Scilab Textbook Companion for Fundamentals of Electronic Devices and Circuits
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Book Description

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

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

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

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

Contents

List of Scilab Codes

Chapter 1

Crystal Structure Of Materials

Scilab code Exa 1.1 Fraction of the total number of electrons

```
// Exa 1.1
clc;
clear;
close;
format('v',9);
// Given data
E_G = 0.72;// in eV
E_F = (1/2)*E_G;// in eV
k = 8.61*10^-5;// in eV/K
T = 300;// in K
// The fraction of the total number of electrons
n_C_by_n = 1/( 1 + (%e^((E_G-E_F)/(k*T))) );
disp(n_C_by_n,"The fraction of the total number of
   electrons is");
```

Scilab code Exa 1.2 Ratio of electron to hole concentration

```
// Exa 1.2
```

```
clc;
clear;
close;
format('v',7)
// Given data
n_i = 1.4*10^18;// in /m^3
N_D = 1.4*10^24;// in /m^3
n = N_D;// in /m^3
p = (n_i^2)/n;// in /m^3
// Ratio of electron to hole concentation,
ratio = n/p;
disp(ratio,"Ratio of electron to hole concentration is");
```

Scilab code Exa 1.3 Resistivity of conductor

```
// Exa 1.3
clc;
clear;
close;
format('v',10)
// Given data
e = 1.6*10^-19;// in C
m = 9.1*10^-31;// in kg
miu_e = 7.04 * 10^-3;// in m^2/V-s
n = 5.8*10^28;// in /m^3
torque = (miu_e/e)*m;// in sec
disp(torque,"The relaxation time in sec is");
sigma = n*e*miu_e;
rho = 1/sigma ;// in ohm-m
disp(rho,"The resistivity of conductor in ohm-m is");
```

Scilab code Exa 1.4 Relaxation time of conducting electorns

```
// Exa 1.4
clc;
clear;
close;
format('v',10)
// Given data
e = 1.601*10^-19;// in C
m = 9.107 * 10^-31;// in kg
E = 100;// in V/m
n = 6*10^28;// in /m^3
rho = 1.5*10^-8;// in ohm-m
sigma = 1/rho;
torque = (sigma*m)/(n*(e^2));// in second
disp(torque,"The relaxation time in second is");
format('v',6)
v = ((e*E)/m)*torque;// in m/s
disp(v,"The drift velocity in m/s is");
```

Scilab code Exa 1.5 Charge density of free electrons

```
// Exa 1.5
clc;
clear;
close;
format('v',10)
// Given data
d = 2;// in mm
d = d * 10^-3;// in m
sigma = 5.8*10^7;// in S/m
miu_e = 0.0032;// in m^2/V-s
E = 20;// in mV/m;
E = E * 10^-3;// in V/m
e = 1.6*10^-19;// in C
```

```
n = sigma/(e*miu_e);// in /m^3
disp(n,"The charge density of free electrons in /m^3 is");
J = sigma*E;// in A/m^2
disp(J,"The current density in A/m^2 is");
format('v',6)
I = J * ( (%pi*(d^2))/4 );// in A
disp(I,"The current flowing in the wire in A is");
format('v',9)
v = miu_e*E;// in m/s
disp(v,"The electron drift velocity in m/s is");
```

Scilab code Exa 1.6 Dopant density

```
// Exa 1.6
clc;
clear;
close;
format('v',9)
// Given data
l = 1;// in cm
l = l * 10^-2;// in m
A = 1;// in mm^2
A = A * 10^-6;// in m^2
R = 100;// in ohm
rho = (R*A)/l;// in ohm-m
sigma = 1/rho;
e = 1.6*10^-19;// in C
miu_e = 1350;// in cm^2/V-s
miu_e = miu_e * 10^-4;// in m^2/V-s
n = sigma/(e*miu_e);// in /m^3
disp(n,"The dopant density in /m^3");

// Note: The unit of the answer is wrong because 0.0463*10^23/m^3 = 4.63*10^21/m^3, not in /cm^3
```

Scilab code Exa 1.7 Concentration of acceptor atoms required

```
// Exa 1.7
clc;
clear;
close;
format('v',9)
// Given data
R = 1;// in k ohm
R = R * 10^3;// in ohm
L = 400;// in  m
L = L * 10^-6;// in m
W = 20;// in  m
W = W * 10^-6;// in m
a = L*W;// in m^2
l = 4;// in mm
l = l * 10^-3;// in m
rho_i = (R*a)/l;// in ohm-m
sigma_i = 1/rho_i;// in S/m
e = 1.6*10^-19;// in C
miu_h = 480;// in cm^2/V-s
miu_h = miu_h * 10^-4;// in m^2/V-s
// sigma_i = p*e*miu_h;
p = sigma_i/(e*miu_h);// in /m^3
disp(p,"The concentration of acceptor atom in /m^3
    is");
```

Scilab code Exa 1.8 Drift velocity

```
// Exa 1.8
clc;
```

```
clear;
close;
format('v',8)
// Given data
rho = 0.5;// in ohm-m
J = 100;// in A/m^2
miu_e = 0.4;// in m^2/V-s
e = 1.6*10^-19;// in C
sigma = 1/rho;
E = J/sigma;
v = miu_e*E;// in m/s
disp(v,"The drift velocity in m/s is");
D = 10;// distance of travel in  m
D = D * 10^-6;// in m
// Time taken by electron
t= D/v;// time taken in second
disp(t,"The time taken in second is");
```

Scilab code Exa 1.9 Electron and hole densities

```
// Exa 1.9
clc;
clear;
close;
format('v',9)
// Given data
rho = 0.039;// in ohm-cm
sigma_n = 1/rho;// in mho/cm
miu_e = 3600;// in cm^2/V-s
e = 1.602*10^-19;// in C
// sigma_n = n*e*miu_e = N_D*e*miu_e;
N_D = sigma_n/(e*miu_e);// in /cm^3
n = N_D;// in /cm^3
disp(n,"The electrons density per cm^3 is");
n_i = 2.5*10^13;// in /cm^3
```

```
p = (n_i^2)/n;// in /cm^3
disp(p,"The hole density per cm^3 is");
```

Scilab code Exa 1.10 Density of free electrons

```
// Exa 1.10
clc;
clear;
close;
format('v',10)
// Given data
rho_i = 0.47;// in ohm-m
sigma_i = 1/rho_i;// in S/m
miu_e = 0.39;// in m^2/V-s
miu_h = 0.19;// in m^2/V-s
e = 1.6*10^-19;// in C
//sigma_i = n_i*e*(miu_e+miu_h);
n_i = sigma_i/( e*(miu_e+miu_h) );// in /m^3
disp(n_i,"The density of electrons per m^3 is");
E = 10^4;
v_n = miu_e*E;// in m/s
disp(v_n,"The drift velocity for electrons in m/s is
   ");
v_h = miu_h*E;// in m/s
disp(v_h,"The drift velocity for holes in m/s is");
```

Scilab code Exa 1.11 Mobility of electrons and holes

```
// Exa 1.11
clc;
clear;
close;
format('v',10)
```

```
// Given data
rho = 3000;// in ohm-m
n = 1.1*10^6;// in /m^3
e = 1.6*10^-19;// in C
//miu_e = 3*miu_h    (i)
// miu_e+miu_h = 1/(rho*e*n)     (ii)
// From eq (i) and (ii)
miu_h = (1/(rho*e*n))/4;// in m^2/V-s
disp(miu_h,"The holes mobility in m^2/V-s is");
miu_e = 3*miu_h;// in m^2/V-s
disp(miu_e,"The electron mobility in m^2/V-s is");

// Note: The calculated value of hole mobility is wrong .
```

Scilab code Exa 1.12 Conductivity of intrinsic Ge

```
// Exa 1.12
clc;
clear;
close;
format('v',7)
// Given data
n_i = 2.5*10^13;// in /cm^3
miu_e = 3800;//in cm^2/V-s
miu_h = 1800;// in m^2/V-s
e = 1.6*10^-19;// in C
sigma_i = n_i*e*(miu_e+miu_h);// in (ohm-cm)^-1
disp(sigma_i,"The intrinsic conductivity in (ohm-cm)^-1 is");
n = 4.4*10^22;
impurity = 10^-7;
N_D = n*impurity;// in /cm^3
n = N_D;// in /cm^3
p = (n_i^2)/N_D;// in holes/cm^3
```

```
sigma_n = e*N_D*miu_e;// in (ohm-cm)^-1
disp(sigma_n,"The conductivity in N-type Ge
    semiconductor in (ohm-cm)^-1 is");
```

Scilab code Exa 1.13 Electron and hole drift velocity

```
// Exa 1.13
clc;
clear;
close;
format('v',9)
// Given data
e = 1.6*10^-19;// in C
miu_e = 0.38;// in m^2/V-s
miu_h = 0.18;// in m^2/V-s
V = 10;// in V
l = 25;// in mm
l = l * 10^-3;// in m
w = 4;// in mm
w = w * 10^-3;// in m
t= 1.5*10^-3;// in m
E = V/l;// in V/m
v_e = miu_e*E;// in m/s
disp(v_e,"The electron drift velocity in m/s is");
v_h = miu_h*E;// in m/s
disp(v_h,"The hole drift velocity in m/s is");
n_i = 2.5*10^19;// in /m^2
sigma_i = n_i*e*(miu_e+miu_h);// in (ohm-cm)^-1
disp(sigma_i,"The interinsic conductivity of Ge in (
    ohm-cm)^-1 is");
A = w*t;// in m^2
I = sigma_i*E*A;// in A
I = I * 10^3;// in mA
disp(I,"The total current in mA is");
```

Scilab code Exa 1.14 Ratio of electron to hole

```
// Exa 1.14
clc;
clear;
close;
format('v',7)
// Given data
I_electrons = 3/4;
I_holes= 1/4;
v_h = 1;
v_e = 3;
ratio = (I_electrons/I_holes)*(v_h/v_e);
disp(ratio,"Ratio of electrons to holes is");
```

Scilab code Exa 1.15 Diffusion coefficients of electrons

```
// Exa 1.15
clc;
clear;
close;
format('v',6)
// Given data
miu_e = 0.17;// in m^2/V-s
miu_h = 0.025;// in m^2/V-s
e = 1.602*10^-19;// in C
T = 27;// in degree C
T = T + 273;// in K
kdas = 1.38*10^-23;// in J/K
De = miu_e*( (kdas*T)/e );// in m^-2/s
De = De * 10^4;// in cm^2/s
```

```
disp(De,"The diffusion coefficients of electrons in cm^2/s");
Dh = miu_h*( (kdas*T)/e );// in m^2/s
Dh = Dh * 10^4;// in cm^2/s
disp(Dh,"The diffusion coefficients of holes in cm^2/s");
```

Scilab code Exa 1.16 Intrinsic carrier concentration in Si

```
// Exa 1.16
clc;
clear;
close;
format('v',9)
// Given data
N = 3*10^25;// in /m^3
e = 1.602*10^-19;// in C
E_G = 1.1;// in eV
E_G = E_G*e;// in J
kdas = 1.38*10^-23;// in J/K
T = 300;// in K
miu_e = 0.14;// in m^2/V-s
miu_h = 0.05;// in m^2/V-s
n_i = N*(%e^((-E_G)/(2*kdas*T)));// in /m^3
disp(n_i,"The interinsic carrier concentration in /m^3 is");
sigma = n_i*e*(miu_e+miu_h);// in S/m
disp(sigma,"The conductivity of silicon in S/m is");
```

Scilab code Exa 1.17 Mobility of electrons

```
// Exa 1.17
clc;
```

```
clear;
close;
format('v',7)
// Given data
Je = 360;// in A/cm^2
T = 300;// in K
d = 1.5;// in mm
d = d * 10^-1;// in cm
e = 1.6*10^-19;// in C
del = 2*10^18-5*10^17;// assumed
dnBYdx = del/d;
De = Je/(e*dnBYdx);// in cm^2/s
V_T = T/11600;
miu_e = De/V_T;// in cm^2/V-s
disp(miu_e,"The mobility of electrons in cm^2/V-s is
    ");
```

