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

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July 17, 2017

[1]Funded by a grant from the National Mission on Education through ICT, http://spoken-tutorial.org/NMEICT-Intro. This Textbook Companion and Scilab codes written in it can be downloaded from the "Textbook Companion Project" section at the website http://scilab.in

Book Description

Title: Operational Amplifiers And Linear Integrated Circuits

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

Publisher: Prentice Hall

Edition: 5

Year: 1998

ISBN: 0132285037

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

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

```
  disp("Value of o/p voltage1 = -13.0000V")//negative saturation voltage
else
  printf("\n\n Value of o/p voltage1 = %.4f V \n\n",Vout1)
end

//Example 2-1(b)
Vbm=-10*(10^-6);//voltage at minus input
Vbp=+15*(10^-6);//voltage at plus input
Ed2=Vbp-Vbm;//Differential Input Voltage
Vout2=Ed2*Aol;//Output Voltage
format(10);
if(Vout2>15) then
  disp("Value of o/p voltage2 = 13.0000V")//positive saturation voltage
elseif(Vout2<-15) then
  disp("Value of o/p voltage2 = -13.0000V")//negative saturation voltage
else
  printf("\n\n Value of o/p voltage2 = %.4f V \n\n",Vout2)
end

//Example 2-1(c)
Vcm=-10*(10^-6);//voltage at minus input
Vcp=-5*(10^-6);//voltage at plus input
Ed3=Vcp-Vcm;//Differential Input Voltage
Vout3=Ed3*Aol;//Output Voltage
format(10);
if(Vout3>15) then
  disp("Value of o/p voltage3 = 13.0000V")//positive saturation voltage
elseif(Vout3<-15) then
  disp("Value of o/p voltage3 = -13.0000V")//negative saturation voltage
else
  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)
```

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

Scilab code Exa 2.2 `ProbOnPWM`

```
//Chapter 2
//Example 2−2
//ProbOnPWM
//Page 34
clear;clc;
//Given
f=50;//in Hz
Vtemp=4; //input signal in volts
Ecm=10; //maximum peak voltage of sawtooth carrier
   wave in volts

//Example 2−2(a)
T=1/f;
Th=(Vtemp*T)/Ecm;//High time in seconds
printf("\n\n High Time = %.4f s \n\n",Th)
```

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

Scilab code Exa 2.3 ProbOnHighTime

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

Chapter 3

Inverting and Noninverting Amplifiers

Scilab code Exa 3.1 ProbOnOpampDescriptions

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

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

Scilab code Exa 3.2 `ProbOnCurrentinOpamp`

```
//Chapter 3
//Example 3-2
//ProbOnCurrentinOpamp
//Page 47,figure 3-2
clear;clc;
//Given
Vout=10;//output voltage
I=0.1*(10^-3);//current through Rf in amperes
Rl=25*(10^3);//Load resistance in ohms
//Calculate
//Example 3-1(a)
Il=Vout/Rl;
printf("\n\n Value of load current = %.4f A \n\n",
    Il)
//Example 3-1(b)
Iout=I+Il;
printf("\n\n Total current into the output pin of
    the opamp = %.4f A \n\n",Iout)
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`

```
//Chapter 3
//Example 3-3
//ProbOnOpampParameters
//Page 48,49,figure 3-2
clear;clc;
//Given
Rf=250*(10^3);//Feedback Resistance in Ohms
Ri=10*(10^3);//Input Resistance in Ohms
Ei=0.5;//Input voltage
//Calculate
//Example 3-3(a)
I=Ei/(Ri);
printf("\n\n Value of current through Rf = %.6f A \n\n",I)
//Example 3-3(b)
VRf=I*Rf;
printf("\n\n Voltage through Rf = %.4f V \n\n",VRf)
//Example 3-3(c)
Ei1=-0.5;
Vout=-(Rf/Ri)*Ei1;
printf("\n\n Output Voltage = %.4f V \n\n",Vout)
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

```
//Chapter 3
//Example 3-4
//ProbOnOpampResistance
//Page 49
clear;clc;
//Given
```

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

Scilab code Exa 3.5 `ProbOnVoltageGain`

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

Scilab code Exa 3.6 `ProbonOutputVoltage`

```
//Chapter 3
//Example 3-6
//ProbonOutputVoltage
//Page 51
clear;clc;
Ei=-5;//input voltage
Acl=-2;//Voltage Gain
Vout=Ei*Acl;//output voltage
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`

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

Scilab code Exa 3.8 ProbOnOutputvoltage

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

Scilab code Exa 3.9 ProbOnOutputvoltage

