Scilab Textbook Companion for Operational Amplifiers And Linear Integrated Circuits by R. F. Coughlin And F. F. Driscoll[1]

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Book Description

Title: Operational Amplifiers And Linear Integrated Circuits

Author: R. F. Coughlin And F. F. Driscoll

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

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

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

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

Contents

List of Scilab Codes

Chapter 2

First Experiences with an opamp

Scilab code Exa 2.1 ProbOnOutputvoltage

```
1 //Chapter 2
2 //Example 2-1
3 //ProbOnOutputvoltage
4 //Page 19, figure 2-3
5 clear;clc;
6 //Given
7 Vplus=15;Vminus=-15;Vsatp=13;Vsatm=-13;//All in
     Volts
8 Aol=200000;//gain
9 //Example 2-1(a)
10 Vam=-10*(10^-6);//voltage at minus input
11 Vap=-15*(10^-6);//voltage at plus input
12 Ed1=Vap-Vam;//Differential Input Voltage
13 Vout1=Ed1*Aol;//Output Voltage
14 format(10);
15 if(Vout1>15) then
16   disp("Value of o/p voltage1 = 13.0000V") //
       positive saturation voltage
17 elseif(Vout1<-15) then
```

```
18    disp("Value of o/p voltage1 = -13.0000V")//
        negative saturation voltage
19  else
20    printf("\n\n Value of o/p voltage1 = %.4f V \n\n"
        ,Vout1)
21  end
22
23  //Example 2-1(b)
24  Vbm=-10*(10^-6);//voltage at minus input
25  Vbp=+15*(10^-6);//voltage at plus input
26  Ed2=Vbp-Vbm;//Differential Input Voltage
27  Vout2=Ed2*Aol;//Output Voltage
28  format(10);
29  if(Vout2>15) then
30    disp("Value of o/p voltage2 = 13.0000V")//positive
        saturation voltage
31  elseif(Vout2<-15) then
32    disp("Value of o/p voltage2 = -13.0000V")//
        negative saturation voltage
33  else
34    printf("\n\n Value of o/p voltage2 = %.4f V \n\n"
        ,Vout2)
35  end
36
37  //Example 2-1(c)
38  Vcm=-10*(10^-6);//voltage at minus input
39  Vcp=-5*(10^-6);//voltage at plus input
40  Ed3=Vcp-Vcm;//Differential Input Voltage
41  Vout3=Ed3*Aol;//Output Voltage
42  format(10);
43  if(Vout3>15) then
44    disp("Value of o/p voltage3 = 13.0000V")//positive
        saturation voltage
45  elseif(Vout3<-15) then
46    disp("Value of o/p voltage3 = -13.0000V")//
        negative saturation voltage
47  else
48    printf("\n\n Value of o/p voltage3 = %.4f V \n\n"
```

```
      ,Vout3)
end

//Example 2-1(d)
Vdm=+1.000001;//voltage at minus input
Vdp=+1.000000;//voltage at plus input
Ed4=Vdp-Vdm;//Differential Input Voltage
Vout4=Ed4*Aol;//Output Voltage
format(10);
if(Vout4>15) then
  disp("Value of o/p voltage4 = 13.0000V")//positive
      saturation voltage
elseif(Vout4<-15) then
  disp("Value of o/p voltage4 = -13.0000V")//
     negative saturation voltage
else
  printf("\n\n Value of o/p voltage4 = %.4f V \n\n"
     ,Vout4)
end

//Example 2-1(e)
Vem=+5*(10^-3);//voltage at minus input
Vep=0;//voltage at plus input
Ed5=Vep-Vem;//Differential Input Voltage
Vout5=Ed5*Aol;//Output Voltage
format(10);
if(Vout5>15) then
  disp("Value of o/p voltage5 = 13.0000V")//positive
      saturation voltage
elseif(Vout5<-15) then
  disp("Value of o/p voltage5 = -13.0000V")//
     negative saturation voltage
else
  printf("\n\n Value of o/p voltage5 = %.4f V \n\n"
     ,Vout5)
end

//Example 2-1(f)
```

```
80 Vfm=0;//voltage at minus input
81 Vfp=+5*(10^-3);//voltage at plus input
82 Ed6=Vfp-Vfm;//Differential Input Voltage
83 Vout6=Ed6*Aol;//Output Voltage
84 format(10);
85 if(Vout6>15) then
86   disp("Value of o/p voltage6 = 13.0000V")//positive
       saturation voltage
87 elseif(Vout6<-15) then
88   disp("Value of o/p voltage6 = -13.0000V")//
       negative saturation voltage
89 else
90   printf("\n\n Value of o/p voltage6 = %.4f V \n\n"
       ,Vout6)
91 end
```

Scilab code Exa 2.2 ProbOnPWM

```
1 //Chapter 2
2 //Example 2-2
3 //ProbOnPWM
4 //Page 34
5 clear;clc;
6 //Given
7 f=50;//in Hz
8 Vtemp=4; //input signal in volts
9 Ecm=10; //maximum peak voltage of sawtooth carrier
     wave in volts
10
11 //Example 2-2(a)
12 T=1/f;
13 Th=(Vtemp*T)/Ecm;//High time in seconds
14 printf("\n\n High Time = %.4f s \n\n",Th)
```

```
15
16 //Example 2-2(b)
17 d=(Th/T)*100;//duty cycle in percentage
18 printf("\n\n Duty cycle = %.4f percent \n\n",d)
```

Scilab code Exa 2.3 ProbOnHighTime

```
1 //Chapter 2
2 //Example 2-3
3 //ProbOnHighTime
4 //Page 34,35,figure 2-16(d)
5 clear;clc;
6 //Given
7 Vtemp=4;//in volts
8 Ecm=5;//maximum peak voltage of a sawtooth carrier
     wave
9 T=0.01;//in seconds
10 //calculate
11 Th=T*(1-(Vtemp/Ecm));//High Time
12 printf("\n\n High Time = %.4f s \n\n",Th)
```

