Scilab Textbook Companion for A Textbook Of Electronic Devices And Circuits by S. Prakash And S. Rawat[1]

Created by
Arshad Khan
B.Tech
Computer Engineering
Uttarakhand Tech. University
College Teacher
NA
Cross-Checked by
Mukul R. Kulkarni

July 31, 2019

[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: A Textbook Of Electronic Devices And Circuits

Author: S. Prakash And S. Rawat

Publisher: Anand Publications, New Delhi

Edition: 3

Year: 2012

ISBN: 978-93-80225-48-7

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 1

Special Diodes

Scilab code Exa 1.1 `Reverse saturation current`

```
//Exa 1.1
clc;
clear;
close;
//Given data
I=40;//in mA
V=0.25;//in Volt
T=20;//in degree C
T=T+273;//in Kelvin
ETA=1;//For Ge
e=1.6*10^-19;//in Coulamb(electronic charge)
k=1.38*10^-23;//in J/K(Boltzman Constant)
//Formula : I=Io*(exp(%e*V/(ETA*k*T))-1)
y=(e*V/(ETA*k*T));//Assumed
y=round(y);
Io=I*10^-3/(exp(y)-1);//in mA
disp(Io*10^6,"Reverse saturation current in micro
   Ampere : ");
```

Scilab code Exa 1.2 Value of forward voltage

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

Scilab code Exa 1.3 DC current DC voltage Ripple factor

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

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

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

```
//Exa 1.4
clc;
clear;
close;
//Given data
rf=20;//in ohm
RL=980;//in Ohm
Vrms=50;//in Volt
Vo=Vrms*sqrt(2);//in Volt
Io=Vo/(RL+rf);//in Ampere
//Part (i)
Idc=2*Io/%pi;//in Ampere
disp(round(Idc*10^3),"Average DC current in mA :");
//Part (ii)
Irms=Io/sqrt(2);//in Ampere
disp(Irms*1000,"rms value of load current in mA :")
//Part (iii)
Vdc=RL*Idc;//in Volt
disp(Vdc,"DC output voltage in volt :");
//Part (iv)
ETA=(Idc^2*RL/(Irms^2*(RL+rf)))*100;//Rectification Efficiency in %
disp("Rectification Efficiency is "+string(ETA)+" %"
```

```
    )
//Part (v)
PIV=2*Vo;//in volt
disp(PIV,"Peak Inverse Voltage in volt :");
```

Scilab code Exa 1.5 Minimum value of resistance

```
//Exa 1.5
clc;
clear;
close;
//Given data
Vin=40;//in volt
VZ=10;//in volt
Vo=10;//in volt
IZmax=50;//in mA
IL=0;//in mA
//Formula : I=IZ+IL=IZmax+0
I=IZmax+0;//in mA
//Formula : VZ=Vin-R*I
Rmin=(Vin-VZ)/(I*10^-3);//in Ohm
disp(Rmin,"Minimum value of resistance in Ohm : ");
```

Scilab code Exa 1.6 Value of series Resistor

```
//Exa 1.6
clc;
clear;
close;
//Given data
Vmin=15;//Minimum input voltage in volt
VZ=6.8;//Voltage across zener in volt
Vo=VZ;//output voltage in volt
```

```
Vsr1=Vmin-Vo;//Voltage aross series resistance in
    volt
disp("If R is the series esistance , Total current in
     series resistance in Ampere : I=Vsr/R=8.2/R ");
ILmin=5;//in mA
disp("current in zener diode in Ampere :IZ=I-IL
    =(8.2/R-IL*10-3)              eqn(1)");
Vmax=20;//mximum output voltage
Vo=VZ;//output voltage in volt
Vsr2=Vmax-Vo;//Voltage aross series resistance in
    volt
disp("Current in series resistance circuit in Ampere
     : I=Vsr/R");
ILmax=15;//in mA
disp("current in zener diode in Ampere :IZ=I-IL=(Rs/
    R-IL*10-3)              eqn(2)")
disp("For Zener diode to work as voltage regulator
    ,(1) and (2) must be same.");
disp("(8.2/R-IL*10-3)=(13.2/R-IL*10-3)")
R=(Vsr2-Vsr1)/(ILmax*10^-3-ILmin*10^-3);//in Ohm
disp(R,"Required value of Series Resistor in ohm : "
    );
```

Scilab code Exa 1.7 `Current limiting resistance and dissipated power`

```
//Exa 1.7
clc;
clear;
close;
//Given data
Vin=18;//in volt
IZ=20;//in mA
ILav=(5+35)/2;//in mA
VZ=12;//in volt
Vo=12;//in volt
```

```
I=IZ+ILav;//in mA
R=(Vin-Vo)/(I*10^-3);//in Ohm
disp(R,"Current limiting resistance in Ohm : ");
P=(I*10^-3)^2*R;//in Watts
disp(P,"Power disspation in resistance in Watt : ");
```

Scilab code Exa 1.8 Maximum and minimum input supply voltage

```
//Exa 1.8
clc;
clear;
close;
//Given data
R=1;//in kOhm
RL=5;//in kOhm
VZ=10;//in volt
Vo=10;//in volt
P=250;//in mW
IL=Vo/RL;//in mA
IZmin=0;//in mA
IZmax=P/VZ;//in mA
Imin=IZmin+IL;//in mA
Imax=IZmax+IL;//in mA
Vin_min=VZ+Imin*10^-3*R*10^3;//in volt
Vin_max=VZ+Imax*10^-3*R*10^3;//in volt
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

```
//Exa 1.9
clc;
clear;
```

```
close;
//Given data
R=5;//in kOhm
R=R*1000;//in Ohm
RL=10;//in kOhm
RL=RL*1000;//in Ohm
Vin=120;//in Volt
VZ=50;//in Volt
//Part (i)
Vo=VZ;//in Volt
disp(Vo,"Output voltage in volt : ");
//Part (ii)
VR=Vin-VZ;//in Volt
disp(VR,"Voltage drop across series resistance in
   volt :");
//Part (iii)
IL=Vo/RL;//in Ampere
disp(IL*1000,"Load Current in mA :");
I=VR/R;//in Ampere
disp(I*1000,"Current through resistance R in mA :");
IZ=I-IL;//in Ampere
disp(IZ*1000,"Load Current in mA :");
```

Scilab code Exa 1.10 Maximum and Minimum LED current

