

Scilab Textbook Companion for
Electronic Instrumentation And Measurements
by D. A. Bell¹

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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 1

units Dimensions and Standards

Scilab code Exa 1.1 Flux density

```
1 // To find the flux density
2 // Example 1-1 in page 8
3 // Given data
4 clc;
5 phi=500*10^-8; // one maxwell=10^-8 Wb, phi=total
   flux
6 Area=(2.54*10^-2)^2; // area in m^2, cross section is
   one inch and linch=2.54cm
7 // Calculation
8 B=phi/Area; //flux density (B) in tesla
9 printf("total flux density=%0.2f mT",B*1000);
10 // Result
11 // the toatal flux density is 7.75 mT
```

Scilab code Exa 1.2 temperature conversion

```
1 //To find the equivalent Celsius & Kelvin Scale
   temperatures
2 //example 1-2 in page 8
3 clc;
4 //given data
5 body_temp=98.6;//human body temperature is 98.6
   degree fahrenheit
6 //calculations
7 cel_temp=(body_temp-32)/1.8;//temperature in celsius
8 kel_temp=cel_temp+273.15;// temperature in kelvin
9 printf("celsius temperature=%0.0f degree celsius \n",
   cel_temp);
10 printf("kelvin temperature=%0.2 f K",kel_temp);
11 //result
12 //the celsius temperature=37 degree celsius
13 //the kelvin temperature=310.15 K
```

Chapter 2

Measurement Errors

Scilab code Exa 2.1 resistance at a given temperature

```
1 // To find the tolerance to be stated & maximum
   resistance at 75 degree celsius
2 //example 2-1 in page 16
3 clc;
4 //given data
5 Rmin=1.14;// minimum resistance 1.14 k-ohm
6 Rmax=1.26// maximum resistance 1.26 k-ohm
7 R=1.2;//stated value
8 dT=75-25;//change in temperature from 25 to 75
   degree celsius
9 // calculation
10 ab=Rmax-R;//Absolute maximum error
11 abmin=Rmin-R;// Absolute minimum error
12 T=(ab/1.2)*100;// Tolerance
13 Rlarge=R+ab;//largest resistance possible at 25
   degree celsius
14 dR_per_C=(1.26/10^6)*500;// resistance change per
   degree celsius dR_per_C
15 dR=dR_per_C*dT;// total resistance increase
16 R_75=Rlarge+dR;//maximum resistance at 75 degree
   celsius
```

```

17 printf("Percentage Tolerance to be stated=+/- %d
    percent \n",T);
18 printf("Maximum resistance at 75 degree celsius=%0.4f
    K-ohm",R_75);
19 //result
20 //Tolerance=5%
21 //maximum resistance at 75 degree celsius=1.2915
    kohm

```

Scilab code Exa 2.2 error in sum voltage

```

1 // To find the maximum percentage error in the sum
    of two voltage measurements
2 //example 2-2 in page 20
3 clc;
4 //given data
5 V1=100;//stated voltage one
6 V2=80;//stated voltage two
7 e1=(1/100)*V1;//absolute error of v1
8 e2=(5/100)*V2;//absolute error of v2
9 //calculation
10 e=e1+e2;//absolute error for the sum of the voltages
11 E=V1+V2;// sum voltage
12 emax=(e/E)*100;//maximum percentage error
13 printf("E=%d V +/- %.1f percent",E,emax);
14 //result
15 //E=180 V +/- 2.8 percent

```

Scilab code Exa 2.3 error in difference voltage

```

1 //To find the maximum percentage error in the
   difference of two measured voltages
2 //example 2-2 in page 20
3 clc;
4 //given data
5 V1=100;//stated voltage one
6 V2=80;//stated voltage two
7 e1=(1/100)*V1;//absolute error of v1
8 e2=(5/100)*V2;//absolute error of v2
9 //calculation
10 e=e1+e2;//absolute error for the sum of the voltages
11 E=V1-V2;// difference voltage
12 emax=(e/E)*100;//maximum percentage error
13 printf("E=%d V +/- %d percent",E,emax);
14 //result
15 //E=20 V +/- 25 percent

```

Scilab code Exa 2.4 power dissipated and accuracy

```

1 // To find the power dissipated and the Accuracy of
   the Result
2 //example 2-4 in page 23
3 clc;
4 //given data
5 eR=10;//percentage error in resistance
6 R=820;// resistance is 820 ohm
7 I=.01;// current through the resistance is 10 mA
8 a=2;//percentage accuracy on full scale of 25 mA
   ammeter
9 //calculation
10 If=(a/100)*25;//full scale error current
11 eI=(If/10)*100;//percentage error in the measured
   current

```

```

12 P=I*I*R; //power dissipated
13 eI2=2*eI; //percentage error in I*I
14 eP=eI2+eR; //percentage error in power
15 printf("Power dissipated=%d mW \n",P*1000);
16 printf("Percentage Accuracy of the result=(+/-)%d
    percent\n",eP);
17 //result
18 //Power dissipated=82 mW
19 //Accuracy of the result=(+/-)20%

```

Scilab code Exa 2.5 average voltage and deviation

```

1 // To find the average of measured voltages and the
    average deviation
2 // example 2-5 in page 25
3 clc;
4 //given data
5 V=[1.001 1.002 0.999 0.998 1.000]; // 5 digital
    voltmeters reading in volts
6 //calculation
7 Vav=sum(V)/5; // average of 5 readings in volts
8 D=abs(V-Vav); //deviation of each reading from the
    average voltage
9 Dav=sum(D)/5; //average of deviation in volts
10 printf("Average measured voltage=%d V\n",Vav);
11 printf("Average deviation=%0.4f V",Dav);
12 //result
13 //the Average measured voltage=1 V
14 //The Average deviation=0.0012 V

```

Scilab code Exa 2.6 standard deviation and probable error

```
1 //To determine the standard deviation and probable
  measurement
2 //example 2-6 in page 26
3 clc;
4 //given data
5 V=[1.001 1.002 0.999 0.998 1.000]; // 5 digital
  voltmeters readings in matrix V in volts
6 //calculation
7 Vavg=sum(V)/5; // average of 5 readings in volts
8 D=abs(V-Vavg); //deviation of each reading from the
  average in volts
9 D1=D.*D; // get the square of each deviation
10 x=sum(D1); // sum of the squares of the deviation
11 sigma=sqrt(x/5); // standard deviation in volts
12 printf("standard deviation=%0.4f V\n",sigma);
13 eP=0.6745*0.0014; //probable error in volts and sigma
  =0.0014 V
14 printf("probable error=%0.2f mV",eP*1000);
15 //result
16 //standard deviation=0.0014 V
17 //propable error=0.94 V
```

Chapter 3

Electromechanical Instruments

Scilab code Exa 3.1 torque on the coil

```
1 // To find the Torque on the coil
2 // example3-1 in page 37
3 clc;
4 //Given data
5 N=100; //Number of turns
6 B=0.2; //Magnetic flux density of 0.2 tesla
7 D=0.01; l=0.015; //diameter and length of the coil
   in meters
8 I=.001; // current=1 mA
9 //calculation
10 T=B*l*I*N*D; // torque in N-m
11 printf(" Torque=%f N-m",T);
12 //result
13 //Torque=0.000003 N-m
```

Scilab code Exa 3.2 voltage and megohm sensitivity

```

1 //To find the voltage sensitivity and Megohm
   sensitivity
2 // Example3-2 in page 39
3 clc;
4 //Given data
5 Is=(1*10^-6)/(10^-3); // current sensitivity in A/m
6 R=1000; // critical damping resistance of 1 kohm
7 //calculation
8 Vs=R*Is; //voltage sensitivity in mV/mm
9 Rs=Vs/Is; // megohm sensitivity i M-ohm
10 printf(" Voltage sensitivity=%d mV/mm\n",Vs);
11 printf("megohm sensitivity=%d M-ohm",Rs/1000);
12 //result
13 //Voltage sensitivity=1 mV/mm
14 //Megohm sensitivity=1 Kohm

```

Scilab code Exa 3.3 total current through the ammeter

```

1 //To find the total current through the ammeter at
   FSD, 0.5FSD & 0.25FSD
2 //example 3-3 in page 41
3 clc;
4 //Given Data
5 A=['a' 'b' 'c'];
6 m=0;
7 Rm=99; //coil resistance in ohm
8 IM=0.1e-3; //FSD(IM)=0.1 mA
9 Rs=1; //shunt resistance in ohm
10 //calculation
11 n=2; //initialisation
12 while n>0.25,
13     n=n/2;
14     Im=IM*n;

```



```

15     Vm=Im*Rm; // Meter voltage in volts
16     Is=Vm/Rs; //current throught the shunt resistance
        in ampere
17     I=Im+Is; //toatal current through the ammeter I=
        Im+Is in ampere
18     m=m+1;
19     printf("(%c) current through the ammeter at %.2 f
        FSD=%.1 f mA\n",A(m),n,I*1000);
20 end
21 //result
22 // (a) current through the ammeter at 1.00 FSD=10.0
        mA
23 // (b) current through the ammeter at 0.50 FSD=5.0
        mA
24 // (c) current through the ammeter at 0.25 FSD=2.5
        mA

```

Scilab code Exa 3.4 shunt resistance

```

1 // To find the Shut resistance of the ammeter
2 // example 3-4 in paage 43
3 clc;
4 //Given data
5 A=['b' 'a'];
6 Im=100*10^-6; // FSD(Im) in ampere
7 Rm=1000; // Coil resistance is 1 K-ohm
8 // calculation
9 I=10; // FSD initialisation
10 m=0;
11 while I>0.1,
12     I=I/10;
13     Vm=Im*Rm; //voltage across the meter in volts
14     Is=I-Im; //current through shunt resistance in