Chapter 3

Inverting and Noninverting Amplifiers

Scilab code Exa 3.1 ProbOnOpampDescriptions

```
1 //Chapter 3
2 //Example 3-1
3 //ProbOnOpampDescriptions
4 //Page 46,47 figure 3-1
5 clear;clc;
6 //Given
7 Rf=100*(10^3);//Feedback Resistance in ohms
8 Ri=10*(10^3);//Input Resistance in ohms
9 Ei=1;//Input volts
10 //Calculate
11 //Example 3-1(a)
12 I=Ei/Ri;//Equation for current through Rf
13 printf("\n\n Current through Rf = %.4f A \n\n",I)
14 //Example 3-1(b)
15 Vout=-(Rf/Ri)*Ei;//Equation for Output Voltage
16 printf("\n\n Value of output voltage = %.4f V \n\n"
   ,Vout)
17 //Example 3-1(c)
18 Acl=-(Rf/Ri);//Closed loop gain of the amplifier
```

```
19 printf("\n\n Value of closed loop gain = %.4f \n\n"
   ,Acl)
```

Scilab code Exa 3.2 ProbOnCurrentinOpamp

```
1  //Chapter 3
2  //Example 3-2
3  //ProbOnCurrentinOpamp
4  //Page 47,figure 3-2
5  clear;clc;
6  //Given
7  Vout=10;//output voltage
8  I=0.1*(10^-3);//current through Rf in amperes
9  Rl=25*(10^3);//Load resistance in ohms
10 //Calculate
11 //Example 3-1(a)
12 Il=Vout/Rl;
13 printf("\n\n Value of load current = %.4f A \n\n",
   Il)
14 //Example 3-1(b)
15 Iout=I+Il;
16 printf("\n\n Total current into the output pin of
   the opamp = %.4f A \n\n",Iout)
17 printf("\n\n The input resistance seen by Ei is Ri.
   In order to keep input resistance of the circuit
   high. Ri should be equal to or greater than 10
   KiloOhm")
```

Scilab code Exa 3.3 ProbOnOpampParameters

```
1  //Chapter 3
2  //Example 3-3
3  //ProbOnOpampParameters
4  //Page 48,49,figure 3-2
5  clear;clc;
6  //Given
7  Rf=250*(10^3);//Feedback Resistance in Ohms
8  Ri=10*(10^3);//Input Resistance in Ohms
9  Ei=0.5;//Input voltage
10 //Calculate
11 //Example 3-3(a)
12 I=Ei/(Ri);
13 printf("\n\n Value of current through Rf = %.6f A \
       n\n",I)
14 //Example 3-3(b)
15 VRf=I*Rf;
16 printf("\n\n Voltage through Rf = %.4f V \n\n",VRf)
17 //Example 3-3(c)
18 Ei1=-0.5;
19 Vout=-(Rf/Ri)*Ei1;
20 printf("\n\n Output Voltage = %.4f V \n\n",Vout)
21 printf("\n\n Thus the magnitude of the output
       voltage does equal the voltage across Rf and Acl
       =-25")
```

Scilab code Exa 3.4 ProbOnOpampResistance

```
1  //Chapter 3
2  //Example 3-4
3  //ProbOnOpampResistance
4  //Page 49
5  clear;clc;
6  //Given
```

```
7 Vout=12.5;//in volts
8 Il=2*10^-3;//in amperes
9 Rl=Vout/Il;//Load resistance in ohm
10 //example 3-4(a)
11 printf("\n\n Value of Load Resistance = %.8f ohm \n
    \n",Rl)
12 //example 3-4(b)
13 I=0.05*10^-3;
14 Iout=I+Il;
15 printf("\n\n Value of output current = %.8f amp \n\
    n",Iout)
16 //example 3-4(c)
17 printf("\n\n The circuit input resistance is Rl=10
    Kohm")
```

Scilab code Exa 3.5 ProbOnVoltageGain

```
1 //Chapter 3
2 //Example 3-5
3 //ProbOnVoltageGain
4 //Page 50,figure 3-3
5 clear;clc;
6 //Given
7 Rf=20*10^3;
8 Ri=10*10^3;
9 Acl=-(Rf/Ri);//Voltage Gain
10 printf("\n\n Value of Voltage Gain = %.6f \n\n",
    Acl)
```

Scilab code Exa 3.6 ProbonOutputVoltage

```
1 //Chapter 3
2 //Example 3-6
3 //ProbonOutputVoltage
4 //Page 51
5 clear;clc;
6 Ei=-5;//input voltage
7 Acl=-2;//Voltage Gain
8 Vout=Ei*Acl;//output voltage
9 printf("\n\n Value of Output Voltage = %.4f V \n\n"
    ,Vout)
```

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

Scilab code Exa 3.7 ProbOnOutputvoltage

```
1 //Chapter 3
2 //Example 3-7
3 //ProbOnO/Pvoltage
4 //Page 51
5 clear;clc;
6 Ri=10*10^3;//input resistance in ohm
7 Gain= 25;
8 Rf=Gain*Ri;//feedback resistance in ohm
9 printf("\n\n Value of Rf = %.4f ohm \n\n",Rf)
10 xcos('Figure3_7.xcos');
```

Scilab code Exa 3.8 ProbOnOutputvoltage

```
1 //Chapter 3
2 //Example 3-8
3 //ProbOnO/Pvoltage
4 //Page 52,Figure 3-4
5 clear;clc;
6 //Given
7 E1=2;E2=3;E3=1;//input voltage
8 R=10*10^3;//in ohm
9 Vout=-(E1+E2+E3);
10 printf("\n\n Value of o/p voltage = %.4f V \n\n",
   Vout)
```

Scilab code Exa 3.9 ProbOnOutputvoltage

```
1 //Chapter 3
2 //Example 3-9
3 //ProbOnO/Pvoltage
4 //Page 53,Figure 3-4
5 clear;clc;
6 //Given
7 E1=2;E2=3;E3=-1;//input voltage
8 R=10*10^3;//in ohm
9 Vout=-(E1+E2+E3);
10 printf("\n\n Value of o/p voltage = %.4f V \n\n",
   Vout)
```