```
//Exa 1.10
clc;
clear;
close;
//Given data
VDmin=1.5;//in Volt
VDmax=2.3;//in Volt
VS=5;//in Volt
RS=270;//in Ohm
Imin=(VS-VDmax)/RS;//in Ampere
```

```
disp(Imin*1000,"Minimum value of LED current in mA :
    ");
Imax=(VS-VDmin)/RS;//in Ampere
disp(round(Imax*1000),"Maximum value of LED current
    in mA : ");
```

Scilab code Exa 1.11 Frequency range of tuning circuit

```
//Exa 1.11
clc;
clear;
close;
//Given data
format('v',6);
C1min=10;//in pF
C2max=50;//in pF
L=5;//in mH
L=L*10^-3;//in H
//Formula : CT=C1*C2/(C1+C2)
//Minimum
C1=10;//in pF
C2=10;//in pF
CTmin=C1*C2/(C1+C2);//in pF
CTmin=CTmin*10^-12;//in F
//Maximum
C1=50;//in pF
C2=50;//in pF
CTmax=C1*C2/(C1+C2);//in pF
CTmax=CTmax*10^-12;//in F
//Formula : f=1/(2*%pi*sqrt(L*C))
//maximum :
fmax=1/(2*%pi*sqrt(L*CTmin));
//minimum :
fmin=1/(2*%pi*sqrt(L*CTmax));
disp("The frequency of tuning circuit ranges from "+
```

```
    string(fmin/10^6)+"MHz to "+string(fmax/10^6)+"
    MHz.");
//Note : Answer in the book is wrong.
```

Scilab code Exa 1.12 Diode Capacitance

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

Scilab code Exa 1.13 Photocurrent

```
//Exa 1.13
clc;
clear;
close;
//Given data
format('v',6);
R=0.90;//in A/W
Pop=1;//in mW
//Part (i)
IP=R*Pop;//in mA
```

```
disp(IP,"Power of incident light 1mW, Photocurrent
    in mA is :");
//Part (ii)
disp("Here IP is not proportional to Pop(for Pop>1.5
    mW)");
disp("Hence Photourrent can not be calculated.");
```

Scilab code Exa 1.14 Responsivity of InGaAs photodiode

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

Scilab code Exa 1.15 Equilibrium contact potential

```
//Exa 1.15
clc;
clear;
close;
```

```
//Given data
W1=2.5;//in eV
W2=1.9;//in eV
ContactPotential=W1-W2;//in Volt
disp(ContactPotential,"Contact potential in Volts :
    ");
```

Chapter 2

Bipolar Junction Transistors

Scilab code Exa 2.1 Current amplification factors

```
//Exa 2.1
clc;
clear;
close;
//Given data
deltaIB=50;//in uA
deltaIC=1;//in mA
deltaIC=deltaIC*10^3;//in uA
Beta=deltaIC/deltaIB;//unitless
disp(Beta,"Current Amplification Factor,Beta :");
Alfa=Beta/(1+Beta);//unittless
disp("Current Amplification Factor,Alfa :"+string(
    Alfa)+" or 20/21");
```

Scilab code Exa 2.2 Value of IE

```
//Exa 2.2
clc;
```

```
clear;
close;
//Given data
IB=25;//in uA
Beta=40;//unitless
IC=Beta*IB;//in uA
IE=IB+IC;//in uA
disp("The value of IE :"+string(IE)+" micro Ampere")
    ;
```

Scilab code Exa 2.3 Change in collector current

```
//Exa 2.3
clc;
clear;
close;
//Given data
alfa=0.98;//unitless
deltaIB=0.2;//in mA
Beta=alfa/(1-alfa);//unitless
deltaIC=Beta*deltaIB;//in mA
disp("Change in collector curent : "+string(deltaIC)
    +" milli Ampere.");
```

Scilab code Exa 2.4 Input current in CE and CB configuration

```
//Exa 2.4
clc;
clear;
close;
//Given data
Beta=45;//unitless
RL=1;//in kOhm
```

```
deltaVCE=1;//in volt
disp("Part (i) : CE coniguration");
IC=deltaVCE/(RL*1000);//in Ampere
//Formula : Beta=deltaIC/deltaIB
IB=IC/Beta;//in Ampere
disp("Input Base Current, IB in mA : "+string(IB
   *10^3));
disp("Part (ii) : CB coniguration");
IC=deltaVCE/(RL*1000);//in Ampere
//Formula : Beta=deltaIC/deltaIB
IE=IB+IC;//in Ampere
disp("Input Emitter Current, IE in mA : "+string(IE
   *10^3));
```

Scilab code Exa 2.5 Current gain and base current

```
//Exa 2.5
clc;
clear;
close;
//Given data
Ileakage=12.5;//in uA
ICBO=12.5;//in uA
IE=2;//in mA
IC=1.97;//in mA
//Formula : IC=alfa*IE+ICBO
alfa=(IC-ICBO/10^3)/IE;//unitless
disp(alfa,"Current Gain : ");
IB=IE-IC;//in mA
disp(IB,"Base current in mA : ");
```

Scilab code Exa 2.6 Input resistance of transistor

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

Scilab code Exa 2.7 Dynamic input resistance

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

Scilab code Exa 2.9 Current gain input resistance and voltage gain

```
//Exa 2.9
clc;
clear;
close;
//Given data
format('v',10);
Ri=500;//in Ohm
RL=1;//in kOhm
```