```

```

        ampere
15     Rs=Vm/Is; //shunt resistance in ohm
16     m=m+1;
17     printf("( %c) shunt resistance value for %.1f A
        FSD is %f ohm\n ",A(m),I,Rs);
18 end
19 //result
20 //(b) shunt resistance for 1 A FSD is 0.100010 ohm
21 //(a) shunt resistance for 100 mA FSD is 1.001001
    ohm

```

Scilab code Exa 3.5 ammeter range

```

1 //To find the ammeter range
2 //example3-5 in page 45
3 clc;
4 // Given data
5 A=['B' 'C' 'D'];
6 R=[4.5 0.45 0.05]; // R3,R2 & R1 values in ohm
7 Rm=1e+3; //coil resistance=1 kohm
8 Im=50e-6; //FSD=50 micro A
9 //calculation
10 Rsum=sum(R); //sum of all resistances
11 for n=0:2
12     m=n+1;
13     if n==0
14         Rx=0;
15     end
16     if n==1
17         R(:,1)=[];
18         x=sum(R);
19         Rx=Rsum-x;
20     end

```

```

21  if n==2
22  Rx=Rsum-0.05; // the resistance
23  end
24  Vs=Im*(Rm+Rx); //voltage accross ammeter in volts
25  printf("for switch at contact %c, Vs=%.2f\n",A(m),Vs
        ); // to check for the approximate value
26  Vs=0.05; // approximate voltage in volts
27  Is=(Vs)/(Rsum-Rx); //shunt current in ampere
28  I=(Im+Is)*1000; //total current in ampere
29  printf("Ammeter range when switch is at %c is %d mA\
        n",A(m),I)
30  end
31  //result
32  // Ammeter range when switch is at B is 10 mA
33  //Ammeter range when switch is at C is 100 mA
34  //Ammeter range when switch is at D is 1005 mA

```

Scilab code Exa 3.6 multiplier resistance and applied voltage

```

1  //To determine the Multipilier resistance and The
    applied voltage when instrument indicates 0.8,0.5
    & 0.2 of FSD
2  //example 3-6 in page 47
3  clc;
4  //Given data
5  IM=100e-6; //FSD=100 micro-A
6  Rm=1e+3; // coil resistance 1 K-ohm
7  V=50; //Full scale voltage in volts
8  //calculation
9  Rs=(V/IM)-Rm; // shunt resistance in ohm
10 for n=0.8:-0.3:0.2,
11     Im=n*IM; // FSD for the respective indication
12     V=Im*(Rs+Rm); //applied voltage for the

```

```

        respective fsd indications
13     printf("the applied voltage when instrument
        indicates %.1f FSD=%d V\n",n,V)
14 end
15 //result
16 // the applied voltage when instrument indicates 0.8
        FSD=40 V
17 //the applied voltage when instrument indicates 0.5
        FSD=25 V
18 //the applied voltage when instrument indicates 0.2
        FSD=10 V

```

Scilab code Exa 3.7 multiplier resistances

```

1 // To find the required multiplier resistance for
    the two given circuits
2 //Example3-7 in page 49
3 clc;
4 //Given data
5 V=[10 50 100]; // voltage ranges in volt
6 Im=50e-6; // FSD=50 micro-A
7 Rm=1700; // coil resistance in ohm
8 //calculation
9 printf("for circuit as in figure 3-16(a)\n");
10 for n=1:3
11     R=(V(n)/Im)-Rm;
12     printf("R%d=%0.4 f M ohm\n",n,R/10^6);
13 end
14 printf("for circuit as in figure 3-16(b)\n");
15 R=zeros(1,3);
16 for n=1:3
17     R(n)=(V(n)/Im)-Rm-R(1)-R(2);
18     printf("R%d=%0.4 f M ohm \n",n,R(n)/10^6);

```

```

19 end
20 //result
21 // for circuit as in figure 3-16(a)
22 //R1=198300 ohm
23 //R2=998300 ohm
24 //R3=1998300 ohm
25 //for circuit as in figure 3-16(b)
26 //R1=198300 ohm
27 //R2=800000 ohm
28 //R3=1000000 ohm

```

This code can be downloaded from the website www.scilab.in

Scilab code Exa 3.8 multiplier resistance

```

1 // To find the required multiplier resistance for
  the two given circuits
2 //Example3-7 in page 49
3 clc;
4 //Given data
5 V=[10 50 100]; // voltage ranges in volt
6 Im=50e-6; // FSD=50 micro-A
7 Rm=1700; // coil resistance in ohm
8 //calculation
9 printf("for circuit as in figure 3-16(a)\n");
10 for n=1:3
11     R=(V(n)/Im)-Rm;
12     printf("R%d=%0.4 f M ohm\n",n,R/10^6);
13 end
14 printf("for circuit as in figure 3-16(b)\n");
15 R=zeros(1,3);
16 for n=1:3

```

```

17     R(n)=(V(n)/Im)-Rm-R(1)-R(2);
18     printf("R%d=%0.4 f M ohm \n",n,R(n)/10^6);
19 end
20 //result
21 // for circuit as in figure 3-16(a)
22 //R1=198300 ohm
23 //R2=998300 ohm
24 //R3=1998300 ohm
25 //for circuit as in figure 3-16(b)
26 //R1=198300 ohm
27 //R2=800000 ohm
28 //R3=1000000 ohm

```

This code can be downloaded from the website www.scilab.in

Scilab code Exa 3.9 pointer indication for the voltmeter

```

1 // to determine the pointer indication
2 // example 3-9 in page 53
3 clc;
4 //given data
5 A=['a' 'b'];
6 Rm=1e+3;// coil resistance of 1 k ohm
7 Rs=890.7e+3;//multiplier resistance in ohm
8 Vf=0.7;//voltage drop across the diode in volt
9 //calculation
10 m=0;// reference to indicate a and b respectively
11 for n=75:-25:50 //voltages 50 and 75 volts
12     Iav=(0.637)*(((1.414*n)-2*Vf)/(Rs+Rm));//
        average current through pmcc instrument in
        ampere
13     m=m+1;

```

```

14     printf("(m),\nIav for %d V is %.2f micro-A\n",A
        (m),n,Iav*10^6);
15     printf("pointer indication for %d V is %.2f FSD\
        n",n,10000*Iav);
16 end
17 //result
18 //(b), Iav for 50 V is 0.000050 A
19 //pointer indication for 50 V is 0.495056 FSD
20 //(a),Iav for 75 V is 0.000075 A
21 //pointer indication for 75 V is 0.747584 FSD

```

Scilab code Exa 3.10 sensitivity of the voltmeter

```

1 //To find the sensitivity
2 //example 3-10 in page 54
3 clc;
4 //given data
5 Im=157e-6;// peak current=157 micro ampere
6 Vrms=100;// FSD rms voltage in volt
7 //calculation
8 Irms=0.707*Im;//FSD rms current
9 R=Vrms/Irms;// total circuit resistance
10 S=R/Vrms;//sensitivity
11 printf("sensitivity=%d K-ohm/volt\n",S/1000);
12 //result
13 //sensitivity=9 k-ohm/Volt

```

Scilab code Exa 3.11 value of given resistances

```

1 //To find resistance Rs and Rsh in the given circuit
2 // example 3-10 in page 55
3 clc;
4 //data given
5 Iav=50e-6;//average current through PMCC instrument
   =50 micro ampere
6 Rm=1700;// coil resistance in ohm
7 Vf=0.7;// diode forward drop in volts
8 If=100e-6;// forward current = 100 micro-ampere
9 Vrms=50;// ac rms voltage in volts
10 // calculation
11 Im=Iav/(0.5*0.637);//peak current in ampere
12 Ifp=(100/20)*If;//at 20% of FSD, diode peak current(
   If) must be at least 100 micro ampere; therefore,
   at 100% of FSD,
13 Ishp=Ifp-Im;// peak current through Rsh in ampere
14 Vm=Im*Rm;// peak voltage in volts
15 Rsh=Vm/Ishp;
16 Rs=(1.414*Vrms-Vm-Vf)/Ifp;
17 printf("Rsh=%d ohm\n",Rsh);
18 printf("Rs=%0.1f K-ohm\n",Rs/1000);
19 //result
20 //Rsh=778 ohm
21 //Rs=139.5 K-ohm

```

Scilab code Exa 3.12 calculate the value of Rl

```

1 //To find the the resistance Rl
2 // example 3-12 in page 58
3 clc;
4 // Given data
5 Iav=1e-3;// Average current through the PMCC = 1 mA
6 Ip=250e-3;// primary current= 250 mA

```



```

7 Rm=1700; // coil resistance in ohm
8 Ns=500; // number of secondary turns
9 Np=4; //number of primary turns
10 Vf=0.7; //diode forward drop in volts
11 Rs=20e+3; // Rs=20 k ohm
12 //calculation
13 Im=Iav/0.637; //peak current
14 Em=(Im*(Rs+Rm))+(2*Vf); //secondary peak voltage
15 Es=Em*0.707; //secondary rms voltage
16 Irms=1.11*Iav; // RMS meter current
17 Is=Ip*(Np/Ns); //transformer rms secondary current
18 Il=Is-Irms; //current through Rl
19 Rl=Es/Il;
20 printf("Rl=%0.1 f K-ohm\n",Rl/1000);
21 //result
22 //Rl=28.2 K-ohm

```

Scilab code Exa 3.13 percentage error

```

1 //To find the upper and lower limits of the measured
   current and percentage error in the measurement
   for FSD and 0.5 FSD
2 //Given Data
3 clc;
4 Im=100e-6; // FSD=100 micro amps
5 e=1; // specified accuracy
6 //calculation
7 for n=1:2
8     I=Im/n; //indicated current
9     Ie=(e/100)*Im; //error current
10    Imax=I+Ie; //actual measured maximum current
11    Imin=I-Ie; //actual measured minimum current
12    eI=(Ie/I)*100; //Percentage error in the measured

