

Scilab Textbook Companion for  
Fundamentals of Electronic Devices and  
Circuits  
by J. B. Gupta<sup>1</sup>

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# Book Description

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

**Exa** Example (Solved example)

**Eqn** Equation (Particular equation of the above book)

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

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

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# Chapter 1

## Crystal Structure Of Materials

Scilab code Exa 1.1 Fraction of the total number of electrons

```
1 // Exa 1.1
2 clc;
3 clear;
4 close;
5 format('v',9);
6 // Given data
7 E_G = 0.72; // in eV
8 E_F = (1/2)*E_G; // in eV
9 k = 8.61*10^-5; // in eV/K
10 T = 300; // in K
11 // The fraction of the total number of electrons
12 n_C_by_n = 1/( 1 + (%e^((E_G-E_F)/(k*T))) );
13 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

```
1 // Exa 1.2
```

```

2  clc;
3  clear;
4  close;
5  format('v',7)
6  // Given data
7  n_i = 1.4*10^18; // in /m^3
8  N_D = 1.4*10^24; // in /m^3
9  n = N_D; // in /m^3
10 p = (n_i^2)/n; // in /m^3
11 // Ratio of electron to hole concentration,
12 ratio = n/p;
13 disp(ratio,"Ratio of electron to hole concentration
      is");

```

---

### Scilab code Exa 1.3 Resistivity of conductor

```

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

```

---

### Scilab code Exa 1.4 Relaxation time of conducting electrons

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

---

### Scilab code Exa 1.5 Charge density of free electrons

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

```

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

```

---

#### Scilab code Exa 1.6 Dopant density

```

1 // Exa 1.6
2 clc;
3 clear;
4 close;
5 format('v',9)
6 // Given data
7 l = 1; // in cm
8 l = l * 10^-2; // in m
9 A = 1; // in mm^2
10 A = A * 10^-6; // in m^2
11 R = 100; // in ohm
12 rho = (R*A)/l; // in ohm-m
13 sigma = 1/rho;
14 e = 1.6*10^-19; // in C
15 miu_e = 1350; // in cm^2/V-s
16 miu_e = miu_e * 10^-4; // in m^2/V-s
17 n = sigma/(e*miu_e); // in /m^3
18 disp(n,"The dopant density in /m^3");
19
20 // 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

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

---

**Scilab code Exa 1.8** Drift velocity

```
1 // Exa 1.8
2 clc;
```

```

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

```

---

### Scilab code Exa 1.9 Electron and hole densities

```

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

```

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

---

### Scilab code Exa 1.10 Density of free electrons

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

---

### Scilab code Exa 1.11 Mobility of electrons and holes

```
1 // Exa 1.11
2 clc;
3 clear;
4 close;
5 format('v',10)
```

```

6 // Given data
7 rho = 3000; // in ohm-m
8 n = 1.1*10^6; // in /m^3
9 e = 1.6*10^-19; // in C
10 //miu_e = 3*miu_h (i)
11 // miu_e+miu_h = 1/(rho*e*n) (ii)
12 // From eq (i) and (ii)
13 miu_h = (1/(rho*e*n))/4; // in m^2/V-s
14 disp(miu_h,"The holes mobility in m^2/V-s is");
15 miu_e = 3*miu_h; // in m^2/V-s
16 disp(miu_e,"The electron mobility in m^2/V-s is");
17
18 // Note: The calculated value of hole mobility is
    wrong .

```

---

### Scilab code Exa 1.12 Conductivity of intrinsic Ge

```

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

```



```

18 sigma_n = e*N_D*miu_e; // in (ohm-cm)^-1
19 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

```

1 // Exa 1.13
2 clc;
3 clear;
4 close;
5 format('v',9)
6 // Given data
7 e = 1.6*10^-19; // in C
8 miu_e = 0.38; // in m^2/V-s
9 miu_h = 0.18; // in m^2/V-s
10 V = 10; // in V
11 l = 25; // in mm
12 l = l * 10^-3; // in m
13 w = 4; // in mm
14 w = w * 10^-3; // in m
15 t = 1.5*10^-3; // in m
16 E = V/l; // in V/m
17 v_e = miu_e*E; // in m/s
18 disp(v_e,"The electron drift velocity in m/s is");
19 v_h = miu_h*E; // in m/s
20 disp(v_h,"The hole drift velocity in m/s is");
21 n_i = 2.5*10^19; // in /m^2
22 sigma_i = n_i*e*(miu_e+miu_h); // in (ohm-cm)^-1
23 disp(sigma_i,"The interinsic conductivity of Ge in (
    ohm-cm)^-1 is");
24 A = w*t; // in m^2
25 I = sigma_i*E*A; // in A
26 I = I * 10^3; // in mA
27 disp(I,"The total current in mA is");

```

---

**Scilab code Exa 1.14** Ratio of electron to hole

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

---

**Scilab code Exa 1.15** Diffusion coefficients of electrons

```
1 // Exa 1.15
2 clc;
3 clear;
4 close;
5 format('v',6)
6 // Given data
7 miu_e = 0.17; // in m^2/V-s
8 miu_h = 0.025; // in m^2/V-s
9 e = 1.602*10^-19; // in C
10 T = 27; // in degree C
11 T = T + 273; // in K
12 kdass = 1.38*10^-23; // in J/K
13 De = miu_e*( (kdass*T)/e ); // in m^-2/s
14 De = De * 10^4; // in cm^2/s
```

```

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

```

---

### Scilab code Exa 1.16 Intrinsic carrier concentration in Si

```

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

```

---

### Scilab code Exa 1.17 Mobility of electrons

```

1 // Exa 1.17
2 clc;

```

```

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

```

---

#### Scilab code Exa 1.18 New position of Fermi Level

