequency in MHz
C1         = 251;     //capacitance in pF
C2         = 50;      //capacitance in pF

//calculations
Cd    = (C1-(4*C2))/(3);        //self capacitance
   of the coil in uuF
//since f1 = 2f2


//result
mprintf("self capacitance of the coil = %3.2f pF",Cd
   );
```

Scilab code Exa 12.26 Determine the self capacitance of the coil

```
//
    ================================================================
//Chapter 12 example 26
clc;clear all;

//variable declaration
C1         = 1530;   //capacitance in pF
C2         = 162;    //capacitance in pF
f1          = 3;     //frequency in MHz
f2          =1;      //frequency in MHz
```

```
//calculations
//f1      = 1/((2*math.pi)*(math.sqrt(L*(C2+Cd))))
//f1      = 1/((2*math.pi)*(math.sqrt(L*(C2+Cd))))
//f2   = 3*f1
Cd     = (C1-(9*C2))/(8);         //self capacitance
    of the coil in pF

//result
mprintf("self capacitance of the coil = %3.2f pF",Cd
    );
```

Scilab code Exa 12.27 Determine the effective inductance and resistance of unknown

```
//
    ==========================================================

//Chapter 12 example 27

clc;clear all;

//variable declaration
f     = 450*10^3;          //resistance inHz
C      = 250*10^-12;       //capcaitance in F
Rsh    = 0.75;        //resistance in
 Q       = 105;                //Q-factor

//calculations
w       = 2*(%pi)*f;
L         = 1/(((w)^2)*(C));      //inductance in uH
R        = ((w*L)/(Q))-Rsh;       //resistance of the
    coil   in

//result
mprintf("inductance = %3.2f uH",(L*10^6));
```

```
mprintf("\n resistance of the coil  = %3.2f   ",R);
```

Scilab code Exa 12.28 Determine the percentage error

```
//
//Chapter 12 example 28

clc;clear all;

//variable declaration
f    = 500*10^3;          //resistance inHz
C     = 120*10^-12;       //capcaitance in F
R   = 5;          //resistance in
r   = 0.02;       //resistance across oscilltory
    circuit in

//calculations
w       = 2*(%pi)*f;
Qt    = 1/(w*C*R);          //the true or effective Q of
     the coil
Qi    = 1/(w*C*(R+r));          //the indicated or
    calculated  Q of the coil
e      = ((Qt-Qi)/(Qt))*100; //percentage error in %

//result
mprintf("percentage error =%3.2f percentage ",e);
```

Scilab code Exa 12.29 Determine the self capacitance

```
//
    ==========================================================

//Chapter 12 example 29

clc;clear all;

//variable declaration
C1        = 95*10^-12;       //capacitance in F
f1    = 800*10^3;       //frequency in Hz
f2   = 2.5*10^6;        //frequency in Hz

//calculations
w2      = 2*%pi*f;
L    = 1/((w2)^2)*Cd;
L    = 1/((w2)^2)*(C1+Cd)
//comparing above equations
// Cd     =(((w1)**2)*C1)/((w2)**2)-(w1)**2))
Cd    =(((f1)^2)*C1)/(((f2)^2)-((f1)^2));       //
    capcitance in pF

//result
mprintf("capacitance = %3.2f pF",(Cd*10^12));
```

Scilab code Exa 12.30 Determine the self capacitance

```
//
    ==========================================================

//Chapter 12 example 30

clc;clear all;

//variable declaration
f1    = 1*10^6;      //frequency in Hz
```

```
f2   = 2*10^6;       //frequency in Hz
C1        = 480*10^-12; //capacitance in F
C2        = 90*10^-12;       //capacitance in F
R       = 10;        //resistance

//calculations
Cd    = (C1-(4*C2))/3;       //self capacitance of
   the coil in pF
Q1     = 1/(2*%pi*f1*(C1+Cd)*R);          //the
   indicated or effective  Q of the coil
Q11     = 1/(2*%pi*f1*(C1)*R);        //the true  Q
   of the first instrument
Q2     = 1/(2*(%pi)*f2*(C2+Cd)*R);        //the
   indicated or effective  Q for the second
   instrument
Q22     = 1/(2*(%pi)*f2*(C2)*R);          //the true
    Q of the second  instrument

//result
mprintf("the indicated or effective  Q of the coil
   = %3.1f ",Q1);
mprintf("\nthe true  Q of the first instrument = %3
   .3f",Q11);
mprintf("\nthe indicated or effective  Q for the
   second instrument = %3.3f",Q2);
mprintf("\nthe true  Q of the second  instrument =
   %3.2f",Q22);
```

Chapter 13

Magnetic measurements

Scilab code Exa 13.1 Find the magnetic field strength

```
//
    ================================================================

//Chapter 13 example 1

clc;clear all;

