

Scilab Textbook Companion for
Electronic Instrumentation and Measurements
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Book Description

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

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

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

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

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Chapter 2

Basic Of Measurement And Error Analysis

Scilab code Exa 2.1 Calculate the precision of the 3rd measurement

```
1 // Exa 2.1
2 format('v',6);clc;clear;close;
3 // Given data
4 // Values of measurements
5 x1 = 49;
6 x2 = 51;
7 x3 = 52;
8 x4 = 50;
9 x5 = 49;
10 n = 5; // numbers of reading
11 Xn_bar = (x1+x2+x3+x4+x5)/n; // average value for the
    set of measurements
12 // For n = 3
13 P = 1 - abs( (x3-Xn_bar)/x3); // the value of third
    measurement
14 P = P * 100; // in %
15 disp(P,"The precision of the 3rd measurement in % is
    ");
```

Scilab code Exa 2.2 Absolute error

```
1 // Exa 2.2
2 format('v',6);clc;clear;close;
3 // Given data
4 At = 150;// in V
5 Am = 149;// in V
6 e = At-Am;//absolute error in V
7 disp(e,"The absolute error in V is");
8 e_r = ((At-Am)/At)*100;// e_r stands for %e_r in %
9 disp(e_r,"The percentage error in % is");
10 A = 1 - abs( (At-Am)/At );// relative accuracy
11 disp(A,"The Relative accuracy is");
12 a = A*100;//Relative accuracy in %
13 disp(a,"The percentage accuracy in % is");
14 fsd = 200;//full scale reading in V
15 // Percentage error
16 PerError = ((At-Am)/fsd)*100;// in %
17 disp(PerError,"Percentage error expressed as
    percentage of full scale reading in % is");
```

Scilab code Exa 2.3 Sensitivity and deflection factor

```
1 // Exa 2.4
2 format('v',7);clc;clear;close;
3 // Given data
4 Fullscaledeflection = 30;//full scale deflection in
    cm
5 n = 30;// number of divisions
6 scaledivision = Fullscaledeflection/n;//scale
    division in cm
7 scaledivision = scaledivision * 10;// in mm
```

```
8 Resolution = (1/20)*scaledivision; // in mm
9 disp(Resolution, "The Resolution of the scale in mm
  is");
```

Scilab code Exa 2.4 Resolution of the scale

```
1 // Exa 2.4
2 format('v',7); clc; clear; close;
3 // Given data
4 Fullscaledeflection = 30; // full scale deflection in
  cm
5 n = 30; // number of divisions
6 scaledivision = Fullscaledeflection/n; // scale
  division in cm
7 scaledivision = scaledivision * 10; // in mm
8 Resolution = (1/20)*scaledivision; // in mm
9 disp(Resolution, "The Resolution of the scale in mm
  is");
```

Scilab code Exa 2.5 Mean value median value and variance

```
1 // Exa 2.5
2 format('v',7); clc; clear; close;
3 // Given data
4 // Reported values for average petrol consumption
5 x= [25.5 30.3 31.1 29.6 32.4 39.4 28.9 30.0 33.3
  31.4 29.5 30.5 31.7 33.0 29.2];
6 n = 15; // number of reading
7 sigma_x=0; // initialization of variable
8 for i=1:1:15
9     sigma_x= sigma_x+x(i); // sum of reading
10 end
11 Mean =sigma_x/n; // mean value
```

```

12 disp(Mean,"The mean value is");
13 sorted_x= gsort(x);
14 Xmedian = sorted_x((n+1)/2); // median value
15 disp(Xmedian,"The median value is");
16 sigma_d_sq=0;
17 for i=1:1:15
18     d(i)=x(i)-Mean
19     sigma_d_sq= sigma_d_sq+d(i)*d(i);
20 end
21 sigma = round(sqrt( sigma_d_sq/(n-1) )); // standard
    deviation
22 disp(sigma,"The standard deviation is");
23 V = sigma^2; // variance
24 disp(V,"The variance is");

```

Scilab code Exa 2.6 Mean and probable error

```

1 // Exa 2.6
2 format('v',7); clc; clear; close;
3 // Given data
4 // Value of readings
5 x=[147.2 147.4 147.9 148.1 147.7 147.5 147.6 147.4
    147.6 147.5]
6 n = 10; // number of reading
7 sigma_x=0; // initialization of variable
8 for i=1:1:n
9     sigma_x= sigma_x+x(i); // sum of readings
10 end
11 x_bar= sigma_x/n; // mean value
12 disp(x_bar,"The arithmetic mean is");
13 sigma_d_sq=0;
14 for i=1:1:n
15     d(i)=x(i)-x_bar;
16     sigma_d_sq= sigma_d_sq+d(i)*d(i);
17 end

```

```

18 sigma = sqrt( sigma_d_sq/(n-1) );// standard
    deviation
19 disp(sigma,"The standard deviation is");
20 // probable error of average of the ten reading
21 e_m = 0.6745 * ( sigma/(sqrt(n-1)) );
22 disp(e_m,"The probable error of average of the ten
    reading is");

```

Scilab code Exa 2.7 Limiting error

```

1 // Exa 2.7
2 format('v',5);clc;clear;close;
3 // Given data
4 Vrange=50;//range of voltmeter in V
5 V= 15;//instrument reading in V
6 // Limiting error at full scale
7 del_A= Vrange*1/100;// in V
8 // limiting error
9 PerE= del_A/V*100;// in %
10 disp(PerE,"The limiting error in % is : ")

```

Scilab code Exa 2.8 Limiting error

```

1 // Exa 2.8
2 format('v',6);clc;clear;close;
3 // Given data
4 del_a1 = 0.02;// limiting error in current
5 del_a2 = 0.5;// limiting error in resistor
6 A1 = 2;
7 A2 = 120;
8 e1 = del_a1/A1;
9 e2 = del_a2/A2;
10 n = 2;

```

```

11 // limiting error
12 e_T = (n*e1)+e2;
13 e_T_Per= e_T*100;// limiting error in percentage
14 disp("The limiting error is "+string(e_T)+" or
      "+string(e_T_Per)+" %")

```

Scilab code Exa 2.9 Percentage relative limiting error

```

1 // Exa 2.9
2 format('v',5);clc;clear;close;
3 // Given data
4 R1= 15;//value of resistance in
5 Re1= R1*5/100;//error in resistance in
6 R2= 33;//value of resistance in
7 Re2= R2*2/100;//error in resistance in
8 R3= 75;//value of resistance in
9 Re3= R3*5/100;//error in resistance in
10 R_T= R1+R2+R3;//resultant resistance in
11 R_T_e= Re1+Re2+Re3;//limiting error in resistance in

12 disp("The resultant is "+string(R_T)+" with the
      limiting error of "+string(R_T_e)+" ")
13 e_T= R_T_e/R_T*100;// in %
14 disp("The percentage relative limiting error in
      resultant is "+string(e_T)+" %")

```

Scilab code Exa 2.10 Uncertainly in combined resistance

```

1 // Exa 2.10
2 format('v',7);clc;clear;close;
3 // Given data
4 R1= 100;//resistance in
5 Re1= 0.1;//error in

```

```

6 R2= 50; //resistance in
7 Re2= 0.03; //error in
8 R= R1+R2; //resistance in
9 w= sqrt(Re1^2+Re2^2);
10 disp("For Series connection , R= "+string(R)+" "+
      string(w)+" ")
11 R= R1*R2/(R1+R2); // in
12 del_RbyR1= ((R1+R2)*R2-R1*R2)/(R1+R2)^2;
13 del_RbyR2= ((R1+R2)*R1-R1*R2)/(R1+R2)^2;
14 w= sqrt(del_RbyR1^2*Re1^2+del_RbyR2^2*Re2^2);
15 disp("For Parallel connection , R= "+string(R)+" "+
      +string(w)+" ")

```

Scilab code Exa 2.11 Absolute error

```

1 // Exa 2.11
2 format('v',5); clc; clear; close;
3 // Given data
4 At = 8.5; //true value in A
5 Am = 8.3; //measured value in A
6 Absoluteerror = At - Am; //absolute error in A
7 disp(Absoluteerror,"The Absolute error in A is");
8 // Relative percentage error
9 Per_Error = ((At-Am)/At)*100; // %e in %
10 disp(Per_Error,"The relative percentage error in %
      is");

```

Scilab code Exa 2.12 True value of the voltage

```

1 // Exa 2.12
2 format('v',7); clc; clear; close;
3 // Given data
4 Am = 111.5; //measured value in V

```

```

5 Per_Error = 5.3; // %e in %
6 // Per_Error = ((At-Am)/At)*100;
7 At = Am/(1 - (Per_Error/100)); //true value of
  voltage in V
8 disp(At,"The true value of voltage in V is");

```

Scilab code Exa 2.13 Resolution of the meter

```

1 // Exa 2.13
2 format('v',7); clc; clear; close;
3 // Given data
4 fullscaledivision = 100; //full scale division in V
5 n = 200; //number of divisions
6 scaledivision = fullscaledivision/n; //scale division
  in V
7 Resolution = 1/2*scaledivision; // in V
8 disp(Resolution,"The Resolution of meter in V is");

```

Scilab code Exa 2.14 New reading

```

1 // Exa 2.14
2 format('v',6); clc; clear; close;
3 // Given data
4 V = 150; //voltage in V
5 R1 = 50; //resistance in k ohm
6 R2 = 100; //resistance in k ohm
7 V_AB = R1 * (V/(R1+R2)); // in V
8 sensitivity = 1; // in k ohm/V
9 R = sensitivity*V_AB; // in k ohm
10 V_AB1 = ((R1*R)/(R1+R))*( V/(R2+(R1*R)/(R1+R)) ); //
  voltage reading on the voltmeter in V
11 disp("Part (i) When voltmeter sensitivity is 1 k /
  volt : ")

```



```

12 disp(V_AB1,"The voltage reading on the voltmeter in
    V is : ")
13 Per_Error= ((V_AB-V_AB1)/V_AB)*100; // %e in %
14 disp(Per_Error,"The percentage error in % is : ")
15 sensitivity = 25; // in k ohm/V
16 R = sensitivity*V_AB; // in k ohm
17 Rnet = (R1*R)/(R1+R); // assumed for calculation
18 V_AB2 = Rnet*( V/(R2+Rnet) ); // in V
19 disp("Part (ii) When voltmeter sensitivity is 25 k
    /volt : ")
20 disp(V_AB2,"The voltage reading on the voltmeter in
    V is : ")
21 Per_Error = ((V_AB-V_AB2)/V_AB)*100; // %e in %
22 disp(Per_Error,"The percentage error in % is : ")
23 disp("Thus the voltmeter with low sensitivity shows
    more error");
24 disp(" while voltmeter with high sensitivity shows
    less error.")

```

Scilab code Exa 2.15 Apparent resistance

```

1 // Exa 2.15
2 format('v',6);clc;clear;close;
3 // Given data
4 V = 80; // in V
5 I = 15; // in mA
6 I = I * 10^-3; // in A
7 R_T = V/I; // in ohm
8 R_T = R_T * 10^-3; //apparent resistance in k ohm
9 Rapp = R_T; // in k ohm
10 disp(Rapp,"The apparent resistance in k is");
11 sensitivity = 1.5; // in k ohm
12 f_s_reading = 150; //full scale reading in V
13 Rv = sensitivity*f_s_reading; // in k ohm
14 //R_T = (Rx*Rv)/(Rx+Rv);

```

```

15 Rx = (R_T*Rv)/(Rv-R_T); //Actual resistance of
    unknown resistor in k ohm
16 disp(Rx,"Actual resistance of unknown resistor in
    k is");
17 At = Rx; // in k ohm
18 Am = Rapp; // in k ohm
19 PerError = ((At-Am)/At)*100; //Error due to loading
    effect of voltmeter in %
20 disp(PerError,"Error due to loading effect of
    voltmeter in % is");
21 PerAccu = (1-abs(PerError*10^-2))*100; //Percentage
    relative accuracy in %
22 disp(PerAccu,"Percentage relative accuracy in % is")
    ;

```

Scilab code Exa 2.16 Magnitude of the resultant resistance

```

1 // Exa 2.16
2 format('v',7); clc; clear; close;
3 // Given data
4 // Values of resistance
5 R1 = 200; // in ohm
6 R2 = 100; // in ohm
7 R3 = 50; // in ohm
8 R_T = R1+R2+R3; //resultant resistance in ohm
9 // Error in resistance
10 e1 = 5; // in %
11 e2 = e1; // in %
12 e3 = e1; // in %
13 a1 = R1; // in ohm
14 a2 = R2; // in ohm
15 a3 = R3; // in ohm
16 Per_e_T = ( ((R1/R_T)*e1) + ((R2/R_T)*e2) + ((R3/R_T
    )*e3) ); // in %
17 // Per_e_T= del_R_T/R_T*100;

```

```

18 del_R_T= Per_e_T*R_T/100; // in
19 disp(R_T,"The magnitude of the resultant resistance
    in is : ")
20 disp("The limiting error (in percentage) is : "+
    string(Per_e_T)+" %")
21 disp("The limiting error (in ohm) is : "+string(
    del_R_T)+" ")

```

Scilab code Exa 2.17 Magnitude of the limiting error

```

1 // Exa 2.17
2 format('v',7); clc; clear; close;
3 // Given data
4 // Values of resistances
5 R1 = 36; // in ohm
6 R2 = 75; // in ohm
7 R_T = (R1*R2)/(R1+R2); // in ohm
8 // Error in resistance
9 e1 = 5; // in %
10 e_1 = e1+e1; // in % assumed
11 e2 = ( ((R1/(R1+R2))*e1) + ((R2/(R1+R2))*e1) ); // in
    %
12 e_T = e_1+e2; //limiting error in %
13 // Per_e_T= del_R_T/R_T*100;
14 del_R_T= e_T*R_T/100; //limiting error in
15 disp("The limiting error (in percentage) is : "+
    string(e_T)+" %")
16 disp("The limiting error (in ohm) is : "+string(
    del_R_T)+" ")

```

Scilab code Exa 2.18 Limiting error

```

1 // Exa 2.18

```

```

2 format('v',7);clc;clear;close;
3 // Given data
4 Error = 2/100;
5 Voltmeterrange = 50;//voltmeter range in V
6 Ammeterrange = 125;//ammeter range in mA
7 A1 = 40;//voltmeter reading in V
8 A2 = 125;//ammeter reading in mA
9 del_a1 = Error*Voltmeterrange;// in V
10 del_a2 = Error*Ammeterrange;// in mA
11 e1 = del_a1/A1;// error in voltage
12 e2 = del_a2/A2;// error in current
13 e_T= (e1+e2)*100;//limiting error of the power
    calculated in %
14 disp("The limiting error of the power calculated is
    :      "+string(e_T)+" %")