```

1 // Exa 1.18
2 clc;
3 clear;
4 close;
5 format('v',7)
6 // Given data
7 E_CminusE_F = 0.24; // in eV
8 T = 300; // in K
9 T1 = 350; // in K
10 // E_CminusE_F = K*T*log(n_c/N_D) (i)
11 // E_CminusE_F1 =K*T1*log(n_C/N_D) (ii)
12 // From eq(i) and (ii)
13 E_CminusE_F1 = E_CminusE_F*(T1/T); // in eV
14 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

```
1 // Exa 1.19
2 clc;
3 clear;
4 close;
5 format('v',5)
6 // Given data
7 E_FminusE_V = 0.39; // in eV
8 kT = 0.026; // in ev
9 //N_A1 = n_V * (%e^(-E_FminusE_V)/kT) (i)
10 // N_A2=3*N_A1=n_V * (%e^(-E_F2minusE_V)/kT) (ii)
11 //From eq(i) and (ii)
12 E_F2minusE_V = kT*(15-log(3)); // in eV
13 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

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

---

### Scilab code Exa 2.4 Interplaner distance in a crystal

```
1 // Exa 2.4
2 clc;
3 clear;
4 close;
5 format('v',5)
6 // Given data
7 lambda = 1.539; // in angstrum
8 theta = 22.5; // in degree
9 n = 1; // first order
10 // n*lambda = 2*d*sind(theta);
11 d = lambda/(2*sind(theta)); // in angstrum
12 disp(d,"The interplaner distance in angstrum is");
```

---

### Scilab code Exa 2.5 Wavelength of X ray

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

---

# Chapter 3

## Magnetic Materials

Scilab code Exa 3.1 Hysteresis loss per cubic meter per cycle

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

---



### Scilab code Exa 3.2 Hysteresis loss

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

---

### Scilab code Exa 3.3 Loss of energy

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

```

12 V = m/rho; // in m^3
13 H = round(Eta*(Bmax^1.6)*f*V); // Hystersis loss in J
    /s
14 H = H * 60 *60; // Hystersis loss in J/hour
15 disp(H,"The Hystersis loss per hour in J is");
16 h = Eta*(Bmax^1.6); // Hystersis loss/m^3/cycle
17 // h = x*y*area of B-H loop
18 x = 12.5; // in AT/m
19 y = 0.1; // in T
20 Area = h/(x*y); // in cm^2
21 format('v',5)
22 disp(Area,"The area of B-H loop in cm^2 is");

```

---

#### Scilab code Exa 3.4 Eddy current loss

```

1 // Exa 3.4
2 clc;
3 clear;
4 close;
5 format('v',7)
6 // Given data
7 Pe1 = 1600; // in W
8 Bmax1 = 1.2; // in T
9 f1 = 50; // in Hz
10 Bmax2 = 1.5; // in T
11 f2 = 60; // in Hz
12 Pe2 = Pe1*(Bmax2/Bmax1)^2*(f2/f1)^2; // in W
13 disp(Pe2,"The eddy current loss in W is");

```

---

# Chapter 4

## Transistor Amplifiers

Scilab code Exa 4.1 DC and AC load line

```
1 // Exa 4.1
2 clc;
3 clear;
4 close;
5 format('v',8)
6 // Given data
7 V_CC = 20; // in V
8 I_C= 2*10^-3; // in A
9 I_CQ= I_C; // in A
10 I_E=I_C; // in A
11 R_C = 3; // in k ohm
12 R_C = R_C * 10^3; // in ohm
13 R_L = 12; // in k ohm
14 R_L = R_L * 10^3; // in ohm
15 R_E = 2; // in k ohm
16 R_E = R_E * 10^3; // in ohm
17 V_CE=0:0.1:20; // in V
18 I_C_sat= (V_CC-V_CE)/(R_C+R_E)*10^3; // in mA
19 subplot(121)
20 plot(V_CE,I_C_sat);
21 xlabel("V_CE in volts")
```

```

22 ylabel("I_C in mA")
23 title("DC load line")
24 Rac= R_C*R_L/(R_C+R_L); // in ohm
25 V_CEQ= V_CC-I_CQ*(R_C+R_E); // in V
26 I_Csat= I_CQ+V_CEQ/Rac; // in A
27 I_Csat=I_Csat*10^3; // in mA
28 V_CEoff= V_CEQ+I_CQ*Rac; // in V
29 subplot(122)
30 plot([V_CEoff 0],[0,I_Csat])
31 xlabel("V_CE in volts")
32 ylabel("I_C in mA")
33 title("AC load line")
34 // Maximum peak output signal
35 POSmax= I_CQ*Rac; // in V
36 // Peak-to-peak value of output signal
37 PP_out_sig= 2*POSmax; // in V
38 disp(PP_out_sig,"Peak-to-peak value of output signal
    in volts is : ")
39 disp("DC and AC load line shown in figure.")

```

---

#### Scilab code Exa 4.2 Voltage gain

```

1 // Exa 4.2
2 clc;
3 clear;
4 close;
5 format('v',6)
6 // Given data
7 delV_BE = 0.02; // in V
8 delI_B = 10; // in A
9 delI_B = delI_B * 10^-6; // in A
10 delI_C = 1; // in mA
11 delI_C = delI_C * 10^-3; // in A
12 R_C = 5; // in k ohm
13 R_C = R_C * 10^3; // in ohm

```

```

14 R_L = 10; // in k ohm
15 R_L = R_L * 10^3; // in ohm
16 Zin = delV_BE/delI_B; // in ohm
17 Zin= Zin*10^-3; // in k ohm
18 disp(Zin,"The input impedance in k ohm is");
19 Zin= Zin*10^3; // in ohm
20 Beta = delI_C/delI_B; // unit less
21 disp(Beta,"The current gain is");
22 Rac = (R_C*R_L)/(R_C+R_L); // in ohm
23 Rac= Rac*10^-3; // in k ohm
24 disp(Rac,"The AC load resistance in k ohm is");
25 Rac= Rac*10^3; // in ohm
26 Rin = 2; // in k ohm
27 Rin = Rin * 10^3; // in ohm
28 Av = Beta*(Rac/Rin);
29 disp(Av,"The voltage gain is");
30 Ai = 100; // unit less
31 Ap = Av*Ai; // unit less
32 disp(Ap,"The power gain is");

```

---

### Scilab code Exa 4.3 Base current