Scilab code Exa 1.18 New position of Fermi Level

```
// Exa 1.18
clc;
clear;
close;
format('v',7)
// Given data
E_CminusE_F = 0.24;// in eV
T = 300;// in K
T1 = 350;// in K
// E_CminusE_F = K*T*log(n_c/N_D) (i)
// E_CminusE_F1 =K*T1*log(n_C/N_D) (ii)
// From eq(i) and (ii)
E_CminusE_F1 = E_CminusE_F*(T1/T);// in eV
disp("The new position of the Fermi level lies "+
    string(E_CminusE_F1)+" eV below the conduction
    band")
```

Scilab code Exa 1.19 New position of Fermi Level

```
// Exa 1.19
clc;
clear;
close;
format('v',5)
// Given data
E_FminusE_V = 0.39;// in eV
kT = 0.026;// in ev
//N_A1 = n_V * (%e^(-E_FminusE_V)/kT)        (i)
// N_A2=3*N_A1=n_V * (%e^(-E_F2minusE_V)/kT)     (ii)
//From eq(i) and (ii)
E_F2minusE_V = kT*(15-log(3));// in eV
disp(E_F2minusE_V,"The new position of fermi level in eV is");
```

Chapter 2

Crystal Structure Of Materials

Scilab code Exa 2.3 Density of copper crystal

```
// Exa 2.3
clc;
clear;
close;
// Given data
format('v',8)
r = 1.278;// in angstrum
At = 63.5;// atomic weight
N_A = 6.023*10^23;// Avagadro number
a = (4*r)/sqrt(2);// in angstrum
a = a * 10^-10;// in m
m = At/N_A;// in gm
m = m * 10^-3;// in kg
V = (a^3);// in m^3
n = 4;// number of atoms present in one unit cell of Cu
rho = (m*n)/V;// in kg/m^3
disp(rho,"The density of crystal in kg/m^3 is");
```

Scilab code Exa 2.4 Interplaner distance in a crystal

```
// Exa 2.4
clc;
clear;
close;
format('v',5)
// Given data
lembda = 1.539;// in angstrum
theta = 22.5;// in degree
n = 1; // first order
// n*lembda = 2*d*sind(theta);
d = lembda/(2*sind(theta));// in angstrum
disp(d,"The interplaner distance in angstrum is");
```

Scilab code Exa 2.5 Wavelength of X ray

```
// Exa 2.5
clc;
clear;
close;
format('v',6)
// Given data
n = 2;// second order
d = 0.4;// in nm
d = d * 10^-9;// in m
theta = 16.8/2;// in degree
// n*lembda = 2*d*sind(theta)  (using Bragg's
    equation)
lembda = (2*d*sind(theta))/n;// in m
lembda = lembda * 10^10;// in angstrum
disp(lembda,"The wavelength of x-rays in angstrum is
    ");
```

Chapter 3

Magnetic Materials

Scilab code Exa 3.1 Hysteresis loss per cubic merter per cycle

```
// Exa 3.1
clc;
clear;
close;
format('v',7)
// Given data
x = 1000;// in AT/m assumed
y = 0.2;// in T assumed
a = 9.3;// area in cm^2
// Hysteresis loss/m^3/cycle
H = a*x*y;// in J/m^3/cycle
disp(H,"Hysteresis loss per cubic meter per cycle in
    J/m^3/cycle is");
f = 50;// in Hz
// Hystersis loss per cubic meter at a frequency of
   50Hz
h = H*f;// in W
h = h * 10^-3;// in kW
disp(h,"Hystersis loss per cubic meter at a
   frequency of 50Hz in kW is");
```

Scilab code Exa 3.2 Hysteresis loss

```
// Exa 3.2
clc;
clear;
close;
format('v',6)
// Given data
a = 93;// in cm^2
x = 0.1;// in Wb/m^2
y = 50;// in AT/m
// Hysteresis loss/m^3/cycle
H = a*x*y;// in J/m^3/cycle
f = 65;// in Hz
V = 1500;// in cm^3
V = V * 10^-6;// in m^3
Ph = H*f*V;// in W
disp(Ph,"The hysteresis loss in W is");
```

Scilab code Exa 3.3 Loss of energy

```
// Exa 3.3
clc;
clear;
close;
format('v',8)
// Given data
Eta =628;// in J/m^3
Bmax = 1.3;// in T
f = 25;// in Hz
m = 50;// in kg
rho = 7.8*10^3;// in kg/m^3
```

```
V = m/rho;// in m^3
H = round(Eta*(Bmax^1.6)*f*V);// Hysteresis loss in J/s
H = H * 60 *60;// Hysteresis loss in J/hour
disp(H,"The Hysteresis loss per hour in J is");
h = Eta*(Bmax^1.6);// Hysteresis loss/m^3/cycle
// h = x*y*area of B_H loop
x = 12.5;// in AT/m
y = 0.1;// in T
Area = h/(x*y);// in cm^2
format('v',5)
disp(Area,"The area of B-H loop in cm^2 is");
```

Scilab code Exa 3.4 Eddy current loss

```
// Exa 3.4
clc;
clear;
close;
format('v',7)
// Given data
Pe1 = 1600;// in W
Bmax1 = 1.2;// in T
f1 = 50;// in Hz
Bmax2 = 1.5;// in T
f2 = 60;// in Hz
Pe2 = Pe1*(Bmax2/Bmax1)^2*(f2/f1)^2;// in W
disp(Pe2,"The eddy current loss in W is");
```

Chapter 4

Transistor Amplifiers

Scilab code Exa 4.1 DC and AC load line

```
// Exa 4.1
clc;
clear;
close;
format('v',8)
// Given data
V_CC = 20;// in V
I_C= 2*10^-3;// in A
I_CQ= I_C;// in A
I_E=I_C;// in A
R_C = 3;// in k ohm
R_C = R_C * 10^3;// in ohm
R_L = 12;// in k ohm
R_L = R_L * 10^3;// in ohm
R_E = 2;// in k ohm
R_E = R_E * 10^3;// in ohm
V_CE=0:0.1:20;// in V
I_C_sat= (V_CC-V_CE)/(R_C+R_E)*10^3;// in mA
subplot(121)
plot(V_CE,I_C_sat);
xlabel("V_CE in volts")
```

```
ylabel("I_C in mA")
title("DC load line")
Rac= R_C*R_L/(R_C+R_L);// in ohm
V_CEQ= V_CC-I_CQ*(R_C+R_E);// in V
I_Csat= I_CQ+V_CEQ/Rac;// in A
I_Csat=I_Csat*10^3;// in mA
V_CEoff= V_CEQ+I_CQ*Rac;// in V
subplot(122)
plot([V_CEoff 0],[0,I_Csat])
xlabel("V_CE in volts")
ylabel("I_C in mA")
title("AC load line")
// Maximum peak output signal
POSmax= I_CQ*Rac;// in V
// Peak-to-peak value of output signal
PP_out_sig= 2*POSmax;// in V
disp(PP_out_sig,"Peak-to-peak value of output signal in volts is : ")
disp("DC and AC load line shown in figure.")
```

Scilab code Exa 4.2 Voltage gain

```
// Exa 4.2
clc;
clear;
close;
format('v',6)
// Given data
delV_BE = 0.02;// in V
delI_B = 10;// in   A
delI_B = delI_B * 10^-6;// in A
delI_C = 1;// in mA
delI_C = delI_C * 10^-3;// in A
R_C = 5;// in k ohm
R_C = R_C * 10^3;// in ohm
```

```
R_L = 10;// in k ohm
R_L = R_L * 10^3;// in ohm
Zin = delV_BE/delI_B;// in ohm
Zin= Zin*10^-3;// in k ohm
disp(Zin,"The input impedance in k ohm is");
Zin= Zin*10^3;// in ohm
Beta = delI_C/delI_B;// unit less
disp(Beta,"The current gain is");
Rac = (R_C*R_L)/(R_C+R_L);// in ohm
Rac= Rac*10^-3;// in k ohm
disp(Rac,"The AC load resistance in k ohm is");
Rac= Rac*10^3;// in ohm
Rin = 2;// in k ohm
Rin = Rin * 10^3;// in ohm
Av = Beta*(Rac/Rin);
disp(Av,"The voltage gain is");
Ai = 100;// unit less
Ap = Av*Ai;// unit less
disp(Ap,"The power gain is");
```

Scilab code Exa 4.3 Base current

```
// Exa 4.3
clc;
clear;
close;
format('v',8)
// Given data
Alpha = 0.988;// unit less
I_E = 1.2;// in mA
I_E = I_E * 10^-3;// in A
I_CO = 0;// in A
I_C = Alpha*I_E + I_CO;// in A
I_B = I_E - I_C;// in A
I_B = I_B * 10^6;// in  A
```

```
disp(I_B,"The base current in  A is");
```

Scilab code Exa 4.4 Alpha Bita and IE

```
// Exa 4.4
clc;
clear;
close;
format('v',7)
// Given data
I_B = 45;// in  A
I_B = I_B * 10^-6;// in A
I_C = 5.45;// in mA
I_C = I_C * 10^-3;// in A
I_E = I_B+I_C;// in A
I_E= I_E*10^3;// in mA
disp(I_E,"The value of I_E in mA is");
I_E= I_E*10^-3;// in A
Alpha = I_C/I_E;// unit less
disp(Alpha,"The value of Alpha is");
format('v',5)
Beta = I_C/I_B;// unit less
disp(Beta,"The value of Beta is");
I_C = 10;// in mA
I_C = I_C * 10^-3;// in A
I_B = I_C/Beta;// in A
I_B = I_B * 10^6;// in  A
disp(I_B,"The required base current in  A is");
```

Scilab code Exa 4.5 Dynamic input resistance

```
// Exa 4.5
clc;
```

```
clear;
close;
format('v',8)
// Given data
delV_EB = 200;// in mV
delI_E = 5;// in mA
// Dynamic input resistance for CB configuration,
r_in = delV_EB/delI_E;// in ohm
disp(r_in,"The dynamic input resistance of
    transistor in ohm is");
```

Scilab code Exa 4.6 Base current

```
// Exa 4.6
clc;
clear;
close;
format('v',5)
// Given data
R_L = 4;// in k ohm
R_L = R_L * 10^3;// in ohm
V_across_RL = 3;// in V
I_C = V_across_RL/R_L;// in A
I_C = I_C * 10^3;// in mA
Alpha = 0.96;// unit less
I_E = I_C/Alpha;// in mA
I_B = I_E - I_C;// in mA
disp(I_B,"The base current in mA is");
```

Scilab code Exa 4.7 Base and collector current

```
// Exa 4.7
clc;
```

```
clear;
close;
format('v',8)
// Given data
I_E = 3;// in mA
I_CO = 10;// in  A
I_CO = I_CO * 10^-3;// in mA
Alpha = 0.98;// unit less
I_C = (Alpha*I_E) + I_CO;// in mA
disp(I_C,"The collector current in mA is");
I_B = I_E - I_C;// in mA
disp(I_B,"The base current in mA is");
```

Scilab code Exa 4.8 Current gain and base current

```
// Exa 4.8
clc;
clear;
close;
format('v',6)
// Given data
I_E = 2;// in mA
I_C = 1.97;// in mA
I_B = I_E-I_C;// in mA
disp(I_B,"The base current in mA is");
I_CO = 12.5;// in  A
I_CO = I_CO * 10^-3;// in mA
Alpha = (I_C-I_CO)/I_E;// unit less
disp(Alpha,"The current gain is");
```

Scilab code Exa 4.9 Dynamic input resistance

```
// Exa 4.9
```

```
clc;
clear;
close;
format('v',8)
// Given data
delV_BE = 250;// in mV
delV_BE = delV_BE * 10^-3;// in V
delI_B = 1;// in mA
delI_B = delI_B * 10^-3;// in A
r_in = delV_BE/delI_B;// in ohm
disp(r_in,"The dynamic input resistance in ohm is");
```