```

Scilab code Exa 2.19 Magnitude of unknown resistance

```

1 // Exa 2.19
2 format('v',7);clc;clear;close;
3 // Given data
4 R1 = 120;//resistance in ohm
5 e1= 0.1;//error in %
6 R2 = 2700;//resistance in ohm
7 e2= 0.5;//error in %
8 R3 = 470;//resistance in ohm
9 e3= 0.5;//error in %
10 Rx = (R2*R3)/R1;//magnitude of the unknown
    resistance in ohm
11 disp(Rx,"The magnitude of the unknown resistance in
    is : ")
12 e_T= e1+e2+e3;//limiting error in %
13 // Per_e_T= del_R_T/R_T*100;
14 del_Rx= e_T*Rx/100;//limiting error in
15 disp("The limiting error (in percentage) is :      "+

```

```

    string(e_T)+" %")
16 disp("The limiting error (in ohm) is :      "+string(
    del_Rx)+"      ")
17 disp("Hence the guaranteed values of the resistance
    is between")
18 disp(string(Rx-del_Rx)+"      to "+string(Rx+del_Rx)+"
    ")

```

Scilab code Exa 2.20 Mean and probable error

```

1 // Exa 2.20
2 format('v',7);clc;clear;close;
3 // Given data
4 x=[101.2 101.4 101.7 101.3 101.3 101.2 101.0 101.3
    101.5 101.1];// measured value
5 n = 10;// number of reading
6 sigma_x= 0;// initialization of variable
7 for i=1:1:n
8     sigma_x= sigma_x+x(i);// sum of readings
9 end
10 x_bar=sigma_x/n;// mean value
11 disp(x_bar,"The arithmetic mean is");
12 sigma_d_sq=0;// initialization of variable
13 sigma_d=0;// initialization of variable
14 for i=1:1:n
15     d(i)=x(i)-x_bar
16     sigma_d= sigma_d+abs(d(i));
17     sigma_d_sq= sigma_d_sq+d(i)*d(i);
18 end
19 DevFrommean =sigma_d/n;// Deviation from mean
20 disp(DevFrommean,"The Deviation from mean is");
21 sigma = sqrt( sigma_d_sq/(n-1) );//standard
    deviation in V
22 disp(sigma,"The standard deviation in V is");
23 ProError= 0.6745*sigma;//probable error of one

```

```

    reading in V
24 disp(ProError,"The probable error of one reading in
    V is : ")
25 ProError = 0.6745*sigma;// in V
26 e_m = ProError/( sqrt(n-1) );// probable error of
    mean
27 disp(e_m,"The probable error of mean is : ");

```

Scilab code Exa 2.21 Mean and standard deviation

```

1 // Exa 2.21
2 format('v',7);clc;clear;close;
3 // Given data
4 x= [29.6 32.4 39.4 28.9 30.0 33.3 31.4 29.5 30.5
    31.7 33.0 29.2];// measured value
5 n = 12;// number of reading
6 sigma_x= 0;// initialization of variable
7 for i=1:1:n
8     sigma_x= sigma_x+x(i);// sum of readings
9 end
10 x_bar=sigma_x/n;// mean value
11 disp(x_bar,"The mean value is");
12 sorted_x= gsort(x);
13 x_median= (sorted_x(n/2)+sorted_x(n/2+1))/2;//
    median value
14 disp(x_median,"The median value is : ")
15 sigma_d_sq=0;
16 for i=1:1:n
17     d(i)=x(i)-x_bar
18     sigma_d_sq= sigma_d_sq+d(i)*d(i);
19 end
20 sigma = sqrt( sigma_d_sq/(n-1) );//standard
    deviation in V
21 disp(sigma,"The standard deviation in V is");

```

Scilab code Exa 2.22 Mean and range

```
1 // Exa 2.22
2 format('v',7);clc;clear;close;
3 // Given data
4 x= [41.7 42.0 41.8 42.0 42.1 41.9 42.0 41.9 42.5
      41.8];// measured value
5 n = 10;// number of reading
6 sigma_x= 0;// initialization of variable
7 for i=1:1:n
8     sigma_x= sigma_x+x(i);// sum of reading
9 end
10 x_bar=sigma_x/n;// mean
11 disp(x_bar,"The mean is");
12 sigma_d_sq=0;
13 for i=1:1:n
14     d(i)=x(i)-x_bar
15     sigma_d_sq= sigma_d_sq+d(i)*d(i);
16 end
17 sigma = sqrt( sigma_d_sq/(n-1) );//standard
      deviation in V
18 disp(sigma,"The standard deviation in V is");
19 ProError= 0.6745*sigma;//probable error of one
      reading in V
20 disp(ProError,"The probable error of one reading in
      V is : ")
21 ProError = 0.6745*sigma;// in V
22 e_m = ProError/( sqrt(n-1) );// probable error of
      mean
23 disp(e_m,"The probable error of mean is : ");
24 sorted_x= gsort(x);
25 Range= sorted_x(1)-sorted_x(n);// range
26 disp("Range = "+string(sorted_x(n))+" to "+string(
      sorted_x(1))+" = "+string(Range))
```

Scilab code Exa 2.23 Limiting error

```
1 // Exa 2.23
2 format('v',7);clc;clear;close;
3 // Given data
4 Vrange= 600;//range in V
5 del_A= 2.5*Vrange/100;//limiting error at full scale
   in V
6 V= 400;//voltage in V
7 PerError= del_A/V*100;//percentage error in %
8 disp("The limiting error is :      "+string(PerError)+
   " %")
```

Scilab code Exa 2.24 The error

```
1 // Exa 2.24
2 format('v',7);clc;clear;close;
3 // Given data
4 At = 6.54;//true value in A
5 Am = 6.7;//measured value in A
6 AbsError = At-Am;// absolute error
7 PerError= ((At-Am)/At)*100;// percentage error
8 disp(PerError,"The error in % is");
```

Scilab code Exa 2.25 Range of reading

```
1 // Exa 2.25
2 format('v',7);clc;clear;close;
3 // Given data
```



```
4 Wrange= 500; //wattmeter range in W
5 del_A= 1.5*Wrange/100; //limiting error at full scale
  in W
6 P= 50; //power in W
7 Pmin= P-del_A; // minimum power in W
8 Pmax= P+del_A; // maximum power in W
9 disp("The range of the reading is : "+string(Pmin)+"
  watts to "+string(Pmax)+" watts");
```

Chapter 3

Analog and Electronics Instruments

Scilab code Exa 3.1 Deflecting torque

```
1 // Exa 3.1
2 format('v',7);clc;clear;close;
3 // Given data
4 N = 100;// number o turns
5 B = 0.15;//air gap in Wb/m^2
6 I = 5;//current in mA
7 I = I * 10^-3;// in A
8 l= 10;//length in mm
9 b = 8;//width in mm
10 A = l*b;//area in mm^2
11 A = A * 10^-6;// in m^2
12 Td = N*B*A*I;//deflecting torque in Nm
13 K = 0.2*10^-6;// in Nm/degree
14 // Td = Tc= K*theta;
15 theta = Td/K;//deflecting in degrees
16 disp(theta,"The deflecting in degrees is");
```

Scilab code Exa 3.2 Deflection of galvanometer

```
1 // Exa 3.2
2 format('v',7);clc;clear;close;
3 // Given data
4 B = 8*10^-3;//flux density in Wb/m^2
5 N = 300;// number of turns
6 l = 15;//length in mm
7 r = 30;//radius in mm
8 K = 2.5*10^-9;//spring constant in Nm/rad
9 J = 10*10^-9;// in kg-m^2
10 D = 2*10^-9;// in Nm/rads^-1
11 Rg = 80;// in ohm
12 A = l*r;// in mm^2
13 A = A * 10^-6;// in m^2
14 G = N*B*A;// in Nm/A
15 i = 1;// in A
16 i = i * 10^-6;// in A
17 theta_f = (G*i)/K;// in rad
18 r = 1;// in m
19 r = r * 10^3;// in mm
20 d = 2*theta_f*r;//deflection of galvanometer in mm
21 disp(d,"The deflection of galvanometer in mm is");
22 Si = d/i;// in mm/A
23 Si = Si * 10^-6;//Current sensitivity in mm/ A
24 disp(Si,"Current sensitivity in mm/ A is");
```

Scilab code Exa 3.3 Logarithmic decrement

```
1 // Exa 3.3
2 format('v',7);clc;clear;close;
3 // Given data
4 B = 10*10^-3;// in Wb/m^2
5 N = 200;// in turns
6 l = 16;// in mm
```

```

7 K = 12*10^-9; // in Nm/rad
8 J = 50*10^-9; // in kg-m^2
9 D = 5*10^-9; // in Nm/rads^-1
10 R = 120; // in ohm
11 A = 1^2; // in mm^2
12 A = A * 10^-6; // in m^2
13 G = N*B*A; // in Nm/A
14 i = 1; // in A
15 i = i * 10^-6; // in A
16 theta_f = (G*i)/K; // in rad
17 r = 1; // in m
18 r = r * 10^3; // in mm
19 // deflection of the galvanometer
20 d = 2*theta_f*r; // in mm
21 disp(d,"The deflection of the galvanometer in mm is"
);
22 i = i * 10^6; // in A
23 // Current sensitivity
24 Si = d/i; // in mm/ A
25 disp(Si,"The current sensitivity in mm/ A is");
26 // Voltage sensitivity
27 Sv = d/(i*R); // in mm/ V
28 disp(Sv,"The voltage sensitivity in mm/ V is");
29 So = d/(i*10^-6*10^6); //megaohm sensitivity in Mohm/
mm
30 disp(So,"The megaohm sensitivity in Mohm/mm is");
31 omega_d = (sqrt((4*J*K) - ((D)^2)))/(2*J); // in rad/
sec
32 f_d = omega_d/(2*%pi); //frequency of damped
oscillation in Hz
33 disp(f_d,"The frequency of damped oscillation in Hz
is");
34 omega_n = sqrt(K/J);
35 // period of free oscillation
36 To = (2*%pi)/omega_n; // in sec
37 disp(To,"The period of free oscillation in sec is");
38 Dc = 2*sqrt( J*K );
39 // The relative damping

```

```

40 Epsilon = D/Dc;
41 disp(Epsilon,"The relative damping is");
42 // The first maximum deflection
43 theta1 = theta_f * ( 1 + (%e^(-%pi*Epsilon)/(sqrt(1
    - ((Epsilon)^2)))) );// in rad
44 theta1 = theta1*2*r;// in mm
45 disp(theta1,"The first maximum deflection in mm is")
    ;
46 // The logarithmic decrement
47 lambda = (%pi*Epsilon)/(sqrt(1 - ((Epsilon)^2)));
48 disp(lambda,"The logarithmic decrement is");

```

Scilab code Exa 3.4 Shunt resistance

```

1 // Exa 3.4
2 format('v',7);clc;clear;close;
3 // Given data
4 Rm = 100;//internal resistance in ohm
5 Im = 2;// in mA
6 Im = Im * 10^-3;// in A
7 I = 150;// in mA
8 I = I * 10^-3;// in A
9 Rsh = (Im*Rm)/(I-Im);//shunt resistance in ohm
10 disp(Rsh,"The value of shunt resistance in ohm is");
11
12 // Note: The calculation in the book is wrong.

```

Scilab code Exa 3.5 Current through shunt

```

1 // Exa 3.5
2 format('v',7);clc;clear;close;
3 // Given data
4 Rsh = 0.01;//shunt resistance in ohm

```

```

5 Rm = 750; //resistance in ohm
6 Vm= 400*10^-3; //voltage in V
7 Ish = 50; //current in A
8 // Ish*Rsh = voltage drop;
9 Ish = Vm/Rsh; //current through shunt in A
10 disp(Ish,"The current through shunt in A is");
11 Ish=50; // in A
12 Vsh = Ish*Rsh; // in V
13 Im = Vm/Rm; // in A
14 // Im*R_m = Vsh;
15 R_m = Vsh/Im; //resistance of meter in ohm
16 disp(R_m,"The resistance of meter in is");

```

Scilab code Exa 3.6 Multirange dc milliammeter

```

1 // Exa 3.6
2 format('v',7); clc; clear; close;
3 // Given data
4 // The first range is 0-10 mA
5 I1 = 10; //in mA
6 Im = 2; // in mA
7 Rm = 75; // in ohm
8 R1 = (Im*Rm)/(I1-Im); // in ohm
9 disp(R1,"The value of R1 in ohm is");
10 // Second range is 0-50 mA
11 I2 = 50; // in mA
12 R2 = (Im*Rm)/(I2-Im); // in ohm
13 disp(R2,"The value of R2 in ohm is");
14 // The third range is 0-100 mA
15 I3 = 100; // in mA
16 R3 = (Im*Rm)/(I3-Im); // in ohm
17 disp(R3,"The value of R3 in ohm is");

```

Scilab code Exa 3.7 Value of Current

```
1 // Exa 3.7
2 format('v',7);clc;clear;close;
3 // Given data
4 I1 = 10; // in A
5 Im = 1*10^-3; // in A
6 Rm = 50; // in ohm
7 I2 = 5; // in A
8 I3 = 1; // in A
9 //  $I1 \cdot R1 = Im \cdot (R2 + R3 + Rm)$  or  $I1 \cdot R1 - Im \cdot R2 - Im \cdot R3 =$   
    $Im \cdot Rm$  (i)
10 //  $I2 \cdot (R1 + R2) = Im \cdot (R3 + Rm)$  or  $I2 \cdot R1 + I2 \cdot R2 - Im \cdot R3$   
    $= Im \cdot Rm$  (ii)
11 //  $I3 \cdot (R1 + R2 + R3) = Im \cdot Rm$  or  $I3 \cdot R1 + I3 \cdot R2 + I3 \cdot R3 =$   
    $Im \cdot Rm$  (iii)
12 // Solving eq (i), (ii) and (iii) by matrix method :
13 A= [I1 I2 I3; -Im I2 I3; -Im -Im I3];
14 B= [Im*Rm Im*Rm Im*Rm];
15 R= B*A^-1;
16 R1= R(1); //value of R1 in ohm
17 R2= R(2); //value of R2 in ohm
18 R3= R(3); //value of R3 in ohm
19 disp(R1,"The value of R1 in ohm is : ")
20 disp(R2,"The value of R2 in ohm is : ")
21 disp(R3,"The value of R3 in ohm is : ")
```

Scilab code Exa 3.8 Required multiplier resistance

```
1 // Exa 3.8
2 format('v',7);clc;clear;close;
3 // Given data
4 Rm = 500; //resistance of meter in ohm
5 Im = 40; //current in A
6 Im = Im * 10^-6; // in A
```

```

7 V = 10; //voltage in V
8 // The required multiplier resistance
9 Rs = (V/Im)-Rm; // in ohm
10 Rs = Rs * 10^-3; // in k ohm
11 disp(Rs,"The required multiplier resistance in k
    is");

```

Scilab code Exa 3.9 Required shunt

```

1 // Exa 3.9
2 format('v',7); clc; clear; close;
3 // Given data
4 Im = 20; //current in mA
5 Vm = 200; //voltage in mV
6 // Vm = Im*Rm;
7 Rm = Vm/Im; //resistance in ohm
8 I = 200; // in A
9 Im = Im * 10^-3; // in A
10 Rsh = (Im*Rm)/(I-Im); //required shunt resistance in
    ohm
11 disp(Rsh,"The required shunt resistance in is");
12 V = 500; // in V
13 Rs = (V/Im)-Rm; //required multiplier resistance in
    ohm
14 Rs = Rs * 10^-3; // in k ohm
15 disp(Rs,"The required multiplier resistance in k
    is");