```

1 // Exa 4.3
2 clc;
3 clear;
4 close;
5 format('v',8)
6 // Given data
7 Alpha = 0.988; // unit less
8 I_E = 1.2; // in mA
9 I_E = I_E * 10^-3; // in A
10 I_CO = 0; // in A
11 I_C = Alpha*I_E + I_CO; // in A
12 I_B = I_E - I_C; // in A
13 I_B = I_B * 10^6; // in A

```

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

---

#### Scilab code Exa 4.4 Alpha Beta and IE

```
1 // Exa 4.4
2 clc;
3 clear;
4 close;
5 format('v',7)
6 // Given data
7 I_B = 45; // in A
8 I_B = I_B * 10^-6; // in A
9 I_C = 5.45; // in mA
10 I_C = I_C * 10^-3; // in A
11 I_E = I_B+I_C; // in A
12 I_E= I_E*10^3; // in mA
13 disp(I_E,"The value of I_E in mA is");
14 I_E= I_E*10^-3; // in A
15 Alpha = I_C/I_E; // unit less
16 disp(Alpha,"The value of Alpha is");
17 format('v',5)
18 Beta = I_C/I_B; // unit less
19 disp(Beta,"The value of Beta is");
20 I_C = 10; // in mA
21 I_C = I_C * 10^-3; // in A
22 I_B = I_C/Beta; // in A
23 I_B = I_B * 10^6; // in A
24 disp(I_B,"The required base current in A is");
```

---

#### Scilab code Exa 4.5 Dynamic input resistance

```
1 // Exa 4.5
2 clc;
```

```

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

```

---

#### Scilab code Exa 4.6 Base current

```

1 // Exa 4.6
2 clc;
3 clear;
4 close;
5 format('v',5)
6 // Given data
7 R_L = 4; // in k ohm
8 R_L = R_L * 10^3; // in ohm
9 V_across_RL = 3; // in V
10 I_C = V_across_RL/R_L; // in A
11 I_C = I_C * 10^3; // in mA
12 Alpha = 0.96; // unit less
13 I_E = I_C/Alpha; // in mA
14 I_B = I_E - I_C; // in mA
15 disp(I_B,"The base current in mA is");

```

---

#### Scilab code Exa 4.7 Base and collector current

```

1 // Exa 4.7
2 clc;

```

```

3 clear;
4 close;
5 format('v',8)
6 // Given data
7 I_E = 3; // in mA
8 I_CO = 10; // in A
9 I_CO = I_CO * 10^-3; // in mA
10 Alpha = 0.98; // unit less
11 I_C = (Alpha*I_E) + I_CO; // in mA
12 disp(I_C,"The collector current in mA is");
13 I_B = I_E - I_C; // in mA
14 disp(I_B,"The base current in mA is");

```

---

#### Scilab code Exa 4.8 Current gain and base current

```

1 // Exa 4.8
2 clc;
3 clear;
4 close;
5 format('v',6)
6 // Given data
7 I_E = 2; // in mA
8 I_C = 1.97; // in mA
9 I_B = I_E - I_C; // in mA
10 disp(I_B,"The base current in mA is");
11 I_CO = 12.5; // in A
12 I_CO = I_CO * 10^-3; // in mA
13 Alpha = (I_C - I_CO) / I_E; // unit less
14 disp(Alpha,"The current gain is");

```

---

#### Scilab code Exa 4.9 Dynamic input resistance

```

1 // Exa 4.9

```



```

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

```

---

Scilab code Exa 4.10 Dynamic output resistance

```

1  // Exa 4.10
2  clc;
3  clear;
4  close;
5  format('v',8)
6  // Given data
7  V1 = 10; // in V
8  V2 = 5; // in V
9  I1 = 5.8; // in mA
10 I2 = 5; // in mA
11 delV_C = V1-V2; // in V
12 delI_C = I1-I2; // in mA
13 r_out = delV_C/delI_C; // in k ohm
14 disp(r_out,"The dynamic output resistance in k ohm
    is");

```

---

Scilab code Exa 4.11 Collector emitter voltage and base current

```

1  // Exa 4.11

```

```

2  clc;
3  clear;
4  close;
5  format('v',5)
6  // Given data
7  V_CC = 8; // in V
8  I_CR_C = 0.5; // in V
9  R_C = 800; // in ohm
10 V_CE = V_CC - I_CR_C; // in V
11 disp(V_CE,"The collector emitter voltage in V is");
12 I_C = I_CR_C/R_C; // in A
13 Alpha = 0.96; // unit less
14 Beta = Alpha/(1-Alpha);
15 I_B = I_C/Beta; // in A
16 I_B = I_B * 10^6; // in A
17 disp(I_B,"The Base current in A is");

```

---

**Scilab code Exa 4.12** Beta dc and leakage current

```

1  // Exa 4.12
2  clc;
3  clear;
4  close;
5  format('v',5)
6  // Given data
7  I_E = 5; // in mA
8  I_C = 4.95; // in mA
9  I_CEO = 200; // in A
10 I_B = I_E - I_C; // in mA
11 Beta_dc = I_C/I_B; // unit less
12 disp(Beta_dc,"The value of Beta_dc is");
13 Alpha_dc = Beta_dc/(1+Beta_dc); // unit less
14 I_CBO = I_CEO * (1-Alpha_dc); // in A
15 disp(I_CBO,"The collector-to-base leakage current in
      A is");

```

---

**Scilab code Exa 4.13** IC IE ICEO and alpha

```
1 // Exa 4.13
2 clc;
3 clear;
4 close;
5 format('v',6)
6 // Given data
7 I_B = 25; // in A
8 I_B = I_B * 10^-6; // in A
9 I_CBO = 100; // in nA
10 I_CBO = I_CBO * 10^-9; // in A
11 Beta = 100; // unit less
12 I_C = (Beta*I_B) + ((Beta+1)*I_CBO); // in A
13 I_C= I_C*10^3; // in mA
14 disp(I_C,"The value of I_C in mA is");
15 I_C= I_C*10^-3; // in A
16 I_E = I_C + I_B; // in A
17 I_E= I_E*10^3; // in mA
18 disp(I_E,"The value of I_E in mA is");
19 I_E= I_E*10^-3; // in A
20 Alpha = Beta/(1+Beta); // unit less
21 disp(Alpha,"The value of Alpha is");
22 I_CEO = I_CBO/(1-Alpha); // in A
23 I_CEO = round(I_CEO *10^6); // in A
24 disp(I_CEO,"The value of I_CEO in A is");
```

---

**Scilab code Exa 4.14** h parameters