```
hie=1;//in kOhm
hre=2*10^-4;//unitless
hfe=50;//unitless
hoe=25;//micro mho
//Part (a) :
Ai=-hfe/(1+hoe*10^-6*RL*10^3);//unitless
disp(Ai,"Current Gain : ");
//Part (b) :
Rin=hie*10^3-(hre*hfe/(hoe*10^-6+1/RL*10^3));//in
    Ohm
disp(Rin,"Input Resistance in Ohm :");
//Part (c) :
Av=Ai*RL*10^3/Ri;//unitless
disp(Av,"Voltage Gain : ");
```

Scilab code Exa 2.10 Collector emitter saturation voltage

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

Scilab code Exa 2.11 Relative size of collector junction

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

Scilab code Exa 2.12 DC load line and operating point

```
//Exa 2.12
clc;
clear;
close;
//Given data
Beta=100;//unitless
VCC=6;//in volt
RB=530;//in kOhm
RC=2;//in kOhm
```

```
VBE=0.7;//in volt(For Si)
//Part (i)
IC1=0;//in A
VCE1=VCC-IC1*RC;//in volt
//If VCE=0;//in volt
VCE2=0;//in volt
IC2=VCC/RC;//in Ampere
title('DC load line');
xlabel('VCE(in volts)');
ylabel('IC(in mA)');
plot([VCE1,IC1],[VCE2,IC2]);//DC load line
//Formula : VCC=VBE+IB*RB
IB=(VCC-VBE)/(RB*10^3);//in Ampere
IC=Beta*IB;//in Ampere
VCE=VCC-IC*RC*10^3;//in volt
disp("Q point coordinates are :");
disp("IC="+string(IC*10^3)+" mA and VCE="+string(VCE)+" Volt.");
```

Scilab code Exa 2.13 `RB and new value of IC`

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

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

Scilab code Exa 2.14 Set the operating point

```
//Exa 2.14
clc;
clear;
close;
//Given data :
format('v',10);
disp("To set the required operating point, value of
   RB will be find out. ")
IC=1;//in mA
VCE=8;//in volt
Beta=100;//unitless
VCC=12;//in volt
VBE=0.3;//in volt(For Ge)
//Prt (i)
RC=(VCC-VCE)/(IC*10^-3);//in ohm
IB=IC/Beta;//in mA
RB=(VCC-VBE-Beta*(IB*10^-3)*RC)/(IB*10^-3);//in Ohm
disp(RB/1000,"Value of RB in kOhm");
//Part (ii)
Beta=50;//unitless
IB=(VCC-VBE)/(RB+Beta*RC);//in mA
IC=Beta*IB;//in Ampere
VCE=VCC-IC*RC;//in volt
disp("New operating point is ("+string(VCE)+"V,"+
   string(IC*10^3)+"mA)");
```

Scilab code Exa 2.15 `Value of IC`

```
//Exa 2.15
clc;
clear;
close;
//Given data :
R1=50;//in kohm
R2=10;//in kohm
RE=1;//in kohm
VCC=12;//in volt
//Prt (i)
VBE=0.1;//in volt
VBBdash=(R2/(R1+R2))*VCC;//in volt
IC1=(VBBdash-VBE)/(RE*1000);//in mA
disp(IC1*1000,"At VBE=0.1V, Value of IC in mA : ");
//Part (ii)
VBE=0.3;//in volt
IC2=(VBBdash-VBE)/(RE*1000);//in mA
disp(IC2*1000,"At VBE=0.3V, Value of IC in mA : ");
```

Scilab code Exa 2.16 `Operating point and stability factor`

```
//Exa 2.16
clc;
clear;
close;
//Given data :
R1=10;//in kohm
R2=5;//in kohm
RE=2;//in kohm
RC=1;//in kohm
```

```
VCC=12;//in volt
Beta=100;//unitless
VBE=0.7;//in volt
//Part (i)
//Formula : VBE=VBBdash-IB*RBdash-IE*RE
disp("IB is ver small : VBE=VBBdash-IE*RE");
VBBdash=(R2/(R1+R2))*VCC;//in volt
IE=(VBBdash-VBE)/(RE*10^3);//in Ampere
disp("As base current is very small IC=IE");
IC=IE;//in mA
//Formul : VCC=IC*RC+VCE+IE*RE
VCE=VCC-IC*RC*10^3-IE*RE*10^3;//in Volt
disp("Operating point is ("+string(VCE)+"V,"+string(
   IC*10^3)+"mA)");
//Part (ii)
RBdash=(R1*R2/(R1+R2));//in kOhm
S=(Beta+1)/(1+Beta*(RE/(RBdash+RE)));
disp("Staility factor S is : "+string(S));
```

Scilab code Exa 2.17 IC and VCE

```
//Exa 2.17
clc;
clear;
close;
//Given data :
R1=200;//in kohm
R2=100;//in kohm
RE=1;//in kohm
RC=1;//in kohm
VCC=9;//in volt
he=2;//in kohm
hfe=100;//unitless
hoe=0;//unitless
hre=0;//unitless
```

```
VBE=0.7;//in volt(For Si)
//Part (i)
RB=R1*R2/(R1+R2);//in kohm
VBBdash=(R2/(R1+R2))*VCC;//in volt
//Applying Kirchoff Law
IB=(VBBdash-VBE)/(RB*10^3+RE*10^3*(1+hfe));//in
    Ampere
IC=hfe*IB;//in Ampere
disp(IC*10^3,"Value of IC in mA : ");
//Part (ii)
//Applying Kirchoff Law
VCE=VCC-IC*RC*10^3-RE*1063*IB*(hfe+1);//in volt
disp(VCE,"VCE in volt :");
//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

```
//Exa 2.18
clc;
clear;
close;
//Given data :
RB=50;//in kohm
RC=3;//in kohm
VCC=10;//in volt
VEE=5;//in volt
hfe=100;//unitless
VCEsat=0.2;//in volt
VBEsat=0.8;//in volt
VBEactive=0.7;//in volt
VBE=0.7;//in volt(For Si)
//Applying
IB=(VEE-VBE)/(RB*10^3);//in Ampere: Kirchoff 2nd Law
     : VEE-RB*IB-VBE=0
```

