Scilab Textbook Companion for Electronics Devices And Circuit Theory by R. L. Boylestad And L. Nashelsky[1]

Created by
Shubhanshu Yadav
B.Tech. (pursuing)
Electronics Engineering
IIIT, Allahabad
College Teacher
Neetesh Purohit
Cross-Checked by
Sonanya Tatikola, IIT Bombay

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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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List of Scilab Codes

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Chapter 1

Semiconductor Diodes

Scilab code Exa 1.1 Thermal Voltage calculation

```
clear; clc; close;

t = 273 + 27;     //in kelvin
t_new = 273 +100;
k = 1.38*10^(-23);//in J/K
q = 1.6*10^(-19);//C

Vt = k*t/q;
format(10);
disp(Vt,'Thermal voltage for 27''C(in V): ');

Vt = k*t_new/q;
disp(Vt,'Thermal voltage for 100''C(in V): ');
```

Scilab code Exa 1.2 Dc level resistance calculation

```
clear; clc; close;

```

```
Id_low = 2;//mA
Id_high = 25;//mA
Vd_reverse_bias = -10;//V

Vd_low = 0.5;//V
Vd_high = 0.85;//V
Id_reverse_bias = -10*10^(-6);//A

Rd_low = Vd_low/Id_low;
Rd_high = Vd_high/Id_high;
Rd_reverse_bias = Vd_reverse_bias/Id_reverse_bias;

disp(Rd_low,'Low level dc resistance(in ohm):');
disp(Rd_high,'High level dc resistance(in ohm):');
disp(Rd_reverse_bias,'Reverse bias dc resistance(in
   ohm):');
```

Scilab code Exa 1.3 Ac resistance calculation

```
clear; clc; close;

Id1 = 2*10^(-3);//A
Id2 = 25*10^(-3);//A

Delta_Id1 = (4-0)*10^(-3);//A
Delta_Vd1 = 0.76-0.65;//V
rd1 = Delta_Vd1/Delta_Id1;

Delta_Id2 = (30-20)*10^(-3);//A
Delta_Vd2 = 0.80-0.78;//V
rd2 = Delta_Vd2/Delta_Id2;

//From graph
Vd1 = 0.7;//V
Vd2 = 0.79;//V
```

```

Rd1 = Vd1/Id1;
Rd2 = Vd2/Id2;

disp(rd1,'ac resistance in part a(in ohm) is : ');
disp(rd2,'ac resistance in part b(in ohm) is : ');
disp(Rd1,'dc resistance in part a(in ohm) is : ');
disp(Rd2,'dc resistance in part b(in ohm) is : ');
```

Scilab code Exa 1.4 Zener voltage determination

```
clear; clc; close;

Tc = 0.072;// %/'C
Vz = 10;//V
T1 = 100;// 'C
T0 = 25;// 'C

Delta_Vz = Tc*Vz*(T1-T0)/100;

Vz_new = Vz + Delta_Vz;

disp(Delta_Vz,'Change in zener potential(in V):');
disp(Vz_new,'Resulting zener potntial(in V):');
```

Scilab code Exa 1.5 Wavelength determination

```
clear; clc; close;


c = 3*10^(17);// nm/s
f = 750*10^(12);// Hz

```

```
Lambda = c/f;

disp(Lambda,'Wavelength provided for visible light(
   in nm): ');
```

Chapter 2

Diode Applications

Scilab code Exa 2.1 Q point using diode characteristics

```
clear; clc; close;

E = 10;     //volts
R = 500;     //ohms

Id = E/R;
Vd = E;

Vdq = 0.78;     //volts
Idq = 18.5*10^(-3);//Amperes

Vr = Idq*R;

diary('C:\Users\DELL\Desktop\intern\chapter_2\2_1.
   txt');
disp(Vdq,'Voltage at Q-point is :');
disp(Idq,'Current at Q-point is :');
disp(Vr,'Vr = ');
```

Scilab code Exa 2.2 `Vdq Vr and Idq by approx equivalent model`

```
clear; clc; close;

E = 10;      //volts
R = 500;      //ohms

Vdq = 0.7;//volts
Idq = 18.5*10^(-3);//amperes

diary('C:\Users\DELL\Desktop\intern\chapter_2\2_2.txt');
disp(Vdq,'Voltage at Q-point is :');
disp(Idq,'Current at Q-point is :');
```

Scilab code Exa 2.3 `Vdq Vr and Idq by ideal diode model`

```
clear; clc; close;

E = 10;      //volts
R = 500;      //ohms

Vdq = 0;      //volts
Idq = 20*10^(-3);      //amperes

diary('C:\Users\DELL\Desktop\intern\chapter_2\2_3.txt');
disp(Vdq,'Voltage at Q-point is :');
disp(Idq,'Current at Q-point is :');
```

Scilab code Exa 2.4 `Vd Vr and Id`

```
clear; clc; close;
```

```

E = 8;     //volts
R = 2.2*10^(3);     //ohms

Vd = 0.7;     //Diode is on
Vr = E-Vd;
Id = Vr/R;

diary('C:\Users\DELL\Desktop\intern\chapter_2\2_4.
    txt');
disp(Vd,'Diode Volatge is : ');
disp(Vr,'Voltage across R is : ');
disp(Id,'Current through diode is : ');
```

Scilab code Exa 2.5 `Vd Vr and Id with diode reversed`

```
clear; clc; close;

E = 8;     //volts
R = 2.2*10^(3);     //ohms

Id = 0;     //diode reversed
Vr = Id*R;
Vd = E-Vr;

diary('C:\Users\DELL\Desktop\intern\chapter_2\2_5.
    txt');
disp(Vd,'Diode Volatge is : ');
disp(Vr,'Voltage across R is : ');
disp(Id,'Current through diode is : ');
```

Scilab code Exa 2.6 `Vd Vr and Id for series diode config`

```
clear; clc; close;

E = 0.5;    //volts
R = 1.2*10^(3);    //ohms

Id = 0;    //diode off
Vr = Id*R;
Vd = E;

diary('C:\Users\DELL\Desktop\intern\chapter_2\2_6.
   txt');
disp(Vd,'Diode Volatge is : ');
disp(Vr,'Voltage across R is : ');
disp(Id,'Current through diode is : ');
```

Scilab code Exa 2.7 `Vo and Id calculation`

```
clear; clc; close;

E = 12;    //volts
Vk1 = 0.7;    //volts
Vk2 = 1.8;    //volts
R = 0.680*10^(3);    //ohms

Vo = E-Vk1-Vk2;
Id = Vo/R;

diary('C:\Users\DELL\Desktop\intern\chapter_2\2_7.
   txt');
disp(Vo,'Output Volatge is : ');
disp(Id,'Output Current is : ');
```

Scilab code Exa 2.8 `Id Vd2 and Vo calculation`

```
clear; clc; close;

E = 20;     //volts
R = 5.6*10^(3);     //ohms

Id = 0;     //amperes
Vd1 = 0;
Vo = Id*R;
Vd2 = E;


diary('C:\Users\DELL\Desktop\intern\chapter_2\2_8.txt');
disp(Vo,'Output Volatge is : ');
disp(Id,'Output Current is : ');
disp(Vd2,'Voltage across diode 2 is :')
```

Scilab code Exa 2.9 `I V1 V2 and Vo calculation`

```
clear; clc; close;

E1 = 10;     //volts
E2 = 5;     //volts
R1 = 4.7*10^(3);     //ohms
R2 = 2.2*10^(3);     //ohms

Vd = 0.7;     //volts
I = (E1+E2-Vd)/(R1+R2);
V1 = I*R1;
V2 = I*R2;
Vo = V2 - E2;

diary('C:\Users\DELL\Desktop\intern\chapter_2\2_9.txt');
disp(Vo,'Output Volatge is : ');
```

```
disp(I,'Output Current is : ');
disp(V1,'Voltage across resistance 1 is :');
disp(V2,'Voltage across resistance 2 is :');
```

Scilab code Exa 2.10 Vo I1 Id1 and Id2 for parallel diode config

```
clear; clc; close;

E = 10;     //volts
R = 0.33*10^(3);     //ohms

Vo = 0.7;     //volts
I = (E - Vo)/R;
Id1 = I/2;
Id2 = I/2;

diary('C:\Users\DELL\Desktop\intern\chapter_2\2_10.
    txt');
disp(Vo,'Output Volatge is : ');
disp(Id1,'Current through diode 1 is : ');
disp(Id2,'Current through diode 2 is :')
```

Scilab code Exa 2.11 Resistor values

```
clear; clc; close;

E = 8;     //volts
Vled = 2;     //volts
I = 20*10^(-3);     //amperes

R = (E-Vled)/I;

disp(R,'resistance value is : ')
```

Scilab code Exa 2.12 Output voltage

```
clear; clc; close;

E = 12;     //volts
Vd = 0.7;     //volts

Vo = E - Vd;

disp(Vo,'output voltage is : ');
```

Scilab code Exa 2.13 Determine network currents

```
clear; clc; close;

E = 20;     //volts
Vk1 = 0.7;     //volts
Vk2 = 0.7;     //volts
R1 = 3.3*10^(3);     //ohms
R2 = 5.6*10^(3);     //ohms

I1 = Vk1/R1;
V2 = E-Vk1-Vk2;
I2 = V2/R2;

Id2 = I2 - I1;

disp(I1,'I1 current is : ');
disp(I2,'I2 current is : ');
disp(Id2,'Id2 current is :');
```

Scilab code Exa 2.14 Output voltage

```
clear; clc; close;

E = 10;     //volts
R = 1*10^(3);     //ohms
Vd1 = 0.7;     //volts
Vd2 = 0;     //volts

Vo = E-Vd1;
I = (E-Vd1)/R;

disp(Vo,'output voltage is : ');
```

Scilab code Exa 2.15 Output voltage for positive logic AND

```
clear; clc; close;

E = 10;     //volts
E1 = 10;     //volts
E2 = 0;      //volts
R = 1*10^(3);     //ohms

Vd1 = 0;     //volts
Vd2 = 0.7;     //volts

Vo = Vd2;

disp(Vo,'output voltage is : ');
```

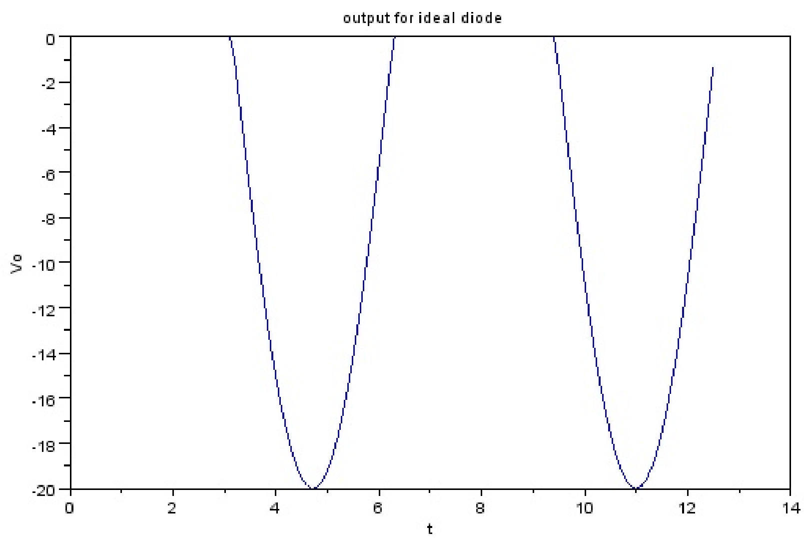

Figure 2.1: Sketch output and determine dc level

Scilab code Exa 2.16.a Sketch output and determine dc level

```
clear; clc; close;

Vm = 20;
Vdc = -0.318*Vm;

disp(Vdc,'Dc volatge for ideal diode :');


t = 0:0.1:4*%pi;
x = 20*sin(t);

for i=1:length(t)
    if(x(i)<=0)
       y(i) = x(i);
```

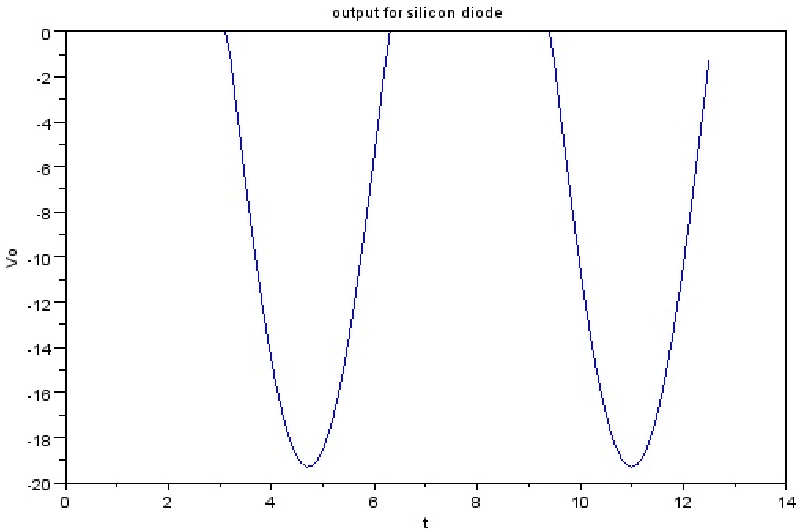

Figure 2.2: Sketch output and determine dc level for Si diode case

```
    else y(i)=0
    end
end

plot(t,y)
xtitle('output for ideal diode','t','Vo');
```

Scilab code Exa 2.16.b Sketch output and determine dc level for Si diode case

```
clear; clc; close;

Vm = 20;     //volts
Vdc = -0.318*(Vm-0.7);     //volts

```

```
disp(Vdc,'Dc voltage for silicon diode :');


t = 0:0.1:4*%pi;
x = (20-0.7)*sin(t);

for i=1:length(t)
    if(x(i)<=0)
       y(i) = x(i);
    else y(i)=0
    end
end

plot(t,y);
xtitle('output for silicon diode','t','Vo');
```

Scilab code Exa 2.16.c Determine dc level if Vm is 200V

```
clear; clc; close;

Vm = 200;     //volts
Vk = 0.7;     //volts
Vdc = -0.318*Vm;
Vdc_si = -0.318*(Vm - Vk);

disp(Vdc,'Dc volatge for ideal diode :');
disp(Vdc_si,'Dc voltage for silicon diode :');
```

Scilab code Exa 2.17 Sketch output waveform

```
clear; clc; close;
```

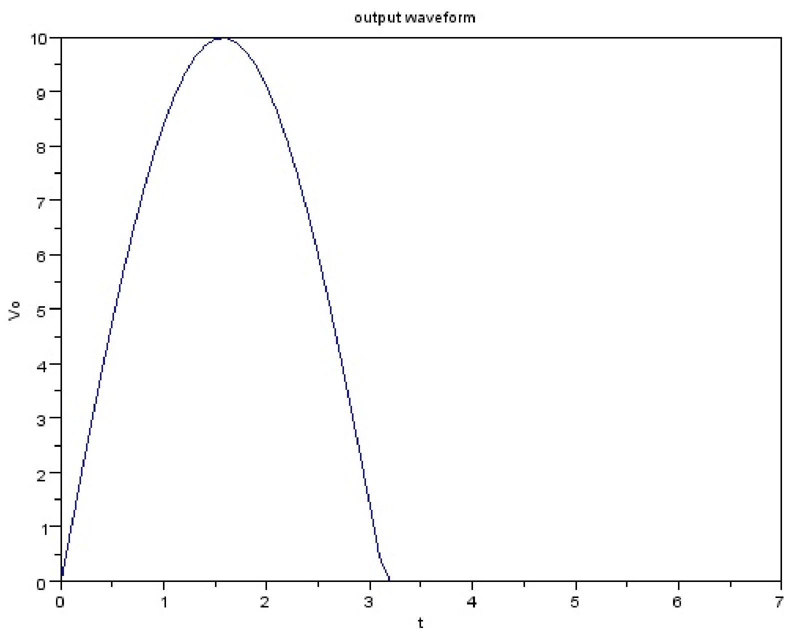

Figure 2.3: Sketch output waveform

```

Vi_max = 10;
Vo_max = 0.5*Vi_max;

Vdc = 0.636*Vo_max;

disp(Vdc,'Required Dc voltage :');

t = 0:0.1:2*%pi;
x = 10*sin(t);

for i=1:length(t)
    if(x(i)>=0)
       y(i) = x(i);
    else y(i)=0;
    end
end

plot(t,y)
xtitle('output waveform','t','Vo');
```

Scilab code Exa 2.18 Sketch output waveform

```
clear; clc; close;

amp = 20;
vi_t = -5;//transition voltage

t = 0:0.1:2*%pi;
vi = amp*sin(t);
vo = vi+5;     //output voltage

disp(vi_t,'transition voltage : ');
```

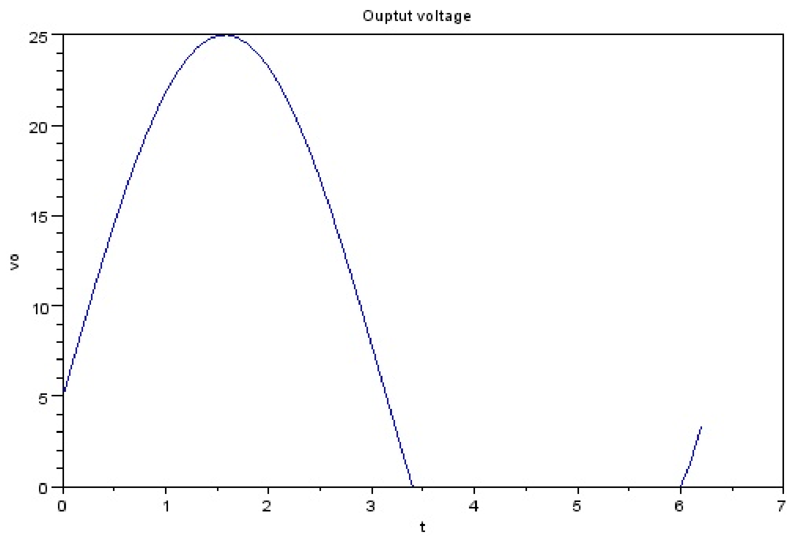

Figure 2.4: Sketch output waveform

```

for i = 1:length(t)
    if(vo(i)<=0)
        vo(i)=0;
    end


end

plot(t,vo);
xtitle('Ouptut voltage','t','vo');
```

Scilab code Exa 2.19 `Sketch output waveform`

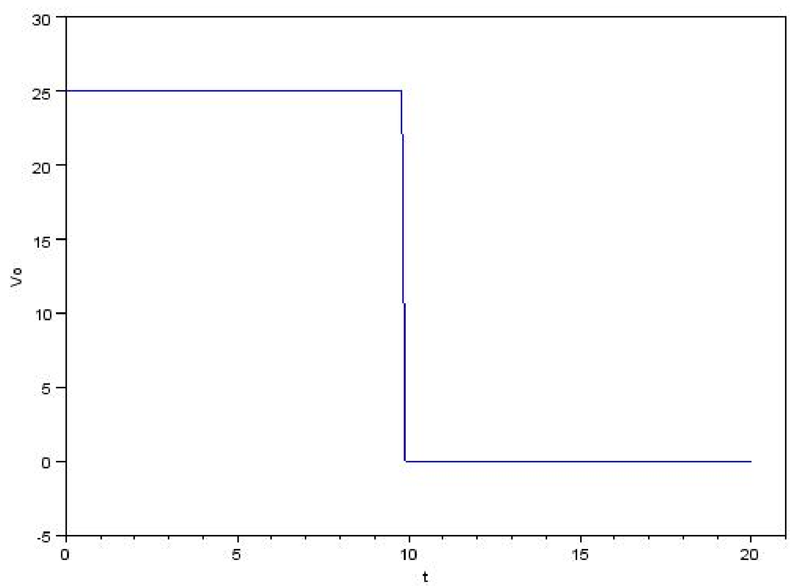

Figure 2.5: Sketch output waveform

```
clear; clc; close;

t = 0:0.1:20;
for i=1:int(length(t)/2)
    vi(i) = 20;
end
for i = int(length(t)/2):length(t)
    vi(i) = 0;
end
for i=1:int(length(t)/2)
    vo(i) = 20+5;
end
for i = int(length(t)/2):length(t)
    vo(i) = 0;
end
plot2d(t,vo,2,'011','',[0,-5,21,30]);
a = gca();
a.x_label.text = 't';
a.y_label.text = 'Vo';
```

Scilab code Exa 2.20 Sketch output waveform

```
clear; clc; close;

t = 0:0.1:20;
for i = 1:length(t);
    if(t(i)<=5)
        x(i) = (16/5)*t(i);
    elseif(t(i)>=5 & t(i)<=16)
        x(i) = -3.2*t(i) + 32;
    elseif(t(i)>=16 & t(i)<=20)
        x(i) = (16/5)*t(i)-64;
    end
```

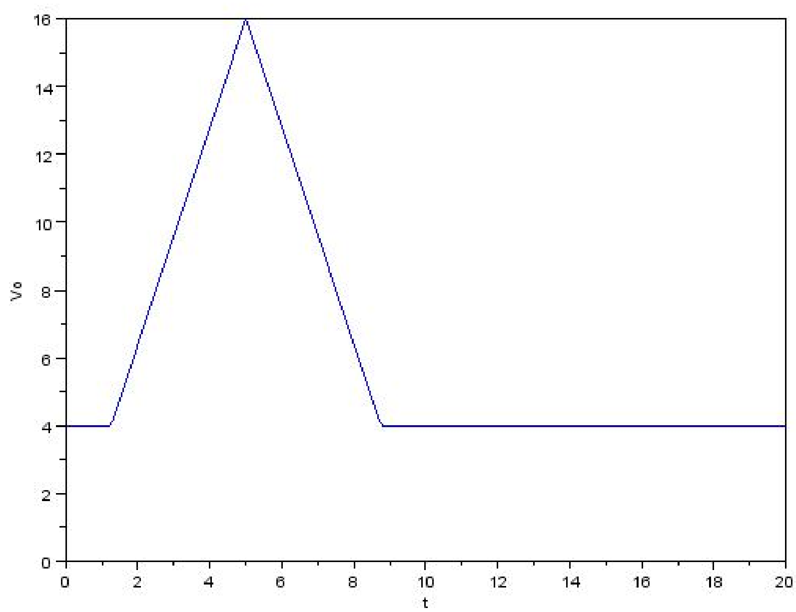

Figure 2.6: Sketch output waveform

```
end

for i = 1:length(t)
    if(x(i)>4)
        y(i)=x(i);
    elseif(x(i)<=4)
        y(i)=4;
    end
end

plot2d(t,y,2,'011','',[0,0,20,16]);

a = gca();
a.x_label.text = 't';
a.y_label.text = 'Vo';
```

Scilab code Exa 2.21 Sketch output waveform using Ge diode

```
clear; clc; close;

V = 4;
Vk = 0.3;
id = 0;
vd = 0.3;

vi = V-Vk;
disp(vi,'new transition level : ');

t = 0:0.1:20;
for i = 1:length(t);
    if(t(i)<=5)
        x(i) = (16/5)*t(i);
    elseif(t(i)>=5 & t(i)<=16)
```

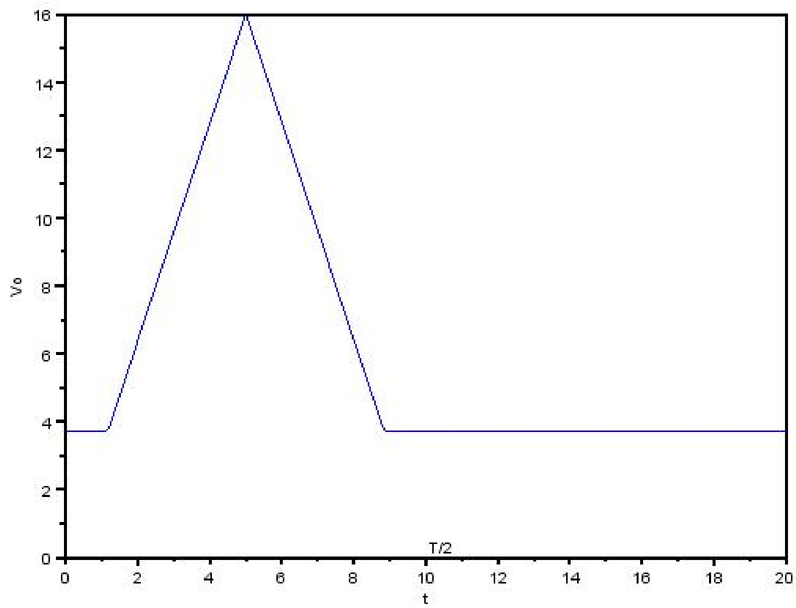

Figure 2.7: Sketch output waveform using Ge diode

```
        x(i) = -3.2*t(i) + 32;
    elseif(t(i)>=16 & t(i)<=20)
        x(i) = (16/5)*t(i)-64;
    end
end

for i = 1:length(t)
    if(x(i)>vi)
        y(i)=x(i);
    elseif(x(i)<=3.7)
        y(i)=3.7;
    end
end

plot2d(t,y,2,'011','',[0,0,20,16]);

a = gca();
a.x_label.text = 't';
a.y_label.text = 'Vo';

xset('thickness',2);
xstring(10,0,'T/2');
```

Scilab code Exa 2.22 Sketch output waveform

```
clear; clc; close;

f = 1000;
T = 1/f;
C = 0.1*10^(-6);
R = 100*10^(3);
//between t1-->t2
vo_1 = 5;
```

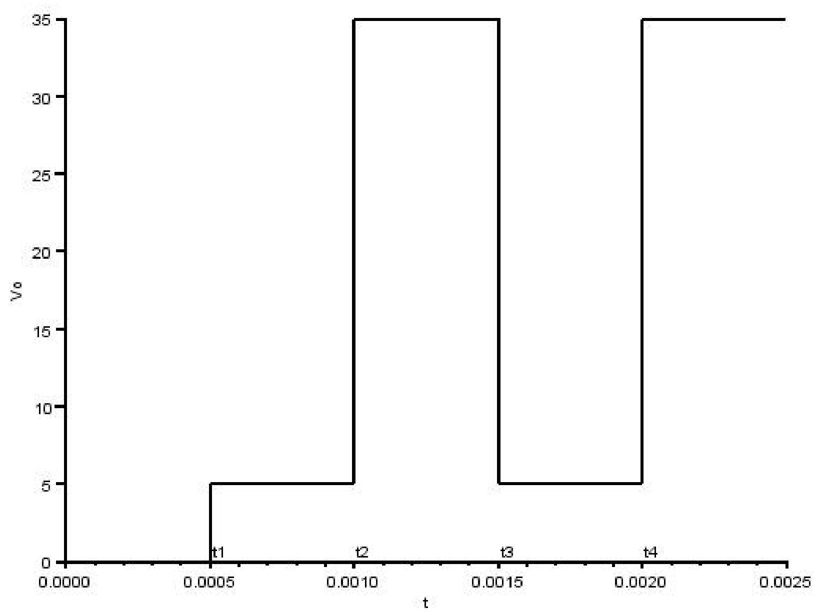

Figure 2.8: Sketch output waveform

```
Vc = 25;
//between t2-->t3
Rth = 0;
Eth = 5;
vo_2 =35;
tau = R*C;
discharge_time = 5*tau;
//between t3-->t4
vo_3 = 5;

disp(vo_1,'output voltage during t1-->t2 : ');
disp(vo_2,'output voltage during t2-->t3 : ');
disp(vo_3,'output voltage during t3-->t4 : ');


t = 0:10^(-6):2.5*10^(-3);

for i= 1:length(t)
    if(t(i)>=0 & t(i)<=0.5*10^(-3))
        y(i) = 0;
    elseif(t(i)>=0.5*10^(-3) & t(i)<=10^(-3))
        y(i) = 5;
    elseif(t(i)>=10^(-3) & t(i)<=1.5*10^(-3))
        y(i)=35;
    elseif(t(i)>=1.5*10^(-3) & t(i)<=2.0*10^(-3))
        y(i)=5;
    elseif(t(i)>=2.0*10^(-3) & t(i)<=2.5*10^(-3))
        y(i)=35;
    end
end
a = gca();
a.thickness = 2;
plot2d(t,y);
a.x_label.text = 't';
a.y_label.text = 'Vo';
xset('thickness',2);
xstring(0.5*10^(-3),0,'t1');
xstring(10^(-3),0,'t2');
```