```
1 // Exa 4.14
2 clc;
```

```

3 clear;
4 close;
5 format('v',7)
6 // Given data
7 R1= 4; // in ohm
8 R2= 8; // in ohm
9 R3= 8; // in ohm
10 i1= 1; // in A (assumed)
11 h11= R1+R2*R3/(R2+R3); // in ohm
12 disp(h11,"The value of h11 in ohm is : ")
13 i2= -1/2*i1; // in A
14 h21= i2/i1; // unit less
15 disp(h21,"The value of h21 is : ")
16 v2= 1; // in V (assumed)
17 i2= v2/(R3+R2); // in A
18 v1= v2/2; // in V
19 h12= v1/v2; // unit less
20 disp(h12,"The value of h12 is : ")
21 h22= i2/v2; // in s
22 disp(h22,"The value of h22 in s is : ")

```

---

#### Scilab code Exa 4.15 Hybrid parameters

```

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

```

```

13 Vce = 0; // in V
14 h_ie = Vbe/Ib; // in ohm
15 h_ie = h_ie * 10^-3; // in k ohm
16 disp(h_ie,"The value of h_ie in k ohm is");
17 h_fe = I_C/Ib; // unit less
18 disp(h_fe,"The value of h_fe is");
19 Ib = 0;
20 Vbe = 0.25; // in mV
21 Vbe = Vbe * 10^-3; // in V
22 I_C = 30; // in A
23 I_C = I_C * 10^-6; // in A
24 Vce = 1; // in V
25 h_re = Vbe/Vce; // unit less
26 disp(h_re,"The value of h_re is");
27 h_oe = I_C/Vce; // in S
28 h_oe = h_oe * 10^6; // in S
29 disp(h_oe,"The value of h_oe in S is");

```

---

#### Scilab code Exa 4.16 Current gain and input impedance

```

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

```

---

#### Scilab code Exa 4.17 Hybrid parameters

```
1 // Exa 4.17
2 clc;
3 clear;
4 close;
5 format('v',7)
6 // Given data
7 h_ie = 2600; // in ohm
8 h_fe = 100;
9 h_re = 0.02*10^-2;
10 h_oe = 5*10^-6; // in S
11 h_ic = h_ie; // in ohm
12 disp(h_ic,"The value of h_ic in ohm is");
13 h_fc = -(1+h_fe);
14 disp(h_fc,"The value of h_fc is");
15 h_rc = 1 - h_re;
16 h_rc = 1;
17 disp(h_rc,"The value of h_rc is");
18 h_oc = h_oe; // in S
19 disp(h_oc,"The value of h_oc in S is");
```

---

#### Scilab code Exa 4.18 Input and output resistance

```
1 // Exa 4.18
2 clc;
3 clear;
4 close;
5 format('v',5)
6 // Given data
7 h_ie = 1000; // in ohm
8 h_fe = 50; // unit less
```

```

 9 h_re = 2.5*10^-4; // unit less
10 h_oe = 25*10^-6; // in A/V
11 R_L = 10; // in k ohm
12 R_L = R_L * 10^3; // in ohm
13 R_s = 100; // in ohm
14 A_i = -h_fe/(1 + (h_oe*R_L)); // unit less
15 disp(A_i,"The current gain is");
16 R_in = h_ie - ( (h_re*h_fe)/(h_oe+(1/R_L)) ); // in
    ohm
17 disp(R_in,"The input resistance in ohm is");
18 A_v = A_i*(R_L/R_in); // unit less
19 disp(A_v,"The voltage gain is");
20 A_is = A_i * (R_s/(R_in+R_s)); // unit less
21 A_vs = A_v*(R_in/(R_in+R_s)); // unit less
22 G_out = h_oe - ( (h_fe*h_re)/(h_ie+R_s) ); // in S
23 R_out = 1/G_out; // in ohm
24 R_out = R_out * 10^-3; // in k ohm
25 disp(R_out,"The output resistance in k ohm is");
26 A_p = A_vs*A_is; // unit less
27 disp(A_p,"The power gain is");

```

---

#### Scilab code Exa 4.19 Ri Ro Av Ai and Ap

```

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

```

```

13 R_L = R_L * 10^3; // in ohm
14 Rs = 200; // in ohm
15 Ai = -h_fe/( 1+(h_oe*R_L) ); // unit less
16 disp(Ai,"The value of Ai is");
17 Ri = h_ie - ( (h_re*h_fe)/( h_oe+(1/R_L) ) ); // in
    ohm
18 disp(Ri,"The value of Ri in ohm is");
19 //Av = -h_fe/( (h_oe + (1/R_L))*Rin ) = Ai*(R_L/Rin)
    ;
20 Av = Ai*(R_L/Ri); // unit less
21 disp(Av,"The value of Av is");
22 Gout = h_oe - ( (h_fe*h_re)/(h_ie+Rs) ); // in S
23 Rout = 1/Gout; // in ohm
24 Rout = Rout * 10^-3; // in k ohm
25 disp(Rout,"The value of Rout in k ohm is");
26 Ais = Ai * (Rs/(Ri+Rs) ); // unit less
27 Avs = Av * (Ri/(Ri+Rs)); // unit less
28 Ap = Av*Ai; // unit less
29 disp(Ap,"The value of Ap is");

```

---

#### Scilab code Exa 4.20 Current gain and overall current gain

```

1 // Exa 4.20
2 clc;
3 clear;
4 close;
5 format('v',6)
6 // Given data
7 R_S = 200; // in ohm
8 R_L = 1200; // in ohm
9 h_ib = 24; // in ohm
10 h_rb = 4*10^-4; // unit less
11 h_fb = -0.98; // unit less
12 h_ob = 0.6; // in A/V
13 h_ob = h_ob * 10^-6; // in A/V

```



