

Scilab Textbook Companion for
A Textbook Of Electronic Devices And
Circuits
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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

Special Diodes

Scilab code Exa 1.1 Reverse saturation current

```
1 //Exa 1.1
2 clc;
3 clear;
4 close;
5 //Given data
6 I=40; //in mA
7 V=0.25; //in Volt
8 T=20; //in degree C
9 T=T+273; //in Kelvin
10 ETA=1; //For Ge
11 e=1.6*10^-19; //in Coulomb(electronic charge)
12 k=1.38*10^-23; //in J/K(Boltzman Constant)
13 //Formula :  $I=I_0 * (\exp(\frac{e*V}{ETA*k*T}) - 1)$ 
14 y=(e*V/(ETA*k*T)); //Assumed
15 y=round(y);
16 I_0=I*10^-3/(exp(y)-1); //in mA
17 disp(I_0*10^6, "Reverse saturation current in micro
    Ampere : ");
```

Scilab code Exa 1.2 Value of forward voltage

```
1 //Exa 1.2
2 clc;
3 clear;
4 close;
5 //Given data
6 Io=10; //in uA
7 I=1; //in Ampere
8 ETA=2; //For Si
9 T=27; //in degree C
10 T=T+273; //in Kelvin
11 e=1.6*10^-19; //in Coulamb(electronic charge)
12 k=1.38*10^-23; //in J/K(Boltzman Constant)
13 //Formula : I=Io*(exp(%e*V/(ETA*k*T))-1)
14 V=(ETA*k*T/e)*log(I/(Io*10^-6)+1); //in Volt
15 disp(V,"Forward Voltage across the diode in Volt :")
    ;
```

Scilab code Exa 1.3 DC current DC voltage Ripple factor

```
1 //Exa 1.3
2 clc;
3 clear;
4 close;
5 //Given data
6 RL=1; //in kOhm
7 //rf<<RL
8 Vrms=200; //in Volt
9 //Part (i)
10 Vo=Vrms*sqrt(2); //in Volt
11 Idc=Vo/(RL*10^3*%pi); //in Ampere
12 disp(round(Idc*10^3),"DC current in load in mA :");
13 //Part (ii)
14 Vdc=RL*10^3*Idc; //in Volt
```

```

15 disp(round(Vdc),"DC voltage across load in volt :");
16 //Part (iii)
17 //Gamma=sqrt((Irms/Idc)^2-1)=sqrt((Io/2)/(Io/%pi)-1)
    =sqrt((%pi/2)^2-1)
18 Gamma=sqrt((%pi/2)^2-1);//unitless
19 disp(Gamma,"Ripple factor : ");
20 //Part (iv)
21 PIV=Vrms*sqrt(2);//in volt
22 disp(PIV,"Peak Inverse Voltage in volt :");

```

Scilab code Exa 1.4 Average dc current rms current rectification efficiency
PIV

```

1 //Exa 1.4
2 clc;
3 clear;
4 close;
5 //Given data
6 rf=20;//in ohm
7 RL=980;//in Ohm
8 Vrms=50;//in Volt
9 Vo=Vrms*sqrt(2);//in Volt
10 Io=Vo/(RL+rf);//in Ampere
11 //Part (i)
12 Idc=2*Io/%pi;//in Ampere
13 disp(round(Idc*10^3),"Average DC current in mA :");
14 //Part (ii)
15 Irms=Io/sqrt(2);//in Ampere
16 disp(Irms*1000,"rms value of load current in mA :")
17 //Part (iii)
18 Vdc=RL*Idc;//in Volt
19 disp(Vdc,"DC output voltage in volt :");
20 //Part (iv)
21 ETA=(Idc^2*RL/(Irms^2*(RL+rf)))*100;//Rectification
    Efficiency in %

```

```

22 disp(" Rectification Efficiency is "+string(ETA)+" %"
    )
23 //Part (v)
24 PIV=2*Vo;//in volt
25 disp(PIV,"Peak Inverse Voltage in volt :");

```

Scilab code Exa 1.5 Minimum value of resistance

```

1 //Exa 1.5
2 clc;
3 clear;
4 close;
5 //Given data
6 Vin=40;//in volt
7 VZ=10;//in volt
8 Vo=10;//in volt
9 IZmax=50;//in mA
10 IL=0;//in mA
11 //Formula : I=IZ+IL=IZmax+0
12 I=IZmax+0;//in mA
13 //Formula : VZ=Vin-R*I
14 Rmin=(Vin-VZ)/(I*10^-3);//in Ohm
15 disp(Rmin,"Minimum value of resistance in Ohm : ");

```

Scilab code Exa 1.6 Value of series Resistor

```

1 //Exa 1.6
2 clc;
3 clear;
4 close;
5 //Given data
6 Vmin=15;//Minimum input voltage in volt
7 VZ=6.8;//Voltage across zener in volt

```

```

8 Vo=VZ;//output voltage in volt
9 Vsr1=Vmin-Vo;//Voltage across series resistance in
  volt
10 disp("If R is the series resistance, Total current in
  series resistance in Ampere :  $I=V_{sr}/R=8.2/R$  ");
11 ILmin=5;//in mA
12 disp("current in zener diode in Ampere :  $I_Z=I-IL$ 
   $= (8.2/R-IL*10^{-3})$  eqn(1)");
13 Vmax=20;//maximum output voltage
14 Vo=VZ;//output voltage in volt
15 Vsr2=Vmax-Vo;//Voltage across series resistance in
  volt
16 disp("Current in series resistance circuit in Ampere
  :  $I=V_{sr}/R$ ");
17 ILmax=15;//in mA
18 disp("current in zener diode in Ampere :  $I_Z=I-IL=(R_s/$ 
   $R-IL*10^{-3})$  eqn(2)");
19 disp("For Zener diode to work as voltage regulator
  ,(1) and (2) must be same.");
20 disp("  $(8.2/R-IL*10^{-3})=(13.2/R-IL*10^{-3})$  ")
21 R=(Vsr2-Vsr1)/(ILmax*10^-3-ILmin*10^-3);//in Ohm
22 disp(R,"Required value of Series Resistor in ohm : "
  );

```

Scilab code Exa 1.7 Current limiting resistance and dissipated power

```

1 //Exa 1.7
2 clc;
3 clear;
4 close;
5 //Given data
6 Vin=18;//in volt
7 IZ=20;//in mA
8 ILav=(5+35)/2;//in mA
9 VZ=12;//in volt

```

```

10 Vo=12; //in volt
11 I=IZ+ILav; //in mA
12 R=(Vin-Vo)/(I*10^-3); //in Ohm
13 disp(R,"Current limiting resistance in Ohm : ");
14 P=(I*10^-3)^2*R; //in Watts
15 disp(P,"Power dissipation in resistance in Watt : ");

```

Scilab code Exa 1.8 Maximum and minimum input supply voltage

```

1 //Exa 1.8
2 clc;
3 clear;
4 close;
5 //Given data
6 R=1; //in kOhm
7 RL=5; //in kOhm
8 VZ=10; //in volt
9 Vo=10; //in volt
10 P=250; //in mW
11 IL=Vo/RL; //in mA
12 IZmin=0; //in mA
13 IZmax=P/VZ; //in mA
14 Imin=IZmin+IL; //in mA
15 Imax=IZmax+IL; //in mA
16 Vin_min=VZ+Imin*10^-3*R*10^3; //in volt
17 Vin_max=VZ+Imax*10^-3*R*10^3; //in volt
18 disp("The input voltage ranges from "+string(Vin_min)
    )+"V to "+string(Vin_max)+"V");

```

Scilab code Exa 1.9 Output voltage voltage drop and current in zener diode

```

1 //Exa 1.9

```

```

2  clc;
3  clear;
4  close;
5  //Given data
6  R=5; //in kOhm
7  R=R*1000; //in Ohm
8  RL=10; //in kOhm
9  RL=RL*1000; //in Ohm
10 Vin=120; //in Volt
11 VZ=50; //in Volt
12 //Part (i)
13 Vo=VZ; //in Volt
14 disp(Vo, "Output voltage in volt : ");
15 //Part (ii)
16 VR=Vin-VZ; //in Volt
17 disp(VR, "Voltage drop across series resistance in
    volt :");
18 //Part (iii)
19 IL=Vo/RL; //in Ampere
20 disp(IL*1000, "Load Current in mA :");
21 I=VR/R; //in Ampere
22 disp(I*1000, "Current through resistance R in mA :");
23 IZ=I-IL; //in Ampere
24 disp(IZ*1000, "Load Current in mA :");

```

Scilab code Exa 1.10 Maximum and Minimum LED current

```

1  //Exa 1.10
2  clc;
3  clear;
4  close;
5  //Given data
6  VDmin=1.5; //in Volt
7  VDmax=2.3; //in Volt
8  VS=5; //in Volt

```

```

9 RS=270; //in Ohm
10 Imin=(VS-VDmax)/RS; //in Ampere
11 disp(Imin*1000,"Minimum value of LED current in mA :
    ");
12 Imax=(VS-VDmin)/RS; //in Ampere
13 disp(round(Imax*1000),"Maximum value of LED current
    in mA : ");