//variable declaration
l   = 0.6;      //length of solenoid in m
N   = 600;      //number of turns
I   = 2;        //current passing through solenoid in
    A
ur   = 1;       //air coiled solenoid
r    = 0.025;   //radius in m

//calculations
H   = (N*I)/(l);       //magnetic field at the centre
    in AT/metre
u0   = 4*(%pi)*(10^-7);    //flux
a    = ((%pi)/(4))*(r^2);     //area
phi  = ur*u0*H*a;          //flux  passing through
```

```
    thesecondary coil

//calculations
mprintf("magnetic field = %3.2f AT/metre",H);
mprintf("flux = %3.2e Wb",phi);
```

Scilab code Exa 13.2 Find the constant of the galvanometer

```
//
    ==================================================

//Chapter 13 example 2
clc;clear all;

//variable declaration
m   = 100;      //number of turns
n    = 1000;      //turns per m
theta1  = 10;       //first throw in mm
theta2   = 9.5;    //second throw in mm
I    =10;      //current in A
R    = 500;  // resistance in
A     = 0.002;     //area in m**2

//calculations
//Q   = (8*(math.pi)*(10**-7)*N*Ns*I*A)/(l*R)
    //in columbs
//Q   = (8*(math.pi)*(10**-7)*n*l*m*I*A)/(l*R)
//Q   =(8*(math.pi)*(10**-7)*n*m*I*A)/(R)
lamda  = log(theta1/(theta2));
theta  = theta1*(1+(lamda/(2)));
K    =(8*(%pi)*(10^-7)*n*m*I*A)/(R*theta);     //
    galvanometer constant in C/mm

//result

```

```
mprintf("galvanometer constant = %3.2e C/mm",K);
```

Scilab code Exa 13.4 Find the capacity of the condenser

```
//

//Chapter 13 example 4


clc;clear all;

//variable declaration
T0    = 4;    //time of swing in seconds
Ig    =0.001;    //current in A
lamda = 0;
theta  = 50;      //steady deflection in scale
   divisions
theta1   = 220;    //maximum throw in scale division
V        =100;  //potential of the condenser in V

//calculations
Q    = (T0/(2*%pi))*(Ig/theta)*(1+(lamda/2))*theta1;
        //quantity of electricity discharged in uC
C    = Q/(V);      //capacity of the condenser in F

//result
mprintf("capacity of the condenser = %3.2d uF",(C
   *10^6));
```

Scilab code Exa 13.5 Calculate the shunt required for the use with search coil

```
//
//Chapter 13 example 5
clc;clear all;

//variable declaration
N      = 1;      //number of turns on search coil
Rc     = 0.025;     //resistance of search coil in
Nw    = 1.5*10^-4;    //number of wb-turns required for deflection of 1 division
M      = 120000;       //reluctane of magnetic circuit
MMF = 8000;     //magnetic circuit is excited in ampere-turn
f     = 1.5*10^-4;        //fluxmeter without shunt (K/N  = phi/theta)
theta  =120;

//calculations
phi  = (MMF/(M));      //flux produced in WB
//phi  = ((Rs+Rc)/Rs)*((K*theta)/N)
Rs     = (Rc*f*theta)/(phi-(f*theta));    //resistance of shunt in

//result
mprintf("resistance of shunt = %3.2e   ",Rs);
```

Scilab code Exa 13.6 Find the resistance of the shunt to be connected in parallel

```
//
//Chapter 13 example 6

clc;clear all;
```

```

//variable declaration
Rc    = 1;     //resistance in
N     = 5;     //multiplying factor

//calculations
//N    = (Rs+Rc)/Rs
Rs    = Rc/(N-1);    //shunt resistance in

//result
mprintf("shunt resistance = %3.2f    ",Rs);
```

Scilab code Exa 13.7 Calculate the flux density in the core

```
//
    ========================================================================

//Chapter 13 example 7

clc;clear all;

//variable declaration
R1   = 180;      //resistance in
R2   = 20;      //resistance in
A    = 0.005;      //area in m^2
Ns    = 1000;        //number of turns on search coil
G1    = 100*10^-6;     //galvanometer constant C
G2    = 100;            //galvanometer throw

//calculations
Rs    = R1+R2;       //total resistance of secondary
    circuit in
Q     = G1*G2;      //charge passed through ballistic
    galvanometer in C
//Q  = i*t  = (E/Rs)*t  = ((2*phi*Ns)/(t*Rs))*t =
```

```
    (2*phi*Ns)/Rs
phi  = (Q*Rs)/(2*Ns);      //flux in Wb
B    = phi/(A);        //flux density in Wb/m^2

//result

mprintf("flux density = %3.2f Wb/m^2",B);
```

Scilab code Exa 13.8 Find the relative permeability of the specimen