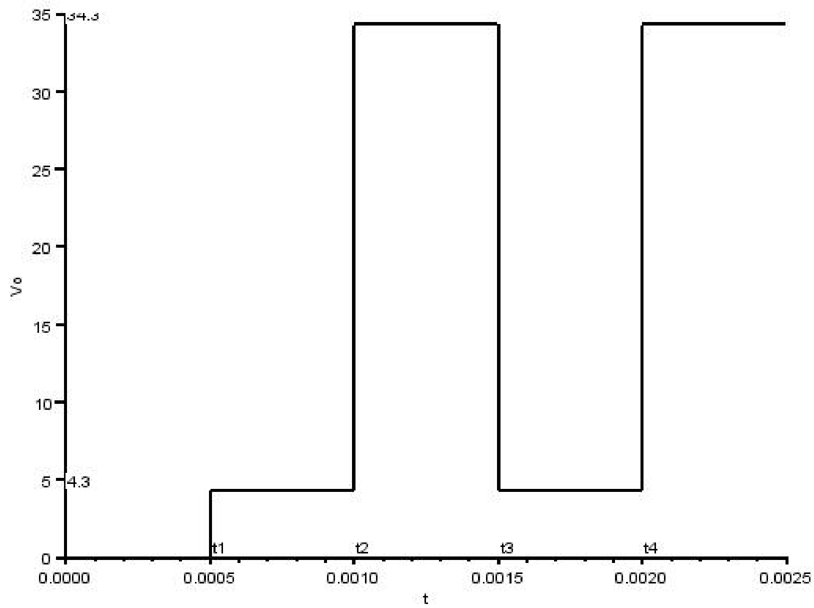

Figure 2.9: Sketch output waveform using Si diode

```
xstring(1.5*10^(-3),0,'t3');
xstring(2*10^(-3),0,'t4');
```

Scilab code Exa 2.23 `Sketch output waveform using Si diode`

```
clear; clc; close;

f = 1000;
T = 1/f;
C = 0.1*10^(-6);
R = 100*10^(3);
```

```
Vk = 0.7;
//between t1-->t2
vo_1 = 4.3;
Vc = 25-0.7;
//between t2-->t3
Rth = 0;
Eth = 4.3;
vo_2 =34.3;
tau = R*C;
discharge_time = 5*tau;
//between t3-->t4
vo_3 = 5;

disp(vo_1,'output voltage during t1-->t2 : ');
disp(vo_2,'output voltage during t2-->t3 : ');
disp(vo_3,'output voltage during t3-->t4 : ');


t = 0:10^(-6):2.5*10^(-3);

for i= 1:length(t)
    if(t(i)>=0 & t(i)<=0.5*10^(-3))
        y(i) = 0;
    elseif(t(i)>=0.5*10^(-3) & t(i)<=10^(-3))
        y(i) = 4.3;
    elseif(t(i)>=10^(-3) & t(i)<=1.5*10^(-3))
        y(i)=34.3;
    elseif(t(i)>=1.5*10^(-3) & t(i)<=2.0*10^(-3))
        y(i)=4.3;
    elseif(t(i)>=2.0*10^(-3) & t(i)<=2.5*10^(-3))
        y(i)=34.3;
    end
end
a = gca();
a.thickness = 2;
plot2d(t,y);
a.x_label.text = 't';
a.y_label.text = 'Vo';
```

```
xset('thickness',2);
xstring(0.5*10^(-3),0,'t1');
xstring(10^(-3),0,'t2');
xstring(1.5*10^(-3),0,'t3');
xstring(2*10^(-3),0,'t4');
xstring(0,4.3,'4.3');
xstring(0,34.3,'34.3');
```

Scilab code Exa 2.24 `Voltages and Power calculation`

```
clear; clc; close;

E = 40;
Vk = 0.7;
Vz1 = 6;
Vz2 = 3.3;
R = 1.3*10^(3);

Vo1 = Vz2 + Vk;
Vled =Vo1;
Vo2 = Vo1 + Vz1;
Vr = E-Vo2-Vled;
Ir = Vr/R;
Iled = Ir;
Iz = Ir;
Ps = E*Ir;
Pled = Vled*Iled;
Pz = Vz1*Iz;

disp(Vo1,'Reference voltage 1 : ');
disp(Vo2,'Reference voltage 2 : ');
disp(Iled,'Level of current through led :');
disp(Ps,'Power supplied by circuit : ');
disp(Pled,'Power absorbed by led :');
disp(Pz,'Power absorbed by zener diode :');
```

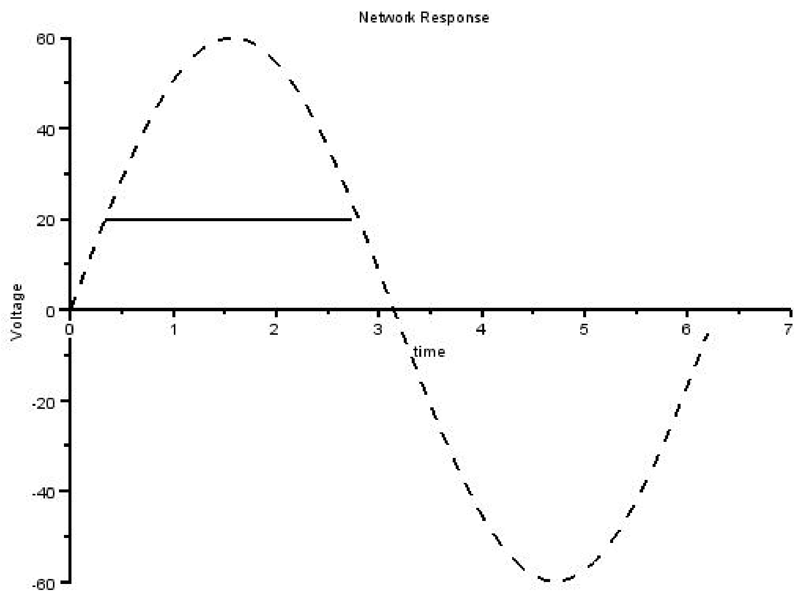

Figure 2.10: Sketch output waveform

Scilab code Exa 2.25 `Sketch output waveform`

```
clear; clc; close;


t = 0:0.1:2*%pi;
y = 60*sin(t);

a = gca();
a.line_style = 3;
```

```
a.thickness = 2;
a.y_location = 'left';
a.x_location = 'middle';
a.x_label.text = 'time';
a.y_label.text = 'Voltage';
a.title.text = 'Network Response';
plot2d(t,y);


//a.grid = [1 1];

t1 = (asin(1/3)):0.1:(%pi-asin(1/3));

y1 = 20*(t1>=(asin(1/3)))

b = gca();
b.line_style = 1;
plot2d(t1,y1);
```

Scilab code Exa 2.26.a Vl Vr Iz Pz

```
//Implementation of example 2.26_a in chapter 2

clear; clc; close;

Rl = 1.2*10^(3);
R = 10^(3);
Vi = 16;
Vz = 10;

V = (Rl*Vi)/(R+Rl);
Vl = V;
Vr = Vi-Vl;
Iz = 0;

```

```
Pz = Iz*Vz;

disp(Vl,'Vl is : ');
disp(Vr,'Vr is :');
disp(Iz,'IZ is :');
disp(Pz,'Pz is :');
```

Scilab code Exa 2.26.b Vl Vr Iz Pz with different Rl

```
clear; clc; close;

Rl = 3*10^(3);
R = 10^(3);
Vi = 16;
Vz = 10;

V = Vz;
Vl = V;
Vr = Vi-Vl;
Il = Vl/Rl;
Ir = Vr/R;
Iz = Ir - Il;


Pz = Iz*Vz;

disp(Vl,'Vl is : ');
disp(Vr,'Vr is :');
disp(Iz,'IZ is :');
disp(Pz,'Pz is :');
```

Scilab code Exa 2.27 Rl Il Range max power and zener increase

```
clear; clc; close;

R = 10^(3);
Vz = 10;
Vi = 50;
Izm = 32*10^(-3);
Pz = 380*10^(-3);

Rlmin = (R*Vz)/(Vi-Vz);
Vr = Vi-Vz;
Ir = Vr/R;
Ilmin = Ir - Izm;
Rlmax = Vz/Ilmin;
Pmax = Vz*Izm;
Izm_2 = Pz/Vz;
Ilmin_2 = Ir - Izm_2;

disp(Rlmin,'Lowest value of R : ' );
disp(Rlmax,'Max value of R : ' );
disp(Ilmin,'Min value of I : ');
disp(Pmax,'Maximum wattage rating of diode : ')
disp(Ilmin_2,'New min value of I : ');
```

Scilab code Exa 2.28 Range of Vi

```
clear; clc; close;

Rl = 1200;
R = 320;
Vz = 20;
Izm = 60*10^(-3);

Vimin = ((Rl+R)*Vz)/(Rl);
Il = Vz/Rl;
```

```
Irmax = Izm+Il;
Vimax = Irmax*R + Vz;
disp(Vimin,'Min value of V :');
disp(Vimax,'Max value of V:  ');
```

Chapter 3

Bipolar Junction Transistor

Scilab code Exa 3.1 Determining Collector current and Vbe

```
clear; clc; close;

//part a
Ie = 3*10^(-3);
Vcb = 10;
Ic = Ie;
disp(Ic,'Ic (A):');

//part b
Vcb = 2;
Ie = 3*10^(-3);
Ic = Ie;
disp(Ic,'No effect of changing Vcb & Ic remains same
    , Ic(A) is : ');
//part c
Ic = 4*10^(-3);
Vcb = 20;
Ie  = Ic;
Vbe = 0.74;
disp(Vbe,'Vbe(volts) is :');
//part d
```

```
Ic = 4*10^(-3);
Ie  = Ic;
Vbe = 0.7;
disp(Vbe,'Vbe(volts) in this case is : ');
```

Scilab code Exa 3.2 Determining Collector current

```
clear; clc; close;


//part a
Ib = 30*10^(-6);
Vce = 7.5;
Ic = 3.3*10^(-3);
disp(Ic,'Ic(A) is : ');
//part b
Vce = 15;
Vbe = 0.7;
Ib = 20*10^(-6);
Ic = 2.5*10^(-3);
disp(Ic,'Ic(A) ate the intersection of Ib & Vceis :'
   );
//part c
Ib = 4*10^(-6);
Vce = 15;
Ic = 800*10^(-6);
disp(Ic,'Ic(A) in this case is : ');
```

Chapter 4

DC Biasing BJT

Scilab code Exa 4.1 Fixed Bias Network characteristics

```
clear; clc; close;

Vcc = 12;
Vbe = 0.7;
Vce = 4.23;
Rb = 240*10^(3);
Rc = 2.2*10^(3);
Beta = 75;
Ic = 3.53*10^(-3);

Ibq = (Vcc-Vbe)/Rb;
Icq = Beta*Ibq;
Vceq = Vcc-Ic*Rc;
Vb = Vbe;
Vc = Vce;
Vbc = Vb-Vc;

disp(Ibq,'Ibq(Amperes) is :');
disp(Icq,'Icq(Amperes) is :');
disp(Vceq,'Vceq(volts) is :');
disp(Vb,'Vb(volts) is :');
```

```
disp(Vc,'Vc(volts) is :');
disp(Vbc,'Vbc(volts) is :');
```

Scilab code Exa 4.2 Saturation level

```
clear; clc; close;

Vcc = 12;
Rc = 2.2*10^(3);

Icsat = Vcc/Rc;
disp(Icsat,'saturation current(Amperes) for network
   is :');
```

Scilab code Exa 4.3 Vcc Rc and Rb for fixed bias config

```
clear; clc; close;

Vce = 16;
Ic = 10*10^(-3);
Vbe = 0.7;
Ib = 25*10^(-6);

Vcc = Vce;
Rc = Vcc/Ic;
Rb = (Vcc-Vbe)/Ib;

disp('At Q-point')
disp(Vcc,'Value of Vcc(Volts) is :');
disp(Rc,'Value of Rc(ohms) is :');
disp(Rb,'Value of Rb(ohms) is :');
```

Scilab code Exa 4.4 Emitter bias Network characteristics

```
clear; clc; close;

Vcc = 16;
Vbe = 0.7;
Rb = 430*10^(3);
Rc = 2*10^(3);
Re = 1*10^(3);
Beta = 75;


Ib  = (Vcc-Vbe)/(Rb+(1+Beta)*Re);
Ic = Beta*Ib;
Vce = Vcc - Ic*(Rc+Re);
Vc = Vcc-Ic*Rc;
Ve = Vc - Vce;
Vb = Vbe + Ve;
Vbc = Vb - Vc;

disp(Ib,'Ib(Amperes) is : ');
disp(Ic,'Ic(Amperes) is : ');
disp(Vce,'Vce(volts) is : ');
disp(Vc,'Vc(Volts) is : ');
disp(Ve,'Ve(volts) is : ');
disp(Vb,'Vb(Volts) is : ');
disp(Vbc,'Vbc(Volts) is : ');
```

Scilab code Exa 4.6 Saturation current

```
clear; clc; close;

```

```
Vcc = 16;
Rc = 2*10^(3);
Re = 1*10^(3);

Icsat = Vcc/(Rc+Re);

disp(Icsat,'Saturation current(amperes) for the
    given network : ');
```

Scilab code Exa 4.7 `Vce and Ic for voltage divider config`

```
clear; clc; close;

R1 = 39*10^(3);
R2 = 3.9*10^(3);
Re = 1.5*10^(3);
Rc = 4*10^(3);
Vcc = 18;
Vbe = 0.7;
Beta = 140;

Rth = R1*R2/(R1+R2);
Eth = R2*Vcc/(R1+R2);
Ib = (Eth - Vbe)/(Rth + (Beta+1)*Re);
Ic = Beta*Ib;
Vce = Vcc - Ic*(Rc+Re);

disp(Ic,'Collector current(Amperes) in :');
disp(Vce,'Vce(Volts) is : ');
disp('Value of Vce differs because wrong value of
    Vcc is used in the book');
```

Scilab code Exa 4.8 `Icq and Vcq calculation`

```
clear; clc; close;

R1 = 39*10^(3);
R2 = 3.9*10^(3);
Re = 1.5*10^(3);
Rc = 4*10^(3);
Vcc = 18;
Vbe = 0.7;
Beta = 140;
Ic = 0.63*10^(-3);

disp('Since the approximate technique can be applied
    ,hence ');
Eth = R2*Vcc/(R1+R2);
Vb = Eth;
Ve = Vb - Vbe;
Icq = Ve/Re;
Vceq = Vcc - Ic*(Rc+Re);

disp(Icq,'Value of Icq(Amperes) is : ');
disp(Vceq,'Value of Vceq(Volts) : ');
```

Scilab code Exa 4.9 `Icq and Vceq calculation`

```
clear; clc; close;

R1 = 39*10^(3);
R2 = 3.9*10^(3);
Re = 1.5*10^(3);
Rc = 4*10^(3);
Vcc = 18;
Vbe = 0.7;
Beta = 70;

Rth = R1*R2/(R1+R2);
```

```
Eth = R2*Vcc/(R1+R2);
Ib = (Eth - Vbe)/(Rth + (Beta+1)*Re);
Icq = Beta*Ib;
Vceq = Vcc - Icq*(Rc+Re);
disp(Icq,'Collector current(Amperes) in :');
disp(Vceq,'Vce(Volts) is : ');
```

Scilab code Exa 4.10 Icq and Vceq calculation for voltage divider

```
clear; clc; close;

R1 = 82*10^(3);
R2 = 22*10^(3);
Re = 1.2*10^(3);
Rc = 5.6*10^(3);
Vcc = 18;
Vbe = 0.7;
Beta = 50;

Rth = R1*R2/(R1+R2);
Eth = R2*Vcc/(R1+R2);
Ib = (Eth - Vbe)/(Rth + (Beta+1)*Re);
Icq = Beta*Ib;
Vceq = Vcc - Icq*(Rc+Re);
disp(Icq,'Collector current(Amperes) in :');
disp(Vceq,'Vce(Volts) is : ');

//approximate analysis
Eth = R2*Vcc/(R1+R2);
Vb = Eth;
Ve = Vb - Vbe;
Icq = Ve/Re;
Vceq = Vcc - Icq*(Rc+Re);
disp('For approximate analysis : ');
disp(Icq,'Value of Icq(Amperes) is : ');
```

```
disp(Vceq,'Value of Vceq(Volts) : ');
```

Scilab code Exa 4.11 Icq and Vceq calculation

```
clear; clc; close;

Re = 1.2*10^(3);
Rc = 4.7*10^(3);
Rb = 250*10^(3);
Vcc = 10;
Vbe = 0.7;
Beta = 90;

Ib = (Vcc - Vbe)/(Rb + (Beta)*(Re+Rc));
Icq = Beta*Ib;
Vceq = Vcc - Icq*(Rc+Re);
disp(Icq,'Value of Icq(Amperes) is : ');
disp(Vceq,'Value of Vceq(Volts) : ');
```

Scilab code Exa 4.12 Icq and Vceq calculation for a different beta

```
clear; clc; close;

Re = 1.2*10^(3);
Rc = 4.7*10^(3);
Rb = 250*10^(3);
Vcc = 10;
Vbe = 0.7;
Beta = 135;

Ib = (Vcc - Vbe)/(Rb + (Beta)*(Re+Rc));
Icq = Beta*Ib;
Vceq = Vcc - Icq*(Rc+Re);
```

```
disp(Icq,'Value of Icq(Amperes) is : ');
disp(Vceq,'Value of Vceq(Volts) : ');
```

Scilab code Exa 4.13 `Ib and Vc calculation`

```
clear; clc; close;

Re = 0.51*10^(3);
Rc = 3.3*10^(3);
Rb = (91+110)*10^(3);
Vcc = 18;
Vbe = 0.7;
Beta = 75;

Ib = (Vcc - Vbe)/(Rb + (Beta)*(Re+Rc));
Ic = Beta*Ib;
Vc = Vcc - Ic*(Rc);
disp(Ic,'Value of Icq(Amperes) is : ');
disp(Vc,'Value of Vceq(Volts) : ');
```

Scilab code Exa 4.14 `Network characteristics determination`

```
clear; clc; close;

Re = 0;
Rc = 4.7*10^(3);
Rb = 680*10^(3);
Vcc = 20;
Vbe = 0.7;
Beta = 120;

Ib = (Vcc - Vbe)/(Rb + (Beta)*(Rc));
Icq = Beta*Ib;
```

```
Vceq = Vcc - Icq*(Rc);
Vb = Vbe;
Vc = Vceq;
Ve = 0;
Vbc = Vb-Vc;
disp(Icq,'Value of Icq(Amperes) is : ');
disp(Vceq,'Value of Vceq(Volts) : ');
disp(Vc,'Vc(volts) is : ');
disp(Vb,'Vb(volts) is :');
disp(Ve,'Ve(volts) is :');
disp(Vbc,'Vbc(volts) is :');
```

Scilab code Exa 4.15 Vc and Vb calculcation

```
clear; clc; close;

Re = 0;
Rc = 1.2*10^(3);
Rb = 100*10^(3);
Vee = 9;
Vbe = 0.7;
Beta = 45;

Ib = (Vee-Vbe)/Rb;
Ic = Beta*Ib;
Vc = -Ic*Rc;
Vb = -Ib*Rb;
disp(Vc,'Vc(Volts) is :');
disp(Vb,'Vb(Volts) is :');
```

Scilab code Exa 4.16 Vceq and Ie

```
clear; clc; close;
```

```

Re = 2*10^(3);
Rb = 240*10^(3);
Vee = 20;
Vbe = 0.7;
Beta = 90;

Ib = (Vee-Vbe)/(Rb+(Beta+1)*Re);
Ic = Beta*Ib;
Ie = (Beta+1)*Ib;
Vceq = Vee - (Beta+1)*Ib*Re;
disp(Vceq,'Vceq(Volts) is :');
disp(Ie,'Ie(amperes) is :');
```

Scilab code Exa 4.17 `Vcb and Ib for common base config`

```
clear; clc; close;

Re = 1.2*10^(3);
Rc = 2.4*10^(3);
Rb = 240*10^(3);
Vee = 4;
Vcc = 10;
Vbe = 0.7;
Beta = 60;

Ie = (Vee-Vbe)/Re;
Ic = Ie;
Vcb = Vcc-Ic*Rc;
Ib = Ic/Beta;
disp(Vcb,'Vcb(Volts) is : ');
disp(Ib,'Ib(amperes) is :');
```

Scilab code Exa 4.18 Vc and Vb calculcation

```
clear; clc; close;

Re = 1.8*10^(3);
Rc = 2.7*10^(3);
R1 = 8.2*10^(3);
R2 = 2.2*10^(3);
Vee = 20;
Vcc = 20;
Vbe = 0.7;
Beta = 120;

Rth = R1*R2/(R1+R2);
I = (Vcc+Vee)/(R1+R2);
Eth = I*R2 - Vee;
Ib = (Vee-Eth-Vbe)/(Rth+(Beta+1)*Re);
Ib = 35.39*10^(-6);
Ic = Beta*Ib;
Vc = Vcc - Ic*Rc;
Vb = Eth+Ib*Rth;
disp(Vc,'Vc(volts) is :');
disp(Vb,'Vb(Volts) is :');
```

Scilab code Exa 4.19 Vcc Rc and Rb for fixed bias config

```
clear; clc; close;

Vcc = 20;
Ic = 8*10^(-3);
Vbe = 0.7;
Ib = 40*10^(-6);

Rc = Vcc/Ic;
Rb = (Vcc-Vbe)/Ib;
```

```

disp(Rc,'Rc(ohms) is : ');
disp(Rb,'Rb(ohms) is : ');
```

Scilab code Exa 4.20 R1 and Rc

```
clear; clc; close;

Re = 1.2*10^(3);
R2 = 18*10^(3);
Vcc = 18;
Vce = 10;
Vbe = 0.7;
Ve = 2.4
Ic = 2*10^(-3);

Ve = Ic*Re;
Vb = Vbe+Ve;
R1 = (R2*Vcc/Vb) - R2;
Vc = Vce+Ve;
Rc = (Vcc-Vc)/Ic;
disp(R1,'R1(ohms) is : ');
disp(Rc,'Rc(ohms) is : ');
```

Scilab code Exa 4.21 Rc Re and Rb

```
clear; clc; close;

Icq = 4*10^(-3);
Vcc = 28;
Vc = 18;
Vbe = 0.7;
Ve = 2.4;
```

```
Beta = 110;
Icsat = 8*10^(-3);

Rc = (Vcc-Vc)/Icq;
Re = (Vcc/Icsat)-Rc;
Ibq = Icq/Beta;
Rb = ((Vcc-Vbe)/Ibq) - (Beta+1)*Re;

disp(Rc,'Rc(ohms) is : ');
disp(Re,'Re(ohms) is : ');
disp(Rb,'Rb(ohms) is : ');
```

Scilab code Exa 4.22 Resistor values for the netowrk

```
clear; clc; close;

Vcc = 20;
Vc = 18;
Vce = 10;
Vbe = 0.7;
Beta = 150;
Ic = 2*10^(-3);
Ie = Ic;

Ve = 0.1*Vcc;
Re = Ve/Ie;
Rc = (Vcc-Vce-Ve)/Ic;
Ib = Ic/Beta;
Rb = (Vcc-Vbe-Ve)/Ib;

disp(Re,'Value of Re(ohms) is : ');
disp(Rc,'Value of Rc(ohms) is : ');
disp(Rb,'Value of Rb(ohms) is : ');
```

Scilab code Exa 4.23 Rc Re R1 and R2

```
clear; clc; close;

Vcc = 20;
Vc = 18;
Vce = 8;
Vbe = 0.7;
Beta = 150;
Ic = 10*10^(-3);
Ie = Ic;
R2 = 1.6*10^(3);
Ve = 0.1*Vcc;
Re = Ve/Ie;
Rc = (Vcc-Vce-Ve)/Ic;

Vb = Vbe + Ve;
R1 = R2*Vcc/Vb - R2;

disp(Re,'Value of Re(ohms) is : ');
disp(Rc,'Value of Rc(ohms) is : ');
disp(R1,'Value of R1(ohms) is : ');
```

Scilab code Exa 4.24 Rb and Rc

```
clear; clc; close;

Vcc = 10;
Vbe = 0.7;
Beta_dc = 250;
Icsat = 10*10^(-3);

```

```
Rc = Vcc/Icsat;
Ib_min = Icsat/Beta_dc;
Rb = (Vcc-Vbe)/Ib_min;
//if we take standard Rb value then
Rb = 150*10^(3);
Ib = (Vcc-Vbe)/Rb;

disp(Rc,'value of Rc(ohms) is : ');
disp(Rb,'value of Rb(ohms) is : ');
```

Scilab code Exa 4.25 Determine proper operation of network

```
clear; clc; close;

Vcc = 20;
Vbe = 0.7;
Beta = 100;
Rb = 250*10^(3);
Re = 2*10^(3);
Vrb = 19.85;
Ic = 0;

Irb = Vcc/(Rb+Re);
Ib = (Vcc-Vbe)/(Rb+(Beta+1)*Re);

disp(Irb,'The base current(amperes) obtained is : ');
disp(Ib,'Ideally Ib(Amperes) should be :');
disp('Hence the transistor is in a damaged state,');
disp('with short-circuit between base and emitter.');
```

Scilab code Exa 4.26 Determine proper operation of network

```
clear; clc; close;

Vcc = 20;
Vb = 4;
Ve = 3.3;
Ic = 0;
disp('Drop across transistor is : ');
disp('This suggests that transistor is in on state.'
   ,Vb-Ve);
disp('Ic is : ')
disp('This suggest 2 things.',Ic)
disp('Either there is poor connection between Rc &
   terminal');
disp('or the transistor has an open base-to-
   collector junction.');
```