Scilab code Exa 4.10 Dynamic output resistance

```
// Exa 4.10
clc;
clear;
close;
format('v',8)
// Given data
V1 = 10;// in V
V2 = 5;// in V
I1 = 5.8;// in mA
I2 = 5;// in mA
delV_C = V1-V2;// in V
delI_C = I1-I2;// in mA
r_out = delV_C/delI_C;// in k ohm
disp(r_out,"The dynamic output resistance in k ohm
    is");
```

Scilab code Exa 4.11 Collector emitter voltage and base current

```
// Exa 4.11
```

```
clc;
clear;
close;
format('v',5)
// Given data
V_CC = 8;// in V
I_CR_C = 0.5;// in V
R_C = 800;// in ohm
V_CE = V_CC - I_CR_C;// in V
disp(V_CE,"The collector emitter voltage in V is");
I_C = I_CR_C/R_C;// in A
Alpha = 0.96;// unit less
Beta = Alpha/(1-Alpha);
I_B = I_C/Beta;// in A
I_B = I_B * 10^6;// in  A
disp(I_B,"The Base current in  A is");
```

Scilab code Exa 4.12 Bita dc and leakage current

```
// Exa 4.12
clc;
clear;
close;
format('v',5)
// Given data
I_E = 5;// in mA
I_C = 4.95;// in mA
I_CEO = 200;// in  A
I_B = I_E-I_C;// in mA
Beta_dc = I_C/I_B;// unit less
disp(Beta_dc,"The value of Beta_dc is");
Alpha_dc = Beta_dc/(1+Beta_dc);// unit less
I_CBO = I_CEO * (1-Alpha_dc);// in  A
disp(I_CBO,"The collector-to-base leakage cuurent in  A is");
```

Scilab code Exa 4.13 IC IE ICEO and alpha

```
// Exa 4.13
clc;
clear;
close;
format('v',6)
// Given data
I_B = 25;// in A
I_B = I_B * 10^-6;// in A
I_CBO = 100;// in nA
I_CBO = I_CBO * 10^-9;// in A
Beta = 100;// unit less
I_C = (Beta*I_B) + ((Beta+1)*I_CBO);// in A
I_C= I_C*10^3;// in mA
disp(I_C,"The value of I_C in mA is");
I_C= I_C*10^-3;// in A
I_E = I_C + I_B;// in A
I_E= I_E*10^3;// in mA
disp(I_E,"The value of I_E in mA is");
I_E= I_E*10^-3;// in A
Alpha = Beta/(1+Beta);// unit less
disp(Alpha,"The value of Alpha is");
I_CEO = I_CBO/(1-Alpha);// in A
I_CEO = round(I_CEO *10^6);// in A
disp(I_CEO,"The value of I_CEO in A is");
```

Scilab code Exa 4.14 h parameters

```
// Exa 4.14
clc;
```

```
clear;
close;
format('v',7)
// Given data
R1= 4;// in ohm
R2= 8;// in ohm
R3= 8;// in ohm
i1= 1;// in A (assumed)
h11= R1+R2*R3/(R2+R3);// in ohm
disp(h11,"The value of h11 in ohm is : ")
i2= -1/2*i1;// in A
h21= i2/i1;// unit less
disp(h21,"The value of h21 is : ")
v2= 1;// in V (assumed)
i2= v2/(R3+R2);// in A
v1= v2/2;// in V
h12= v1/v2;// unit less
disp(h12,"The value of h12 is : ")
h22= i2/v2;// in s
disp(h22,"The value of h22 in s is : ")
```

Scilab code Exa 4.15 Hybrid parameters

```
// Exa 4.15
clc;
clear;
close;
format('v',9)
// Given data
Ib = 20;// in  A
Ib = Ib * 10^-6;// in A
I_C = 1;// in mA
I_C = I_C * 10^-3;// in A
Vbe = 22;// in mV
Vbe = Vbe * 10^-3;// in V
```

```
Vce = 0;// in V
h_ie = Vbe/Ib;// in ohm
h_ie = h_ie * 10^-3;// in k ohm
disp(h_ie,"The value of h_ie in k ohm is");
h_fe = I_C/Ib;// unit less
disp(h_fe,"The value of h_fe is");
Ib = 0;
Vbe = 0.25;// in mV
Vbe = Vbe * 10^-3;// in V
I_C = 30;// in  A
I_C = I_C * 10^-6;// in A
Vce = 1;// in V
h_re = Vbe/Vce;// unit less
disp(h_re,"The value of h_re is");
h_oe = I_C/Vce;// in S
h_oe = h_oe * 10^6;// in  S
disp(h_oe,"The value of h_oe in  S is");
```

Scilab code Exa 4.16 Current gain and input impedance

```
// Exa 4.16
clc;
clear;
close;
format('v',6)
// Given data
h_fe = 50;// unit less
h_ie = 0.83;// in k ohm
h_ie = h_ie * 10^3;// in ohm
h_fb = -h_fe/(1+h_fe);// unit less
disp(h_fb,"The current gain is");
h_ib = h_ie/(1+h_fe);// in ohm
disp(h_ib,"The input impedance in ohm is");
```

Scilab code Exa 4.17 Hybrid parameters

```
// Exa 4.17
clc;
clear;
close;
format('v',7)
// Given data
h_ie = 2600;// in ohm
h_fe = 100;
h_re = 0.02*10^-2;
h_oe = 5*10^-6;// in S
h_ic = h_ie;// in ohm
disp(h_ic,"The value of h_ic in ohm is");
h_fc = -(1+h_fe);
disp(h_fc,"The value of h_fc is");
h_rc = 1 - h_re;
h_rc = 1;
disp(h_rc,"The value of h_rc is");
h_oc = h_oe;// in S
disp(h_oc,"The value of h_oc in S is");
```

Scilab code Exa 4.18 Input and output resistance

```
// Exa 4.18
clc;
clear;
close;
format('v',5)
// Given data
h_ie = 1000;// in ohm
h_fe = 50;// unit less
```

```
h_re = 2.5*10^-4;// unit less
h_oe = 25*10^-6;// in A/V
R_L = 10;// in k ohm
R_L = R_L * 10^3;// in ohm
Rs = 100;// in ohm
Ai = -h_fe/(1 + (h_oe*R_L));// unit less
disp(Ai,"The current gain is");
Rin = h_ie - ( (h_re*h_fe)/(h_oe+(1/R_L)) );// in ohm
disp(Rin,"The input resistance in ohm is");
Av = Ai*(R_L/Rin);// unit less
disp(Av,"The voltage gain is");
Ais = Ai * (Rs/(Rin+Rs));// unit less
Avs = Av*(Rin/(Rin+Rs));// unit less
Gout = h_oe - ( (h_fe*h_re)/(h_ie+Rs) );// in S
Rout = 1/Gout;// in ohm
Rout = Rout * 10^-3;// in k ohm
disp(Rout,"The output resistance in k ohm is");
Ap = Avs*Ais;// unit less
disp(Ap,"The power gain is");
```

Scilab code Exa 4.19 Ri Ro Av Ai and Ap

```
// Exa 4.19
clc;
clear;
close;
format('v',6)
// Given data
h_ie = 2;// in k ohm
h_ie = h_ie * 10^3;// in ohm
h_re = 2*10^-4;// unit less
h_fe = 50;// unit less
h_oe = 20*10^-6;// in A/V
R_L = 4;// in k ohm
```

```
R_L = R_L * 10^3;// in ohm
Rs = 200;// in ohm
Ai = -h_fe/( 1+(h_oe*R_L) );// unit less
disp(Ai,"The value of Ai is");
Ri = h_ie - ( (h_re*h_fe)/( h_oe+(1/R_L) ) );// in ohm
disp(Ri,"The value of Ri in ohm is");
//Av = -h_fe/( (h_oe + (1/R_L))*Rin ) = Ai*(R_L/Rin);
Av = Ai*(R_L/Ri);// unit less
disp(Av,"The value of Av is");
Gout = h_oe - ( (h_fe*h_re)/(h_ie+Rs) );// in S
Rout = 1/Gout;// in ohm
Rout = Rout * 10^-3;// in k ohm
disp(Rout,"The value of Rout in  k ohm is");
Ais = Ai * (Rs/(Ri+Rs) );// unit less
Avs = Av * (Ri/(Ri+Rs));// unit less
Ap = Av*Ai;// unit less
disp(Ap,"The value of Ap is");
```

Scilab code Exa 4.20 Current gain and overall current gain

```
// Exa 4.20
clc;
clear;
close;
format('v',6)
// Given data
R_S = 200;// in ohm
R_L = 1200;// in ohm
h_ib = 24;// in ohm
h_rb = 4*10^-4;// unit less
h_fb = -0.98;// unit less
h_ob = 0.6;// in  A /V
h_ob = h_ob * 10^-6;// in A/V
```

```
Ai = -h_fb/(1+(h_ob*R_L));// unit less
disp(Ai,"The current gain is");
Ri = h_ib + (h_rb*Ai*R_L);// in ohm
disp(Ri,"The input impedance in ohm is");
Av = round((Ai*R_L)/Ri);// unit less
disp(Av,"The Voltage gain is");
Ais = (Ai*R_S)/(Ri+R_S);// unit less
disp(Ais,"The overall current gain is");
```

Scilab code Exa 4.21 Voltage gain of amplifier circuit

```
// Exa 4.21
clc;
clear;
close;
format('v',5)
// Given data
g_m = 2500;// in   S
g_m = g_m * 10^-6;// in S
R_L = 12;// in k ohm
R_L = R_L * 10^3;// in ohm
//Av = -g_m*(r_d||R_D||R_L);
Av = -g_m*R_L;
disp(Av,"The voltage gain is");
```

Scilab code Exa 4.22 Voltage gain and output resistance

```
// Exa 4.22
clc;
clear;
close;
format('v',6)
// Given data
```

```
R_D = 5;// in k ohm
R_D = R_D * 10^3;// in ohm
r_d = 35;// in k ohm
r_d = r_d * 10^3;// in ohm
miu = 50;// amplifier factor
g_m = miu/r_d;// in S
Av = -g_m*( (r_d*R_D)/(r_d+R_D) );
disp(Av,"The voltage gain is");
Rout = (R_D*r_d)/(R_D+r_d);// in  ohm
Rout= Rout*10^-3;// in k ohm
disp(Rout,"The output resistance in k ohm is");
```

Scilab code Exa 4.23 RD and Rs

```
// Exa 4.23
clc;
clear;
close;
format('v',5)
// Given data
V_GS = -1.0;// in V
V_DS = 4.0;// in V
I_DS = 1;// in mA
I_DS = I_DS * 10^-3;// in A
I_G = 0;// in A
R_G = 500;// in k ohm
R_G = R_G * 10^3;// in ohm
V_DD = 10;// in V
V_DS = 4;// in V
V_G = I_G*R_G;// in V
Vs = V_G-V_GS;// in V
R_S = Vs/I_DS;// in ohm
R_S= R_S*10^-3;// in k ohm
disp(R_S,"The value of R_S in k ohm is");
R_S= R_S*10^3;// in ohm
```

```
// V_DD = I_DD*R_D + V_DS+ I_DS*R_S = I_DS*(R_D+R_S)
    + V_DS
R_D = ((V_DD-V_DS)/I_DS)-R_S;// in ohm
R_D = R_D * 10^-3;// in k ohm
disp(R_D,"The value of R_D in k ohm is");
```

Scilab code Exa 4.24 RD and Rs

```
// Exa 4.24
clc;
clear;
close;
format('v',5)
// Given data
V_GS = -1;// in V
V_DS = -4;// in V
I_DS = 1;// in mA
I_DS = I_DS * 10^-3;// in A
g_m = 5*10^-3;// in mhos
Rds = 20;// in k ohm
Rds = Rds * 10^3;// in ohm
R_S = 1;// in k ohm
R_S = R_S * 10^3;// in ohm
R_D = 5;// in  k ohm
R_D = R_D * 10^3;// in ohm
//Av = Vout/Vin  = -g_m*(r_d||R_D||R_L) = -g_m*((R_D
    *Rds)/(R_D+Rds));
Av = -g_m*((R_D*Rds)/(R_D+Rds));
disp(Av,"The voltage gain is");
R_G = 500;// in k ohm
R_G  = R_G * 10^3;// in ohm
Rin = R_G;// in ohm
Rin= Rin*10^-3;// in k ohm
disp(Rin,"The value of Rin in k ohm is");
Rin= Rin*10^3;// in ohm
```

```
Rout = (R_D*Rds)/(R_D+Rds);// in ohm
Rout= Rout*10^-3;// in k ohm
disp(Rout,"The value of Rout in  k ohm is");
```