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

Scilab code Exa 3.10 ProbOnDCVoltage

```
1  //Chapter 3
2  //Example 3-10
3  //ProbOnDCVoltage
4  //Page 53,54
5  clear;clc;
6  xcos('Figure3_10.xcos');
7  //Figure 3-5(b)
8  x=[0 1 2]
9  y=[-5,5,-5]
10 subplot(2,2,1)
11 a=gca()
12 a.thickness = 1;
13 a.x_location = 'middle';
14 plot2d(x,y,style=3,rect=[0,-5,2,5])
15 xtitle ( " Eac Vs t " , " t(ms) " , " Eac(V) " );
16 subplot(2,2,2)
17 x1=[0 0.5 1 1.5 2]
18 y1=[10 5 0 5 10]
19 a=gca()
20 a.thickness = 1;
21 a.x_location = 'middle';
22 plot2d(x1,y1,style=3,rect=[0,-15,2,15])
23 xtitle ("Edc Vs t" , " t(ms)", " Edc(V)");
24 y2=[5 0 -5 0 5]
25 y3=[-2.5 -7 -12.5 -7 -2.5]
26 plot2d(x1,y2,style=2)
27 plot2d(x1,y3,style=1)
```

```
28 legend ( " Edc= - 5 V " , " Edc= 0 V ", " Edc= 7 V"
   );
29 xtitle (" Waveshapes of Vo for Edc = 0V, -5V , 7V")
30 //Figure 3-5(c)
31 subplot(2,2,3)
32 x4=[-5 0 5]
33 y4=[10 5 0]
34 y5=[5 0 -5]
35 y6=[-2.5 -7.5 -12.5]
36 a=gca()
37 a.thickness = 1;
38 a.y_location = 'middle';
39 a.x_location = 'middle';
40 plot2d(x4,y4,style=3,rect=[-5,-15,5,15])
41 plot2d(x4,y5,style=2,rect=[-5,-15,5,15])
42 plot2d(x4,y6,style=1,rect=[-5,-15,5,15])
43 legend ( " Edc= - 5 V " , " Edc= 0 V ", " Edc= 7 V"
   );
44 xtitle (" Vo Vs Eac " , " Eac(V)", " Vo ");
45 xtitle (" Output-Input Characteristic")
46 printf("\n\n If Edc = 0 V , Eac appears inverted at
   Vo ( Gain is -1 )")
47 printf("\n\n If Edc = - 5 V , Eac appears at the
   output as a 5 V dc-offset voltage upon which
   rides the inverted Eac ")
48 printf("\n\n If Edc = 7 V , then Eac shifts down by
   7 V ")
```

Scilab code Exa 3.11 ProbonThreeChannelInvertingAmplifier

```
1 //Chapter 3
2 //Example 3-11
3 //ProbonThreeChannelInvertingAmplifier
```

```
4 //Page 56
5 clear;clc;
6 //Channel 1
7 Ri= 10*10^3;//Choosing Input resistance
8 Acl = -10 ;
9 Rf1 = - (Acl * Ri);
10 printf("\n\n Value of Rf1 = %.4f ohm \n\n",Rf1)
11 //Channel 2
12 Acl1 = -5;
13 Rf2 = - (Acl1 * Ri);
14 printf("\n\n Value of Rf2 = %.4f ohm \n\n",Rf2)
15 //channel 3
16 Acl2 = -2;
17 Rf3 = - (Acl2 * Ri);
18 printf("\n\n Value of Rf3 = %.4f ohm \n\n",Rf3)
```

Scilab code Exa 3.12 ProbOnOutputvoltage

```
1 //Chapter 3
2 //Example 3-12
3 //ProbOnOutputvoltage
4 //Page 57
5 clear;clc;
6 //Given
7 R1=100000;R2=100000;R3=100000;R=100000//in ohm
8 Rf=33*10^3;//in ohm
9 E1=5;E2=5;E3=-1;//in volts
10 n=3;//number of inputs
11 Vout=-(E1+E2+E3)/n;//output voltage
12 printf("\n\n Value of output voltage = %.4f V \n\n"
   ,Vout)
```

Scilab code Exa 3.13 ProbOnOpampParameters

```
1 //Chapter 3
2 //Example 3-13
3 //ProbOnOpampParameters
4 //Page 58,Figure 3-8
5 clear;clc;
6 //Given
7 Ei=4;//in volts
8 Rl=10*10^3;//in ohm
9 I=0;//in ampere
10 Vout=Ei;//output voltage
11 Il=Vout/Rl;//load current
12 I0=I+Il;//output current
13 printf("\n\n Value of o/p voltage = %.4f V \n\n",
   Vout)
14 printf("\n\n Value of load current = %.4f A \n\n",
   Il)
15 printf("\n\n Value of output current = %.4f A \n\n"
   ,I0)
```

Scilab code Exa 3.14 ProbOnVoltageGain

```
1 //Chapter 3
2 //Example 3-14
3 //ProbOnVoltageGain
4 //Page 62,63, Figure 3-11
5 clear;clc;
```

```
6  //Given
7  Rf = 40*10^3;
8  R1 = 10*10^3;
9  //Example 3-14(a)
10 Acl = (Rf + R1)/R1;
11 printf("\n\n Value of Voltage Gain = %.4f \n\n",Acl
       )
12 //Example 3-14(b)
13 x=[0 2.5 5 7.5 10]
14 y=[-2 0 2 0 -2]
15 subplot(2,2,1)
16 a=gca()
17 a.thickness = 1;
18 a.x_location = 'middle';
19 plot2d(x,y,style=3,rect=[0,-2,10,2])
20 xtitle ( " Ei Vs t " , " t(ms) " , " Ei(V) " );
21 subplot(2,2,2)
22 x1=[0 2.5 5 7.5 10]
23 y1=[-10 0 10 0 -10]
24 x2=[0 2.5 5 7.5 10]
25 y2=[-2 0 2 0 -2]
26 a=gca()
27 a.thickness = 1;
28 a.x_location = 'middle';
29 plot2d(x1,y1,style=3,rect=[0,-15,10,15])
30 plot2d(x2,y2,style=1)
31 xtitle ( " Vo Vs t " , " t(ms) " , " Vo and Ei " );
32 legend ( " Vo Vs t " , " Ei Vs t ");
33 xtitle ( " CRO waveshape of Vo and Ei Vs t ")
34 subplot(2,2,3)
35 //Example 3-14(c)
36 x=[-2 -1 0 1 2]
37 y=[-10 -5 0 5 10]
38 a=gca()
39 a.thickness = 1;
40 a.x_location = 'middle';
41 a.y_location = 'middle';
42 plot2d(x,y,style=3,rect=[-2,-15,2,15])
```

```
43 xtitle ( " Vo Vs Ei  " , " Ei(V) " , "Vo(V) " );
44 legend ( " Slope = +5 ");
45 xtitle ( "Input-output characteristic of a
     noninverting Amplifier")
```