```

Scilab code Exa 1.11 Frequency range of tuning circuit

```

1 //Exa 1.11
2 clc;
3 clear;
4 close;
5 //Given data
6 format('v',6);
7 C1min=10; //in pF
8 C2max=50; //in pF
9 L=5; //in mH
10 L=L*10^-3; //in H
11 //Formula : CT=C1*C2/(C1+C2)
12 //Minimum
13 C1=10; //in pF
14 C2=10; //in pF
15 CTmin=C1*C2/(C1+C2); //in pF
16 CTmin=CTmin*10^-12; //in F
17 //Maximum
18 C1=50; //in pF
19 C2=50; //in pF
20 CTmax=C1*C2/(C1+C2); //in pF
21 CTmax=CTmax*10^-12; //in F
22 //Formula : f=1/(2*%pi*sqrt(L*C))
23 //maximum :
24 fmax=1/(2*%pi*sqrt(L*CTmin));
25 //minimum :

```

```
26 fmin=1/(2*%pi*sqrt(L*CTmax));
27 disp("The frequency of tuning circuit ranges from "+
      string(fmin/10^6)+"MHz to "+string(fmax/10^6)+"
      MHz.");
28 //Note : Answer in the book is wrong.
```

Scilab code Exa 1.12 Diode Capacitance

```
1 //Exa 1.12
2 clc;
3 clear;
4 close;
5 //Given data
6 format('v',6);
7 C1=21;//in pF
8 V1=4;//in volt
9 V2=9;//in volt
10 disp("C is proportional to 1/sqrt(V)");
11 disp("So, C2/C1=sqrt(V1/V2)");
12 C2=sqrt(V1/V2)*C1;//in pF
13 disp(C2,"At reverse bias 9V, Diode capacitance in pF
      : ");
```

Scilab code Exa 1.13 Photocurrent

```
1 //Exa 1.13
2 clc;
3 clear;
4 close;
5 //Given data
6 format('v',6);
7 R=0.90;//in A/W
8 Pop=1;//in mW
```



```

9 //Part (i)
10 IP=R*Pop;//in mA
11 disp(IP,"Power of incident light lmW, Photocurrent
    in mA is :");
12 //Part (ii)
13 disp("Here IP is not proportional to Pop(for Pop>1.5
    mW)");
14 disp("Hence Photourrent can not be calculated.");

```

Scilab code Exa 1.14 Responsivity of InGaAs photodiode

```

1 //Exa 1.14
2 clc;
3 clear;
4 close;
5 //Given data
6 format('v',7);
7 ETA=70;//in %
8 Eg=0.75;//in eV
9 Eg=Eg*1.6*10^-19;//in Joule
10 h=6.63*10^-34;//Planks constant in J-s
11 c=3*10^8;//speed of light in m/s
12 e=1.6*10^-19;//in coulomb
13 lambda=h*c/Eg;//in meter
14 disp(lambda*10^9,"Wavelength in nm :");
15 R=(ETA/100)*e*lambda/(h*c);//in A/W
16 disp(R,"Responsivity of InGaAs photodiode in A/W : "
    );

```

Scilab code Exa 1.15 Equilibrium contact potential

```

1 //Exa 1.15
2 clc;

```

```
3 clear;
4 close;
5 //Given data
6 W1=2.5;//in eV
7 W2=1.9;//in eV
8 ContactPotential=W1-W2;//in Volt
9 disp(ContactPotential,"Contact potential in Volts :
    ");
```

Chapter 2

Bipolar Junction Transistors

Scilab code Exa 2.1 Current amplification factors

```
1 //Exa 2.1
2 clc;
3 clear;
4 close;
5 //Given data
6 deltaIB=50;//in uA
7 deltaIC=1;//in mA
8 deltaIC=deltaIC*10^3;//in uA
9 Beta=deltaIC/deltaIB;//unitless
10 disp(Beta,"Current Amplification Factor ,Beta :");
11 Alfa=Beta/(1+Beta);//unitless
12 disp("Current Amplification Factor ,Alfa :"+string(
    Alfa)+" or 20/21");
```

Scilab code Exa 2.2 Value of IE

```
1 //Exa 2.2
2 clc;
```

```

3 clear;
4 close;
5 //Given data
6 IB=25;//in uA
7 Beta=40;//unitless
8 IC=Beta*IB;//in uA
9 IE=IB+IC;//in uA
10 disp("The value of IE :"+string(IE)+" micro Ampere")
    ;

```

Scilab code Exa 2.3 Change in collector current

```

1 //Exa 2.3
2 clc;
3 clear;
4 close;
5 //Given data
6 alfa=0.98;//unitless
7 deltaIB=0.2;//in mA
8 Beta=alfa/(1-alfa);//unitless
9 deltaIC=Beta*deltaIB;//in mA
10 disp("Change in collector curent : "+string(deltaIC)
    +" milli Ampere.");

```

Scilab code Exa 2.4 Input current in CE and CB configuration

```

1 //Exa 2.4
2 clc;
3 clear;
4 close;
5 //Given data
6 Beta=45;//unitless
7 RL=1;//in kOhm

```

```

8 deltaVCE=1;//in volt
9 disp("Part (i) : CE coniguration");
10 IC=deltaVCE/(RL*1000);//in Ampere
11 //Formula : Beta=deltaIC/deltaIB
12 IB=IC/Beta;//in Ampere
13 disp("Input Base Current , IB in mA : "+string(IB
    *10^3));
14 disp("Part (ii) : CB coniguration");
15 IC=deltaVCE/(RL*1000);//in Ampere
16 //Formula : Beta=deltaIC/deltaIB
17 IE=IB+IC;//in Ampere
18 disp("Input Emitter Current , IE in mA : "+string(IE
    *10^3));

```

Scilab code Exa 2.5 Current gain and base current

```

1 //Exa 2.5
2 clc;
3 clear;
4 close;
5 //Given data
6 Ileakage=12.5;//in uA
7 ICBO=12.5;//in uA
8 IE=2;//in mA
9 IC=1.97;//in mA
10 //Formula : IC=alfa*IE+ICBO
11 alfa=(IC-ICBO/10^3)/IE;//unitless
12 disp(alfa,"Current Gain : ");
13 IB=IE-IC;//in mA
14 disp(IB,"Base current in mA : ");

```

Scilab code Exa 2.6 Input resistance of transistor

```

1 //Exa 2.6
2 clc;
3 clear;
4 close;
5 //Given data
6 deltaVBE=200;//in mVolt
7 deltaIB=100;//in uA
8 ri=deltaVBE*10^-3/(deltaIB*10^-6);//in Ohm
9 disp(ri/1000,"Input resistane of transistor in kohm
:");

```

Scilab code Exa 2.7 Dynamic input resistance

```

1 //Exa 2.7
2 clc;
3 clear;
4 close;
5 //Given data
6 deltaVEB=200;//in mVolt
7 deltaIE=5;//in mA
8 ri=deltaVEB*10^-3/(deltaIE*10^-3);//in Ohm
9 disp(ri,"Input resistane of transistor in Ohm :");

```

Scilab code Exa 2.9 Current gain input resistance and voltage gain

```

1 //Exa 2.9
2 clc;
3 clear;
4 close;
5 //Given data
6 format('v',10);
7 Ri=500;//in Ohm
8 RL=1;//in kOhm

```

```

 9 hie=1;//in kOhm
10 hre=2*10^-4;//unitless
11 hfe=50;//unitless
12 hoe=25;//micro mho
13 //Part (a) :
14 Ai=-hfe/(1+hoe*10^-6*RL*10^3);//unitless
15 disp(Ai,"Current Gain : ");
16 //Part (b) :
17 Rin=hie*10^3-(hre*hfe/(hoe*10^-6+1/RL*10^3));//in
    Ohm
18 disp(Rin,"Input Resistance in Ohm :");
19 //Part (c) :
20 Av=Ai*RL*10^3/Ri;//unitless
21 disp(Av,"Voltage Gain : ");

```

Scilab code Exa 2.10 Collector emitter saturation voltage

```

1 //Exa 2.10
2 clc;
3 clear;
4 close;
5 //Given data
6 alfaF=0.99;//unitless
7 alfaR=0.20;//unitless
8 IC=1;//in mA
9 IB=50;//in micro Ampere
10 T=300;//in kelvin
11 k=1.38*10^-23;//Boltzman constant
12 e=1.6*10^-19;//in coulomb
13 Vth=k*T/e;//in Volt
14 VCEsat=Vth*log(((IC*10^-3*(1-alfaR)+IB*10^-6)*alfaF)
    /((alfaF*IB*10^-6-(1-alfaF)*IC*10^-3)*alfaR));//
    in volt
15 disp(VCEsat,"Collector-Emitter saturation voltage in
    volt :");

```

Scilab code Exa 2.11 Relative size of collector junction

```
1 //Exa 2.11
2 clc;
3 clear;
4 close;
5 //Given data
6 IES=10^-14;//in A
7 alfaF=1;//unitless
8 alfaR=0.1;//unitless
9 //Formula : alfaF*IES=alfaR*ICS
10 ICS=(alfaF/alfaR)*IES;//in Ampere
11 disp(ICS," Collector base junction saturation current
    in Ampere : ");
12 RelativeSize=ICS/IES;//unitless
13 disp(" Collector is "+string(RelativeSize)+" times
    larger in size than emitter.");
14 BetaR=alfaR/(1-alfaR);//unitless
15 disp(BetaR," Value of BetaR : ");
```