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

Scilab code Exa 2.19 `Voltage across RE`

```
//Exa 2.19
clc;
clear;
close;
//Given data :
VCC=20;//in volt
VBE=0.7;//in volt(For Si)
Beta=50;//unitless
RE=200;//in ohm
R1=60;//in kohm
R2=30;//in kohm
V2=VCC*R2/(R1+R2);//in volt
VE0=V2-VBE;//in volt
disp(VE0,"Voltage across RE in volt : ");
```

Chapter 3

Transistor Amplifiers

Scilab code Exa 3.1 Gain Impedence and ac load

```
//Exa 3.2
clc;
clear;
close;
//Given data
ib=10;//in uA
ic=1;//in mA
ic=ic*10^3;//in uA
vi=0.02;//in Volt
RC=5;//in kohm
RL=10;//in kohm
//Part (i)
Ai=-ic/ib;//unitless
Beta=Ai;//unitless
disp(Ai,"Current gain : ");
//Part (ii)
Rie=vi/(ib*10^-6);//in Ohm
disp(Rie*10^-3,"Input impedence in kohm :");
//Part (iii)
Rac=RC*RL/(RC+RL);//in kohm
disp(Rac,"AC load in kohm : ");
```

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

Scilab code Exa 3.2 `Gain input and output impedence`

```
//Exa 3.2
clc;
clear;
close;
//Given data
RL=10;//in kohm
RS=1;//in kohm
hie=1.1;//in kOhm
hre=2.5*10^-4;//unitless
hfe=50;//unitless
hoe=25;//in u mho
Aie=-hfe/(1+hoe*10^-6*RL*10^3);//unitless
Zie=hie+hre*Aie*RL;//in kOhm
Zie=round(Zie);
Ave=Aie*RL/Zie;//unitless
Avs_e=Ave*Zie/(Zie+RS);//
deltah=hoe*10^-6*hie*10^3-hfe*hre;
Zoe=(hie*10^3+RS*10^3)/(hoe*10^-6*RS*10^3+deltah);
Ais_e=Aie*RS/(Zie+RS);
Ape=Ave*Aie;
Aps_e=Avs_e*Ais_e;
disp(Aie,"Current gain : ");
disp(Ais_e,"Current gain with source resistance : ")
    ;
```

```
disp(Ave,"Voltage gain : ");
disp(Avs_e,"Voltage gain with source resistance : ")
    ;
disp(Ape,"Power gain : ");
disp(Aps_e,"Power gain with source resistance : ");
disp(Zie,"Input impedence in kohm :");
disp(Zoe/10^3,"Output impedence in kohm :");
```

Scilab code Exa 3.3 `Input Output impedence and output voltage`

```
//Exa 3.3
clc;
clear;
close;
//Given data :
InputVoltage=1;//in mV
RL=5.6;//in kohm
RS=600;//in ohm
hre=6.5*10^-4;//unitless
hie=1.7;//in kOhm
hfe=125;//unitless
hoe=80;//in uA/V
deltah=hoe*10^-6*hie*10^3-hfe*hre;
Zie=(hie*10^3+RL*10^3*deltah)/(1+hoe*10^-6*RL*10^3);
    //in Ohm
Zoe=(hie*10^3+RS)/(hoe*10^-6*RS+deltah);//in Ohm
Ave=-(hfe*RL*10^3)/(hie*10^3+RL*10^3*deltah);//
    unitless
Avs_e=Ave*Zie/(Zie+RS);//
OutputVoltage=Avs_e*InputVoltage;//in
disp(Zie/1000,"Input impedence in kohm :");
disp(Zoe/10^3,"Output impedence in kohm :");
disp(Ave,"Voltage gain : ");
disp(Avs_e,"Voltage gain with source resistance : ")
    ;
```

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

Scilab code Exa 3.4 Net voltage gain in dB

```
//Exa 3.4
clc;
clear;
close;
//Given data :
A1=100;//unitless
A2=200;//unitless
A3=400;//unitless
A1=20*log10(A1);//in dB
A2=20*log10(A2);//in dB
A3=20*log10(A3);//in dB
NetVoltageGain=A1+A2+A3;//in dB
disp(NetVoltageGain,"Net Voltage Gain in decibels :"
   );
//Note : Answer in the book is wrong.
```

Scilab code Exa 3.5 Bandwidth and cut off frequencies

```
//Exa 3.5
clc;
clear;
close;
//Given data :
MaxGain=1000;//unitless(at 2kHz)
f1=50;//in Hz
f2=10;//in KHz
```

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

Scilab code Exa 3.6 `Overall voltage gain`

```
//Exa 3.6
clc;
clear;
close;
//Given data :
RC=10;//in kohm
hfe=330;//unitless
hie=4.5;//in kOhm
//RS<<hie
AVM=hfe*RC*10^3/(hie*10^3+RC*10^3);//unitless
AVM1=AVM;//Gain of 1st stage
AVM2=AVM;//Gain of 2nd stage
AVM3=hfe*RC*10^3/(hie*10^3);//unitless(//Gain of 3rd
    stage)
OverallGain=AVM1*AVM2*AVM3;//unitless
disp(AVM,"Gain in mid frequeny range : ");
disp("This is the gain of 1st and 2nd stage.")
disp(OverallGain,"Overall Voltage gain for mid
   frequency range : ");
```

Scilab code Exa 3.7 `Couopling capacitor`

```
//Exa 3.7
clc;
clear;
close;
```

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

Scilab code Exa 3.8 Voltage gain

```
//Exa 3.8
clc;
clear;
close;
//Given data :
RC=10;//in kohm
Rin=1;//in kohm
Beta=100;//unitless
RL=100;//in ohm
RCdash=RC*10^3*RL/(RC*10^3+RL);//in ohm
VoltageGain=Beta*RCdash/(Rin*10^3);//in volt
disp(VoltageGain,"Voltage Gain : ");
```

Scilab code Exa 3.9 Inductance of primary and secondary

```
//Exa 3.9
clc;
clear;
close;
//Given data :
Rout=10;//in kohm
```