Scilab code Exa 4.27 `Vce for voltage divider config`

```
clear; clc; close;

Vcc = -18;
Vbe = -0.7;
Beta = 100;
R1 = 47*10^(3);
R2 = 10*10^(3);
Re = 1.1*10^(3);
Rc = 2.4*10^(3);

Vb = R2*Vcc/(R1+R2);
Ve = Vb-Vbe;
Ie = abs(Ve)/Re;
Ic = Ie;
Vce = Vcc+Ic*(Rc+Re);
disp(Vce,'Vce(volts) is : ');
```

Scilab code Exa 4.28 Stabiliity factor and change in Ic

```
clear; clc; close;

Beta = 50;
//denoting Rb/Re by x, we have
//for part a
x = 250;
ico = 19.9*10^(-9);
s = (1+Beta)*((1+x)/(Beta+1+x));
delta_ic = s*ico;
disp(s,'stability factor for part a is :');
disp(delta_ic,'change in Ic(amperes) is : ');

//for part b
x = 10;
s = (1+Beta)*((1+x)/(Beta+1+x));
delta_ic = s*ico;
disp(s,'stability factor for part b is :');
disp(delta_ic,'change in Ic(amperes) is : ');

//for part c
x = 0.01;
s = (1+Beta)*((1+x)/(Beta+1+x));
delta_ic = s*ico;
disp(s,'stability factor for part c is :');
disp(delta_ic,'change in Ic(amperes) is : ');
```

Scilab code Exa 4.29 Stabiliity factor and change in Ic

```
clear; clc; close;

```

```
//for part a
beta = 100;
delta_vbe = -0.17;
Rb = 240*10^(3);

s = -beta/Rb;
delta_ic = delta_vbe*s;
disp(s,'Stability factor for part a is : ');
disp(delta_ic,'change in Ic(amperes) for part a is :
    ');

//for part b
Rb = 240*10^(3);
Re = 1*10^(3);
s = -beta/(Rb+(beta+1)*Re);
delta_ic = delta_vbe*s;
disp(s,'Stability factor for part b is : ');
disp(delta_ic,'change in Ic(amperes) for part b is :
    ');

//for part c
Rb = 47*10^(3);
Re = 4.7*10^(3);
s = -1/Re;
delta_ic = delta_vbe*s;
disp(s,'Stability factor for part c is : ');
disp(delta_ic,'change in Ic(amperes) for part c is :
    ');
```

Scilab code Exa 4.30 Determine Icq

```
clear; clc; close;

//lets say Rb/Re = x,then we have
x = 20;
```

```
Ic1 = 2*10^(-3);
beta1=50;
beta2=80;

s = (Ic1*(1+x))/(beta1*(1+beta2+x));
delta_ic = s*(beta2-beta1);

disp(delta_ic,'change in the level of Ic(amperes) is
    : ')
```

Chapter 5

BJT AC Analysis

Scilab code Exa 5.1 Common base config characteristics

```
clear; clc; close;

Vt=26*(10^(-3)); //thermal voltage=26mV
Vi=3*(10^(-3));
Ie=4*(10^(-3));;     //emitter current=4mV
alpha=0.991; //common base amplification factor
Rl=610;         //Load Resistance(in ohms)

//Part-1 -> Determinig input impedance
re = Vt/Ie;
disp(re,'Input impedance(ohms) :');

//Part-2 -> Calculating the voltage gain
Ii = (Vi/re);
Ie = Ii;
Ic=alpha*Ie;
Vo=Ic*Rl;
Av = Vo/Vi;
disp(Av,"Voltage gain :");

//Part-3 -> Calculating the output impedance and
```

```
    current gain
disp(%inf,"The output impedance(ohms) is :");
Ai = -Ic/Ie;
disp(Ai,"Current gain is :");
```

Scilab code Exa 5.2 Zi Av and Ai for common emitter

```
clear; clc; close;

Vt=26*(10^(-3));        //thermal voltage
Ie=3.2*(10^(-3));       //emitter current
Beta=150;              //Common Emitter amplification
    factor
Rl = 2*(10^(3));      //Load Resistance

re = Vt/Ie;
Zi = Beta*re;
disp(Zi,"Input Impedance(ohms) is : ");

Av = -(Rl/re);
disp(Av,"Voltage gain is :");

Ai = Beta;
disp(Ai,"Current gain is :");
```

Scilab code Exa 5.3 Common emitter hybrid and common base model

```
clear; clc; close;

Vt=26*(10^(-3)); //thermal voltage
Ie=3.2*(10^(-3));    //emitter current
Beta = 150;//Common Emitter amplification factor
h_oe = 25*(10^(-6));
```

```
h_ob =0.5*(10^(-6));

re = Vt/Ie;
h_ie = Beta*re;
r_o = 1/h_oe;
disp("For the common emitter hybrid equivalent circuit :-")
disp(re,'re(ohms) =');
disp(h_ie,"hie(ohms) = ");
disp(r_o,"hoe(ohms) = ");

r_o = 1/h_ob;
alpha = 1;     //approximation
disp("For the common base re model :-")
disp(re,'re(ohms) =');
disp(alpha,"alpha = ");
disp(r_o,"ro(ohms) = ");
```

Scilab code Exa 5.4 Network characteristics determination

```
clear; clc; close;

Vcc = 15;
Vbe = 0.7;
Vt = 26*(10^(-3));
Rb = 470*(10^(3));
Rc = 4.7*(10^(3));
ro = 50*(10^(3));
Beta = 100;


Ib = (Vcc-Vbe)/Rb;
Ie = (Beta+1)*Ib;
re = Vt/Ie;
disp(re,"Value of diode resistive element is :")
```

```
Zb = Beta*re;     //resistance seen from base into
    the diode
Zi = (Rb*Zb)/(Rb+Zb);
disp(Zi,"Input impedance(ohms) :");

disp("At ro = infinity values are :-");
Zo = Rc;
disp(Zo,"Output impedance(ohms) :");

Av = -Rc/re;
disp(Av,"Voltage gain :");

disp("At ro = 50kohm,values are :-");
Zo_2 = (ro*Rc)/(ro+Rc);
disp(Zo_2,"Input impedance(ohms) :");

Av_2 = -((ro*Rc)/(ro+Rc))/re;
disp(Av_2,"Voltage gain :");
```

Scilab code Exa 5.5 `Network characteristics determination`

```
clear; clc; close;

Vcc = 22;
Vbe = 0.7;
Vt = 26*(10^(-3));
R1 = 56*(10^(3));
R2 = 8.2*(10^(3));
Re = 1.5*(10^(3));
Rc = 6.8*(10^(3));
ro = 50*(10^(3));
Beta = 90;
```

```
Vb = (R2/(R1+R2))*Vcc;
Ve = Vb - Vbe;
Ie = Ve/Re;
re = Vt/Ie;
disp(re,"Value of diode resistive element is :");

disp("At ro=infinity ,the values are :-");
Rx = (R1*R2)/(R1+R2);
Zb = Beta*re;
Zi = (Rx*Zb)/(Rx+Zb);
disp(Zi,"Input Impedance(ohms) :");

Zo = Rc;
disp(Zo,"Output Impedance(ohms) :");

Av = -Rc/re;
disp(Av,"Voltage gain :");

disp("At ro=1/hoe,the values are :-")
disp(Zi,"Input Impedance(ohms) :");
Zo_2 = (Rc*ro)/(Rc+ro);
disp(Zo_2,"Output Impedance(ohms) :");
Av_2 = -((ro*Rc)/(ro+Rc))/re;
disp(Av_2,"Voltage gain :");
```

Scilab code Exa 5.6 `Network characteristics without Ce`

```
clear; clc; close;

Vcc = 20;
Vbe = 0.7;
Vt = 26*(10^(-3));
Re = 0.56*(10^(3));
Rc = 2.2*(10^(3));
Rb = 470*(10^(3));
```

```
ro = 40*(10^(3));
Beta = 120;

Ib = (Vcc-Vbe)/(Rb+(Beta+1)*Re);
Ie = (Beta+1)*Ib;
re = Vt/Ie;
disp(re,"Value of diode resistive element is :");

Zb = Beta*(re+Re);
Zi = (Rb*Zb)/(Rb+Zb);
disp(Zi,"Input Impedance(ohms) :");

Zo = Rc;
disp(Zo,"Output Impedance(ohms) :");

Av = -Beta*Rc/Zb;
disp(Av,"Voltage gain :");
```

Scilab code Exa 5.7 Network characteristics with Ce

```
clear; clc; close;

Vcc = 20;
Vbe = 0.7;
Vt = 26*(10^(-3));
Re = 0.56*(10^(3));
Rc = 2.2*(10^(3));
Rb = 470*(10^(3));
ro = 40*(10^(3));
Beta = 120;

Ib = (Vcc-Vbe)/(Rb+(Beta+1)*Re);
Ie = (Beta+1)*Ib;
re = Vt/Ie;
disp(re,"Value of diode resistive element is (in
```

```
    ohms) :");

Zb = Beta*re;
Zi = (Rb*Zb)/(Rb+Zb);
disp(Zi,"Input Impedance(ohms) :");

Zo = Rc;
disp(Zo,"Output Impedance(ohms) :");

Av = -Rc/re;
disp(Av,"Voltage gain :");
```

Scilab code Exa 5.8 Network characteristics determination

```
clear; clc; close;

Vcc = 16;
Vbe = 0.7;
Vt = 26*(10^(-3));
R1 = 90*(10^(3));
R2 = 10*(10^(3));
Re = 0.68*(10^(3));
Rc = 2.2*(10^(3));
ro = 50*(10^(3));
Beta = 210;

Vb = (R2/(R1+R2))*Vcc;
Ve = Vb - Vbe;
Ie = Ve/Re;
re = Vt/Ie;
disp(re,"Value of diode resistive element is(in ohms
    ) :");

Rb = (R1*R2)/(R1+R2);
Zb = Beta*Re;
```

```
Zi = (Rb*Zb)/(Rb+Zb);
disp(Zi,"Input Impedance(ohms) :");

Zo = Rc;
disp(Zo,"Output Impedance(ohms) :");

Av = -Rc/Re;
disp(Av,"Voltage gain :");
```

Scilab code Exa 5.9 Network characteristics determination with Ce

```
clear; clc; close;

Vcc = 16;
Vbe = 0.7;
Vt = 26*(10^(-3));
R1 = 90*(10^(3));
R2 = 10*(10^(3));
Re = 0.68*(10^(3));
Rc = 2.2*(10^(3));
ro = 50*(10^(3));
Beta = 210;

Vb = (R2/(R1+R2))*Vcc;
Ve = Vb - Vbe;
Ie = Ve/Re;
re = Vt/Ie;
disp(re,"Value of diode resistive element is(in ohms
    ) :");

Rb = (R1*R2)/(R1+R2);
Zb = Beta*re;
Zi = (Rb*Zb)/(Rb+Zb);
disp(Zi,"Input Impedance(ohms) :");

```

```
Zo = Rc;
disp(Zo,"Output Impedance(ohms) :");

Av = -Rc/re;
disp(Av,"Voltage gain :");
```

Scilab code Exa 5.10 Emitter follower Network characteristics determination

```
clear; clc; close;

Vcc = 12;
Vbe = 0.7;
Vt = 26*(10^(-3));
Re = 3.3*(10^(3));
Rb = 220*(10^(3));
ro = %inf;
Beta = 100;

disp("For ro=infinity the values are:-");
Ib = (Vcc-Vbe)/(Rb+(Beta+1)*Re);
Ie = (Beta+1)*Ib;
re = Vt/Ie;
disp(re,"Value of diode resistive element is(in ohms
   ) :");

Zb = (Beta*re) + ((Beta+1)*Re);
Zi = (Rb*Zb)/(Rb+Zb);
disp(Zi,"Input Impedance(ohms) :");

Zo = (Re*re)/(Re+re);
disp(Zo,"Output Impedance(ohms) :");

Av = Re/(Re+re);
disp(Av,"Voltage gain :");

```

```
disp("For ro=25kohm the values are :-")
ro_2 = 25*(10^(3));

Zb_2 = (Beta*re) + ((Beta+1)*Re)/(1+(Re/ro_2));
Zi_2 = (Rb*Zb_2)/(Rb+Zb_2);
disp(Zi_2,"Input Impedance(ohms) :");

Zo_2 = (Re*re)/(Re+re);
disp(Zo_2,"Output Impedance(ohms) :");

Av_2 = (((Beta+1)*Re)/Zb_2)/(1+(Re/ro_2));
disp(Av_2,"Voltage gain :");
```

Scilab code Exa 5.11 `Network characteristics determination`

```
clear; clc; close;

Vee = 2;
Vbe = 0.7;
Vt = 26*(10^(-3));
Re = 1*(10^(3));
Rc = 5*(10^(3));
ro = 1*(10^(6));
alpha = 0.98;

Ie = (Vee-Vbe)/Re;
re = Vt/Ie;
disp(re,"Value of diode resistive element(re) :");

Zi = (Re*re)/(Re+re);
disp(Zi,"Input Impedance(Zi) :");

Zo = Rc;
disp(Zo,"Output Impedance(Zo) :");

```

```
Av = Rc/re;
disp(Av,"Voltage gain(Av) :");

Ai = -alpha;
disp(Ai,"Current gain(Ai) :");
```

Scilab code Exa 5.12 Network characteristics determination

```
clear; clc; close;

Vcc = 9;
Vbe = 0.7;
Vt = 26*(10^(-3));
Rf = 180*(10^(3));
Rc = 2.7*(10^(3));
Beta = 200;
ro = %inf;

disp("Values at ro=infinity are :-");
Ib = (Vcc-Vbe)/(Rf+(Beta*Rc));
Ie = (Beta+1)*Ib;
re = Vt/Ie;
disp(re,"Value of diode resistive element(re) :");

Zi = re/((1/Beta)+(Rc/Rf));
disp(Zi,"Input Impedance(Zi) :");

Zo = (Rc*Rf)/(Rc+Rf);
disp(Zo,"Output Impedance(Zo) :");

Av = -Rc/re;
disp(Av,"Voltage gain(Av) :");
disp("Values at ro=25kohm are :- ");
ro_2 = 20*(10^(3));

```

```
Zi_2 = (1+((Rc*ro_2)/(Rc+ro_2))/Rf)/((1/(Beta*re))+(1/Rf)+(((Rc*ro_2)/(Rc+ro_2))/(Rf*re)));
disp(Zi_2,"Input Impedance(Zi) :");

Zo_2 = (ro_2*Rc*Rf)/(ro_2*Rc+Rc*Rf+Rf*ro_2);
disp(Zo_2,"Output Impedance(Zo) :");

Av_2 = -[1/Rf + 1/re]*[ro_2*Rc/(ro_2+Rc)]/[1+[(ro_2*Rc)/(ro_2+Rc)]/Rf];
disp(Av_2,"Voltage gain(Av) :");
```

Scilab code Exa 5.13 `Network characteristics determination`

```
clear; clc; close;

Vcc = 12;
Vbe = 0.7;
Vt = 26*(10^(-3));
Rc = 3*(10^(3));
Rf1 = 120*(10^(3));
Rf2 = 68*(10^(3));
Rf = Rf1 + Rf2;
ro = 30*(10^(3));
Beta = 140;

Ib = (Vcc-Vbe)/(Rf+Beta*Rc);
Ie = (1+Beta)*Ib;
re = Vt/Ie;
disp(re,"Value of diode resistive element(re) :");

Zb = Beta*re;
Zi = (Rf1*Zb)/(Rf1+Zb);
disp(Zi,"Input Impedance(Zi) :");

Zo = (Rc*Rf2)/(Rc+Rf2);
```

```
disp(Zo,"Output Impedance(Zo) :");

Av = -[(Rf2*Rc)/(Rf2+Rc)]/re;
disp(Av,"Voltage gain(Av) :");
```

Scilab code Exa 5.14 Fixed Bias Network characteristics

```
clear; clc; close;

Vcc = 15;
Vbe = 0.7;
Vt = 26*(10^(-3));
Rb = 470*(10^(3));
Rc = 4.7*(10^(3));
Rl = 4.7*(10^(3));
Rs = 0.3*(10^(3));
ro = 50*(10^(3));
Beta = 100;


Ib = (Vcc-Vbe)/Rb;
Ie = (Beta+1)*Ib;
re = Vt/Ie;
disp(re,"Value of diode resistive element(re) :")

Zb = Beta*re;
Zi_prev = (Rb*Zb)/(Rb+Zb);
disp(Zi_prev,"Input Impedance(Zi) :");

Zo_prev = Rc;
disp(Zo_prev,"Output Impedance(Zo) :");

Av_prev = -Rc/re;
disp(Av_prev,"Voltage gain(Av) with no-load :");

```

```
Av = -[(Rc*Rl)/(Rc+Rl)]/re;
disp(Av,"Voltage gain(Av) with 4.7kohm load :");

Avs = (Zi_prev/(Zi_prev+Rs))*Av;
disp(Avs,"Voltage gain(Avs) from source to output
    with 4.7kohm load :");
disp(Av_prev,"Voltage gain(Av) with no-load :");
```

Scilab code Exa 5.15 `Av and Avs`

```
clear; clc; close;

Rl = 4.7*(10^(3));
Rs = 0.3*(10^(3));
Ro = 4.7*(10^(3));
Zi = 846.1;
Zo = 4.7*(10^(3));
AvNL = -555.55;     //gain under no-load condition

Av = {Rl/(Rl+Ro)}*AvNL;
disp(Av,"Voltage gain(Av) with 4.7kohm load :");

Avs = (Zi/(Zi+Rs))*(Rl/(Rl+Ro))*AvNL;
disp(Avs,"Voltage gain(Avs) from source to output
    with 4.7kohm load :");
```

Scilab code Exa 5.16 `Network characteristics determination`

```
clear; clc; close;

Zi = 4*(10^(3));
```

```
Zo = 2*(10^(3));
Rs = 0.2*(10^(3));
AvNL = -480;
disp(AvNL,"Voltage gain(Av) with no-load :")

Rl = 1.2*(10^(3));
Av = {Rl/(Rl+Zo)}*AvNL;
disp(Av,"Voltage gain(Av) with 1.2kohm load :");

Rl = 5.6*(10^(3));
Av = {Rl/(Rl+Zo)}*AvNL;
disp(Av,"Voltage gain(Av) with 5.6kohm load :");

Rl = 1.2*(10^(3));
Avs = {Zi/(Zi+Rs)}*{Rl/(Rl+Zo)}*AvNL;
disp(Avs,"Voltage gain(Avs) from source to output with 1.2kohm load :");

Rl = 5.6*(10^(3));
Ai = -Av*(Zi/Rl);
disp(Ai,"Current gain with 5.6kohm load :");
```

Scilab code Exa 5.17 Network characteristics determination

```
clear; clc; close;

Rs = 1*(10^(3));
Rl = 8.2*(10^(3));

Zi1 = 10*(10^(3));
Zo1 = 12;
AvNL1 = 1;
Vi1 = rand();

Zi2 = 26;
```

```
Zo2 = 5.1*(10^(3));
AvNL2 = 240;
Vi2 = rand();

Vo1 = (Zi2/(Zi2+Zo1))*AvNL1*Vi1;
Av1 = Vo1/Vi1;
disp(Av1,"Voltage gain(Av1) for first stage :");

Vo2 = (Rl/(Rl+Zo2))*AvNL2*Vi2;
Av2 = Vo2/Vi2;
disp(Av2,"Voltage gain(Av2) for second stage :");

Avt = Av1*Av2;
disp(Avt,"Total Voltage gain(Avt) :");

Avs = {Zi1/(Zi1+Rs)}*Avt;
disp(Avs,"Total Voltage gain(Avs) from source:");

Ait = -Avt*(Zi1/Rl);
disp(Ait,"Total current gain(Ai) :");

Vs = rand();
Vi = {Zi2/(Zi2+Rs)}*Vs;
Avs = (Vi/Vs)*Av2;
disp(Avs,"Total gain if emitter-follower
    configuration removed :");
```

Scilab code Exa 5.18 Network characteristics determination

```
clear; clc; close;

Vi = 25*(10^(-6));
Beta = 200;
R1 = 15*(10^(3));
R2 = 4.7*(10^(3));
```

```
Rc = 2.2*(10^(3));
Zo = Rc;
Re = 1*(10^(3));

Vb = 4.7;
Ve = 4;
Vc = 11;
Vt = 26*(10^-(3));
Ie = 4*(10^(-3));

re = Vt/Ie;
Zb  = Beta*re;
Zi2 = (R1*R2*Zb)/(R1*R2 + R2*Zb + Zb*R1);
Av1 = -{(Rc*Zi2)/(Rc+Zi2)}/re;
AvNL2 = -Rc/re;
AvT_NL = Av1*AvNL2;
disp(AvT_NL,"No-load voltage gain(Avt(NL)) :");

Vo = AvT_NL*Vi;
disp(Vo," Voltage gain(Vo) :");

Rl = 10*(10^(3));
Avt = {Rl/(Rl+Zo)}*AvT_NL;
disp(Avt," Voltage gain(Avt) when 10kohm load applied to stage 2:");

Zi1 = Zi2;
disp(Zi1,"input impedance of first stage(Zi1) :");

Zo2 = Rc;
disp(Zo2,"Output impedance of second stage(Vo2) :");
```

Scilab code Exa 5.19 No load voltage gain

```
clear; clc; close;
```

```

Vcc = 18;
Vt = 26*(10^(-3));
Beta = 200;

Vb1 = 4.9;
Vb2 = 10.8;
Ic1 = 3.8*(10^(-3));
Ic2 = 3.8*(10^-(3));
Ie = Ic1;
Re1 = 1.1*(10^(3));
Rc2 = 1.8*(10^(3));


re = Vt/Ie;
Rc1 = re;
Av1 = -Rc1/re;

Av2 = Rc2/re;
Avt = Av1*Av2;
disp(Avt,"no-load voltage gain(Avt) :");
```

Scilab code Exa 5.20 Dc bias voltage and current

```
clear; clc; close;

Vcc = 18;
Vbe = 1.6;
Rb = 3.3*(10^(6));
Re = 390;
Beta = 8000;

Ib = (Vcc-Vbe)/(Rb+(Beta*Re));
disp(Ib,"Ib :");
Ie = (Beta+1)*Ib;
```

```
disp(Ie,"Ie :");
Ve = Ie*Re;
disp(Ve,"Ve :");
Vb = Ve+Vbe;
disp(Vb,"Vb :");
disp(Vcc,"Vc :");
```

Scilab code Exa 5.21 Input impedance

```
clear; clc; close;

ri = 5*(10^(3));
Rb = 3.3*(10^(6));
Beta = 8000;
Re = 390;

Zb = ri + (Beta*Re);
Zi = (Rb*Zb)/(Rb+Zb);
disp(Zi,"input impedance(Zi) :");
```

Scilab code Exa 5.22 Ac current gain

```
clear; clc; close;

Rb = 3.3*(10^(6));
Beta = 8000;
Re = 390;

Ai = (Beta*Rb)/(Rb+Beta*Re);
disp(Ai,"ac current gain(Ai) :");
```

Scilab code Exa 5.23 Output impedance

```
clear; clc; close;

Beta = 8000;
Re = 390;
ri = 5*(10^(3));

x = ri/Beta;
Zo = (Re*ri*x)/(Re*ri+ri*x+x*Re);
disp(Zo,"output impedance(Zo) :");
```

Scilab code Exa 5.24 Ac voltage gain

```
clear; clc; close;

Beta = 8000;
Re = 390;
ri = 5*(10^(3));

Av = (Re+(Beta*Re))/(ri+(Re+Beta*Re));
disp(Av,"ac voltage gain(Av) :");
```

Scilab code Exa 5.25 Dc bias voltage and current

```
clear; clc; close;

Vcc = 18;
Veb1 = 0.7;
Rb = 2*(10^(6));
Rc = 75;
Beta1 = 140;
Beta2 = 180;
```

```

Ib1 = (Vcc-Veb1)/(Rb+(Beta1*Beta2*Rc));
Ic1 = Beta1*Ib1;
Ib2 = Ic1;
disp(Ib2,"Ib :");
Ic2 = Beta2*Ib2;
disp(Ic2,"Ic :");
Ie1 = Ic1-Ib1;
Ic = Ie1+Ic2;
disp(Ic,"Ic(Total) :");
Vo_dc = Vcc-Ic*Rc;
disp(Vo_dc,"Dc voltage(Ouput) :");
Vi_dc = Vo_dc-Veb1;
disp(Vi_dc,"Dc voltage (Input) :");
```

Scilab code Exa 5.26 Ac circuit values of Zi Zo Ai Av

```
clear; clc; close;

Vcc = 18;
Veb1 = 0.7;
Rb = 2*(10^(6));
Rc = 75;
Beta1 = 140;
Beta2 = 180;
ri1 = 3*(10^(3));

Zb = ri1+(Beta1*Beta2*Rc);
Zi = (Rb*Zb)/(Rb+Zb);
disp(Zi,"Input impedance(Zi) :");

Ai = (Beta1*Beta2)*(Rb/(Rb+Zi));
disp(Ai,"Current gain(Ai) :");

Zo = ri1/(Beta1*Beta2);
```

```
disp(Zo,"Output impedance(Zo) :");
Av = (Beta1*Beta2*Rc)/((Beta1*Beta2*Rc)+ri1);
disp(Av,"volatge gain(Av) :");
```

Scilab code Exa 5.27 `Mirrored Current`

```
clear; clc; close;

Vcc = 12;
Vbe = 0.7;
Rx = 1.1*(10^(3));

Ix = (Vcc-Vbe)/Rx;
disp(Ix,"Mirrored current :");
```

Scilab code Exa 5.28 `Current through transistors`

```
clear; clc; close;

Vcc = 6;
Vbe = 0.7;
Rx = 1.3*(10^(3));

Ix = (Vcc-Vbe)/Rx;
disp(Ix,"Current through each transistor :");
```

Scilab code Exa 5.29 `Constant current`

```
clear; clc; close;

```

```
Vee = 20;
Vbe = 0.7;
R1 = 5.1*(10^(3));
R2 = R1;
Re = 2.2*(10^(3));

Vb = (R1/(R1+R2))*(-Vee);
Ve = Vb - Vbe;
Ie = (Ve-(-Vee))/Re;
disp(Ie,"Constant current :");
```

Scilab code Exa 5.30 Constant current

```
clear; clc; close;

Vee = 18;
Vz = 6.2;
Vbe = 0.7;
Re = 1.8*(10^(3));

I = (Vz-Vbe)/Re;
disp(I,"Constant current :");
```

Scilab code Exa 5.31 Network characteristics determination

```
clear; clc; close;

Vcc = 10;
Vbe = 0.7;
hfe = 120;
hie = 1.175*(10^(3));
hoe = 20*(10^(-6));
Rb = 470*(10^(3));
```

```
Rc = 2.7*(10^(3));

Zi = (Rb*hie)/(Rb+hie);
disp(Zi,"Input impedance(Zi) :");
ro = 1/hoe;
Zo = (ro*Rc)/(ro+Rc);
disp(Zo,"Output impedance(Zo) :");
Av = -hfe*Zo/hie;
disp(Av,"Voltage gain(Av) :");
Ai = hfe;
disp(Ai,"Current gain(Ai) :");
```