```
//Chapter 3
//Example 3-9
//ProbOnO/Pvoltage
//Page 53,Figure 3-4
clear;clc;
//Given
E1=2;E2=3;E3=-1;//input voltage
R=10*10^3;//in ohm
Vout=-(E1+E2+E3);
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`

```
//Chapter 3
//Example 3-10
//ProbOnDCVoltage
//Page 53,54
clear;clc;
xcos('Figure3_10.xcos');
//Figure 3-5(b)
x=[0 1 2]
y=[-5,5,-5]
subplot(2,2,1)
a=gca()
a.thickness = 1;
a.x_location = 'middle';
plot2d(x,y,style=3,rect=[0,-5,2,5])
xtitle ( " Eac Vs t " , " t(ms) " , " Eac(V) " );
subplot(2,2,2)
x1=[0 0.5 1 1.5 2]
y1=[10 5 0 5 10]
a=gca()
a.thickness = 1;
a.x_location = 'middle';
plot2d(x1,y1,style=3,rect=[0,-15,2,15])
xtitle ("Edc Vs t" , " t(ms)", " Edc(V)");
y2=[5 0 -5 0 5]
y3=[-2.5 -7 -12.5 -7 -2.5]
plot2d(x1,y2,style=2)
plot2d(x1,y3,style=1)
```

```
legend ( " Edc= − 5 V " , " Edc= 0 V ", " Edc= 7 V"
   );
xtitle (" Waveshapes of Vo for Edc = 0V, −5V , 7V")
//Figure 3−5(c)
subplot(2,2,3)
x4=[-5 0 5]
y4=[10 5 0]
y5=[5 0 -5]
y6=[-2.5 -7.5 -12.5]
a=gca()
a.thickness = 1;
a.y_location = 'middle';
a.x_location = 'middle';
plot2d(x4,y4,style=3,rect=[-5,-15,5,15])
plot2d(x4,y5,style=2,rect=[-5,-15,5,15])
plot2d(x4,y6,style=1,rect=[-5,-15,5,15])
legend ( " Edc= − 5 V " , " Edc= 0 V ", " Edc= 7 V"
   );
xtitle (" Vo Vs Eac " , " Eac(V)", " Vo ");
xtitle (" Output−Input Characteristic")
printf("\n\n If Edc = 0 V , Eac appears inverted at
   Vo ( Gain is −1 )")
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 ")
printf("\n\n If Edc = 7 V , then Eac shifts down by
   7 V ")
```

Scilab code Exa 3.11 `ProbonThreeChannelInvertingAmplifier`

```
//Chapter 3
//Example 3−11
//ProbonThreeChannelInvertingAmplifier
```

```
//Page 56
clear;clc;
//Channel 1
Ri= 10*10^3;//Choosing Input resistance
Acl = -10 ;
Rf1 = - (Acl * Ri);
printf("\n\n Value of Rf1 = %.4f ohm \n\n",Rf1)
//Channel 2
Acl1 = -5;
Rf2 = - (Acl1 * Ri);
printf("\n\n Value of Rf2 = %.4f ohm \n\n",Rf2)
//channel 3
Acl2 = -2;
Rf3 = - (Acl2 * Ri);
printf("\n\n Value of Rf3 = %.4f ohm \n\n",Rf3)
```

Scilab code Exa 3.12 `ProbOnOutputvoltage`

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

Scilab code Exa 3.13 ProbOnOpampParameters

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

Scilab code Exa 3.14 ProbOnVoltageGain

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

```
//Given
Rf = 40*10^3;
R1 = 10*10^3;
//Example 3-14(a)
Acl = (Rf + R1)/R1;
printf("\n\n Value of Voltage Gain =  %.4f \n\n",Acl)
//Example 3-14(b)
x=[0 2.5 5 7.5 10]
y=[-2 0 2 0 -2]
subplot(2,2,1)
a=gca()
a.thickness = 1;
a.x_location = 'middle';
plot2d(x,y,style=3,rect=[0,-2,10,2])
xtitle ( " Ei Vs t " , " t(ms) " , " Ei(V) " );
subplot(2,2,2)
x1=[0 2.5 5 7.5 10]
y1=[-10 0 10 0 -10]
x2=[0 2.5 5 7.5 10]
y2=[-2 0 2 0 -2]
a=gca()
a.thickness = 1;
a.x_location = 'middle';
plot2d(x1,y1,style=3,rect=[0,-15,10,15])
plot2d(x2,y2,style=1)
xtitle ( " Vo Vs t  " , " t(ms) " , " Vo and Ei " );
legend ( " Vo Vs t " , " Ei Vs t ");
xtitle ( " CRO waveshape of Vo and Ei Vs t ")
subplot(2,2,3)
//Example 3-14(c)
x=[-2 -1 0 1 2]
y=[-10 -5 0 5 10]
a=gca()
a.thickness = 1;
a.x_location = 'middle';
a.y_location = 'middle';
plot2d(x,y,style=3,rect=[-2,-15,2,15])
```

```
xtitle ( " Vo Vs Ei  " , " Ei(V) " , "Vo(V) " );
legend ( " Slope = +5 ");
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

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

Scilab code Exa 3.16 ProbOnServoAmplifier