Scilab code Exa 2.12 DC load line and operating point

```
1 //Exa 2.12
2 clc;
3 clear;
4 close;
5 //Given data
6 Beta=100;//unitless
7 VCC=6;//in volt
8 RB=530;//in kOhm
9 RC=2;//in kOhm
```



```

10 VBE=0.7; //in volt (For Si)
11 //Part (i)
12 IC1=0; //in A
13 VCE1=VCC-IC1*RC; //in volt
14 //If VCE=0; //in volt
15 VCE2=0; //in volt
16 IC2=VCC/RC; //in Ampere
17 title('DC load line');
18 xlabel('VCE(in volts)');
19 ylabel('IC(in mA)');
20 plot([VCE1,IC1],[VCE2,IC2]); //DC load line
21 //Formula : VCC=VBE+IB*RB
22 IB=(VCC-VBE)/(RB*10^3); //in Ampere
23 IC=Beta*IB; //in Ampere
24 VCE=VCC-IC*RC*10^3; //in volt
25 disp("Q point coordinates are :");
26 disp("IC=" + string(IC*10^3) + " mA and VCE=" + string(VCE
    ) + " Volt.");

```

Scilab code Exa 2.13 RB and new value of IC

```

1 //Exa 2.13
2 clc;
3 clear;
4 close;
5 //Given data
6 Beta=100; //unitless
7 IC=1; //in mA
8 VCC=12; //in volt
9 VBE=0.3; //in volt (For Ge)
10 //Prt (i)
11 IB=IC/Beta; //in mA
12 //Formula : VCC=VBE+IB*RB
13 RB=(VCC-VBE)/(IB*10^-3); //in Ampere
14 disp(RB/10^3," Resistance RB in kOhm : ");

```

```

15 //part (ii)
16 Beta=50;//unitless
17 IB=(VCC-VBE)/RB;//in Ampere
18 IC=Beta*IB;//in Ampere
19 disp(IC*10^3,"Zero signal IC in mA:");

```

Scilab code Exa 2.14 Set the operating point

```

1 //Exa 2.14
2 clc;
3 clear;
4 close;
5 //Given data :
6 format('v',10);
7 disp("To set the required operating point , value of
      RB will be find out. ")
8 IC=1;//in mA
9 VCE=8;//in volt
10 Beta=100;//unitless
11 VCC=12;//in volt
12 VBE=0.3;//in volt(For Ge)
13 //Prt (i)
14 RC=(VCC-VCE)/(IC*10^-3);//in ohm
15 IB=IC/Beta;//in mA
16 RB=(VCC-VBE-Beta*(IB*10^-3)*RC)/(IB*10^-3);//in Ohm
17 disp(RB/1000,"Value of RB in kOhm");
18 //Part (ii)
19 Beta=50;//unitless
20 IB=(VCC-VBE)/(RB+Beta*RC);//in mA
21 IC=Beta*IB;//in Ampere
22 VCE=VCC-IC*RC;//in volt
23 disp("New operating point is (" +string(VCE)+"V," +
      string(IC*10^3)+"mA)");

```

Scilab code Exa 2.15 Value of IC

```
1 //Exa 2.15
2 clc;
3 clear;
4 close;
5 //Given data :
6 R1=50;//in kohm
7 R2=10;//in kohm
8 RE=1;//in kohm
9 VCC=12;//in volt
10 //Prt (i)
11 VBE=0.1;//in volt
12 VBBdash=(R2/(R1+R2))*VCC;//in volt
13 IC1=(VBBdash-VBE)/(RE*1000);//in mA
14 disp(IC1*1000,"At VBE=0.1V, Value of IC in mA : ");
15 //Part (ii)
16 VBE=0.3;//in volt
17 IC2=(VBBdash-VBE)/(RE*1000);//in mA
18 disp(IC2*1000,"At VBE=0.3V, Value of IC in mA : ");
```

Scilab code Exa 2.16 Operating point and stability factor

```
1 //Exa 2.16
2 clc;
3 clear;
4 close;
5 //Given data :
6 R1=10;//in kohm
7 R2=5;//in kohm
8 RE=2;//in kohm
9 RC=1;//in kohm
```

```

10 VCC=12; //in volt
11 Beta=100; // unitless
12 VBE=0.7; //in volt
13 //Part (i)
14 //Formula :  $V_{BE}=V_{BBdash}-I_B*R_{Bdash}-I_E*R_E$ 
15 disp("IB is ver small :  $V_{BE}=V_{BBdash}-I_E*R_E$ ");
16  $V_{BBdash}=(R_2/(R_1+R_2))*V_{CC}$ ; //in volt
17  $I_E=(V_{BBdash}-V_{BE})/(R_E*10^3)$ ; //in Ampere
18 disp("As base current is very small  $I_C=I_E$ ");
19  $I_C=I_E$ ; //in mA
20 //Formul :  $V_{CC}=I_C*R_C+V_{CE}+I_E*R_E$ 
21  $V_{CE}=V_{CC}-I_C*R_C*10^3-I_E*R_E*10^3$ ; //in Volt
22 disp("Operating point is (" + string(VCE) + "V," + string(
    IC*10^3) + "mA)");
23 //Part (ii)
24  $R_{Bdash}=(R_1*R_2/(R_1+R_2))$ ; //in kOhm
25  $S=(Beta+1)/(1+Beta*(R_E/(R_{Bdash}+R_E)))$ ;
26 disp("Staility factor S is : " + string(S));

```

Scilab code Exa 2.17 IC and VCE

```

1 //Exa 2.17
2 clc;
3 clear;
4 close;
5 //Given data :
6 R1=200; //in kohm
7 R2=100; //in kohm
8 RE=1; //in kohm
9 RC=1; //in kohm
10 VCC=9; //in volt
11 he=2; //in kohm
12 hfe=100; // unitless
13 hoe=0; // unitless
14 hre=0; // unitless

```

```

15 VBE=0.7; //in volt (For Si)
16 //Part (i)
17 RB=R1*R2/(R1+R2); //in kohm
18 VBBdash=(R2/(R1+R2))*VCC; //in volt
19 //Applying Kirchoff Law
20 IB=(VBBdash-VBE)/(RB*10^3+RE*10^3*(1+hfe)); //in
    Ampere
21 IC=hfe*IB; //in Ampere
22 disp(IC*10^3,"Value of IC in mA : ");
23 //Part (ii)
24 //Applying Kirchoff Law
25 VCE=VCC-IC*RC*10^3-RE*1063*IB*(hfe+1); //in volt
26 disp(VCE,"VCE in volt :");
27 //Note : Ans of VCE is wrong in the book as VCC=10 V
    has been taken instead of 9 volt.

```

Scilab code Exa 2.18 Region of Q point

```

1 //Exa 2.18
2 clc;
3 clear;
4 close;
5 //Given data :
6 RB=50; //in kohm
7 RC=3; //in kohm
8 VCC=10; //in volt
9 VEE=5; //in volt
10 hfe=100; //unitless
11 VCEsat=0.2; //in volt
12 VBEsat=0.8; //in volt
13 VBEactive=0.7; //in volt
14 VBE=0.7; //in volt (For Si)
15 //Applying
16 IB=(VEE-VBE)/(RB*10^3); //in Ampere: Kirchoff 2nd Law
    : VEE-RB*IB-VBE=0

```

```

17 IC=hfe*IB;//in Ampere
18 VCB=VCC-IC*RC*10^3-VBEactive;//in volt: //Applying
    Kirchoff 2nd Law to collector-emitter loop: VCC-
    IC*RC-VCB-VBEactive=0
19 disp(VCB,"Collector to base voltage , VCB(in V) :");
20 disp("This shows that the base collector junction is
    forward biased. This implies that the transistor
    is in saturation region.");
21 IB=(VEE-VBEsat)/(RB*10^3);//in Ampere
22 disp(IB*10^3,"Value of IB in mA :");
23 IC=(VCC-VCEsat)/(RC*10^3);
24 disp(IC*10^3,"Value of IC in mA :");

```

Scilab code Exa 2.19 Voltage across RE

```

1 //Exa 2.19
2 clc;
3 clear;
4 close;
5 //Given data :
6 VCC=20;//in volt
7 VBE=0.7;//in volt(For Si)
8 Beta=50;//unitless
9 RE=200;//in ohm
10 R1=60;//in kohm
11 R2=30;//in kohm
12 V2=VCC*R2/(R1+R2);//in volt
13 VEO=V2-VBE;//in volt
14 disp(VEO,"Voltage across RE in volt : ");

```

Chapter 3

Transistor Amplifiers

Scilab code Exa 3.1 Gain Impedence and ac load

```
1 //Exa 3.2
2 clc;
3 clear;
4 close;
5 //Given data
6 ib=10;//in uA
7 ic=1;//in mA
8 ic=ic*10^3;//in uA
9 vi=0.02;//in Volt
10 RC=5;//in kohm
11 RL=10;//in kohm
12 //Part (i)
13 Ai=-ic/ib;//unitless
14 Beta=Ai;//unitless
15 disp(Ai,"Current gain : ");
16 //Part (ii)
17 Rie=vi/(ib*10^-6);//in Ohm
18 disp(Rie*10^-3,"Input impedance in kohm :");
19 //Part (iii)
20 Rac=RC*RL/(RC+RL);//in kohm
21 disp(Rac,"AC load in kohm : ");
```

```

22 //Part (iv)
23 Av=-Rac*10^3*Beta/Rie;//unitless
24 disp(Av,"Voltage gain : ");
25 //Part (v)
26 PowerGain=Av*Ai;//unitless
27 disp(PowerGain,"Power Gain is : ");
28 //Note : Ans of Av and Power gain is wrong in the
    book.