```

14 Ai = -h_fb/(1+(h_ob*R_L)); // unit less
15 disp(Ai,"The current gain is");
16 Ri = h_ib + (h_rb*Ai*R_L); // in ohm
17 disp(Ri,"The input impedance in ohm is");
18 Av = round((Ai*R_L)/Ri); // unit less
19 disp(Av,"The Voltage gain is");
20 Ais = (Ai*R_S)/(Ri+R_S); // unit less
21 disp(Ais,"The overall current gain is");

```

---

#### Scilab code Exa 4.21 Voltage gain of amplifier circuit

```

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

```

---

#### Scilab code Exa 4.22 Voltage gain and output resistance

```

1 // Exa 4.22
2 clc;
3 clear;
4 close;
5 format('v',6)
6 // Given data

```

```

7 R_D = 5; // in k ohm
8 R_D = R_D * 10^3; // in ohm
9 r_d = 35; // in k ohm
10 r_d = r_d * 10^3; // in ohm
11 miu = 50; // amplifier factor
12 g_m = miu/r_d; // in S
13 Av = -g_m*( (r_d*R_D)/(r_d+R_D) );
14 disp(Av,"The voltage gain is");
15 Rout = (R_D*r_d)/(R_D+r_d); // in ohm
16 Rout= Rout*10^-3; // in k ohm
17 disp(Rout,"The output resistance in k ohm is");

```

---

#### Scilab code Exa 4.23 RD and Rs

```

1 // Exa 4.23
2 clc;
3 clear;
4 close;
5 format('v',5)
6 // Given data
7 V_GS = -1.0; // in V
8 V_DS = 4.0; // in V
9 I_DS = 1; // in mA
10 I_DS = I_DS * 10^-3; // in A
11 I_G = 0; // in A
12 R_G = 500; // in k ohm
13 R_G = R_G * 10^3; // in ohm
14 V_DD = 10; // in V
15 V_DS = 4; // in V
16 V_G = I_G*R_G; // in V
17 Vs = V_G-V_GS; // in V
18 R_S = Vs/I_DS; // in ohm
19 R_S= R_S*10^-3; // in k ohm
20 disp(R_S,"The value of R_S in k ohm is");
21 R_S= R_S*10^3; // in ohm

```

```

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

```

---

#### Scilab code Exa 4.24 RD and Rs

```

1 // Exa 4.24
2 clc;
3 clear;
4 close;
5 format('v',5)
6 // Given data
7 V_GS = -1; // in V
8 V_DS = -4; // in V
9 I_DS = 1; // in mA
10 I_DS = I_DS * 10^-3; // in A
11 g_m = 5*10^-3; // in mhos
12 Rds = 20; // in k ohm
13 Rds = Rds * 10^3; // in ohm
14 R_S = 1; // in k ohm
15 R_S = R_S * 10^3; // in ohm
16 R_D = 5; // in k ohm
17 R_D = R_D * 10^3; // in ohm
18 //Av = Vout/Vin = -g_m*(r_d || R_D || R_L) = -g_m*((R_D
    *Rds)/(R_D+Rds));
19 Av = -g_m*((R_D*Rds)/(R_D+Rds));
20 disp(Av,"The voltage gain is");
21 R_G = 500; // in k ohm
22 R_G = R_G * 10^3; // in ohm
23 Rin = R_G; // in ohm
24 Rin= Rin*10^-3; // in k ohm
25 disp(Rin,"The value of Rin in k ohm is");
26 Rin= Rin*10^3; // in ohm

```

```

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

```

---

#### Scilab code Exa 4.25 Input and output impedance voltage gain

```

1 // Exa 4.25
2 clc;
3 clear;
4 close;
5 format('v',5)
6 // Given data
7 R1 = 4; // in M ohm
8 R2 = 2; // in Mohm
9 R_G = (R1*R2)/(R1+R2); // in Mohm
10 Zin = R_G; // in Mohm
11 disp(Zin,"The input impedance in Mohm is");
12 R_S = 2.5; // in k ohm
13 R_S = R_S * 10^3; // in ohm
14 R_L = 25; // in k ohm
15 R_L = R_L * 10^3; // in ohm
16 g_m = 2500; // in S
17 g_m = g_m * 10^-6; // in S
18 Zout = (R_S*(1/g_m))/(R_S+(1/g_m)); // in ohm
19 disp(Zout,"The output impedance in ohm is");
20 Av = g_m*((R_S*R_L)/(R_S+R_L))/( 1+g_m*((R_S*R_L)/(
    R_S+R_L)) ); // unite less
21 disp(Av,"The voltage gain is");

```

---

# Chapter 5

## Amplifier Frequency Response

Scilab code Exa 5.1 fbita and bita

```
1 // Exa 5.1
2 clc;
3 clear;
4 close;
5 format('v',6)
6 // Given data
7 Alpha_o = 0.978; // unit less
8 f_Alpha = 2.5; // in MHz
9 f_Beta = (1-Alpha_o)*f_Alpha; // in MHz
10 disp(f_Beta,"The value of f_Beta in MHz is");
11 Beta = (0.707*Alpha_o)/(1-Alpha_o); // unit less
12 disp(Beta,"The value of Beta is");
```

---

Scilab code Exa 5.2 Cut off frequency

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

```

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

```

---

### Scilab code Exa 5.3 Voltage gain and lower cut off frequency

```

1 // Exa 5.3
2 clc;
3 clear;
4 close;
5 format('v',5)
6 // Given data
7 R_S = 1; // in k ohm
8 R1 = 20; // in k ohm
9 R2 = 10; // in k ohm
10 R_C = 2; // in k ohm
11 R_E = 2; // in k ohm
12 R_L = 2; // in k ohm
13 V_BE = 0.7; // in V
14 V_T = 26*10^-3; // in V
15 Beta = 100; // unite less
16 V_CC = 15; // in V
17 Cin = 10; // in F
18 C_E = 20; // in F
19 Cout = 1; // in F
20 V_B = R2/(R1+R2) *V_CC; // in V
21 //I_E = V_E/R_E = (V_B-V_BE)/(R_E*10^3); // in A
22 I_E = (V_B-V_BE)/(R_E*10^3); // in A
23 r_e = V_T/I_E; // in ohm

```