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

Scilab code Exa 3.10 `Turn ratio of transformer`

```
//Exa 3.10
clc;
clear;
close;
//Given data :
ZL=10;//in ohm
ZP=1000;//in ohm
//For max power : ZP=n^2*ZL
n=sqrt(ZP/ZL);//turn ratio
disp(n,"Turn ratio : ");
```

Scilab code Exa 3.11 `Collector efficieny and power rating`

```
//Exa 3.11
clc;
clear;
close;
//Given data :
Po_dc=10;//in watt
Po_ac=3.5;//in watt
//Part (i) :
```

```
ETAcollector=Po_ac/Po_dc;//unitless
ETAcollector=ETAcollector*100;//collector efficiency
    in %
disp(ETAcollector,"Collector Efficiency(in %) : ");
//Part (ii)
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 effiiency`

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

```
//part (iv) :
Ptr_dc=Pin_dc-PRc_dc;//in watt
disp(Ptr_dc,"dc power dissipated by the collector
    load in Watt : ");
//part (v) :
PC_dc=Pin_dc-PRc_dc-Po_ac;//in watt
disp(PC_dc,"dc power dissipated by the collector
    load in Watt : ");
//part (vi) :
ETAoverall=Po_ac*100/Pin_dc;//Overall Efficiency (in
    %)
disp(ETAoverall,"Overall Efficiency (in %) :");
//part (vii) :
ETAcollector=Po_ac*100/PRc_dc;//Collector Efficiency
    (in %)
disp(ETAcollector,"Collector Efficiency (in %) :");
```

Scilab code Exa 3.13 Maximum ac power output

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

Scilab code Exa 3.14 Maximum permissible power dissipation

```
//Exa 3.14
clc;
clear;
close;
//Given data :
//Part (i) : without heat sink
ThetaMax=90;//in degree C
Theta_o=30;//in degree C
R=300;//in degree C/W
Pr=(ThetaMax-Theta_o)/R;//in watt
disp(Pr,"Without heat sink, Maximum permissible
    power dissipatio in watt :");
//Part (ii) : with heat sink
ThetaMax=90;//in degree C
Theta_o=30;//in degree C
R=60;//in degree C/W
Pr=(ThetaMax-Theta_o)/R;//in watt
disp(Pr,"With heat sink, Maximum permissible power
    dissipatio in watt :");
```

Chapter 4

Frequency Response

Scilab code Exa 4.1 3dB Frequeny

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

Scilab code Exa 4.2 Upper 3dB Frequency

```
//Exa 4.2
clc;
```

```
clear;
close;
//Given data
Omega_P1=10^4;//in Radian/sec
Omega_P2=2*10^4;//in Radian/sec
Omega_Z1=10^5;//in Radian/sec
omegaH=1/sqrt(1/Omega_P1^2+1/Omega_P2^2-2/Omega_Z1
    ^2);//in radian/sec
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

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

Scilab code Exa 5.2 Voltage gain and reduction in voltage

```
//Exa 5.2
clc;
clear;
close;
```

```
//Given data :
A=1000;//gainWithoutFeedback(unitless)
//Part (i) :
disp("At normal collector supply :");
disp("with feedback gain reduces by a factor 0.40");
Af=A-A*0.40;//gainWithFeedback(unitless)
disp(Af,"At normal collector supply, Gain with feedback : ");
//Formula : Af=A/(1+A*Beta)
Beta=(A/Af-1)/A;//feedback factor (unitless)
disp("At reduced power supply :");
Adash=800;//gainWithoutFeedback(unitless)
Af_dash=Adash/(1+Adash*Beta)
disp(round(Af_dash),"At Reduced collector supply, Gain with feedback : ");
//Part (ii)
Reduction=((A-Adash)/A)*100;//% reduction without feedback
disp(Reduction,"percentage reduction in gain without feedback(%) :");
Reduction1=((Af-Af_dash)/Af)*100;//% reduction without feedback
disp(round(Reduction1),"percentage reduction in gain with feedback(%) :");
//Note : answer of Af is wrong in the book.
```

Scilab code Exa 5.3 Gain with feedback factor and feedback voltage

```
//Exa 5.3
clc;
clear;
close;
//Given data :
A=100;//gain without feedback(unitless)
Beta=1/25;//feedback ratio (unitless)
```

```
Vi=50;//in mV
//Part (i) :
Af=A/(1+A*Beta);//gain with feedback(unitless)
disp(Af,"(i) Gain with feedback :");
//Part (ii) :
FeedbackFactor=Beta*A;//unitless
disp(FeedbackFactor,"(ii) Feedback Factor :");
//Part (iii) :
Vo_dash=Af*Vi*10^-3;//in volt
disp(Vo_dash,"(iii) Output Voltage in volts :");
//Part (iv) :
FeedbackVoltage=Beta*Vo_dash;//in volt
disp(FeedbackVoltage,"(iv) Feedback Voltage in volts
    :");
//Part (v) :
Vi_dash=Vi*(1+Beta*A);//in mv
disp(Vi_dash,"(v) New Increased Input Voltage in
    milli volts :");
```

Scilab code Exa 5.4 Bandwidth with negative feedback

```
//Exa 5.4
clc;
clear;
close;
//Given data :
BW=200;//in kHz
A=40;//gain without feedback(in dB)
Beta=5;//negative feedback in %
Beta=Beta/100;//feedback factor
//Formula : Af=A/(1+A*Beta)
Af=A/(1+A*Beta);//gain with feedback(in dB)
disp("Since gain bandwidth product remains constant,
    A*BW=Af*BW_dash");
BW_dash=A*BW/Af;//in kHz
```