```

Scilab code Exa 3.10 Series string of multipliers

```

1 // Exa 3.10
2 format('v',7); clc; clear; close;
3 // Given data

```



```

4 Rm = 50; //resistance of meter in ohm
5 Im = 2; //current in mA
6 Im = Im * 10^-3; // in A
7 V4 = 10; //voltage in V
8 R4 = (V4/Im) - Rm; // in ohm
9 R4= R4*10^-3; // in k ohm
10 disp(R4,"The value of R4 in k is");
11 R4= R4*10^3; // in ohm
12 V3 = 50; // in V
13 // (R3+R4) = (V3/Im) - Rm;
14 R3 = (V3/Im) - Rm - R4; // in ohm
15 R3= R3*10^-3; // in k ohm
16 disp(R3,"The value of R3 in k is");
17 R3= R3*10^3; // in ohm
18 V2 = 100; // in V
19 // (R2+R3+R4) = (V2/Im) - Rm;
20 R2 = (V2/Im) - Rm - R3 - R4; // in ohm
21 R2= R2*10^-3; // in k ohm
22 disp(R2,"The value of R2 in k is");
23 R2= R2*10^3; // in ohm
24 V1 = 500; // in V
25 // (R1+R2+R3+R4) = (V1/Im) - Rm;
26 R1 = (V1/Im) - Rm - R4 - R3 - R2; // in ohm
27 R1= R1*10^-3; // in k ohm
28 disp(R1,"The value of R1 in k is");

```

Scilab code Exa 3.11 Sensitivity method

```

1 // Exa 3.11
2 format('v',7); clc; clear; close;
3 // Given data
4 Rm = 50; //meter resistance in ohm
5 Im = 2; //current in mA
6 Im = Im * 10^-3; // in A
7 S = 1/Im; //sensitivity in ohm/V

```

```

8 // Voltage ranges
9 V1 = 500; // in V
10 V2 = 100; // in V
11 V3 = 50; // in V
12 V4 = 10; // in V
13 R4 = (S*V4) - Rm; // in ohm
14 R4= R4*10^-3; // in k ohm
15 disp(R4,"The value of R4 in k is");
16 R4= R4*10^3; // in ohm
17 R3 = (S*V3) - (Rm+R4); // in ohm
18 R3= R3*10^-3; // in k ohm
19 disp(R3,"The value of R3 in k is");
20 R3= R3*10^3; // in ohm
21 R2 = (S*V2) - (Rm+R4+R3); // in ohm
22 R2= R2*10^-3; // in k ohm
23 disp(R2,"The value of R2 in k is");
24 R2= R2*10^3; // in ohm
25 R1 = (S*V1) - (Rm+R2+R3+R4); // in ohm
26 R1= R1*10^-3; // in k ohm
27 disp(R1,"The value of R1 in k is");

```

Scilab code Exa 3.12 Multiplier resistance

```

1 // Exa 3.12
2 format('v',7); clc; clear; close;
3 // Given data
4 Im = 50; //current in A
5 Im = Im * 10^-6; // in A
6 S = 1/Im; // in ohm/V
7 V = 500; // in V
8 Rm = 200; //internal resistance in ohm
9 Rs = (S*V) - Rm; //multiplier resistance in ohm
10 Rs = Rs * 10^-6; // in Mohm
11 disp(Rs,"The value of multiplier resistance in M
    is");

```

Scilab code Exa 3.13 Sensitivity of the meter

```
1 // Exa 3.13
2 format('v',7);clc;clear;close;
3 // Given data
4 Rs = 25;//resistance in k ohm
5 Rs = Rs * 10^3;// in ohm
6 Rm = 1;//meter resistance in k ohm
7 Rm = Rm * 10^3;// in k ohm
8 V = 100;//voltage in V
9 //  $R_s = (S \cdot V) - R_m$ ;
10 S = (Rs+Rm)/V;//sensitivity in ohm/V
11 disp("For meter A: The value of S is : "+string(S)+
    " /V")
12 Rs = 150;// in k ohm
13 Rs = Rs * 10^3;// in ohm
14 V = 1000;// in V
15 //  $R_s = (S \cdot V) - R_m$ ;
16 S = (Rs+Rm)/V;// in ohm/V meter B
17 disp("For meter B: The value of S is : "+string(S)+
    " /V")
18 disp("The meter A is more sensitive than meter B")
```

Scilab code Exa 3.14 Accuracy of the meter

```
1 // Exa 3.14
2 format('v',7);clc;clear;close;
3 // Given data
4 // Case (i): When voltmeter having a sensitivity of
    500 /V
5 R1 = 20;// in k ohm
```

```

6 R2 = 25; // in k ohm
7 Vdc = 250; // in V
8 V = (Vdc/(R1+R2))*R2; // in V
9 Vrange = 150; // in V
10 S = 500; // in ohm/V
11 R_V = S*Vrange; // in ohm
12 R_V = R_V * 10^-3; // in k ohm
13 Req = (R2*R_V)/(R2+R_V); // in k ohm
14 V = (Req/(Req+R1))*Vdc; // in V voltmeter first
15 disp("Case (i): When voltmeter having a sensitivity
      of 500 /V")
16 disp("                The voltmeter will reads : "+
      string(V)+" V");
17 // Case (ii): When voltmeter having a sensitivity of
      1000 /V
18 S = 10000; // in ohm/V
19 R_V = S*Vrange; // in ohm
20 R_V = R_V * 10^-3; // in k ohm
21 Req = (R2*R_V)/(R2+R_V); // in k ohm
22 V = (Req/(Req+R1))*Vdc; // in V Voltmeter second
23 disp("Case (ii): When voltmeter having a sensitivity
      of 1000 /V")
24 disp("                The voltmeter will reads : "+
      string(V)+" V");
25 disp("Thus the second voltmeter reads more
      accurately.")

```

Scilab code Exa 3.15 Percentage accuracy

```

1 // Exa 3.15
2 format('v',6); clc; clear; close;
3 // Given data
4 Ra = 5; // in k ohm
5 Rb = 1; // in k ohm
6 V = 25; // in V

```

```

7 Vrange = 5; // in V
8 S = 1; // in k ohm/V
9 // True voltage across Rb
10 Vb = (Rb/(Ra+Rb))*V; // in V
11 disp(Vb,"The true voltage across Rb in V is");
12 R_V = S*Vrange; // in k ohm
13 Req = (Rb*R_V)/(Rb+R_V); // in k ohm
14 V1 = (Req/(Req+Ra))*V; //reading on the voltmeter 1
    in V
15 disp(V1,"The reading on the voltmeter 1 in V is");
16 S = 20; // in k ohm/V
17 R_V = S*Vrange; // in k ohm
18 Req = (Rb*R_V)/(Rb+R_V); // in k ohm
19 V2 = (Req/(Ra+Req))*V; //reading on the voltmeter 2
    in V
20 disp(V2,"The reading on the voltmeter 2 in V is");
21 PerError1 = ((Vb-V1)/Vb)*100; //percentage error in
    meter 1 in %
22 disp(PerError1,"The percentage error in meter 1 in %
    is");
23 PerError2 = ((Vb-V2)/Vb)*100; //percentage error in
    meter 2 in %
24 disp(PerError2,"The percentage error in meter 2 in %
    is");
25 PerAccuracy1 = 100 - PerError1; //percentage accuracy
    of meter 1 in %
26 disp(PerAccuracy1,"The percentage accuracy of meter
    1 in % is");
27 PerAccuracy2 = 100-PerError2; //percentage accuracy
    of meter 2 in %
28 disp(PerAccuracy2,"The percentage accuracy of meter
    2 in % is");
29 disp("Thus voltmeter 2 is "+string(PerAccuracy2)+" %
    accurate while voltmeter 1 is "+string(
    PerAccuracy1)+" % accurate")

```

Scilab code Exa 3.16 Multiplier resistance

```
1 // Exa 3.16
2 format('v',7);clc;clear;close;
3 // Given data
4 Erms = 10;//r.m.s. range of the voltmeter in V
5 Ep = sqrt(2)*Erms;// in V
6 Eav = 0.6*Ep;// in V
7 Eav = 9;// in V
8 Eavoutput = (1/2)*Eav;// in V
9 Edc = 0.45*Erms;// in V
10 Idc = 1;// in mA
11 Idc = Idc * 10^-3;// in A
12 Rm = 200;// in W
13 Rs = (Edc/Idc) - Rm;//required multiplier resistance
    in ohm
14 Rs = Rs * 10^-3;// in k ohm
15 disp(Rs,"The required multiplier resistance in k
    is");
```

Scilab code Exa 3.17 Multiplier resistance

```
1 // Exa 3.17
2 format('v',7);clc;clear;close;
3 // Given data
4 Idc = 2;//dc current in mA
5 Idc = Idc * 10^-3;// in A
6 Rm = 500;//meter resistance in ohm
7 Erms = 10;//r.m.s value in v
8 Eav = 9;//average value in V
9 Edc = 0.9*Erms;//dc voltage in V
10 Rs = (Edc/Idc) - Rm;//multiplier resistance in ohm
```

```
11 Rs = Rs * 10^-3; // in k ohm
12 disp(Rs, "The multiplier resistance in k is");
```

Scilab code Exa 3.18 Error in meter reading

```
1 // Exa 3.18
2 format('v',7); clc; clear; close;
3 // Given data
4 Kf_true = 1; // true value of form factor
5 Kf_measured = 1.11; // measured value of form factor
6 PerError = ((Kf_true - Kf_measured) / Kf_true) * 100; //
   percentage error in the meter reading in %
7 disp(PerError, "The percentage error in the meter
   reading in % is");
```

Scilab code Exa 3.19 Percentage error in reading

```
1 // Exa 3.19
2 format('v',5); clc; clear; close;
3 // Given data
4 V1 = 100; // in V
5 V2 = 0; // in V
6 e1 = 0; // in V
7 e2 = 100; // in V
8 T = 2; // in sec
9 T1 = 0; // in sec
10 T2 = 2; // in sec
11 // Slope of ramp
12 A = (e2 - e1) / (T2 - T1); // in V/sec
13 e = 'A*t'; // in sec
14 Erms = sqrt(1/T * integrate('(A*t)^2', 't', 0, T)); // in V
15 Eav = 1/T * integrate('(A*t)', 't', 0, T); // in V
16 Kf = Erms / Eav; // form factor
```

```

17 Kf_sine= 1.11; // form factor of sine wave
18 True_reading= 1; // true reading
19 Meas_reading= Kf_sine/Kf; // measured reading
20 PerError= (True_reading-Meas_reading)/True_reading
    *100; //percentage error in the reading in %
21 disp(PerError,"The percentage error in the reading
    in % is : ")

```

Scilab code Exa 3.20 Series resistance

```

1 // Exa 3.20
2 format('v',7); clc; clear; close;
3 // Given data
4 Erms = 200; //r.m.s value in V
5 Rm = 100; //meter resistance in ohm
6 Idc = 25; //dc current in mA
7 Idc= Idc*10^-3; // in A
8 Rf = 500; // in ohm
9 R_D = 2*Rf; // in ohm
10 Edc = 0.9*Erms; // in V
11 Rs = (Edc/Idc) - Rm; // in ohm
12 R_m = Rm+R_D; // in ohm
13 Rs = (Edc/Idc) - R_m; //required series resistance in
    ohm
14 disp(Rs,"The required series resistance in is");

```

Scilab code Exa 3.21 Required resistance

```

1 // Exa 3.21
2 format('v',7); clc; clear; close;
3 // Given data
4 r = 2; //radius in m
5 r = r * 10^3; // in mm

```



```

6 d = 200; // deflection in mm
7 To = 3.1415; // in sec
8 J = 2*10^-6; // in kg-m^2
9 i = 1; // in A
10 i = i * 10^-6; // in A
11 // d = 2*r*theta_f;
12 theta_f = d/(2*r); // in rad
13 // To = 2*pi * (sqrt( J/K ));
14 K = 4*pi^2*J/To^2; // in Nm/A
15 // theta_f = (G*i)/K;
16 G = (theta_f*K)/i; // in Nm/A
17 // The required resistance to obtain critical
    damping
18 Rc = G^2/( 2*sqrt(J*K)); // in ohm
19 Rc = Rc * 10^-3; // in k ohm
20 disp(Rc,"The required resistance to obtain critical
    damping in k is");

```

Scilab code Exa 3.22 Relative damping

```

1 // Exa 3.22
2 format('v',6); clc; clear; close;
3 // Given data
4 theta1 = 128; // first maximum deflection in mm
5 theta3 = 90; // second maximum deflection in mm
6 theta_f = 70; // in mm
7 i = 6.2; // in A
8 // The current sensitivity
9 Si = theta_f/i; // in mm/ A
10 disp(Si,"The current sensitivity in mm/ A is");
11 // The logarithmic decrement
12 // Formula %e^(2*lambda) = (theta1-theta_f)/(theta3-
    theta_f)
13 lambda = log((theta1-theta_f)/(theta3-theta_f) )
    *(1/2);

```

```

14 disp(lambda,"The logarithmic decrement is");
15 // lambda = (%pi*sie)/(sqrt( 1-((sie)^2) ));
16 // ((lambda/%pi)^2) = ((sie)^2)/(sqrt( 1-((sie)^2) )
    );
17 sie = lambda/sqrt(lambda^2+%pi^2);// the relative
    damping
18 disp(sie,"The relative damping is");

```

Scilab code Exa 3.23 Error

```

1 // Exa 3.23
2 format('v',5);clc;clear;close;
3 // Given data
4 I = 100;// in mA
5 Im = 1;// in mA
6 Rm = 25;// in ohm
7 // m = I/Im = 1 + Rm/Rsh;
8 Rsh = Rm/((I/Im) - 1);// in ohm
9 del_t = 10;// in C
10 Alpha_c = 0.004;
11 Alpha_m = 0.00015;
12 // When temperature increase by 10 C
13 R_m = Rm * ( 1 + (Alpha_c*del_t) );// in ohm
14 R_sh = Rsh * (1 + (Alpha_m*del_t));// in ohm
15 // When I= 100 mA then
16 I_m = (R_sh/(R_sh+R_m))*I;// in mA
17 // But Im required for full scale deflection
18 PerError= ((I_m-Im)/Im)*100;// in %
19 disp("Part (i) ");
20 disp(PerError,"The percentage error in % is");
21 Rx = 75;// in ohm
22 Rtotal = Rm+Rx;// in ohm
23 Rsh = Rtotal/((I/Im) - 1);// in ohm
24 //R_total =R_m+R_x;
25 R_total = R_m + (Rx*(1+(Alpha_m*del_t)));// in ohm

```

```

26 R_sh = Rsh * (1+( Alpha_m*del_t )); // in ohm
27 I_m = (R_sh/(R_sh+R_total))*I; // in mA
28 PerError = ((I_m-Im)/Im)*100; //percentage error in
    %
29 disp("Part (ii) ");
30 disp(PerError,"The percentage error in % is");