```
//
    ================================================================

//Chapter 13 example 8

clc;clear all;

//variable declaration
d    = 0.1;        //diameter in m
a    = 33.5*10^-6;      //cross sectional area of iron
     ring in m^2
Ns    = 220;         //number of turns on secondary
    coil
Nm    = 320;         //number of turns on magnetising
    winding
I     = 10;          //current in A
B     = 2.5*10^-3;       //flux in Wb
n     = 102;            //reading of scale
g      = 272;          //galvanometer throw


//calculations
l    = (%pi)*d;      //mean length of iron ring in m
H     = (Nm*I)/(l);     //magnetising force with 10 A
    current
```

```
K     = B/(n);
//2*phi*Ns   = K*g
phi    = (K*g)/(2*Ns);      //flux  in  Wb
B1      = phi/(a);     //flux  density  in  Wb/m**2
u0     = 4*%pi*10^-7;
//B   = u0*ur*H
x     = u0*H;
//B     = x*ur
//ur   = B/x
ur     = B1/x;     //relative  permeability

//result
mprintf("relative  permeability  = %3.1f",ur);
```

Scilab code Exa 13.9 Compute the flux density and relative permeability

```
//
//Chapter  13  example  9
clc;clear all;

//variable  declaration
R   = 2000;      //resistance  in
l    = 1;      //mean  length  of  iron  ring  in  m
A    = 350*10^-6;      //area  in  m**2
Ns    = 200;        //number  of  turns  on  secondary
   coil
G1    = 1*10^-6;     //galvanometer  constant  C
G2    = 100;            //galvanometer  throw
N     =100;

//calculations
u0    = 4*(%pi)*10^-7;
H     = (N*I)/(l);     //magnetising  force  with  10  A
```

```
current
Q     = G1*G2;      //charge passed through ballistic galvanometer in C
//Q  = i*t  = (E/Rs)*t  = ((2*phi*Ns)/(t*Rs))*t = (2*phi*Ns)/Rs
phi   = (Q*R)/(2*Ns);      //flux in Wb
B    = phi/(A);         //flux density in Wb/m**2
ur    = (B/(u0*H));      //relative permeability

//result
mprintf("flux density = %3.3f Wb/m**2",B);
mprintf("\nrelative permeability = %3.0f",ur);
```

Scilab code Exa 13.10 Calculate the relative permeability

```
//

//Chapter 13 example 10

clc;clear all;

//variable declaration
d     = 0.3;     //diameter in m
a     = 4*10^-4;      //cross sectional area of iron ring in m**2
N     = 80;       //number of turns on magnetising coil
Ns     = 30;      //number of turns on secondary coil
F      = 0.1*10^-3;      //flux meter constant in Wb-turn
D      = 46;        //deflection factor
I      = 2;       //current in A

//calculations
```

```
//phi  = (N*I*u0*ur*a)/l
//  phi = x*l
//lat x = (N*I*u0*a)/l
l     = d*%pi;
u0    = 4*(%pi)*10^-7;
x    =(N*I*u0*a)/(l);
// total change in Wb-turns y = 2*phi*Ns = 2*x*ur*Ns
y    = 2*x*Ns;
df    = F*D;      //change in flux measuredby the flux
    meter in wb-turns
ur    =df/y;      //relative permeability

//result
mprintf("relative permeabitlity = %3.0d",ur);
mprintf("\n Note:textbook answer represents the
   approximate value")
```

Scilab code Exa 13.11 Find the quantity of the electricity

```
//
   ==========================================================================

//Chapter 13 example 13

clc;clear all;

//variable declaration
Q     = 1000;      //Charge passed through
   galvanometer in uC
theta1 = 60;
d      = 10;      //defelction in mm
r      = 1000;     //m=circular scale

//calculations
theta2  = %pi/(3)    //conversion of degrees to
```

```
radians
K    = Q/(theta2);      //galvanometer constant in uC/radian
theta  = d/(2*r);       //angle turned through by reflected ray for aswing of 10 mm
Q1      = K*theta;          //charge for a swing of 0.005 radian in uC

//result
mprintf("charge for a swing of 0.005 radian = %3.2f uC",Q1);
```

Scilab code Exa 13.12 Calculate the hysteresis loss in watts per kg

```
//

//Chapter 13 example 12

clc;clear all;

//variable declaration
f     = 50;            //number of reversals
m     = 1;             //mass
d     = 7.8*10**3;             //density
A     = 4800;                  //area of the loop m^3
x     = 200;                   //in AT/m
x1     = 10;                   // 1 unit in mm
y1     = 10;                   // 1 unit in mm
y     = 0.1;                   //in T

//claculations
V     = m/d;               //volume of magnetic material in m^3
l     = A*(x/x1)*(y/y1);
```

```
l1    = l*V*f;                     //hysteresis loss in watts per kg at 50 Hz