```

24 r_e= r_e*10^-3;// in k ohm
25 // Av = Vout/Vin = ( -(R_C*R_L)/(R_C+R_L))/r_e );
26 Av = ( -(R_C*R_L)/(R_C+R_L))/r_e );
27 Rin = (R1*R2*Beta*r_e)/((R1*R2)+(R2*Beta*r_e)+(Beta*
    r_e*R1));// in k ohm
28 Zin = Rin;// in k ohm
29 // Vin = (Rin/(Rin+R_S))*V_S;
30 Vin_by_V_S = Rin/(Rin+R_S);
31 Avi = Av*Vin_by_V_S;// unite less
32 disp(Avi,"The voltage gain is");
33 f_Li = 1/( 2*pi*(R_S+Rin)*10^3*Cin*10^-6 );// in Hz
34 disp(f_Li,"The lower cutoff frequency in Hz is");
35
36 // 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

```

1 // Exa 5.4
2 clc;
3 clear;
4 close;
5 format('v',6)
6 // Given data
7 Cin = 0.02*10^-6;// in F
8 Cout = 0.47*10^-6;// in F
9 Cs = 2.2*10^-6;// in F
10 Rsignal = 12*10^3;// in ohm
11 R_G = 2*10^6;// in ohm
12 R_D = 1.5*10^3;// in ohm
13 Rout = 1.5*10^3;// in ohm
14 Rs = 2*10^3;// in ohm
15 R_L = 2.7*10^3;// in ohm

```

```

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

```

---

#### Scilab code Exa 5.5 Input capacitance

```

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

```

---

#### Scilab code Exa 5.6 Miller capacitance

```

1 // Exa 5.6
2 clc;

```



```

3 clear;
4 close;
5 format('v',6)
6 // Given data
7 V_DD = 10; // in V
8 Cds = 0.5*10^-12; // in F
9 Cgs = 5*10^-12; // in F
10 Cgd = 4*10^-12; // in F
11 R_D = 2*10^3; // in ohm
12 I_DSS = 10*10^-3; // in A
13 V_P = -4; // in V
14 V_GSQ = -2; // in V
15 g_mo = (-2*I_DSS)/V_P; // in S
16 g_m = g_mo * (1-(V_GSQ/V_P)); // in S
17 Av = -R_D*g_m; // circuit mid-frequency gain
18 // Miller capacitance
19 C_M = (1-Av)*Cgd; // in F
20 C_M= C_M*10^12; // in pF
21 disp(C_M,"The miller capacitance in pF is");

```

---

### Scilab code Exa 5.7 Value of gm

```

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

```

```

    is");
14 h_ie = 6; // in k ohm
15 h_ie = h_ie * 10^3; // in ohm
16 r_b_desh_b = h_ie - r_b_desh_e; // in ohm
17 disp(r_b_desh_b, "The value r_b''b in ohm is");
18 fT = 80; // in MHz
19 fT = fT * 10^6; // in Hz
20 C_b_desh_c = 12; // in pF
21 C_b_desh_c = C_b_desh_c * 10^-12; // in F
22 C_b_desh_e = (g_m / (2 * %pi * fT)) - C_b_desh_c; // in F
23 C_b_desh_e = C_b_desh_e * 10^12; // in pF
24 disp(C_b_desh_e, "The value of C_b''e in pF is");

```

---

#### Scilab code Exa 5.8 All hybrid parameters

```

1 // Exa 5.8
2 clc;
3 clear;
4 close;
5 format('v',6)
6 // Given data
7 I_C = 10; // in mA
8 I_C = I_C * 10^-3; // in A
9 V_CE = 10; // in V
10 h_ie = 500; // in ohm
11 h_oe = 4 * 10^-5; // in A/V
12 h_fe = 100; // unit less
13 h_re = 10^-4; // unit less
14 V_T = 26; // in mV
15 V_T = V_T * 10^-3; // in V
16 g_m = I_C / V_T; // in S
17 g_m = g_m * 10^3; // in mS
18 disp(g_m, "The value of g_m in mS is");
19 g_m = g_m * 10^-3; // in S
20 r_b_desh_e = h_fe / g_m; // in ohm

```

```

21 disp(r_b_desh_e,"The value of r_b''e in ohm is");
22 r_b_desh_b = h_ie - r_b_desh_e;// in ohm
23 disp(r_b_desh_b,"The value of r_b''b in ohm is");
24 r_b_desh_c = r_b_desh_e/h_re;// in ohm
25 r_b_desh_c= r_b_desh_c *10^-6;// in M ohm
26 disp(r_b_desh_c,"The value of r_b''c in Mohm is");
27 r_b_desh_c= r_b_desh_c *10^6;// in ohm
28 g_b_desh_c = 1/r_b_desh_c;// unit less
29 g_ce = h_oe - (1+h_fe)*g_b_desh_c;// in S
30 format('v',11)
31 disp(g_ce,"The value of g_ce in S is");
32 Cob = 3;// in pF
33 Cbdasc = Cob;// in pF
34 disp(Cbdasc,"The value of C_b''c in pF is : ")
35 format('v',6)
36 fT = 50;// in MHz
37 fT = fT * 10^6;// in Hz
38 Cbdase = (g_m/(2*pi*fT))-Cbdasc * 10^-12;// in F
39 Cbdase= Cbdase *10^12;// in pF
40 disp(Cbdase,"The value of C_b''e in pF is");

```

---

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

```

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