```

Scilab code Exa 3.2 Gain input and output impedance

```

1 //Exa 3.2
2 clc;
3 clear;
4 close;
5 //Given data
6 RL=10;//in kohm
7 RS=1;//in kohm
8 hie=1.1;//in kOhm
9 hre=2.5*10^-4;//unitless
10 hfe=50;//unitless
11 hoe=25;//in u mho
12 Aie=-hfe/(1+hoe*10^-6*RL*10^3);//unitless
13 Zie=hie+hre*Aie*RL;//in kOhm
14 Zie=round(Zie);
15 Ave=Aie*RL/Zie;//unitless
16 Avs_e=Ave*Zie/(Zie+RS);//
17 deltah=hoe*10^-6*hie*10^3-hfe*hre;
18 Zoe=(hie*10^3+RS*10^3)/(hoe*10^-6*RS*10^3+deltah);
19 Ais_e=Aie*RS/(Zie+RS);
20 Ape=Ave*Aie;
21 Aps_e=Avs_e*Ais_e;
22 disp(Aie,"Current gain : ");
23 disp(Ais_e,"Current gain with source resistance : ")
    ;

```



```

24 disp(Ave,"Voltage gain : ");
25 disp(Avs_e,"Voltage gain with source resistance : ")
    ;
26 disp(Ape,"Power gain : ");
27 disp(Aps_e,"Power gain with source resistance : ");
28 disp(Zie,"Input impedance in kohm :");
29 disp(Zoe/10^3,"Output impedance in kohm :");

```

Scilab code Exa 3.3 Input Output impedance and output voltage

```

1 //Exa 3.3
2 clc;
3 clear;
4 close;
5 //Given data :
6 InputVoltage=1;//in mV
7 RL=5.6;//in kohm
8 RS=600;//in ohm
9 hre=6.5*10^-4;//unitless
10 hie=1.7;//in kOhm
11 hfe=125;//unitless
12 hoe=80;//in uA/V
13 deltah=hoe*10^-6*hie*10^3-hfe*hre;
14 Zie=(hie*10^3+RL*10^3*deltah)/(1+hoe*10^-6*RL*10^3);
    //in Ohm
15 Zoe=(hie*10^3+RS)/(hoe*10^-6*RS+deltah);//in Ohm
16 Ave=-(hfe*RL*10^3)/(hie*10^3+RL*10^3*deltah);//
    unitless
17 Avs_e=Ave*Zie/(Zie+RS);//
18 OutputVoltage=Avs_e*InputVoltage;//in
19 disp(Zie/1000,"Input impedance in kohm :");
20 disp(Zoe/10^3,"Output impedance in kohm :");
21 disp(Ave,"Voltage gain : ");
22 disp(Avs_e,"Voltage gain with source resistance : ")
    ;

```

```
23 disp(OutputVoltage,"Output Voltage in mV : ");
24 //Note : Ans of output impedance is wrong in the
    book.
```

Scilab code Exa 3.4 Net voltage gain in dB

```
1 //Exa 3.4
2 clc;
3 clear;
4 close;
5 //Given data :
6 A1=100; //unitless
7 A2=200; //unitless
8 A3=400; //unitless
9 A1=20*log10(A1); //in dB
10 A2=20*log10(A2); //in dB
11 A3=20*log10(A3); //in dB
12 NetVoltageGain=A1+A2+A3; //in dB
13 disp(NetVoltageGain,"Net Voltage Gain in decibels :")
    );
14 //Note : Answer in the book is wrong.
```

Scilab code Exa 3.5 Bandwidth and cut off frequencies

```
1 //Exa 3.5
2 clc;
3 clear;
4 close;
5 //Given data :
6 MaxGain=1000; //unitless(at 2kHz)
7 f1=50; //in Hz
8 f2=10; //in KHz
```

```

9 disp("Bandwidth is from "+string(f1)+"Hz to "+string
      (f2)+"kHz");
10 disp("Lower cutoff frequency " +string(f1)+"Hz");
11 disp("Upper cutoff frequency " +string(f2)+"kHz");

```

Scilab code Exa 3.6 Overall voltage gain

```

1 //Exa 3.6
2 clc;
3 clear;
4 close;
5 //Given data :
6 RC=10;//in kohm
7 hfe=330;//unitless
8 hie=4.5;//in kOhm
9 //RS<<hie
10 AVM=hfe*RC*10^3/(hie*10^3+RC*10^3);//unitless
11 AVM1=AVM;//Gain of 1st stage
12 AVM2=AVM;//Gain of 2nd stage
13 AVM3=hfe*RC*10^3/(hie*10^3);//unitless(//Gain of 3rd
      stage)
14 OverallGain=AVM1*AVM2*AVM3;//unitless
15 disp(AVM,"Gain in mid frequency range : ");
16 disp("This is the gain of 1st and 2nd stage.")
17 disp(OverallGain,"Overall Voltage gain for mid
      frequency range : ");

```

Scilab code Exa 3.7 Coupling capacitor

```

1 //Exa 3.7
2 clc;
3 clear;
4 close;

```

```

5 //Given data :
6 RC=5.5;//in kohm
7 hfe=330;//unitless
8 hie=4.5;//in kohm
9 f1=30;//in Hz
10 //Formula :  $f1 = 1/(2*\%pi*C*(hie+RC))$ 
11  $C = 1/(2*\%pi*f1*(hie*10^3+RC*10^3))$ ;//in F
12 disp(C*10^6,"Value of coupling capacitor in micro
    farad : ");

```

Scilab code Exa 3.8 Voltage gain

```

1 //Exa 3.8
2 clc;
3 clear;
4 close;
5 //Given data :
6 RC=10;//in kohm
7 Rin=1;//in kohm
8 Beta=100;//unitless
9 RL=100;//in ohm
10 RCdash=RC*10^3*RL/(RC*10^3+RL);//in ohm
11 VoltageGain=Beta*RCdash/(Rin*10^3);//in volt
12 disp(VoltageGain,"Voltage Gain : ");

```

Scilab code Exa 3.9 Inductance of primary and secondary

```

1 //Exa 3.9
2 clc;
3 clear;
4 close;
5 //Given data :
6 Rout=10;//in kohm

```

```

7 Rin=2.5;//in kohm
8 f=200;//in Hz
9 //Formula : Rout=omega*Lp=2*%pi*f*Lp
10 Lp=Rout*10^3/(2*%pi*f);//in H
11 disp(round(Lp),"Inductance of primary in Henry : ");
12 //Formula : Rin=omega*Ls=2*%pi*f*Ls
13 Ls=Rin*10^3/(2*%pi*f);//in H
14 disp(round(Ls),"Inductance of seondary in Henry : ")
    ;

```

Scilab code Exa 3.10 Turn ratio of transformer

```

1 //Exa 3.10
2 clc;
3 clear;
4 close;
5 //Given data :
6 ZL=10;//in ohm
7 ZP=1000;//in ohm
8 //For max power : ZP=n^2*ZL
9 n=sqrt(ZP/ZL);//turn ratio
10 disp(n,"Turn ratio : ");

```

Scilab code Exa 3.11 Collector efficieny and power rating

```

1 //Exa 3.11
2 clc;
3 clear;
4 close;
5 //Given data :
6 Po_dc=10;//in watt
7 Po_ac=3.5;//in watt
8 //Part (i) :

```

```

9  ETAclector=Po_ac/Po_dc;//unitless
10 ETAclector=ETAclector*100;//collector efficiency
    in %
11 disp(ETAclector,"Collector Efficiency(in %) : ");
12 //Part (ii)
13 disp(Po_dc,"Zero signal condition represents maximum
    power loss. Therefore, all the 10 W power is
    dissipated by it. Hence Powe Rating of transistor
    in Watt : ")

```

Scilab code Exa 3.12 Power and efficiency

```

1 //Exa 3.12
2 clc;
3 clear;
4 close;
5 //Given data :
6 VCC=20;//in volt
7 RC=20;//in ohm
8 VCEQ=10;//in volt
9 ICQ=500;//in mA
10 //part (i) :
11 Pin_dc=VCC*ICQ*10^-3;//in watt
12 disp(Pin_dc,"Total dc power taken by the circuit in
    Watt : ");
13 //part (ii) :
14 PRc_dc=ICQ^2*10^-6*RC;//in watt
15 disp(PRc_dc,"dc power dissipated by the collector
    load in Watt : ");
16 //part (iii) :
17 Io=250;//in mA(maximum value of output ac current)
18 Irms=Io/sqrt(2);//in mA
19 Po_ac=Irms^2*10^-6*RC;//in watt
20 disp(Po_ac,"Power developed across the load in Watt
    : ");

```

```

21 //part (iv) :
22 Ptr_dc=Pin_dc-PRc_dc;//in watt
23 disp(Ptr_dc,"dc power dissipated by the collector
    load in Watt : ");
24 //part (v) :
25 PC_dc=Pin_dc-PRc_dc-Po_ac;//in watt
26 disp(PC_dc,"dc power dissipated by the collector
    load in Watt : ");
27 //part (vi) :
28 ETAoverall=Po_ac*100/Pin_dc;//Overall Efficiency (in
    %)
29 disp(ETAoverall," Overall Efficiency (in %) :");
30 //part (vii) :
31 ETAcollector=Po_ac*100/PRc_dc;//Collector Efficiency
    (in %)
32 disp(ETAcollector," Collector Efficiency (in %) :");