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

Scilab code Exa 5.5 Fraction of output fed back

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

Scilab code Exa 5.6 Small Change in gain

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

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

Scilab code Exa 5.7 New gain distortion and input voltage

```
//Exa 5.7
clc;
clear;
close;
//Given data :
A=200;//gain without feedback(unitless)
Dn=10;//Distortion in %
Vi=0.5;//Initial input voltage in volt
Beta=0.05;//feedback ratio (unitless)
//Formula : Af=A/(1+A*Beta)
Af=A/(1+A*Beta);//gain with feedback(unitless)
disp(Af,"New gain :");
Dn_dash=Dn/(1+A*Beta);//new distortion in %
disp(Dn_dash,"Distortion with negative feedback in %
     : ");
InitialOutputVoltage=A*Vi;//in Volt
disp(InitialOutputVoltage,"Initial Output Voltage in
     volt:");
NewInputVoltage=InitialOutputVoltage/Af;//in volt
disp(NewInputVoltage,"New Input Voltage in volts :")
    ;
//Note :Ans of Af and NewInputVoltage is not
    acurate in the book.
```

Scilab code Exa 5.8 `Feedback rction voltage and impedence`

```
//Exa 5.8
clc;
clear;
close;
//Given data :
A=10000;//gain without feedback(unitless)
Zi=10;//in kOhm
Zo=100;//in Ohm
R1=2;//in Ohm
R2=18;//in Ohm
//Part (i) :
Beta=R1/(R1+R2);//feedback fraction(unitless)
disp(Beta,"(i) Feedback Fraction :");
//Part (ii) :
Af=A/(1+A*Beta);//Gain with negative feedback(
    unitless)
disp(round(Af),"(ii) Gain with negative feedback :")
    ;
//Part (iii) :
inputVoltge=0.5;//in mV
outputVoltge=Af*inputVoltge;//in mV
disp(round(outputVoltge),"(iii) Output Voltage in
    milli volts :");
//Part (iv) :
Zif=Zi*(1+Beta*A);//in kOhm
disp(Zif*10^-3,"(iv) Input impedance of feedback
    amplifier in Mohm : ");
//Part (v) :
Zof=Zo/(1+Beta*A);//in kOhm
format('v',4);
disp(Zof,"(v) Output impedance with feedback in Ohm
    : ");
```

Scilab code Exa 5.9 `Voltage gain input and output resistance`

```
//Exa 5.9
clc;
clear;
close;
//Given data :
A=200;//gain without feedback(unitless)
Ri=2;//in kOhm
Ro=12;//in kOhm
Beta=0.02;//feedbak ratio(unitless)
//Part (i) :
Af=A/(1+A*Beta);//gain with feedback(unitless)
disp(Af,"(i) Gain with Negative Feedback :");
//Part (ii) :
Rif=Ri*(1+A*Beta);//in kOhm
disp(Rif,"(ii) Input resistance with feedback in
    kOhm :");
//Part (ii) :
Rof=Ro/(1+A*Beta);//in kOhm
disp(Rof,"(ii) Output resistance with feedback in
    kOhm :");
```

Scilab code Exa 5.10 `Gain wih feedbck in dB`

```
//Exa 5.10
clc;
clear;
close;
//Given data :
format('v',5);
A=1000;//gain(unitless)
```

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

Scilab code Exa 5.11 Bandwidth after feedback

```
//Exa 5.11
clc;
clear;
close;
//Given data :
A=800;//gain(unitless)
f1=40;//in Hz
f2=16;//in kHz
Beta=2/100;//feedback fator (unitless)
//Formula : Af=A/(1+A*Beta)
Af=A/(1+A*Beta);//gain with feedback(unitless)
disp(Af,"Voltage gin with feedback : ");
BW=f2*10^3-f1;//Bandwidth of amplifier in Hz
disp(BW*10^-3,"Bandwidth of amplifier in kHz : ");
f1_f=f1/(1+A*Beta);//in Hz
f2_f=f2*(1+A*Beta);//in kHz
BW_f=f2_f*10^3-f1_f;//Bandwith after feedback in Hz
disp(round(BW_f*10^-3),"Bandwith after feedback in
    KHz : ");
```

Scilab code Exa 5.12 Gain and new bandwidth

```
//Exa 5.12
clc;
clear;
```

```
close;
//Given data :
A=100;//gain(unitless)
BW=10;//in Hz
Beta=5;//in %
//Part (i) :
//Formula : Af=A/(1+A*Beta)
Af=A/(1+A*Beta/100);//gain with feedback(unitless)
disp(Af,"Voltage gin with feedback : ");
//Part (ii)
BW_f=BW*(1+A*Beta/100);//Bandwith after feedback in
    Hz
disp(BW_f,"Bandwith with negative feedback in KHz :
    ");
```

Scilab code Exa 5.13 Input resistance and voltage gain

```
//Exa 5.13
clc;
clear;
close;
//Given data :
hfe=50;//unitless
hie=1.1;//in kOhm
hoe=0;//unitless
hre=0;//unitless
RL=4;//in kOhm
Rs=10;//in kOhm
RB=40;//in kOhm
RLdash=RB*RL/(RB+RL);//in Kohm
AV=-hfe*RLdash/hie;//unitless
//Part (i) ;
Rif=hie*(RB/(1-AV))/(hie+(RB/(1-AV)));//in kOhm
disp(round(Rif*1000),"Input resistance with feedback
     in Ohm : ");
```

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

Chapter 6

Field Effect Transistors and MOSFETS

Scilab code Exa 6.1 `Value of Transconductance`

```
//Exa 6.1
clc;
clear;
close;
//given data
VGS1=-3.1;//in Volt
VGS2=-3;//in Volt
ID1=1;//in mA
ID2=1.3;//in mA
delVGS=VGS2-VGS1;//in Volts
delID=ID2-ID1;//in mA
gm=delID*10^-3/delVGS;//in mhos
disp(gm,"Transconductance in mhos : ");
```