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

Scilab code Exa 3.15 DesignAnAmplifier

```
1 //Chapter 3
2 //Example 3-15
3 //DesignAnAmplifier
4 //Page 64
5 clear;clc;
6 //Given
7 Acl = 10;// Gain is positive, so choose noninvering
     amplifier
8 R1 = 10*10^3;
9 Rf = (Acl*R1)-R1;
10 printf("\n\n Value of Rf = %.4f ohm \n\n",Rf)
11 xcos('Figure3_15.xcos')//Design will be as shown in
     the figure
```

Scilab code Exa 3.16 ProbOnServoAmplifier

```
1 //Chapter 3
2 //Example 3-16
3 //ProbOnServoAmplifier
```

```
4 //Page 72
5 clear;clc;
6 //Given
7 Ei=2;//in volts
8 Vf=Ei;//feedback voltage
9 Vout=2*Vf;//output voltage
10 Vr=-Vout;//Reference voltage
11 Vcap=3*Ei;//capacitor voltage
12 printf("\n\n Value of feedback voltage = %.4f V \n\
   n",Vf)
13 printf("\n\n Value of output voltage = %.4f V \n\n"
   ,Vout)
14 printf("\n\n Value of reference voltage = %.4f V \n
   \n",Vr)
15 printf("\n\n Value of capacitor voltage = %.4f V \n
   \n",Vcap)
```

Scilab code Exa 3.17 ProbOnEquilibriumVoltage

```
1 //Chapter 3
2 //Example 3-17
3 //ProbOnEquilibriumVoltage
4 //Page 72
5 clear;clc;
6 //Given
7 Ei=4;//in volts
8 Vf=Ei;//feedback voltage
9 Vout=2*Vf;//output voltage
10 Vr=-Vout;//Reference voltage
11 Vcap=3*Ei;//capacitor voltage
12 printf("\n\n Value of feedback voltage = %.4f V \n\
   n",Vf)
13 printf("\n\n Value of output voltage = %.4f V \n\n"
```

```
    ,Vout)
14 printf("\n\n Value of reference voltage = %.4f V \n
    \n",Vr)
15 printf("\n\n Value of capacitor voltage = %.4f V \n
    \n",Vcap)
```

Scilab code Exa 3.18 ProbOnEquilibriumTime

```
1  //Chapter 3
2  //Example 3-18
3  //ProbOnEquilibriumTime
4  //Page 73,Figure 3-17
5  clear;clc;
6  //Given
7  Ri=10^5;//in ohm
8  C=10^-6;//in farad
9  T=3*Ri*C;//Time constant
10 ETime=5*T;//equilibrium time
11 printf("\n\n Value of Equilibrium Time = %.4f s \n\
    n",ETime)
```

Chapter 4

Comparators and Controls

Scilab code Exa 4.1 ProbOnThresholdVoltage

```
1 //Chapter 4
2 //Example 4-1
3 //ProbOnThresholdVoltage
4 //Page 90
5 clear;clc;
6 //Given
7 Vsat = 14;//Saturation Voltage
8 R1 = 1000; R2 = 100 ; //Load resistances
9 Vut = (R2/(R1*R2))*Vsat;
10 printf("\n\n Value of Upper Threshold Voltage = %.6
   f V \n\n",Vut)
```

Scilab code Exa 4.2 ProbOnLowerThresholdVoltage

```
1 //Chapter 4
2 //Example 4-2
3 //ProbOnLowerThresholdVoltage
```

```
4 //Page 91
5 clear;clc;
6 //Given
7 Vsat = -13;//Saturation Voltage
8 R1 = 1000; R2 = 100 ; //Load resistances
9 Vlt = (R2/(R1*R2))*Vsat;
10 printf("\n\n Value of Lower Threshold Voltage = %.6
   f V \n\n",Vlt)
```

Scilab code Exa 4.3 ProbOnOutputvoltage

```
1 //Chapter 4
2 //Example 4-3
3 //ProbOnOutputVoltage
4 //Page 91,Figure 4-4
5 clear;clc;
6 printf ("\n\n The dashed lines drawn on Ei in thew
   figure locate Vut and Vlt.\n\n At time t=0, Ei is
    below Vlt, so Vo is at +Vsat. When Ei goes above
    Vut, at times (a) and (c), Vo switches quickly
   to -Vsat. \n\nWhen Ei again goes below Vlt, at
   times (b) and (d), Vo switches quickly to +Vsat.
   \n\nObserve how positive feedback has eliminated
   the false crossings ")
```

Scilab code Exa 4.4 DesignUsingVutAndVlt

```
1 //Chapter 4
2 //Example 4-4
```

```
3 //DesignUsingVutAndVlt
4 //Page 96
5 clear;clc;
6 //Given
7 Vut = 12 ; Vlt = 8 ; //Upper and Lower Threshold
     Voltages
8 Vsatp = 15 ; Vsatm = -15 ;// Saturation Voltages
9 R = 10*10^3 ;//Choosing R
10 //Design
11 Vh = Vut - Vlt ; // Hysteresis Voltage
12 Vctr = (Vut + Vlt)/2;//Center Voltage
13 n = (Vsatp - Vsatm)/Vh ; // Resistor Factor
14 Vref = Vctr / (1 + (1/n)); //Reference Voltage
15 Resistance = n * R;
16 printf ( "\n\n Hysteresis Voltage = %.4f V \n\n",Vh
     )
17 printf ( "\n\n Center Voltage = %.4f V \n\n", Vctr )
18 printf ( "\n\n Resistor Factor = %.4f \n\n" , n )
19 printf ( "\n\n Reference Voltage = %.4f \n\n", Vref)
20 printf ( "\n\n Feedback resistor = %.4f \n\n",
     Resistance)
```

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

Scilab code Exa 4.5 designInvertingVoltageDetector

```
1 //Chapter 4
2 //Example 4-5
3 //designInvertingVoltageDetector
4 //Page 97
5 clear;clc;
6 //Given
```

```
Vsatp = 15 ; Vsatm = -15 ;// Saturation Voltages
Vh = 4 ; //Hysteresis Voltage
Vctr = 10 ; //Center voltage
n = ((Vsatp - Vsatm)/Vh)-1 ;
R = 10*10^3 ;//Input Resistance
Vref = ((n + 1)*(Vctr))/n ; // Reference Voltage
Resistance = n * R // Feedback Resistance
printf (" \n\n Resistance Factor = %.4f ", n)
printf (" \n\n Reference Voltage = %.4f ", Vref)
printf (" \n\n Feedback Resistance = %.4f ",
   Resistance)
xcos('Figure4_5.xcos');
```