```

```

13 R_C = 10; // in k ohm
14 R_C = R_C * 10^3; // in ohm
15 R_sig = 5; // in k ohm
16 R_sig = R_sig * 10^3; // in ohm
17 R_L = 5; // in k ohm
18 R_L = R_L * 10^3; // in ohm
19 Beta = 125; // unit less
20 V_A = 200; // in V
21 C_miu = 1; // in pF
22 C_miu = C_miu * 10^-12; // in F
23 fT = 1000; // in MHz
24 fT = fT * 10^6; // in Hz
25 r_x = 50; // in ohm
26 V_T = 25; // in mV
27 V_T = V_T * 10^-3; // in V
28 g_m = I/V_T; // in A/V
29 r_pie = Beta/g_m; // in ohm
30 r_o = V_A/I; // in ohm
31 C_pie = (g_m/(2*pi*fT))-C_miu; // in F
32 RdasL = (r_o*R_C*R_L)/((r_o*R_C)+(R_C*R_L)+(R_L*r_o
    ) ); // in ohm
33 Gm = g_m*RdasL; // unit less
34 R = (R_B*R_sig)/(R_B+R_sig); // in ohm
35 A_VM = (-R_B/(R_B+R_sig)) * (r_pie/(r_pie+r_x+R)) *
    Gm;
36 disp(A_VM,"The mid band gain is");
37 Avm = 20*log(abs(A_VM)); // in dB
38 Cin = C_pie+C_miu*(1+Gm); // in F
39 Rdassig = (r_pie*(r_x+R))/(r_pie+(r_x+R)); // in ohm
40 f2 = 1/(2*pi*Cin*Rdassig); // in Hz
41 f2 = f2 * 10^-3; // in kHz
42 disp(f2,"The upper 3-dB frequency in kHz is");

```

---

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

```

1 // Exa 5.10
2 clc;
3 clear;
4 close;
5 format('v',5)
6 // Given data
7 R_G = 3.9*10^6; // in ohm
8 R_L = 18*10^3; // in ohm
9 R_D = R_L; // in ohm
10 g_m = 2*10^-3; // in A/V
11 r_o = 250*10^3; // in ohm
12 C_gs = 1*10^-12; // in F
13 C_gd = 0.25*10^-12; // in F
14 R_sig = 50*10^3; // in ohm
15 A_VM = -R_G/(R_G+R_sig)*g_m*r_o*R_D*R_L/(r_o*R_D+R_D*
    R_L+R_L*r_o);
16 disp(A_VM,"The midband gain is");
17 R_dasL = (r_o*R_D*R_L)/( (r_o*R_D) +(R_D*R_L)+(R_L*
    r_o) ); // in ohm
18 C_eq = (1 + g_m*R_dasL)*C_gd; // in F
19 C_in = C_gs+C_eq; // in F
20 f2 = 1/( 2*%pi*C_in*( (R_sig*R_G)/(R_sig+R_G) ) ); // in
    Hz
21 f2 = f2 * 10^-3; // in kHz
22 disp(f2,"The upper 3dB frequency in kHz is");

```

---

# Chapter 6

## Feedback Amplifiers

Scilab code Exa 6.1 Voltage gain and power gain

```
1 // Exa 6.1
2 clc;
3 clear;
4 close;
5 format('v',8)
6 // Given data
7 Rs = 10; // in k ohm
8 Rs = Rs * 10^3; // in ohm
9 Rin = 10; // in ohm
10 Rout = 10; // in k ohm
11 Rout = Rout * 10^3; // in ohm
12 R_L = 10; // in ohm
13 Ai = 1000; // unit less
14 VinBY_Iin= Rin; // in ohm
15 VoutBY_Iin= Ai*Rout*R_L/(Rout+R_L); // in V
16 Av= VoutBY_Iin/VinBY_Iin; // unit less
17 disp(Av,"The voltage gain is : ")
18 Ai= (VoutBY_Iin/R_L)/((Rs+Rin)/Rs); // unit less
19 Ap= Av*Ai; // unit less
20 disp(Ap,"The power gain is : ")
```

---

### Scilab code Exa 6.2 Voltage gain

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

---

### Scilab code Exa 6.3 Gain of a negative feedback amplifier

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

---

### Scilab code Exa 6.4 Voltage gain with feedback

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

---

### Scilab code Exa 6.5 Gain in dB

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



---

**Scilab code Exa 6.6** Gain with feedback

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

---

**Scilab code Exa 6.7** Feedback factor

```
1 // Exa 6.7
2 clc;
3 clear;
4 close;
5 format('v',7)
6 // Given data
7 A = 60; // in dB
8 A = 10^(A/20); // unit less
9 Af = 40; // in dB
10 Af = 10^(Af/20); // unit less
```

```

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

```

---

#### Scilab code Exa 6.8 Percentage of output

```

1 // Exa 6.8
2 clc;
3 clear;
4 close;
5 format('v',6)
6 // Given data
7 A = 600;// unit less
8 Af = 50;// unit less
9 // Af = A/(1+(A*Beta));
10 Beta = ((A/Af)-1)/A;// unit less
11 //P = Vf/Vout = Beta*100;
12 P = Beta*100;// percentage of output voltage in %
13 disp(P,"The percentage of output voltage in % is");

```

---

#### Scilab code Exa 6.9 Voltage gain without feedback

```

1 // Exa 6.9
2 clc;
3 clear;
4 close;
5 format('v',7)
6 // Given data
7 Vout = 12.5;// in V
8 Vin = 0.25;// in V
9 Av = Vout/Vin;// unit less
10 disp(Av,"The voltage gain without feed back is ");
11 Vin = 1.5;// in V

```

```

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

```

---

### Scilab code Exa 6.10 Amount of feedback in dB

```

1 // Exa 6.10
2 clc;
3 clear;
4 close;
5 format('v',7)
6 // Given data
7 Af = -100; // unit less
8 Vin = 0.06; // in V
9 Vout = Af*Vin; // in V
10 Vin = 50; // in mV
11 Vin = Vin * 10^-3; // in V
12 A = Vout/Vin; // unit less
13 //Af = A/(1+(A*Beta));
14 Beta = (abs(A)-abs(Af))/(Af*A); // unit less
15 disp(Beta, "The value of      is");
16 Amount = 20*log10(abs( 1/(1+(-Af*Beta)) )); // in dB
17 disp(Amount, "The Amount of feed back in dB is");