Scilab code Exa 4.25 Input and output impedance voltage gain

```
// Exa 4.25
clc;
clear;
close;
format('v',5)
// Given data
R1 = 4;// in M ohm
R2 = 2;// in Mohm
R_G = (R1*R2)/(R1+R2);// in Mohm
Zin = R_G;// in Mohm
disp(Zin,"The input impedance in Mohm is");
R_S = 2.5;// in k ohm
R_S = R_S * 10^3;// in ohm
R_L = 25;// in k ohm
R_L =  R_L * 10^3;// in ohm
g_m = 2500;// in   S
g_m = g_m * 10^-6;// in S
Zout = (R_S*(1/g_m))/(R_S+(1/g_m));// in ohm
disp(Zout,"The output impedance in ohm is");
Av = g_m*((R_S*R_L)/(R_S+R_L))/( 1+g_m*((R_S*R_L)/(R_S+R_L)) );// unite less
disp(Av,"The voltage gain is");
```

Chapter 5

Amplifier Frequency Response

Scilab code Exa 5.1 fbita and bita

```
// Exa 5.1
clc;
clear;
close;
format('v',6)
// Given data
Alpha_o = 0.978;// unit less
f_Alpha = 2.5;// in MHz
f_Beta = (1-Alpha_o)*f_Alpha;// in MHz
disp(f_Beta,"The value of f_Beta in MHz is");
Beta = (0.707*Alpha_o)/(1-Alpha_o);// unit less
disp(Beta,"The value of Beta is");
```

Scilab code Exa 5.2 Cut off frequency

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

```
close;
format('v',6)
// Given data
C =0.15;// in   F
C = C * 10^-6;// in F
R = 7.5;// in k ohm
R = R * 10^3;// in ohm
f1 = 1/(2*%pi*R*C);// in Hz
disp(f1,"The cutoff frequency in Hz is");
```

Scilab code Exa 5.3 Voltage gain and lower cut off frequency

```
// Exa 5.3
clc;
clear;
close;
format('v',5)
// Given data
R_S = 1;// in k ohm
R1 = 20;// in k ohm
R2 = 10;// in  k ohm
R_C = 2;// in k ohm
R_E = 2;// in k ohm
R_L = 2;// in k ohm
V_BE = 0.7;// in V
V_T = 26*10^-3;// in V
Beta = 100;// unite less
V_CC = 15;// in V
Cin = 10;// in   F
C_E = 20;// in   F
Cout = 1;// in   F
V_B = R2/(R1+R2) *V_CC;// in V
//I_E = V_E/R_E = (V_B-V_BE)/(R_E*10^3);// in A
I_E = (V_B-V_BE)/(R_E*10^3);// in A
r_e = V_T/I_E;// in ohm
```

```
r_e= r_e*10^-3;// in k ohm
// Av = Vout/Vin = ( (-(R_C*R_L)/(R_C+R_L))/r_e );
Av = ( (-(R_C*R_L)/(R_C+R_L))/(r_e) );
Rin = (R1*R2*Beta*r_e)/((R1*R2)+(R2*Beta*r_e)+(Beta*
    r_e*R1));// in  k ohm
Zin = Rin;// in k ohm
// Vin = (Rin/(Rin+R_S))*V_S;
Vin_by_V_S = Rin/(Rin+R_S);
Avi = Av*Vin_by_V_S;// unite less
disp(Avi,"The voltage gain is");
f_Li = 1/( 2*%pi*(R_S+Rin)*10^3*Cin*10^-6 );// in Hz
disp(f_Li,"The lower cutoff frequency in Hz is");

// Note: The wrong value is putted of Rin to
    evaluating the value of f_Li , So there is some
    difference between coding and the answer of the
    book.
```

Scilab code Exa 5.4 Lower cut off frequency

```
// Exa 5.4
clc;
clear;
close;
format('v',6)
// Given data
Cin = 0.02*10^-6;// in F
Cout = 0.47*10^-6;// in F
Cs = 2.2*10^-6;// in F
Rsignal = 12*10^3;// in ohm
R_G = 2*10^6;// in ohm
R_D = 1.5*10^3;// in ohm
Rout = 1.5*10^3;// in ohm
Rs = 2*10^3;// in ohm
R_L = 2.7*10^3;// in ohm
```

```
I_DSS = 15*10^-3;// in A
V_P = -4;// in V
V_GSQ = -2;// in V
V_DD = 30;// in V
g_mo = (-2*I_DSS)/V_P;// in S
g_m = g_mo * (1-(V_GSQ/V_P));// in S
fLi = 1/( 2*%pi*(Rsignal+R_G)*Cin );// in Hz
fLo = 1/( 2*%pi*(Rout+R_L)*Cout );// in Hz
Req = (Rs*(1/g_m))/(Rs+(1/g_m));// in ohm
fLs = 1/(2*%pi*Req*Cs);// in Hz
disp(fLs,"The lower cutoff frequency in Hz is");
```

Scilab code Exa 5.5 Input capacitance

```
// Exa 5.5
clc;
clear;
close;
format('v',6)
// Given data
Ccb = 5;// in pF
Cbe = 12;// in pF
h_fe = 100;// unite less
h_ie = 1.5;// in k ohm
R_C = 12;// in k ohm
Av = (-h_fe/h_ie)*R_C;
Cin = Cbe + (1-Av)*Ccb;// in pF
disp(Cin,"The input capacitance in pF is");
```

Scilab code Exa 5.6 Miller capacitance

```
// Exa 5.6
clc;
```

```
clear;
close;
format('v',6)
// Given data
V_DD = 10;// in V
Cds = 0.5*10^-12;// in F
Cgs = 5*10^-12;// in F
Cgd = 4*10^-12;// in F
R_D = 2*10^3;// in ohm
I_DSS = 10*10^-3;// in A
V_P = -4;// in V
V_GSQ = -2;// in V
g_mo = (-2*I_DSS)/V_P;// in S
g_m = g_mo * (1-(V_GSQ/V_P));// in S
Av = -R_D*g_m;// circuit mid-frequency gain
// Miller capacitance
C_M = (1-Av)*Cgd;// in F
C_M= C_M*10^12;// in pF
disp(C_M,"The miller capacitance in pF is");
```

Scilab code Exa 5.7 Value of gm

```
// Exa 5.7
clc;
clear;
close;
format('v',6)
// Given data
I_C = 1;// in mA
V_T = 26;// in mV
g_m = I_C/V_T;// in S
disp(g_m*10^3,"The value of g_m in mS is");
h_fe = 224;// unit less
r_b_desh_e= h_fe/g_m;// in ohm
disp(r_b_desh_e*10^-3,"The value of r_b''e in k ohm
```

```
    is");
h_ie = 6;// in k ohm
h_ie = h_ie  *10^3;// in ohm
r_b_desh_b= h_ie - r_b_desh_e;// in ohm
disp(r_b_desh_b,"The value r_b''b in ohm is");
fT = 80;// in MHz
fT = fT * 10^6;// in Hz
C_b_desh_c = 12;// in pF
C_b_desh_c = C_b_desh_c* 10^-12;// in F
C_b_desh_e= (g_m/(2*%pi*fT)) - C_b_desh_c;// in F
C_b_desh_e=C_b_desh_e*10^12;// in pF
disp(C_b_desh_e,"The value of C_b''e in pF is");
```

Scilab code Exa 5.8 All hybrid parameters

```
// Exa 5.8
clc;
clear;
close;
format('v',6)
// Given data
I_C = 10;// in mA
I_C = I_C * 10^-3;// in A
V_CE = 10;// in V
h_ie = 500;// in ohm
h_oe = 4*10^-5;// in A/V
h_fe = 100;// unit less
h_re = 10^-4;// unit less
V_T = 26;// in mV
V_T = V_T * 10^-3;// in V
g_m = I_C/V_T;// in S
g_m= g_m*10^3;// in mS
disp(g_m,"The value of g_m in mS is");
g_m= g_m*10^-3;// in S
r_b_desh_e = h_fe/g_m;// in ohm
```

```
disp(r_b_desh_e,"The value of r_b''e in ohm is");
r_b_desh_b = h_ie - r_b_desh_e;// in ohm
disp(r_b_desh_b,"The value of r_b''b in ohm is");
r_b_desh_c = r_b_desh_e/h_re;// in ohm
r_b_desh_c= r_b_desh_c *10^-6;// in M ohm
disp(r_b_desh_c,"The value of r_b''c in Mohm is");
r_b_desh_c= r_b_desh_c *10^6;// in ohm
g_b_desh_c = 1/r_b_desh_c;// unit less
g_ce = h_oe - (1+h_fe)*g_b_desh_c;// in S
format('v',11)
disp(g_ce,"The value of g_ce in S is");
Cob = 3;// in pF
Cbdasc = Cob;// in pF
disp(Cbdasc,"The value of C_b''c in pF is : ")
format('v',6)
fT = 50;// in MHz
fT = fT * 10^6;// in Hz
Cbdase = (g_m/(2*%pi*fT))-Cbdasc * 10^-12;// in F
Cbdase= Cbdase *10^12;// in pF
disp(Cbdase,"The value of C_b''e in pF is");
```

Scilab code Exa 5.9 The midband gain and upper 3 dB frequency

```
// Exa 5.9
clc;
clear;
close;
format('v',6)
// Given data
V_CC = 12;// in V
V_EE = V_CC;// in V
I = 1;// in mA
I = I * 10^-3;// in A
R_B = 120;// in k ohm
R_B = R_B * 10^3;// in ohm
```

```
R_C = 10;// in  k ohm
R_C = R_C * 10^3;// in ohm
Rsig = 5;// in k ohm
Rsig = Rsig * 10^3;// in ohm
R_L = 5;// in k ohm
R_L = R_L * 10^3;// in  ohm
Beta = 125;// unit less
V_A = 200;// in V
Cmiu = 1;// in pF
Cmiu = Cmiu * 10^-12;// in F
fT = 1000;// in MHz
fT = fT * 10^6;// in Hz
r_x = 50;// in ohm
V_T = 25;// in mV
V_T = V_T * 10^-3;// in V
g_m = I/V_T;// in A/V
r_pie = Beta/g_m;// in ohm
r_o = V_A/I;// in ohm
Cpie = (g_m/(2*%pi*fT))-Cmiu;// in F
RdasL = (r_o*R_C*R_L)/( (r_o*R_C)+(R_C*R_L)+(R_L*r_o) );// in ohm
Gm = g_m*RdasL;// unit less
R = (R_B*Rsig)/(R_B+Rsig);// in ohm
A_VM = (-R_B/(R_B+Rsig)) * (r_pie/(r_pie+r_x+R)) * Gm;
disp(A_VM,"The mid band gain is");
Avm = 20*log(abs(A_VM));// in dB
Cin = Cpie+Cmiu*(1+Gm);// in F
Rdassig = (r_pie*(r_x+R))/(r_pie+(r_x+R));// in ohm
f2 = 1/( 2*%pi*Cin*Rdassig);// in Hz
f2 = f2 * 10^-3;// in kHz
disp(f2,"The upper 3-dB frequency in kHz is");
```