Scilab code Exa 4.6 DesignOnInvertingVoltageLevelDetector

```
//Chapter 4
//Example 4-6
//DesignOnInvertingVoltageLevelDetector
//Page 100
clear;clc;
//Given
Vut = 13.5 ; Vlt = 10.5 ; //Upper and Lower
   Threshold Voltages
Vref = -15 ; // Reference Voltage
Vsatp = 13 ; Vsatm = -13;//Saturation Voltages
R = 10*10^3 ; // Input Resistance
Vctr = (Vut + Vlt)/2;
Vh = Vut - Vlt ;
m = -(Vref / Vctr);
Resistance = m * R ;
n = (Vsatp-Vsatm)/Vh ;
Resistance1 = n * R ;
printf (" \n\n Hysteresis Voltage = %.4f ", Vh )
```

```
18 printf (" \n\n Center Voltage = %.4f ", Vctr )
19 printf (" \n\n Resistor mR = %.4f ", Resistance)
20 printf (" \n\n Resistor nR = %.4f ", Resistance1)
```

Chapter 5

Selected Applications of Opamp

Scilab code Exa 5.1 ProbOnMeterCurrent

```
1 //Chapter 5
2 //Example 5-1
3 //ProbOnMeterCurrent
4 //Page 121,122, Figure 5-1
5 clear;clc;
6 //Given
7 Ei = 0.5;//Input voltage
8 Ri = 1*10^3;//Input resistance in ohm
9 Im = Ei / Ri ;//Meter Current
10 printf (" \n\n Meter Current = %.4f ", Im )
```

Scilab code Exa 5.2 ProbOnInputResistance

```
1 //Chapter 5
2 //Example 5-2
3 //ProbOnInputResistance
4 //Page 121,122, Figure  5-1
```

```
clear;clc;
//Given
Efs = 5 ;//Full scale Voltage
Ifs = 50*10^-6;//Full scale Meter Current
Ri = Efs / Ifs ;// Input Resistance
printf ( "\n\n Input Resistance = %.4f ", Ri )
```

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

Scilab code Exa 5.3 DesignASimpleSwitchArrangement

```
//Chapter 5
//Example 5-3
//DesignASimpleSwitchArrangement
//Page 124
clear;clc;
//Given
Edc = 5 ; Erms = 5 ; Epeak = 5 ; Eptop = 5 ;//
   Voltages of meters
Ifs = 50*10^-6 ; // Full scale Meter Current
Ri1 = Edc / Ifs ; // DC Voltmeter
Ri2 = 0.90 * (Erms / Ifs );// Rms ac voltmeter (
   Sine wave only )
Ri3 = 0.636 * (Epeak / Ifs );//Peak Reading
   Voltmeter ( Sine wave only )
Ri4 = 0.318 * (Eptop / Ifs );//Peak-to-Peak ac
   Voltmeter(sine wave only)
printf ( "\n\n Ri1 = %.4f ohm", Ri1 )
printf ( "\n\n Ri2 = %.4f ohm", Ri2 )
printf ( "\n\n Ri3 = %.4f ohm", Ri3 )
printf ( "\n\n Ri4 = %.4f ohm", Ri4 )
xcos ('Figure5_3.xcos')
```

Scilab code Exa 5.4 ProbOnZenerCurrentAndVoltage

```
1 //Chapter 5
2 //Example 5-4
3 //ProbOnZenerCurrentAndVoltage
4 //Page 125,126, Figure 5-3(a)
5 clear;clc;
6 //Given
7 Vo = 10.3 ; //Voltage across the load resistor
8 Ei = 5 ; //Input voltage
9 Ri = 1*10^3 ; //Input Resistance
10 //Example 5-4(a)
11 I = Ei / Ri ; //Zener Current
12 printf ( "\n\n Zener Current = %.4f A", I )
13 //Example 5-4(b)
14 Vt = Vo - Ei ; //Zener Voltage
15 printf ( "\n\n Zener Voltage = %.4f V", Vt )
```

Scilab code Exa 5.5 ProbOnOpampParameters

```
1 //Chapter 5
2 //Example 5-5
3 //ProbOnOpampParameters
4 //Page 126, Figure 5-3(b)
5 clear;clc;
6 //Given
7 Ei = 1 ; //Reference voltage
```

```
Ri = 1*10^3 ; //Input Resistance
Vo = 0.6 ; //Outpur Voltage
//example 5-5(a)
I = Ei / Ri ; //Diode Current
printf ( "\n\n Diode Current = %.4f A ", I )
//example 5-5(b)
Vdiode = Vo ;
printf ( "\n\n Voltage drop across the diode = %.4f
   V ", Vdiode )
```

Scilab code Exa 5.6 ProbOnOpampParameters

```
//Chapter 5
//Example 5-6
//ProbOnOpampParameters
//Page 128,129, Figure 5-5
clear;clc;
//Given
R = 10*10^3 ; //Resistance
E2 = 0 ; //Source across negative terminal
Rl = 5*10^3 ; // Load Resistance
E1 = 5 ; // source across positive terminal
//example 5-6(a)
Il = (E1 - E2)/R ; //Load Current
printf ("\n\n Load current across Rl = %.4f A " , Il
    )
//example 5-6(b)
Vl = Il * Rl ; // Voltage across Rl
printf ("\n\n Voltage across load resistance = %.4f
   V " , Vl )
//example 5-6(c)
Vo = (2*Vl)-E2 ; //Output voltage
printf ( "\n\n Output Voltage = %.4f V ", Vo )
```

Scilab code Exa 5.7 ProbOnOpampParameters

```
1 //Chapter 5
2 //Example 5-7
3 //ProbOnOpampParameters
4 //Page 128,129, Figure 5-5
5 clear;clc;
6 //Given
7 R = 10*10^3 ; //Resistance
8 E2 = 5 ; //Source across negative terminal
9 Rl = 5*10^3 ; // Load Resistance
10 E1 = 0 ; // source across positive terminal
11 //example 5-6(a)
12 Il = (E1 - E2)/R ; //Load Current
13 printf ("\n\n Load current across Rl = %.4f A " , Il
     )
14 //example 5-6(b)
15 Vl = Il * Rl ; // Voltage across Rl
16 printf ("\n\n Voltage across load resistance = %.4f
    V " , Vl )
17 //example 5-6(c)
18 Vo = (2*Vl)-E2 ; //Output voltage
19 printf ( "\n\n Output Voltage = %.4f V ", Vo )
20 printf ( "\n\n Vl and Il are reversed in polarity
    and direction respectively from example 5-6. If
    the polarity of E2 is reversed , Il and Vl change
     sign but not magnitude ")
```