Scilab code Exa 5.32 `Network characteristics determination`

```
clear; clc; close;

hfb = -0.99;
hib = 14.3;
hob = 0.5*(10^(-6));
Re = 2.2*(10^(3));
Rc = 3.3*(10^(3));

Zi = (Re*hib)/(Re+hib);
disp(Zi,"Input impedance(Zi) :");
ro=1/hob;
Zo = (ro*Rc)/(ro+Rc);
disp(Zo,"Output impedance(Zo) :");
Av = -hfb*Rc/hib;
disp(Av,"Voltage gain(Av) :");
Ai = hfb;
disp(Ai,"Current gain(Ai) :");
```

Scilab code Exa 5.33 `Determing parameters using hybrid equivalent model`

```
clear; clc; close;

Vcc = 8;
hfe = 110;
hie = 1.6*(10^(3));
hoe = 20*(10^(-6));
hre = 2*(10^(-4));
Rl = 4.7*(10^(3));
Rc = 4.7*(10^(3));
Rb = 470*(10^(3));
Rs = 1*(10^(3));

Zi = hie - (hfe*hre*Rl)/(1+hoe*Rl);
disp(Zi,"Input impedance using hybrid equivalent :");
disp(hie,"Input impedance using approximate model :")
Zi_b = (Rb*hie)/(Rb+hie);
disp(Zi_b,"Input impedance including Rb :");

Av = -hfe*Rl/(hie+(hie*hoe-hfe*hre)*Rl);
disp(Av,"Voltage gain using hybrid equivalent :");
Av_approx = -hfe*Rl/hie;
disp(Av_approx,"Voltage gain using approximate model :");

Ai = hfe/(1+hoe*Rl);
disp(Ai,"Current gain using hybrid equivalent :");
Ai_approx = hfe;
disp(Ai_approx,"Current gain using approximate model :");

Zo = 1/[hoe-(hfe*hre)/(hie+Rs)];
disp(Zo,"Output impedance using hybrid equivalent :");
Zo_approx = 1/hoe;
disp(Zo_approx,"Output impedance using approximate model :");
```

```
Zo_rc = (Rc*Zo)/(Rc+Zo);
disp(Zo_rc,"Output impedance including Rc & using hybrid equivalent :");
Zo_rc_approx = Rc;
disp(Zo_rc_approx,"Output impedance including Rc & using approximate model :");
```

Scilab code Exa 5.34 Determing parameters using hybrid equivalent model

```
clear; clc; close;

hfe = 110;
hie = 1.6*(10^(3));
hoe = 20*(10^(-6));
hre = 2*(10^(-4));
Rl = 2.2*(10^(3));
Rc = 2.2*(10^(3));
R1 = 3*(10^(3));
Rs = 1*(10^(3));
disp("Common base hybrid parameters are as follows :")
hib =  hie/(1+hfe);
disp(hib,"hib :");
hrb = (hie*hoe)/(1+hfe)-hre;
disp(hrb,"hrb :");
hfb = -hfe/(1+hfe);
disp(hfb,"hfb :");
hob = hoe/(1+hfe);
disp(hob,"hob :");

Zi = hib - (hfb*hrb*Rl)/(1+hob*Rl);
disp(Zi,"Input impedance using hybrid equivalent :");
disp(hib,"Input impedance using approximate model :");
```

```
Zi_b = (R1*hib)/(R1+hib);
disp(Zi_b,"Input impedance including Rb :");

Ai = hfb/(1+hob*Rl);
disp(Ai,"Current gain using hybrid equivalent :");
Ai_approx = hfb;
disp(Ai_approx,"Current gain using approximate model
    :");

Av = -hfb*Rl/(hib+(hib*hob-hfb*hrb)*Rl);
disp(Av,"Voltage gain using hybrid equivalent :");
Av_approx = -hfb*Rl/hib;
disp(Av_approx,"Voltage gain using approximate model
    :");

Zo = 1/[hob-(hfb*hrb)/(hib+Rs)];
disp(Zo,"Output impedance using hybrid equivalent :"
   );
Zo_approx = 1/hob;
disp(Zo_approx,"Output impedance using approximate
   model :");
Zo_rc = (Rc*Zo)/(Rc+Zo);
disp(Zo_rc,"Output impedance including Rc & using
   hybrid equivalent :");
Zo_rc_approx = Rc;
disp(Zo_rc_approx,"Output impedance including Rc &
   using approximate model :");
```

Chapter 6

Field Effect Transistor

Scilab code Exa 6.1 Sketching the transfer curve

```
clear; clc; close;

Idss = 12;
Vp = -4;
//point 1
Vgs1 = Vp/2;
Id1 = Idss/4;
//point 2
Id2 = Idss/2;
Vgs2 = 0.3*Vp;


x = [-4 -2 -1.2 0];
y = [0 3 6 12];
//plot2d(x,y);
yi=smooth([x;y],0.1);
a = gca();
a.thickness = 2;
a.y_location = 'right';
```

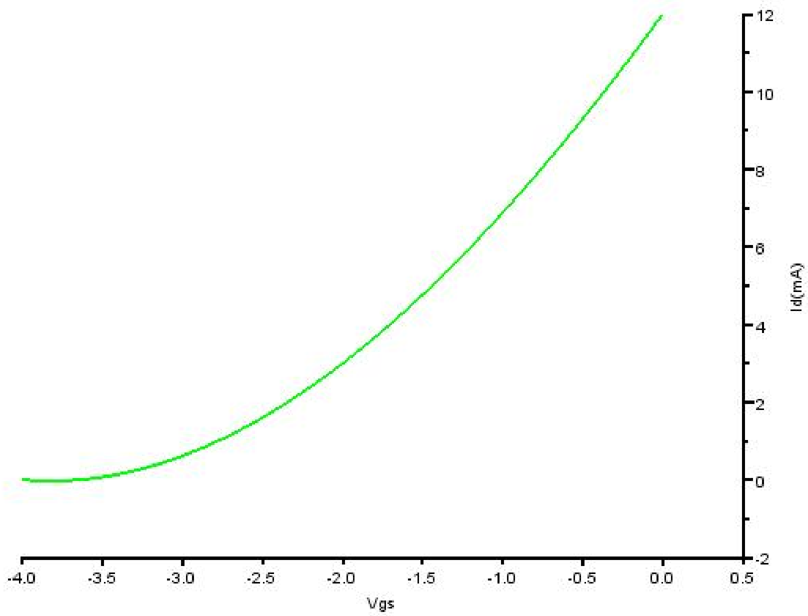

Figure 6.1: Sketching the transfer curve

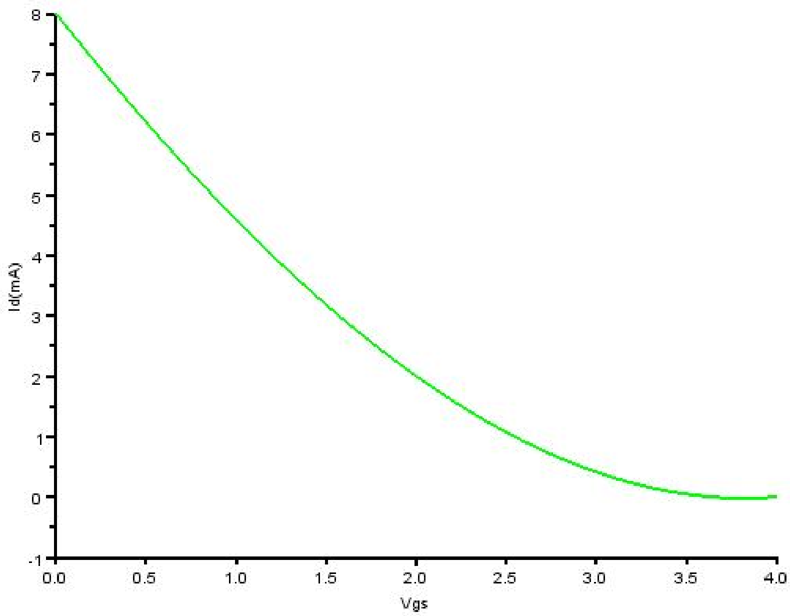

Figure 6.2: Sketching the transfer curve

```
a.x_label.text = 'Vgs';
a.y_label.text = 'Id(mA)';
plot2d(yi(1,:)',yi(2,:)',[3]);
```

Scilab code Exa 6.2 Sketching the transfer curve

```
clear; clc; close;

Idss = 8;
Vp = 4;
//point 1
```

```
Vgs1 = Vp/2;
Id1 = Idss/4;
//point 2
Id2 = Idss/2;
Vgs2 = 0.3*Vp;


x = [0 1.2 2 4];
y = [8 4 2 0];
yi=smooth([x;y],0.1);
a = gca();
a.thickness = 2;
a.y_location = 'left';
a.x_label.text = 'Vgs';
a.y_label.text = 'Id(mA)';
plot2d(yi(1,:)',yi(2,:)',[3]);
```

Scilab code Exa 6.3 Sketching the transfer curve

```
clear; clc; close;

Idss = 10;
Vp = -4;
//point 1
Vgs1 = Vp/2;
Id1 = Idss/4;
//point 2
Id2 = Idss/2;
Vgs2 = 0.3*Vp;
Vgs3 = 1;
Id = Idss(1-Vgs3/Vp)^2;
x = [-4 -2 -1.2 1];
y = [0 2.5 5 15.63];

yi=smooth([x;y],0.1);
```

```
a = gca();
a.thickness = 2;
a.y_location = 'middle';
a.x_label.text = 'Vgs';
a.y_label.text = 'Id(mA)';
plot2d(yi(1,:)',yi(2,:)',[3]);
```

Scilab code Exa 6.4 Sketching the transfer curve and finding value of k

```
clear; clc; close;

Id_on = 3*10^(-3);
Vgs_on = 10;
Vgs_th = 3;
Vt = 3;

k = Id_on/(Vgs_on-Vgs_th)^2;
disp(k,'resulting value of k(A/V^2) is : ');

Vgs1 = 5;
Id1 = k*(Vgs1-Vt)^2;
Vgs2 = 8;
Id2 = k*(Vgs2-Vt)^2;
Vgs3 = 10;
Id3 = k*(Vgs3-Vt)^2;
Vgs4 = 12;
Id4 = k*(Vgs4-Vt)^2;
Vgs5 = 14;
Id5 = k*(Vgs5-Vt)^2;

x = [Vt Vgs1 Vgs2 Vgs3 Vgs4 Vgs5];
y = [0 Id1 Id2 Id3 Id4 Id5];
yi=smooth([x;y],0.1);
a = gca();
a.thickness = 2;
```

```
a.y_location = 'left';
a.x_label.text = 'Vgs';
a.y_label.text = 'Id(A)';
plot2d(yi(1,:)',yi(2,:)',[3]);
```

Chapter 7

FET Biasing

Scilab code Exa 7.1 Network characteristics determination

```
clear; clc; close;

Vgg = 2;
Idss = 10*10^(-3);
Vp = -4;
Vdd = 16;
Rd = 2*10^(3);

Vgs = -Vgg;
Id = Idss*(1-(Vgs/Vp))^2;
Vds = Vdd - Id*Rd;
Vd = Vds;
Vg = Vgs;
Vs = 0;

disp(Vgs,'Vgsq(Volts) = ');
disp(Id,'Idq(Amperes) = ');
disp(Vds,'Vds(Volts) = ');
disp(Vd,'Vd(Volts) = ');
disp(Vg,'Vg(Volts) = ');
disp(Vs,'Vs(Volts) = ');
```

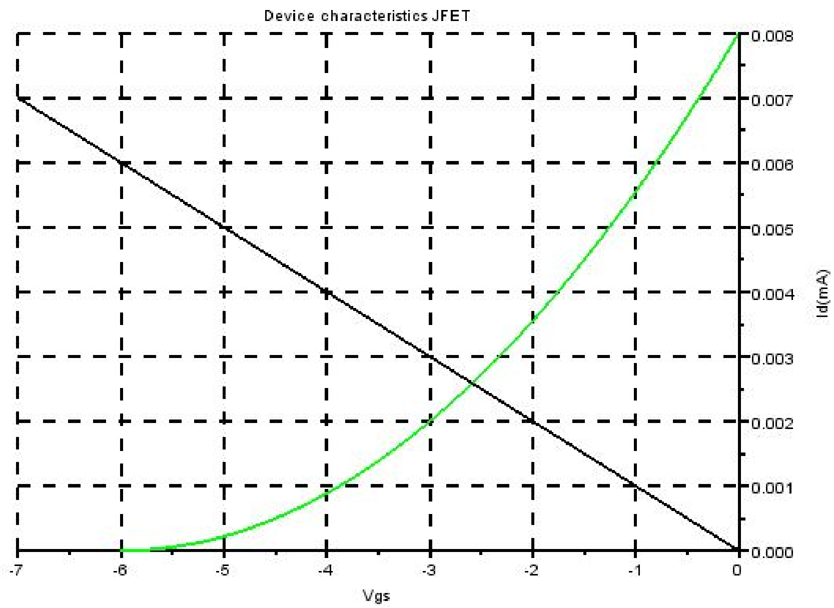

Figure 7.1: Network characteristics determination

Scilab code Exa 7.2 `Network characteristics determination`

```
clear; clc; close;

Idss = 8*10^(-3);
Vp = -6;
Vdd = 20;
Rd = 3.3*10^(3);
Rs = 1*10^(3);

Vgs1 = Vp;
```

```
Id1 = 0;
Vgs2 = Vp/2;
Id2 = Idss/4;
Vgs3 = 0;
Id3 = Idss;
x = [Vgs1 Vgs2 Vgs3];
y = [Id1 Id2 Id3];

yi=smooth([x;y],0.1);
a = gca();
a.thickness = 2;
a.y_location = 'right';
a.x_label.text = 'Vgs';
a.y_label.text = 'Id(mA)';
a.title.text = 'Device characteristics JFET';
a.grid = [1 1];
plot2d(yi(1,:)',yi(2,:)',[3]);


Vgs1 = 0;
Id1 = 0;
Id2 = 4*10^(-3);
Vgs2 = -Id2*Rs;
Id3 = 8*10^(-3);
Vgs3 = -Id3*Rs;
x = [Vgs1 Vgs2 Vgs3];
y = [Id1 Id2 Id3];
plot2d(x,y);

Vgsq = -2.6;
disp(Vgsq,'Q-point value of Vgs(found after
   interpolation) is :');

Idq = 2.6*10^(-3);
Vds = Vdd - Idq*(Rs+Rd);
Vs = Idq*Rs;
Vg  = 0;
Vd = Vds + Vs;
```

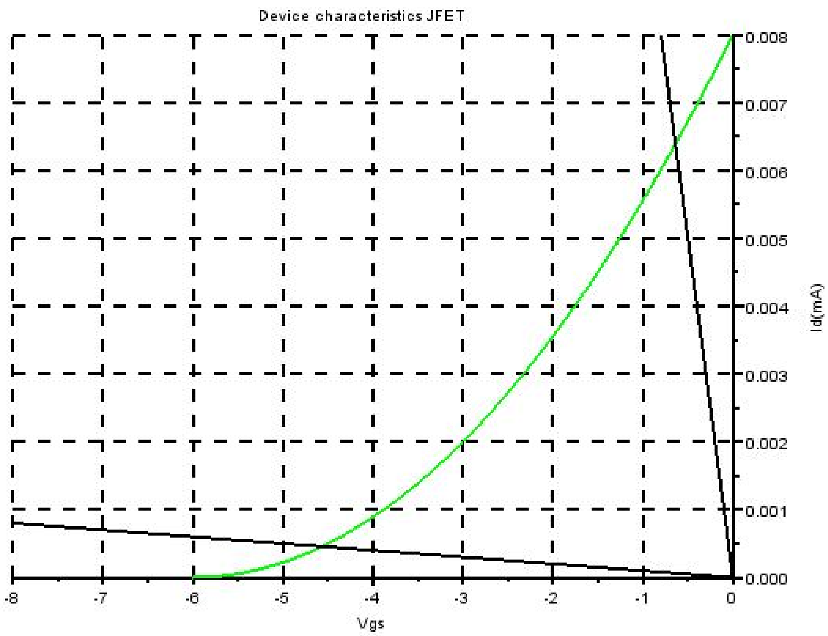

Figure 7.2: Q point for network

```

disp(Idq,'Idq(Amperes) = ');
disp(Vds,'Vds(Volts) = ');
disp(Vd,'Vd(Volts) = ');
disp(Vg,'Vg(Volts) = ');
disp(Vs,'Vs(Volts) = ');
```

Scilab code Exa 7.3 `Q point for network`

```
clear; clc; close;

```

```
Rs = 100;
Idss = 8*10^(-3);
Vp = -6;
Vdd = 20;

Vgs1 = Vp;
Id1 = 0;
Vgs2 = Vp/2;
Id2 = Idss/4;
Vgs3 = 0;
Id3 = Idss;
x = [Vgs1 Vgs2 Vgs3];
y = [Id1 Id2 Id3];

yi=smooth([x;y],0.1);
a = gca();
a.thickness = 2;
a.y_location = 'right';
a.x_label.text = 'Vgs';
a.y_label.text = 'Id(mA)';
a.title.text = 'Device characteristics JFET';
a.grid = [1 1];

plot2d(yi(1,:)',yi(2,:)',[3]);


Vgs1 = 0;
Id1 = 0;
Id2 = 4*10^(-3);
Vgs2 = -Id2*Rs;
Id3 = 8*10^(-3);
Vgs3 = -Id3*Rs;
x = [Vgs1 Vgs2 Vgs3];
y = [Id1 Id2 Id3];
plot2d(x,y);
```

```

Idq = 6.4*10^(-3);
Vgsq = -0.64;
disp('From the figure ,for part a  i.e Rs=100Kohm,we
    get ');
disp(Idq,'Idq(Amperes) = ');
disp(Vgsq,'Vgsq(Volts) = ');

//part b

Rs = 10*10^(3);
Idss = 8*10^(-3);
Vp = -6;
Vdd = 20;



Vgs1 = 0;
Id1 = 0;
Id2 = 4*10^(-3);
Vgs2 = -Id2*Rs;
Id3 = 8*10^(-3);
Vgs3 = -Id3*Rs;
x = [Vgs1 Vgs2 Vgs3];
y = [Id1 Id2 Id3];
plot2d(x,y);
a.data_bounds = [-8 0;0 8*10^(-3)];
Idq = 0.46*10^(-3);
Vgsq = -4.6;
disp('From the figure ,for part b  i.e Rs=10Kohm,we
    get ')
disp(Idq,'Idq(Amperes) = ');
disp(Vgsq,'Vgsq(Volts) = ');
```

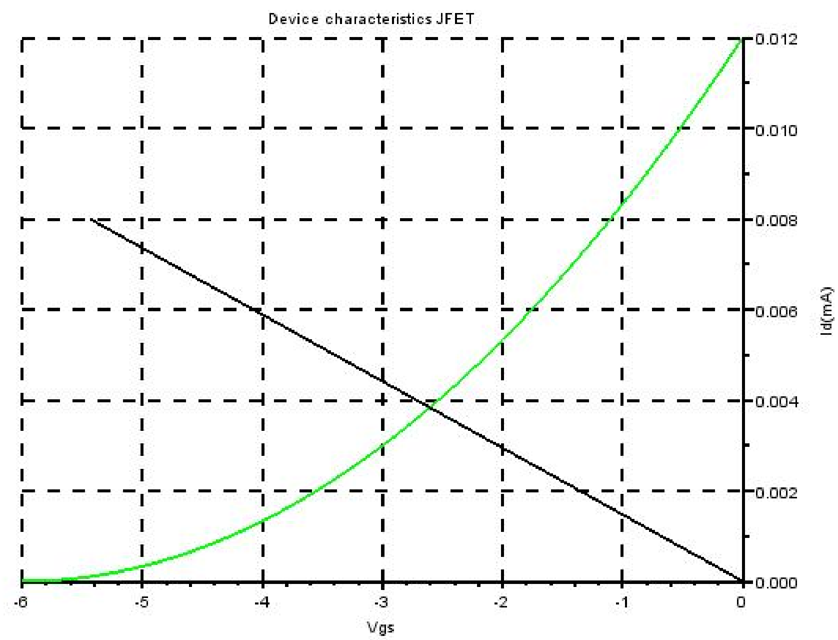

Figure 7.3: Network characteristics determination

Scilab code Exa 7.4 Network characteristics determination

```
clear; clc; close;

Idss = 12*10^(-3);
Vp = -6;
Vdd = 12;
Rd = 1.5*10^(3);
Rs = 680;

Vgs1 = Vp;
Id1 = 0;
Vgs2 = Vp/2;
Id2 = Idss/4;
Vgs3 = 0;
Id3 = Idss;
x = [Vgs1 Vgs2 Vgs3];
y = [Id1 Id2 Id3];

yi=smooth([x;y],0.1);
a = gca();
a.thickness = 2;
a.y_location = 'right';
a.x_label.text = 'Vgs';
a.y_label.text = 'Id(mA)';
a.title.text = 'Device characteristics JFET';
a.grid = [1 1];
plot2d(yi(1,:)',yi(2,:)',[3]);


Vgs1 = 0;
Id1 = 0;
Id2 = 4*10^(-3);
Vgs2 = -Id2*Rs;
Id3 = 8*10^(-3);
Vgs3 = -Id3*Rs;
x = [Vgs1 Vgs2 Vgs3];
y = [Id1 Id2 Id3];
```

```
plot2d(x,y);


Vgsq = -2.6;
disp(Vgsq,'Q-point value of Vgs(found after
   interpolation) is :');

Idq = 3.8*10^(-3);
Vd = Vdd - Idq*Rd;
Vg = 0;
Vs = Idq*Rs;
Vds = Vd-Vs;

disp(Idq,'Idq(Amperes) = ');
disp(Vds,'Vds(Volts) = ');
disp(Vd,'Vd(Volts) = ');
disp(Vg,'Vg(Volts) = ');
disp(Vs,'Vs(Volts) = ');
disp(Vds,'Vds(Volts) = ');
```

Scilab code Exa 7.5 Network characteristics determination

```
clear; clc; close;

Idss = 8*10^(-3);
Vp = -4;
Vdd = 16;
Rd = 2.4*10^(3);
Rs = 1.5*10^(3);
R1 = 2.1*10^(6);
R2 = 0.27*10^(6);
//finding Vg
Vg = R2*Vdd/(R1+R2);
```

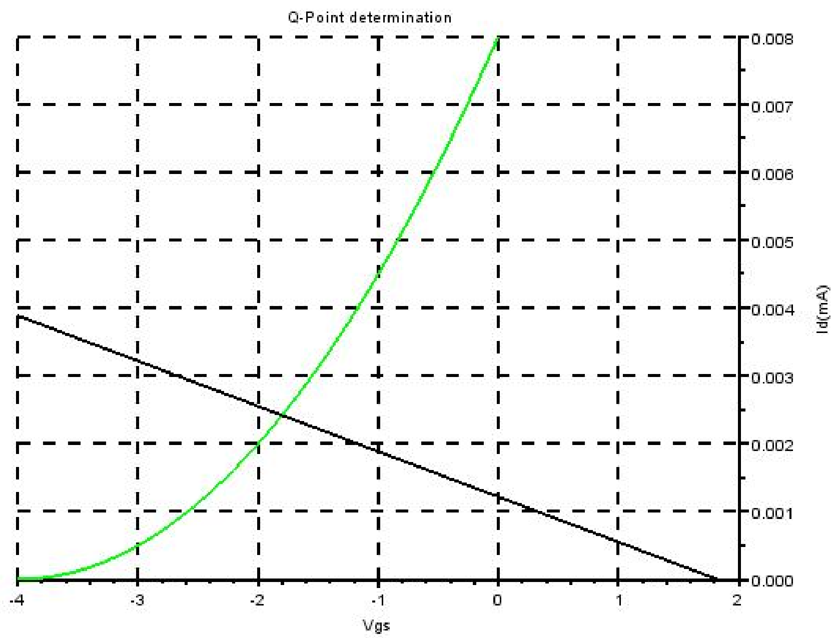

Figure 7.4: Network characteristics determination

```
//plotting transfer curve

Vgs1 = Vp;
Id1 = 0;
Vgs2 = Vp/2;
Id2 = Idss/4;
Vgs3 = 0;
Id3 = Idss;
x = [Vgs1 Vgs2 Vgs3];
y = [Id1 Id2 Id3];

yi=smooth([x;y],0.1);
a = gca();
a.thickness = 2;
a.y_location = 'right';
a.x_label.text = 'Vgs';
a.y_label.text = 'Id(mA)';
a.title.text = 'Q-Point determination';
a.grid = [1 1];
plot2d(yi(1,:)',yi(2,:)',[3]);


Id1 = 0;
Vgs1 = Vg-Id1*Rs;
Id2 = 4*10^(-3);
Vgs2 = Vg-Id2*Rs;
Id3 = 8*10^(-3);
Vgs3 = Vg-Id3*Rs;
x = [Vgs1 Vgs2 Vgs3];
y = [Id1 Id2 Id3];
plot2d(x,y);
a.data_bounds = [-4 0;2 8*10^(-3)];


Vgsq = -1.8;
disp(Vgsq,'Q-point value of Vgs(found after
   interpolation) is :');
```

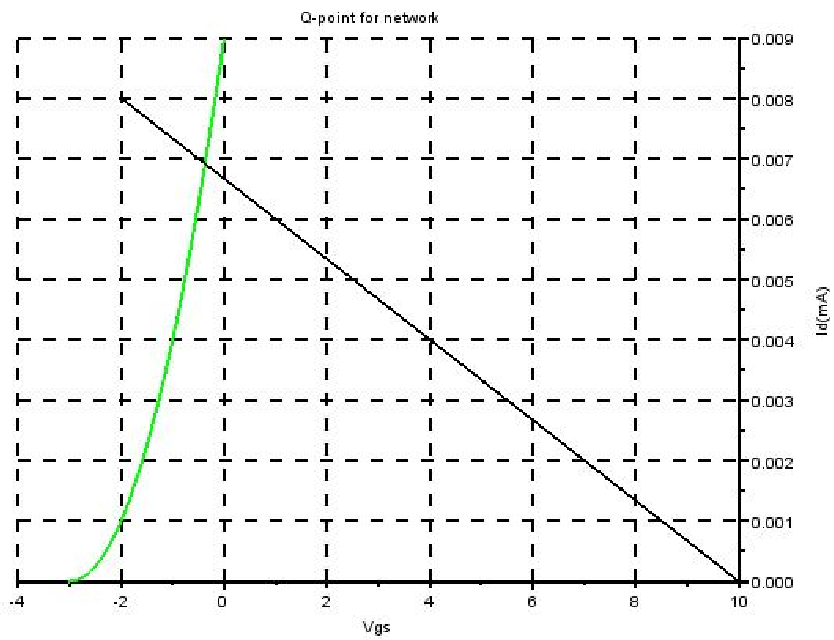

Figure 7.5: Network characteristics determination

```

Idq = 2.4*10^(-3);

Vd = Vdd-Idq*Rd;
Vs = Idq*Rs;
Vds = Vdd - Idq*(Rd+Rs);

disp(Idq,'Idq(Amperes) = ');
disp(Vds,'Vds(Volts) = ');
disp(Vd,'Vd(Volts) = ');
disp(Vs,'Vs(Volts) = ');
disp(Vds,'Vds(Volts) = ');
```