```

Scilab code Exa 3.24 Required multiplier to be connected in series

```

1 // Exa 3.24
2 format('v',7); clc; clear; close;
3 // Given data
4 Im =25; //current in mA
5 Im = Im * 10^-3; // in A
6 Rm = 10; //resistance in ohm
7 I = 20; // in A
8 Rsh = (Im*Rm)/(I-Im); //shunt resistance in ohm
9 disp(Rsh,"The value of Rsh in      is");
10 V = 120; // in V
11 Rs = (V/Im)-Rm; // in ohm
12 disp(Rs,"The value of Rs in      is");

```

Scilab code Exa 3.25 Values of multiplier

```

1 // Exa 3.25
2 format('v',7); clc; clear; close;
3 // Given data
4 Vm = 10; // in mV
5 Vm = Vm * 10^-3; // in V
6 Rm = 1; // in k ohm
7 Rm = Rm * 10^3; // in ohm
8 Im = Vm/Rm; // in A
9 // Part (i) : For the range of 100 mV

```

```

10 Vrange = 100; // in mV
11 Vrange = Vrange * 10^-3; // in V
12 Rs = (Vrange/Im) - Rm; // in ohm
13 Rs= Rs*10^-3; // in kohm
14 disp("Part (i) For the range of 100 mV")
15 // Part (ii) : For the range of 1 V
16 disp(Rs,"The value of Rs in k is");
17 Vrange = 1; // in V
18 Rs = (Vrange/Im) - Rm; // in ohm
19 Rs= Rs*10^-3; // in kohm
20 disp("Part (i) For the range of 1V")
21 disp(Rs,"The value of Rs in k is");

```

Scilab code Exa 3.26 Universal shunt for a PMMC instrument

```

1 // Exa 3.26
2 format('v',7); clc; clear; close;
3 // Given data
4 Vm = 0.1; //full scale deflection voltage in V
5 Rm = 20; //meter resistance in ohm
6 Im = Vm/Rm; //current in A
7 I1= 10; // in A
8 I2= 1; // in A
9 I3= 100*10^-3; // in A
10 // I1*R1 = Im*(R2+R3+Rm) or I1*R1 - Im*R2 - Im*R3
    = Im*Rm (i)
11 // I2*(R1+R2) = Im*(R3+Rm) or I2*R1 + I2*R2 -Im*R3 =
    Im*Rm (ii)
12 // I3*(R1+R2+R3) = Im*Rm or I3*R1 + I3*R2 + I3*R3
    = Im*Rm (iii)
13 A= [I1 I2 I3; -Im I2 I3; -Im -Im I3];
14 B= [Im*Rm Im*Rm Im*Rm];
15 R= B*A^-1; // Solving equation (i), (ii) and (iii) by
    matrix method
16 R1= R(1); // in ohm

```

```

17 R2= R(2); // in ohm
18 R3= R(3); // in ohm
19 disp(R1,"The value of R1 in ohm is : ")
20 disp(R2,"The value of R2 in ohm is : ")
21 disp(R3,"The value of R3 in ohm is : ")

```

Scilab code Exa 3.27 Value of the resistance

```

1 // Exa 3.27
2 format('v',7);clc;clear;close;
3 // Given data
4 Im = 10; //current in mA
5 Im = Im * 10^-3; // in A
6 Rm = 50; //meter resistance in ohm
7 I = 5; // in A
8 // Value of resistance to be connected in parallel
9 Rsh = (Im*Rm)/(I-Im); // in ohm
10 disp(Rsh,"The value of resistance to be connected in
    parallel in is");
11 V = 250; // in V
12 // The value of resistance to be connected in series
13 Rs = (V/Im) - Rm; // in ohm
14 disp(Rs,"The value of resistance to be connected in
    series in is");

```

Scilab code Exa 3.28 Shunt resistance

```

1 // Exa 3.28
2 format('v',6);clc;clear;close;
3 // Given data
4 Im = 1; // in mA
5 Im = Im * 10^-3; // in A
6 Rm = 100; // in ohm

```

```

7 I = 100; // in mA
8 I = I * 10^-3; // in A
9 // For 100 mA range, the value of Rsh to be
  connected in parallel
10 Rsh = (Im*Rm)/(I-Im); // in ohm
11 disp(Rsh,"For 100 mA range, the value of Rsh to be
  connected in parallel in is");
12 I = 1; // in A
13 // For 1 A range, the value of Rsh to be connected
  in parallel
14 Rsh = (Im*Rm)/(I-Im); // in ohm
15 disp(Rsh,"For 1A range, the value of Rsh to be
  connected in parallel in is");
16 V = 1; // in V
17 // For 1V range, the value of Rs to be connected in
  series
18 Rs = (V/Im)-Rm; // in ohm
19 disp(Rs,"For 1V range, the value of Rs to be
  connected in series in is");
20 V = 100; // in V
21 // For 100 V range, the value of Rs to be connected
  in series
22 Rs = (V/Im)-Rm; // in ohm
23 Rs = Rs*10^-3; // in k ohm
24 disp(Rs,"For 100V range, the value of Rs to be
  connected in series in k is");

```

Scilab code Exa 3.29 Required shunt

```

1 // Exa 3.29
2 format('v',7); clc; clear; close;
3 // Given data
4 Rm = 100; //meter resistance in ohm
5 Im = 2; //current in mA
6 Im = Im * 10^-3; // in A

```

```

7 I = 150; // in mA
8 I = I * 10^-3; // in A
9 m = I/Im;
10 Rsh = Rm/(m-1); //required shunt resistance in ohm
11 disp(Rsh,"The value of required shunt resistance in
    is");
12 Pm = ((Im)^2)*Rm; // in W
13 Psh = ((I-Im)^2)*Rsh; // in W
14 P = Pm+Psh; //power consumption in W
15 P = P * 10^3; // in mW
16 disp(P,"The power consumption in mW is");

```

Scilab code Exa 3.30 Magnitude of current

```

1 // Exa 3.30
2 format('v',7); clc; clear; close;
3 // Given data
4 std_cell_emf = 1.45; //e.m.f. of standard cell in V
5 l = 50; //length in cm
6 Vdrop = std_cell_emf /l; //voltage drop per unit
    length in V/cm
7 Vstdresistor = Vdrop*75; //voltage across standard
    resistor in V
8 Stdresistor = 0.1; //standard resistor in ohm
9 I = Vstdresistor/Stdresistor; //magnitude of current
    in A
10 disp(I,"The magnitude of current in A is");

```

Chapter 4

Digital Instruments

Scilab code Exa 4.1 Resolution and digital output

```
1 // Exa 4.1
2 format('v',7);clc;clear;close;
3 // Given data
4 Vi = 5.1;//input voltage in V
5 n = 8;// number of bit
6 Resolution = 2^n;
7 Resolution = Vi/(Resolution-1);// in V/LSB
8 Resolution= Resolution*10^3;// in mV/LSB
9 disp(Resolution,"The Resolution in mV/LSB is");
10 Resolution= Resolution*10^-3;// in V/LSB
11 Vi = 1.28;// in V
12 D = Vi/Resolution;//digital output in LSBs
13 DigitalOutput= dec2bin(round(D));// digital output
    in binary
14 disp(DigitalOutput,"The digital output in binary is
    :")
```

Scilab code Exa 4.2 Quantizing error


```

1 // Exa 4.2
2 format('v',7);clc;clear;close;
3 // Given data
4 n = 12;//number of bit
5 Vi = 4.095;//input voltage in V
6 Q_E = Vi/(((2^n)-1)*2);//quantizing error in V
7 Q_E = Q_E * 10^3;// in mV
8 disp(Q_E,"The quantizing error in mV is");

```

Scilab code Exa 4.3 The value of t2

```

1 // Exa 4.3
2 format('v',7);clc;clear;close;
3 // Given data
4 // When Vi=100 mV
5 Vi = 100;// in mV
6 V_R = 100;// in mV
7 t1 = 83.33;// in ms
8 t2 = (Vi/V_R)*t1;// in ms
9 disp(t2,"When Vi=100 mV, the value of t2 in ms is");
10 // When Vi=200 mV
11 Vi = 200;// in mV
12 t2 = (Vi/V_R)*t1;// in ms
13 disp(t2,"When Vi=200 mV, the value of t2 in ms is");

```

Scilab code Exa 4.4 Digital output

```

1 // Exa 4.4
2 format('v',7);clc;clear;close;
3 // Given data
4 t1 = 83.33;// in ms
5 V_R = 100;// in mV
6 Vi = 100;// in mV

```

```

7 fc = 12; //clock frequency in kHz
8 fc = fc* 10^3; // in Hz
9 Digitaloutput = round(fc*t1*(Vi/V_R)*10^-3); //
  digital output in counts
10 disp(Digitaloutput,"The Digital output in counts is"
  );

```

Scilab code Exa 4.5 Conversion time

```

1 // Exa 4.5
2 format('v',7); clc; clear; close;
3 // Given data
4 f = 1; // in MHz
5 f = f * 10^6; // in Hz
6 T = 1/f; // in sec
7 T = T * 10^6; // in sec
8 n = 8;
9 // Conversion time
10 T_C = T*(n+1); // in sec
11 disp(T_C,"The conversion time in sec is");

```

Scilab code Exa 4.6 Maximum frequency

```

1 // Exa 4.6
2 format('v',7); clc; clear; close;
3 // Given data
4 n = 8; // number of bit
5 T_C = 9; //conversion time in s
6 T_C = T_C * 10^-6; // in s
7 // The maximum frequency
8 f_max = 1/(2*%pi*T_C*(2^n)); // in Hz
9 disp(f_max,"The maximum frequency in Hz is");

```

Scilab code Exa 4.7 Resolution

```
1 // Exa 4.7
2 format('v',7);clc;clear;close;
3 // Given data
4 n = 3;// number of bit
5 R = 1/(10^n);
6 V = 1;// in V
7 // For 1V range ,
8 Resolution = V*R;// in V
9 disp(Resolution,"For 1 V range, the resolution in V
   is");
10 // For 50 V range ,
11 V = 50;// in V
12 Resolution = V*R;// in V
13 disp(Resolution,"For 50 V range, the resolution in V
   is");
```

Scilab code Exa 4.8 Resolution

```
1 // Exa 4.8
2 clc;clear;close;
3 // Given data
4 format('v',8)
5 n = 4;// number of bit
6 R = 1/(10^n);
7 disp(R,"Part (i) : The resolution is");
8 // There are 5 digit places in 4 1/2 digits , so
9 disp("Part (ii) : 11.87 would be displayed as 11.870
   ")
10 Reading= 0.5573;
11 format('v',7)
```

```
12 disp(Reading,"Part (iii) : On 1 V range, 0.5573 will  
    be displayed as : ")  
13 format('v',6)  
14 disp(Reading,"On 10 V range, 0.5573 will be  
    displayed as : ")
```

Chapter 5

Measurement of Resistance

Scilab code Exa 5.1 Value of R1 and R2

```
1 // Exa 5.1
2 format('v',7);clc;clear;close;
3 // Given data
4 Rh = 1000; // in ohm
5 Rm = 50; // in ohm
6 V = 3; // in V
7 Ifsd = 1; // in mA
8 Ifsd = Ifsd * 10^-3; // in A
9 R1 = Rh - ( (Ifsd*Rm*Rh)/V ); // in ohm
10 disp(R1,"The value of R1 in is");
11 R2 = (Ifsd*Rm*Rh)/(V-(Ifsd*Rh)); // in ohm
12 disp(R2,"The value of R2 in is");
13 // Due to 5 % drop in battery voltage , the voltage
    becomes
14 V = V - (0.05*V); // in V
15 R2 = (Ifsd*Rm*Rh)/(V-(Ifsd*Rh)); // in ohm
16 disp(R2,"Maximum value of R2 in is");
```

Scilab code Exa 5.2 Unknown resistance

```

1 // Exa 5.2
2 format('v',7);clc;clear;close;
3 // Given data
4 R1 = 10;//resistance in k ohm
5 R2 = 2;//resistance in k ohm
6 R3 = 5;//resistance in k ohm
7 Rx = (R1/R2)*R3;//value of unknown resistance in k
  ohm
8 disp(Rx,"The value of unknown resistance in k is")
  ;

```

Scilab code Exa 5.3 Current through galvanometer

```

1 // Exa 5.3
2 format('v',7);clc;clear;close;
3 // Given data
4 // Values of resistances of the circuit
5 R1 = 7;// in k ohm
6 R2 = 2;// in k ohm
7 R3 = 4;// in k ohm
8 R4 = 20;// in k ohm
9 Rg = 300;// in ohm
10 E = 8;// in V
11 //Use Thevenin's equivalent for Ig, V_TH=V_BD=V_AD-
  V_AB=((E/(R3+R4))*R4) - ((E/(R1+R2))*R1) );
12 V_TH = ( ((E/(R3+R4))*R4) - ((E/(R1+R2))*R1) );// in
  V
13 Req = ((R1*R2)/(R1+R2)) + ((R3*R4)/(R3+R4));// in k
  ohm
14 // Current through galvanometer
15 Ig = V_TH/((Req*10^3)+Rg);// in A
16 Ig = Ig * 10^6;// in A
17 disp(Ig,"The current through galvanometer in A is")
  );

```

Scilab code Exa 5.4 Unknown resistance

```
1 // Exa 5.4
2 format('v',7);clc;clear;close;
3 // Given data
4 R3 = 100.03; //standard resistance in ohm
5 R3 = R3 * 10^-6; // in ohm
6 R2 = 100.24; //outer ratio arms resistance in ohm
7 R1 = 200; //outer ratio arms resistance in ohm
8 b = 100.31; // in ohm
9 a = 200; // in ohm
10 Ry = 700; // in ohm
11 Ry = Ry * 10^-6; // in ohm
12 Rx = ((R1*R3)/R2) + ( ((b*Ry)/(Ry+a+b)) * ((R1/R2) -
    (a/b)) ); // in ohm
13 Rx = Rx * 10^6; //unknown resistance in ohm
14 disp(Rx,"The unknown resistance in is");
```

Scilab code Exa 5.5 Deflection of galvanometer

```
1 // Exa 5.5
2 format('v',7);clc;clear;close;
3 // Given data '
4 R1 = 100; // in ohm
5 R2 = 1000; // in ohm
6 R3 = 200; // in ohm
7 R4 = 2000; // in ohm
8 Rg = 200; // in ohm
9 S = 12; // in mm/ A
10 R = 5; // in ohm
11 R4 = R4 + R; // in ohm
12 E = 10; // in V
```

```

13 // By Thevenin's equivalent
14 V_TH = E*( (R3/(R1+R3)) - (R4/(R2+R4)) );// in V
15 Req = ((R1*R3)/(R1+R3)) + ((R2*R4)/(R2+R4));// in
    ohm
16 Ig = abs(V_TH)/(Req+Rg);// in A
17 Ig = Ig * 10^6;// in A
18 // S =D/I;
19 D = S*Ig;//deflection of the galvanomter in mm
20 disp(D,"The deflection of the galvanomter in mm is")
    ;
21
22 // Note:In the book the calculated value of V_TH is
    not correct. Correct value of V_TH is -5.546312
    mV not -5.213 mV, So there is some difference
    between coding and the answer of the book.