//result
mprintf("hysteresis loss at 50 Hz = %3.3f  watts per kg ",l1);
```

Scilab code Exa 13.13 At what frequency will the iron loss be doubled if the flux

```
clc;
clear all;

//variable declaration
f     = 60;          //supply frequency in Hz
Pi     = 360;          //iron loss in W
f     = 60;
//Pe     =6*Ph;
//Pi     = Pe+Ph
//360= (6*Ph)+Ph
Ph     = Pi/7;     //hysteresis loss in W
Pe     = Pi-Ph;     //eddy current loss in W
 //Ph1     = (f1/f)*Ph
Ph1     = (1/f)*Pe;     //hysteresis loss in watts
//Ph1     =Ph1*f1
//Pe1     = ((f1/f)^2)*Pe
Pe1     =((1/f)^2)*Pe;     //eddy current loss
//Pe1     = Pe1*Pe
Pi1     =Ph1+Pe1;
Pi1      = 2*Pi;
//720     = 0.857*f1+(0.0857*f1^2)
f1     =86.8


//result
mprintf("new supplyfrequency = %3.2f HZ",f1);
```

Scilab code Exa 13.14 Estimate the hysteresis and eddy current losses

```
//
=====================================================================
//Chapter 13 example 14

clc;
clear all;

//variable declaration
//Ph    = A*f
//Pe    = B*f^2
//Pi    = Ph+Pe
Pi  = 17.2;     //power in W
f   = 50;       //frequency in Hz
Pi1 = 28.9;     //iron loss in W

m       = 13;       //weight in kg

//calculations
//17.2  = 40*A+((40)^2)*B
//28.9  = 60*A+((60)^2)*B
A   = 0.326667
B   = 0.002583
Ph  = (A*f)/m       //hysteresis loss per kg in W
Pe  = (B*(f^2))/m   //eddy current loss per kg in W

//result
mprintf("hysteresis loss per kg = %3.2f W",Ph);
mprintf("\neddy current loss per kg = %3.3f W",Pe);
```

Scilab code Exa 13.15 Calculate the eddy current loss per kg

```
//
    ================================================================
//Chapter 13 example 15
clc;
clear all;

//variable declaration
A    = 0.5;
B    = 0.01;
f    = 50;
n    = 10;

//calculations
Pe   = B*(f^2);        //eddy current loss at 50 Hz in
    W
Pe1 = Pe/n;      //eddy current loss per kg at 50 Hz
    in watts

//result
mprintf("eddy current loss per kg at 50 Hz = %3.2f
    watts",Pe1);
```

Scilab code Exa 13.16 Calculate the percentage change in hysteresis loss

```
//
    ================================================================
//Chapter 13 example 16

clc;
clear all;

```

```
//variable declaration
x   = 0.8;       //Kf2/Kf1
y   =1.2;

//Pe2/Pe1 = (Kf2/Kf1)^2
p   = x^2;
//Pe2   = p*Pe1;    //
//p1    = (Pe1-Pe2)/Pe1;
p1  = (1-p)*100;         //percentage change in hysteresis current loss
p2  = y^2;
p12 = (y-1)*100;         //percentage change in hysteresis current loss
p3  =(p2-1)*100;         //percentage change in eddy current loss in %

//result
mprintf("percentage change in hysteresis current loss  = %3.3f percentage decrease",p1);
mprintf("\npercentage change in hysteresis current loss  = %3.3f percentage increase",p12);
mprintf("\npercentage change in eddy current loss in = %3.2f percentage increase",p3);
```

Scilab code Exa 13.17 Calculate the iron in watts loss per kg

```
//==========================================================================
//Chapter 13 example 17

clc;
clear all;

//variable declaration
```

```
w    = 0.03;       //width of plates in m
n    = 51;         //number of plates
t    = 0.000489; //thickness in m^3
f    = 50;         //frequency in Hz
Bmax     = 1;
N    = 600;
P1   = 3;          //copper loss in watts
m    = 11;         //weight in kg

//calculations
A    = w*n*t;           //mean area of plates in m^3
E    = 4.44*f*Bmax*A*N;         //induced voltage in V
//from graph corresponding to voltage of 100 volts
P2   = 30.5;       //total losses in watts
P    = P2-P1;           //iron loss in watts
PL   = P/m;        //loss per kg in watts

//result
mprintf("iron loss per kg = %3.2f watts",PL);
```

Chapter 14

Digital Measurement of Electrical Quantities

Scilab code Exa 14.1 Determine the full scale output

```
//

//Chapter 14 example 1
clc;
clear all;

//variable declaration
VREF    =10;        //reference voltage in V


//calculations
W1  = VREF/2;           //the second MSB weight in V
W2 = VREF/4;           //the third MSB weight in V
W3 = VREF/8            //the fourth (or LSB ) MSB weight in V
W   = VREF+W1+W2+W3;          //full scale output in V
r      = W/4;           //resolution in V
```