```

```

        current
13     printf("At %.1f FSD\n",1/n);
14     printf("Actual measured current=%d to %d micro-A\n",
        Imin*(1e+6),Imax*(1e+6));
15     printf("error=(+/-)%d percent of measured current\n"
        ,eI);
16     printf("\n");
17     end
18 //result
19 // At 1.000000 FSD
20 //Actual measured current=99 to 101 micro-A
21 //error=(+/-)1 percent of measured current
22
23 //At 0.500000 FSD
24 //Actual measured current=49 to 51 micro-A
25 //error=(+/-)2 percent of measured current

```

Scilab code Exa 3.14 instrument indication and resistance scale

```

1 // To find the instrument indication when Rx=0 and
   resistance scale at 0.5,0.25,0.75 FSD
2 // example 3-14 in page 61
3 clc;
4 //Given Data
5 Eb=1.5;//battery rating in volts
6 Im=100e-6;// FSD=100 micro ampere
7 R=15e+3;// R1+Rx=15 K-ohm
8 //calculation
9 printf("meter indication when Rx=0 is %d micro-A (
   FSD)\n", (Eb/R+0)*10^6);// here Rx=0
10 for n=0.25:0.25:0.75//FSD's in ampere at which
   resistance Rx should be calculated
11     Rx=(Eb/(n*Im))-R;// resistance in ohm

```

```

12     printf("Rx for %.2f FSD=%.0f K-ohm \n",n,Rx
           /1000);
13 end
14 //result
15 // meter indication when Rx=0 is 100 micro A (FSD)
16 //Rx for 0.25 FSD=45 K-ohm
17 //Rx for 0.5 FSD=15 K-ohm
18 //Rx for 0.75 FSD=5 K-ohm

```

Scilab code Exa 3.15 to find the resistance

```

1 //To find Rx and R2 in the given circuit for the
  said conditions
2 //example3-15 in page 63
3 clc;
4 //Given data
5 R1=15e+3; // resistance R1=15 K-ohm
6 Rm=50; // coil resistance in ohm
7 R2=50; // resistance R2 in ohm
8 Im=50e-6; // FSD=50 micro-ampere
9 //calculations
10 printf(" at Rx=0 & Eb=1.3 V,\n");
11 Rx=0; Eb=1.3;
12 Ib=Eb/(Rx+R1);
13 I2=Ib-Im;
14 Vm=Im*Rm;
15 R21=Vm/I2; // the resistance R2 in ohm
16 printf("R2=%.2f ohm\n",R21);
17 for Eb=1.5:-0.2:1.3, // To find Rx
18     Vm=0.5*Im*Rm;
19     if Eb==1.3
20         R2=R21;
21     end

```

```

22     I2=Vm/R2;
23     Ib=I2+Im*0.5;
24     Rx=(Eb/Ib)-R1;
25     printf("At 0.5 FSD with Eb=%0.1f V,\n",Eb);
26     printf("Rx=%0d K-ohm \n",Rx/1000);
27     end
28     //result
29     //at Rx=0 & Eb=1.3 V
30     //R2=68.181818 ohm
31     //At 0.5 FSD with Eb=1.5V,
32     //Rx=15 K-ohm
33     //At 0.5 FSD with Eb=1.3 V,
34     //Rx=15 K-ohm

```

Scilab code Exa 3.16 ohmeter indication and the resistance

```

1 // To find the meter current and indicated
  resistance
2 // example 3-16 in page65
3 clc;
4 //Given data
5 //the equivalent circuit is derived as shown in the
  fig3-24 from the R X 1 range ohmmeter circuit
6 E=1.5;// battery rating in volts
7 //calculation
8 for Rx=0:24:24, //Rx in ohm
9     Ib=E/(Rx+14+((10*(9990+2875+3820))
      /(9990+2875+3820))); //the resistance values
      are choose from equivalent circuit thus we get
      the battery current
10 //using the current divider rule
11 Im=Ib*(10/(10+9990+2875+3820)); // meter current
12 printf("meter current when Rx=%0d ohm is %0.2f

```

```
        micro-A\n",Rx,Im*1e+6);  
13 end  
14 // result  
15 // meter current when Rx=0 ohm is 37.436358 micro-A=  
    full scale =0 ohm  
16 //meter current when Rx=24 ohm is 18.718179 micro-A=  
    half scale=24 ohm
```

Chapter 4

analog electronic volt ohm milliammeter

Scilab code Exa 4.1 meter current and voltage input resistance

```
1 // To find the meter current and the voltmeter
  resistance
2 //example 4-1 in page 88
3 clc;
4
5 //given data
6 Vcc=20; //Vcc in volts
7 R=9.3e+3; // R=Rs+Rm=9.3 K-ohm
8 Im=1e-3' // Im=1 mA
9 hfe=100;
10 E=10; // E in volts
11 Vb=0.7; //voltage drop across base in volts
12
13 // calculation
14 Ve=E-Vb; // emitter voltage in volts
15 printf("meter current=%d mA\n",Ve*1000/R);
16 Ib=Im/hfe; // base current
17 printf("input resistance with transistor = %d M-ohm\
  n",E/(Ib*1000000));
```

```

18 printf("input resistance with out transistor = %.1f
      K-ohm\n",R/1000);
19 //result
20 //meter current = 1 mA
21 //input resistance with transistor = 1 M-ohm
22 //input resistance with out transistor = 9300 ohm

```

Scilab code Exa 4.2 meter circuit voltage and currents

```

1 // To find currents I2 and I3 and calculate the
      meter circuit voltage in the given circuit
2 //example 4-2 in page 89
3 clc;
4 //Given data
5 R2=3.9e+3;//resistance R2=R3=3.9 K-ohm
6 R3=R2;
7 Vcc=12;//Vcc in volt
8 Vee=-12;// Vee in volt
9 Vbe=0.7;// voltage drop across the base_emitter
10 Vp=0;// base voltage of transistor 2
11 //calculation
12 VR2=0-Vbe-Vee;
13 VR3=VR2;
14 I2=VR2/R2;
15 I3=I2;
16 printf(" I2=I3=%.1f mA\n",I2*1000);
17 for E=1:-0.5:0.5// voltage applied to the base of
      transistor 1 in volts
18     Ve1=E-Vbe;// emitter voltage of transistor 1
19     Ve2=Vp-Vbe;// emitter voltage of transistor 2
20     V=Ve1-Ve2;// voltage difference b/w the two
      emitters
21     printf(" when E=%.1f V,\n",E);

```

```

22     printf(" circuit voltage (V)=%.1f V\n",V);
23 end
24 //result
25 //I2=I3=2.9 mA
26 //when E=1.0 V,
27 //circuit voltage (V)=1.0 V
28 //when E=0.5 V,
29 //circuit voltage (V)=0.5 V

```

Scilab code Exa 4.3 meter reading and gate source voltage

```

1 // To determine the meter reading for the circuit in
   the figure 4-4
2 // example 4-3 in page 93
3 clc;
4 //Given data
5 Range=10; //range in volts
6 Ra=800e+3; Rb=100e+3; Rc=60e+3; Rd=40e+3; // given
   resistance values in ohm
7 E=7.5; //battery voltage in volts
8 Vgs=-5; // gate source voltage in volts
9 Vp=5; // base voltage of transistor 2 in volts
10 R=1e+3; // R=Rs+Rm=1 K-ohm
11 Im=1e-3; //FSD=1 mA
12 Vbe=0.7 //base emitter voltage in volt
13 //calculation
14 Eg=E*((Rc+Rd)/(Ra+Rb+Rc+Rd)); //gate voltage
15 Vs=Eg-Vgs; //souce voltage
16 Ve1=Vs-Vbe; // emitter voltage of transistor 1
17 Ve2=Vp-Vbe; //emitter voltage of transistor 2
18 V=Ve1-Ve2; // voltage difference b/w the two emitters
19 I=V/R;
20 P=I/Im; //P% of full scale

```



```

21 printf("THE METER READING=%0.1 f V\n",P*Range);
22 //result
23 //THE METER READING=7.50000 V

```

Scilab code Exa 4.4 suitable resistance values

```

1 // to determine the resistance values for the
  circuit in the figure4-7
2 //example 4-4 in page 97
3 clc;
4 //Given data
5 E=20e-3;//maximum input voltage = 20 mV
6 Ib=0.2e-6;//op-amp input current 0.2 micro amps
7 Im=100e-6;//FSD=100 micro amps
8 Rm=10e+3;// coil resistance in 10 k-ohm
9 //As I4>>Ib select
10 I4=1000*Ib;// current in ampere
11 // at full scale Im=100 micro-A
12 Vout=Im*Rm;
13 printf("R3=%d ohm\n",E/I4);
14 printf("R4=%0.1 f K-ohm\n", (Vout-E)/(1000*I4));
15 //result
16 //R3=100 ohm
17 //R4=4900 ohm

```

Scilab code Exa 4.5 value of resistance and voltage at output

```

1 // To find the resistance value R3 for the circuit
   in the figure 4-8 and also the maximum voltage at
   the out-put terminal of the op-amp
2 //example 4-5 in page 98
3 clc;
4 //data given
5 E=1; // E=1 V
6 Im=1e-3; //FSD=1 mA
7 Rm=100; // Rm in ohm
8 //calculation
9 R3=E/Im;
10 printf("R3=%d K-ohm\n", R3/1000);
11 printf("Vout=%0.1 f V\n", Im*(R3+Rm));
12 //result
13 //R3=1 K-ohm
14 //Vout=1.1 V

```

Scilab code Exa 4.6 resistance scale marking

```

1 // to find the resistance value Rx in the circuit
   4-9 for 1/3rd and 2/3rd value of full scale
2 // example 4-6 in page 100
3 clc;
4 // data give
5 Eb=1.5; // Full scale voltage in volts
6 R1=1e+3; //R1=1 K-ohm
7 //calculation
8 for n=1:2
9     E=Eb*(n/3); // 1/3rd and 2/3rd value of full
       scale
10    Rx=R1/((Eb/E) -1);
11    printf(" at %d/3 FSD, Rx=%d ohm\n", n, Rx)
12 end