Scilab code Exa 5.8 ProbOnShortCircuitCurrent

```
1 //Chapter 5
2 //Example 5-8
3 //ProbOnShortCircuitCurrent
4 //Page 133,134, Figure 5-8(c)
5 clear;clc;
6 //Given
7 Vo = 5 ;//Output Voltage
8 Rf = 100*10^3 ; //Feedback Resistance
9 Isc = Vo / Rf ; //Short Circuit Current
10 printf ( "\n\n Short Circuit Current = %.7f A " ,
     Isc )
```

Scilab code Exa 5.9 ProbOnPhotoDetectors

```
1 //Chapter 5
2 //Example 5-9
3 //ProbOnPhotoDetectors
4 //Page 134,135, Figure 5-9
5 clear;clc;
6 //Given
7 Rf = 10*10^3 ;//Feedback Resistance
8 I = 10*10^-6 ; //Current through Photo Detector
9 //example 5-9(a)
10 Vo = Rf * I ;//Vo for Dark Condition
11 printf ( "\n\n Output Voltage for dark Condition = %
     .4f V ", Vo )
12 //example 5-9(b)
13 I1 = 1*10^-3 ; //Current in presence of sunlight
14 Vo1 = Rf * I1 ; //output voltage in light condition
15 printf ( "\n\n Output voltage in light condition = %
     .4f V ", Vo1 )
```

Scilab code Exa 5.10 ProbOnPhotoDetector

```
1 //Chapter 5
2 //Example 5-10
3 //ProbOnPhotoDetector
4 //Page 134,135, Figure 5-9
5 clear;clc;
6 //Given
7 Rf = 100*10^3 ;//Feedback Resistance
8 //example 5-10(a)
9 Il1 = 1*10^-6 ; //Load current 1
10 Vo1 = Rf * Il1 ; //Output voltage in photo detector
11 printf ( "\n\n Output Voltage in photo detector for
     Il1 = %.4f V ",Vo1 )
12 //example 5-10(b)
13 Il2 = 50*10^-6 ; // Load current 2
14 Vo2 = Rf * Il2 ; //Output Voltage in photo detector
15 printf ( "\n\n Output Voltage in photo detector for
     Il2 = %.4f V ",Vo2 )
```

Scilab code Exa 5.11 ProbOnOpticalCoupler

```
1 //Chapter 5
2 //Example 5-11
3 //ProbOnOpticalCoupler
4 //Page 136, Figure 5-10
5 clear;clc;
```

```
6 //Given
7 R = 1*10^3;
8 R1 = 99*10^3 ;
9 m = R1 / R ; //multiplier
10 Isc = 10*10^-6; //Current on short-circuit condition
11 Il = (1 + m)*Isc ;
12 printf ( "\n\n Load current = %.4f A ", Il)
```

Scilab code Exa 5.12 ProbonCurrentDivider

```
1 //Chapter 5
2 //Example 5-12
3 //ProbonCurrentDivider
4 //Page 138, Figure 5-12
5 clear;clc;
6 //Given
7 Im = 100*10^-6;//Meter current
8 Isc = 0.5;// Current in short-circuit condition
9 Rf = 20 ; // Feedback resistance
10 Rm = 0.8*10^3 ; //Meter resistance
11 d = Isc / Im ;//Current divider
12 R1 = d * Rf ;
13 Rscale = R1 - Rm ;
14 printf ( "\n\n Resistance dRf = %.4f ohm ", R1 )
15 printf ( "\n\n Rscale = %.4f ohm ", Rscale )
```

Scilab code Exa 5.13 ProbOnPhaseShifter

```
1 //Chapter 5
```

```
2 //Example 5-13
3 //ProbOnPhaseShifter
4 //Page 140, Figure 5-13(b)
5 clear;clc;
6 //Given
7 f = 10^3 ; //Frequency of Ei in Hz
8 Ci = 0.01*10^-6 ;
9 m = tan(%pi/4);
10 Ri = m / (2*%pi*f*Ci);
11 printf ("\n\n Value of Ri = %.4f ohm ", Ri )
```

Scilab code Exa 5.14 ProbOnPhaseAngle

```
1 //Chapter 5
2 //Example 5-14
3 //ProbOnPhaseAngle
4 //Page 140, Figure 5-13(b)
5 clear;clc;
6 //Given
7 f = 10^3 ;
8 Ri = 100*10^3 ;
9 Ci = 0.01*10^-6;
10 phaseangle = 2*atan(2*%pi*f*Ri*Ci);
11 printf ("\n\n Phase angle = %.4f radians ",
   phaseangle)
```

Chapter 6

Signal Generators

Scilab code Exa 6.1 ProbOnThresholdVoltage

```
1 //Chapter 6
2 //Example 6-1
3 //ProbOnThresholdVoltage
4 //Page 149,151, Figure 6-1
5 clear;clc;
6 //Given
7 R1 = 100*10^3 ;
8 R2 = 86*10^3 ;
9 Vsatp = 15 ; Vsatm = -15 ;//Saturation voltages
10 Vut = (R2 * Vsatp)/(R1 + R2);
11 Vlt = (R2 * Vsatm)/(R1 + R2);
12 printf ( "\n\n Upper Threshold Voltage = %.4f V ",
   Vut )
13 printf ( "\n\n Lower Threshold Voltage = %.4f V ",
   Vlt )
```

Scilab code Exa 6.2 ProbOnMultivibrator

```
1 //Chapter 6
2 //Example 6-2
3 //ProbOnMultivibrator
4 //Page 151
5 clear;clc;
6 //Given
7 Rf = 100*10^3;//Feedback Resistance
8 C = 0.1*10^-6 ;
9 T = 2 * Rf * C;
10 printf ("\n\n Period = %.4f sec ", T )
```

Scilab code Exa 6.3 ProbOnFrequency

```
1 //Chapter 6
2 //Example 6-3
3 //ProbOnFrequency
4 //Page 151
5 clear;clc;
6 //Given
7 T = 20*10^-3; //Period
8 f = 1 / T;
9 printf ("\n\n Frequency = %.4f Hz ", f )
```