```
//result
mprintf("the second MSB weight =%3.2d",W1);
mprintf("\nthe third MSB weight =%3.2d",W2);
mprintf("\nthe fourth (or LSB ) weight =%3.2d",W3);
mprintf("\nthe resolution of DAC is equal to the weight of the LSB = %3.2f V",W3);
mprintf("\nfull scale output = %3.2f V",r);
```

Scilab code Exa 14.2 Find out the voltage

```
//
//Chapter 14 example 2

clc;
clear all;

//variable declaration
D      = 16;           //output voltage in V

//calculations
Dn1      = D/(2^1);          //first MSB output in V
Dn2     = D/(2^2);          //second MSB output in V
Dn3     = D/(2^3);          //third MSB output in V
Dn4     = D/(2^4);          //fourth MSB output in V
Dn5     = D/(2^5);          //fifth MSB output in V
Dn6     = D/(2^6);          //Sixth MSB output in V
```

```
V            = Dn1+Dn2+Dn3+Dn4+Dn5+Dn6;
Vout         = ((D*(2^0))+(D*(2^1))+(0*(2^2))+(D
   *(2^3))+(0*(2^4))+(D*(2^5)))/(2^6);      //for
   digital input 101011

//result
mprintf(" first MSB output = %3.2f V",Dn1);
mprintf("\n second MSB output = %3.2f V",Dn2);
mprintf("\n third MSB output = %3.2f V",Dn3);
mprintf("\n fourth MSB output = %3.2f V",Dn4);
mprintf("\n fifth MSB output = %3.2f V",Dn5);
mprintf("\n Sixth MSB output = %3.2f V",Dn6);
mprintf("\nthe resolution is equal to the weight of
   the LSB = %3.2f V",Dn6);
mprintf("\nthe full scale output for digital input
   of 101011 =%3.2f V",V);
mprintf("\nthe voltage output for a digital input of
    101011 = %3.2f V",Vout);
```

Scilab code Exa 14.3 Determine the display indication

```
//
   ===========================================================

//Chapter 14 example 3

clc;
clear all;

//variable declaration

T   = 2500;          //transitions per second
t1  = 0.1;       //time in s
t2  = 1;       //time in s
t3  = 10;       //time in s
```

```
//calculations
C1       = T*t1;          //counter can count or display
C2       = T*t2;          //counter can count or display
C3       = T*t3;          //counter can count or display

//result
mprintf(" counter can count or display when 0.1 s = %3.2d",C1);
mprintf(" \ncounter can count or display when 1 s = %3.2d",C2);
mprintf(" \ncounter can count or display when 10 s = %3.2d",C3);
```

Scilab code Exa 14.4 Calculate the frequency of the system

```
//===========================================================================

//Chapter 14 example 4
clc;
clear al;

//variable declaration
N    = 45;        //count
t    = 0.01;      //gate enable time in s

//calculations
f    = N/t;       //frequency in Hz

//result
mprintf("frequency  = %3.1f kHz",(f*10^-3));
```

Scilab code Exa 14.5 `Find the maximum likely errors`

```
//====================================================================
//Chapter 14 example 5
clc;
clear all;

//variable declaration
t       = 5*10^6;    //time reaading in ms
t2       = 500;    //time reaading in ms
x       = 0.005;      //accuracy in percent of reading
t3       = 500*10^3;    //time reaading in ms

//calculations
e       = ((x/100)*t)+1;        //maximum likely timing error in ms
e1      = ((x/100)*t2)+1;        //maximum timing error in ms
a       = t2*10^6;            //maximum accuracy mininum error will be obtained when the time is read on the us read
e3      = ((x/100)*t3)+1;        //maximum timing error in ms

//result
mprintf("maximum likely timing error  when time reading is 05000000 ms = %3.2f ms",e);
mprintf("\nmaximum  timing error  when time reading is 00000500 ms = %3.2f ms",e1);
mprintf("\nmaximum  error  when time reading is 00500000 = %3.2f ms",e3);
```

Scilab code Exa 14.6 Calculate the resolution

```
//==========================================================================
//Chapter 14 example 6

clc;
clear all;

//variable declaration
n   =3;           //number of full digits
v1  = 1;          //voltage in V
v2      = 10;         //voltage in V
v3      = 5;         //voltage in V
a       = 0.5;       //accuracy of reading in %
r   = 2;          //reading in V

//calculations
R   = 1/(10^n);       //resolution
V1  = R*v1;           //for full scale range of 1V , the resolution in V
V2  = R*v2;           //for full scale range of 10V , the resolution in V
v      = v3*R;       //the digit in least significant digit has a value of in V
e       = ((a/100)*r)+v;      //total possible error on in  V