```

Scilab code Exa 3.13 Maximum ac power output

```

1 //Exa 3.13
2 clc;
3 clear;
4 close;
5 //Given data :
6 n=10;//turn ratio
7 RL=100;//in ohm
8 ICQ=100;//in mA
9 RLdash=n^2*RL;//in ohm
10 MaxPowerOut=(ICQ*10^-3)^2*RLdash/2;//in watt
11 disp(MaxPowerOut,"Maximum Power output in watt : ");

```

Scilab code Exa 3.14 Maximum permissible power dissipation

```
1 //Exa 3.14
2 clc;
3 clear;
4 close;
5 //Given data :
6 //Part (i) : without heat sink
7 ThetaMax=90;//in degree C
8 Theta_o=30;//in degree C
9 R=300;//in degree C/W
10 Pr=(ThetaMax-Theta_o)/R;//in watt
11 disp(Pr,"Without heat sink , Maximum permissible
    power dissipatio in watt :");
12 //Part (ii) : with heat sink
13 ThetaMax=90;//in degree C
14 Theta_o=30;//in degree C
15 R=60;//in degree C/W
16 Pr=(ThetaMax-Theta_o)/R;//in watt
17 disp(Pr,"With heat sink , Maximum permissible power
    dissipatio in watt :");
```

Chapter 4

Frequency Response

Scilab code Exa 4.1 3dB Frequency

```
1 //Exa 4.1
2 clc;
3 clear;
4 close;
5 //Given data
6 Omega_Z1=0; //in Radian/sec
7 Omega_Z2=10; //in Radian/sec
8 Omega_P1=100; //in Radian/sec
9 Omega_P2=25; //in Radian/sec
10 WL=sqrt(Omega_P1^2+Omega_P2^2-2*Omega_Z1^2-2*
    Omega_Z2^2); //in radian/sec
11 disp(WL,"Approximate value of lower 3dB Frequency in
    radian/sec : ");
```

Scilab code Exa 4.2 Upper 3dB Frequency

```
1 //Exa 4.2
2 clc;
```

```
3 clear;
4 close;
5 //Given data
6 Omega_P1=10^4; //in Radian/sec
7 Omega_P2=2*10^4; //in Radian/sec
8 Omega_Z1=10^5; //in Radian/sec
9 omegaH=1/sqrt(1/Omega_P1^2+1/Omega_P2^2-2/Omega_Z1
    ^2); //in radian/sec
10 disp(round(omegaH),"Approximate value of lower 3dB
    Frequency in radian/sec : ");
```

Chapter 5

Feed Back

Scilab code Exa 5.1 Percentage of output which is fed back

```
1 //Exa 5.1
2 clc;
3 clear;
4 close;
5 //Given data :
6 A=50; //gain (unitless)
7 Af=10; //gain (unitless)
8 //Formula : Af=A/(1+A*Beta)
9 Beta=(A/Af-1)/A; //feedback ratio (unitless)
10 disp(Beta*100,"Percentage of output fed back(%) : ")
    ;
```

Scilab code Exa 5.2 Voltage gain and reduction in voltage

```
1 //Exa 5.2
2 clc;
3 clear;
4 close;
```

```

5 //Given data :
6 A=1000;//gainWithoutFeedback(unitless)
7 //Part (i) :
8 disp("At normal collector supply :");
9 disp("with feedback gain reduces by a factor 0.40");
10 Af=A-A*0.40;//gainWithFeedback(unitless)
11 disp(Af,"At normal collector supply , Gain with
      feedback : ");
12 //Formula : Af=A/(1+A*Beta)
13 Beta=(A/Af-1)/A;//feedback factor (unitless)
14 disp("At reduced power supply :");
15 Adash=800;//gainWithoutFeedback(unitless)
16 Af_dash=Adash/(1+Adash*Beta)
17 disp(round(Af_dash),"At Reduced collector supply ,
      Gain with feedback : ");
18 //Part (ii)
19 Reduction=((A-Adash)/A)*100;//% reduction without
      feedback
20 disp(Reduction,"percentage reduction in gain without
      feedback(%) :");
21 Reduction1=((Af-Af_dash)/Af)*100;//% reduction
      without feedback
22 disp(round(Reduction1),"percentage reduction in gain
      with feedback(%) :");
23 //Note : answer of Af is wrong in the book.

```

Scilab code Exa 5.3 Gain with feedback factor and feedback voltage

```

1 //Exa 5.3
2 clc;
3 clear;
4 close;
5 //Given data :
6 A=100;//gain without feedback(unitless)
7 Beta=1/25;//feedback ratio (unitless)

```

```

 8 Vi=50; //in mV
 9 //Part (i) :
10 Af=A/(1+A*Beta); //gain with feedback(unitless)
11 disp(Af,"(i) Gain with feedback :");
12 //Part (ii) :
13 FeedbackFactor=Beta*A; //unitless
14 disp(FeedbackFactor,"(ii) Feedback Factor :");
15 //Part (iii) :
16 Vo_dash=Af*Vi*10^-3; //in volt
17 disp(Vo_dash,"(iii) Output Voltage in volts :");
18 //Part (iv) :
19 FeedbackVoltage=Beta*Vo_dash; //in volt
20 disp(FeedbackVoltage,"(iv) Feedback Voltage in volts
    :");
21 //Part (v) :
22 Vi_dash=Vi*(1+Beta*A); //in mv
23 disp(Vi_dash,"(v) New Increased Input Voltage in
    milli volts :");

```

Scilab code Exa 5.4 Bandwidth with negative feedback

```

1 //Exa 5.4
2 clc;
3 clear;
4 close;
5 //Given data :
6 BW=200; //in kHz
7 A=40; //gain without feedback(in dB)
8 Beta=5; //negative feedback in %
9 Beta=Beta/100; //feedback factor
10 //Formula : Af=A/(1+A*Beta)
11 Af=A/(1+A*Beta); //gain with feedback(in dB)
12 disp("Since gain bandwidth product remains constant ,
    A*BW=Af*BW_dash");
13 BW_dash=A*BW/Af; //in kHz

```

```
14 disp(BW_dash,"New Bandwidth in kHz : ");
```

Scilab code Exa 5.5 Fraction of output fed back

```
1 //Exa 5.5
2 clc;
3 clear;
4 close;
5 //Given data :
6 A=140; //gain without feedback(unitless)
7 Af=17.5; //gain with feedback(unitless)
8 //Formula : Af=A/(1+A*Beta)
9 Beta=(A/Af-1)/A; //feedback ratio (unitless)
10 disp("Fraction of output fed back to input : "+
      string(Beta)+" or 1/20");
```

Scilab code Exa 5.6 Small Change in gain

```
1 //Exa 5.6
2 clc;
3 clear;
4 close;
5 //Given data :
6 A=200; //gain without feedback(unitless)
7 Beta=0.25; //fraction ratio(unitless)
8 disp("We have , Af=A/(1+Beta*A) eqn(1)");
9 disp("Differentiating it with respect to A, we get")
;
10 disp("dAf/dA=((1+Beta*A)-Beta*A)/(1+Beta*A)^2=1/(1+
Beta*A)^2");
11 disp("dAf=dA/(1+Beta*A)^2 eqn(2)");
12 disp("Dividing eqn(2) by eqn(1),");
```

```

13 disp(" dAf/Af=(dA/((1+Beta*A)^2))*((1+Beta*A)/A)
    =(1/(1+Beta*A))*(dA/A)");
14 //Given : Normal gain changes by 10 %, it means dA/A
    =10/100
15 dABYA=10/100; //change in gain
16 dAfBYAf=(1/(1+Beta*A))*(dABYA); //change in gain
17 disp(dAfBYAf,"Change in gain : ");

```

Scilab code Exa 5.7 New gain distortion and input voltage

```

1 //Exa 5.7
2 clc;
3 clear;
4 close;
5 //Given data :
6 A=200; //gain without feedback (unitless)
7 Dn=10; //Distortion in %
8 Vi=0.5; //Initial input voltage in volt
9 Beta=0.05; //feedback ratio (unitless)
10 //Formula : Af=A/(1+A*Beta)
11 Af=A/(1+A*Beta); //gain with feedback (unitless)
12 disp(Af,"New gain :");
13 Dn_dash=Dn/(1+A*Beta); //new distortion in %
14 disp(Dn_dash,"Distortion with negative feedback in %
    : ");
15 InitialOutputVoltage=A*Vi; //in Volt
16 disp(InitialOutputVoltage,"Initial Output Voltage in
    volt:");
17 NewInputVoltage=InitialOutputVoltage/Af; //in volt
18 disp(NewInputVoltage,"New Input Voltage in volts :")
    ;
19 //Note : Ans of Af and NewInputVoltage is not
    acurate in the book.