```

Scilab code Exa 5.6 Deflection of galvanometer

```

1 // Exa 5.6
2 format('v',7);clc;clear;close;
3 // Given data
4 R1 = 1000;// in ohm
5 R2 = 1000;// in ohm
6 R3 = 121;// in ohm
7 R4 = 119;// in ohm
8 Rg = 200;// in ohm
9 E = 5;// in V
10 S = 1;// in mm/ A
11 // Calculation of Thevenin's equivalent due to
    change in R3 and R4
12 V_TH = E*( (R3/(R3+R1)) - (R4/(R4+R2)) );// in V
13 Req = ((R1*R3)/(R1+R3)) + ((R2*R4)/(R2+R4));// in
    ohm
14 Ig = V_TH/(Req+Rg);// in A
15 Ig = Ig * 10^6;// in A

```



```

16 // S = D/I;
17 D = S*Ig; // deflection of the galvanometer in mm
18 disp(D, "The deflection of the galvanometer in mm is"
    );

```

Scilab code Exa 5.7 Current through galvanometer

```

1 // Exa 5.7
2 format('v',7); clc; clear; close;
3 // Given data
4 R = 500; // in ohm
5 del_r = 20; // in ohm
6 E = 10; // in V
7 Rg = 125; // in ohm
8 V_TH = (E*del_r)/(4*R); // in V
9 Req = R; // in ohm
10 // The current through the galvanometer
11 Ig = V_TH/(Req+Rg); // in A
12 Ig = Ig * 10^6; // in A
13 disp(Ig, "The current through the galvanometer in A
    is");

```

Scilab code Exa 5.8 Unknown resistance

```

1 // Exa 5.8
2 format('v',7); clc; clear; close;
3 // Given data
4 // Rx/R2 = Rb/Ra = 1/1200;
5 R1 = 10; // in ohm
6 // Rx/R2 = Rb/Ra = 1/1200
7 R2 = R1/0.5; // in ohm
8 Rx = R2/1200; // unknown resistance in ohm
9 disp(Rx, "The value of unknown resistance in ohm is");

```

Scilab code Exa 5.9 Temperature

```
1 // Exa 5.9
2 format('v',7);clc;clear;close;
3 // Given data
4 //format()
5 R1 = 10;// in k ohm
6 R2 = 10;// in k ohm
7 R3 = 10;// in k ohm
8 E = 10;// in V
9 // R2/R_V = R1/R3;
10 R_V = (R2*R3)/R1;// in k ohm
11 T=80;// in C
12 Rv=9;// in k
13 // Evaluation of error voltage by Thevenin's
    equivalent voltage
14 e = E*( (R3/(R1+R3)) - (Rv/(R2+Rv)) );// in V
15 // Evaluation of error voltage by approximation of
    slightly unbalanced bridge
16 del_r = R_V-Rv;// in k ohm
17 errorVoltage = (E*del_r)/(4*R1);// in V
18 disp(T,"The temperature at which the bridge is
    balanced in C is : ");
19 disp(e,"The error voltage at 60 C by Thevenin's
    voltage in volts is : ")
20 disp(errorVoltage,"The error voltage at 60 C by
    approximation of slightly unbalanced bridge in
    Volts is ");
```

Scilab code Exa 5.10 Required supply voltage

```

1 // Exa 5.10
2 format('v',7);clc;clear;close;
3 // Given data
4 R1 = 120;// in ohm
5 R2 = 120;// in ohm
6 R3 = 120;// in ohm
7 R_V = 121;// in ohm
8 E_TH = 10;// in mV
9 E_TH = E_TH * 10^-3;// in V
10 // E_TH = E * ( (R3/(R3+R1)) - (R_V/(R_V+R2)) );
11 E = E_TH/((R3/(R3+R1)) - (R_V/(R_V+R2)));//required
    supply voltage in V
12 disp(E,"The required supply voltage in V is");
13 R = 120;// in ohm
14 del_r = R_V-R;// in ohm
15 // E_TH = (E*del_r)/(4*R);
16 E = E_TH*4*R;//The approximation of slightly
    unbalanced bridge in V
17 disp(E,"The approximation of slightly unbalanced
    bridge in V is");

```

Scilab code Exa 5.11 Maximum unknown resistance

```

1 // Exa 5.11
2 format('v',7);clc;clear;close;
3 // Given data
4 R1 = 1000;// in ohm
5 R2 = 100;// in ohm
6 R3 = 4;// in k ohm
7 R3 = R3*10^3;// in ohm
8 //At bridge balance , R1*R3 = R2*R4;
9 R4 = (R1*R3)/R2;// in ohm
10 R4= R4*10^-3;//maximum unknown resistance in k ohm
11 disp(R4,"The maximum unknown resistance in k is");
12 R4= R4*10^3;// in ohm

```

```

13 R_TH = ((R1*R2)/(R1+R2)) + ((R3*R4)/(R3+R4)); // in
    ohm
14 Si = 70; // in mm/ A
15 Si = Si * 10^6; // in mm/A
16 theta = 3; // in mm
17 E = 10; // in V
18 Rg = 80; // in ohm
19 // theta = (Si*E*R3*del_R)/((R_TH+Rg)*((R3+R4)^2));
20 del_R = (theta*((R_TH+Rg)*((R3+R4)^2)))/(Si*E*R3); //
    in ohm
21 disp(del_R,"The value of del_R in      is : ")
22 disp("This much unbalance is necessary to cause the
    deflection of 3 mm")

```

Scilab code Exa 5.12 Required series resistance

```

1 // Exa 5.12
2 format('v',7); clc; clear; close;
3 // Given data
4 P = 0.4; //power dissipation in each arm in W
5 Rarm = 150; // in ohm
6 //P = (I^2)*Rarm;
7 I = sqrt(P/Rarm); // in A
8 //Apply KVL to the loop ABCEFA, (-I*Rarm) - (I*Rarm
    ) - (2*I) + 25 - (2*I*R) = 0;
9 R = ((-I*Rarm) - (I*Rarm) - (2*I) + 25)/(2*I); //
    required series resistance in ohm
10 disp(R,"The required series resistance in      is");

```

Scilab code Exa 5.13 Unknown resistance

```

1 // Exa 5.13
2 format('v',7); clc; clear; close;

```

```

3 // Given data
4 R1 = 100; // in ohm
5 R2 = 1000; // in ohm
6 R3 = 0.00377; // standard resistance in ohm
7 a = 99.92; // in ohm
8 b = 1000.6; // in ohm
9 Ry = 0.1; // resistance of link in ohm
10 Rx = R1*R3/R2+b*Ry/(Ry+a+b)*(R1/R2-a/b); // unknown
    resistance in ohm
11 Rx = Rx * 10^3; // in mohm
12 disp(Rx, "The value of unknown resistance in m is")
    ;
13
14 // Note: The answer will be in m not M .

```

Scilab code Exa 5.14 Value of R

```

1 // Exa 5.14
2 format('v',7); clc; clear; close;
3 // Given data
4 P = 10; // in ohm
5 Q = 10; // in ohm
6 S = 10; // in ohm
7 // For first balance
8 p = 30000; // in ohm
9 q = 25000; // in ohm
10 R_AB = (P*p)/(P+p); // in ohm
11 R_BC = (Q*q)/(Q+q); // in ohm
12 // R_AB*R = R_BC*S;
13 R = (R_BC/R_AB)*S; // in ohm
14 disp(R, "The value of R for first balance in is");
15 // For second balance
16 p = 15000; // in ohm
17 q = 40000; // in ohm
18 R_AB = (P*p)/(P+p); // in ohm

```

```

19 R_BC = (Q*q)/(Q+q); // in ohm
20 // R_AB*S = R_BC*R;
21 R = (R_AB/R_BC)*S; // in ohm
22 disp(R,"The value of R for second balance in      is")
    ;

```

Scilab code Exa 5.15 Unknown resistance

```

1 // Exa 5.15
2 format('v',7); clc; clear; close;
3 // Given data
4 P = 1000; // in ohm
5 Q = 1000; // in ohm
6 p = 1000; // in ohm
7 q = 1000; // in ohm
8 S = 0.001; // in ohm
9 R = (P/Q)*S; // in ohm
10 disp(R,"The value of unknown resistance in      is");
11 Rb = 5; // in ohm
12 V = 100; // in V
13 I = V/(Rb+R+S); // in A
14 disp(I,"The current through the unknown resistance
    in A is");
15 R = R*0.1; // in ohm
16 // Vac = ( (R+r+S)/(Rb+R+r+S) ) * V;
17 Vac = ((R+S)/(Rb+R+S))*V; // in V .. correction
18 Vab = (P/(P+Q))*Vac; // in V
19 Vab = Vab * 10^3; // in mV
20 // Vamd = (R + (Pr/(p+q+r)))/(R+S+(((p+q)*r)/(p+q+r)
    ));
21 Vamd = (R/(R+S))*Vab*10^-3; // in V
22 Vamd = Vamd * 10^3; // in mV
23 Vout = Vab - Vamd; //output voltage in mV
24 Vout = Vout*10^-3; // in V
25 disp(Vout,"The output voltage in V is");

```

Scilab code Exa 5.16 Smallest change in resistance

```
1 // Exa 5.16
2 format('v',7);clc;clear;close;
3 // Given data
4 R = 1000;// in ohm
5 E = 20;// in V
6 Ig = 0.1;// in nA
7 Ig = Ig * 10^-9;// in A
8 Req = R;// in ohm
9 //For small change in resistance , Thevenin's voltage
   , V_TH = (E*del_r)/(4*R);
10 // Ig = V_TH/Req;
11 del_r = (Ig*4*R*R)/E;//smallest change in
   resistance in ohm
12 del_r= del_r*10^6;// in
13 disp(del_r,"The smallest change in resistance in
   is");
```

Chapter 6

A C Bridges

Scilab code Exa 6.1 Constant of unknown impedance

```
1 // Exa 6.1
2 format('v',7);clc;clear;close;
3 // Given data
4 Z1 = 50;// in ohm
5 Z2 = 250;// in ohm
6 Z3 = 200;// in ohm
7 theta1 = 80;// in degree
8 theta2 = 0;// in degree
9 theta3 = 30;// in degree
10 //bridge balance equation , Z1*Z4 = Z2*Z3;
11 Z4 = (Z2*Z3)/Z1;// in ohm
12 //phase angle condition , theta1+theta4 = theta2+
    theta3;
13 theta4 = theta2+theta3-theta1;// in degree
14 Z4=Z4*expm(%i*theta4*pi/180);
15 disp("The resistance part of Z4 is "+string(real(Z4))
    )+" while ")
16 disp(" it is in series with capacitive reactance of
    "+string(abs(imag(Z4)))+"
```

Scilab code Exa 6.2 Whether or not the bridge is complete balance

```
1 // Exa 6.2
2 format('v',7);clc;clear;close;
3 // Given data
4 Z1 = 50;// in ohm
5 Z2 = 100;// in ohm
6 Z3 = 15;// in ohm
7 Z4 = 30;// in ohm
8 theta1 = 40;// in degree
9 theta2 = -90;// in degree
10 theta3 = 45;// in degree
11 theta4 = 30;// in degree
12 if abs(Z1*Z4)== abs(Z3*Z2) then
13     flag1=1;
14     disp("The condition of balance for magnitude is
15         satisfied")
16 else
17     flag1=0
18     disp("The condition of balance for magnitude is
19         not satisfied")
20 end
21 if theta1+theta4==theta2+theta3 then
22     flag2=1
23     disp("The condition of balance for phase is also
24         satisfied")
25 else
26     flag2=0
27     disp("But the condition of balance for phase is
28         not satisfied")
29 end
30 if flag1==1 then
31     if flag2==1 then
32         disp("Hence the bridge is under balanced
```

```

        condition")
29     else
30         disp("Hence the bridge is not under balanced
              condition")
31     end
32 else
33         disp("Hence the bridge is not under balanced
              condition")
34 end

```

Scilab code Exa 6.3 Equivalent series circuit of unknown impedance

```

1 // Exa 6.3
2 format('v',7); clc; clear; close;
3 // Given data
4 C3 = 10; // in F
5 C3 = C3*10^-6; // in F
6 R1 = 1.2; // in k ohm
7 R1 = R1 * 10^3; // in ohm
8 R2 = 100; // in k ohm
9 R2 = R2 * 10^3; // in ohm
10 R3 = 120; // in k ohm
11 R3 = R3 * 10^3; // in ohm
12 Rx = (R2*R3)/R1; //unknown resistance in ohm
13 Rx = Rx * 10^-6; // in M ohm
14 disp(Rx,"The value of Rx in M is");
15 Cx = (R1*C3)/R2; // in F
16 Cx = Cx * 10^6; //unknown capacitance in F
17 disp(Cx,"The value of Cx in F is");

```

Scilab code Exa 6.4 Equivalent series circuit of unknown impedance

```

1 // Exa 6.4

```

```

2 format('v',7);clc;clear;close;
3 // Given data
4 L3 = 8; // in mH
5 L3 = L3 * 10^-3; // in H
6 R1 = 1; // in k ohm
7 R1 = R1 * 10^3; // in ohm
8 R2 = 25; // in k ohm
9 R2 = R2 * 10^3; // in ohm
10 R3 = 50; // in k ohm
11 R3 = R3 * 10^3; // in ohm
12 Rx = (R2*R3)/R1; //unknown resistance in ohm
13 Rx = Rx * 10^-6; // in M ohm
14 disp(Rx,"The value of Rx in M is");
15 Lx = (R2*L3)/R1; //unknown inductance in H
16 Lx = Lx * 10^3; // in mH
17 disp(Lx,"The value of Lx in mH is");

```

Scilab code Exa 6.5 Component of branch BC

```

1 // Exa 6.5
2 format('v',7);clc;clear;close;
3 // Given data
4 C1 = 0.5; // in F
5 C1 = C1 * 10^-6; // in F
6 R1 = 1200; // in ohm
7 R2 = 700; // in ohm
8 R3 = 300; // in ohm
9 // From bridge balance equation
10 Rx = (R2*R3)/R1; // in ohm
11 disp("Component of the brach BC :")
12 disp("Rx = "+string(Rx)+" ");
13 Lx = R2*R3*C1; // in H
14 Lx = Lx * 10^3; // in mH
15 disp("Lx = "+string(Lx)+" mH");

```

Scilab code Exa 6.6 Value of Rx and Lx

```
1 // Exa 6.6
2 format('v',7);clc;clear;close;
3 // Given data
4 R2 = 1000;//resistance in ohm
5 R3 = 500;// resistance in ohm
6 R4 = 1000;// resistance in ohm
7 C = 3;//capacitance in F
8 C = C * 10^-6;// in F
9 r = 100;// in ohm
10 Rx = (R2*R3)/R4;//value of Rx in ohm
11 disp(Rx,"The value of Rx in is");
12 Lx = ((C*R2)/R4)*((R3*r) + (R4*r) + (R3*R4));//
    value of Lx in H
13 disp(Lx,"The value of Lx in H is");
```