//result
mprintf("for full scale range of 1V ,the resolution = %3.4f V",V1);
mprintf("\nfor full scale range of 10V ,the resolution = %3.4f V",V2);
```

```
mprintf("\ntotal possible error = %3.5f V",e);
```

Scilab code Exa 14.7 Find the resolution

```
//

//Chapter 14 example 7
clc;
clear all;

//variable declaration
n   =4;          //number of full digits
v1  = 1;         //voltage in V
v2      = 10;        //voltage in V

//calculations
R       = 1/(10^n);      //resolution
R1      = R*v1;      //resolution on 1V range in V
R2      = R*v2;      //resolution on 10V range in V

//result
mprintf("R  = %3.4f V",R);

mprintf("\nthere are 5 digits in 4 (1/2) display
   digit display ,so 15.84 would display as 15.840")
   ;
mprintf("\nR1 = %3.4f V",R1);
mprintf("\nany reading upto 4 th decimal can be
   displayed ");
mprintf("\nhence 0.5243 can be dislayed as 0.5243")
mprintf("\n R2 = %3.4f V",R2);
mprintf("\nany reading upto third decimal can be
   displayed ");
mprintf("\nhence 0.5243 can be dislayed as 0.524
```

```
instead of 0.5243");
```

Scilab code Exa 14.8 Find the resolution

```
//
//Chapter 14 example 8

clc;
clear all;

//variable declaration
n    =3;           //number of full digits
v1   = 10;          //voltage in V
v2       = 100;        //voltage in V

//calculations
R        = 1/(10^n);      //resolution
R1       = R*v1;      //resolution on 1V range in V
R2       = R*v2;      //resolution on 10V range in V

//result
mprintf("R  = %3.4f V",R);

mprintf("\nthe meter cannot distinguish the values
   that differ from each by less than 0.001 of full
   scale");
mprintf("\nR1 = %3.4f V",R1);
mprintf("\nany decimal upto second  decimal can be
   displayed ");
mprintf("\nhence 15.45 can be dislayed as 15.45")
mprintf("\n R2 = %3.4f V",R2);
mprintf("\nany deccimal upto one decimal can be
   displayed ");
```

```
mprintf("\nhence 25.65 can be dislayed as 025.6
    instead of 25.65");
```

Scilab code Exa 14.9 Find the resolution

```
//
    ==================================================================

//Chapter 14 example 9

clc;
clear all;

//variable declaration
n   =4;          //number of full digits
v1  = 10;        //voltage in V
V1      = 1;        //voltage in V
V2      =10;        //voltage in V

//calculations
R       = 1/(10^n);      //resolution
R1      = R*v1;      //resolution on 1V range in V
R2      = R*V1;      //resolution on 1V range in V
    for display 0.6132 V
R3      = R*V2;      //resolution on 10V range in V
    for display 0.6132 V

//result
mprintf("R  = %3.4f V",R);
mprintf("\nR1 = %3.4f V",R1);
mprintf("\nany decimal upto third  decimal can be
    displayed ");
mprintf("\nhence 13.97 can be dislayed as 13.970")
mprintf("\n R2 = %3.4f V",R2);
mprintf("\nany deccimal upto fourth decimal can be
```

```
   displayed on 1V");
mprintf("\nhence 0.6132 can be dislayed as 0.6132 V"
   );
mprintf("\n R3 = %3.4f V",R3);
mprintf("\nany deccimal upto third decimal can be
   displayed on 10 V ");
mprintf("\nhence 0.6132 can be dislayed as 0.613 V")
   ;
```

Chapter 15

Signal Analyzers

Scilab code Exa 15.1 Find the dynamic range

```
//
    ================================================================
//Chapter 15 example 1
clc;clear all;

//variable declaration
Ip      = 25;           //power level ot the third-order
     intercept in dBm
M       = -85;           //minimum detectable signal in
   dBm

//calculations
Rd      = (2/3)*(Ip-M);

//result
mprintf("dynamic range = %3.0f dB",Rd);
```

Scilab code Exa 15.2 Find the minimum detectable signal of a spectrum

```
//==========================================================================
//Chapter 15 example 2

clc;clear all;

//variable decalaration
N      = 20;        //noise figure indB
B      = 1000;      //bandwidth in Hz

//calculations
x      = B/(10^6);
//log(10**-3)= (-3)*log(1) = -3
M      = (-114)+((10*(-3))*(1))+N;     //log(1) = 1

//result
mprintf("minimum detectable signal = %3.2f dBm",M);
```

Chapter 16

Cathode Ray Oscilloscope

Scilab code Exa 16.1 Find the rms value and also the electrostatic deflection sens

```
//
    ==================================================================

//Chapter 16 example 1


clc;clear all;