```

Scilab code Exa 5.8 Feedback rction voltage and impedance

```
1 //Exa 5.8
2 clc;
3 clear;
4 close;
5 //Given data :
6 A=10000;//gain without feedback(unitless)
7 Zi=10;//in kOhm
8 Zo=100;//in Ohm
9 R1=2;//in Ohm
10 R2=18;//in Ohm
11 //Part (i) :
12 Beta=R1/(R1+R2);//feedback fraction(unitless)
13 disp(Beta,"(i) Feedback Fraction :");
14 //Part (ii) :
15 Af=A/(1+A*Beta);//Gain with negative feedback(
    unitless)
16 disp(round(Af),"(ii) Gain with negative feedback :")
    ;
17 //Part (iii) :
18 inputVoltge=0.5;//in mV
19 outputVoltge=Af*inputVoltge;//in mV
20 disp(round(outputVoltge),"(iii) Output Voltage in
    milli volts :");
21 //Part (iv) :
22 Zif=Zi*(1+Beta*A);//in kOhm
23 disp(Zif*10^-3,"(iv) Input impedance of feedback
    amplifier in Mohm : ");
24 //Part (v) :
25 Zof=Zo/(1+Beta*A);//in kOhm
26 format('v',4);
27 disp(Zof,"(v) Output impedance with feedback in Ohm
    : ");
```

Scilab code Exa 5.9 Voltage gain input and output resistance

```
1 //Exa 5.9
2 clc;
3 clear;
4 close;
5 //Given data :
6 A=200; //gain without feedback (unitless)
7 Ri=2; //in kOhm
8 Ro=12; //in kOhm
9 Beta=0.02; //feedback ratio (unitless)
10 //Part (i) :
11 Af=A/(1+A*Beta); //gain with feedback (unitless)
12 disp(Af, "(i) Gain with Negative Feedback :");
13 //Part (ii) :
14 Rif=Ri*(1+A*Beta); //in kOhm
15 disp(Rif, "(ii) Input resistance with feedback in
    kOhm :");
16 //Part (ii) :
17 Rof=Ro/(1+A*Beta); //in kOhm
18 disp(Rof, "(ii) Output resistance with feedback in
    kOhm :");
```

Scilab code Exa 5.10 Gain with feedback in dB

```
1 //Exa 5.10
2 clc;
3 clear;
4 close;
5 //Given data :
6 format('v',5);
7 A=1000; //gain (unitless)
```

```

8 Beta=1/20; //feedback ratio (unitless)
9 //Formula : Af=A/(1+A*Beta)
10 Af=A/(1+A*Beta); //gain with feedback(unitless)
11 Af=20*log10(Af); //in dB
12 disp(Af, "Gain with feedback in dB : ");

```

Scilab code Exa 5.11 Bandwidth after feedback

```

1 //Exa 5.11
2 clc;
3 clear;
4 close;
5 //Given data :
6 A=800; //gain(unitless)
7 f1=40; //in Hz
8 f2=16; //in kHz
9 Beta=2/100; //feedback fator (unitless)
10 //Formula : Af=A/(1+A*Beta)
11 Af=A/(1+A*Beta); //gain with feedback(unitless)
12 disp(Af, "Voltage gin with feedback : ");
13 BW=f2*10^3-f1; //Bandwidth of amplifier in Hz
14 disp(BW*10^-3, "Bandwidth of amplifier in kHz : ");
15 f1_f=f1/(1+A*Beta); //in Hz
16 f2_f=f2*(1+A*Beta); //in kHz
17 BW_f=f2_f*10^3-f1_f; //Bandwith after feedback in Hz
18 disp(round(BW_f*10^-3), "Bandwith after feedback in
    KHz : ");

```

Scilab code Exa 5.12 Gain and new bandwidth

```

1 //Exa 5.12
2 clc;
3 clear;

```

```

4 close;
5 //Given data :
6 A=100; //gain (unitless)
7 BW=10; //in Hz
8 Beta=5; //in %
9 //Part (i) :
10 //Formula : Af=A/(1+A*Beta)
11 Af=A/(1+A*Beta/100); //gain with feedback (unitless)
12 disp(Af,"Voltage gain with feedback : ");
13 //Part (ii)
14 BW_f=BW*(1+A*Beta/100); //Bandwith after feedback in
    Hz
15 disp(BW_f,"Bandwith with negative feedback in KHz :
    ");

```

Scilab code Exa 5.13 Input resistance and voltage gain

```

1 //Exa 5.13
2 clc;
3 clear;
4 close;
5 //Given data :
6 hfe=50; //unitless
7 hie=1.1; //in kOhm
8 hoe=0; //unitless
9 hre=0; //unitless
10 RL=4; //in kOhm
11 Rs=10; //in kOhm
12 RB=40; //in kOhm
13 RLdash=RB*RL/(RB+RL); //in Kohm
14 AV=-hfe*RLdash/hie; //unitless
15 //Part (i) ;
16 Rif=hie*(RB/(1-AV))/(hie+(RB/(1-AV))); //in kOhm
17 disp(round(Rif*1000),"Input resistance with feedback
    in Ohm : ");

```

```
18 //Part (ii) :  
19 AVf=AV*(Rif/(Rs+Rif));// unitless  
20 disp(AVf,"Voltage gain with feedback : ");
```

Chapter 6

Field Effect Transistors and MOSFETS

Scilab code Exa 6.1 Value of Transconductance

```
1 //Exa 6.1
2 clc;
3 clear;
4 close;
5 //given data
6 VGS1=-3.1;//in Volt
7 VGS2=-3;//in Volt
8 ID1=1;//in mA
9 ID2=1.3;//in mA
10 delVGS=VGS2-VGS1;//in Volts
11 delID=ID2-ID1;//in mA
12 gm=delID*10^-3/delVGS;//in mhos
13 disp(gm," Transconductance in mhos : ");
```

Scilab code Exa 6.2 AC drain resistance transconductance and amplification factor

```

1 //Exa 6.2
2 clc;
3 clear;
4 close;
5 //given data
6 VGS1=0;//in Volt
7 VGS2=0;//in Volt
8 VGS3=-0.2;//in Volt
9 VDS1=7;//in Volt
10 VDS2=15;//in Volt
11 VDS3=15;//in Volt
12 ID1=10;//in mA
13 ID2=10.25;//in mA
14 ID3=9.65;//in mA
15 delVDS=VDS2-VDS1;//in Volts
16 delID=ID2-ID1;//in mA
17 rd=delVDS/delID;//in Kohm
18 disp(rd,"AC drain resistance in Kohm : ");
19 delVGS=VGS3-VGS2;//in Volts
20 delID=ID3-ID2;//in mA
21 gm=delID*10^-3/delVGS;//in mhos
22 disp(gm," Transconductance in mhos : ");
23 mu=rd*10^3*gm;//unitless
24 disp(mu," Amplification factor : ");

```

Scilab code Exa 6.5 Voltage Amplification

```

1 //Exa 6.5
2 clc;
3 clear;
4 close;
5 //given data
6 gm=2;//in milli-mho
7 RL=10;//in Kohm
8 disp(" assuming rd>>RL");

```

```
9 Av=gm*10-3*RL*103; // unitless
10 disp(Av," Voltage amplification : ");
```

Scilab code Exa 6.6 Output voltage of amplifier

```
1 //Exa 6.6
2 clc;
3 clear;
4 close;
5 //given data
6 RL=20; //in Kohm
7 RS=1; //in Kohm
8 RG=1; //in Mohm
9 Cs=25; //in uF
10 mu=20; // unitless
11 rd=100; //in Kohm
12 Vs=2; //in Volt
13 f=1; //in KHz
14 Xc=1/(2*%pi*f*Cs); //in Ohm
15 disp(Xc,"Xc in Ohm : ");
16 disp("As Xc<<Rs, therefore Cs bypasses all ac
      components. ");
17 Av=mu*RL/(rd+RL); // unitless
18 Vo=Av*Vs; //in Volt
19 disp(Vo,"Output voltage in volt : ");
```

Scilab code Exa 6.7 IDQ VGSQ VD VS VDS VDG

```
1 //Exa 6.7
2 clc;
3 clear;
4 close;
5 //given data
```

```

6 R1=2.1; //in Mohm
7 R2=270; //in Kohm
8 RD=4.7; //in Kohm
9 RS=1.5; //in Kohm
10 VDD=20; //in Volt
11 VP=-4; //in Volt
12 IDSS=8; //in mA
13 //step 1 : Find VGS :
14 VG=R2*10^3*VDD/(R1*10^6+R2*10^3); //in Volt
15 disp("VS=ID*RS-VGS Volt");
16 disp("VGS=VG-VS=2.28-1.5*ID")
17 //step 2 : Find ID :
18 disp("ID=IDSS*[1-VGS/VP]^2 mA");
19 disp("ID=8*[1-(2.28-1.5*ID)/4]^2 mA");
20 disp("2*ID=39.44-18.84*ID+2.25*ID^2");
21 disp("2.25*ID^2-20.84*ID+39.44=0")
22 disp("ID=6.6mA or 2.65mA");
23 disp("For ID =6.6mA VDS=-ve");
24 disp("So discard the value so IDQ = 2.65mA.");
25 ID=2.65; //in mA
26 //step 3 : Find VGSQ :
27 IDQ=ID; //in mA
28 VGS=2.28; //in Volt
29 VGSQ=VGS-1.5*IDQ; //in Volt
30 //step 4 : Find VDSQ :
31 VDSQ=VDD-IDQ*(RD+RS); //in Volt
32 //step 5 : Find VD, VS and VDG :
33 VDS=VDSQ; //in Volt
34 VG=VGS; //in Volt
35 VS=ID*RS; //in Volt
36 VD=VS+VDS //in Volt
37 VDG=VD-VG; //in Volt
38 disp(IDQ,"IDQ in mA : ");
39 disp(VGSQ,"VGSQ in Volt :");
40 disp(VD,"VD in Volt :");
41 disp(VS,"VS in Volt :");
42 disp(VDS,"VDS in Volt :");
43 disp(VDG,"VDG in Volt :");