Scilab code Exa 5.10 The midband gain and upper 3 dB frequency

```
// Exa 5.10
clc;
clear;
close;
format('v',5)
// Given data
R_G = 3.9*10^6;// in ohm
R_L = 18*10^3;// in ohm
R_D = R_L;// in ohm
g_m = 2*10^-3;// in A/V
r_o = 250*10^3;// in ohm
Cgs = 1*10^-12;// in F
Cgd = 0.25*10^-12;// in F
Rsig = 50*10^3;// in ohm
A_VM =-R_G/(R_G+Rsig)*g_m*r_o*R_D*R_L/(r_o*R_D+R_D*
    R_L+R_L*r_o);
disp(A_VM,"The midband gain is");
RdasL = (r_o*R_D*R_L)/( (r_o*R_D) +(R_D*R_L)+(R_L*
    r_o) );// in ohm
Ceq = (1 + g_m*RdasL)*Cgd;// in F
Cin = Cgs+Ceq;// in F
f2 = 1/( 2*%pi*Cin*( (Rsig*R_G)/(Rsig+R_G) ) );// in
     Hz
f2 = f2 * 10^-3;// in kHz
disp(f2,"The upper 3dB frequency in kHz is");
```

Chapter 6

Feedback Amplifiers

Scilab code Exa 6.1 Voltage gain and power gain

```
// Exa 6.1
clc;
clear;
close;
format('v',8)
// Given data
Rs = 10;// in k ohm
Rs = Rs * 10^3;// in ohm
Rin = 10;// in ohm
Rout = 10;// in k ohm
Rout = Rout * 10^3;// in ohm
R_L = 10;// in ohm
Ai = 1000;// unit less
VinBY_Iin= Rin;// in ohm
VoutBY_Iin= Ai*Rout*R_L/(Rout+R_L);// in V
Av= VoutBY_Iin/VinBY_Iin;// unit less
disp(Av,"The voltage gain is : ")
Ai= (VoutBY_Iin/R_L)/((Rs+Rin)/Rs);// unit less
Ap= Av*Ai;// unit less
disp(Ap,"The power gain is : ")
```

Scilab code Exa 6.2 Voltage gain

```
// Exa 6.2
clc;
clear;
close;
format('v',7)
// Given data
Beta = 0.01;//feedback fraction
// Voltage gain with negative feedback
A = 3000;// unit less
Af = A/(1+(Beta*A));// unit less
disp(Af,"The voltage gain of the amplifier is");
```

Scilab code Exa 6.3 Gain of a negative feedback amplifier

```
// Exa 6.3
clc;
clear;
close;
format('v',6)
// Given data
A = 75;// internal gain
Beta = 1/15;//feedback fraction
Af = A/(1+(Beta*A));// voltage gain with negative
   feedback
disp(Af,"The voltage gain with negative feedback is"
   );
A_desh = 2*A;// unit less
A_desh_f = A_desh/(1+(Beta*A_desh));// unit less
disp(A_desh_f,"The new value of gain is");
```

Scilab code Exa 6.4 Voltage gain with feedback

```
// Exa 6.4
clc;
clear;
close;
format('v',6)
// Given data
A = 40;// open loop voltage gain
Beta = 10/100;// feedback ratio
Af = A/(1+(Beta*A));// voltage gain with feedback
disp(Af,"The voltage gain with feedback is");
Amount = 20*log10(abs( 1/(1+(Beta*A)) ));// Amount
   of feedback in dB
disp(Amount,"Amount of feedback in dB is");
Loopgain = A*Beta;// unit less
disp(Loopgain,"The Loop gain is");
```

Scilab code Exa 6.5 Gain in dB

```
// Exa 6.5
clc;
clear;
close;
format('v',6)
// Given data
A = 60;// in dB
A = 10^(A/20);// unit less
Beta = 1/20;// feedback fraction
Af = A/(1+(Beta*A));// gain with feedback
Af = 20*log10(Af);// in dB
disp(Af,"The gain with feed back in dB is");
```

Scilab code Exa 6.6 Gain with feedback

```
// Exa 6.6
clc;
clear;
close;
format('v',7)
// Given data
A = 2500;// open loop gain
// Desensitivity of transfer gain
trnsfr_gain_densitivity = 40;// in dB
trnsfr_gain_densitivity = 10^(trnsfr_gain_densitivity/20);
Af = A/trnsfr_gain_densitivity;// unit less
disp(Af,"The gain with feed back is");
I = A/Af;// assumed
disp("The input for same output will become "+string(I)+" times the input without feedback.")
```

Scilab code Exa 6.7 Feedback factor

```
// Exa 6.7
clc;
clear;
close;
format('v',7)
// Given data
A = 60;// in dB
A = 10^(A/20);// unit less
Af = 40;// in dB
Af = 10^(Af/20);// unit less
```

```
// Af = A/(1+(A*Beta));
BetaIntoA = (A/Af)-1;// feedback factor
disp(BetaIntoA,"The feed back factor is");
```

Scilab code Exa 6.8 Percentage of output

```
// Exa 6.8
clc;
clear;
close;
format('v',6)
// Given data
A = 600;// unit less
Af = 50;// unit less
// Af = A/(1+(A*Beta));
Beta = ((A/Af)-1)/A;// unit less
//P = Vf/Vout = Beta*100;
P = Beta*100;// percentage of output voltage in %
disp(P,"The percentage of output voltage in % is");
```

Scilab code Exa 6.9 Voltage gain without feedback

```
// Exa 6.9
clc;
clear;
close;
format('v',7)
// Given data
Vout = 12.5;// in V
Vin = 0.25;// in V
Av = Vout/Vin;// unit less
disp(Av,"The voltage gain without feed back is ");
Vin = 1.5;// in V
```

```
Avf = round(Vout/Vin);// unit less
// Avf = Av/(1+(Beta*Av));
Beta = ((Av/Avf)-1)/Av;// unit less
Beta = Beta*100;// in %
disp(Beta,"The value of    in % is");
```

Scilab code Exa 6.10 Amount of feedback in dB

```
// Exa 6.10
clc;
clear;
close;
format('v',7)
// Given data
Af = -100;// unit less
Vin = 0.06;// in V
Vout = Af*Vin;// in V
Vin = 50;// in mV
Vin = Vin * 10^-3;// in V
A = Vout/Vin;// unit less
//Af = A/(1+(A*Beta));
Beta = (abs(A)-abs(Af))/(Af*A);// unit less
disp(Beta,"The value of    is");
Amount = 20*log10(abs( 1/(1+(-Af*Beta)) ));// in dB
disp(Amount,"The Amount of feed back in dB is");
```

Scilab code Exa 6.11 Change in overall gain

```
// Exa 6.11
clc;
clear;
close;
format('v',4)
```

```
// Given data
A = 1000;// unit less
Beta = 0.002;// unit less
Af = A/(1+(A*Beta));// unit less
// When open-loop gain is reduced by
A_desh = (1-15/100)*A;// unit less
A_desh_f = A_desh/(1+(A_desh*Beta));// unit less
P = ((Af-A_desh_f)/Af)*100;// percentage change in
    overall gain in %
disp(P,"The change in overall gain in % is");
```

Scilab code Exa 6.12 Feedback ration and factor

```
// Exa 6.12
clc;
clear;
close;
format('v',6)
// Given data
R_C = 2.5;// in k ohm
R_C = R_C * 10^3;// in ohm
R_E = 1;// in k ohm
R_E = R_E * 10^3;// in ohm
h_ie = 1.1;// in k ohm
h_ie = h_ie * 10^3;// in ohm
h_fe = 200;// unit less
Beta = 200;// unit less
A = round((-h_fe/h_ie)*R_C);// unit less
disp(A,"The voltage gain without feed back is");
Af = -R_C/R_E;// unit less
disp(Af,"The voltage gain with feed back is");
// Af = A/(1+(A*Beta));
Beta = (abs(A)-abs(Af))/(A*Af);// unit less
disp(Beta,"The feed back ratio is");
feedbackfactor = round(abs(A)*Beta);// unit less
```

```
disp(feedbackfactor,"The feed back factor is");
```

Scilab code Exa 6.13 Av and bita

```
// Exa 6.13
clc;
clear;
close;
format('v',7)
// Given data
dAvByAv = 20/100;// variation in open loop gain
dAvf_by_Avf = 1/100;// variation in closed loop gain
BetaAv = (dAvByAv/dAvf_by_Avf)-1;// feedback factor
Avf = 100;//unit less
Av = Avf*(1+BetaAv);// open loop voltage gain
disp(Av,"The value of Av is");
Beta = ((Av/Avf)-1)/Av;// unit less
disp(Beta,"The value of    is");
```

Scilab code Exa 6.14 Percentage change in closed loop gain

```
// Exa 6.14
clc;
clear;
close;
format('v',6)
// Given data
Av =10000;// open loop gain
Beta = 1/10;// feedback ratio
Avf = Av/(1+(Av*Beta));// closed loop gain
dAvByAv = 50/100;// change in open loop gain
dAvByAvf = 1/(1+(Beta*Av))*dAvByAv*100;// change in closed loop gain in %
```

```
disp(dAvByAvf,"The percentage change in closed loop
    gain in % is");
```

Scilab code Exa 6.15 Percentage change in closed loop gain

```
// Exa 6.15
clc;
clear;
close;
format('v',5)
// Given data
BetaAvPlus1 = 10;// in dB
BetaAvPlus1 = 10^(BetaAvPlus1/20);// unit less
BetaAv = BetaAvPlus1 - 1;// unit less
dAvByAv = 0.05;// unit less
//Beta*Av = (dAvByAv/dAvfByAvf)-1;
dAvfByAvf = dAvByAv/( BetaAv+1 );// unit less
dAvfByAvf = dAvfByAvf * 100;// in %
disp(dAvfByAvf,"The percentage change in the closed
    loop gain in % is");
```

Scilab code Exa 6.16 Open and closed loop gain

```
// Exa 6.16
clc;
clear;
close;
format('v',7)
// Given data
D = 10/100;// distortion without feedback
Df = 1/100;// distortion with feedback
Beta = 10/100;// feedback ratio
// Df = D/(1+(Beta*A));
```

```
A = ((D/Df)-1)/Beta;// open loop gain
disp(A,"The open loop gain is");
Af = A/(1+(Beta*A));// closed loop gain
disp(Af,"The closed loop gain is");
```

Scilab code Exa 6.17 Distortion of the amplifier

```
// Exa 6.17
clc;
clear;
close;
format('v',7)
// Given data
A = 150;// open loop voltage gain
Beta = 10/100;// feedback ratio
D = 5/100;// distortion without feedback
Df = D/(1+(Beta*A));// distortion with feedback
Df = Df * 100;// in %
disp(Df,"The distortion of the amplifier with feed
   back in % is");
```

Scilab code Exa 6.18 Gain and output voltage with feedback

```
// Exa 6.18
clc;
clear;
close;
format('v',7)
// Given data
D = 10/100;// distortion without feedback
Df = 1/100;// distortion with feedback
A = 200;// unit less
// Df = D/(1+(Beta*A));
```

```
Beta = ((D/Df)-1)/A;// unit less
Af = A/(1+(Beta*A));// unit less
disp(Af,"The gain voltage with feed back is");
Vs = 10;// in mV
Vs = Vs * 10^-3;// in V
Vout = Af*Vs;// in V
disp(Vout,"The output voltage with feed back in V is
   ");
```

Scilab code Exa 6.19 Required input signal

```
// Exa 6.19
clc;
clear;
close;
format('v',5)
// Given data
A = 1000;// open loop gain
D = 10/100;// distortion without feedback
Vs = 10;// in mV
Vs = Vs * 10^-3;// in V
BetaA = 40;// in dB
BetaA= 10^(BetaA/20);// unit less
Vdesh_s = Vs*(1+BetaA);// in V
disp(Vdesh_s,"The required input signal in V is");
Df = (D/(1+BetaA))*100;// in %
disp(Df,"The percentage second harmonic distortion
   in % is");
Af = A/(1+BetaA);// unit less
disp(Af,"The closed loop voltage gain is");
```

Scilab code Exa 6.20 Voltage gain and input output resistance

```
// Exa 6.20
clc;
clear;
close;
format('v',5)
// Given data
A = 300;// voltage gain
Rin = 1.5;// in k ohm
Rout = 50;// in k ohm
Beta = 1/15;// unit less
Af = A/(1+(Beta*A));// unit less
disp(Af,"The voltage gain is");
Rinf = (1+(Beta*A))*Rin;// in k ohm
disp(Rinf,"The input resistance in k ohm is");
Routf = Rout/(1+(Beta*A));// in k ohm
disp(Routf,"The output resistance in k ohm is");
```