Scilab code Exa 6.2 `AC drain resistance transconductance and amplification factor`

```
//Exa 6.2
clc;
clear;
close;
//given data
VGS1=0;//in Volt
VGS2=0;//in Volt
VGS3=-0.2;//in Volt
VDS1=7;//in Volt
VDS2=15;//in Volt
VDS3=15;//in Volt
ID1=10;//in mA
ID2=10.25;//in mA
ID3=9.65;//in mA
delVDS=VDS2-VDS1;//in Volts
delID=ID2-ID1;//in mA
rd=delVDS/delID;//in Kohm
disp(rd,"AC drain resistance in Kohm : ");
delVGS=VGS3-VGS2;//in Volts
delID=ID3-ID2;//in mA
gm=delID*10^-3/delVGS;//in mhos
disp(gm,"Transconductance in mhos : ");
mu=rd*10^3*gm;//unitless
disp(mu,"Amplification factor : ");
```

Scilab code Exa 6.5 `Voltage Amplification`

```
//Exa 6.5
clc;
clear;
close;
//given data
gm=2;//in milli-mho
RL=10;//in Kohm
disp("assuming rd>>RL");
```

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

Scilab code Exa 6.6 Output voltage of amplifier

```
//Exa 6.6
clc;
clear;
close;
//given data
RL=20;//in Kohm
RS=1;//in Kohm
RG=1;//in Mohm
Cs=25;//in uF
mu=20;//unitless
rd=100;//in Kohm
Vs=2;//in Volt
f=1;//in KHz
Xc=1/(2*%pi*f*Cs);//in Ohm
disp(Xc,"Xc in Ohm : ");
disp("As Xc<<Rs, therefore Cs bypasses all ac
   components. ");
Av=mu*RL/(rd+RL);//unitless
Vo=Av*Vs;//in Volt
disp(Vo,"Output voltage in volt : ");
```

Scilab code Exa 6.7 IDQ VGSQ VD VS VDS VDG

```
//Exa 6.7
clc;
clear;
close;
//given data
```

```
R1=2.1;//in Mohm
R2=270;//in Kohm
RD=4.7;//in Kohm
RS=1.5;//in Kohm
VDD=20;//in Volt
VP=-4;//in Volt
IDSS=8;//in mA
//step 1 : Find VGS :
VG=R2*10^3*VDD/(R1*10^6+R2*10^3);//in Volt
disp("VS=ID*RS-VGS Volt");
disp("VGS=VG-VS=2.28-1.5*ID")
//step 2 : Find ID :
disp("ID=IDSS*[1-VGS/VP]^2 mA");
disp("ID=8*[1-(2.28-1.5*ID)/4]^2 mA");
disp("2*ID=39.44-18.84*ID+2.25*ID^2");
disp("2.25*ID^2-20.84*ID39.44=0")
disp("ID=6.6mA or 2.65mA");
disp("For ID =6.6mA VDS=-ve");
disp("So discard the value so IDQ = 2.65mA.");
ID=2.65;//in mA
//step 3 : Find VGSQ :
IDQ=ID;//in mA
VGS=2.28;//in Volt
VGSQ=VGS-1.5*IDQ;///in Volt
//step 4 : Find VDSQ :
VDSQ=VDD-IDQ*(RD+RS);//in Volt
//step 5 : Find VD,VS and VDG :
VDS=VDSQ;//in Volt
VG=VGS;//in Volt
VS=ID*RS;//in Volt
VD=VS+VDS'//in Volt
VDG=VD-VG;//in Volt
disp(IDQ,"IDQ in mA : ");
disp(VGSQ,"VGSQ in Volt :");
disp(VD,"VD in Volt :");
disp(VS,"VS in Volt :");
disp(VDS,"VDS in Volt :");
disp(VDG,"VDG in Volt :");
```

Scilab code Exa 6.8 Pinch off voltage

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

Scilab code Exa 6.10 Plot gm VS IDSS

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

```
IDSS=1:8;//in mA
for i=1:8
    gm(i)=-2*IDSS(i)/VP
end
title('gm versus IDSS');
xlabel('gm(in mS)');
ylabel('IDSS(in mA)');
plot2d(gm,IDSS);
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

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

Chapter 7

Magnetic Materials

Scilab code Exa 7.1 `Horizontal component of magnetic Intensity`

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

Scilab code Exa 7.2 `Current through solenoid`

```
//Exa 7.2
clc;
clear;
close;
```

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

Scilab code Exa 7.3 Magnetic moment of rod

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

Scilab code Exa 7.4 Flux density magnetic intensity and permeability

```
//Exa 7.4
clc;
clear;
```

```
close;
//Given data
l=30;//in cm
l=l*10^-2;//in meter
A=1;//in cm^2
A=A*10^-4;//in meter^2
N=300;//turns of wire
i=0.032;//in Ampere
FI_B=2*10^-6;//in weber
meu_o=4*%pi*10^-7;//permeability of free space in
    weber/amp-meter
B=FI_B/A;//in weber/meter^2
disp(B,"Flux Density in weber/meter^2 : ");
H=N*i/l;//in amp-turn/meter
disp(H,"magnetic Intensity in amp-turn/meter : ");
meu=B/H;//in weber/Amp-meter
disp(meu,"Permeability in weber/amp-meter :");
meu_r=meu/meu_o;//Relative Permeability
disp(meu_r,"Relative Permeability : ");
//Answer of relative permeability is wrong in the
    book.
```

Scilab code Exa 7.5 Relative Permeability

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

Scilab code Exa 7.6 Magnetising Force and material magnetisation

```
//Exa 7.6
clc;
clear;
close;
//Given data
n=10;//turns/cm
n=n*10^2;//turns/meter
i=2;//in Ampere
B=1;//in weber/meter^2
meu_o=4*%pi*10^-7;//permeability of free space in
    weber/amp-meter
H=n*i;//in amp-turn/meter
disp(H,"Magnetising Force in amp-turn/meter : ");0
//Formula : B=meu_o*(H+I)
I=B/meu_o-H;//in amp-turn/meter
disp(I,"Magnetisation of material in amp-turn/meter
    :");
meu_r=B/(meu_o*H);//relative permeability(unitless)
disp(meu_r,"Relative Permeability : ");
```

Chapter 8

Oscillators

Scilab code Exa 8.m.1 `Value of L1`

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

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