Scilab code Exa 7.6 Network characteristics determination

```
clear; clc; close;

Idss = 9*10^(-3);
Vp = -3;
Vdd = 20;
Vss = 10;
Rd = 1.8*10^(3);
Rs = 1.5*10^(3);


Vgs1 = Vp;
Id1 = 0;
Vgs2 = Vp/2;
Id2 = Idss/4;
Vgs3 = 0;
Id3 = Idss;
x = [Vgs1 Vgs2 Vgs3];
y = [Id1 Id2 Id3];

yi=smooth([x;y],0.1);
a = gca();
a.thickness = 2;
a.y_location = 'right';
a.x_label.text = 'Vgs';
a.y_label.text = 'Id(mA)';
a.title.text = 'Q-point for network';
a.grid = [1 1];
plot2d(yi(1,:)',yi(2,:)',[3]);



Id1 = 0;
```

```
Vgs1 = Vss-Id1*Rs;
Id2 = 4*10^(-3);
Vgs2 = Vss-Id2*Rs;
Id3 = 8*10^(-3);
Vgs3 = Vss-Id3*Rs;
x = [Vgs1 Vgs2 Vgs3];
y = [Id1 Id2 Id3];
plot2d(x,y);
a.data_bounds = [-3 0;10 9*10^(-3)];



Vgsq = -0.35;
disp(Vgsq,'Q-point value of Vgs(found after
    interpolation) is :');

Idq = 6.9*10^(-3);

Vds = Vdd+Vss-Idq*(Rd+Rs);
Vd = Vdd-Idq*Rd;
Vs = Vd-Vds;

disp(Idq,'Idq(Amperes) = ');
disp(Vds,'Vds(Volts) = ');
disp(Vd,'Vd(Volts) = ');
disp(Vs,'Vs(Volts) = ');
disp(Vds,'Vds(Volts) = ');
```

Scilab code Exa 7.7 Idq Vgsq and Vds calculation

```
clear; clc; close;

Idss = 6*10^(-3);
```

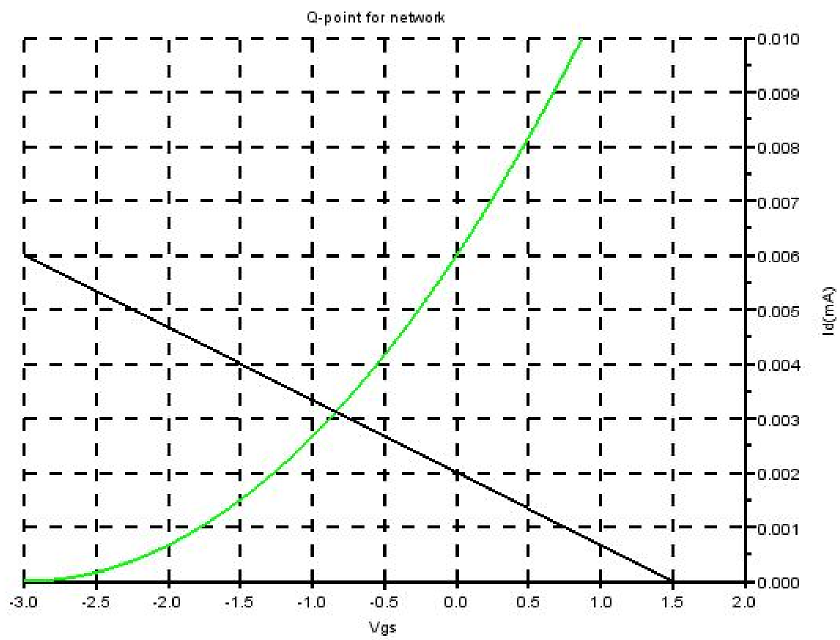

Figure 7.6: Idq Vgsq and Vds calculation

```
Vp = -3;
Vdd = 18;
Rd = 1.8*10^(3);
Rs = 750;

Vg = 10*10^(6)*18/((10+110)*10^(6));

Vgs1 = Vp;
Id1 = 0;
Vgs2 = Vp/2;
Id2 = Idss/4;
Vgs3 = 0;
Id3 = Idss;
Vgs4 = 1;
Id4 = Idss*(1-(Vgs4/Vp))^2;
disp(Id4);
x = [Vgs1 Vgs2 Vgs3 Vgs4];
y = [Id1 Id2 Id3 Id4];

yi=smooth([x;y],0.1);
a = gca();
a.thickness = 2;
a.y_location = 'right';
a.x_label.text = 'Vgs';
a.y_label.text = 'Id(mA)';
a.title.text = 'Q-point for network';
a.grid = [1 1];
plot2d(yi(1,:)',yi(2,:)',[3]);


Id1 = 0;
Vgs1 = Vg-Id1*Rs;
Id2 = 3*10^(-3);
Vgs2 = Vg-Id2*Rs;
Id3 = 6*10^(-3);
Vgs3 = Vg-Id3*Rs;
x = [Vgs1 Vgs2 Vgs3];
y = [Id1 Id2 Id3];
```

```
plot2d(x,y);
a.data_bounds = [-3 0;2 10*10^(-3)];


Vgsq = -0.8;
disp(Vgsq,'Q-point value of Vgs(found after
   interpolation) is :');

Idq = 3.1*10^(-3);

Vds = Vdd - Idq*(Rd+Rs);

disp(Idq,'Idq(Amperes) = ');
disp(Vds,'Vds(Volts) = ');
```

Scilab code Exa 7.8 Idq Vgsq and Vds calculation

```
clear; clc; close;

Idss = 6*10^(-3);
Vp = -3;
Vdd = 18;
Rd = 1.8*10^(3);
Rs = 150;


Vg = 10*10^(6)*18/((10+110)*10^(6));

Vgs1 = Vp;
Id1 = 0;
Vgs2 = Vp/2;
Id2 = Idss/4;
Vgs3 = 0;
```

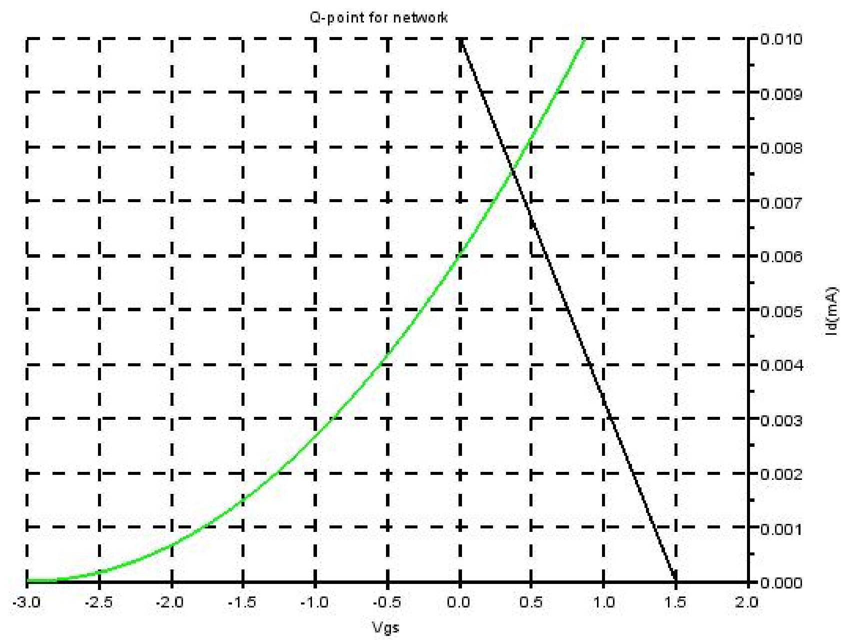

Figure 7.7: Idq Vgsq and Vds calculation

```
Id3 = Idss;
Vgs4 = 1;
Id4 = Idss*(1-(Vgs4/Vp))^2;
disp(Id4);
x = [Vgs1 Vgs2 Vgs3 Vgs4];
y = [Id1 Id2 Id3 Id4];

yi=smooth([x;y],0.1);
a = gca();
a.thickness = 2;
a.y_location = 'right';
a.x_label.text = 'Vgs';
a.y_label.text = 'Id(mA)';
a.title.text = 'Q-point for network';
a.grid = [1 1];
plot2d(yi(1,:)',yi(2,:)',[3]);


Id1 = 0;
Vgs1 = Vg-Id1*Rs;
Id2 = 3*10^(-3);
Vgs2 = Vg-Id2*Rs;
Id3 = 6*10^(-3);
Vgs3 = Vg-Id3*Rs;
Vgs4 = 0;
Id4 = (Vg - Vgs4)/Rs;
x = [Vgs1 Vgs2 Vgs3 Vgs4];
y = [Id1 Id2 Id3 Id4];
plot2d(x,y);
a.data_bounds = [-3 0;2 10*10^(-3)];




Vgsq = 0.35;
disp(Vgsq,'Q-point value of Vgs(found after interpolation) is :');

```

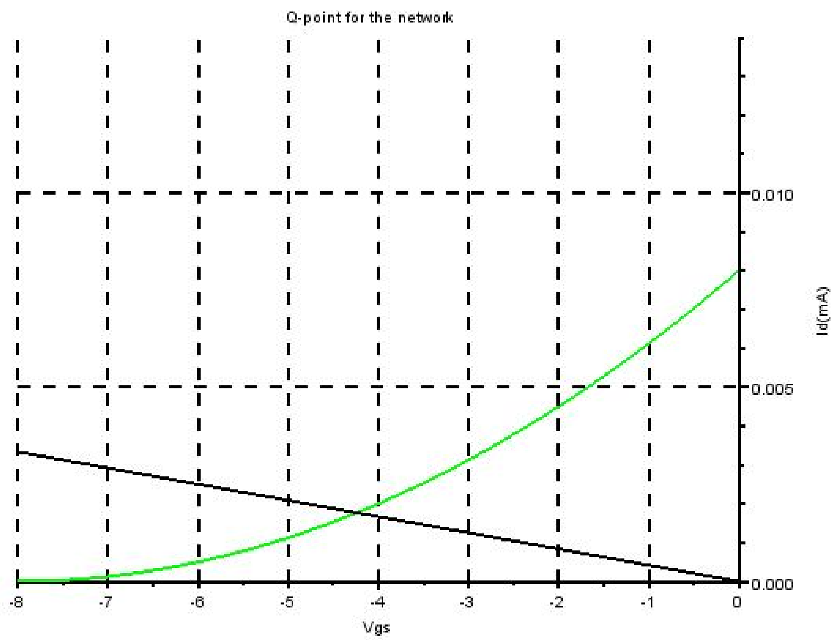

Figure 7.8: Idq Vgsq and Vd calculation

```
Idq = 7.6*10^(-3);

Vds = Vdd - Idq*(Rd+Rs);

disp(Idq,'Idq(Amperes) = ');
disp(Vds,'Vds(Volts) = ');
```

Scilab code Exa 7.9 Idq Vgsq and Vd calculation

```
clear; clc; close;

```

```
Idss = 8*10^(-3);
Vp = -8;
Vdd = 20;
Rd = 6.2*10^(3);
Rs = 2.4*10^(3);

Vgs1 = Vp;
Id1 = 0;
Vgs2 = Vp/2;
Id2 = Idss/4;
Vgs3 = 0;
Id3 = Idss;
Vgs4 = 2;
Id4 = Idss*(1-(Vgs4/Vp))^2;
x = [Vgs1 Vgs2 Vgs3 Vgs4];
y = [Id1 Id2 Id3 Id4];

yi=smooth([x;y],0.1);
a = gca();
a.thickness = 2;
a.y_location = 'right';
a.x_label.text = 'Vgs';
a.y_label.text = 'Id(mA)';
a.title.text = 'Q-point for the network';
a.grid = [1 1];
plot2d(yi(1,:)',yi(2,:)',[3]);


Vgs1 = 0;
Id1 = 0;
Id2 = 4*10^(-3);
Vgs2 = -Id2*Rs;
Id3 = 8*10^(-3);
Vgs3 = -Id3*Rs;
x = [Vgs1 Vgs2 Vgs3];
y = [Id1 Id2 Id3];
plot2d(x,y);
a.data_bounds = [-8 0;0 13*10^(-3)];
```

```
Vgsq = -4.3;
disp(Vgsq,'Q-point value of Vgs(found after
    interpolation) is :');

Idq = 1.7*10^(-3);

Vd = Vdd - Idq*(Rd);

disp(Idq,'Idq(Amperes) = ');
disp(Vd,'Vd(Volts) = ');
```

Scilab code Exa 7.10 `Vds determination`

```
clear; clc; close;

Idss = 10*10^(-3);
Vp = -4;
Vdd = 20;
Rd = 1.5*10^(3);

Vgsq = 0;
disp(Vgsq,'Q-point value of Vgs(found after
    interpolation) is :');

Idq = 10*10^(-3);

Vd = Vdd - Idq*(Rd);

disp(Idq,'Idq(Amperes) = ');
disp(Vd,'Vds(Volts) = ');
```

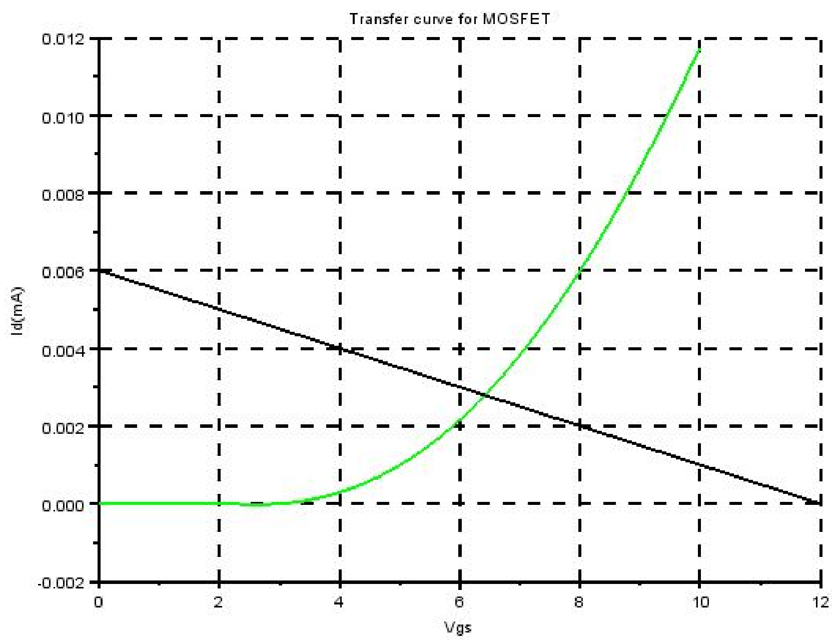

Figure 7.9: Idq Vdsq Calculation

Scilab code Exa 7.11 Idq Vdsq Calculation

```
clear; clc; close;

Id_on = 6*10^(-3);
Vgs_on = 8;
Vgs_th = 3;
Rd = 2*10^(3);
Vdd = 12;

k = Id_on/(Vgs_on-Vgs_th);

Vgs1 = Vgs_th;
Id1 = 0;
Vgs2 = 6;
Id2 = 0.24*10^(-3)*(6-3)^2;
Vgs3 = Vgs_on;
Id3 = Id_on;
Vgs4 = 10;
Id4 = 0.24*10^(-3)*(10-3)^2;

x = [0 1 2 Vgs1 Vgs2 Vgs3 Vgs4];
y = [0 0 0 Id1 Id2 Id3 Id4];

yi=smooth([x;y],0.1);
a = gca();
a.thickness = 2;
a.y_location = 'left';
a.x_label.text = 'Vgs';
a.y_label.text = 'Id(mA)';
a.title.text = 'Transfer curve for MOSFET';
a.grid = [1 1];
plot2d(yi(1,:)',yi(2,:)',[3]);
```

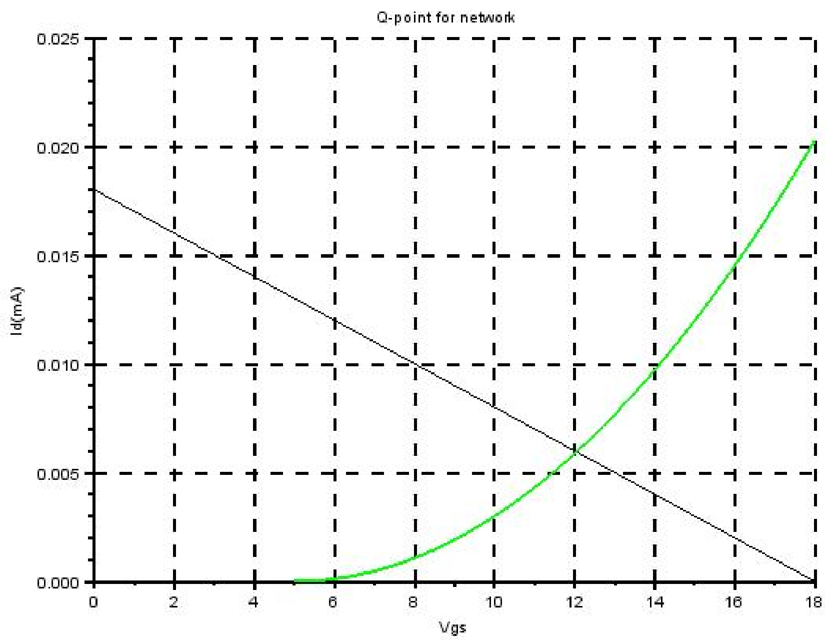

Figure 7.10: Idq Vgsq and Vds calculation

```
Vgs = Vdd; //at Id = 0
Id = Vdd/Rd;     //at Vgs = 0
x = 0:1:12;
y = (-0.5*10^(-3))*x + 6*10^(-3);
plot2d(x,y);
Idq = 2.75*10^(-3);
Vgsq = 6.4;
Vdsq = Vgsq;
disp(Idq,'Idq(Amperes) = ');
disp(Vdsq,'Vdsq(Volts) = ');
```

Scilab code Exa 7.12 Idq Vgsq and Vds calculation

```
clear; clc; close;

Id_on = 3*10^(-3);
Vgs_on = 10;
Vgs_th = 5;
Vdd = 40;
R1 = 22*10^(6);
R2 = 18*10^(6);
Rs = 1*10^(3);
Rd = 3*10^(3);

Vg = (R2*Vdd)/(R1+R2)
Vgs = 0:1:18;
Id = (Vg-Vgs)/Rs;
plot2d(Vgs,Id);
a = gca();
a.thickness = 2;
a.y_location = 'left';
a.x_label.text = 'Vgs';
a.y_label.text = 'Id(mA)';
a.title.text = 'Q-point for network';
a.grid = [1 1];

k = Id_on/(Vgs_on-Vgs_th)^2;
Vgs = 5:1:18;
Id = k*(Vgs-Vgs_th)^2;
yi=smooth([Vgs;Id],0.1);
plot2d(yi(1,:)',yi(2,:)',[3]);

Idq = 5.2*10^(-3);
Vgsq = 12.5;
Vds = Vdd-Idq*(Rs+Rd);

disp(Idq,'Idq(Amperes) = ');
disp(Vgsq,'Vgsq(Volts) = ')
disp(Vds,'Vds(Volts) = ');
```

Scilab code Exa 7.13 Vd and Vc level determination

```
clear; clc; close;

Idss = 12*10^(-3);
Vp = -3;
Vbe = 0.7;
Beta = 180;
Re = 1.6*10^(3);

Vb = (24*10^(3)*16)/((82+24)*10^(3));
Ve = Vb-Vbe;
Vre = Ve;
Ie = Vre/Re;
Ic = Ie;
Id = Ic;
Vd = 16-Id*(2.7*10^(3));
Vgsq = -1.8;
Vc = Vb - Vgsq;

disp(Vd,'Vd(Volts) = ');
disp(Vc,'Vc(Volts) = ');
```

Scilab code Exa 7.14 Vd level determination

```
clear; clc; close;

Idss = 12*10^(-3);
Vp = -3;
Vbe = 0.7;
Beta = 80;
```

```
Re = 1.6*10^(3);
Rs = 2.4*10^(3);

Vgsq = -2.6;
Idq = 1*10^(-3);
Ic = Idq;
Ie = Ic;
Ib = Ic/Beta;
Vb = 16-Ib*(470*10^(3));
Vd = Vb-Vbe;
disp(Vd,'Vd(Volts) = ');
```

Scilab code Exa 7.15 Vdq and Idq level

```
clear; clc; close;

Vdd = 20;
Vdq = 12;
Idq = 2.5*10^(-3);
Vgsq = -1;
Rd = (Vdd-Vdq)/Idq;
Rs = -Vgsq/Idq;

disp(Rd,'Rd(Ohms) = ');
disp(Rs,'Rs(Ohms) = ');
disp(3.3*10^(3),'Closest commercial value of Rd(Ohms
    ) = ');
disp(0.39*10^(3),'Closest commercial value of Rs(
    Ohms) = ');
```

Scilab code Exa 7.16 Rs determination

```
clear; clc; close;
```

```

Vd =12;
Vdd = 16;
Vgsq = -2;
Rd = 1.8*10^(3);

Vg = (47*10^(3)*16)/((47+91)*10^(3));
Id = (Vdd-Vd)/Rd;

Rs = (Vg-Vgsq)/Id;

disp(Rs,'Rs(Ohms) = ');
```

Scilab code Exa 7.17 Vdd and Rd determination

```
clear; clc; close;

Id_on = 4*10^(-3);
Vgs_on = 6;
Vgs_th = 3;

Vgs = Vgs_on;
Vdd = 2*Vgs;
Vds = Vgs;
Id = Id_on;

Rd = (Vdd-Vds)/Id;

disp(Rd,'Rd(Ohms) = ');
```

Scilab code Exa 7.18 Idq Vgsq and Vds calculation

```
clear; clc; close;
```

```
Idss = 8*10^(-3);
Vp = 4;
Vdd = 20;
Rd = 4*10^(3);
Rs = 1.8*10^(3);

Vg = 20*10^(3)*(-20)/((20+68)*10^(3));

Vgs1 = 0;
Id1 = Idss;
Vgs2 = Vp/2;
Id2 = Idss/4;
Vgs3 = Vp;
Id3 = 0;
x = [Vgs1 Vgs2 Vgs3];
y = [Id1 Id2 Id3];

yi=smooth([x;y],0.1);
a = gca();
a.thickness = 2;
a.data_bounds = [-5 0;5 8*10^(-3)];
a.y_location = 'middle';
a.x_label.text = 'Vgs';
a.y_label.text = 'Id(mA)';
a.title.text = 'Q-point for network';
a.grid = [1 1];
plot2d(yi(1,:)',yi(2,:)',[3]);


Id1 = 0;
Vgs1 = Vg+Id1*Rs;
Vgs2 = 0;
Id2 = (Vgs2-Vg)/Rs;
Id3 = 4*10^(-3);
Vgs3 = Vg+Id3*Rs;
x = [Vgs1 Vgs2 Vgs3];
y = [Id1 Id2 Id3];
```

```
plot2d(x,y);


Vgsq = 1.6;
Idq = 3.1*10^(-3);
Vds = -Vdd+Idq*(Rd+Rs);

disp(Vgsq,'Q-point value of Vgs(found after
   interpolation) is :');
disp(Idq,'Q-point value of Id(found after
   interpolation) is :');
disp(Vds,'Vds(Volts) = ');
```

Scilab code Exa 7.19 Q point value of Id and Vgs

```
clear; clc; close;

Idss = 6*10^(-3);
Vp = -3;
Vdd = 16;
Rd = 3.9*10^(3);
Rs = 1.6*10^(3);

m = abs(Vp)/(Idss*Rs);
Idq = 0.18*Idss;
Vgsq = -0.575*abs(Vp);

disp(Vgsq,'Vgsq(Volts) = ');
disp(Idq,'Idq(Amperes) = ');
```

Scilab code Exa 7.20 Q point value of Id and Vgs

```
clear; clc; close;
```

```
Idss = 8*10^(-3);
Vp = -6;
Vdd = 18;
Rs = 1.2*10^(3);
R1 = 2*10^(6);
R2 = 470*10^(3);

m = abs(Vp)/(Idss*Rs);
Vg = R2*Vdd/(R1+R2);
M = m*(Vg/abs(Vp));

Idq = 0.52*Idss;
Vgsq = -0.27*abs(Vp);

disp(Vgsq,'Vgsq(Volts) = ');
disp(Idq,'Idq(Amperes) = ');
```

Chapter 8

FET Amplifiers

Scilab code Exa 8.1 Calculation of gm for different Vgs

```
clear; clc; close;

Idss = 8*10^(-3);
Vp = -4;


Vgs1 = Vp;
Id1 = 0;
Vgs2 = Vp/2;
Id2 = Idss/4;
Vgs3 = 0;
Id3 = Idss;
x = [Vgs1 Vgs2 Vgs3];
y = [Id1 Id2 Id3];

yi=smooth([x;y],0.1);
a = gca();
a.thickness = 2;
a.y_location = 'right';
```

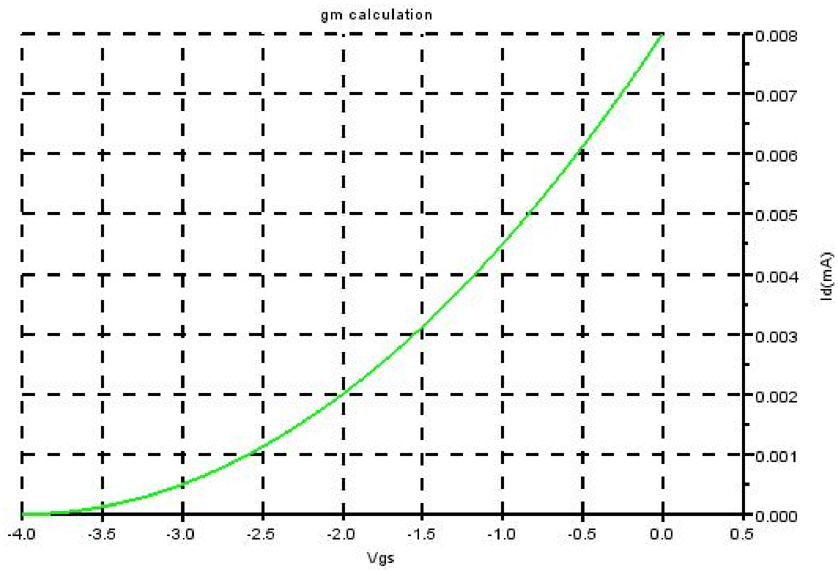

Figure 8.1: Calculation of gm for different Vgs

```
a.x_label.text = 'Vgs';
a.y_label.text = 'Id(mA)';
a.title.text = 'gm calculation';
a.grid = [1 1];
plot2d(yi(1,:)',yi(2,:)',[3]);


//part-a
Vgs = -0.5;
Id_delta = 2.1*10^(-3);
Vgs_delta = 0.6;

gm = Id_delta/Vgs_delta;
disp(gm,'gm(in S) for part a = ');

//part-b
Vgs = -1.5;
Id_delta = 1.8*10^(-3);
```

```
Vgs_delta = 0.7;

gm = Id_delta/Vgs_delta;
disp(gm,'gm(in S) for part b = ');

//part-c
Vgs = -2.5;
Id_delta = 1.5*10^(-3);
Vgs_delta = 1;

gm = Id_delta/Vgs_delta;
disp(gm,'gm(in S) for part c = ');
```