Scilab code Exa 6.7 Unknown inductance and resistance

```
1 // Exa 6.7
2 format('v',7);clc;clear;close;
3 // Given data
4 R1 = 5.1;// in k ohm
5 R1 = R1 * 10^3;// in ohm
6 R2 = 7.9;// in k ohm
7 R2 = R2 * 10^3;// in ohm
8 R3 = 790;// in ohm
9 C1 = 2;// in F
10 C1 = C1 * 10^-6;// in F
11 omega = 1000;// in rad/sec
12 Rx = (((omega)^2)*R1*((C1)^2)*R2*R3)/(1+(((omega)
    ^2) * ((R1)^2) * ((C1)^2)));// unknown resistance
```

```

        in ohm
13 Rx = Rx * 10^-3; // in k ohm
14 disp(Rx,"The value of unknown resistance in k is")
    ;
15 Lx = (R2*R3*C1)/( 1+(((omega)^2) * ((R1)^2)* ((C1)
    ^2)) ); // unknown inductance in H
16 Lx = Lx * 10^3; // in mH
17 disp(Lx,"The value of unknown inductance in mH is");

```

Scilab code Exa 6.8 Unknown capacitance and its dissipation factor

```

1 // Exa 6.8
2 format('v',7); clc; clear; close;
3 // Given data
4 R1 = 1.2; // in k ohm
5 R1 = R1 * 10^3; // in ohm
6 R2 = 4.7; // in k ohm
7 R2 = R2 * 10^3; // in ohm
8 C1 = 1; // in F
9 C1 = C1 * 10^-6; // in F
10 C3 = 1; // in F
11 C3 = C3 * 10^-6; // in F
12 Rx = (R2*C1)/C3; // unknown resistance in ohm
13 Rx = Rx * 10^-3; // in k ohm
14 Cx = (R1*C3)/R2; // unknown capacitance in F
15 Cx = Cx * 10^6; // in F
16 disp(Rx,"The unknown resistance in k is ")
17 disp(Cx,"The unknown capacitance in F is");
18 f = 0.5; // in kHz
19 f = f * 10^3; // in Hz
20 // omega = 2*%pi*f;
21 D = 2*%pi*f*Cx*10^-6*Rx*10^3; // dissipation factor
22 disp(D,"The dissipation factor is");

```

Scilab code Exa 6.9 Equivalent parallel resistance and capacitance

```
1 // Exa 6.9
2 format('v',7);clc;clear;close;
3 // Given data
4 R1 = 2.7; // in k ohm
5 R1 = R1 * 10^3; // in ohm
6 R2 = 22; // in k ohm
7 R2 = R2 * 10^3; // in ohm
8 R4 = 100; // in k ohm
9 R4 = R4 * 10^3; // in ohm
10 C1 = 5; // in F
11 C1 = C1 * 10^-6; // in F
12 f = 2.2; // in kHz
13 f = f * 10^3; // in Hz
14 //From  $\omega^2 = 1/(R1*C1*R3*C3)$ ;
15 //  $C3 = 1/(R1*C1*R3*(\omega^2))$ ; (i)
16 //  $R2/R4 = R1/R3 + C3/C1$  (ii)
17 // From eq(i) and (ii)
18 R3 = (R4/R2) * (R1 + 1/((2*pi*f)^2)*R1*(C1^2));
    // equivalent parallel resistance in ohm
19 R3= R3*10^-3; // in k ohm
20 disp(R3,"The equivalent parallel resistance in k
    is");
21 R3= R3*10^3; // in ohm
22 C3 = 1/(R1*C1*R3*((2*pi*f)^2)); // equivalent
    parallel capacitance in F
23 C3 = C3 * 10^12; // in pF
24 disp(C3,"The equivalent parallel capacitance in pF
    is");
```

Scilab code Exa 6.10 Distributed capacitance and inductance

```

1 // Exa 6.10
2 format('v',7);clc;clear;close;
3 // Given data
4 C1 = 550;// in pF
5 C2 = 110;// in pF
6 Cd = (C1-(4*C2))/3;// distributed capacitance in pF
7 disp(Cd,"The distributed capacitance in pF is");
8 Cd = Cd * 10^-12;// in F
9 C1 = C1 * 10^-12;// in F
10 f1 = 1.5;// in MHz
11 f1 = f1 * 10^6;// in Hz
12 // f1 = 1/(2*%pi*(sqrt(L*(C1+Cd))));
13 L = ((1/(2*%pi*f1))^2) * (1/(C1+Cd));// distributed
    inductance in H
14 L = L * 10^6;// in H
15 disp(L,"The distributed inductance in H is");

```

Scilab code Exa 6.11 Percentage error in reading

```

1 // Exa 6.11
2 format('v',7);clc;clear;close;
3 // Given data
4 f = 1.5;//frequency in MHz
5 f = f * 10^6;// in Hz
6 C = 60;// in pF
7 C = C * 10^-12;// in F
8 R = 8;// in ohm
9 R_SH = 0.02;// in ohm
10 omega = 2*%pi*f;
11 Qactual = 1/(omega*C*R);// true value of Q
12 Qobserved = 1/(omega*C*(R+R_SH));// observed value
    of Q
13 PerError = ((Qactual-Qobserved)/Qactual) * 100;//
    Percentage error in %
14 disp(PerError,"The Percentage error in % is");

```

Scilab code Exa 6.12 Self capacitance

```
1 // Exa 6.12
2 format('v',7);clc;clear;close;
3 // Given data
4 f1 = 2;//frequency in MHz
5 f1 = f1 * 10^6;// in Hz
6 C1 = 500;// in pF
7 C2 = 60;// in pF
8 // f1 = 1/(2*%pi*sqr(L*(C1+Cd))) (i)
9 // f2 = 1/(2*%pi*sqr(L*(C2+Cd))) (ii)
10 // and f2 = 2.5*f1 (iii)
11 //From eq(i),(ii) and (iii)
12 Cd = (C1 - (6.25*C2))/5.25;// value of self
    capacitance in pF
13 disp(Cd,"The value of self capacitance in pF is");
```

Scilab code Exa 6.13 Percentage error

```
1 // Exa 6.13
2 format('v',7);clc;clear;close;
3 // Given data
4 f = 1;// in MHz
5 f = f * 10^6;// in Hz
6 omega = 2*%pi*f;// in rad/sec
7 C = 65;// in pF
8 C = C * 10^-12;// in F
9 R = 10;// in ohm
10 R_SH = 0.02;// in ohm
11 // Q = X_L/R = X_C/R = 1/(omega*C*R);
12 Qactual = 1/(omega*C*R);// True value of Q
```



```

13 Qmeasured = 1/(omega*C*(R+R_SH)); // measured value
    of Q
14 PerError = ((Qactual-Qmeasured)/Qactual)*100; //
    percentage error in %
15 disp(PerError , "The Percentage error in % is");

```

Scilab code Exa 6.14 Self capacitance

```

1 // Exa 6.14
2 format('v',7); clc; clear; close;
3 // Given data
4 C1 = 450; // capacitance in pF
5 C1 = C1 * 10^-12; // in F
6 C2 = 60; // capacitance in pF
7 C2 = C2 * 10^-12; // in F
8 // f1 = 1/(2*%pi*(sqrt(L*(C1+Cd)))) (i)
9 // f2 = 1/(2*%pi*(sqrt(L*(C2+Cd)))) (ii)
10 // and f2 = 2.5*f1 (iii)
11 // from eq(i),(ii) and (iii)
12 Cd = (C1 - (6.25*C2))/5.25; // value of self
    capacitance in F
13 Cd = Cd * 10^12; // in pF
14 disp(Cd, "The value of self capacitance in pF is");

```

Scilab code Exa 6.15 Inductance and self capacitance

```

1 // Exa 6.15
2 format('v',7); clc; clear; close;
3 // Given data
4 f1 = 8; // frequency in MHz
5 f1 = f1*10^6; // in Hz
6 f2 = 12; // frequency in MHz
7 f2 = f2*10^6; // in Hz

```

```

8 C1 = 120; //capacitance in pF
9 C1 = C1 * 10^-12; // in F
10 C2 = 40; //capacitance in pF
11 C2 = C2 * 10^-12; // in F
12 // f1 = 1/(2*pi*(sqrt(L*(C1+Cd))))      (i)
13 // f2 = 1/(2*pi*(sqrt(L*(C2+Cd))))      (ii)
14 // From eq(i) and (ii)
15 Cd= (f2^2*C2-f1^2*C1)/(f1^2-f2^2); // in F
16 // From eq(i)
17 C=C1+Cd;
18 L=1/((C1+Cd)*(2*pi*f1)^2); // inductance in H
19 L= L*10^6; // in H
20 Cd= Cd*10^12; // self capacitance in pF
21 disp(Cd,"The self capacitance in pF is");
22 disp(L,"The inductance in H is : ")

```

Scilab code Exa 6.16 Inductance and self capacitance

```

1 // Exa 6.16
2 format('v',7); clc; clear; close;
3 // Given data
4 f1 = 1; //frequency in MHz
5 f1= f1*10^6; // in Hz
6 f2 = 2; //frequency in MHz
7 f2= f2*10^6; // in Hz
8 C1 = 500; //capacitance in pF
9 C1 = C1 * 10^-12; // in F
10 C2 = 110; //capacitance in pF
11 C2 = C2 * 10^-12; // in F
12 // f1 = 1/(2*pi*(sqrt(L*(C1+Cd))))      (i)
13 // f2 = 1/(2*pi*(sqrt(L*(C2+Cd))))      (ii)
14 // From eq(i) and (ii)
15 Cd= (f2^2*C2-f1^2*C1)/(f1^2-f2^2); // in F
16 // From eq(i)
17 C=C1+Cd;

```

```

18 L=1/((C1+Cd)*(2*%pi*f1)^2); // in H
19 L= L*10^6; //inductance in H
20 Cd= Cd*10^12; // self capacitance in pF
21 disp(Cd,"The self capacitance in pF is");
22 disp(L,"The inductance in H is : ")

```

Scilab code Exa 6.17 Constant of arm CD

```

1 // Exa 6.17
2 format('v',7); clc; clear; close;
3 // Given data
4 f = 1; //frequency in kHz
5 f = f * 10^3; // in Hz
6 R1 = 400; //resistance in ohm
7 R2 = 150; //resistance in ohm
8 C2 = 0.2; //capacitance in F
9 C2 = C2 * 10^-6; // in F
10 XC2= 1/(2*%pi*f*C2);
11 R3 = 100; //resistance in ohm
12 L3 = 10; //inductance in mH
13 L3 = L3 * 10^-3; // in H
14 XL3= 2*%pi*f*L3;
15 Z1= R1+%i*0; // in
16 Z2= R2-%i*XC2; // in
17 Z3= R3+%i*XL3; // in
18 Z4= Z2*Z3/Z1; // in
19 R4= real(Z4); //resistance in
20 XC4= abs(imag(Z4)); // in
21 C4= 1/(2*%pi*f*XC4); // in F
22 C4= C4*10^6; // in F
23 disp("The components of branch CD : ")
24 disp("R4= "+string(R4)+" ")
25 disp("C4= "+string(C4)+" F ")

```

Scilab code Exa 6.18 Equivalent series circuit of unknown impedance

```
1 // Exa 6.18
2 format('v',7);clc;clear;close;
3 // Given data
4 C3 = 10;//capacitance in F
5 C3 = C3 * 10^-6;// in F
6 R1 = 1.2;//resistance in k ohm
7 R1 = R1 * 10^3;// in ohm
8 R2 = 100;//resistance in k ohm
9 R2 = R2 * 10^3;// in ohm
10 R3 = 120;//resistance in k ohm
11 R3 = R3 * 10^3;// in ohm
12 Rx = (R2*R3)/R1;//resistance of unknown impedance
    in ohm
13 Rx = Rx * 10^-6;// in M ohm
14 disp(Rx,"The resistance of unknown impedance in M
    is");
15 Cx = (R1*C3)/R2;//capacitance of unknown impedance
    in F
16 Cx = Cx * 10^6;// in F
17 disp(Cx,"The capacitance of unknown impedance in F
    is");
```

Scilab code Exa 6.19 Constant of arm CD

```
1 // Exa 6.19
2 format('v',7);clc;clear;close;
3 // Given data
4 f = 1000;//frequency in Hz
5 C1 = 0.2;//capacitance in F
6 C1 = C1 * 10^-6;// in F
```

```

7 XC1= 1/(2*%pi*f*C1);
8 R2= 500; // in
9 R3= 300; // in
10 C3= 0.1*10^-6; // in F
11 XC3= 1/(2*%pi*f*C3);
12 omega = 2*%pi*f; // in rad/sec
13 Z1= 0-%i*XC1; // in
14 Z2= R2; // in
15 Y3= 1/R3+%i*1/XC3; // in
16 Z3= R3*XC3/(R3+XC3); // in
17 Z4= Z2/(Z1*Y3); // in
18 R4= real(Z4); // in
19 XL4= abs(imag(Z4)); // in
20 L4= XL4/(2*%pi*f); // in F
21 L4= L4*10^3; // in mH
22 disp("The components of branch CD : ")
23 disp("Rx= "+string(R4)+" ")
24 disp("Lx= "+string(L4)+" mH")

```

Scilab code Exa 6.20 Unknown impedence

```

1 // Exa 6.20
2 format('v',7);clc;clear;close;
3 // Given data
4 f = 2; // in kHz
5 f = f * 10^3; // in Hz
6 omega = 2*%pi*f; // in rad/sec
7 Z1 = 10; // in k ohm
8 Z2 = 50; // in k ohm
9 R3 = 100; // in k ohm
10 C3 = 100; // in F
11 C3 = C3 * 10^-6; // in F
12 XC3= 1/(2*%pi*f*C3);
13 Z3= R3-%i*XC3; // in
14 // From balance equation , Z1*Z4= Z2*Z3

```

```

15 Z4= Z2*Z3/Z1; // in
16 R4= real(Z4); // in k
17 XC4= abs(imag(Z4)); // in k
18 C4= 1/(2*pi*f*XC4); // in F
19 C4= C4*10^6; // in F
20 disp("The components of branch DC : ")
21 disp("Rx= "+string(R4)+" k ")
22 disp("Cx= "+string(C4)+" F ")

```

Scilab code Exa 6.21 Constant of Zx

```

1 // Exa 6.21
2 format('v',7); clc; clear; close;
3 // Given data
4 f = 1; // in kHz
5 f = f * 10^3; // in Hz
6 omega = 2*pi*f; // in rad/sec
7 Z1 = 200; // in ohm
8 R2 = 200; // in ohm
9 C2 = 5; // in F
10 C2 = C2 * 10^-6; // in F
11 XC2= 1/(2*pi*f*C2);
12 Z2= R2-%i*XC2; // in
13 R3 = 500; // in ohm
14 C3 = 0.2; // in F
15 C3 = C3 * 10^-6; // in F
16 XC3= 1/(2*pi*f*C3);
17 Z3= R3-%i*XC3; // in
18 // From balance equation , Z1*Z4= Z2*Z3
19 Z4= Z2*Z3/Z1; // in
20 R4= real(Z4); // in
21 XC4= abs(imag(Z4)); // in
22 C4= 1/(2*pi*f*XC4); // in F
23 C4= C4*10^6; // in F
24 disp("The components of Zx : ")