```

Scilab code Exa 6.8 Pinch off voltage

```
1 //Exa 6.8
2 clc;
3 clear;
4 close;
5 //given data
6 a=5.6*10^-6/2;//in meter
7 k=12;//unitless
8 epsilon_o=8.86*10^-12;//in F/m
9 epsilon=k*epsilon_o;//in F/m
10 ND=10^15;//in cm^-3
11 ND=10^15*10^6;//in m^-3
12 e=1.6*10^-19;//in Coulomb
13 VP=e*ND*a^2/(2*epsilon);//in Volt
14 disp(VP,"Pinch off voltage in volts : ");
```

Scilab code Exa 6.10 Plot gm VS IDSS

```
1 //Exa 6.10
2 clc;
3 clear;
4 close;
5 //given data
6 VP=-6;//in Volt
7 IDSS=8;//in mA
8 disp("We have ID=IDSS*[1-VGS/VP]^2");
9 disp("Mutual conductance , gm=(delID/delVGS)=IDSS
      *2*[1-VGS/VP]*(-1/VP)=(-2*IDSS/VP)*[1-VGS/VP]");
10 //For VGS=0
11 VGS=0;//in Volt
```

```

12 IDSS=1:8; //in mA
13 for i=1:8
14     gm(i)=-2*IDSS(i)/VP
15 end
16 title('gm versus IDSS');
17 xlabel('gm(in mS)');
18 ylabel('IDSS(in mA)');
19 plot2d(gm, IDSS);
20 disp("Clearly the plot of gm vs IDSS for VD=-6V,
      IDSS=8mA is a straight line of slope=-2/VP
      =-(2/-6)=1/3");

```

Scilab code Exa 6.11 Channel width W

```

1 //Exa 6.11
2 clc;
3 clear;
4 close;
5 //given data
6 L=1.25; //in um
7 mu_n=0.065; //in m^2/V-s
8 Cox=6.9*10^-4; //in F/m^2
9 VT=0.65 //in Volt
10 ID_sat=4; //in mA
11 VGS=5; //in Volt
12 //Formula : ID_sat=W*mu_n*Cox*(VGS-VT)^2/(2*L)
13 W=ID_sat*10^-3*2*L*10^-6/(mu_n*Cox*(VGS-VT)^2); //in
      meter
14 disp(W*10^6, "Channel Width in micro meter :");

```

Chapter 7

Magnetic Materials

Scilab code Exa 7.1 Horizontal component of magnetic Intensity

```
1 //Exa 7.1
2 clc;
3 clear;
4 close;
5 //Given data
6 Bo=1.7*10^-5; //in weber/m^2
7 meu_o=4*pi*10^-7; //permeability of free space in
   weber/amp-meter
8 H=Bo/meu_o; //in A/m
9 disp(H,"Horizontal component of magnetic filed
   intensity in A/m : ");
```

Scilab code Exa 7.2 Current through solenoid

```
1 //Exa 7.2
2 clc;
3 clear;
4 close;
```

```

5 //Given data
6 H=5*10^3; //in Ampere-turns/m
7 l=10; //in cm
8 l=1*10^-2; //in meter
9 N=50; //no. of turns
10 n=N/l; //no. of turns per unit length
11 //Formula : H=n*i
12 i=H/n; //in Ampere
13 disp(i,"Current should be sent through solenoid in
    Ampere : ");

```

Scilab code Exa 7.3 Magnetic moment of rod

```

1 //Exa 7.3
2 clc;
3 clear;
4 close;
5 //Given data
6 meu_r=1000; //relative permeability
7 n=5; //turns/cm
8 n=n*10^2; //turns/meter
9 i=0.5; //in Ampere
10 Volume=10^-4; //in m^3
11 I=(meu_r-1)*n*i; //in Ampere
12 MagneticMoment=I*Volume; //in Ameter^2
13 disp(round(MagneticMoment),"Magnetic moment of the
    rod in Ampere-meter^2 : ");

```

Scilab code Exa 7.4 Flux density magnetic intensity and permeability

```

1 //Exa 7.4
2 clc;
3 clear;

```

```

4 close;
5 //Given data
6 l=30;//in cm
7 l=1*10^-2;//in meter
8 A=1;//in cm^2
9 A=A*10^-4;//in meter^2
10 N=300;//turns of wire
11 i=0.032;//in Ampere
12 FI_B=2*10^-6;//in weber
13 meu_o=4*pi*10^-7;//permeability of free space in
    weber/amp-meter
14 B=FI_B/A;//in weber/meter^2
15 disp(B,"Flux Density in weber/meter^2 : ");
16 H=N*i/l;//in amp-turn/meter
17 disp(H,"magnetic Intensity in amp-turn/meter : ");
18 meu=B/H;//in weber/Amp-meter
19 disp(meu,"Permeability in weber/amp-meter : ");
20 meu_r=meu/meu_o;//Relative Permeability
21 disp(meu_r,"Relative Permeability : ");
22 //Answer of relative permeability is wrong in the
    book.

```

Scilab code Exa 7.5 Relative Permeability

```

1 //Exa 7.5
2 clc;
3 clear;
4 close;
5 //Given data
6 format('v',15);
7 Xci_m=9.48*10^-9;//usceptibility of medium(unitless)
8 meu_r=1+Xci_m;//relative permeability(unitless)
9 disp(meu_r,"Relative Permeability : ");
10 disp("i.e, Relative Permeability is slightly greater
    than 1.");

```

Scilab code Exa 7.6 Magnetising Force and material magnetisation

```
1 //Exa 7.6
2 clc;
3 clear;
4 close;
5 //Given data
6 n=10; //turns/cm
7 n=n*10^2; //turns/meter
8 i=2; //in Ampere
9 B=1; //in weber/meter^2
10 meu_o=4*pi*10^-7; //permeability of free space in
    weber/amp-meter
11 H=n*i; //in amp-turn/meter
12 disp(H,"Magnetising Force in amp-turn/meter : ");
13 //Formula : B=meu_o*(H+I)
14 I=B/meu_o-H; //in amp-turn/meter
15 disp(I,"Magnetisation of material in amp-turn/meter
    :");
16 meu_r=B/(meu_o*I); //relative permeability(unitless)
17 disp(meu_r,"Relative Permeability : ");
```

Chapter 8

Oscillators

Scilab code Exa 8.m.1 Value of L1

```
1 //Exa Misc 8.1
2 clc;
3 clear;
4 close;
5 //given data
6 format('v',5);
7 L2=0.4; //in mH
8 C=0.004; //in F
9 f=120; //in KHz
10 L1=1/(4*%pi^2*(f*10^3)^2*C*10^-6)-L2*10^-3; //in H
11 disp(L1*10^3," Value of L1(in mH) :");
```

Scilab code Exa 8.m.2 Value of C and hfe

```
1 //Exa Misc 8.2
2 clc;
3 clear;
4 close;
```

```

5 //given data
6 format('v',6);
7 fo=10;//in KHz
8 R1=25;//in kohm
9 R2=60;//in kohm
10 Rc=40;//in kohm
11 R=7.1;//in kohm
12 hie=1.8;//in kohm
13 C=1/(2*pi*fo*10^3*R*10^3*sqrt(6+4*Rc/R));//in F
14 disp(C*10^9,"Value of Capacitor(in nF) :");
15 hfe=23+29*R/Rc+4*Rc/R;//unitless
16 disp("Value of hfe is "+string(hfe));

```

Scilab code Exa 8.m.3 Value of Capacitor

```

1 //Exa Misc 8.3
2 clc;
3 clear;
4 close;
5 //given data
6 format('v',5);
7 R=100;//in kohm
8 fo=10;//in KHz
9 C=1/(2*pi*fo*10^3*R*10^3);//in F
10 disp(C*10^12,"Value of Capacitor(in pF) :");

```

Scilab code Exa 8.m.4 Various parameter of colpitt oscillator

```

1 //Exa Misc 8.4
2 clc;
3 clear;
4 close;
5 //given data

```



```

6  format('v',5);
7  L=40; //in mH
8  C1=100; //in pF
9  C2=500; //in pF
10 Vout=10; //in volt
11 fo=1/(2*pi*sqrt(L*10^-3*C1*10^-12*C2*10^-12/(C1
    *10^-12+C2*10^-12)))
12 disp(fo*10^-3,"Frequency of oscillation (in KHz) :")
    ;
13 Vf=Vout*C1/C2; //in volt
14 disp(Vf,"Feedback voltage in volt :");
15 Gain=C2/C1; //unitless
16 disp(Gain,"Minimum Gain is ");
17 //if Gain=10
18 Gain=10; //given
19 C1=C2/Gain; //in pF
20 disp(C1,"For a gain of 10 C1 in pF is :");
21 fo=1/(2*pi*sqrt(L*10^-3*C1*10^-12*C2*10^-12/(C1
    *10^-12+C2*10^-12)))
22 disp(fo*10^-3,"New frequency of oscillation (in KHz)
    :");