Scilab code Exa 8.2 Calculation of gm for different Vgs and max gm

```
clear; clc; close;

Idss = 8*10^(-3);
Vp = -4;

gmo = 2*Idss/abs(Vp);

//part-a
Vgs = -0.5;

gm = gmo*(1-(Vgs/Vp));
disp(gm,'gm(in S) for part a = ');

//part-b
Vgs = -1.5;
gm = gmo*(1-(Vgs/Vp));
disp(gm,'gm(in S) for part b = ');

//part-c
Vgs = -2.5;
```

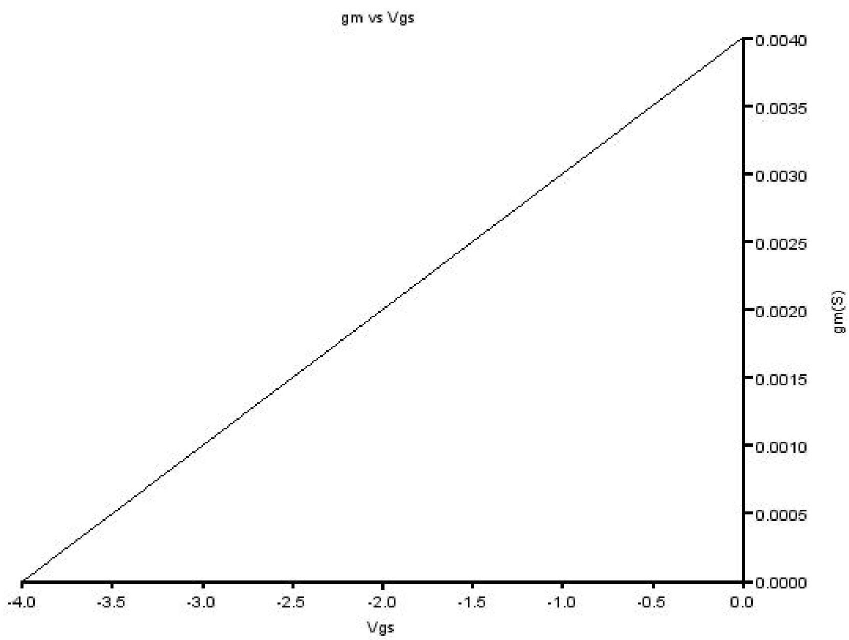

Figure 8.2: gm vs Vgs

```
Id_delta = 1.5*10^(-3);
Vgs_delta = 1;

gm = gmo*(1-(Vgs/Vp));
disp(gm,'gm(in S) for part c = ');

disp(gmo,'Max gm(in S) is = ')
```

Scilab code Exa 8.3 gm vs Vgs

```
clear; clc; close;
```

```
Vp = -4;
gmo = 4*10^(-3);

vgs1 = -4;
gm1 = gmo*(1-(vgs1/Vp));
vgs2 = -2.5;
gm2 = gmo*(1-(vgs2/Vp));
vgs3 = -1.5;
gm3 = gmo*(1-(vgs3/Vp));
vgs4 = -1.5;
gm4 = gmo*(1-(vgs4/Vp));
vgs5 = 0;
gm5 = gmo*(1-(vgs5/Vp));

x = [vgs1 vgs2 vgs3 vgs4 vgs5];
y = [gm1 gm2 gm3 gm4 gm5];
plot2d(x,y);
a = gca();
a.thickness = 2;
a.y_location = 'right';
a.x_label.text = 'Vgs';
a.y_label.text = 'gm(S)';
a.title.text = 'gm vs Vgs';
```

Scilab code Exa 8.4 gm vs Id

```
clear; clc; close;

Idss = 8*10^(-3);
Vp = -4;

gmo = 2*Idss/abs(Vp);
```

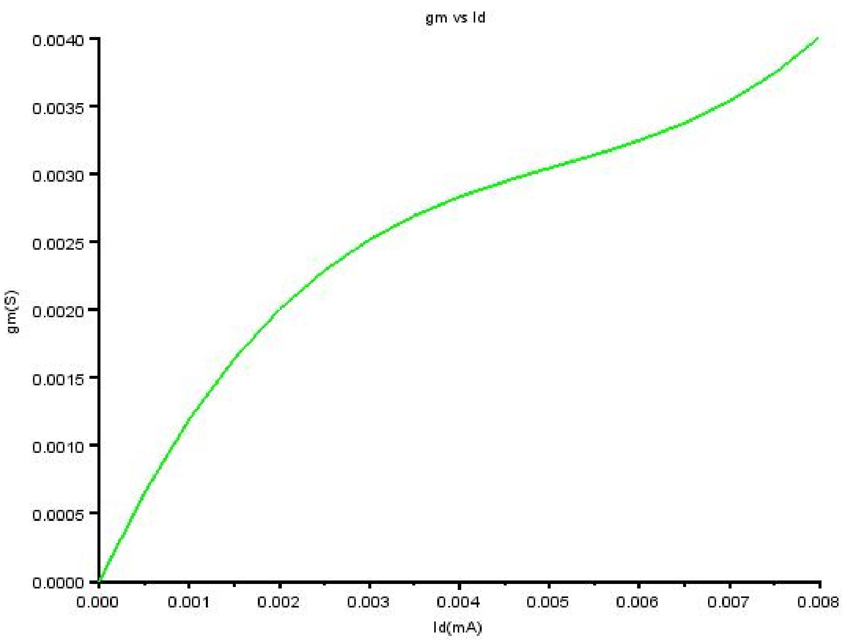

Figure 8.3: gm vs Id

```
Id1 = 0;
gm1 = gmo*(sqrt(Id1/Idss));
Id2 = Idss/4;
gm2 = gmo*(sqrt(Id2/Idss));
Id3 = Idss/2;
gm3 = gmo*(sqrt(Id3/Idss));
Id4 = Idss;
gm4 = gmo*(sqrt(Id4/Idss));

x = [Id1 Id2 Id3 Id4];
y = [gm1 gm2 gm3 gm4];
yi=smooth([x;y],0.0005);
a = gca();
a.thickness = 2;
a.y_location = 'left';
a.x_label.text = 'Id(mA)';
a.y_label.text = 'gm(S)';
a.title.text = 'gm vs Id';
plot2d(yi(1,:)',yi(2,:)',[3]);
```

Scilab code Exa 8.5 Output impedance

```
clear; clc; close;

Vds = 8;

Vgs = 0;
Vds_delta = 5;
Id_delta = 0.2*10^(-3);
rd = Vds_delta/Id_delta;
disp(rd,'For Vgs = 0V,rd(ohms) = ');

Vgs = -2;
Vds_delta = 8;
```

```
Id_delta = 0.1*10^(-3);
rd = Vds_delta/Id_delta;
disp(rd,'For Vgs = -2V, rd(ohms) = ');
```

Scilab code Exa 8.6 `FET equivalent model`

```
clear; clc; close;

yfs = 3.8*10^(-3);
yos = 20*10^(-6);

gm = yfs;
rd = 1/yos;

disp(gm,'gm(in S) = ');
disp(rd,'rd(ohms) = ');
```

Scilab code Exa 8.7 `JFET fix bias configuration calculation`

```
clear; clc; close;

yos = 20*10^(-6);
Idss = 10*10^(-3);
Vp = -8;
Vgsq = -2;
Idq = 5.625*10^(-3);
Rg = 1*10^(6);
Rd = 2*10^(3);

gmo = 2*Idss/abs(Vp);
gm = gmo*(1-(Vgsq/Vp));
rd = 1/yos;
Zi = Rg;
```

```
Zo = Rd*rd/(Rd+rd);
Av = -gm*(Rd*rd/(Rd+rd));
Av2 = -gm*Rd;

disp(gm,'gm(S) = ');
disp(rd,'rd(ohms) = ');
disp(Zi,'Zi(ohms) = ');
disp(Zo,'Zo(ohms) = ');
disp(Av,'Voltage gain Av = ');
disp(Av2,'Volatge gain Av(ignoring rd) = ');
```

Scilab code Exa 8.8 JFET self bias configuration calculation

```
clear; clc; close;

yos = 25*10^(-6);
Idss = 8*10^(-3);
Vp = -6;
Vgsq = -2.6;
Idq = 2.6*10^(-3);
Rg = 1*10^(6);
Rd = 3.3*10^(3);
Rs = 1*10^(3);

gmo = 2*Idss/abs(Vp);
gm = gmo*(1-(Vgsq/Vp));
rd = 1/yos;
Zi = Rg;
Zo = Rd;
Av = -gm*Rd/(1+gm*Rs+((Rd+Rs)/rd));
Av2 = -gm*Rd/(1+gm*Rs);

disp(gm,'gm(S) = ');
disp(rd,'rd(ohms) = ');
disp(Zi,'Zi(ohms) = ');
```

```
disp(Zo,'Zo(ohms) = ');
disp(Av,'Voltage gain Av = ');
disp(Av2,'Volatge gain Av(ignoring rd) = ');
```

Scilab code Exa 8.9 JFET source follower configuration calculation

```
clear; clc; close;

yos = 30*10^(-6);
Idss = 16*10^(-3);
Vp = -4;
Vgsq = -2.86;
Idq = 4.56*10^(-3);
Rg = 1*10^(6);
Rs = 2.2*10^(3);


gmo = 2*Idss/abs(Vp);
gm = gmo*(1-(Vgsq/Vp));
rd = 1/yos;
Zi = Rg;
Zo = rd*Rs*gm^(-1)/((rd*Rs)+(Rs*gm^(-1))+(rd*gm^(-1)
    ));
Zo2 = Rs*gm^(-1)/(Rs+gm^(-1));
Av = gm*(rd*Rs/(rd+Rs))/(1+(gm*(rd*Rs/(rd+Rs))));
Av2 = gm*Rs/(1+gm*Rs);

disp(gm,'gm(S) = ');
disp(rd,'rd(ohms) = ');
disp(Zi,'Zi(ohms) = ');
disp(Zo,'Zo(ohms) = ');
disp(Zo2,'Zo without rd = ')
disp(Av,'Voltage gain Av = ');
disp(Av2,'Volatge gain Av(ignoring rd) = ');
```

Scilab code Exa 8.10 `JFET common gate configuration calculation`

```
clear; clc; close;

yos = 50*10^(-6);
Idss = 10*10^(-3);
Vp = -4;
Vgsq = -2.2;
Idq = 2.03*10^(-3);
Rd = 3.6*10^(3);
Rs = 1.1*10^(3);
Vi = 40*10^(-3);

gmo = 2*Idss/abs(Vp);
gm = gmo*(1-(Vgsq/Vp));
rd = 1/yos;
Zi = Rs*((rd+Rd)/(1+gm*rd))/(Rs+((rd+Rd)/(1+gm*rd)))
    ;
Zi2 = Rs*gm^(-1)/(Rs+gm^(-1));
Zo = Rd*rd/(Rd+rd);
Zo2 = Rd;
Av = (gm*Rd+(Rd/rd))/(1+Rd/rd);
Vo = Av*Vi;
Av2 = gm*Rd;
Vo2 = Av2*Vi;

disp(gm,'gm(S) = ');
disp(rd,'rd(ohms) = ');
disp(Zi,'Zi(ohms) = ');
disp(Zi2,'Zi(ohms) without rd = ');
disp(Zo,'Zo(ohms) = ');
disp(Zo2,'Zo(ohms) without rd = ')
disp(Av,'Voltage gain Av = ');
disp(Vo,'Vo = ');
```

```
disp(Av2,'Volatge gain Av(ignoring rd) = ');
disp(Vo2,'Vo2 witout rd  = ');
```

Scilab code Exa 8.11 Network components determination

```
clear; clc; close;

yos = 10*10^(-6);
Idss = 6*10^(-3);
Vp = -3;
Vgsq = 0.35;
Idq = 7.6*10^(-3);
Rd = 1.8*10^(3);
R1 = 10*10^(6);
R2 = 110*10^(6);


gmo = 2*Idss/abs(Vp);
gm = gmo*(1-(Vgsq/Vp));
rd = 1/yos;
Zi = R1*R2/(R1+R2);
Zo = rd*Rd/(Rd+rd);
Av = -gm*Rd;

disp(gmo,'gmo(S) = ');
disp(gm,'gm(S) = ');
disp(rd,'rd(ohms) = ');
disp(Zi,'Zi(ohms) = ');
disp(Zo,'Zo(ohms) = ');
disp(Av,'Av = ');
```

Scilab code Exa 8.12 E MOSFET components determination

```
clear; clc; close;

yos = 20*10^(-6);
Vgs_on = 8;
Vgs_th = 3;
Vgsq = 6.4;
Idq = 2.75*10^(-3);
Id_on = 6*10^(-3);
k = 0.24*10^(-3);
Rf = 10*10^(6);
Rd = 2*10^(3);

gm = 2*k*(Vgsq-Vgs_th);
rd = 1/yos;
Zi = (Rf+(rd*Rd/(rd+Rd)))/(1+gm*(rd*Rd/(rd+Rd)));
Zi2 = Rf/(1+gm*Rd);
Zo = Rf*Rd*rd/(Rf*rd+rd*Rd+Rd*Rf);
Zo2 = Rd;
Av = -gm*Rf*Rd*rd/(Rf*rd+rd*Rd+Rd*Rf);
Av2 = -gm*Rd;

disp(gm,'gm(S) = ');
disp(rd,'rd(ohms) = ');
disp(Zi,'Zi(ohms) = ');
disp(Zi2,'Zi without rd(ohms) = ');
disp(Zo,'Zo(ohms) = ');
disp(Zo2,'Zo without rd(ohms) = ')
disp(Av,'Voltage gain Av = ');
disp(Av2,'Volatge gain Av(ignoring rd) = ');
```

Scilab code Exa 8.13 Rd value determination

```
clear; clc; close;

yos = 30*10^(-6);
```

```
Idss = 10*10^(-3);
Idq = 10*10^(-3);
Vp = -4;
Vgsq = 0;
Rg = 10*10^(6);
Av = -15;
Vdd = 30;

gmo = 2*Idss/abs(Vp);
gm = gmo;
rd = 1/yos;

//let x = Rd||rd
x = -Av/gm;
Rd = 100*10^(3)/30.33;//found by solving for x
Vdsq = Vdd-Idq*Rd;
Zi = Rg;
Zo = Rd*rd/(Rd+rd);


disp(Rd,'Rd(ohms) = ');
disp(Zi,'Zi(ohms) = ');
disp(Zo,'Zo(ohms) = ');
```

Scilab code Exa 8.14 Rd and Rs determination

```
clear; clc; close;

yos = 20*10^(-6);
Idss = 10*10^(-3);
Idq = 10*10^(-3);
Vp = -4;
Vdsq = Vp/4;
Rg = 10*10^(6);
Av = -8;
```

```
Vdd = 20;


Vgsq = Vp/4;
Id = Idss*(1-(Vgsq/Vp))^2;
gmo = 2*Idss/abs(Vp);
gm = gmo*(1-(Vgsq/Vp));
//let Rd||rd = x
x = abs(Av)/gm;
rd = 1/yos;
Rd =  106.5*10^(3)/47.87;
Rs = -Vgsq/Id;

disp(Rd,'Rd(ohms) = ');
disp(Rs,'Rs(ohms) = ');
```

Scilab code Exa 8.15 Rd and Rs determination

```
clear; clc; close;

yos = 20*10^(-6);
Idss = 10*10^(-3);
Idq = 10*10^(-3);
Vp = -4;
Vdsq = Vp/4;
Rg = 10*10^(6);
Av = -8;
Vdd = 20;

Vgsq = Vp/4;
Id = Idss*(1-(Vgsq/Vp))^2;

Rs = -Vgsq/Id;

gmo = 2*Idss/abs(Vp);
```

```
gm = gmo*(1-(Vgsq/Vp));
Rd = -Av*(1+gm*Rs)/gm;

disp(Rs,'Rs(ohms) = ');
disp(Rd,'Rd(ohms) = ');
```

Scilab code Exa 8.16 Network characteristics determination

```
clear; clc; close;

yos = 20*10^(-6);
Idss = 10*10^(-3);
Idq = 2.8*10^(-3);
Vp = -4;
Vgsq = -1.9;
Vi = 20*10^(-3);
Rd = 2.4*10^(3);
Rg = 3.3*10^(6);
Rl = 10*10^(3);

gmo = 2*Idss/abs(Vp);
gm = gmo*(1-(Vgsq/Vp));
Av2 = -gm*Rd;
Av1 = -gm*(Rd*Rg/(Rd+Rg));
Av = Av1*Av2;
Vo = Av*Vi;
Zi = Rg;
Zo = Rd;
Vl = (Rl/(Zo+Rl))*Vo;


disp(gm,'gm(S) = ');
disp(Av2,'voltage gain = ');
disp(Vo,'output voltage(Volts) = ');
disp(Zi,'input impedance(ohms) = ');
```

```
disp(Zo,'output impedance(ohms) = ');
disp(Vl,'output voltage across the load(Volts) = ');
```

Scilab code Exa 8.17 Input output impedance and output voltage

```
clear; clc; close;

Ri_stage2 = 15*(10^(3))*4.7*(10^(3))
    *1300/(15*(10^(3))*4.7*(10^(3))+4.7*(10^(3))
    *1300+15*(10^(3))*1300);
Rd1 = 2.4*10^(3);
Rd2 = 2.2*10^(3);
gm = 2.6*10^(-3);
Vi1 = 20*10^(-3);
Vi2 = 1*10^(-3);

Av1 = -gm*(Rd1*Ri_stage2/(Rd1+Ri_stage2));
Av2 = -338.46;
Av = Av1*Av2;
Vo1 = Av*Vi1;
Vo2 = Av*Vi2;
Zi = 3.3*10^(6);
Zo = Rd2;


disp(Vo2,'Output voltage is ');
disp(Zi,'Input impedance is ');
disp(Zo,'Output impedance is ');
```

Chapter 9

BJT and JFET frequency response

Scilab code Exa 9.1 Log calculation

```
clear; clc; close;

disp(log10(10^6),'ans for part a :- ');
disp(log(%e^3),'ans for part b :- ');
disp(log10(10^(-2)),'ans for part c :- ');
disp(log(%e^-1),'ans for part d :- ');
```

Scilab code Exa 9.2 Log calculation

```
clear; clc; close;

disp(log10(64),'ans for part a :- ');
disp(log(64),'ans for part b :- ');
disp(log10(1600),'ans for part c :- ');
disp(log10(8000),'ans for part d :- ');
```

Scilab code Exa 9.3 Anti Log calculation

```
clear; clc; close;

disp(10^1.6,'ans for part a :- ');
disp(%e^0.04,'ans for part b :- ');
```

Scilab code Exa 9.4 Log calculation

```
clear; clc; close;

disp(log10(0.5),'ans for part a :- ');
disp(log10(4000/250),'ans for part b :- ');
disp(log10(0.6*30),'ans for part c :- ');
```

Scilab code Exa 9.5 Magnitude gain calculation

```
clear; clc; close;

Gdb = 100;
Ratio_V2_by_V1 = 10^(Gdb/20);

disp(Ratio_V2_by_V1,'Magnitude gain = ');
```

Scilab code Exa 9.6 Power and voltage gain

```
clear; clc; close;

Pi = 10*10^(3);
Po = 500;
Vi = 1000;
Ro = 20;

Gdb = 10*log10(Po/Pi);
Gv = 20*log10(sqrt(Po*Ro)/Vi);
Ri = Vi^2/Pi;

disp(Gdb,'Power gain in decibels = ');
disp(Gv,'Voltage gain in decibels = ');
disp(Ri,'Ri(ohms) is ');
disp('which is not equal to Ro');
```

Scilab code Exa 9.7 Input power and input voltage

```
clear; clc; close;

Po = 40;
Ro = 10;
Gv = 40;
Gdb = 25;

Pi = Po/(10^(25/10));
disp(Pi,'Input power in Watt = ');

Vo = sqrt(Po*Ro);
Vi = Vo/10^(Gv/20);
disp(Vi,'Input voltage in volts = ');
```

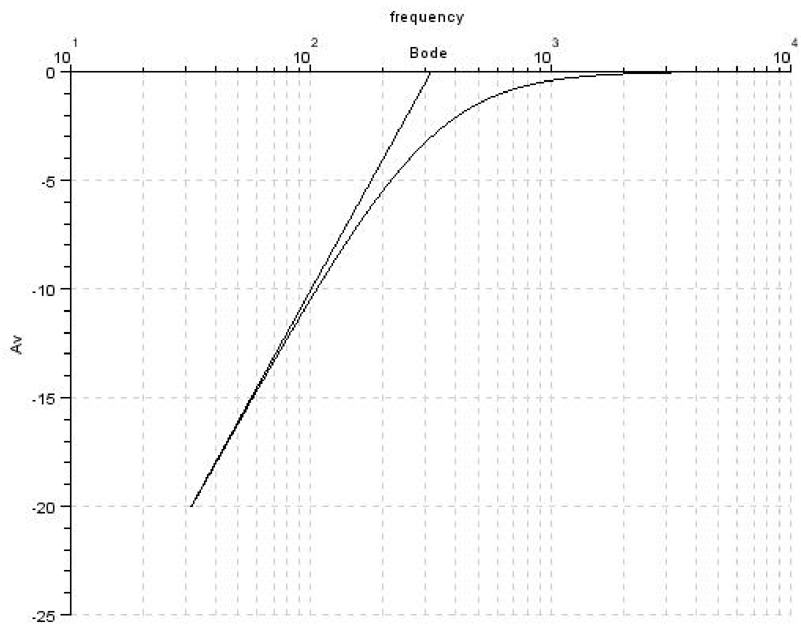

Figure 9.1: Break frequency and bode plot

Scilab code Exa 9.8 Break frequency and bode plot

```
clear; clc; close;

R = 5*10^(3);
C = 0.1*10^(-6);

f1 = 1/(2*%pi*R*C);
disp(f1,'Break frequency = ');

f = 31.85:10:10*f1;
av = (1+(f1./f)^2)^(-1/2);//-10*log10
av1 = -20*log10(f1/f1);
f2 = f1/10;
av2 = -20*log10(f1/f2);
f3 = f1/4;
av3 = -20*log10(f1/f3);
f4 = f1/2;
av4 = -20*log10(f1/f4);


x = [f2 f3 f4 f1];
y = [av2 av3 av4 av1];

gainplot(f,av);
a = gca();
a.y_location = 'left';
a.x_location = 'top';
a.x_label.text = 'frequency';
a.y_label.text = 'Av';
a.title.text = 'Bode';
plot2d(x,y);
```

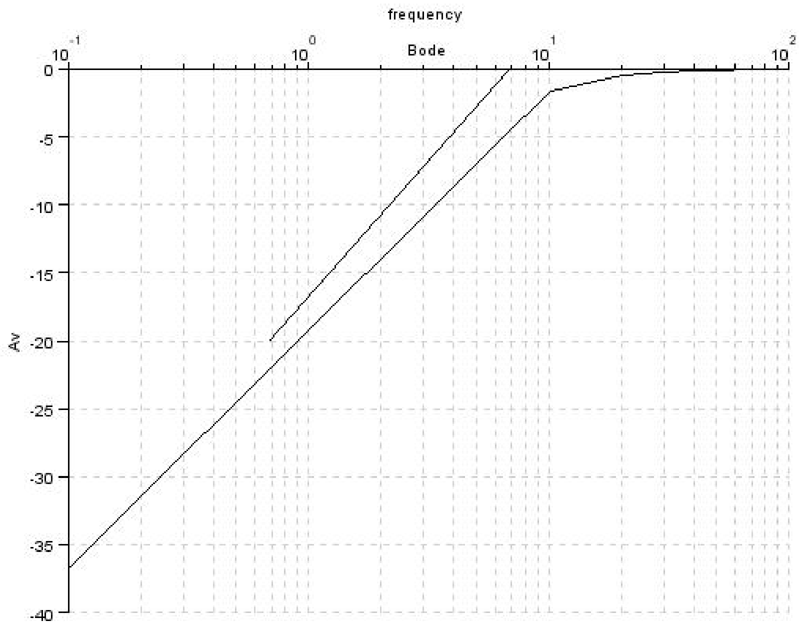

Figure 9.2: Frequency aand bode plot

Scilab code Exa 9.9 `Frequency aand bode plot`

```
clear; clc; close;

Cs = 10*10^(-6);
Ce = 20*10^(-6);
Cc = 1*10^(-6);
Rs = 1*10^(3);
R1 = 40*10^(3);
R2 = 10*10^(3);
```

```
Re = 2*10^(3);
Rc = 4*10^(3);
Rl = 2.2*10^(3);
Beta = 100;
ro = %inf;
Vcc = 20;
Ve = 4-0.7;

Vb = R2*Vcc/(R2+R1);
Ie = Ve/Re;
re = 26*10^(-3)/(1.65*10^(-3));
x = Beta*re;
Av = -Rc*Rl/((Rc+Rl)*re);
Zi = R1*R2*x/(R1*R2+R2*x+x*R1);
Ri = Zi;
Vi_by_Vs = Ri/(Ri+Rs);
Avs = Av*Vi_by_Vs;
fls = 1/(2*%pi*(Rs+Ri)*Cs);
disp(fls,'Low cutoff frequency is ');

f1 = fls;
f = .1:10:10*f1;
av = (1+(f1./f)^2)^(-1/2);
av1 = -20*log10(f1/f1);
f2 = f1/10;
av2 = -20*log10(f1/f2);
f3 = f1/4;
av3 = -20*log10(f1/f3);
f4 = f1/2;
av4 = -20*log10(f1/f4);


x = [f2 f3 f4 f1];
y = [av2 av3 av4 av1];

gainplot(f,av);
a = gca();
a.y_location = 'left';
```

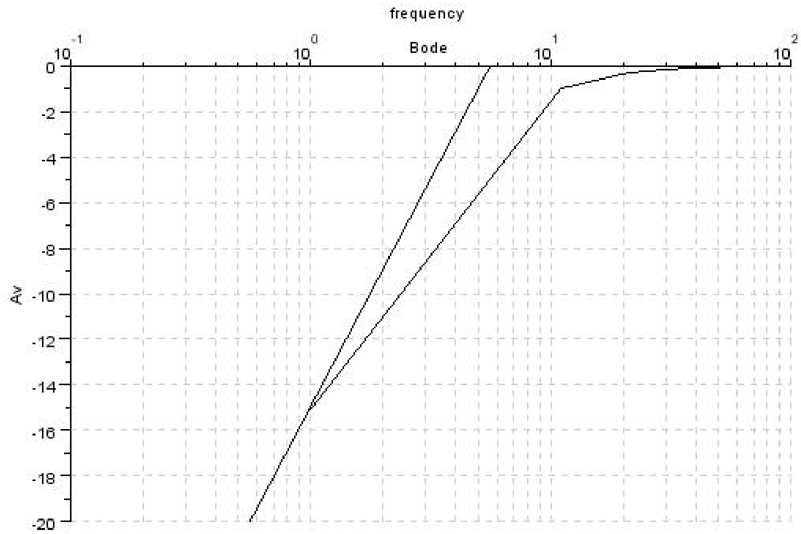

Figure 9.3: Frequency and bode plot

```
a.x_location = 'top';
a.x_label.text = 'frequency';
a.y_label.text = 'Av';
a.title.text = 'Bode';
plot2d(x,y);
```