//variable declaration
l     = 0.025;     //length of plates in m
d     = 0.005;     //distance between plates in m
S     = 0.2;       //the distance between the screen
    and centre of plates in m
Va    =3000;      //accelerating voltage in V
x     =0.1;      //trace length(2*y) in m


//cacualtions
//y    = lSVd/(2*d*Va)
Vd    = (d*Va*x)/(l*S);    //deflection voltgae in V
Vrms    = Vd/(sqrt(2));     //rms value of sinusoidal
```

```
    voltage applied to the X-deflecting plates in V
Sd      = (l*S)/(2*d*Va);        //deflection voltage
    in mm/V

//result
mprintf("rms value of sinusoidal voltage applied to
    the X-deflecting plates = %3.2d V",Vrms);
mprintf("\ndefelection sensitivity = %3.3f mm/V",(Sd
    *10**3));
```

Scilab code Exa 16.2 Find the input voltage

```
//

//Chapter 16 example 2

clc;clear all;

//variable declaration
l     = 0.02;     //length of plates in m
d     = 0.005;     //distance between plates in m
S     = 0.3;       //the distance between the screen
    and centre of plates in m
Va    =2000;      //accelerating voltage in V
Y     =0.03;      //trace length in m


//cacualtions
//y    = lSVd/(2*d*Va)
Vd    = (d*Va*x)/(l*S);    //deflection voltgae in V
Vrms    = Vd/(sqrt(2));     //rms value of sinusoidal
    voltage applied to the X-deflecting plates in V
Vin   = Vrms/(Vd);       //input voltage required in V

```

```
//result
mprintf(" nput voltage required = %3.3f V",Vin);
```

Scilab code Exa 16.3 Calculate the maximum velocity of electrons

```
//
//Chapter 16 example 3

clc;clear all;

//variable declaration
Va  = 1000;   //accelerating voltage in V
e    = 1.6*10^-19;      //charge of electron in C
m    = 9.1*10^-31;      //mass of electron in kg


//calcuations
V      = sqrt(2*Va*(e/m));    //maximum velocity of electrons in m/s

//result
mprintf("maximum velocity of electrons = %3.3e m/s",V);
```

Scilab code Exa 16.4 Find the beam speed and deflection sensitivity of the tube an

```
//
//Chapter 16 example 4

```

```
clc;clear all;

//variable declaration
Va  = 2000;   //accelerating voltage in V
e    = 1.6*10^-19;      //charge of electron in C
m    = 9.1*10^-31;      //mass of electron in kg
l    = 0.015;    //length of plates in m
d    = 0.005;    //distance between plates in m
S    = 0.5;      //the distance between the screen
    and centre of plates in m

//calcuations
V    = sqrt(2*Va*(e/m));    //beam speed in m/s
Sd    = (l*S)/(2*d*Va);            //deflection
    sensitivity of the tube in mm/V
D     = 1/(Sd);              //defelection factor in V
    /mm

//result
mprintf("Beam speed  = %3.3e m/s",V);
mprintf("\ndeflection sensitivity of the tube %3.3f
   mm/V",(Sd*10^3));
mprintf("\ndefelcction factor = %3.4f V/mm",(D
    *10^-3));
```

Scilab code Exa 16.5 Determine the deflection sensitivity

```
//
    ====================================================================

//Chapter 16 example 5

clc;clear all;

//variable declaration
```

```
l     = 0.02;     //length of plates in m
d     = 0.005;     //distance between plates in m
S     = 0.2;       //the distance between the screen and centre of plates in m
Va     = 2500;     //accelerating voltage in V

//calculations
Sd     = (l*S)/(2*d*Va);              //deflection sensitivity of the tube in mm/V

//result
mprintf("deflection sensitivity of the tube %3.2f mm/V",(Sd*10^3));
```

Scilab code Exa 16.6 Deduce the formula used

```
//

//Chapter 16 example 6

clc;clear all;

//varable declaration
l     = 2.5;     //length of plates in cm
d     = 1;     //distance between plates in cm
theta   = 1;      //angular defelecction of electron beam  in degrees
Va     = 1000;     //accelerating voltage in V

//calculations
//tan(theta)    = l*Vd/(2*d*Va)
x      = tan(((theta*%pi)/180));
Vd    =(( 2*d*Va)/(l))*x;       //required voltage in V
```

```

//result
mprintf("Voltage required across the deflection
   plates = %3.2f V",Vd);
```

Scilab code Exa 16.7 Calculate the deflection voltage

```
//
   ====================================================================

//Chapter 16 example 7

clc;clear all;

//variable declaartion
l     = 0.025;     //length of plates in m
d     = 0.005;     //distance between plates in m
S     = 0.2;       //the distance between the screen
   and centre of plates in m
Va     = 2500;     //accelerating voltage in V