Scilab code Exa 6.21 Feedback factor and percentage change in overall gain

```
// Exa 6.21
clc;
clear;
close;
format('v',6)
// Given data
dA_ByA = 0.1;// change in gain of internal amplifier
A = 60;// in dB
A = A * 16.666;// unit less
Zo = 12;// in k ohm
Zo = Zo * 10^3;// in ohm
Zoutf = 600;// in ohm
Beta = ((Zo/Zoutf)-1)/A;// unit less
disp(Beta,"The value of feed back factor is");
dAf_byAf = 1/(1+(A*Beta))*(dA_ByA)*100;// change in
```

```
    overall gain in %
disp(dAf_byAf,"The percentage change in overall gain
    in % is");
```

Scilab code Exa 6.22 Amplifier voltage gain

```
// Exa 6.22
clc;
clear;
close;
format('v',6)
// Given data
D = 5/100;// distortion without feedback
A = 1000;// open loop voltage gain
Beta = 0.01;// feedback ratio
Af = A/(1+(Beta*A));// unit less
disp(Af,"The Amplifier voltage gain is");
f1 = 50;// in Hz
fdas1 = f1/(1+(Beta*A));// in Hz
disp(fdas1,"The lower cutoff frequency with feedback
    in Hz is");
f2 = 200;// in kHz
f2 = f2 * 10^3;// in Hz
fdas2 = f2*(1+(Beta*A));// in Hz
fdas2 = fdas2 * 10^-6;// in MHz
disp(fdas2,"The upper cutoff frequency with feedback
    in MHz is");
Df = (D/(1+(Beta*A)))*100;// in %
disp(Df,"The distortion with feed back in % is");
```

Scilab code Exa 6.23 Feedback factor and bandwidth

```
// Exa 6.23
```

```
clc;
clear;
close;
format('v',7)
// Given data
Avm = 1500;// midband gain
Avmf = 150;// midband gain with feedback
// Avmf = Avm/(1+(Beta*Avm));
BetaAvm = (Avm/Avmf)-1;// feedback factor
disp(BetaAvm,"The value of feed back factor is");
bandwidth = 4;// in MHz
BWf = (1+BetaAvm)*bandwidth;// in MHz
disp(BWf,"The band width with feedback in MHz is");
```

Scilab code Exa 6.24 New bandwidth and gain

```
// Exa 6.24
clc;
clear;
close;
format('v',6)
// Given data
A = 100;//mid frequency gain
BW = 200;// in kHz
Beta = 5/100;// feedback ratio
BWf = (1+(Beta*A))*BW;// in kHz
BWf = BWf * 10^-3;// in MHz
disp(BWf,"The bandwidth with feedback in MHz is");
Af = A/(1+(Beta*A));// unit less
disp(Af,"The gain with feedback is");
BWf = 1000;// in kHz
Beta = ((BWf/BW)-1)/A*100;//feedback ratio in %
disp(Beta,"The amount of feedback in % is");
```

Scilab code Exa 6.25 Input impedance

```
// Exa 6.25
clc;
clear;
close;
format('v',5)
// Given data
V_CC = 20;// in V
R1 = 10;// in k ohm
R1 = R1 * 10^3;// in ohm
R2 = 10;// in k ohm
R2 = R2 * 10^3;// in ohm
R_E = 9.3;// in k ohm
R_E = R_E * 10^3;// in ohm
R_L = 18.6;// in k ohm
R_L = R_L * 10^3;// in ohm
V2 = (V_CC/(R1+R2))*R2;// in V
V_BE = 0.7;// in V
Ve = V2-V_BE;// in V
Ie = Ve/R_E;// in A
V_T = 25*10^-3;// in V
rdase = V_T/Ie;// in ohm
RdasE = (R_E*R_L)/(R_E+R_L);// in ohm
Beta = 100;// unit less
Zinbase = Beta*(rdase+RdasE);// in ohm
Zin =R1*R2*Zinbase/(R1*R2+R2*Zinbase+Zinbase*R1);//
   in ohm
Zin= Zin*10^-3;// in k ohm
disp(Zin,"The input impedance in k ohm is");
```

Chapter 7

Oscillators

Scilab code Exa 7.1 Frequency of oscillaiton

```
// Exa 7.1
clc;
clear;
close;
format('v',5)
// Given data
L = 29.3;// in  H
L = L * 10^-6;// in H
C = 450;// in pF
C = C * 10^-12;// in F
f_o = 1/( 2*%pi*(sqrt( L*C )) );// in Hz
f_o = f_o * 10^-6;// in MHz
disp(f_o,"The frequency of oscillation in MHz is");
```

Scilab code Exa 7.2 Range of required capacitor

```
// Exa 7.2
clc;
```

```
clear;
close;
format('v',6)
// Given data
f_o = 100;// in kHz
f_o = f_o * 10^3;// in Hz
L = 100;//in  H
L = L * 10^-6;// in H
//Formula  f_o = 1/( 2*%pi*(sqrt(L*C)) );
C1 = 1/(4*(%pi^2)*(f_o^2)*L);// in F
C1 = C1 * 10^12;// in pF
f_o = 1500;// in kHz
f_o = f_o * 10^3;// in Hz
C2 = 1/(4*(%pi^2)*(f_o^2)*L);// in F
C2 = C2 * 10^12;// in pF
disp("The range of variable capacitor is "+string(C2
   )+" pF to "+string(C1)+" pF")
```

Scilab code Exa 7.3 Transformer winding turn ratio

```
// Exa 7.3
clc;
clear;
close;
format('v',7)
// Given data
V_CC = 12;// in V
Pout = 88;// in mW
Plosses = 8;// in mW
Pin = Pout+Plosses;// in mW
Pin = Pin * 10^-3;// in W
I_C = Pin/V_CC;// in A
Gm = 10;// in mA/V
Gm = Gm * 10^-3;// in A/V
V_B = I_C/Gm;// in V
```

```
ratio = V_CC/V_B;// Transformer winding turn ratio
disp(ratio,"The Transformer winding turn ratio is");
```

Scilab code Exa 7.4 Operating frequency

```
// Exa 7.4
clc;
clear;
close;
format('v',5)
// Given data
L = 100;// in  H
L = L * 10^-6;// in H
C1 = 0.001;// in  F
C1 = C1 * 10^-6;// in F
C2 = 0.01;// in  F
C2 = C2 * 10^-6;// in F
f = (1/(2*%pi))*(sqrt( (1/(L*C1))+(1/(L*C2)) ));// in Hz
f = f * 10^-3;// in kHz
disp(f,"The opertaing frequency in kHz is");
Beta = C1/C2;// feedback fraction
disp(Beta,"The feed back fraction is");
Amin = 1/Beta;// minimum gain to sustain oscillations
disp(Amin,"The minimum gain to sustain oscillations is");
// A = R_C/R_E ;
R_C = 2.5;// in k ohm
R_C = R_C * 10^3;// in ohm
R_E = R_C/Amin;// in ohm
disp(R_E,"The emitter resistance in ohm is");
```

Scilab code Exa 7.5 Range of inductance

```
// Exa 7.5
clc;
clear;
close;
format('v',6)
// Given data
f_o = 950;// in kHz
f_o = f_o  *10^3;// in Hz
C1 = 100;// in pF
C1 = C1 * 10^-12;// in F
C2 = 7500;// in pF
C2 = C2 * 10^-12;// in F
//Formula  f_o = (1/(2*Pi))*(sqrt( (1/(L*C1))+(1/(L*C2)) ));
L1 = (1/(4*(%pi^2)*(f_o^2)))*( (1/C1) + (1/C2) );// in H
L1 = L1 * 10^3;// in mH
f_o = 2050;// in kHz
f_o = f_o * 10^3;// in Hz
L2 = (1/(4*(%pi^2)*(f_o^2)))*( (1/C1) + (1/C2) );// in H
L2 = L2 * 10^3;// in mH
disp("The range of inductance values is : "+string(L2)+" mH to "+string(L1)+" mH");
```

Scilab code Exa 7.6 Frequency of oscillaiton

```
// Exa 7.6
clc;
clear;
close;
format('v',5)
// Given data
```

```
L1 = 30;// in mH
L1 = L1 * 10^-3;// in H
L2 = 1*10^-8;// in H
M = 0;// in H
L = L1+L2+(2*M);// in H
C = 100;// in pF
C = C * 10^-12;// in F
f_o = 1/(2*%pi*(sqrt( L*C )));// in Hz
f_o = f_o * 10^-3;// in kHz
disp(f_o,"The frequency of oscillation in kHz is");
```

Scilab code Exa 7.7 Frequency of oscillations

```
// Exa 7.7
clc;
clear;
close;
format('v',5)
// Given data
L1 = 1;// in mH
L1 = L1 * 10^-3;// in H
L2 = 100;// in  H
L2 = L2 * 10^-6;// in H
M = 50;// in  H
M = M * 10^-6;// in H
C = 100;// in pF
C = C * 10^-12;// in F
L = L1+L2+(2*M);// in H
f_o = 1/(2*%pi*(sqrt( L*C )));// in Hz
f_o = f_o * 10^-3;// in kHz
disp(f_o,"The oscillation frequency in kHz is");
```

Scilab code Exa 7.8 Resonance frequencies

```
// Exa 7.8
clc;
clear;
close;
format('v',5)
// Given data
Rs = 5;// in k ohm
Rs =Rs * 10^3;// in ohm
Ls = 0.8;// in H
Cs = 0.08;// in pF
Cs = Cs * 10^-12;// in pF
C_P = 1;// in pF
C_P = C_P * 10^-12;// in F
f_s = 1/(2*%pi*(sqrt( Ls*Cs )));// in Hz
f_s = f_s * 10^-3;// in kHz
disp(f_s,"The series resonant frequency in kHz is");
f_p = (1/(2*%pi)) * (sqrt( (1+(Cs/C_P))/(Ls*Cs) ));
    // in Hz
f_p = f_p * 10^-3;// in kHz
disp(f_p,"The parallel resonant frequency in kHz is"
    );
```

Scilab code Exa 7.9 Value of inductance

```
// Exa 7.9
clc;
clear;
close;
format('v',7)
// Given data
f_s = 1;// in MHz
f_s = f_s * 10^6;// in Hz
Cs = 0.1;// in pF
Cs = Cs * 10^-12;// in pF
// f_s = 1/(2*%pi*(sqrt( Ls*Cs )));
```

```
Ls = 1/(4*(%pi^2)*Cs*(f_s^2));// in H
disp(Ls,"The value of inductance in H is");
```

Scilab code Exa 7.10 Percentage by parallel resosnant frequency greater than series

```
// Exa 7.10
clc;
clear;
close;
format('v',6)
// Given data
C = 0.04;// in pF
Cdesh = 2;// in pF
Per1 = (1/2)*(C/Cdesh)*100;// in %
Per2 = (sqrt(1+C/Cdesh)-1)*100;// in %
disp("Parallel resonant frequency is greater than
    series resonant frequency by "+string(Per2)+" %")
    ;
```

Scilab code Exa 7.11 Frequency of oscillations

```
// Exa 7.11
clc;
clear;
close;
format('v',5)
// Given data
R1 = 800;// in k ohm
R1 = R1 * 10^3;// in ohm
R2 = R1;// in ohm
R3 = R1;// in ohm
R = R1;// in ohm
```

```
C1 = 100;// in pF
C1 = C1 * 10^-12;// in F
C2 = C1;// in F
C3 = C1;// in F
C = C1;// in F
f_o = 1/(2*%pi*R*C*sqrt(6));// in Hz
disp(f_o,"The frequency of oscillation in Hz is");
```