Scilab code Exa 9.10 Frequency and bode plot

```
clear; clc; close;

Cs = 10*10^(-6);
Ce = 20*10^(-6);
Cc = 1*10^(-6);
Rs = 1*10^(3);
```

```
R1 = 40*10^(3);
R2 = 10*10^(3);
Re = 1.2*10^(3);
Rc = 4*10^(3);
Rl = 10*10^(3);
Beta = 100;
ro = %inf;
Vcc = 10;
Ve = 2-0.7;

Vb = R2*Vcc/(R2+R1);
Ie = Ve/Re;
re = 26*10^(-3)/(1.083*10^(-3));
x = Beta*re;
Av = -Rc*Rl/((Rc+Rl)*re);
Zi = R1*R2*x/(R1*R2+R2*x+x*R1);
Ri = Zi;
Vi_by_Vs = Ri/(Ri+Rs);
Avs = Av*Vi_by_Vs;
fls = 1/(2*%pi*(Rs+Ri)*Cs);
disp(fls,'Low cutoff frequency is ');

f1 = fls;
f = 1:10:10*f1;
av = (1+(f1./f)^2)^(-1/2);
av1 = -20*log10(f1/f1);
f2 = f1/10;
av2 = -20*log10(f1/f2);
f3 = f1/4;
av3 = -20*log10(f1/f3);
f4 = f1/2;
av4 = -20*log10(f1/f4);


x = [f2 f3 f4 f1];
y = [av2 av3 av4 av1];

gainplot(f,av);
```

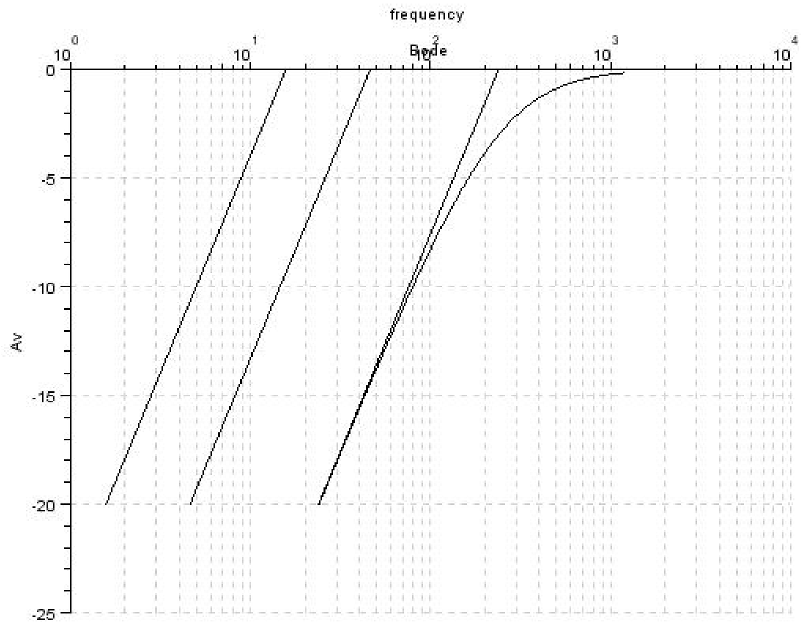

Figure 9.4: Frequency and bode plot

```
a = gca();
a.y_location = 'left';
a.x_location = 'top';
a.x_label.text = 'frequency';
a.y_label.text = 'Av';
a.title.text = 'Bode';
plot2d(x,y);
```

Scilab code Exa 9.11 `Frequency and bode plot`

```
clear; clc; close;
```

```

Cs = 2*10^(-6);
Cg = 0.01*10^(-6);
Cc = 0.5*10^(-6);
Rs = 1*10^(3);
Rg = 1*10^(6);
Rsig = 10*10^(3);
Rd = 4.7*10^(3);
Rl = 2.2*10^(3);

Idss = 8*10^(-3);
Vp = -4;
rd = %inf;
Vdd = 20;

Vgsq = -2;
Idq = 2*10^(-3);
gmo = 2*Idss/abs(Vp);
gm = gmo*(1-(Vgsq/Vp));
flg = 1/(2*%pi*(Rsig+Rg)*Cg);
flc = 1/(2*%pi*(Rd+Rl)*Cc);
Req = Rs*(1/gm)/(Rs+(1/gm));
fls = 1/(2*%pi*Req*Cs);
Avmid = -gm*(Rd*Rl/(Rd+Rl));

disp(fls,'Lowest frequency cutoff = ');
disp(Avmid,'midband gain = ');

f1 = fls;
f = .1*f1:10:5*f1;
av = (1+(f1./f)^2)^(-1/2);
av1 = -20*log10(f1/f1);
f2 = f1/10;
av2 = -20*log10(f1/f2);
f3 = f1/4;
av3 = -20*log10(f1/f3);
f4 = f1/2;
av4 = -20*log10(f1/f4);
```

```
x = [f2 f3 f4 f1];
y = [av2 av3 av4 av1];

gainplot(f,av);
a = gca();
a.y_location = 'left';
a.x_location = 'top';
a.x_label.text = 'frequency';
a.y_label.text = 'Av';
a.title.text = 'Bode';
plot2d(x,y);


f1 = flg;
//f = .1*f1:10:10*f1;
av = -10*log10(1+(f1./f)^2);
av1 = -20*log10(f1/f1);
f2 = f1/10;
av2 = -20*log10(f1/f2);
f3 = f1/4;
av3 = -20*log10(f1/f3);
f4 = f1/2;
av4 = -20*log10(f1/f4);

x = [f2 f3 f4 f1];
y = [av2 av3 av4 av1];

plot2d(x,y);

f1 = flc;
//f = .1*f1:10:10*f1;
av = -10*log10(1+(f1./f)^2);
av1 = -20*log10(f1/f1);
f2 = f1/10;
av2 = -20*log10(f1/f2);
f3 = f1/4;
av3 = -20*log10(f1/f3);
```

```
f4 = f1/2;
av4 = -20*log10(f1/f4);

x = [f2 f3 f4 f1];
y = [av2 av3 av4 av1];
plot2d(x,y);
```

Scilab code Exa 9.12 Frequency

```
clear; clc; close;

Cs = 10*10^(-6);
Ce = 20*10^(-6);
Cc = 1*10^(-6);
Rs = 1*10^(3);
R1 = 40*10^(3);
R2 = 10*10^(3);
Re = 2*10^(3);
Rc = 4*10^(3);
Rl = 2.2*10^(3);
Beta = 100;
ro = %inf;
re = 15.76;
Vcc = 20;
Ve = 4-0.7;
Cwo = 8*10^(-12);
Cwi = 6*10^(-12);
Cce = 1*10^(-12);
Cbc = 4*10^(-12);
Cbe = 36*10^(-12);
fls = 6.86;

Ri = 1.32*10^(3);
Avmid = -90;
Rthi = Rs*R1*R2*Ri/(Rs*R1*R2+R1*R2*Ri+R2*Ri*Rs+Ri*Rs
```

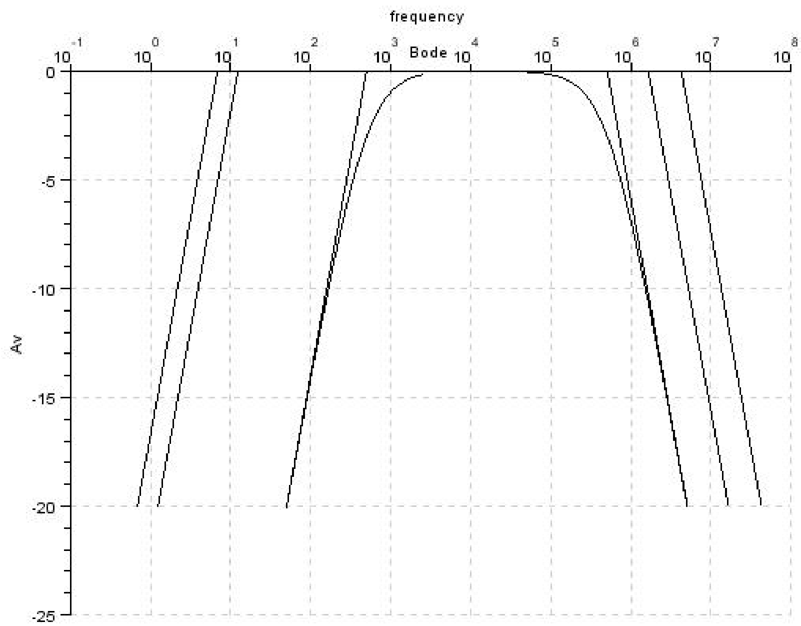

Figure 9.5: Frequency and bode plot

```
   *R1);
Ci = Cwi+Cbe+(1-Avmid)*Cbc;
fhi = 1/(2*%pi*Rthi*Ci);
Rtho = Rc*Rl/(Rc+Rl);
Co = Cwo+Cce+(1-(1/Avmid))*Cbc;
fho = 1/(2*%pi*Rtho*Co);
fbeta = 1/(2*%pi*Beta*re*(Cbe+Cbc));
ft = Beta*fbeta;
disp(fhi,'fhi = ');
disp(fho,'fho = ');
disp(fbeta,'fbeta = ');
disp(ft,'ft = ');
```

Scilab code Exa 9.13 Frequency and bode plot

```
clear; clc; close;

Cs = 10*10^(-6);
Ce = 20*10^(-6);
Cc = 1*10^(-6);
Rs = 1*10^(3);
R1 = 40*10^(3);
R2 = 10*10^(3);
Re = 1.2*10^(3);
Rc = 4*10^(3);
Rl = 10*10^(3);
Beta = 100;
ro = %inf;
re = 24.01;
Vcc = 10;
Ve = 2-0.7;
Cwo = 8*10^(-12);
Cwi = 6*10^(-12);
Cce = 1*10^(-12);
Cbc = 4*10^(-12);
Cbe = 36*10^(-12);
fls = 6.86;

Ri = 1.85*10^(3);
Avmid = -119;
Rthi = Rs*R1*R2*Ri/(Rs*R1*R2+R1*R2*Ri+R2*Ri*Rs+Ri*Rs
    *R1);
Ci = Cwi+Cbe+(1-Avmid)*Cbc;
fhi = 1/(2*%pi*Rthi*Ci);
Rtho = Rc*Rl/(Rc+Rl);
Co = Cwo+Cce+(1-(1/Avmid))*Cbc;
fho = 1/(2*%pi*Rtho*Co);
```

```
fpie = 1/(2*%pi*Beta*re*(Cbe+Cbc));
ft = Beta*fpie;

disp(fhi,'fhi = ');
disp(fho,'fho = ');
disp(fpie,'fbeta = ');
disp(ft,'ft = ');
fle = 500;
flc = 1/(2*%pi*(Rl+Rtho)*Cc);

f1 = fle;
f = 0.1*f1:100:10*f1;
av = (1+(f1./f)^2)^(-1/2);
av1 = -20*log10(f1/f1);
f2 = f1/10;
av2 = -20*log10(f1/f2);
f3 = f1/4;
av3 = -20*log10(f1/f3);
f4 = f1/2;
av4 = -20*log10(f1/f4);

x = [f2 f3 f4 f1];
y = [av2 av3 av4 av1];

gainplot(f,av);
a = gca();
a.y_location = 'left';
a.x_location = 'top';
a.x_label.text = 'frequency';
a.y_label.text = 'Av';
a.title.text = 'Bode';
plot2d(x,y);


f1 = fls;
//f = .1*f1:10:10*f1;
av = -10*log10(1+(f1./f)^2);
av1 = -20*log10(f1/f1);
```

```
f2 = f1/10;
av2 = -20*log10(f1/f2);
f3 = f1/4;
av3 = -20*log10(f1/f3);
f4 = f1/2;
av4 = -20*log10(f1/f4);

x = [f2 f3 f4 f1];
y = [av2 av3 av4 av1];
plot2d(x,y);


f1 = flc;
//f = .1*f1:10:10*f1;
av = -10*log10(1+(f1./f)^2);
av1 = -20*log10(f1/f1);
f2 = f1/10;
av2 = -20*log10(f1/f2);
f3 = f1/4;
av3 = -20*log10(f1/f3);
f4 = f1/2;
av4 = -20*log10(f1/f4);

x = [f2 f3 f4 f1];
y = [av2 av3 av4 av1];
plot2d(x,y);

f1 = fhi;
f = 0.1*f1:100:10*f1;
av = (1+(f/f1)^2)^(-1/2);
av1 = -20*log10(f1/f1);
f2 = f1*10;
av2 = -20*log10(f2/f1);
f3 = f1*4;
av3 = -20*log10(f3/f1);
f4 = f1*2;
av4 = -20*log10(f4/f1);

```

```
x = [f1 f4 f3 f2];
y = [av1 av4 av3 av2];

gainplot(f,av);
plot2d(x,y);


f1 = fpie;
av1 = -20*log10(f1/f1);
f2 = f1*10;
av2 = -20*log10(f2/f1);
f3 = f1*4;
av3 = -20*log10(f3/f1);
f4 = f1*2;
av4 = -20*log10(f4/f1);

x = [f1 f4 f3 f2];
y = [av1 av4 av3 av2];

plot2d(x,y);


f1 = fho;
av1 = -20*log10(f1/f1);
f2 = f1*10;
av2 = -20*log10(f2/f1);
f3 = f1*4;
av3 = -20*log10(f3/f1);
f4 = f1*2;
av4 = -20*log10(f4/f1);

x = [f1 f4 f3 f2];
y = [av1 av4 av3 av2];

plot2d(x,y);
```

Scilab code Exa 9.14 Frequency

```
clear; clc; close;

Cs = 2*10^(-6);
Cg = 0.01*10^(-6);
Cc = 0.5*10^(-6);
Rs = 1*10^(3);
Rg = 1*10^(6);
Rsig = 10*10^(3);
Rd = 4.7*10^(3);
Rl = 2.2*10^(3);
Idss = 8*10^(-3);
Vp = -4;
rd = %inf;
Vdd = 20;
Cgd = 2*10^(-12);
Cgs = 4*10^(-12);
Cds = 0.5*10^(-12);
Cwi = 5*10^(-12);
Cwo = 6*10^(-12);


Rthi = Rsig*Rg/(Rsig+Rg);
Av = -3;
Ci = Cwi+Cgs+(1-Av)*Cgd;
fhi = 1/(2*%pi*Rthi*Ci);
Rtho = Rd*Rl/(Rd+Rl);
Co = Cwo+Cds+(1-(1/Av))*Cgd;
fho = 1/(2*%pi*Rtho*Co);

disp(fhi,'fhi = ');
disp(fho,'fho = ');
```

Scilab code Exa 9.15 Fourier transform and time

```
clear; clc; close;

V = 50*10^(-3);
V_bar = 40*10^(-3);
fs = 5*10^(3);

vi = (4*10^(-3)/%pi)*(sin(2*%pi*5*10^(3)*%t)+(1/3)*
    sin(2*%pi*15*10^(3)*%t)+(1/5)*sin(2*%pi*25*10^(3)
    *%t)+(1/7)*sin(2*%pi*35*10^(3)*%t)+(1/9)*sin(2*
    %pi*45*10^(3)*%t));

tr = (18-2)*10^(-6);
BW = 0.35/tr;
P = (V-V_bar)/V;
flo = (P/%pi)*fs;

disp(BW,'Bandwidth is ')
disp(flo,'Low cutoff frequency = ');
```

Chapter 10

Operational Amplifiers

Scilab code Exa 10.1 `Dc voltages and currents calculation`

```
clear; clc; close;

Vcc = 9;
Vee = Vcc;
Rc = 3.9*10^(3);
Re = 3.3*10^(3);


Ie = (Vee-0.7)/Re;
Ic = Ie/2;
Vc = Vcc-Ic*Rc;

disp(Ie,'Emitter current(Amperes) = ');
disp(Ic,'Collector current(Amperes) = ');
disp(Vc,'Collector voltage(Volts) = ');
```

Scilab code Exa 10.2 `Single ended output voltage`

```
clear; clc; close;

Vcc = 9;
Vee = Vcc;
Vi = 2*10^(-3);
Rc = 47*10^(3);
Re = 43*10^(3);


Ie = (Vee-0.7)/Re;
Ic = Ie/2;
Vc = Vcc-Ic*Rc;
re = 26/0.0965;
Av = Rc/(2*re);
Vo = Av*Vi;

disp(Vo,'Single ended output voltage(Volts) = ');
```

Scilab code Exa 10.3 Common mode gain

```
clear; clc; close;

Beta = 75;
Rc = 47*10^(3);
ri = 20*10^(3);
Re = 43*10^(3);

Ac = Beta*Rc/(ri+2*(Beta+1)*Re);

disp(Ac,'Common mode gain = ');
```

Scilab code Exa 10.4 Common mode gain

```
clear; clc; close;

Beta = 75;
Rc = 10*10^(3);
ri = 11*10^(3);
Re = 200*10^(3);
ro = 200*10^(3);

Re = ro;
Ac = Beta*Rc/(ri+2*(Beta+1)*Re);

disp(Ac,'Common mode gain = ');
```

Scilab code Exa 10.5 `Output voltage`

```
clear; clc; close;

Rf = 500*10^(3);
R1 = 100*10^(3);
V1 = 2;

Vo = -(Rf/R1)*V1;

disp(Vo,'Output voltage(Volts) = ');
```

Scilab code Exa 10.6 `Output voltage`

```
clear; clc; close;

Rf = 500*10^(3);
R1 = 100*10^(3);
V1 = 2;

```

```
Vo = (1+(Rf/R1))*V1;

disp(Vo,'Output voltage(Volts) = ');
```

Scilab code Exa 10.7 `Output voltage`

```
clear; clc; close;

//part a

V1 = 1;
V2 = 2;
V3 = 3;
R1 = 500*10^(3);
R2 = 1*10^(6);
R3 = 1*10^(6);
Rf = 1000*10^(3);

Vo = -((Rf/R1)*V1+(Rf/R2)*V2+(Rf/R3)*V3);
disp(Vo,'Output voltage(Volts) = ');

//part b


V1 = -2;
V2 = 3;
V3 = 1;
R1 = 200*10^(3);
R2 = 500*10^(3);
R3 = 1*10^(6);
Rf = 1000*10^(3);

Vo = -((Rf/R1)*V1+(Rf/R2)*V2+(Rf/R3)*V3);
disp(Vo,'Output voltage(Volts) = ');
```

Scilab code Exa 10.8 `Output offset voltage`

```
clear; clc; close;

Vio = 1.2*10^(-3);
R1 = 2*10^(3);
Rf = 150*10^(3);

Vo = Vio*((R1+Rf)/R1);
disp(Vo,'Output offset voltage(Volts) = ');
```

Scilab code Exa 10.9 `Output offset voltage`

```
clear; clc; close;

Iio = 100*10^(-9);
Rf = 150*10^(3);

Vo = Iio*Rf;
disp(Vo,'Output offset voltage(Volts) = ');
```

Scilab code Exa 10.10 `Total offset voltage`

```
clear; clc; close;

Iio = 150*10^(-9);
Rf = 500*10^(3);
R1 = 5*10^(3);
Vio = 4*10^(-3);
```

```

Vo_vio = Vio*(R1+Rf)/R1;
Vo_io = Iio*Rf;
Vo = Vo_vio+Vo_io;

disp(Vo,'Total voltage offset(Volts) = ');
```

Scilab code Exa 10.11 Input bias current

```
clear; clc; close;

Iio = 5*10^(-9);
Iib = 30*10^(-9);

Iib_positive = Iib + Iio/2;
Iib_negative = Iib -Iio/2;

disp(Iib_positive,'Positive input bias current(
    Amperes) = ');
disp(Iib_negative,'Negative input bias current(
    Amperes) = ');
```

Scilab code Exa 10.12 Cut off frequency

```
clear; clc; close;

B1 = 1*10^(6);
Avd = 200*10^(3);//converting from V/mV

f1 = B1;
fc = f1/Avd;

disp(fc,'Cutoff frequency(Hertz) = ')
```

Scilab code Exa 10.13 Maximum closed loop voltage gain

```
clear; clc; close;

SR = 2;
Vi_delta = 0.5;
t_delta = 10;

Acl = SR/(Vi_delta/t_delta);

disp(Acl,'Maximum Closed loop voltage gain = ');
```

Scilab code Exa 10.14 Maximum frequency

```
clear; clc; close;

Rf = 240*10^(3);
R1 = 10*10^(3);
Vi = 0.02;
w = 300*10^(3);
SR = 0.5;

Acl = abs(Rf/R1);
K = Acl*Vi;
w1 = SR/K;

disp(w,'Since this frequency is much less than
    maximum obtained,hence no distortion will be
    observed');
```

Scilab code Exa 10.15 `Current drawn calculation`

```
clear; clc; close;

V = 12;
P = 250*10^(-3);

I = P/V;

disp(I,'Current drawn(Amperes) = ');
```

Scilab code Exa 10.16 `Output offset voltage`

```
clear; clc; close;

Rf = 360*10^(3);
R1 = 12*10^(3);
Iio = 20*10^(-9);
Vio = 1*10^(-3);

Vo_vio = Vio*(R1+Rf)/R1;
Vo_iio = Iio*Rf;
Vo = Vo_vio + Vo_iio;

disp(Vo,'Output offset voltage(Volts) = ');
```

Scilab code Exa 10.17 `Gain and input output impedance calculation`

```
clear; clc; close;

Rf = 360*10^(3);
R1 = 12*10^(3);
ro = 75;
```

```
A = 200*10^(3);
Beta = 1/30;

Acl = -Rf/R1;
Zi = R1;
Zo = ro/(1+Beta*A)

disp(Acl,'Acl = ');
disp(Zi,'Zi(Ohms) = ');
disp(Zo,'Zo(Ohms) = ');
```

Scilab code Exa 10.18 `Cut off frequency`

```
clear; clc; close;

B1 = 1*10^(6);
Avd = 20*10^3;

f1 = B1;
fc = f1/Avd;


disp(fc,'Cutoff frequency(Hertz) = ');
```

Scilab code Exa 10.19 `Maximum frequency`

```
clear; clc; close;

Vi = 25*10^(-3);
Acl = 30;
SR = 0.5*10^6;//convertin from us to s

K = Acl*Vi;
```

```
fmax = SR/(2*%pi*K);

disp(fmax,'Maximum frequency(Hertz) = ');
```

Scilab code Exa 10.20 Open loop voltage gain

```
clear; clc; close;

Avd_db = 104;
Avd = 10^(104/20);

disp(Avd,'Open loop voltage gain(Volts) = ');
```

Scilab code Exa 10.21 CMRR calculation

```
clear; clc; close;

Vo = 8;
Vo_1 = 12*10^(-3);
Vd = 1*10^(-3);
Vc = 1*10^(-3);


Ad = Vo/Vd;
Ac = Vo_1/Vc;
CMRR = Ad/Ac;
CMRR = 20*log10(Ad/Ac);

disp(CMRR,'CMRR(dB) = ');
```

Scilab code Exa 10.22 `Output voltage`

```
clear; clc; close;

Vi1 = 150*10^(-6);
Vi2 = 140*10^(-6);
Ad = 4000;

//part a
CMRR = 100;

Vd = Vi1 - Vi2;
Vc = 1/2*(Vi1+Vi2);
Vo = Ad*Vd*(1+(1/CMRR)*(Vc/Vd));
disp(Vo,'Output voltage(Volts) = ');


//part b

CMRR = 100000;

Vd = Vi1 - Vi2;
Vc = 1/2*(Vi1+Vi2);
Vo = Ad*Vd*(1+(1/CMRR)*(Vc/Vd));
disp(Vo,'Output voltage(Volts) = ');
```

Chapter 11

Op Amp Applications

Scilab code Exa 11.1 Output voltage

```
clear; clc; close;

Rf = 200*10^(3);
R1 = 2*10^(3);
Vi = 2.5*10^(-3);

A = -Rf/R1;
Vo = A*Vi;

disp(Vo,'Output voltage(Volts) = ');
```

Scilab code Exa 11.2 Output voltage

```
clear; clc; close;

Rf = 240*10^(3);
R1 = 2.4*10^(3);
Vi = 120*10^(-6);
```

```

A = 1+(Rf/R1);
Vo = A*Vi;

disp(Vo,'Output voltage(Volts) = ');
```

Scilab code Exa 11.3 Output voltage

```
clear; clc; close;

Rf = 470*10^(3);
R1 = 4.3*10^(3);
R2 = 33*10^(3);
R3 = 33*10^(3);

Vi = 80*10^(-6);

A = ((1+(Rf/R1))*(-Rf/R2)*(-Rf/R3));
Vo = A*Vi;

disp(Vo,'Output voltage(Volts) = ');
```

Scilab code Exa 11.4 Output voltage

```
clear; clc; close;

Rf = 270*10^(3);
A1 = 10;
A2 = -18;
A3 = -27;
Vi = 150*10^(-6);
```

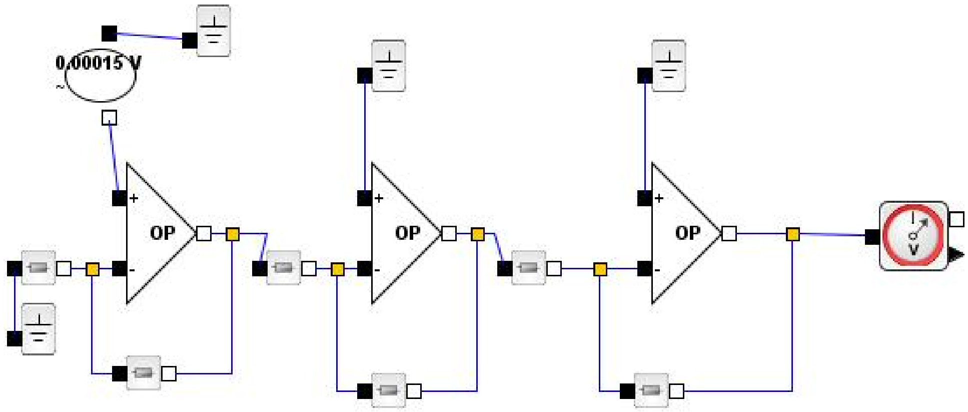

Figure 11.1: Output voltage

```


R1 = Rf/(A1-1);
R2 = Rf/-A2;
R3 = Rf/-A3;

Vo = A1*A2*A3*Vi;

disp(Vo,'Output voltage(Volts) = ');
```