```

```

13 //result
14 //at 1/3 FSD, Rx=500 ohm
15 //at 2/3 FSD, Rx=2000 ohm

```

Scilab code Exa 4.7 value of R3 and deflection

```

1 //To find the resistance R3 value and meter
  deflection for the given input
2 // example 4-7 in page 107
3 clc;
4 // Given data
5 Iav=1e-3; //for , FSD the average meter current is 1
  mA
6 Rm=1.2e+3; // coil resistance 1.2 K-ohm
7 E=100e-3; // ac input rms voltage=100 mV
8 //calculations
9 Ip=(2/0.637)*Iav; // peak current for half wave
  rectifier
10 Ep=E/0.707; // input peak voltage
11 R3=Ep/Ip;
12 printf("R3=%d ohm\n\n",R3);
13 printf("When E=50 mV,\n");
14 Ep=(50e-3)/0.707;
15 Ip=Ep/R3;
16 printf("meter deflection=Iav=%0.1f mA\n", (0.637/2)*Ip
  *1000); //half scale
17 //result
18 // R3=45 ohm
19 //When E=50 mV,
20 //meter deflection=Iav=0.5 mA

```

Chapter 5

Digital instrument Basics

Scilab code Exa 5.1 high and low output voltages

```
1 // to find the high and low output voltage values
2 // example 5-1 in page 120
3 clc;
4 //Given data
5 Vcc=5; // DC source in volts
6 Io=1e-3; // output current= 1mA
7 R1=1e+3; //R1=1K-ohm
8 Vi=0; //lowest input voltage
9 Vd=0.7; // silicon-diode drop in volts
10 //calculation
11 printf("High output voltage=%d V\n",Vcc-(Io*R1));
12 printf("low output voltage=%.1 f V\n",Vi+Vd);
13 //result
14 //High output voltage=4 V
15 //low output voltage=0.7 V
```

Scilab code Exa 5.2 collector and base voltage

```
1 // To find the collector and base voltages
2 // example 5-2 in page 121
3 clc;
4 // Given data
5 R1=15e+3; R2=27e+3; Rc1=2.7e+3; R11=R1; R21=R2; //
   resistance values in Ohm where R11=R1' and R21=R2
6 Vc2=0.2; // collector voltage of on transistor in
   volt
7 Vce=Vc2; // collector-emitter saturation voltage in
   volt
8 Vbb=-5; // dc power supply in volt
9 Vcc=5; // dc power supply in volt
10 // calculations
11 Vr1r2=Vc2-Vbb; // voltage across Ri and R2 in volt
12 Vr1=(R1/(R1+R2))*Vr1r2; // voltage across R1 resistor
   in volt
13 Vb1=Vc2-Vr1; // base voltage
14 printf("Vb1=%0.1 f V\n", Vb1);
15 // with Q1 off
16 Vrc1=(Rc1/(Rc1+R11+R21))*(Vcc-Vbb);
17 Vc1=Vcc-Vrc1; // collector voltage in volt
18 printf("Vc1=%0.1 f V", Vc1);
19 // result
20 // Vb1=-1.657143 V
21 // Vc1=4.395973 V
```

Scilab code Exa 5.3 supply current required

```
1 // to find the total supply voltage for led and lcd
  display
2 //example 5-3 in page 124
3 clc;
4 // Given data
5 // 3(1/2) digit display
6 If1=20e-3;//forward current per segment of led=20 mA
7 If2=300e-6;//forward current per segment of lcd
8 //calculations
9 for n=1:2
10     if n==1
11         I=If1;
12     else I=If2;
13     end
14     It=3*7*I+2*I;// each digit has 7 segments and
        there are three digits with a half digit that
        has 2 segments
15     printf("case %d,\n Total current=%.0f mA\n",n,It
        *1000);
16 end
17 //result
18 // case 1,
19 //Total current=0.460000 A
20 //case 2,
21 //Total current=0.006900 A
```

Scilab code Exa 5.4 out put frequency

```
1 // to find the out put frequency in fig 5-10
2 // example 5-4 in page 130
3 clc;
4 //Given data
5 To=1e-6;//oscillator time period=1 micro-second
6 N=16;// modulus number of the counter = 16
7 n=3;// number of counters
8 //calculations
9 T=To*(N^n);//out put time period
10 printf("output frequency=%d hertz",1/T);//output
    frequency
11 //result
12 //output frequency=244 hertz
```

Scilab code Exa 5.5 number of clock pulses counted

```
1 //To find the number of pulses counted
2 //example5-5 in page 131
3 clc;
4 //data given
5 Vr=1.25;//peak voltage of ramp in volts
6 tr=125e-3;//time period of the ramp=1.25 ms
7 T=1/(1e+6);// frequency =1 Mhz and time period of
    the clock pulses is 1/f
8 for Vi=0.75:(0.9-0.75):0.9, // analog input voltages
    for which clock pulses has to b found
9     t1=(tr/Vr)*Vi;//time period of the comparator
        high out put
10     N=t1/T;// pulses counted
11     printf("number of pulses counted for Vi=%0.2 f V
        are %d\n",Vi,N/100);
```

```
12 end
13 //result
14 //number of pulses counted for Vi=0.750000 V are 750
15 //number of pulses counted for Vi=0.900000 V are 900
```

Scilab code Exa 5.6 number of output bits required

```
1 // To find the number of output bits for an ADC to
   give a quantizing error less than 1%
2 // example 5-6 in page 133
3 clc;
4 //Given data
5 //error should be less than 1%
6 // for less than 1% error count >= 100
7 n=6;
8 N=0;
9 while(N<100)
10 N=(2^n)-1; //count value
11 if(N<100)
12 n=n+1; //increment n and check whether N has exceeded
   100
13 end
14 end
15 printf("for less 1percent error , use n=%d\n",n);
16 //end
17 // for less 1percent error , use n=7
```

Scilab code Exa 5.7 output voltage of DAC


```
1 // To find the out put voltage from thee DAC in the
   fig 5-12
2 // example 5-7 in page 135
3 clc;
4 //Given data
5 D=8; C=0; B=2; A=0; //corresponding analog input
   voltages for the digital input 1-0-1-0
6 Vi=10;//input voltage in volts
7 //calculation
8 Vo=(D+C+B+A)*Vi/16;// output voltage
9 printf("out put voltage=%0.2f V",Vo);
10 //result
11 //out put voltage=6.25 V
```

Chapter 6

Digital voltmeters and frequency meters

Scilab code Exa 6.1 maximum time and suitable frequency

```
1 //To find the maximum time for he digital voltmeter
   and to find the approximate frequency of the ramp
   for the same
2 // example 6-1 in page 139
3 clc;
4 //Given data
5 N=1999;//maximum count
6 f=1.5e+6;//clock frequency in hertz
7 //Calculation
8 t1=N*(1/f);// maximum time in seconds
9 fr=1/(t1+0.25*t1);// suggested frequency in hertz
10 printf("maximum time for the dac=%0.2f ms\n suggested
   frequency of the ramp=%0d Hz",t1*1000,fr);
11 //result
12 //maximum time for the dac=1.33 ms
13 //suggested frequency of the ramp=600 Hz
```

Scilab code Exa 6.2 measurement accuracy

```
1 // To determine the measurement accuracy
2 // example 6-2 in page 149
3 clc;
4 // Given data
5 V=20; // voltage measured in volts
6 a=2/100; // specified accuracy
7 a1=0.6; // accuracy of the digital instrument
8 // calculation
9 Ve=a*25; //voltage error in volts by the instrument
   with 25 V range
10 e=Ve*100/V; //measurement accuracy
11 printf("measurement accuracy for analog voltmeter
   =(+/-)%.1f percent\n",e);
12 //for digital instrument
13 d=0.1; // voltage required for one digit in volt
14 Ve=(0.6/100)*V+d; // voltage error in volt
15 e=Ve*100/V; //error in the measured voltage
16 printf("measurement accuracy for digital voltmeter
   =(+/-)%.1f percent",e);
17 //result
18 // measurement accuracy for analog voltmeter=(+/-)
   2.5 percent
19 //measurement accuracy for digital voltmeter=(+/-)
   1.1 percent
```

Scilab code Exa 6.3 determine the measured frequency

```

1 //To find the measured frequency of the digital
  frequency meter
2 // example 6-3 in page 153
3 clc;
4 //Given data
5 A=['a' 'b'];
6 N=[6 4]; //6 and 4 decade counters
7 f1=1e+6; // time base frequency in hertz
8 fi=1.512e+3; //input frequency in hertz
9 //calculation
10 i=[1000 10]; // divisors to give the accurate
  frequency
11 for n=1:2, //for 6 and 4 decade counters
12     t1=10^N(n)/f1; // time base
13     C=fi*t1; //cycles counted
14     f=C/i(n); //measured frequency
15     if n==1
16         printf(" \n %s) using %d decade counters, \n the
  measured frequency =%.3 f K-Hz", A(n), N(n), f);
17 end
18 if n==2
19     printf(" \n %s) using %d decade counters, \n the
  measured frequency =0%.1 f K-Hz", A(n), N(n), f)
  ;
20 end
21 end
22 //result
23 //a) using 6 decade counters ,
24 //the measured frequency =1.512 KHz
25 //b) using 4 decade counters ,
26 //the measured frequency =01.5 K-Hz

```

Scilab code Exa 6.4 percentage measurement error

```

1 // to DETERMINE THE MEASUREMENT ERROR OF FREQUENCY
  COUNTER
2 // example 6-4 in page 154
3 clc;
4 // Given data
5 // accuracy a=(+/-)1 LSD(+/-)(1*10^-6)
6 // calculation
7 F=[100 1e+6 100e+6]; // frequencies in Hz
8 for n=1:3
9     Ce=1+(F(n)*10^-6); // error in number of counts
10    e=Ce*100/F(n); //percentage error
11    printf(" \nAt f=%0.0e hertz, \npercentage
        measurement error=(+/-)%0.0e percent\n", F(n), e
        );
12 end
13 // results
14 // percentage measurement error=(+/-)1e+000 percent
15 //percentage measurement error=(+/-)2e-004 percent
16 //percentage measurement error=(+/-)1e-004 percent