```
//Exa Misc 8.2
clc;
clear;
close;
```

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

Scilab code Exa 8.m.3 `Value of Capacitor`

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

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

```
//Exa Misc 8.4
clc;
clear;
close;
//given data
```

```
format('v',5);
L=40;//in mH
C1=100;//in pF
C2=500;//in pF
Vout=10;//in volt
fo=1/(2*%pi*sqrt(L*10^-3*C1*10^-12*C2*10^-12/(C1
    *10^-12+C2*10^-12)))
disp(fo*10^-3,"Frequency of oscillation (in KHz) :")
    ;
Vf=Vout*C1/C2;//in volt
disp(Vf,"Feedback voltage in volt :");
Gain=C2/C1;//unitless
disp(Gain,"Minimum Gain is ");
//if Gain=10
Gain=10;//given
C1=C2/Gain;//in pF
disp(C1,"For a gain of 10 C1 in pF is :");
fo=1/(2*%pi*sqrt(L*10^-3*C1*10^-12*C2*10^-12/(C1
    *10^-12+C2*10^-12)))
disp(fo*10^-3,"New frequency of oscillation (in KHz)
     :");
```

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

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

```
Q=2*%pi*fs*L/(R*10^3);//Q-factor
disp(fs/10^3,"Seies resonance frequency(in KHz)")
disp(round(Q),"Q-factor f the crystal at fs is ");
fp=(1/(2*%pi))*sqrt((Cs*10^-12+Cp*10^-12)/(L*Cs
   *10^-12*Cp*10^-12));//in Hz
Q=2*%pi*fp*L/(R*10^3);//Q-factor
disp(fp/10^3,"Seies resonance frequency(in KHz)")
disp(round(Q),"Q-factor f the crystal at fs is ");
```

Scilab code Exa 8.1 feed bck factor

```
//Exa 8.1
clc;
clear;
close;
//Given data
A=50;//unitless
disp("Barkhausen criterion for oscillator : Beta*A=1
   ");
Beta=1/A;//unitless
disp(Beta,"Feedback Factor to make oscillator : ");
```

Scilab code Exa 8.2 Range of variable capacitor

```
//Exa 8.2
clc;
clear;
close;
//Given data
format('v',5);
L=100;//in uH
L=L*10^-6;//in H
f1=500;//in kHz
```

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

Scilab code Exa 8.3 `C2 of colpitt oscilator`

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

Scilab code Exa 8.4 `Frequency of oscillation`

```
//Exa 8.4
```

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

Scilab code Exa 8.5 `Amplifier voltage gain`

```
//Exa 8.5
clc;
clear;
close;
//Given data
disp("Put alfa=sqrt(6) to find the gain");
alfa=sqrt(6);//unitless
Beta=1/(1-5*alfa^2);
//Barkhausen critera : A*|Beta|>=1
Beta=-Beta;//
A=1/Beta;//unitless
disp(A,"Minimum Gain of Amplifier must be  : ");
```

Scilab code Exa 8.6 `Frequency of oscillation and min current gain`

```
//Exa 8.6
clc;
clear;
close;
```

```
//Given data :
R1=50;//in kohm
R1=R1*10^3;//in ohm
C1=0.001;//in uF
C1=C1*10^-6;//in F
R2=1;//in kohm
R2=R2*10^3;//in ohm
C2=0.01;//in uF
C2=C2*10^-6;//in F
//Part (i)
//Formula : f=1/(2*%pi*sqrt(C1*C2*R1*R2))
f=1/(2*%pi*sqrt(C1*C2*R1*R2));//in Hz
disp(f/1000,"Frequency of oscillations in kHz : ");
//Part (ii)
CurrentGain=1+C2/C1+R1/R2;//unitless
disp(CurrentGain,"Current Gain : ");
```

Scilab code Exa 8.7 Resistnce to cover frequency range

```
//Exa 8.7
clc;
clear;
close;
//Given data :
fmin=20;//in Hz
fmax=20;//in kHz
Cmin=30;//in pF
Cmax=300;//in pF
//Formula : fo=1/(2*%pi*R*C))
disp("Minimum Fequeny correspond to maximum
    capacitance.")
R=1/(2*%pi*fmin*Cmax*10^-12)
disp(R/10^6,"Required resistance in Mohm : ");
```

Scilab code Exa 8.8 Resonant Frequency

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

Scilab code Exa 8.9 Resonant Frequency

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

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

Scilab code Exa 8.10 Parallel and series resonant frequencies

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

```
//Exa 9.1
clc;
clear;
close;
//Given data :
VBB=20;//in volt
VB=0.7;//in volt(For Si)
ETA=0.6;//intrinsic stand off ratio
//Part (i)
StandOffVoltage=ETA*VBB;//in volt
disp(StandOffVoltage,"Stand Off Voltage in volts :")
    ;
//Part (ii)
VP=ETA*VBB+VB;//in volts
disp(VP,"Peak point Voltage in volts : ");
```

Scilab code Exa 9.2 Time period of sawtooth waveform

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

Scilab code Exa 9.3 `Resistances RB1 and RB2`

```
//Exa 9.3
clc;
clear;
close;
//Given data :
RBB=10;//in Kohm
ETA=0.6;//intrinsic stand off ratio
RB1=ETA*RBB;//in Kohm
RB2=RBB-RB1;//in Kohm
disp(RB1,"Resistance RB1 in Kohm :");
disp(RB2,"Resistance RB2 in Kohm :");
```

Chapter 11

Multivibrators

Scilab code Exa 11.1 Frequency of Oscillators

```
//Exa 11.1
clc;
clear;
close;
//Given data
R1=15;//in kohm
R2=15;//in kohm
C1=0.005;//in uF
C2=0.005;//in uF
R=R1;//in Kohm
C=C1;//in uF
T=0.69*(R*10^3*C*10^-6+R*10^3*C*10^-6);//in second
f=1/T;//in Hz
disp(f*10^-3,"Frequency of oscillators in KHz : ");
```