Scilab code Exa 11.5 `Connection of op amp stages`

```
clear; clc; close;

Rf = 500*10^3;
A1 = -10;
A2 = -20;
A3 = -50;

```

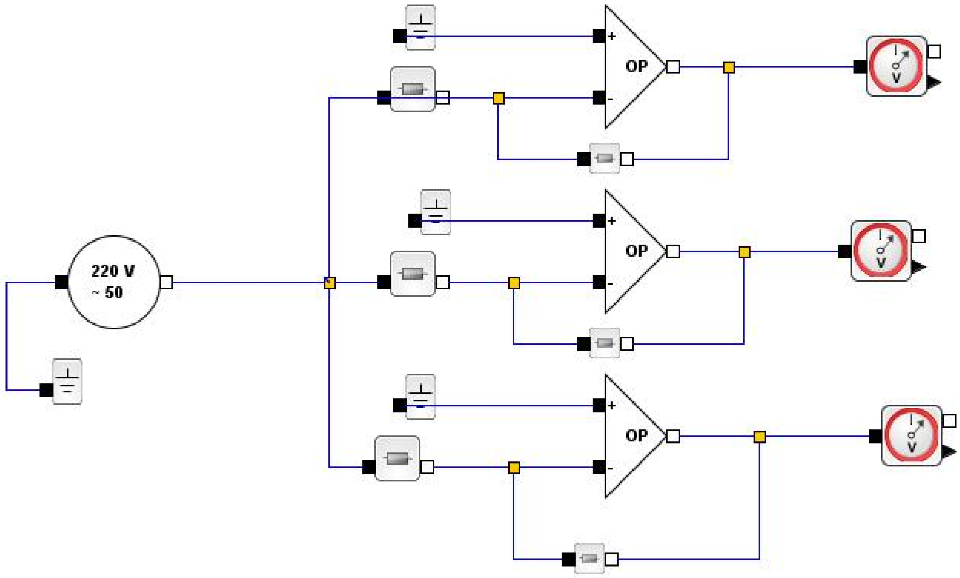

Figure 11.2: Connection of op amp stages

```
R1 = -Rf/A1;
R2 = -Rf/A2;
R3 = -Rf/A3;


disp(R1,'R1(ohms) = ');
disp(R2,'R2(ohms) = ');
disp(R3,'R3(ohms) = ');
```

Scilab code Exa 11.6 `Output voltage`

```
clear; clc; close;

v1 = ["*sin(1000t)"];
v2 = ["*sin(3000t)"];

```

```
Vo = strcat([string(-(330*10^3)/(33*10^3)*50*10^(-3)
    ),v1,string(-(330*10^3)/(10*10^3)*10^(-3)),v2]);

disp(Vo,'Output voltage(Volts) = ');
```

Scilab code Exa 11.7 Output voltage

```
clear; clc; close;

Rf = 1*10^(6);
R1 = 100*10^(3);
R2 = 50*10^(3);
R3 = 500*10^(3);

v2 = ["*V2"];
v1 = ["*V1"];
Vo = strcat([string((-Rf/R2)),v2,"+",string((Rf/R3)
    *(Rf/R1)),v1]);

disp(Vo,'Output voltage = ');
```

Scilab code Exa 11.8 Output voltage

```
clear; clc; close;

Vo = strcat([ string((20/(20+20)) * ((100+100)/100))
    ,"*V1",string(-(100*10^3)/(100*10^3)),"*V2"]);

disp(Vo,'Output voltage = ');
```

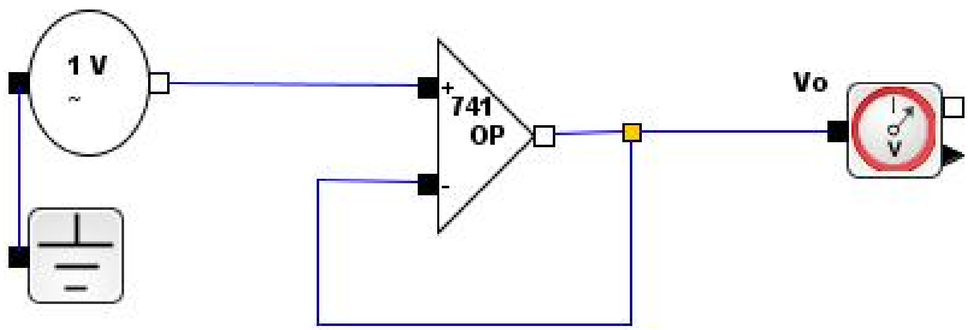

Figure 11.3: Connection of unity gain ckt

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

Scilab code Exa 11.10 `Il and Vo calculation`

```
clear; clc; close;

V1 = 8;
R1 = 2*10^3;
I1 = 10*10^(-3);


Il = V1/R1;
Vo = -I1*R1;

disp(Il,'Il(Amperes) = ');
disp(Vo,'Vo(Volts) = ');
```

Scilab code Exa 11.11 `Output voltage`

```
clear; clc; close;

R = 5000;
Rp = 500;


a = ['*(V1-V2)'];
Vo = strcat([string((1+(2*R/Rp))),a]);

disp(Vo,'Output voltage ');
```

Scilab code Exa 11.12 Cut off frequency

```
clear; clc; close;

R1 = 1.2*10^(3);
C1 = 0.02*10^(-6);

foh = 1/(2*%pi*R1*C1);

disp(foh,'Cutoff frequency of low pass filter(Hertz)
    = ');
```

Scilab code Exa 11.13 Cut off frequency of high pass filter

```
clear; clc; close;

Rf = 50*10^(3);
Rg = 10*10^(3);
R1 = 2.1*10^(3);
C1 = 0.05*10^(-6);

Av = 1+(Rf/Rg);
```

```
fol = 1/(2*%pi*R1*C1);

disp(fol,'Cutoff frequency of second order high pass
    filter(Hertz) = ');
```

Scilab code Exa 11.14 Cut off frequency of band pass filter

```
clear; clc; close;

R1 = 10*10^(3);
R2 = 10*10^(3);
C1 = 0.1*10^(-6);
C2 = 0.002*10^(-6);


fol = 1/(2*%pi*R1*C1);
foh = 1/(2*%pi*R2*C2);

disp(fol,'Low Cutoff frequency of band pass filter(
    hertz) = ');
disp(foh,'High Cutoff frequency of band pass filter(
    hertz) = ');
```

Chapter 12

Power Amplifiers

Scilab code Exa 12.1 input output power and efficiency

```
clear; clc; close;

Vcc = 20;
Rb = 1*10^(3);
Rc = 20;
Beta = 25;
Ib_p = 10*10^(-3);


Ibq = (Vcc-0.7)/Rb;
Ib = Ibq;
Icq = Beta*Ibq;
Ic=  Icq;
Vceq = Vcc-Ic*Rc;
Ic_p = Beta*Ib_p;
Po_ac = (Ic_p^2)*Rc/2;
Pi_dc = Vcc*Icq;
n = (Po_ac/Pi_dc)*100;

disp(Po_ac,'Output power = ');
disp(Pi_dc,'Input power = ');
```

```
disp(n,'Efficiency in percentage = ');
```

Scilab code Exa 12.2 Effective Resistance

```
clear; clc; close;

a = 15;
Rl = 8;

Rl_dash = (a^2)*Rl;

disp(Rl_dash,'Effective resistance looking into
   primary transformer is ');
```

Scilab code Exa 12.3 Turns ratio

```
clear; clc; close;

Rl_dash = 10*10^(3);
Rl = 8;

N1_N2 = sqrt(Rl_dash/Rl);

disp(N1_N2,'Turns ratio = ');
```

Scilab code Exa 12.4 Ac power delivered

```
clear; clc; close;

Vcc = 10;
```

```
a = 3;
Rl = 8;


Vceq = Vcc;
Vce = Vceq;
Icq = 140*10^(-3);

Rl_dash = (a^2)*Rl;
Ic = Vce/Rl_dash;

Vce_min = 1.7;
Vce_max = 18.3;
Ic_min = 25*10^(-3);
Ic_max = 255*10^(-3);

Po_ac = (Vce_max-Vce_min)*(Ic_max-Ic_min)/8;

disp(Po_ac,'Ac Power delivered(Watts) = ');
```

Scilab code Exa 12.5 input and dissipated power and efficiency

```
clear; clc; close;

Vcc = 10;
Icq = 140*10^(-3);
Po_ac = 0.477;


Pi_dc = Vcc*Icq;
Pq = Pi_dc-Po_ac;
n = (Po_ac/Pi_dc)*100;

disp(Pi_dc,'Dc input power(Watts) = ');
disp(Pq,'Power dissipated by transistor(Watts) = ');
```

```
disp(n,'Efficiency(Percentage) = ');
```

Scilab code Exa 12.6 Efficiency calculation

```
clear; clc; close;

Vcc = 12;

//part a
V_p = 12;
Vceq = Vcc;
Vce_max = Vceq + V_p;
Vce_min = Vceq - V_p;

n = 50*((Vce_max-Vce_min)/(Vce_max+Vce_min))^2;

disp(n,'Efficiency(Percentage) = ');

//part b
V_p = 6;
Vceq = Vcc;
Vce_max = Vceq + V_p;
Vce_min = Vceq - V_p;

n = 50*((Vce_max-Vce_min)/(Vce_max+Vce_min))^2;

disp(n,'Efficiency(Percentage) = ');


//part c
V_p = 8;
Vceq = Vcc;
Vce_max = Vceq + V_p;
Vce_min = Vceq - V_p;

```

```
n = 50*((Vce_max-Vce_min)/(Vce_max+Vce_min))^2;

disp(n,'Efficiency(Percentage) = ');
```

Scilab code Exa 12.7 Input output power and efficiency

```
clear; clc; close;

Vl_p = 20;
Vcc = 30;
Rl = 16;


Il_p = Vl_p/Rl;
Idc = (2/%pi)*Il_p;
Pi_dc = Vcc*Idc;
Po_ac = ((Vl_p)^2)/(2*Rl);
n = (Po_ac/Pi_dc)*100;


disp(Pi_dc,'Input power(Watts) = ');
disp(Po_ac,'Output power(Watts) = ');
disp(n,'Efficiency(Percentage) = ');
```

Scilab code Exa 12.8 Power and transmission dissipation

```
clear; clc; close;

Vcc =30;
Rl = 16;


Po_max = (Vcc^2)/(2*Rl);
```

```
Pi_max = (2*Vcc^2)/(%pi*Rl);
n_max = (Po_max/Pi_max)*100;
Pq_max = (1/2)*(2*Vcc^2/((%pi^2)*Rl));

disp(Po_max,'Maximum output power(Watts) = ');
disp(Pi_max,'Maximum input power(Watts) = ');
disp(Pq_max,'Transmission dissipation(Watts) = ');
```

Scilab code Exa 12.9 Efficiency calculation

```
clear; clc; close;

Vcc = 24;

//part a
Vl_p = 22;
n = 78.54*(Vl_p/Vcc);
disp(n,'Efficiency(Percentage) = ');


//part b
Vl_p = 12;
n = 78.54*(Vl_p/Vcc);
disp(n,'Efficiency(Percentage) = ');
```

Scilab code Exa 12.10 Input output dissipated power and efficiency

```
clear; clc; close;

Vi_rms = 12;
Rl = 4;
Vcc = 25;

```

```
Vi_p = sqrt(2)*Vi_rms;
Vl_p = Vi_p;
Po_ac = (Vl_p^2)/(2*Rl);
Il_p = Vl_p/Rl;
Idc = (2/%pi)*(Il_p);
Pi_dc = Vcc*Idc;
Pq = (Pi_dc-Po_ac)/2;

n = (Po_ac/Pi_dc)*100;

disp(Po_ac,'Output power(Watts) = ');
disp(Pi_dc,'Input power(Watts) = ');
disp(Pq,'Power dissipated(Watts) = ');
disp(n,'Efficiency(Percentage) = ');
```

Scilab code Exa 12.11 Dissipated power and efficiency

```
clear; clc; close;

Vcc =25;
Rl = 4;


Po_max = (Vcc^2)/(2*Rl);
Pi_max = (2*Vcc^2)/(%pi*Rl);
n_max = (Po_max/Pi_max)*100;
Vl_p = Vcc;
P2q = Pi_max-Po_max;


disp(Po_max,'Output power(Watts) = ');
disp(Pi_max,'Input power(Watts) = ');
disp(P2q,'Power dissipated(Watts) = ');
```

```
disp(n_max,'Efficiency(Percentage) = ');
```

Scilab code Exa 12.12 Max dissipated power and input voltage

```
clear; clc; close;

Vcc =25;
Rl = 4;
Vl_p = Vcc;

P2q_max = (2*Vcc^2)/((%pi^2)*Rl);
Vl = 0.636*Vl_p;

disp(P2q_max,'Maximum power dissipated(Watts) = ');
disp(Vl,'Input voltage at which this occurs(Volts) =
    ');
```

Scilab code Exa 12.13 Harmonic distortion components

```
clear; clc; close;

A1 = 2.5;
A2 = 0.25;
A3 = 0.1;
A4 = 0.05;

D2 = (abs(A2)/abs(A1))*100;
D3 = (abs(A3)/abs(A1))*100;
D4 = (abs(A4)/abs(A1))*100;


disp(D2,'Second harmonic distortion(Percentage) = ')
    ;
```

```
disp(D3,'Third harmonic distortion(Percentage) = ');
disp(D4,'Fourth harmonic distortion(Percentage) = ')
    ;
```

Scilab code Exa 12.14 Total Harmonic distortion components

```
clear; clc; close;

D2 = 0.1;
D3 = 0.04;
D4 = 0.02;

THD = sqrt((D2^2)+(D3^2)+(D4^2))*100;

disp(THD,'Total harmonic distortion(Percentage) = ')
    ;
```

Scilab code Exa 12.15 Second Harmonic distortion

```
clear; clc; close;

//part a
Vce_min = 1;
Vce_max =22;
Vceq = 12;
D2 = abs(((1/2)*(Vce_max+Vce_min)-Vceq)/(Vce_max-
    Vce_min))*100;
disp(D2,'Second harmonic distortion(Percentage) = ')
    ;

//part b
Vce_min = 4;
Vce_max =20;
```

```
Vceq = 12;
D2 = abs(((1/2)*(Vce_max+Vce_min)-Vceq)/(Vce_max-
   Vce_min))*100;
disp(D2,'Second harmonic distortion(Percentage) = ')
   ;
```

Scilab code Exa 12.16 Total Harmonic distortion and fundamental and total power

```
clear; clc; close;

D2 = 0.1;
D3 = 0.02;
D4 = 0.01;
I1 = 4;
Rc = 8;

THD = sqrt((D2^2)+(D3^2)+(D4^2));
P1 = (I1^2)*Rc/2;
P = (1+THD^2)*P1;

disp(THD,'Total harmonic distortion = ');
disp(P1,'Fundamental power component(Watts) = ');
disp(P,'Total power(Watts) = ');
```

Scilab code Exa 12.17 Maximum dissipation

```
clear; clc; close;

Pd_temp0 = 80;
T1 = 100;
T0 = 25;
D = 0.5;

```

```
Pd_temp1 = Pd_temp0-(T1-T0)*(D);

disp(Pd_temp1,'Maximum power dissipation(Watts) = ')
    ;
```

Scilab code Exa 12.18 Max dissipated power

```
clear; clc; close;

Tj = 200;
Ta = 40;
Qjc = 0.5;
Qcs = 0.6;
Qsa = 1.5;


Pd = (Tj-Ta)/(Qjc+Qcs+Qsa);

disp(Pd,'Maximum power dissipated(Watts) = ');
```

Chapter 13

Linear Digital ICs

Scilab code Exa 13.1 `frequency and output waveform`

```
clear; clc; close;

Ra = 7.5*10^(3);
Rb = 7.5*10^(3);
C = 0.1*10^(-6);

Thigh = 0.7*(Ra+Rb)*C;
Tlow = 0.7*(Rb*C);
T  = Thigh +Tlow;

f = 1/T;

disp(f,'Frequency = ');


x = 0:0.001:1.575;
y = 5*(x<=1.05) + 1*(x>1.05);
plot2d(x,y);
a = gca();
```

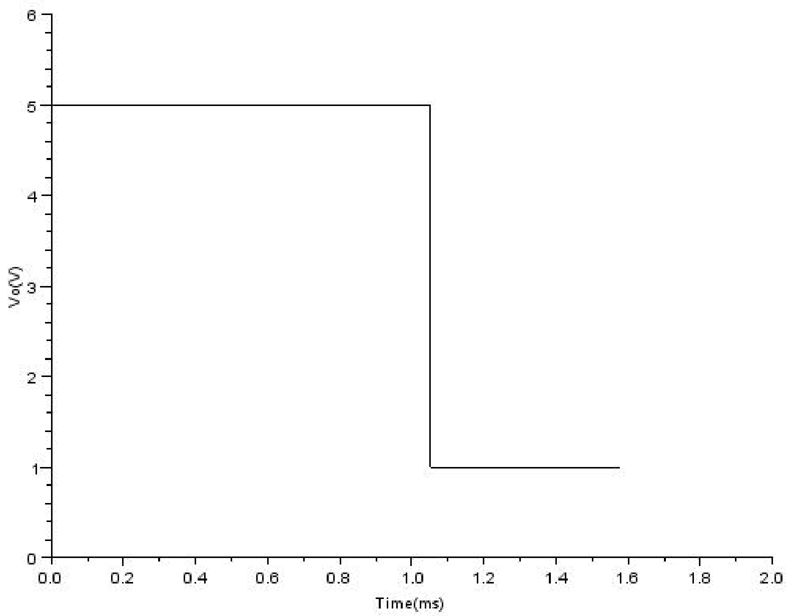

Figure 13.1: frequency and output waveform

```
a.data_bounds = [0 0;2 5.2];
a.x_label.text = 'Time(ms)';
a.y_label.text = 'Vo(V)';
```

Scilab code Exa 13.2 Period of output waveform

```
clear; clc; close;

Ra = 10*10^(3);
C = 0.1*10^(-6);

Thigh = 1.1*Ra*C;

disp(Thigh,'Period of output waveform = ')
```

Chapter 14

Feedback and oscillator circuits

Scilab code Exa 14.1 input output impedance and voltage gain

```
clear; clc; close;

A = -100;
Zi = 10*10^(3);
Zo = 20*10^(3);


//part a
Beta = -0.1;
Af = A/(1+Beta*A);
Zif = Zi*(1+Beta*A);
Zof = Zo/(1+Beta*A);

disp(Af,'Voltage gain for part a= ');
disp(Zif,'Input impedance for part a= ');
disp(Zof,'Output Impedance for part a= ');

//part b
Beta = -0.5;
Af = A/(1+Beta*A);
Zif = Zi*(1+Beta*A);
```

```
Zof = Zo/(1+Beta*A);

disp(Af,'Voltage gain for part b = ');
disp(Zif,'Input impedance for part b = ');
disp(Zof,'Output Impedance for part b = ');
```

Scilab code Exa 14.2 change in gain of feedback amplifier

```
clear; clc; close;

Beta = -0.1;
dA_A = 20;
A = -1000;

dAf_Af = abs(1/(Beta*A))*abs((dA_A));
disp(dAf_Af,'Percentage Change in gain of feedback
    amplifier = ');
```

Scilab code Exa 14.3 gain with and without feedback

```
clear; clc; close;

R1 = 80*10^(3);
R2 = 20*10^(3);
Ro = 10*10^(3);
Rd = 10*10^(3);
gm = 4000*10^(-6);


Rl = Ro*Rd/(Ro+Rd);
A = -gm*Rl;
Beta = -R2/(R1+R2);
Af = A/(1+Beta*A);
```

```
disp(A,'Gain without feedback = ');
disp(Af,'Gain with feedback = ');
```

Scilab code Exa 14.4 amplifier gain

```
clear; clc; close;

R1 = 1.8*10^(3);
R2 = 200;
A = 100000;


Beta = R2/(R1+R2);
Af = A/(1+Beta*A);
Af = 1/Beta;

disp(Af,'Amplifier gain = ');
```

Scilab code Exa 14.5 voltage gain

```
clear; clc; close;

hfe = 120;
hie = 900;
Re = 510;
Rc = 2.2*10^(3);
re = 7.5;

A = -hfe/(hie+Re);
Beta = -Re;
Af = A/(1+Beta*A);
Avf = Af*Rc;
```

```
Av = -Rc/re;


disp(Avf,'Voltage gain with feedback = ');
disp(Av,'Voltage gain without feedback = ');
```

Scilab code Exa 14.6 voltage gain

```
clear; clc; close;

gm = 5*10^(-3);
Rd = 5.1*10^(3);
Rs = 1*10^(3);
Rf = 10*10^(3);


Av = -gm*Rd;
Avf = (-gm*Rd)*(Rf/(Rf+(gm*Rd*Rs)));

disp(Av,'Voltage gain without feedback = ');
disp(Avf,'Voltage gain with feedback = ');
```

Scilab code Exa 14.7 value of C

```
clear; clc; close;

R = 10*10^(3);
f = 5*10^(3);
A = 40;
gm = 5000*10^(-6);

C = 1/(2*%pi*R*f*sqrt(6));
Rl = abs(A)/gm;
```

```
disp(C,'Value of C = ');
disp(Rl,'Value of Rl = ');
```

Scilab code Exa 14.8 `resonant frequency and RC elements`

```
clear; clc; close;

R  = 51*10^(3);
C = 0.001*10^(-6);


fo = 1/(2*%pi*R*C);

disp(fo,'Resonant frequency = ');

fo2 = 2*fo;
RC = 1/(2*%pi*fo2);
R = 50*10^(3);
C = 510*10^(-12);

disp(R,'Value of R can be = ');
disp(C,'Value of C can be = ');
```

Scilab code Exa 14.9 `RC elements for wien bridge`

```
clear; clc; close;

fo = 5*10^(3);

R = 50*10^(3);
C = 1/(2*%pi*fo*R);

```

```
disp(R,'Value of R can be = ');
disp(C,'Value of C is = ');
```

Chapter 15

Power Supplies

Scilab code Exa 15.1 Measure output and filter voltage

```
clear; clc; close;

Vdc = 25;
Vr = 1.5;


r_a = (Vr/Vdc)*100;
r_b = (Vr*0.35/Vdc)*100;

disp(r_a,'Ripple value in part a = ');
disp(r_b,'New Ripple value in part b = ');
```

Scilab code Exa 15.2 Voltage regulation value

```
clear; clc; close;

Vnl = 60;
Vfl = 56;
```

```
VR = ((Vnl-Vfl)/Vfl)*100;

disp(VR,'Voltage regulation in percentage = ');
```

Scilab code Exa 15.3 Ripple voltage and output voltage value

```
clear; clc; close;

//part a
Idc = 50*10^(-3);
C = 100*10^(-6);

Vr_rms = 2.4*(10^-3)*Idc/(C);

disp(Vr_rms,'Ripple voltage = ');

//part b

Rl = 100;

Vdc = Vr_rms*Rl*C/2.4;

disp(Vdc,'Output voltage = ');
```

Scilab code Exa 15.4 Filter dc voltage value

```
clear; clc; close;

Vm = 30;
Idc = 50;
C  = 100;

```

```
Vdc = Vm - 4.17*Idc/C;

disp(Vdc,'Filter dc voltage = ');
```

Scilab code Exa 15.5 Ripple of capacitor

```
clear; clc; close;

Idc = 50;
C = 100;
Vdc = 27.9;

r = (2.4*Idc/(C*Vdc))*100;

disp(r,'Ripple value of capacitor in percentage = ')
    ;
```

Scilab code Exa 15.6 dc voltage across 1k load

```
clear; clc; close;

Rl = 1000;
R = 120;
Vdc = 60;

Vdc_dash = (Rl/(R+Rl))*Vdc;

disp(Vdc_dash,'Dc voltage across 1k-ohm load = ');
```

Scilab code Exa 15.7 dc ac and ripple values of output signal

```
clear; clc; close;

Rl = 5*10^(3);
R = 500;
Vdc = 150;
C = 10*10^(-3);
Vr_rms = 15;

Vdc_dash = (Rl/(R+Rl))*Vdc;
Xc = 1.3/C;
Vr_rms_dash = (Xc/R)*Vr_rms;
r = (Vr_rms_dash/Vdc_dash)*100;

disp(Vdc_dash,'Dc component of output voltage = ');
disp(Vr_rms_dash,'Ac component of output voltage = '
    );
disp(r,'Ripple = ');
```

Scilab code Exa 15.8 output voltage and zener current

```
clear; clc; close;

Vz = 12;
Vbe = 0.7;
Vi = 20;
Rl = 5*10^(3);
Ic = 2.26*10^(-3);
Beta = 50;
R = 220;

Vo = Vz-Vbe;
Vce = Vi-Vo;
Ir = (Vi-Vz)/R;
Il = Vo/Rl;
Ib = Ic/Beta;
```

```
Iz = Ir-Ib;

disp(Vo,'Output voltage = ');
disp(Iz,'Zener current = ');
```

Scilab code Exa 15.9 regulated output voltage

```
clear; clc; close;

R1 = 20*10^(3);
R2 = 30*10^(3);
Vz = 8.3;
Vbe = 0.7;

Vo = ((R1+R2)/R2)*(Vz+Vbe);

disp(Vo,'Regulated Output voltage = ');
```

Scilab code Exa 15.10 regulated output voltage

```
clear; clc; close;

Vo = (1+( 30*10^(3)/(15*10^(3)) ))*6.2;

disp(Vo,'Regulated Output voltage = ');
```

Scilab code Exa 15.11 regulated voltage and circuit current

```
clear; clc; close;

```

```
Rl = 320;
Vi = 22;
Rs = 120;


Vl = 8.2+0.7;
Il = Vl/Rl;
Is = (Vi-Vl)/Rs;
Ic = Is-Il;

disp(Vl,'Vl = ');
disp(Il,'Il = ');
disp(Is,'Is = ');
disp(Ic,'Ic = ');
```

Scilab code Exa 15.13 minimum input voltage

```
clear; clc; close;

Idc = 400*10^(-3);
C = 250*10^(-6);
Vm = 15;
Vdc = 15;

Vr_peak = sqrt(3)*2.4*(10^-3)*Idc/C;
Vi = Vdc - Vr_peak;

disp(Vi,'Minimum input voltage = ');
```

Scilab code Exa 15.14 max value of load current

```
clear; clc; close;

```

```
Vm = 15;
Vi_min = 7.3;
C = 250*10^(-6);

Vr_peak = Vm - Vi_min;
Vr_rms = Vr_peak/sqrt(3);

Idc = Vr_rms*C/(2.4*(10^-3));

disp(Idc,'Max value of load current = ');
```

Scilab code Exa 15.15 regulated output voltage

```
clear; clc; close;

Vo = 1.25*(1+ (1.8*10^3/240)) + (100*10^(-6))
    *(1.8*10^3);

disp(Vo,'Regulated Output voltage = ');
```

Scilab code Exa 15.16 regulated output voltage

```
clear; clc; close;

Vo = 1.25*(1+ (1.8*10^3/240)) + (100*10^(-6))
    *(1.8*10^3);

disp(Vo,'Regulated Output voltage = ');
```