```

Chapter 7

Low High and Precise Resistance Measurements

Scilab code Exa 7.1 Caption find the resistance

```
1 // To find the value of measured Resistance R
2 // example 7-1 in page 165
3 clc;
4 // Given data
5 I=0.5; //measured current in amps
6 V=500; // voltmeter indication in volts
7 Ra=10; //ammeter resistance in ohms
8 //calculation
9 R=(V/I)-Ra; // measured resistance
10 printf("The value of R=%d ohm",R);
11 //result
12 // The value of R=990 ohm
```

Scilab code Exa 7.2 ammeter and ohmeter indications

```
1 // To find the ammeter and ohmeter indication for
   the circuit 7-1(a)
2 // example 7-2 in page 166
3 clc;
4 //Data given
5 V=1000; S=10e+3; // voltmeter range and sensitivity
   in volt and ohm/volt
6 R=990; // the resistance measured
7 E=500; // supply voltage in volts
8 Ra=10; // ammeter resistance in ohm
9 //calculaTION
10 Rv=V*S; // voltmeter resistance
11 R1=(R*Rv)/(R+Rv); // as voltmeter is connected in
   parallel with the measured resistance, the
   equivalent resistance is the parallel combination
   of both resistances
12 Ev=(E*R1)/(R1+Ra); // voltmeter reading using voltage
   divider formula
13 I=Ev/R1; // ammeter reading
14 printf(" voltmeter reading=%0.0 f V\nAmmeter reading=%0
   .1 f A\n",Ev,I);
15 //result
16 //voltmeter reading=495 V
17 //Ammeter reading=0.5 A
```

Scilab code Exa 7.3 accuracy

```
1 // To determine which of the circuits 7-1(a) or 7-2(
   b) has greater accuracy
2 // example 7-3 in page 166
3 clc;
```

```

4 //Data given
5 V1=495; I1=0.5; // voltmeter and ammeter reading in
    volt and ampere respectively of circuit 7-1(a)
6 V2=500; I2=0.5; // voltmeter and ammeter reading in
    volt and ampere respectively of circuit 7-1(b)
7 //calculation
8 printf("R from circuit 7-1(a)=%d ohm\nR from circuit
    7-1(b)=%d ohm\n",V1/I1,V2/I2);
9 printf("thus circuit 7-1(a) gives the more accurate
    result");
10 //result
11 //R from circuit 7-1(a)=990 ohm
12 //R from circuit 7-1(b)=1000 ohm
13 //thus circuit 7-1(a) gives the more accurate result

```

Scilab code Exa 7.4 find the resistance

```

1 // to calculate the value of Resistance R
2 // example 7-4 in page 169
3 clc;
4 // data given
5 P=3.5e+3; Q=7e+3; S=5.51e+3; // resistance values of
    the wheatstone bridge arms in ohm
6 //calculation
7 R=S*P/Q; // equation for balancng condition
8 printf("R=%f K-ohm\n",R/1000);
9 S=[1e+3 8e+3]; // adjusting s from 1 to 8 K-ohm
10 for n=1:2
11     R=S(n)*P/Q;
12     printf(" when S=%d K-ohm,\n",S(n)/1000);
13     printf("R=%d ohm\n",R);
14 end
15 //result

```


16 //Measurement range is from 500 ohm to 4000 ohm

Scilab code Exa 7.5 accracy upper and lower values

```
1 // To calculate the accuracy of the measured value
  of resistance and to find the upper and lower
  values
2 // example 7-5 in page 169
3 clc;
4 //Data given
5 R=2.755e+3;//measured value of R in ohm
6 E=[0.05 0.05 0.1]// percentage errors of the
  resistances P Q and S respectively
7 //calculation
8 Re=sum(E);// percentage error in R
9 Rmax=R+((Re/100)*R);//upper limit of resistance R in
  ohm
10 Rmin=R-((Re/100)*R);// lower limit of resistance R
  in ohm
11 printf("the upper and lower limits of R are %.4f K-
  ohm and %.4f K-ohm respectively",Rmax/1000,Rmin
  /1000);
12 //result
13 // the upper and lower limits of R are 2.760510 K-
  ohm and 2.749490 K-ohm respectively
```

Scilab code Exa 7.6 minimum change

```

1 // to calculate the minimum change detectable by the
   bridge
2 // example 7-6 in page 172
3 clc;
4 //Given data
5 P=3.5e+3; Q=7e+3; S=4e+3; R=2e+3; // bridge arm
   resistances in ohm
6 Eb=10; // supply voltage in volt
7 Ig=1e-6; //galvano meter reading in ampere
8 rg=2.5e+3; //galvanometer resistance=2.5 K-ohm
9 //calculations
10 r=((P*R)/(P+R))+((Q*S)/(Q+S)); // internal resistance
   of the bridge in ohm
11 dVR=Ig*(r+rg); // open-circuit galvano meter voltage
   i,e VR-VS in volt
12 VR=Eb*R/(R+P); // voltage across resistance R in volt
13 VP=Eb-(VR+dVR); //voltage across resistance P in volt
14 IR=VP/P; // current through P which is equal to
   current through R in ampere
15 dR=((VR+dVR)/IR)-R; //Change in R value that the
   device can detect in ohm
16 printf("the minimum change in R which is detected by
   the bridge is %f ohm\n",dR);
17 //result
18 // the minimum change in R which is detected by the
   bridge is 5.466141 ohm

```

Scilab code Exa 7.7 ratio of resistances

```

1 // to determinr the required ratio of R/P
2 // example 7-7 in page 176
3 clc;
4 // Given data

```

```

5 S=0.1; Q=0.15; // resistances in ohm
6 // calculation
7 r=S/Q; // here R/P=S/Q
8 printf("the required ratio is %d/%d", (S*100), (Q*100)
9 );
9 // result
10 // the required ratio is 10/15

```

Scilab code Exa 7.8 volume and surface leakage resistance

```

1 // to find the volume resistance and the surface
   leakage resistance
2 // example 7-8 in page 180
3 clc;
4 //Data given
5 Is=5e-6; // surface current in ampere
6 Iv=1.5e-6; // volume current in ampere
7 E=10000; // supply voltage in volt
8 // calculation
9 printf("volume resistance=%0.1e ohm\n", E/Iv);
10 printf("surface leakage resistance=%0.1e ohm", E/(Is-
   Iv));
11 // result
12 // volume resistance=6.7e+009 ohm
13 // surface leakage resistance=2.9e+009 ohm

```

Chapter 8

Inductance and capacitance Measurements

Scilab code Exa 8.1 components and connections

```
1 // To find the components and connections
2 // example 8-1 in page 194
3 clc;
4 // Given data
5 C=0.005e-6; Rs=8e+3; f=1e+3; // the circuits
   capacitance ,resistance and measurement frequency
   in farad , ohm and hertz respectively
6 ohm_meter_reading=134e+3; // in ohm
7 //calculation
8 Xs=1/(2*%pi*f*C); //series inductive reactance in ohm
9 Rp=(Rs*Rs+Xs*Xs)/Rs; // parallel resistance ih ohm
10 Xp=(Rs*Rs+Xs*Xs)/Xs; // parallel inductive reactance
   in ohm
11 Cp=1/(2*%pi*f*Xp); // parallel capacitance in farad
12 printf("Rp=%d K-ohm\nXp=%0.1 f K-ohm\nCp=%0.3 f micro-F"
   ,Rp/1000 ,Xp/1000 ,Cp*1000000);
13 //result
```

```
14 // since the measured terminal resistance is 134 k-  
    ohm, the circuit must consist of a 0.005 micro-  
    farad capacitor connected in parallel with a 134  
    kilo-ohm resistor. For a series connected circuit.  
    the terminal resistance would be much higher  
    than 134 K-ohm
```

Scilab code Exa 8.2 range of capacitance

```
1 // to find the range of Cx in fig 8-5  
2 // example 8-2 in page 199  
3 clc;  
4 // data given  
5 C1=0.1e-6; //standard capacitance in micro farad  
6 r=[100/1 1/100]; // range of the ratio R3/R4  
7 Cx=C1*r; // range of Cx  
8 printf("The range of Cx is from %.3f micro-F to %d  
    micro-F", Cx(2)*10^6, Cx(1)*10^6);  
9 //result  
10 //The range of Cx is from 0.001 micro-F to 10 micro-  
    F
```

Scilab code Exa 8.3 resistance capacitance and dissipation factor

```
1 // to find the capacitance , resistance and the  
    dissipation factor  
2 // example 8-3 in page 202  
3 clc;  
4 //Given data
```

```

5 f=100; // frequency in Hz
6 C1=0.1e-6; // standard capacitance in farad
7 R=[125 0 10e+3 14.7e+3]; // resistances R1,R3 and R4
   values in ohms as R2 is not used it is take as 0
   for convinence
8 //calculation
9 Cs=C1*(R(3)/R(4)); //series capacitance
10 Rs=R(1)*R(4)/R(3); // series resistance
11 D=2*pi*f*C1*Rs; // dissipation factor
12 printf("Cs=%0.3 f micro-F\nRs=%0.1 f ohm\nD=%0.3 f", Cs
   *10^6, Rs, D);
13 //result
14 //Cs=0.068 micro-F
15 //Rs=183.8 ohm
16 //D=0.008