```

```

25 disp("Rx= "+string(R4)+" ")
26 disp("Cx= "+string(C4)+" nF")

```

Scilab code Exa 6.22 Constant of Zx

```

1 // Exa 6.22
2 format('v',7);clc;clear;close;
3 // Given data
4 f = 1; // in kHz
5 f = f * 10^3; // in Hz
6 omega = 2*pi*f; // in rad/sec
7 Z1 = 1.65; // in k ohm
8 Z2 = 15.3; // in k ohm
9 R3 = 2.5; // in k ohm
10 C3 = 10; // in F
11 C3 = C3 * 10^-6; // in F
12 XC3= 1/(2*pi*f*C3);
13 Z3= R3-%i*XC3; // in
14 // From balance equation , Z1*Z4= Z2*Z3
15 Z4= Z2*Z3/Z1; // in
16 R4= real(Z4); // in k
17 XC4= abs( imag(Z4) ); // in k
18 C4= 1/(2*pi*f*XC4); // in F
19 C4= C4*10^6; // in F
20 disp("The components of branch DC : ")
21 disp("Rx= "+string(R4)+" k ")
22 disp("Cx= "+string(C4)+" F ")

```

Scilab code Exa 6.23 Inductance of Rx and Lx at balance

```

1 // Exa 6.23
2 format('v',7);clc;clear;close;
3 // Given data

```

```

4 f = 1; // in kHz
5 f = f * 10^3; // in Hz
6 R1 = 600; // in ohm
7 C1 = 1; // in F
8 C1 = C1 * 10^-6; // in F
9 XC1= 1/(2*pi*f*C1);
10 R2 = 100; // in ohm
11 R3 = 1; // in k ohm
12 R3 = R3 * 10^3; // in ohm
13 omega = 2*pi*f; // in rad/sec
14 Y1= 1/R1+i*1/XC1; // in
15 Z2=R2; // in
16 Z3= R3; // in
17 // From balance equation , Z1*Z4= Z2*Z3
18 Z4= Z2*(Z3*Y1); // in
19 R4= real(Z4); // in
20 XL4= abs(imag(Z4)); // in
21 L4= XL4/(2*pi*f); // in F
22 disp("Rx= "+string(R4)+" ")
23 disp("Lx= "+string(L4)+" H")

```

Scilab code Exa 6.24 Unknown parameters in arm AB

```

1 // Exa 6.24
2 format('v',7); clc; clear; close;
3 // Given data
4 R2 = 842; //resistance in ohm
5 C2 = 0.135; //capacitance in F
6 C2 = C2 * 10^-6; // in F
7 f=1000; //frequency in Hz
8 XC2= 1/(2*pi*f*C2);
9 R3= 10; //resistance in ohm
10 C4= 1*10^-6; //capacitance in F
11 XC4= 1/(2*pi*f*C4);
12 Z2= R2-i*XC2; //impedance in ohm

```



```

13 Z3= R3; //impedance in ohm
14 Z4= -%i*XC4; //impedance in ohm
15 // From balance equation
16 Z1= Z2*Z3/Z4; // in
17 R1= real(Z1); // in
18 XL1= abs(imag(Z1)); // in
19 L1= XL1/(2*%pi*f); // in F
20 L1= L1*10^3; // in mH
21 disp(R1,"The value of R1 in      is : ")
22 disp(L1,"The value of L1 in mH is : ")

```

Scilab code Exa 6.25 Resistance and inductance of coil

```

1 // Exa 6.25
2 format('v',7); clc; clear; close;
3 // Given data
4 L2 = 47.8; //inductance in mH
5 R2 = 1.36; //resistance in ohm
6 r1 = 32.7; //resistance in ohm
7 R1 = 1.36; //resistance in ohm
8 //At balance, 100*(r1+J*omega*L1) = 100*((R2+r2)+(J*
   omega*L2));
9 L1 = L2; // in mH (equating imaginary terms)
10 disp(L1,"The inductance of coil in mH is");
11 // R2+r2 = r1 (equating real terms)
12 r2 = r1-R1; //resistance of coil in ohm
13 disp(r2,"The resistance of coil in ohm is");
14
15 // Note: In the book the value of L1 is wrong.

```

Scilab code Exa 6.26 Resistance and inductance of coil

```

1 // Exa 6.26

```

```

2 format('v',7);clc;clear;close;
3 // Given data
4 R=1.36;//resistance in ohm
5 r2= 32.7;//resistance in ohm
6 L2= 47.8;//inductance in mH
7 L2= L2*10^-3;// in H
8 f=1000;//frequency in Hz
9 XL2=2*%pi*f*L2;// in
10 Z3 = 100;// in ohm
11 Z4 = 100;// in ohm
12 Z2= r2+%i*XL2;// in ohm
13 // Under balance condition
14 Z1= Z2*Z3/Z4;// in ohm
15 R1= real(Z1);
16 r1= R1-R;//resistance of the coil in ohm
17 XL1= imag(Z1);// in ohm
18 L1= XL1/(2*%pi*f);//inductance of the coil in F
19 L1= L1*10^3;// in mH
20 disp(r1,"The resistance of the coil in      is : ")
21 disp(L1,"The inductance of the coil in mH is : ")

```

Scilab code Exa 6.27 Whether or not the bridge is complete balance

```

1 // Exa 6.27
2 format('v',7);clc;clear;close;
3 // Given data
4 Z1 = 400;// in ohm
5 Z2 = 200;// in ohm
6 Z3 = 800;// in ohm
7 Z4 = 400;// in ohm
8 theta1 = 50;// in degree
9 theta2 = 40;// in degree
10 theta3 = -50;// in degree
11 theta4 = 20;// in degree
12 if abs(Z1*Z4)== abs(Z3*Z2) then // Applying the

```

```

        condition of balance for magnitude
13     flag1=1;
14     disp("The condition of balance for magnitude is
        satisfied")
15 else
16     flag1=0
17     disp("The condition of balance for magnitude is
        not satisfied")
18 end
19 if theta1+theta4==theta2+theta3 then // Applying the
        condition of balance for phases
20     flag2=1
21     disp("The condition of balance for phase is also
        satisfied")
22 else
23     flag2=0
24     disp("But the condition of balance for phase is
        not satisfied")
25 end
26 if flag1==1 then
27     if flag2==1 then
28         disp("Hence the bridge is under balanced
                condition")
29     else
30         disp("Hence the bridge is not under balanced
                condition")
31     end
32 else
33     disp("Hence the bridge is not under balanced
            condition")
34 end

```

Scilab code Exa 6.28 Whether or not the bridge is complete balance

```
1 // Exa 6.28
```

```

2  format('v',7); clc; clear; close;
3  // Given data
4  Z1 = 200; // in ohm
5  Z2 = 400; // in ohm
6  Z3 = 300; // in ohm
7  Z4 = 600; // in ohm
8  theta1 = 60; // in degree
9  theta2 = -60; // in degree
10 theta3 = 0; // in degree
11 theta4 = 30; // in degree
12 if abs(Z1*Z4)== abs(Z3*Z2) then // Applying the
    condition of balance for magnitude
13     flag1=1;
14     disp("The condition of balance for magnitude is
        satisfied")
15 else
16     flag1=0
17     disp("The condition of balance for magnitude is
        not satisfied")
18 end
19 if theta1+theta4==theta2+theta3 then // Applying the
    condition of balance for phases
20     flag2=1
21     disp("The condition of balance for phase is also
        satisfied")
22 else
23     flag2=0
24     disp("But the condition of balance for phase is
        not satisfied")
25 end
26 if flag1==1 then
27     if flag2==1 then
28         disp("Hence the bridge is under balanced
            condition")
29     else
30         disp("Hence the bridge is not under balanced
            condition")
31     end

```

```

32 else
33     disp("Hence the bridge is not under balanced
           condition")
34 end

```

Scilab code Exa 6.29 R L and C constant of arm CD

```

1 // Exa 6.29
2 format('v',7);clc;clear;close;
3 // Given data
4 f = 1;//frequency in kHz
5 f = f * 10^3;// in Hz
6 C1 = 0.2;// in F
7 C1 = C1 * 10^-6;// in F
8 XC1= 1/(2*%pi*f*C1);// in
9 C2 = 0.1;// in F
10 C2 = C2 * 10^-6;// in F
11 XC2= 1/(2*%pi*f*C2);// in
12 R2= 300;// in
13 R3= 500;// in
14 Z1= 0-%i*XC1;// in
15 Z2= R2-%i*XC2/(R2-%i*XC2);// in
16 Z3=R3;// in
17 // For balanced condition
18 Z4= Z2*Z3/Z1;// in
19 R4= real(Z4);// in
20 XL4= imag(Z4);// in
21 L4= XL4/(2*%pi*f);// in H
22 L4= L4*10^3;// in mH
23 disp("Components of arm CD : ")
24 disp("L4= "+string(L4)+" mH")
25 disp("R4= "+string(R4)+" ")

```

Scilab code Exa 6.30 Resistance and inductance

```
1 // Exa 6.30
2 format('v',7);clc;clear;close;
3 // Given data
4 R3 = 100; // in ohm
5 R4 = 200; // in ohm
6 R2 = 250; // in ohm
7 C = 1; // in F
8 C = C * 10^-6; // in F
9 r = 229.7; // in ohm
10 r1 = 43.1; // in ohm
11 // Value of unknown resistance for Anderson's bridge
12 R1 = ((R2*R3)/R4) - r1; //resistance in ohm
13 disp(R1,"The resistance in ohm is");
14 L1 = ((C*R3)/R4) * ( ((R2+R4)*r) + (R2*R4) ); //
    inductance in H
15 L1 = L1 * 10^3; // in mH
16 disp(L1,"The inductance in mH is");
```

Scilab code Exa 6.31 Value of C1 and r1

```
1 // Exa 6.31
2 format('v',7);clc;clear;close;
3 // Given data
4 f = 450; //frequency in Hz
5 omega = 2*%pi*f; // in rad/sec
6 R2 = 4.8; // in ohm
7 R3 = 200; // in ohm
8 R4 = 2850; // in ohm
9 C2 = 0.5; // in F
10 C2 = C2*10^-6; // in F
11 XC2= 1/(2*%pi*f*C2); // in
12 r2 = 0.4; // in ohm
13 Z2= (R2+r2)-%i*XC2; // in
```

```

14 Z3= R3; // in
15 Z4= R4; // in
16 // For balanced condition
17 Z1= Z2*Z3/Z4; // in
18 r1= real(Z1); // in
19 XC1= abs(imag(Z1)); // in
20 C1= 1/(2*pi*f*XC1); // in F
21 Df= 2*pi*f*C1*r1; // dissipating factor
22 C1= C1*10^6; // in F
23 disp(r1,"The value of r1 in is : ")
24 disp(C1,"The value of C1 in F is : ")
25 disp(Df,"The dissipating factor is : ")

```

Scilab code Exa 6.32 Effective impedance of the specimen

```

1 // Exa 6.32
2 format('v',7); clc; clear; close;
3 // Given data
4 f = 2; //frequency in kHz
5 f = f * 10^3; // in Hz
6 omega = 2*pi*f; // in rad/sec
7 R2 = 834; //resistance in ohm
8 C2 = 0.124; //capacitance in F
9 C2 = C2 * 10^-6; // in F
10 XC2= 1/(2*pi*f*C2); // in
11 R3= 100; //resistance in
12 C4= 0.1*10^-6; //capacitance in F
13 XC4= 1/(2*pi*f*C4); // in
14 Z2= R2-%i*XC2; // in
15 Z3=R3; // in
16 Z4= 0-%i*XC4; // in
17 // For balanced condition , effective impedance
18 Z1= Z2*Z3/Z4; //in
19 disp(Z1,"The effective impedance in is : ")

```

Scilab code Exa 6.33 Largest value of Rx and Lx

```
1 // Exa 6.33
2 format('v',7);clc;clear;close;
3 // Given data
4 R1= 20*10^3;//resistance in ohm
5 R2= 50*10^3;//resistance in ohm
6 C2= 0.003*10^-6;//capacitance in F
7 R4= 10*10^3;//resistance in ohm
8 C1= 150*10^-12;//capacitance in F
9 omega= 10^6;// in rad/sec
10 Z1= R1/(1+%i*omega*C1*R1);// in ohm
11 Z2= (1+%i*omega*C2*R2)/(%i*omega*C2);// in ohm
12 // At balance condition : Z1*R4 = Z2*(Rx+%i*omega*Lx
    ) or
13 // R4= omega^2*R1*C2*(R1*R4*C1-Lx) (i)
14 // R4= R1*(Rx*C2-R4*C1)/(R2*C2) (ii)
15 Rx= R4*(R1*C1+R2*C2)/(R1*C2);// in from eq(ii)
16 Lx= R4*(R2*C1-1/(omega^2*R1*C2));// in H from eq (i)
17 Rx= Rx*10^-3;// in k ohm
18 Lx= Lx*10^3;// in mH
19 disp(Rx,"The value of Rx in k is : ")
20 disp(Lx,"The value of Lx in mH is : ")
21
22 // Note: The calculated value of Rx will be as in
    k not in only , so the answer in the book is
    wrong.
```

Scilab code Exa 6.34 Value of R1 and L1

```
1 // Exa 6.34
2 format('v',7);clc;clear;close;
```



```

3 // Given data
4 R2 = 1000; //resistance in
5 R3 = 1000; //resistance in
6 R4 = 1000; //resistance in
7 C4 = 0.5; //capacitance in F
8 C4 = C4 * 10^-6; // in F
9 //At balance , (R1+(%i*omega*L1))*(R4/( 1+(%i*omega*
    C4*R4) )) = R2*R3;
10 // R1*R4 + (%i*omega*L1*R4) = (R2*R3) + (%i*omega*R2
    *R4*C4);
11 R1 = (R2*R3)/R4; // in (equating real terms)
12 L1 = R2*R3*C4; // in H (equating imaginary terms)
13 disp(R1,"The value of R1 in ohm is");
14 disp(L1,"The value of L1 in H is");

```

Scilab code Exa 6.35 Capacitance power factor and permittivity

```

1 // Exa 6.35
2 format('v',7); clc; clear; close;
3 // Given data
4 R3 = 260; //resistance in ohm
5 C4 = 0.5; // in F
6 C4 = C4 * 10^-6; // in F
7 C2 = 106; // in pF
8 C2 = C2 * 10^-12; // in F
9 R4 = 1000/%pi; //resistance in ohm
10 r1 = (C4/C2)*R3; //resistance in ohm
11 C1 = (R4/R3)*C2; // in F
12 Epsilon_o = 8.854*10^-12;
13 d = 4.5 // in mm
14 d = d * 10^-3; // in m
15 D= 0.12; // in m
16 A= %pi*D^2/4; // in m^2
17 disp(r1,"The resistance in is :")
18 C1= C1*10^12; // in pF

```

```

19 disp(C1,"The capacitance in pF is");
20 C1= C1*10^-12;// in F
21 f = 50;// in Hz
22 omega = 2*%pi*f;// in rad/sec
23 Pf= omega*C1*r1;// power factor
24 disp(Pf,"The power factor is");
25 // C1 = Epsilon_r*Epsilon_o*(A/d);
26 Epsilon_r = (C1*d)/(Epsilon_o*A);// the relative
    permittivity
27 disp(Epsilon_r,"The relative permittivity is");
28
29 // Note: The calculation of evaluating the value of
    C1 is wrong, so the answer of C1 in the book is
    wrong. But they putted the correct value of C1 to
    find the value of relative permittivity

```

Scilab code Exa 6.36 Capacitance and dielectric loss angle of capacitor

```

1 // Exa 6.36
2 format('v',7);clc;clear;close;
3 // Given data
4 C2 = 500;// capacitance in nF
5 C2 = C2 * 10^-9;// in F
6 f = 50;//frequency in Hz
7 omega = 2*%pi*f;// in rad/sec
8 C4 = 0.148;//capacitance in F
9 C4 = C4 * 10^-6;// in F
10 R4 = 72.6;//resistance in ohm
11 R3 = 300;//resistance in ohm
12 C1 = C2*(R4/R3);// capacitance in F
13 C1 = C1 * 10^6;// in F
14 disp(C1,"The capacitance in F is");
15 delta = atand(omega*C4*R4);//dielectric loss angle
    of capacitance in degree
16 disp(delta,"The dielectric loss angle of capacitance

```

```

        in degree is");
17
18 // Note: The calculation in the book is wrong, so
    the answer in the book is wrong.