Scilab code Exa 7.12 Value of resistances

```
// Exa 7.12
clc;
clear;
close;
format('v',6)
// Given data
C1 = 0.016;// in  F
C1 = C1 * 10^-6;// in F
C2 = C1;// in F
C3 = C1;// in F
C = C1;// in F
//f_o = 1/(2*%pi*R*C*sqrt(10));
f_o = 1;// in kHz
f_o = f_o * 10^3;// in Hz
R = 1/(2*%pi*f_o*C*sqrt(10));// in  ohm
disp(R,"The value of resiatnce in ohm is");
disp("Standard value : 3.3 kohm")
```

Scilab code Exa 7.13 RC elements of a Wien bridge oscillator

```
// Exa 7.13
clc;
clear;
```

```
close;
format('v',5)
// Given data
f_o = 10;// in kHz
f_o = f_o * 10^3;// in Hz
R = 200;// in k ohm
R = R * 10^3;// in ohm
C = 1/(2*%pi*f_o*R);// in F
C=C*10^12;// in pF
disp(C,"The value of C in pF is");
R4 = R;// in ohm
R4= R4*10^-3;// in k ohm
disp(R4,"The value of R4 in k ohm is");
R3 = R4*2;// in k ohm
disp(R3,"The value of R3 in k ohm is");
```

Scilab code Exa 7.14 RC elements of a Wien bridge oscillator

```
// Exa 7.14
clc;
clear;
close;
format('v',4)
// Given data
f = 15;// in kHz
f = f * 10^3;// in Hz
R = 200;// in k ohm
R = R * 10^3;// in ohm
C = 1/(2*%pi*f*R);// in F
C= C*10^12;// in pF
disp(C,"The value of C in pF is");
R4 = R;// in ohm
R4= R4*10^-3;// in k ohm
disp(R4,"The value of R4 in k ohm is");
R3 = R4*2;// in k ohm
```

```
disp(R3,"The value of R3 in k ohm is");
```

Scilab code Exa 7.15 Frequency of oscillations

```
// Exa 7.15
clc;
clear;
close;
format('v',5)
// Given data
R1 = 20;// in k ohm
R1 = R1 * 10^3;// in ohm
R2 = R1;// in ohm
R = R1;// in ohm
C1 = 1000;// in pF
C1 = C1 * 10^-12;// in F
C2 = C1;// in F
C = C1;// in F
f = 1/(2*%pi*R*C);// in Hz
f= f*10^-3;// in kHz
disp(f,"The frequency of oscillations in kHz is");
```

Scilab code Exa 7.16 Pulse repetition frequency

```
// Exa 7.16
clc;
clear;
close;
format('v',5)
// Given data
R_E = 60;// in k ohm
R_E = R_E * 10^3;// in ohm
C = 0.25;// in   F
```

```
C = C * 10^-6;// in F
Eta = 0.65;
f = 1/(2.3*R_E*C*log10(1/(1-Eta)));// in Hz
disp(f,"The pulse repetition frequency in Hz is");
```

Chapter 8

Multistage Amplifiers

Scilab code Exa 8.1 Overall voltage gain in dB

```
// Exa 8.1
clc;
clear;
close;
format('v',8)
// Given data
Av1 = 60;// voltage gain of first stage
Av2 = 100;// voltage gain of second stage
Av3 = 160;// voltage gain of third stage
Av= Av1*Av2*Av3;// overall voltage gain
Av_indB= 20*log10(Av);// overall voltage gain in dB
disp(Av_indB,"The overall voltage gain of the
    amplifier in dB is : ")
```

Scilab code Exa 8.2 Voltage gain of the first stage in dB

```
// Exa 8.2
clc;
```

```
clear;
close;
format('v',6)
// Given data
Av = 80;// overall voltage gain in dB
Av2 = 20*log10(150);// voltage gain of second stage
    in dB
Av1= Av-Av2;//voltage gain of first stage in dB
disp(Av1,"The voltage gain of first stage in dB is")
    ;
```

Scilab code Exa 8.3 Overall voltage gain

```
// Exa 8.3
clc;
clear;
close;
format('v',5)
// Given data
Av1 = -60;// voltage gain of first stage
R_C = 500;// in ohm
Rin = 1;// in k ohm
Rin = Rin * 10^3;// in ohm
h_fe = 50;// unit less
Av2 = -h_fe*(R_C/Rin);// voltage gain of second
    stage
Av = Av1*Av2;// overall voltage gain stage
disp(Av,"The overall voltage gain is");
```

Scilab code Exa 8.4 Input and output impedance and overall voltage gain

```
// Exa 8.4
clc;
```

```
clear;
close;
format('v',6)
// Given data
R11 = 4;// in k ohm
R21 = 20;// in k ohm
h_ie = 1.1;// in k ohm
R_C1=4;// in k ohm
R22= 10;// in k ohm
R12= 2;// in k ohm
Zb = h_ie;// in k ohm
Zin = (R11*R21*Zb)/( (R11*R21)+(R21*Zb)+(Zb*R11) );// in k ohm
disp(Zin,"The input impedance in k ohm is");
h_oe = 0;// unit less
Q2 = %inf;// output impedance of transistor
R_C2 = 2;// in k ohm
// Zout= 1/h_oe || R_C2 = R_C2
Zout = R_C2;// in k ohm
disp(Zout,"The output impedance in k ohm is");
h_fe = 50;// unit less
R_L = 10;// in k ohm
Av2= -h_fe/h_ie*(R_C2*R_L/(R_C2+R_L));// voltage gain of second stage
Rac1= 1/(1/R_C1+1/R22+1/R12+1/h_ie);// in k ohm
Av1= -h_fe/h_ie*Rac1;// voltage gain of first stage
Av= Av1*Av2;// overall voltage gain
disp(Av,"The overall voltage gain is : ")
```

Scilab code Exa 8.5 Input and output impedance voltage gain

```
// Exa 8.5
clc;
clear;
close;
```

```
format('v',6)
// Given data
R1 = 10;// in k ohm
R2 = 5;// in k ohm
Zb = 1;// in k ohm
Zin = (R1*R2*Zb)/( (R1*R2)+(R2*Zb)+(Zb*R1) );// in k
    ohm
disp(Zin,"The input impedance in k ohm is");
R_C1 = 2;// in k ohm
R_E1 = 2;// in k ohm
R_C2 = 2;// in k ohm
R_E2 = 2;// in k ohm
h_oe = 0;// unit less
Q2 = %inf;// output impedance of transistor
//Zout= 1/h_oe || R_C2
Zout = R_C2;// in k ohm
disp(Zout,"The output impedance in k ohm is");
h_fe = 100;// unit less
h_ie = 1;// in k ohm
R_ac=0.222;// in k ohm
Av2= -h_fe/h_ie*R_C2;// voltage gain of second stage
Rac1= 1/(1/R_C1+1/R1+1/R2+1/h_ie);// in k ohm
Av1= -h_fe/h_ie*R_ac;// voltage gain of first stage
Av= Av1*Av2;// overall voltage gain
disp(Av,"The overall voltage gain is : ")
```

Scilab code Exa 8.7 Transformer turn ratio

```
// Exa 8.7
clc;
clear;
close;
format('v',5)
// Given data
Z_L = 16;// in ohm
```

```
Z_desh_L = 10;// in k ohm
Z_desh_L = Z_desh_L* 10^3;// in ohm
// a = N1/N2 = sqrt( ZdasL/Z_L );
a = sqrt( Z_desh_L/Z_L );// ratio of primary to secondary turns of step-down transformer
disp(a,"The transformer turm ratio is");
```

Scilab code Exa 8.8 Transformer turn ratio

```
// Exa 8.8
clc;
clear;
close;
format('v',5)
// Given data
Z_L = 10;// in ohm
Z_desh_L = 1;// in k ohm
Z_desh_L = Z_desh_L * 10^3;// in ohm
Zs = Z_desh_L;// in ohm
// a = N1/N2 = sqrt(Z_desh_L/Z_L);
a = sqrt(Z_desh_L/Z_L);//turn ratio of the transformer
disp(a,"The turn ratio of the transformer is");
```

Scilab code Exa 8.9 Transformer turn ratio and load voltage

```
// Exa 8.9
clc;
clear;
close;
format('v',5)
// Given data
Z_L = 25;// in ohm
```

```
Z_S = 10;// in k ohm
Z_S = Z_S * 10^3;// in k ohm
// Z_S = (a^2)*Z_L;
a = sqrt(Z_S/Z_L);//turn ratio of the transformer
disp(a,"The transformer turn ratio is");
//V2 = V1/a = Vs/a;
Vs = 8;// in V
V2 = Vs/a;// in V
V_L =V2;// in V
disp(V_L,"The load voltage in V is");
```

Scilab code Exa 8.10 Av2 and Av1 and Av in dB

```
// Exa 8.10
clc;
clear;
close;
format('v',5)
// Given data
V_CC = 12;// in V
r_e = 25;// in mV
r_e = r_e * 10^-3;// in V
R1 = 1.2;// in Mohm
R1 = R1 * 10^6;// in ohm
R3 = 1.2;// in Mohm
R3 = R3 * 10^6;// in ohm
R4 = 8;// in k ohm
R4 = R4 * 10^3;// in ohm
R5 = 24;// in k ohm
R5 = R5 * 10^3;// in ohm
Beta1 = 100;// unit less
Beta2 = 100;// unit less
I_B2 = V_CC/R3;// in A
I_C2 = Beta2*I_B2;// in A
I_E2 = I_C2;// in A
```

```
r_e2 = r_e/I_E2;// in ohm
Rac2 = (R4*R5)/(R4+R5);// in ohm
Av2 = -(Rac2/r_e2);//voltage gain of second stage
disp(Av2,"The voltage gain of second stage is");
Rac1 = (R3*(Beta2*r_e2))/(R3+(Beta2*r_e2));// in
    ohm
L = 1;// in H
f = 4;// in kHz
f = f * 10^3;// in Hz
X_L = 2*%pi*f*L;// in ohm
r_e1 = r_e2;// in ohm
Av1 = round(-Rac1/r_e1 );// voltage gain of first
    stage
disp(Av1,"The voltage gain of first stage at 4 kHz
    is");
Av = Av1*Av2;// overall voltage gain
Av = 20*log10(Av);// in dB
disp(Av,"The overall voltage gain in dB is");
```

Scilab code Exa 8.11 Voltage gain and input resistance

```
// Exa 8.11
clc;
clear;
close;
format('v',6)
// Given data
V_CC = 25;// in V
R1 = 180;// in k ohm
R1 = R1*10^3;// in ohm
R2 = 20;// in k ohm
R2 = R2 * 10^3;// in ohm
R_C2 = 20;// in k ohm
R_C2 = R_C2 * 10^3;// in ohm
R_C1 = R_C2;// in ohm
```

```
R_E1 = 1.8;// in k ohm
R_E1 = R_E1 * 10^3;// in ohm
R_E2 = 4.3;// in k ohm
R_E2 = R_E2 * 10^3;// in ohm
R_L = 30;// in k ohm
R_L = R_L * 10^3;// in ohm
V_BE = 0.7;// in V
Beta2 = 50;// unit less
Beta1 = 50;// unit less
V_Th1 = (V_CC/(R1+R2))*R2;// in V
R_Th1 = (R1*R2)/(R1+R2);// in  ohm
I_B = (V_Th1-V_BE)/( R_Th1+((Beta1+1)*R_E1) );// in A
I_E1 = (Beta1+1)*I_B;// in A
V_T = 25;// in mV
V_T = V_T * 10^-3;// in V
r_e1 = V_T/I_E1;// in ohm
I_C1 = I_E1;// in A
V_C1 = V_CC-(I_C1*R_C1);// in V
//V_E2 = V_B2-V_BE = V_C1-V_BE;// in V
V_E2 = V_C1-V_BE;// in V
I_E2 = V_E2/R_E2;// in A
r_e2 = V_T/I_E2;// in ohm
Rac2 = (R_C1*R_L)/(R_C1+R_L);// in  ohm
Av2 = -Rac2/(r_e2+R_E2);// voltage gain of second stage
Rac1 = (R_C1*(Beta1*(r_e2+R_E2)))/(R_C1+(Beta1*(r_e2+R_E2)));// in ohm
Av1 = -Rac1/(r_e1+R_E1);// voltage gain of first stage
Av = Av1*Av2;// voltage gain
disp(Av,"The voltage gain is");
r_in = R1*R2*Beta1*(r_e1+R_E1)/( (R1*R2)+(R2*(Beta1*(r_e1+R_E1)))+((Beta1*(r_e1+R_E1))*R1) );// in ohm
r_in= r_in*10^-3;// in k ohm
disp(r_in,"The input resistance in k ohm is");
```