```

Scilab code Exa 8.4 resistance capacitance and dissipation factor

```

1 // To find the resistance , capacitance and
   dissipation factors
2 // example 8-4 in page 204
3 clc;
4 //Given Data
5 f=100; // frequency in Hz
6 C1=0.1e-6; // standard capacitance in farad
7 R=[375e+3 0 10e+3 14.7e+3]; // resistances R1,R3 and
   R4 values in ohms as R2 is not used it is take as
   0 for convinence
8 //calculation
9 Cp=C1*(R(3)/R(4)); //parallel capacitance in farad
10 Rp=R(1)*R(4)/R(3); // parallel resistance in ohm
11 D=1/(2*pi*f*Cp*Rp); // dissipation factor
12 printf("Cp=%0.3 f micro-F\nRp=%0.1 f K-ohm\nD=%0.2 e\n",

```

```

        Cp*106, Rp/1000, D);
13 // result
14 // Cp=0.068027 micro-F
15 //Rp=551.250000 K-ohm
16 //D=0.042441

```

Scilab code Exa 8.5 parallel resistance and capacitance

```

1 // to calculate the equivalent parallel capacitance
  and resistance
2 // example 8-5 in page 204
3 clc;
4 //Given dATA
5 R3=10e+3; // resistance R3 in ohm
6 f=100; //frequency in hertz
7 Cs=0.068e-6; Rs=183.8; // series capacitance in
  farad and resistance in ohm
8 //Calculation
9 Xs=1/(2*%pi*f*Cs); // series capacitive reactance in
  ohm
10 Rp=(Rs*Rs+Xs*Xs)/Rs; //equivalent parallel resistance
  in ohm
11 Xp=(Rs*Rs+Xs*Xs)/Xs; //equivalent parallel capacitive
  reactance in ohm
12 Cp=1/(2*%pi*f*Xp); // equivalent capacitance in farad
13 R4=C1*R3/Cp; // parallel resistance in ohm
14 R1=R3*Rp/R4; // parallel resistance in ohm
15 printf("Rp=%0.2 f M-ohm\nCp=%0.3 f Micro-F\nR1=%0.2 f M-
  ohm\nR4=%0.1 f K-ohm", Rp/106, Cp*106, R1/106, R4
  /1000);
16 // result
17 //Rp=2.98 M-ohm
18 //Cp=0.068 Micro-F

```

```
19 //R1=2.03 M-ohm
20 //R4=14.7 K-ohm
```

Scilab code Exa 8.6 find the resistance

```
1 // To find the resistance R1 and R3 in fig 8-8
2 // example 8-6 in page 207
3 clc;
4 // Given data
5 R4=5e+3; L1=100e-3; Ls=500e-3; Rs=270; R3=1e+3; //
   resistances in ohm and inductances in henry
6 //calculation
7 printf("R3=%d K-ohm\n",R4*L1/(Ls*1000));
8 printf("R1=%d ohm",Rs*R3/R4);
9 //result
10 //R3=1 K-ohm
11 //R1=54 ohm
```

Scilab code Exa 8.7 inductance resistance and Q factor

```
1 // to find the resistance inductance and the Q
   factor of the inductor
2 // example 8-7 in page 209
3 clc;
4 // given data
5 // it is a maxwell's induction bridge
6 C3=0.1e-6; R1=1.26e+3; R4=500; R3=470; //
   capacitance and resistor values in farad and ohm
7 f=100; // frequency =100 Hz
```



```

8 // calculation
9 printf("Ls=%d mH\n", C3*R1*R4*1000); // here Ls=C3*R1*
    R4
10 printf("Rs=%.2 f K-ohm\n", R1*R4/(R3*1000)); // here Rs=
    R1*R4/R3
11 printf("Q=%.2 f", (2*pi*f*C3*R1*R4)/(R1*R4/R3)); // Q=
    w*Ls/Rs
12 // result
13 //Ls=63 mH
14 //Rs=1.34 K-ohm
15 //Q=0.03

```

Scilab code Exa 8.8 inductance resistance and Q factor

```

1 //to find the resistance inductance and the Q factor
    of the inductor
2 // example 8-8 in page 210
3 clc;
4 // given data
5 // it is a maxwell's induction bridge
6 C3=0.1e-6; R1=1.26e+3; R4=500; R3=75; // capacitance
    and resistor values in farad and ohm
7 f=100; // frequency =100 Hz
8 // calculation
9 printf("Lp=%d mH\n", C3*R1*R4*1000); // here Lp=C3*R1*
    R4
10 printf("Rp=%.1 f K-ohm\n", R1*R4/(R3*1000)); // here Rp=
    R1*R4/R3
11 printf("Q=%d", (R1*R4/R3)/(2*pi*f*C3*R1*R4)); // Q=Rs
    /(w*Lp)
12 // result
13 //Lp=63 mH
14 //Rp=8.4 K-ohm

```

15 //Q=212

Scilab code Exa 8.9 find the inductance and resistance

```
1 // to find series equivalent inductance and
  resistance and find R1 and R3 for maxwell circuit
2 // example 8-9 in page 211
3 clc;
4 printf(" part a,\n");
5 //Data Given
6 Lp=63e-3; Rp=8.4e+3; f=100; // the parallel
  inductance in henry and resistace in ohm with 100
  hertz frequency
7 //calculation
8 Xp=2*%pi*f*Lp; //parallel inductive reactance in ohm
9 Rs=(Rp*Xp*Xp)/(Xp*Xp+Rp*Rp); // series resistance in
  ohm
10 printf("Rs=%0.3 f ohm\n",Rs); // equivalent series
  resistance in ohm
11 Xs=(Rp*Rp*Xp)/(Xp*Xp+Rp*Rp); // series inductive
  reactance in ohm
12 Ls=Xs/(2*%pi*f); // equivalent series inductance in
  henry
13 printf("Ls=%0.0 f mH\n",Ls*1000);
14 printf(" part b,\n");
15 //Data given
16 C3=0.1e-6; R4=500; // capacitance in farad and
  resistance in ohm of maxwell bridge
17 //calculation
18 R1=Ls/(C3*R4); //resistance in ohm
19 printf("R3=%0.2 f M-ohm", (R1*R4)/(Rs*10^6));
20 printf(" \nR1=%0.2 f K-ohm", R1/1000);
21 //result
```

```
22 //part a,
23 //Rs=0.187 ohm
24 //Ls=63 mH
25 //part b,
26 //R3=3.38 M-ohm
27 //R1=1.26 K-ohm
```

Scilab code Exa 8.10 find the capacitance and resistance

```
1 // to find Cx and Rx of figure 8-7 for new balance
2 // example 8-10 in page 214
3 clc;
4 //Data given
5 C1=0.1e-6; R3=10e+3; R4=14.66e+3; R1=369.3e+3; //
   bridge capacitance and resistance in farad and
   ohm respectively
6 Rp=553.1e+3; Cp=0.068e-6; // parallel resistance in
   ohm and capacitance in farad
7 //calculations
8 Cx=(C1*R3/R4)-Cp; // here Cx+Cp = C1*R3/R4 in farad
9 printf("Cx=%d pF\n",Cx*10^12);
10 R=R1*R4/R3; // let R=Rx parallel with Rp in ohm
11 Rx=1/((1/R)-(1/Rp)); // Rx in ohm
12 printf("Rx=%.0 f M-ohm\n",Rx/10^6);
13 //result
14 //Cx=212 pF
15 //Rx=26 M-ohm
```

Scilab code Exa 8.11 determine the q factor

```

1 // to determine the Q factor
2 // example 8-11 in page 221
3 clc;
4 //Data given
5 E=100D-3; R=[5 10]; XC=100; XL=XC; // supply
    resistance , capacitive reactance and inductive
    reactance respectively for the fig 8-17, all in
    ohm
6 //calculation
7 for n=1:2
8     I=E/R(n); // current in ampere
9     V=I*XC; // VL=VC=V and XC=XL, voltage in volts
10    Q=V/E; // Q factor
11    printf("for %d st coil,\n",n);
12    printf("voltmeter indication=%d V\n",V);
13    printf("Q=%d\n",Q);
14 end
15 //result
16 //for 1 st coil ,
17 //voltmeter indication=2 V
18 //Q=20
19 //for 2 st coil ,
20 //voltmeter indication=1 V
21 //Q=10

```

Scilab code Exa 8.12 coil inductance and resistance

```

1 // To Determine the coil inductance and the
    resistance
2 // example 8-12 in page 225
3 clc;
4 // Data given
5 f=1.25e+6; C=147D-12; Q=98; // frequency in hertz ,

```

```
        Capacitance in farad and Q factor of the Q metre
6 //calculation
7 L=1/((2*%pi*f)^2*C); // inductance in henry
8 printf("inductance=%0.0 f micro-henry\n",L*10^6);
9 printf("R=%0.1 f ohm", (2*%pi*f*L)/Q);
10 //result
11 //inductance=110 micro-henry
12 //R=8.8 ohm
```

Chapter 9

Cathode Ray Oscilloscopes

Scilab code Exa 9.2 peak to peak voltage and time period

```
1 // to find the peak to peak voltage and the time
   period for the sweep generator circuit in fig 9-7
2 // example 9-2 in page 243
3 clc;
4 // Given Data
5 R3=4.2e+3; C1=0.25D-6; Vb1=4.9; Vbe=0.7; //resistance
   in ohm, capacitance in farad and voltages in
   volt respectively
6 UL=2; // UTP,LTP=(+/-)2 V
7 // Calculation
8 dV=2*UL; //peak-peak voltage in volt
9 Ic1=(Vb1-Vbe)/R3; //current in ampere
10 T=dV*C1/Ic1; // time period in seconds
11 printf("peak-peak voltage=%d V p-to-p\n",dV);
12 printf("time period=%d ms",T*1000);
13 //result
14 //peak-peak voltage=4 V p-to-p
15 //time period=1 ms
16 x=linspace(0,1,100);
```

```

17 y=4*x-2;
18 plot(x,y);
19 xlabel('Time period in ms');
20 ylabel('voltage in V');
21 set(gca(),"grid",[1 1]);