Scilab code Exa 6.5 ProbOnDurationOfOutputPulse

```
1 //Chapter 6
2 //Example 6-5
3 //ProbOnDurationOfOutputPulse
4 //Page 155
```

```
clear;clc;
//Given
Rf = 100*10^3 ;//Feedback Resistance
C = 0.1*10^-6 ;
t = (Rf * C)/ 5 ;
printf ( "\n\n Duration of output pulse of one-shot
   = %.4f sec ", t )
```

Scilab code Exa 6.6 ProbonTriangularGenerator

```
//Chapter 6
//Example 6-6
//ProbonTriangularGenerator
//Page 157,158, Figure 6-6
clear;clc;
//Given
Vsatm = -13.8 ;
Vut = 5 ; //Upper Threshold Voltage
R = 10*10^3 ;
f = 1000;//Frequency
C = 0.05*10^-6 ;
p = -Vsatm / Vut ;
p1 = p * R ;
Ri = p / (4*f*C);
printf ( "\n\n Value of p = %.4f ", p )
printf ( "\n\n Value of p1 = %.4f ", p1 )
printf ( "\n\n Value of Ri = %.4f ", Ri )
```

Scilab code Exa 6.7 ProbOnUnipolarTriangularWaveGenerator

```
1  //Chapter 6
2  //Example 6-7
3  //ProbOnUnipolarTriangularWaveGenerator
4  //Page 159
5  clear;clc;
6  //Given
7  p = 2.8 ;
8  Vsatm = -13.8 ;
9  Ri = 28*10^3 ;
10 C = 0.05*10^-6;
11 Vut = - ((Vsatm+0.6)/p);
12 f = p / (2*Ri*C);
13 printf ( "\n\n Peak Voltage = %.4f V ", Vut )
14 printf ( "\n\n frequency = %.4f Hz ", f )
```

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

Scilab code Exa 6.8 DesignOnSawtoothWaveGenerator

```
1  //Chapter 6
2  //Example 6-8
3  //DesignOnSawtoothWaveGenerator
4  //Page 163
5  clear;clc;
6  //Design a voltage divider to give voltage reference
       10 V
7  //Here Ri = 10 KiloOhm and C = 0.1 microfarad
8  //The Circuit will be as shown below
9  xcos('Figure6_8.xcos');
10 //Checking Frequency value
11 Ri = 10*10^3 ;
12 Ci = 0.1*10^-6 ;
```

```
13 Ei = 1 ;
14 Vref = 10 ;
15 f = Ei / (Ri*Ci*Vref) ;
16 printf ( "\n\n Frequency is %.4f Hz ", f )
```

Scilab code Exa 6.9 ProbOnFrequency

```
1 //Chapter 6
2 //Example 6-9
3 //ProbOnFrequency
4 //Page 164
5 clear;clc;
6 //Given
7 Ri = 10*10^3 ;
8 Ci = 0.1*10^-6 ;
9 Ei = 2 ;
10 Vref = 10 ;
11 f = Ei / (Ri*Ci*Vref) ;
12 printf ( "\n\n Frequency is %.4f Hz ", f )
```

Scilab code Exa 6.10 ProbOnFrequency

```
1 //Chapter 6
2 //Example 6-10
3 //ProbOnFrequency
4 //Page 164
5 clear;clc;
6 //Given
7 Ri = 10*10^3 ;
```

```
Ci = 0.1*10^-6 ;
Ei = 2 ;
Vref = 2 ;
f = Ei / (Ri*Ci*Vref) ;
printf ( "\n\n Frequency is %.4f Hz ", f )
```

Scilab code Exa 6.12 ProbOnAD639A

```
//Chapter 6
//Example 6-12
//ProbOnAD639A
//Page 170,171, Figure 6-11
clear;clc;
//Given
Ei = 1 ;
t1 = 45 ; t2 = 90 ; t3 = 225 ; t4 = 405;
Vang1 = (20*10^-3)*t1 ;//example 6-12(a)
Vang2 = (20*10^-3)*t2 ;//example 6-12(b)
Vang3 = (20*10^-3)*t3 ;//example 6-12(c)
Vang4 = (20*10^-3)*t4 ;//example 6-12(d)
Vo1 = Ei*sin(t1);//example 6-12(a)
Vo2 = Ei*sin(t2);//example 6-12(b)
Vo3 = Ei*sin(t3);//example 6-12(c)
Vo4 = Ei*sin(t4);//example 6-12(d)
printf ( "\n\n Input Voltages are %.4f,%.4f,%.4f,%.4
   f V", Vang1,Vang2,Vang3,Vang4 )
printf ( "\n\n Output Voltages are %.4f,%.4f,%.4f,%
   .4f V ", Vo1,Vo2,Vo3,Vo4 )
printf ( "\n\n Angles are in radians " )
```

Scilab code Exa 6.13 ProbOnFrequency

```
1 //Chapter 6
2 //Example 6-13
3 //ProbOnFrequency
4 //Page 173,174, Figure 6-12(a)
5 clear;clc;
6 //Given
7 R1 = 10*10^3 ;
8 R2 = 100*10^3 ;
9 C = 0.025*10^-6;
10 f1 = 1 / (4*R1*C) ;
11 f2 = 1 / (4*R2*C) ;
12 printf ( "\n\n Frequency when Ri is 10KiloOhm is %.4
     f Hz " , f1 )
13 printf ( "\n\n Frequency when Ri is 100KiloOhm is %
     .4f Hz " , f2 )
```

Chapter 7

OpAmps With Diodes

Scilab code Exa 7.1 ProbOnDeadZoneCircuit

```
1  //Chapter 7
2  //Example 7-1
3  //ProbOnDeadZoneCircuit
4  //Page 201,202, Figure 7-15
5  clear;clc;
6  V = 15 ;
7  mR = 30*10^3 ;
8  R = 10*10^3 ;
9  Ei = -10 ;
10 Vref = V / 3 ;
11 Voa = -Ei-Vref ;
12 Vob = Ei / 2 ;
13 printf ( "\n\n Values of Voa and Vob are %.4f V , %
       .4f V" , Voa, Vob)
```