Scilab code Exa 8.12 Voltage gain and input output impedance and output voltage

```
// Exa 8.12
clc;
clear;
close;
format('v',6)
// Given data
I_DSS = 15;// in mA
I_DSS  = I_DSS * 10^-3;// in A
V_P = -4;// in V
g_mo = (-2*I_DSS)/V_P;// in S
V_GSQ = -2;// in V
g_m = g_mo*( 1-(V_GSQ/V_P) );// in S
R_D = 2.7;// in k ohm
R_D = R_D * 10^3;// in ohm
Av1 = -g_m*R_D;// voltage gain of first stage
Av2 = Av1;// voltage gain of second stage
Av = Av1*Av2;// overall voltage gain
disp(Av,"The overall voltage gain is");
R_G = 2;// in Mohm
Rin = R_G;// in Mohm
disp(Rin,"The input impedance in Mohm is");
Rout = R_D;// in ohm
Rout= Rout*10^-3;// in k ohm
disp(Rout,"The output impedance in k ohm is");
Rout= Rout*10^3;// in ohm
Vin = 15;// in mV
Vin = Vin  * 10^-3;// in V
Vout = Av*Vin;// in V
disp(Vout,"The output voltage in V is");
R_L = 15;// in k ohm
R_L = R_L * 10^3;// in ohm
```

```
V_L = (R_L/(Rout+R_L))*Vout;// in V
disp(V_L,"The output voltage across load resistance
   in V is");
```

Scilab code Exa 8.13 Upper and lower 3dB frequency

```
// Exa 8.13
clc;
clear;
close;
format('v',7)
// Given data
f2 = 100;// in kHz
f_H = f2/(sqrt(2^(1/3)-1 ));// in kHz
disp(f_H,"The upper 3-dB frequency of each stage in
   kHz is");
f1 = 25;// in kHz
f_L = f1/(sqrt(2^(1/3)-1 ));// in kHz
disp(f_L,"The lower 3-dB frequency of each stage in
   kHz is");

// Note: The value of upper 3-dB frequency in the
   book is not accurate and the calculated value of
   f_L is wrong. because 25 will be divided by 0.51
   not multiplied.
```

Scilab code Exa 8.14 Z matrix for idential T1 and T2

```
// Exa 8.14
clc;
clear;
close;
format('v',5)
```

```
// Given data
R_E= 1;// in k ohm
h_ie= R_E;// in k ohm
h_fe= 100;// unit less
//V1= I1*[h_ie+(1+h_fe)*h_ie+(1+h_fe)^2*R_E]+I2*R_E        (i)
//V2= I1*(1+h_fe)^2*R_E + I2*R_E        (ii)
Z= [(h_ie+(1+h_fe)*h_ie+(1+h_fe)^2*R_E) R_E;(1+h_fe)^2*R_E R_E]
Z11= Z(1);// k ohm
Z21= Z(2);// k ohm
Z12= Z(3);// k ohm
Z22= Z(4);// k ohm
disp(Z11*10^-3,"The value of Z11 in M ohm is : ")
disp(Z12,"The value of Z12 in M ohm is : ")
disp(Z21*10^-3,"The value of Z21 in M ohm is : ")
disp(Z22,"The value of Z22 in M ohm is : ")
```

Chapter 9

Tuned Amplifiers

Scilab code Exa 9.1 Resonant frequency and Q factor and bandwidth

```
// Exa 9.1
clc;
clear;
close;
format('v',5)
// Given data
R = 10;// in ohm
L = 20;// in mH
L = L * 10^-3;// in H
C = 0.05;// in  F
C = C * 10^-6;// in F
f_r = (1/(2*%pi))*sqrt( (1/(L*C)) - ((R^2)/(L^2)) );// in Hz
f_r = round(f_r * 10^-3);// in kHz
disp(f_r,"The resonant frequency in kHz is");
Q = (2*%pi*f_r*10^3*L)/R;//Q factor of the tank circuit
disp(Q,"The Q factor of the tank circuit is");
BW = (f_r*10^3)/Q;// in Hz
disp(BW,"The band width of the amplifier in Hz is");
```

Chapter 10

Multivibrators

Scilab code Exa 10.1 Time period and frequency

```
// Exa 10.1
clc;
clear;
close;
format('v',5)
// Given data
R2 = 5;// in k ohm
R2 = R2 * 10^3;// in  ohm
R1 = R2;// in ohm
R_B = R2;// in ohm
R4 = 0.4;// in k ohm
R4 = R4 * 10^3;// in ohm
R3 = R4;// in ohm
R_C = R4;// in ohm
C2 = 0.02;// in  F
C2 = C2 * 10^-6;//  in F
C1 = C2;// in F
C = C2;// in F
T = 1.386*R_B*C;// in sec
T= T*10^3;// in ms
disp(T,"The time period in ms is");
```

```
f = 1/T;// in kHz
disp(f,"The frequency of circuit oscillation in kHz
   is");
Beta_min = R_B/R_C;//minimum value of transistor
disp(Beta_min,"The minimum value of transistor    is
   ");
```

Scilab code Exa 10.2 Astable multivibrator

```
// Exa 10.2
clc;
clear;
close;
format('v',6)
// Given data
V_CC = 20;// in V
V_BB = 20;// in V
R_C2 = 1;// in k ohm
R_C2 = R_C2 * 10^3;// in ohm
R_C1 = R_C2;// in  ohm
f = 500;// in Hz
h_fe = 50;// unit less
PW = 0.2;// in ms
PW = PW*10^-3;// in sec
V_CEsat = 0.3;// in V
V_BEsat = 0.7;// in V
I_CEsat= (V_CC-V_CEsat)/R_C1;// in A
I_Bmin= I_CEsat/h_fe;// in A
I_B= 1.5*I_Bmin;// in A
R= (V_BB-V_BEsat)/I_B;// in ohm
R= floor(R*10^-3);// in k ohm
R1=R;// in k ohm
R2= R1;// in k ohm
T= 1/f;// in sec
D_cycle= PW/T;
```

```
T2= D_cycle*T;//sec
T1= T-T2;// in sec
C1= T1/(0.693*R2);// in mF
C1= C1*10^3;// in  F
C2= T2/(0.693*R1);// in mF
C2= C2*10^3;// in  F
disp(R1,"The value of R1 in k ohm is : ")
disp(R2,"The value of R2 in k ohm is : ")
disp(C1,"The value of C1 in  F is : ")
disp(C2,"The value of C2 in  F is : ")
```

Scilab code Exa 10.3 Check up the saturation of the transistor

```
// Exa 10.3
clc;
clear;
close;
format('v',7)
// Given data
V_CC = 12;// in V
R_B = 20;// in k ohm
R_B = R_B * 10^3;// in ohm
R_C = 2;// in k ohm
R_C = R_C * 10^3;// in ohm'
C = 0.1;// in  F
C = C * 10^-6;// in F
V_CEsat = 0.2;// in V
V_BEsat = 0.8;// in V
Beta = 50;// unit less
T =R_B*C*log( (2*V_CC-V_BEsat)/(V_CC-V_BEsat) );// in S
disp(T*10^3,"The input pulse in ms is");
I_Csat = (V_CC-V_CEsat)/R_C;// in A
I_Csat = I_Csat * 10^3;// in mA
// Beta = h_fe;
```

```
I_Bmin = I_Csat/Beta;// in mA
I_B = (V_CC-V_BEsat)/R_B;// in A
I_B = I_B * 10^3;// in mA
if I_B>I_Bmin then
    disp("The value of I_B ("+string(I_B)+" mA) is
       greater than the value of  I_Bmin ("+string(
       I_Bmin)+" mA).");
    disp("Hence the transistor in saturaion ")
end
```

Scilab code Exa 10.4 Component value of monostable mutivibrator

```
// Exa 10.4
clc;
clear;
close;
format('v',6)
// Given data
T= 500*10^-6;// in sec
h_femin = 25;// unit less
I_CEsat = 5;// in mA
I_CEsat = I_CEsat * 10^-3;// in A
V_CC = 10;// in V
V_BB = 4;// in V
V_CEsat = 0.4;// in V
V_BEsat = 0.8;// in V
V_BEoff = -1;// in V
R_C2 = (V_CC-V_CEsat)/I_CEsat;// in ohm
R_C1= R_C2;// in ohm
disp(R_C1*10^-3,"The value of R_C1 in k ohm is");
disp(R_C2*10^-3,"The value of R_C2 in k ohm is");
I_B2min = I_CEsat/h_femin;// in A
I_B2actual = 1.5*I_B2min;// in A
R = (V_CC-V_BEsat)/(I_B2actual);// in ohm
disp(R*10^-3,"The value of R in k ohm is");
```

```
C= T/(0.693*R);// in F
disp(C*10^6,"The value of C in  F is : ")
R1= poly(0,'R1');
R2= 2.143*R1;// in ohm
// I_B1actual= (V_CC-V_BE1sat)/(R_C+R1) - (V_BE1sat+V_BB)/R2 and R2= 2.143*R1 so
R1= I_B2actual*R2*(R1+R_C1)-V_CC*R2+V_BEsat*R2+R1*V_BEsat+R1*V_BB+R_C1*V_BEsat+R_C1*V_BB;
R1= roots(R1);// in ohm
R1= R1(1);// in ohm
R1= R1*10^-3;// in kohm
R2= 2.143*R1;// in k ohm
disp(R1,"The value of R1 in k  is : ")
disp(R2,"The value of R2 in k  is : ")
R1= R1*10^3;// in ohm
R1C1= 1*10^-6;// in F
C1= R1C1/R1;// in F
C1= C1*10^12;// in pF
disp(C1,"The value of C1 in pF is : ")
```

Scilab code Exa 10.5 Stable current and voltages

```
// Exa 10.5
clc;
clear;
close;
format('v',5)
// Given data
V_CC = 10;// in V
V_BB = -10;// in V
R_C2 = 1.2* 10^3;// in ohm
R_C1 = R_C2;// in ohm
R_B1 = 39 * 10^3;// in ohm
R_B2 = R_B1;// in ohm
R2 = 10* 10^3;// in ohm
```

```
R1 = R2;// in ohm
h_fe = 30;// unit less
V_CE2sat = 0;// in V
I1 = (V_CC-V_CE2sat)/R_C2;// in A
I2 = (V_CE2sat-V_BB)/(R1+R_B2);// in A
I_C2 = I1-I2;// in A
I_B2min = I_C2/h_fe;// in A
V_C2 = 0;// in V
V_B1 = V_C2 - (I2*R1);// in V
V_B2 = 0;// in V
V_C1 = 10;// in V
I3 = (V_CC-V_C1)/R_C1;// in A
V_BE2sat = 0;// in V
I4 = (V_C1-V_BE2sat)/R2;// in A
I_D = I3-I4;// in A
I5 = (V_BE2sat-V_BB)/R_B1;// in A
I_B2actual = I4-I5;// in A
I_B2actual= I_B2actual*10^3;// in mA
I_C1 = 0;// in mA
I_B1 = 0;// in mA
I_C2= I_C2*10^3;// in mA
disp(V_C1,"The value of V_C1 in V is");
disp(V_C2,"The value of V_C2 in V is");
disp(V_B1,"The value of V_B1 in V is");
disp(V_B2,"The value of V_B2 in V is");
disp(I_C1,"The value of I_C1 in mA is");
disp(I_C2,"The value of I_C2 in mA is");
disp(I_B1,"The value of I_B1 in mA is");
disp(I_B2actual,"The value of I_B2 in mA is");
```