```

Scilab code Exa 9.3 amplitude frequency and phase difference

```

1 // to find the amplitude ,frequency and the phase
  difference b/w two waveforms in the figure 9-20
2 // example 9-3 in page 256
3 clc;
4 //Data Given
5 x=['A' 'B'];
6 V=200D-3;// volatge/division=200mV
7 T=0.1D-3;//time/division=0.1ms
8 one_cycle=360;// one cycle=360 degree
9 Vd=[6 2.4];// vertical divisions of A and B
  respectively
10 Hd=[6 7];// horizontal divisions of A and B
  respectively
11 //calculation
12 for n=1:2
13     Vp=Vd(n)*V;// V peak-to-peak
14     Tp=T*Hd(n);// time period
15     f=1/Tp;//frequency
16     printf("V peak-peak of wave from %c=%0.2 f V\n",x(
        n),Vp);
17     printf("frequency of wave form %c=%0.0 f Hz\n",x(n
        ),f);
18 end
19 phase_diff=Hd(2)-Hd(1);
20 phase_diff=one_cycle*phase_diff/6;// here one cycle

```

```

    makes 6 horizontal divisions
21 printf("phase difference=%d degree",phase_diff);
22 //result
23 //V peak-peak of wave from A=1.20 V
24 //frequency of wave form A=1667 Hz
25 //V peak-peak of wave from B=0.48 V
26 //frequency of wave form B=1429 Hz
27 //phase difference=60 degree

```

Scilab code Exa 9.4 pulse amplitude frequency raise and fall time

```

1 // to find the pulse amplitude ,frequency ,rise time
  and fall time of fig9-22
2 // example 9-3 in page 259
3 clc;
4 // Data given
5 Vpd=2; // voltage/division=2 V
6 Hpd=5D-6; // time/division=5 micro seconds per
  division
7 Vd=4; // number of vertical divisions
8 Hd=5.6 // number of horizontal divisions
9 // calculation
10 printf("Pulse amplitude=%d V\n",Vd*Vpd);
11 printf("frequency=%0.1f kHz\n", (1/(Hd*Hpd))/10^3);
12 printf("raise time=%0.1f micro-s\nfall time=%d micro-
  s",0.5*Hpd*10^6,10^6*0.6*Hpd);
13 //result
14 //Pulse amplitude=8 V
15 //frequency=35.7 kHz
16 //raise time=2.5 micro-s
17 //fall time=3.0 micro-s

```

Scilab code Exa 9.5 longest pulse width

```
1 // to find the longest pulse width
2 // example 9-5 in page 261
3 clc;
4 //Given data
5 Ri=10e+6;// input resistance in ohm
6 Cc=0.1e-6;// coaxial cable capacitance in farad
7 //calculation
8 printf("pulse width=%.1f s",Ri*Cc/10);// here pulse
   width=tou/10 seconds
9 //result
10 //pulse width=0.1 s
```

Scilab code Exa 9.6 shortest pulse width

```
1 // to find the shortest pulse width that can be
   displayed
2 // example 9-6 in page 262
3 clc;
4 //DATA GIVEN
5 Rs=3.3e+3; Ci=15D-12;// source resistance in ohm and
   input capacitance in farad
6 //calculation
7 printf("shortest pulse width=%.3f micro-second",10*
   Rs*Ci*2.2*10^6);//here shortest pulse width =10*
   tuo in seconds where tuo is the rise time imposed
   by the oscilloscope
```

```
8 //result
9 //shortest pulse width=1.089 micro-second
```

Scilab code Exa 9.7 raise time

```
1 //to find the raise time of the displayed waveform
2 // example 9-7 in page 262
3 clc;
4 //Data given
5 Rs=3.3e+3; Ci=15D-12;//source resistance in ohm and
   input capacitance in farad
6 tri=[109e-9 327e-9];//input raise times in seconds
   for which trd is to be determined
7 //calculations
8 tuo=2.2*Rs*Ci;//tuo is the rise time in seconds
   imposed by the osscilloscope
9 for n=1:2
10     trd=sqrt(tri(n)^2+tuo^2); // displayed raise
       time in seconds
11     printf("the displayed raise time for input pulse
       raise time %d ns=%d ns\n",tri(n)*10^9,trd
       *10^9);
12 end
13 //result
14 //the displayed raise time for input pulse raise
   time 109 ns=154 ns
15 //the displayed raise time for input pulse raise
   time 327 ns=344 ns
```

Scilab code Exa 9.8 terminal oscilloscope voltage and frequency

```
1 //to find the terminal oscilloscope voltage and its
   frequency
2 // exmaple 9-8 in page 264
3 clc;
4 //Data given
5 Vs=1; //supply voltage in volt
6 Rs=600; //source resistance in ohm
7 Ri=1e+6; //input resistance in ohm
8 Ci=30D-12; //input parallel capacitance in farad
9 Ccc=100D-12; //coaxial cable capacitance in farad
10 f=100; // signal frequency in hertz
11 //calculation
12 Vi=Vs*Ri/(Rs+Ri); // input voltage in volts
13 Xc=1/(2*%pi*f*(Ci+Ccc)); //capacitive reactance in
   ohm for total capacitance
14 printf("the input terminal voltage at 100 Hz =%.4f V
   \n",Vi);
15 printf("when Vi=(Vs-3 dB),\n");
16 f=1/(2*%pi*(Ci+Ccc)*Rs); // frequency in hertz
17 printf("frequency=%.2f MHz",f/10^6);
18 //result
19 //the input terminal voltage at 100 Hz =0.9994 V
20 //when Vi=(Vs-3 dB),
21 //frequency=2.04 MHz
```

Scilab code Exa 9.9 find the capacitance

```
1 // to find the capacitance to compensate a probe and
   input capacitance
2 //example 9-9 in page 267
3 clc;
```

```

4 //data given
5 Ci=30D-12;// input capacitance in farad
6 Ccc=100D-12;// coaxial cable capacitance in farad
7 R1=9e+6; Ri=1e+6;// resistances in ohm
8 //calculation
9 C2=Ccc+Ci;// capacitance in farad
10 C1=C2*Ri/R1;// capacitance in farad
11 printf("C1=%.1 f pF\n",C1*10^12);
12 printf("The probe input capacitance as seen from the
    source=%d pF", (C1*C2)*10^12/(C1+C2))
13 //result
14 //C1=14.4 pF
15 //The probe input capacitance as seen from the
    source=13 pF

```

Scilab code Exa 9.10 find the frequency

```

1 // to find the frequency
2 // example 9-10 in page 268
3 clc;
4 // data given
5 C=13D-12; Rs=600; // input capacitance in farad and
    source resistance in ohm
6 //calculation
7 printf("frequency=%.1 f MHz",1/(2*%pi*C*Rs*10^6));
8 //result
9 //frequency=20.4 MHz

```

Scilab code Exa 9.11 find the frequency

```

1 // to determine the frequency
2 // example 9-11 in page 269
3 clc;
4 // Data Given
5 C=3.5D-12; Rs=600; // capacitance in farad and
   source resistance in ohm
6 //calculation
7 printf("frequency=%0.1 f MHz" ,1/(2*%pi*C*Rs*10^6));
8 //result
9 //frequency=75.8 MHz

```

Scilab code Exa 9.12 minimum time per sensitivity

```

1 // to find the minimum time/division sensitivity
2 // example 9-12 in page 278
3 clc;
4 //Data Given
5 f=50e+6; // frequency of the waveform in hertz
6 //calculation
7 T=1/f; //time period in seconds
8 printf("using the five times magnifier ,\n");
9 printf("minimum time/div setting=%0d ns/div" ,5*(T/4)
   *10^9); // here one cycle occupies 4 horizontal
   divisions
10 //result
11 //using the five times magnifier ,
12 //minimum time/div setting=25 ns/div

```

Scilab code Exa 9.13 raise time

```

1 // to determine the raise time displayed waveform
2 // example9-13 in page 279
3 clc;
4 // Data given
5 fH=[20e+6 50e+6]; // upper cut-off frequency in hertz
6 tri=21D-9; // input raise time in seconds
7 // calculation
8 for n=1:2
9     tro=0.35/fH(n); // tro is the raise time in
        seconds
10    trd=sqrt(tri^2+tro^2); // trd is the fall time in
        seconds
11    printf(" for fH=%d MHz,\ ntrd=%d ns\n", fH(n)/10^6,
        trd*10^9);
12 end
13 // result
14 // for fH=20 MHz,
15 // trd=27 ns
16 // for fH=50 MHz,
17 // trd=22 ns

```

Chapter 11

signal generators

Scilab code Exa 11.1 maximum and minimum output frequencies

```
1 // to calculate the maximum and minimum output
  frequencies of oscillator in fig 11-1
2 // example 11-1 in page 317
3 clc;
4 // Data Given
5 R=[5e+3 500]; // resistance R2 and R1 all in ohm
6 C1=300D-9; C2=C1; // Capacitance=300 nF
7 // calculation
8 f=[ 'f(min) ' 'f(max) '];
9 for n=1:2
10     printf("%s=%d Hz\n",f(n),1/(2*%pi*C1*R(n))); //
      frequency in hertz
11 end
12 //result
13 //f(min)=106 Hz
14 //f(max)=1061 Hz
```

Scilab code Exa 11.2 find the resistor values

```
1 //to find the resistor values in fig 11-3
2 // example 11-2 in page 319
3 clc;
4 //data given
5 Vi=5; //input sine wave voltage in volt
6 VR3=[0.1 1]; // range of voltage across resistor R3
   in volt
7 IB=500D-9; // input current to the op-amp in ampere
8 //calculation
9 V=Vi-VR3(1); // with R1 and R2 in the circuit , V=VR1+
   VR2 in volt
10 I3=100D-6; // as I3>>IB, select I3=100 micro ampere
11 R3=VR3(1)/I3; // resistance in ohm
12 R=V/I3; //R=R1+R2 in ohm
13 //with R2 switched off the circuit
14 I3=VR3(2)/R3; // current in ampere
15 VR1=Vi-VR3(2); // voltage in volt
16 R1=VR1/I3; // here I3=I1, resistance in ohm
17 R2=R-R1; // resistance in ohm
18 printf("R1=%d K-ohm\nR2=%d K-ohm\nR3=%d K-ohm",R1
   /1000,R2/1000,R3/1000);
19 //result
20 //R1=4 K-ohm
21 //R2=45 K-ohm
22 //R3=1 K-ohm
```