```

Scilab code Exa 8.m.5 Resonant frequencies and Q factor

```

1  //Exa Misc 8.5
2  clc;
3  clear;
4  close;
5  //given data
6  format('v',6);
7  L=0.5; //in H
8  Cs=0.06; //in pF
9  Cp=1; //in pF
10 R=5; //in Kohm
11 fs=1/(2*pi*sqrt(L*Cp*10^-12)); //in Hz

```

```

12 Q=2*%pi*fs*L/(R*10^3); //Q-factor
13 disp(fs/10^3,"Series resonance frequency(in KHz)")
14 disp(round(Q),"Q-factor of the crystal at fs is ");
15 fp=(1/(2*%pi))*sqrt((Cs*10^-12+Cp*10^-12)/(L*Cs
    *10^-12*Cp*10^-12)); //in Hz
16 Q=2*%pi*fp*L/(R*10^3); //Q-factor
17 disp(fp/10^3,"Series resonance frequency(in KHz)")
18 disp(round(Q),"Q-factor of the crystal at fs is ");

```

Scilab code Exa 8.1 feed bck factor

```

1 //Exa 8.1
2 clc;
3 clear;
4 close;
5 //Given data
6 A=50; //unitless
7 disp("Barkhausen criterion for oscillator : Beta*A=1
    ");
8 Beta=1/A; //unitless
9 disp(Beta,"Feedback Factor to make oscillator : ");

```

Scilab code Exa 8.2 Range of variable capacitor

```

1 //Exa 8.2
2 clc;
3 clear;
4 close;
5 //Given data
6 format('v',5);
7 L=100; //in uH
8 L=L*10^-6; //in H
9 f1=500; //in kHz

```

```

10 f1=f1*10^3; //in Hz
11 f2=1500; //in kHz
12 f2=f2*10^3; //in Hz
13 //Formula : f=1/(2*%pi*sqrt(L*C))
14 C1=1/(4*%pi^2*f1^2*L); //in F
15 C2=1/(4*%pi^2*f2^2*L); //in F
16 disp("Range of capacitor : "+string(C2*10^12)+" pF
      to "+string(C1*10^12)+" pF");

```

Scilab code Exa 8.3 C2 of colpitt oscillator

```

1 //Exa 8.3
2 clc;
3 clear;
4 close;
5 //Given data
6 format('v',9);
7 L=100; //in mH
8 L=L*10^-3; //in H
9 C1=0.1; //in uF
10 C1=C1*10^-6; //in F
11 f=100; //in kHz
12 f=f*10^3; //in Hz
13 //Formula : f=1/(2*%pi*sqrt(L*C))
14 C=1/(4*%pi^2*f^2*L); //in F
15 //Formula : C=C1*C2/(C1+C2)
16 C2=C*C1/(C1-C);
17 disp(C2,"C2 in micro farad : ");
18 //Note : Answer in the book is wrong.

```

Scilab code Exa 8.4 Frequency of oscillation

```

1 //Exa 8.4

```

```

2  clc;
3  clear;
4  close;
5  //Given data
6  R=100;//in kOhm
7  R=R*103;//in Ohm
8  C=0.01;//in uF
9  C=C*10-6;//in F
10 fo=sqrt(6)/(2*%pi*R*C);//in Hz
11 disp(fo,"Frequency of oscillation in Hz : ");
12 //Note : Answer in the book is not accurate.

```

Scilab code Exa 8.5 Amplifier voltage gain

```

1  //Exa 8.5
2  clc;
3  clear;
4  close;
5  //Given data
6  disp("Put alfa=sqrt(6) to find the gain");
7  alfa=sqrt(6);//unitless
8  Beta=1/(1-5*alfa2);
9  //Barkhausen critera : A*|Beta|>=1
10 Beta=-Beta;//
11 A=1/Beta;//unitless
12 disp(A,"Minimum Gain of Amplifier must be : ");

```

Scilab code Exa 8.6 Frequency of oscillation and min current gain

```

1  //Exa 8.6
2  clc;
3  clear;
4  close;

```

```

5 //Given data :
6 R1=50;//in kohm
7 R1=R1*10^3;//in ohm
8 C1=0.001;//in uF
9 C1=C1*10^-6;//in F
10 R2=1;//in kohm
11 R2=R2*10^3;//in ohm
12 C2=0.01;//in uF
13 C2=C2*10^-6;//in F
14 //Part (i)
15 //Formula :  $f=1/(2*\%pi*\text{sqrt}(C1*C2*R1*R2))$ 
16  $f=1/(2*\%pi*\text{sqrt}(C1*C2*R1*R2))$ ;//in Hz
17 disp(f/1000,"Frequency of oscillations in kHz : ");
18 //Part (ii)
19 CurrentGain=1+C2/C1+R1/R2;// unitless
20 disp(CurrentGain,"Current Gain : ");

```

Scilab code Exa 8.7 Resistnce to cover frequency range

```

1 //Exa 8.7
2 clc;
3 clear;
4 close;
5 //Given data :
6 fmin=20;//in Hz
7 fmax=20;//in kHz
8 Cmin=30;//in pF
9 Cmax=300;//in pF
10 //Formula :  $f_o=1/(2*\%pi*R*C)$ 
11 disp("Minimum Fequeny correspond to maximum
    capacitance.")
12  $R=1/(2*\%pi*fmin*Cmax*10^{-12})$ 
13 disp(R/10^6,"Required resistance in Mohm : ");

```

Scilab code Exa 8.8 Resonant Frequency

```
1 //Exa 8.8
2 clc;
3 clear;
4 close;
5 //Given data :
6 f=500; //in kHz
7 T1=50; //in degree C
8 T2=60; //in degree C
9 TC=-20; //in ppm/degree C
10 ChangeInFreq=TC*(f*10^-3)*(T1-T2); //in Hz
11 ResonantFreq=f*1000-ChangeInFreq; //in Hz
12 disp(ResonantFreq/1000,"Resonant frequency in kHz :
    ");
13 //Note : answer in the book is wrong.
```

Scilab code Exa 8.9 Resonant Frequency

```
1 //Exa 8.9
2 clc;
3 clear;
4 close;
5 //Given data :
6 f=450; //in kHz
7 T1=30; //in degree C
8 T2=50; //in degree C
9 TC=-10; //in ppm/degree C
10 PercentChange=-TC*100/10^6; //in %
11 TotalChangeInFreq=(PercentChange/100)*(f*10^3)*(T2-
    T1); //in Hz
12 ResonantFreq=f*1000-TotalChangeInFreq; //in Hz
```

```
13 disp(ResonantFreq/1000,"Resonant frequency in kHz :
    ");
14 //Note : answer in the book is wrong.
```

Scilab code Exa 8.10 Parallel and series resonant frequencies

```
1 //Exa 8.10
2 clc;
3 clear;
4 close;
5 //Given data :
6 L=0.5;//in H
7 C=0.05;//in pF
8 R=1;//in kohm
9 Cm=1;//in pF
10 fs=1/(2*pi*sqrt(L*C*10^-12));//in Hz
11 disp(fs/10^6,"Series resonant frequency in MHz :");
12 fp=1/(2*pi*sqrt((L*C*10^-12*Cm*10^-12)/(C*10^-12+Cm
    *10^-12)));//in Hz
13 disp(fp/10^6,"Parallel resonant frequency in MHz :")
    ;
```

Chapter 9

Unijunction Transistor

Scilab code Exa 9.1 Stand off voltage and peak point Voltage

```
1 //Exa 9.1
2 clc;
3 clear;
4 close;
5 //Given data :
6 VBB=20;//in volt
7 VB=0.7;//in volt(For Si)
8 ETA=0.6;//intrinsic stand off ratio
9 //Part (i)
10 StandOffVoltage=ETA*VBB;//in volt
11 disp(StandOffVoltage,"Stand Off Voltage in volts :")
12 ;
13 //Part (ii)
14 VP=ETA*VBB+VB;//in volts
15 disp(VP,"Peak point Voltage in volts : ");
```

Scilab code Exa 9.2 Time period of sawtooth waveform


```

1 //Exa 9.2
2 clc;
3 clear;
4 close;
5 //Given data :
6 VP=10; //in volt
7 R=100; //in Kohm
8 C=1000; //in pF
9 VBB=20; //in Volts
10 ETA=VP/VBB; //intrinsic stand off ratio
11 T=R*103*C*10-12*log(1/(1-ETA)); //in sec
12 disp(T*106, "Time period of sawtooth wave in miro
    seconds : ")

```

Scilab code Exa 9.3 Resistances RB1 and RB2

```

1 //Exa 9.3
2 clc;
3 clear;
4 close;
5 //Given data :
6 RBB=10; //in Kohm
7 ETA=0.6; //intrinsic stand off ratio
8 RB1=ETA*RBB; //in Kohm
9 RB2=RBB-RB1; //in Kohm
10 disp(RB1, "Resistance RB1 in Kohm :");
11 disp(RB2, "Resistance RB2 in Kohm :");

```

Chapter 11

Multivibrators

Scilab code Exa 11.1 Frequency of Oscillators

```
1 //Exa 11.1
2 clc;
3 clear;
4 close;
5 //Given data
6 R1=15;//in kohm
7 R2=15;//in kohm
8 C1=0.005;//in uF
9 C2=0.005;//in uF
10 R=R1;//in Kohm
11 C=C1;//in uF
12 T=0.69*(R*103*C*10-6+R*103*C*10-6);//in second
13 f=1/T;//in Hz
14 disp(f*10-3,"Frequency of oscillators in KHz : ");
```