Chapter 8

Differential Instrumentation and Bridge Amplifiers

Scilab code Exa 8.1 ProbOnOutputVoltage

```
1 //Chapter 8
2 //Example 8-1
3 //ProbOnOutputVoltage
4 //Page 216, Figure 8-1
5 clear;clc;
6 //Given
7 m = 100 ; //Differential Gain
8 E1 = 10*10^-3; E2 = 10*10^-3;//input voltages
9 E3 = 0*10^-3; E4 = -20*10^-3;//input voltages
10 Vout1 = (m*E1)-(m*E2);//example 8-1(a)
11 Vout2 = (m*E1)-(m*E3);//example 8-1(b)
12 Vout3 = (m*E1)-(m*E4);//example 8-1(c)
13 printf ( "\n\n Output Voltages are %.4f V, %.4f V, %
   .4f V ", Vout1,Vout2,Vout3)
```

Scilab code Exa 8.2 ProbOnDifferentialAmplifier

```
1 //Chapter 8
2 //Example 8-2
3 //ProbOnDifferentialAmplifier
4 //Page 220,221, Figure 8-5(b)
5 clear;clc;
6 //Given
7 a = 2/9 ; //Differential Gain
8 E1 = 10*10^-3; E2 = 5*10^-3; //Input Voltages
9 Vout = (E1 - E2)*(1+(2/a));
10 printf ( "\n\n output voltage = %.4f V ", Vout )
```

Scilab code Exa 8.3 ProbOnVoltageGain

```
1 //Chapter 8
2 //Example 8-3
3 //ProbOnVoltageGain
4 //Page 223
5 clear;clc;
6 R = 25*10^3 ;
7 aR = 50 ;
8 a = aR / R ;
9 Gain = 1 + (2/a) ;
10 printf ( "\n\n Voltage Gain = %.4f " , Gain )
```

Scilab code Exa 8.4 ProbOnVoltageGain

```
1 //Chapter 8
```

```
2 //Example 8-4
3 //ProbOnVoltageGain
4 //Page 223
5 clear;clc;
6 a = %i; //Infinity
7 Gain = 1+(2/a) ;
8 printf ( "\n\n Voltage Gain = %.4f ", Gain )
```

Scilab code Exa 8.5 ProbOnInstrumentationAmplifier

```
1 //Chapter 8
2 //Example 8-5
3 //ProbOnInstrumentationAmplifier
4 //Page 222,223, Figure 8-6
5 clear;clc;
6 m = 1001 ;//Gain
7 E1 = 5.001 ; E2 = 5.002 ; //example 8-5(a)
8 E3 = 5.001 ; E4 = 5.000 ; //example 8-5(b)
9 E5 = -1.001 ; E6 = -1.002 ; //example 8-5(c)
10 Vout1 = m*(E1-E2); Vout2 = m*(E3-E4); Vout3 = m*(E5-
   E6);
11 printf ( "\n\n Output Voltages are %.4f V , %.4f V,
   %.4f V ", Vout1,Vout2,Vout3)
```

Scilab code Exa 8.6 ProbOnCollectorVoltage

```
1 //Chapter 8
2 //Example 8-6
3 //ProbOnCollectorVoltage
```

```
4 //Page 226,227, Figure 8-9(b)
5 clear;clc;
6 //Given
7 Vout = 5 ; //Output Voltage
8 Vce = Vout ;
9 printf ( "\n\n Collector Voltage = %.4f V ", Vce )
```

Scilab code Exa 8.7 ProbOnVoltages

```
1 //Chapter 8
2 //Example 8-7
3 //ProbOnVoltages
4 //Page 226,227, Figure 8-9
5 clear;clc;
6 //Given
7 Vre = 1.2 ; Re = 1*10^3 ;Vce = 5 ;Vcc = 15; //
     Voltages in the circuit
8 Ie = Vre / Re ;
9 Vcol = Vce + Vre ;
10 Vrl = Vcc - Vcol ;
11 printf ( "\n\n Collector Voltage = %.4f V ", Vcol )
12 printf ( "\n\n Voltage across Rl  = %.4f V ", Vrl )
```

Scilab code Exa 8.8 ProbOnVtoIConverter

```
1 //Chapter 8
2 //Example 8-8
3 //ProbOnVtoIConverter
4 //Page 228, Figure 8-10
```

```
clear;clc;
Rs = 1*10^3 ; E1 = 100*10^-3 ;
E2 = 0 ; Rl = 5*10^3 ;
Gain = 10 ;
Il = 10*((E1-E2)/Rs);
Vr = Il * Rs ;
Vref = Il * Rl ;
V9 = Vref + Gain*(E1 - E2);
printf ( "\n\n Current across Load Resistor = %.4f A
    ", Il )
printf ( "\n\n Voltage across R  = %.4f V ", Vr)
printf ( "\n\n Reference Voltage  = %.4f V ", Vref )
printf ( "\n\n Voltage at terminal 9  = %.4f V ", V9
    )
```

Scilab code Exa 8.9 ProbOnStrainGage

```
//Chapter 8
//Example 8-9
//ProbOnStrainGage
//Page 230,231
clear;clc;
//Given
GF = 2 ;//Gage factor
DR = 0.001 ;
R = 120 ;
L = DR /(R*GF)  ;
printf ( "\n\n Change in length is %.9f inches per
   inch ", L )
```

Scilab code Exa 8.10 ProbOnWheatstoneBridge

```
1 //Chapter 8
2 //Example 8-10
3 //ProbOnWheatstoneBridge
4 //Page 232, Figure 8-12
5 clear;clc;
6 E = 1 ;
7 DR = 0.001 ; R = 120 ; //Resistance in Ohm
8 Vout = (E*DR)/(4*R) ;
9 printf ( "\n\n Output of the Bridge = %.9f V ", Vout
    )
```

Scilab code Exa 8.11 ProbOnAD620

```
1 //Chapter 8
2 //Example 8-11
3 //ProbOnAD620
4 //Page 237,238, Figure 8-17
5 clear;clc;
6 //Given
7 Vout = 100*10^-3 ; E = 5 ; R = 120 ;
8 Gain = 1000 ;
9 E1 = 30 *10^6 ;
10 Gf = 2 ;//Gage factor
11 Vbridge = Vout / Gain ;
12 DL = 20*10^-6 ;
13 DR = (R * Vbridge)/E ;
```

```
14 Rratio = DR / R ;//Change in Resistance
15 Strain = DL / Gf ;//Change in Length
16 Stress = E1 * Strain ;
17 printf ( "\n\n Change in Resistance = %.4f ohm ", DR
       )
18 printf ( "\n\n Ratio of Resistance = %.9f ohm per
      ohm ", Rratio )
19 printf ( "\n\n Strain value = %.9f ", Strain )
20 printf ( "\n\n Stress value = %.9f psi ", Stress )
```