Scilab code Exa 11.3 find the output frequency

```
1 // to find the output frequency of the circuit 11-8
2 // example 11-3 in page 326
3 clc;
4 // Data given
5 Vcc=15; // supply voltage=15 V
6 C1=0.1D-6; // capacitance in farad
7 R1=1e+3; R2=10e+3; // resistances in ohm
8 utp=3; ltp=-3; // upper and lower trigger points in
   volt
9 //calculation
10 a=['For contact at top of R1' 'For R1 contact at 10%
   from bottom'];
11 V3=Vcc-1; // voltage in volt
12 dV=utp-ltp; //change in voltage in volt
13 V1=[V3 10*V3/100]; // V1 when R1 is at the top and 10
   % from the bottom of R1 in volt
14 for n=1:2
15     I2=V1(n)/R2; // current in ampere
16     t=C1*dV/I2; // time in seconds
17     f=1/(2*t); // frequency in hertz
18     printf(" %s, \nfrequency=%0.2 f Hz\n\n", a(n), f);
19 end
20 //result
21 //For contact at top of R1,
22 //frequency=1166.67 Hz
23 //For R1 contact at 10% from bottom ,
24 //frequency=116.67 Hz
```

Scilab code Exa 11.4 output square wave frequency

```
1 // to find the out put square wave frequency in
```

```

11-14
2 // example 11-4 in page 332
3 clc;
4 //Data given
5 Vcc=12;//supply voltage (+/-)12 V
6 R=10^3*[20 6.2 5.6];//resistance R1, R2 and R3 all
   in ohm
7 C1=0.2D-6;// capacitance=0.2 micro farad
8 // calculation
9 Vo=Vcc-1;// out put voltage = (+/-)(Vcc-1) in volt
10 utp=Vo*R(3)/(R(2)+R(3));// upper trigger point in
   volt
11 ltp=-utp;// lower trigger point in volt
12 t=C1*R(1)*log((Vo-ltp)/(Vo-utp));// time in seconds
13 printf("out put frequency=%d Hz",1/(2*t));
14 //result
15 //out put frequency=121 Hz

```

Scilab code Exa 11.5 output pulse width and the capacitance

```

1 // to find the output pulse width and capacitance
   for the given pulse width in figure 11-15
2 // example 11-5 in page 334
3 clc;
4 //data given
5 Vcc=10;//supply voltage in Volt
6 Vee=10;// supply voltage in volt
7 VB=1;// base voltage in volt
8 R=1e+3*[22 10];//resistances R1 in ohm and R2 in ohm
9 C=[100D-12 0.01D-6];//capacitance C1 in farad and C2
   in farad
10 //calculation
11 Vop=Vcc-1;// positive output voltage in volt

```

```
12 Von=-(Vee-1); // negative output voltage in volt
13 PW=C(2)*R(2)*log((Vop-Von)/VB); //pulse width in
    seconds
14 printf("PULSE WIDTH=%d micro-sec\n",PW*10^6);
15 PW=6e-3; //to calculate C2 for PW=6 ms
16 C2=PW/(R(2)*log((Vop-Von)/VB)); // capacitance in
    farad
17 printf("For pulse width of 6 ms,\nC2=%0.1f micro-F",
    C2*10^6);
18 //result
19 //PULSE WIDTH=289 micro-sec
20 //For pulse width of 6 ms,
21 //C2=0.2 micro-F
```

Chapter 12

instrument calibration

Scilab code Exa 12.1 accuracy

```
1 //to find the accuracy as a percentage of reading
   and percentage of full scale
2 // example 12-1 in page 355
3 clc;
4 // Data given
5 r=[10 50]; //scale readings
6 c=[-0.5 1.7]; // respective correction
7 f=100; //full scale reading
8 //calculation
9 for n=1:2
10     pr=c(n)*100/r(n); // accuracy as a percentage of
       reading
11     pf=c(n)*100/f; //accuracy as a percentage of full
       scale
12     printf("accuracy as a percentage of reading for
       scale reading %d= %.1f percent\n",r(n),pr);
13     printf("accuracy as a percentage of full scale=
       %.1f percent\n",pf);
14 end
```

```

15 //result
16 //accuracy as a percentage of reading for scale
    reading 10= -5.0
17 //accuracy as a percentage of full scale= -0.5
18 //accuracy as a percentage of reading for scale
    reading 50= 3.4
19 //accuracy as a percentage of full scale= 1.7

```

Scilab code Exa 12.2 error and correction figure

```

1 // to find the wattmeter error and the correction
    figure
2 // example 12-2 in page 357
3 clc;
4 //Data given
5 V=114;// measured voltage in volt
6 P=120;// indicated power in watt
7 I=1;// current in ampere
8 //calculation
9 cf=V*I-P;// here power = v*i, capacitance in farad
10 e=cf*100/P;//percentage error
11 printf("correction figure=%d W\n",cf);
12 printf("wattmeter error=%d percent",e);
13 //result
14 //correction figure=-6 W
15 //wattmeter error=-5 percent

```

Scilab code Exa 12.4 resistance voltage and current

```

1 // to find the resistance., voltage and current in
  fig 12-8
2 //examole 12-4 in page364
3 clc;
4 // Data given
5 V=1.0190; // the standard cell voltage in volt , VBC=
  VB2=V
6 VB1=3; // terminal voltage of battery B1 in volt
7 RAB=100; l=100D-2; //resistance in ohm and length
  in meter of the wire AB
8 lBC=50.95D-2; //length of BC in meter
9 //calculation
10 printf("At calibration ,\n");
11 VAB=l*V/lBC; // voltage accross AB in volt where V/
  lBC is the volatge per unit length
12 I=VAB/RAB; // current in ampere
13 printf("current through AB=%d mA\n", I*1000);
14 R1=(VB1-VAB)/I; // resistance in ohm
15 printf("Resistance R1=%d ohm\n\n", R1); // R=V/I ohm
16 printf("Vx=%.2f V\n", 94D-2*V/lBC); //volatge Vx in
  volt when null is obtained at 94.3cm
17 printf("R2=%d K-ohm", (VB1+V)/(20D-6*1000)); // R2
  in ohm to limit the standard cell current to a
  maximum of 20 micro-A
18 //result
19 //At calibration ,
20 //current through AB=20 mA
21 //Resistance R1=50
22
23 //Vx=1.88 V
24
25 //R2=200 K-ohm

```

Scilab code Exa 12.5 maximum voltage and instrument resolution

```
1 // to find the maximum measurable voltage and the
  instrument resolution
2 // example 12-5 in page 367
3 clc;
4 // Data given
5 V=1.0190; // Standard cell voltage V=VR3=VB2 in volt
6 R13=100; R3=509.5; R4=290.5; // R13 is the slider
  resistance and resistance R3 and R4 all in ohm
7 R=100; // resistances R6 through R12 in ohm
8 l=100D-2; // length of the sliding wire in meter
9 // claculacion
10 VAE=(V/R3)*(R3+R4); // maximum measurable voltage in
  volt where I1=V/R3
11 printf("Maximum measurable voltage=%0.1f V\n",VAE);
12 I2=VAE/(8*R); //current I2 in ampere
13 VAB=I2*R13; //voltage across R13 in volt
14 Vp1=VAB/l; // slide wire voltage per unit length in
  volt/meter
15 printf("instrument resolution=(+/-)%0.1f mV",Vp1)
16 //result
17 //Maximum measurable voltage=1.6 V
18 //instrument resolution=(+/-)0.2 mV
```

Chapter 16

Laboratory power supplies

Scilab code Exa 16.1 load effects and line regulation

```
1 //to find the source & load effects and load & line
  regulation
2 // example 16-1 in page 423
3 clc;
4 //Data Given
5 Es=[12 11.95]; // change in Dc power supply when ac
  drops by 10%
6 Eo=[12 11.9]; // change in output voltage when load
  current goes from zero to maximum
7 //calculation
8 printf("source effect=%d mV\n", (Es(1)-Es(2))*1000);
9 printf("line regulation=%0.2f percent\n", (Es(1)-Es(2)
  )*100/Es(1));
10 printf("load effect=%d mV\n", (Eo(1)-Eo(2))*1000);
11 printf("line regulation=%0.2f percent\n", (Eo(1)-Eo(2)
  )*100/Eo(1));
12 //result
13 //source effect=50 mV
14 //line regulation=0.42 percent
```



```
15 //load effect=99 mV
16 //line regulation=0.83 percent
```

Scilab code Exa 16.2 maximum and minimum output voltage

```
1 // to find the maximum and minimum output voltages
  in the fig 16-8(b)
2 // example 16-2 in page 428
3 clc;
4 //Data given
5 Vz=6; R=1000*[0 5.6 5.6 3]; // zener voltage and the
  resistance values
6 A=['when the moving contact is at the bottom of R4'
    '0' '0' 'when the moving contact is at the top of
    R4'];
7 //calculation
8 for n=1:3:4
9     I3=Vz/(R(3)+R(n));
10    Eo=I3*sum(R);
11    printf("%s, Eo=%0.1 f V\n", A(n), Eo);
12 end
13 //result
14 //when the moving contact is at the bottom of R4, Eo
  =15.2 V
15 //when the moving contact is at the top of R4, Eo=9.9
  V
```

This code can be downloaded from the website www.scilab.in