//calculations
//y    = (s*(d/2))/(l/2)
y     = (S*d)/(l);     //defelction in m

//result
mprintf("deflection= %3.2f m",y);
```

Scilab code Exa 16.8 Find the Phase angle

```
//
   ====================================================================
```

```
//Chapter 16 example 8

clc;clear all;

//variable declaration
//as shown in patern is straight line
dvo   = 0;
Dv    = 6;
//pattern is ellipse
dvo1   = 3;
Dv1  =6;
//pattern is circle
dvo2  = 1;
Dv2 = 1;
//pattern is ellipse
dvo3   = 3;
Dv3  =5;

//calculations
y4   =dvo1/(Dv1);
phi1  = asin(dvo/(Dv));      //phase angle in degrees
phi2  = asin(dvo1/(Dv1));      //phase angle in degrees
phi3  = asin(dvo2/(Dv2));      //phase angle in degrees
phi4  = asin(dvo3/(Dv3));      //phase angle in degrees
phi22 = 180-((phi2*180)/(%pi));
phi44 = 180-((phi4*180)/(%pi));

//result

mprintf("phase angle = %3.2f   ",((phi1*180)/%pi));
mprintf("\nphase angle = %3.2f    or %3.2f   ",((phi2*180)/%pi),(phi22));
mprintf("\nbut from figure ellipse is inn 2nd and fourt quarterso the valid value of phase angle is %3.2f   ",phi2);
```

```
mprintf("\nphase angle = %3.2f   ",((phi3*180)/(%pi)
   ));
mprintf("\nphase angle = %3.2f    or %3.2f   ",(((
   phi4*180)/%pi)),(phi44));
mprintf("\nbut from figure ellipse is inn 2nd and
   fourt quarterso the valid value of phase angle is
    %3.2f   ",phi44);
```

Scilab code Exa 16.9 Find the pulse duration

```
//
   ==================================================

//Chapter 16 example 9
clc;clear all;

//variable declaration
f    = 2000;     //frequency in Hz
D    = 0.2;      //duty cycle

//calculations
T    = 1/(f);     //time period in ms
d   = D*T;             //pulse duration in ms

//result
mprintf("pulse duration = %3.2f ms",(d*10^3));
```

Scilab code Exa 16.10 Find the ratio of frequencies of vertical and horizontal sig

```
//
   ==================================================

//Chapter 16 example 10
```

```
clc;clear all;

//variable declartion
wy      = 3;     //positive Y-axis in pattern
wx      = 2;     //positive X-axis in pattern

//calculations
f    =wy/(wx);     //frequency of vertical and
    horizontal signal

//result
mprintf("frequency of vertical and horizontal signal
      = %3.1f",f);
```

Scilab code Exa 16.11 Find out the frequency of vertical signal

```
//
   ========================================================================

//Chapter 16 example 11

clc;clear all;

//variable declaration
y1    = 2;       //positive y- peaks in pattern
y2    = 0.5;     //positive y-peaks in pattern
x1    = 0.5;     //positive x-peaks in pattern
x2    = 0.5;     //positive x-peaks in pattern
F     = 3;        //frequency of horizontal voltage
    signal in kHz

//calculations
fx    = x1+x2;      //frequency of X
fy     = y1+y2;     //frequency of Y
```

```
f      = fy/(fx);
fv     = f*F;        //frequency of vertical voltage signal in kHz

//Result
mprintf("frequency of vertical voltage signal in = %3.1f kHz",fv);
```

Scilab code Exa 16.12 Determine the frequency of vertical input

```
//

//Chapter 16 example 12
clc;clear all;

//variable declaration
fx     = 1000;     //frequency of horizontal input in Hz
Pv    = 2;        //pointsof tangency to vertical line
Ph    = 5;        //pointsof tangency to horizontal line

//calculations
fy    = fx*(Ph/(Pv));      //frequency ofvertical input in Hz

//result
mprintf("frequency ofvertical input = %3.2f Hz",fy);
```

Scilab code Exa 16.13 Determine the mark to space ratio of the pulse

```
//
//Chapter 16 example 13

clc;clear all;

//variable declaration
d   = 1;      //1 division is equal to 1 cm
M    = 0.4;    //mark in cm
S    = 1.6;    //mark in cm
A    = 2.15;    //amplitude in cm
t     = 10;     //time-base control setting in us
p     = 0.2;        //amplitude control setting

//calcculations
R   = M/S;     //mark to space ratio
T   = (M+S)*t;        //time for mark and space in divisions
f    = 1/T;     //pulse in frequency kHz
P    = A*p;             //magnitude of pule voltage in V

//Result
mprintf("mark-to-space ratio  = %3.2f",R);
mprintf("\npulse frequency = %3.2f kHz",f);
mprintf("\nmagnitude of pulse voltage = %3.2f V",P);
```