```
//Chapter 3
//Example 3−16
//ProbOnServoAmplifier
```

```
//Page 72
clear;clc;
//Given
Ei=2;//in volts
Vf=Ei;//feedback voltage
Vout=2*Vf;//output voltage
Vr=-Vout;//Reference voltage
Vcap=3*Ei;//capacitor voltage
printf("\n\n Value of feedback voltage = %.4f V \n\n",Vf)
printf("\n\n Value of output voltage = %.4f V \n\n",Vout)
printf("\n\n Value of reference voltage = %.4f V \n\n",Vr)
printf("\n\n Value of capacitor voltage = %.4f V \n\n",Vcap)
```

Scilab code Exa 3.17 `ProbOnEquilibriumVoltage`

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

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

Scilab code Exa 3.18 ProbOnEquilibriumTime

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

Chapter 4

Comparators and Controls

Scilab code Exa 4.1 `ProbOnThresholdVoltage`

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

Scilab code Exa 4.2 `ProbOnLowerThresholdVoltage`

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

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

Scilab code Exa 4.3 ProbOnOutputvoltage

```
//Chapter 4
//Example 4-3
//ProbOnOutputVoltage
//Page 91,Figure 4-4
clear;clc;
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

```
//Chapter 4
//Example 4-4
```

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

```
//Chapter 4
//Example 4-5
//designInvertingVoltageDetector
//Page 97
clear;clc;
//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 )
```

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

Chapter 5

Selected Applications of Opamp

Scilab code Exa 5.1 `ProbOnMeterCurrent`

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

Scilab code Exa 5.2 `ProbOnInputResistance`

```
//Chapter 5
//Example 5-2
//ProbOnInputResistance
//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`

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

Scilab code Exa 5.5 `ProbOnOpampParameters`

```
//Chapter 5
//Example 5-5
//ProbOnOpampParameters
//Page 126, Figure 5-3(b)
clear;clc;
//Given
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

```
//Chapter 5
//Example 5-7
//ProbOnOpampParameters
//Page 128,129, Figure 5-5
clear;clc;
//Given
R = 10*10^3 ; //Resistance
E2 = 5 ; //Source across negative terminal
Rl = 5*10^3 ; // Load Resistance
E1 = 0 ; // 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 )
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

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

Scilab code Exa 5.9 ProbOnPhotoDetectors

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

Scilab code Exa 5.10 ProbOnPhotoDetector

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

Scilab code Exa 5.11 ProbOnOpticalCoupler

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

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

Scilab code Exa 5.12 `ProbonCurrentDivider`

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

Scilab code Exa 5.13 `ProbOnPhaseShifter`

```
//Chapter 5
```

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

Scilab code Exa 5.14 `ProbOnPhaseAngle`

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

Chapter 6

Signal Generators

Scilab code Exa 6.1 ProbOnThresholdVoltage

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

Scilab code Exa 6.2 ProbOnMultivibrator

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

Scilab code Exa 6.3 `ProbOnFrequency`

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

Scilab code Exa 6.5 `ProbOnDurationOfOutputPulse`

```
//Chapter 6
//Example 6-5
//ProbOnDurationOfOutputPulse
//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`

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

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

Scilab code Exa 6.8 DesignOnSawtoothWaveGenerator

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

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

Scilab code Exa 6.9 `ProbOnFrequency`

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

Scilab code Exa 6.10 `ProbOnFrequency`

```
//Chapter 6
//Example 6-10
//ProbOnFrequency
//Page 164
clear;clc;
//Given
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`

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

Chapter 7

OpAmps With Diodes

Scilab code Exa 7.1 ProbOnDeadZoneCircuit

```
//Chapter 7
//Example 7-1
//ProbOnDeadZoneCircuit
//Page 201,202, Figure 7-15
clear;clc;
V = 15 ;
mR = 30*10^3 ;
R = 10*10^3 ;
Ei = -10 ;
Vref = V / 3 ;
Voa = -Ei-Vref ;
Vob = Ei / 2 ;
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`

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

Scilab code Exa 8.2 `ProbOnDifferentialAmplifier`

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

Scilab code Exa 8.3 `ProbOnVoltageGain`

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

Scilab code Exa 8.4 `ProbOnVoltageGain`

```
//Chapter 8
```

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

Scilab code Exa 8.5 `ProbOnInstrumentationAmplifier`

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

Scilab code Exa 8.6 `ProbOnCollectorVoltage`

```
//Chapter 8
//Example 8-6
//ProbOnCollectorVoltage
```

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

Scilab code Exa 8.7 ProbOnVoltages

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

Scilab code Exa 8.8 ProbOnVtoIConverter

```
//Chapter 8
//Example 8-8
//ProbOnVtoIConverter
//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

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

Scilab code Exa 8.11 ProbOnAD620

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

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