```

Scilab code Exa 6.37 Self capacitance

```

1 // Exa 6.37
2 format('v',7);clc;clear;close;
3 // Given data
4 f1 = 3;//frequency in MHz
5 f1 = f1 * 10^6;// in Hz
6 C1 = 251;//capacitance in pF
7 C1 = C1 * 10^-12;// in F
8 f2 = 6;//frequency in MHz
9 f2 = f2 * 10^6;// in Hz
10 C2 = 50;//capacitance in pF
11 C2 = C2 * 10^-12;// in F
12 // f1 = 1/(2*%pi*(sqrt(L*(C1+Cd))) )      (i)
13 // f2 = 1/(2*%pi*(sqrt(L*(C2+Cd))) )      (ii)
14 // From eq(i) and (ii)
15 Cd = (C1 - (4*C2))/3;// self capacitance of the coil
    in F
16 Cd = Cd * 10^12;// in pF
17 disp(Cd,"The self capacitance of the coil in pF is")
    ;

```

Scilab code Exa 6.38 Resistance and inductance of choke coil

```

1 // Exa 6.38
2 format('v',7);clc;clear;close;
3 // Given data
4 f=500;//frequency in Hz

```

```

5 R2 = 2410; //resistance in ohm
6 R3 = 750; //resistance in ohm
7 R4 = 64.5; //resistance in ohm
8 R_C4 = 0.4; //resistance in ohm
9 C4 = 0.35; //capacitance in F
10 C4 = C4 * 10^-6; // in F
11 XC4= 1/(2*%pi*f*C4); // in
12 Z4= R4+R_C4-%i*XC4; // in
13 Z2= R2; // in
14 Z3= R3; // in
15 Z1= Z2*Z3/Z4; // in
16 R1= real(Z1); //resistance of choke coil in
17 XL1= imag(Z1); // in
18 L1= XL1/(2*%pi*f); //inductance of choke coil in H
19 disp(R1,"The resistance of choke coil in is : ")
20 disp(L1,"The inductance of choke coil in H is : ")

```

Scilab code Exa 6.39 Value of R and C

```

1 // Exa 6.39
2 format('v',7);clc;clear;close;
3 // Given data
4 f = 50; // in Hz
5 omega = 2*%pi*f; // in rad/sec
6 R1 = 50; // in ohm
7 L1 = 0.1; // in H
8 XL1= 2*%pi*f*L1; // in
9 R2= 100; // in
10 R3= 1000; // in
11 Z1= R1+%i*XL1; // in
12 Z2= R2; // in
13 Z3= R3; // in
14 // The bridge balance condition
15 Zx= Z2*Z3/Z1; // in
16 // Comparing real part

```

```

17 Rx= real(Zx); // in
18 // Comparing imaginary part
19 XCx= abs(imag(Zx)); // in
20 Cx= 1/(2*pi*f*XCx); // in F
21 disp(Rx,"The value of Rx in      is : ")
22 disp(Cx*10^6,"The value of Cx in  F is : ")

```

Scilab code Exa 6.40 Effective impedance of the specimen

```

1 // Exa 6.40
2 format('v',7); clc; clear; close;
3 // Given data
4 f = 2; // in kHz
5 f = f * 10^3; // in Hz
6 R2= 834; // in
7 C2= 0.124*10^-6; // in F
8 XC2= 1/(2*pi*f*C2); // in
9 R3= 100; // in
10 C4 = 0.1; // in F
11 C4 = C4*10^-6; // in F
12 XC4= 1/(2*pi*f*C4); // in
13 Z2= R2+%i*XC2; // in
14 Z3= R3; // in
15 Z4= -%i*XC4; // in
16 // The bridge balance condition
17 Z1= Z2*Z3/Z4; // in
18 mag= abs(Z1); // magnitude of effective impedance in
19 theta= atand(imag(Z1),real(Z1)); // phase angle of
    effective impedance in
20 disp(mag,"The magnitude of effective impedance in
    is : ")
21 disp(theta,"The phase angle of effective impedance
    in      is")

```

Scilab code Exa 6.41 Resistance and inductance of coil

```
1 // Exa 6.41
2 format('v',7);clc;clear;close;
3 // Given data
4 L1 = 52.6;//inductance in mH
5 R2 = 1.68;//resistance in ohm
6 //  $80*(r1+(J*\omega*L1)) = 80*((R2+r2) + (J*\omega*L2))$ ;
7 L2 = L1;//inductance of the coil in mH
8 disp(L2,"The inductance of the coil in mH is");
9 r1 = 28.5;// in ohm
10 r2 = r1-R2;//resistance of the coil in ohm
11 disp(r2,"The resistance of the coil in ohm is");
```

Scilab code Exa 6.42 Value of R and L

```
1 // Exa 6.42
2 format('v',7);clc;clear;close;
3 // Given data
4 Q = 1;// in k ohm
5 Q = Q * 10^3;// in ohm
6 S = Q;// in ohm
7 P = 500;// in ohm
8 r = 100;// in ohm
9 C = 0.5;// in F
10 C = C * 10^-6;// in F
11 //Using standard condition ,  $R_x = (R2*R3)/R4$ ;
12  $R_x = (P*Q)/S$ ;// in ohm
13 disp(Rx,"The value of Rx in ohm is");
14 //  $L_x = ((C*R2)/R4) * ((R3*r) + (R4*r) + (R3*R4))$ ;
15  $L_x = ((C*P)/S) * ((Q*r) + (S*r) + (Q*S))$ ;// in H
```

```
16 disp(Lx,"The value of Lx in H is");
```

Chapter 7

Oscilloscopes

Scilab code Exa 7.1 Rise time of the signal

```
1 // Exa 7.1
2 format('v',7);clc;clear;close;
3 // Given data
4 BW = 25;//bandwidth in MHz
5 Trd = 20;//rise time in ns
6 Trd = Trd * 10^-9;// in s
7 // BW = 0.35/Tro;
8 Tro = 0.35/(BW*10^6);// in s
9 // Trd = sqrt( (Trs^2) + (Tro^2) );
10 Trs = sqrt( (Trd^2)-(Tro^2) );// rise time of signal
    in sec
11 Trs = Trs * 10^9;// in ns
12 disp(Trs,"The rise time of signal in ns is");
```

Scilab code Exa 7.2 Bandwidth of CRO

```
1 // Exa 7.2
2 format('v',7);clc;clear;close;
```



```

3 // Given data
4 Trs = 17; //rise time in s
5 Trs = Trs * 10^-6; // in s
6 Trd = 21; // in s
7 Trd = Trd * 10^-6; // in s
8 // Trd = sqrt( (Trs^2) + (Tro^2) );
9 Tro = sqrt( (Trd^2) - (Trs^2) ); // in sec
10 BW = 0.35/Tro; //band width in Hz
11 BW = BW * 10^-3; // in kHz
12 disp(BW, "The band width in kHz is");

```

Scilab code Exa 7.3 Amplitude and rms value of sinusoidal voltage

```

1 // Exa 7.3
2 format('v',7); clc; clear; close;
3 // Given data
4 subdivision = 1/5; //sub division in units
5 positivepeak = 2.6; //positive peak in units
6 Vpp = positivepeak + positivepeak; //peak to peak in
   divisions
7 verticalattenuation = 2; //vertical attenuation in mV
   /div
8 verticalattenuation = verticalattenuation * 10^-3; //
   in V/div
9 Vpp = Vpp * verticalattenuation; // in V
10 Vpp = Vpp * 10^3; // in mV
11 Vm = Vpp/2; //amplitude of the sinusoidal voltage
   in mV
12 disp(Vm, "The amplitude of the sinusoidal voltage in
   mV is");
13 V_RMS = Vm/sqrt(2); //r.m.s. value of the sinusoidal
   voltage in mV
14 disp(V_RMS, "The r.m.s. value of the sinusoidal
   voltage in mV is");

```

Scilab code Exa 7.4 rms value of voltage

```
1 // Exa 7.4
2 format('v',7);clc;clear;close;
3 // Given data
4 voltsBYdiv = 2;//volts per division in V/div
5 Timebase = 2;//base time in ms/div
6 Verticaloccupancy = 3;//Vertical occupancy in cm
7 Vpp = voltsBYdiv*Verticaloccupancy;//peak to peak
   voltage in V
8 Vm = Vpp/2;// in V
9 V_RMS = Vm/sqrt(2);//r.m.s. value of the voltage in
   V
10 disp(V_RMS,"The r.m.s. value of the voltage in V is"
   );
11 Horizontaloccupancy = 2;//Horizontal occupancy in cm
12 timeBYdiv = 2;//time per division in mV
13 timeBYdiv = timeBYdiv*10^-3;// in V
14 T = timeBYdiv*Horizontaloccupancy;// in sec
15 f = 1/T;// in Hz
16 disp(f,"The frequency in Hz is");
```

Scilab code Exa 7.5 Phase difference

```
1 // Exa 7.5
2 format('v',7);clc;clear;close;
3 // Given data
4 y1 = 8;// in units
5 y2 = 10;// in units
6 phi = asind(y1/y2);// phase difference in degree
7 disp(phi,"The phase difference in degree is");
```

Scilab code Exa 7.6 Unknown frequency of vertical signal

```
1 // Exa 7.6
2 format('v',7);clc;clear;close;
3 // Given data
4 verticaltangencies = 2;// vertical tangencies
5 horizontaltangencies = 5;// horizontal tangencies
6 f_H = 1;// frequency in kHz
7 // f_V/f_H = horizontaltangencies/verticaltangencies
8 ;
9 f_V = (horizontaltangencies/verticaltangencies)*f_H;
10 //unknown frequency of vertical signal in kHz
11 disp(f_V,"The unknown frequency of vertical signal
12 in kHz is");
```

Scilab code Exa 7.7 Compensating capacitance

```
1 // Exa 7.7
2 format('v',6);clc;clear;close;
3 // Given data
4 Cin = 35;// in pF
5 // (R1+Rin)/Rin = 10;
6 RinBYR1= 1/9;
7 //while balance equation with compensating capacitor
8 // R1*C1 = Rin*(C2+Cin);
9 C1= Cin*RinBYR1;//compensating capacitor in pF
10 disp(C1,"The compensating capacitor in pF is");
```

Scilab code Exa 7.8 Sampling rate

```

1 // Exa 7.8
2 format('v',7);clc;clear;close;
3 // Given data
4 n = 10;// number of cycle
5 fs = 1;//signal frequency in kHz
6 fs = fs * 10^3;// in Hz
7 Timeperiod = n/fs;//time period in sec
8 Samplingfrequency = 1/Timeperiod;//Sampling
   frequency in samples/sec
9 disp(Samplingfrequency,"The sampling rate for 1 kHz
   in samples/sec is");
10 fs = 10;// in kHz
11 fs = fs * 10^3;// in Hz
12 Samplingperiod = n/fs;//Sampling period in sec
13 Samplingfrequency = 1/Samplingperiod;//sampling rate
   for 10 kHz in samples/sec
14 disp(Samplingfrequency,"The sampling rate for 10 kHz
   in samples/sec is");

```

Scilab code Exa 7.9 Minimum rise time of the pulse

```

1 // Exa 7.9
2 format('v',7);clc;clear;close;
3 // Given data
4 Samplingrate = 200;//Sampling rate in MS/s
5 Samplingrate = Samplingrate * 10^6;// in S/s
6 t_r = 1/Samplingrate;//minimum rise time of pulse in
   s
7 t_r = t_r * 10^9;// in ns
8 disp(t_r,"The minimum rise time of pulse in ns is");

```

Scilab code Exa 7.10 Frequency of signal

```

1 // Exa 7.10
2 format('v',7);clc;clear;close;
3 // Given data
4 Vd = 4;// vertical division
5 Va = 0.5;//Vertical attenuation in V/Div
6 App = Vd*Va;//peak to peak amplitude in V
7 disp(App,"The peak to peak amplitude of the signal
      in V is");
8 TimebyDiv = 2;//time per division in s/Div
9 Hd = 4;// horizontal division
10 Time = Hd*TimebyDiv;// in s
11 f = 1/(Time*10^-6);// frequency of signal in Hz
12 f = f * 10^-3;// in kHz
13 disp(f,"The frequency of signal in kHz is");

```

Scilab code Exa 7.11 Parameter of a high impedance probe

```

1 // exa 7.11
2 format('v',5);clc;clear;close;
3 // Given data
4 Rin = 2;//resistance in Mohm
5 Cin = 50;//capacitance in pF
6 Cin = Cin * 10^-12;// in F
7 // (R1+Rin)/Rin = 10;
8 R1 = 9*Rin;//resistance in Mohm
9 disp(R1,"The value of R1 in M is");
10 R1 = R1*10^6;// in ohm
11 Rin = Rin * 10^6;// in ohm
12 // While balance equation with compensating
    capacitor
13 // R1*C1 = Rin*(C2+Cin)
14 C1 = (Rin*Cin)/R1;// in F(neglecting C2)
15 C1 = C1 * 10^12;// in pF
16 disp(C1,"The value of C1 in pF is");

```

Chapter 8

Instrument Calibration

Scilab code Exa 8.1 Accuracy

```
1 // Exa 7.1
2 format('v',7);clc;clear;close;
3 // Given data
4 BW = 25;//bandwidth in MHz
5 Trd = 20;//rise time in ns
6 Trd = Trd * 10^-9;// in s
7 // BW = 0.35/Tro;
8 Tro = 0.35/(BW*10^6);// in s
9 // Trd = sqrt( (Trs^2) + (Tro^2) );
10 Trs = sqrt( (Trd^2)-(Tro^2) );// rise time of signal
    in sec
11 Trs = Trs * 10^9;// in ns
12 disp(Trs,"The rise time of signal in ns is");
```