```

---

### Scilab code Exa 6.11 Change in overall gain

```

1 // Exa 6.11
2 clc;
3 clear;
4 close;
5 format('v',4)

```

```

6 // Given data
7 A = 1000; // unit less
8 Beta = 0.002; // unit less
9 Af = A/(1+(A*Beta)); // unit less
10 // When open-loop gain is reduced by
11 A_desh = (1-15/100)*A; // unit less
12 A_desh_f = A_desh/(1+(A_desh*Beta)); // unit less
13 P = ((Af-A_desh_f)/Af)*100; // percentage change in
    overall gain in %
14 disp(P,"The change in overall gain in % is");

```

---

#### Scilab code Exa 6.12 Feedback ration and factor

```

1 // Exa 6.12
2 clc;
3 clear;
4 close;
5 format('v',6)
6 // Given data
7 R_C = 2.5; // in k ohm
8 R_C = R_C * 10^3; // in ohm
9 R_E = 1; // in k ohm
10 R_E = R_E * 10^3; // in ohm
11 h_ie = 1.1; // in k ohm
12 h_ie = h_ie * 10^3; // in ohm
13 h_fe = 200; // unit less
14 Beta = 200; // unit less
15 A = round((-h_fe/h_ie)*R_C); // unit less
16 disp(A,"The voltage gain without feed back is");
17 Af = -R_C/R_E; // unit less
18 disp(Af,"The voltage gain with feed back is");
19 // Af = A/(1+(A*Beta));
20 Beta = (abs(A)-abs(Af))/(A*Af); // unit less
21 disp(Beta,"The feed back ratio is");
22 feedbackfactor = round(abs(A)*Beta); // unit less

```

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

---

### Scilab code Exa 6.13 Av and bita

```
1 // Exa 6.13
2 clc;
3 clear;
4 close;
5 format('v',7)
6 // Given data
7 dAvByAv = 20/100; // variation in open loop gain
8 dAvf_by_Avf = 1/100; // variation in closed loop gain
9 BetaAv = (dAvByAv/dAvf_by_Avf)-1; // feedback factor
10 Avf = 100; //unit less
11 Av = Avf*(1+BetaAv); // open loop voltage gain
12 disp(Av,"The value of Av is");
13 Beta = ((Av/Avf)-1)/Av; // unit less
14 disp(Beta,"The value of      is");
```

---

### Scilab code Exa 6.14 Percentage change in closed loop gain

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

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

---

#### Scilab code Exa 6.15 Percentage change in closed loop gain

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

---

#### Scilab code Exa 6.16 Open and closed loop gain

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

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

---

#### Scilab code Exa 6.17 Distortion of the amplifier

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

---

#### Scilab code Exa 6.18 Gain and output voltage with feedback

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

```

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

```

---

**Scilab code Exa 6.19** Required input signal

```

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

```

---

**Scilab code Exa 6.20** Voltage gain and input output resistance



```

1 // Exa 6.20
2 clc;
3 clear;
4 close;
5 format('v',5)
6 // Given data
7 A = 300; // voltage gain
8 Rin = 1.5; // in k ohm
9 Rout = 50; // in k ohm
10 Beta = 1/15; // unit less
11 Af = A/(1+(Beta*A)); // unit less
12 disp(Af,"The voltage gain is");
13 Rinf = (1+(Beta*A))*Rin; // in k ohm
14 disp(Rinf,"The input resistance in k ohm is");
15 Routf = Rout/(1+(Beta*A)); // in k ohm
16 disp(Routf,"The output resistance in k ohm is");

```

---

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

```

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

```

```

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

```

---

**Scilab code Exa 6.22** Amplifier voltage gain

```

1 // Exa 6.22
2 clc;
3 clear;
4 close;
5 format('v',6)
6 // Given data
7 D = 5/100;// distortion without feedback
8 A = 1000;// open loop voltage gain
9 Beta = 0.01;// feedback ratio
10 Af = A/(1+(Beta*A));// unit less
11 disp(Af,"The Amplifier voltage gain is");
12 f1 = 50;// in Hz
13 fdas1 = f1/(1+(Beta*A));// in Hz
14 disp(fdas1,"The lower cutoff frequency with feedback
    in Hz is");
15 f2 = 200;// in kHz
16 f2 = f2 * 10^3;// in Hz
17 fdas2 = f2*(1+(Beta*A));// in Hz
18 fdas2 = fdas2 * 10^-6;// in MHz
19 disp(fdas2,"The upper cutoff frequency with feedback
    in MHz is");
20 Df = (D/(1+(Beta*A)))*100;// in %
21 disp(Df,"The distortion with feed back in % is");

```

---

**Scilab code Exa 6.23** Feedback factor and bandwidth

```

1 // Exa 6.23

```

```

2  clc;
3  clear;
4  close;
5  format('v',7)
6  // Given data
7  Avm = 1500; // midband gain
8  Avmf = 150; // midband gain with feedback
9  // Avmf = Avm/(1+(Beta*Avm));
10 BetaAvm = (Avm/Avmf)-1; // feedback factor
11 disp(BetaAvm,"The value of feed back factor is");
12 bandwidth = 4; // in MHz
13 BWf = (1+BetaAvm)*bandwidth; // in MHz
14 disp(BWf,"The band width with feedback in MHz is");

```

---

#### Scilab code Exa 6.24 New bandwidth and gain

```

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

```

---

### Scilab code Exa 6.25 Input impedance

```
1 // Exa 6.25
2 clc;
3 clear;
4 close;
5 format('v',5)
6 // Given data
7 V_CC = 20; // in V
8 R1 = 10; // in k ohm
9 R1 = R1 * 10^3; // in ohm
10 R2 = 10; // in k ohm
11 R2 = R2 * 10^3; // in ohm
12 R_E = 9.3; // in k ohm
13 R_E = R_E * 10^3; // in ohm
14 R_L = 18.6; // in k ohm
15 R_L = R_L * 10^3; // in ohm
16 V2 = (V_CC/(R1+R2))*R2; // in V
17 V_BE = 0.7; // in V
18 Ve = V2-V_BE; // in V
19 Ie = Ve/R_E; // in A
20 V_T = 25*10^-3; // in V
21 rdase = V_T/Ie; // in ohm
22 RdasE = (R_E*R_L)/(R_E+R_L); // in ohm
23 Beta = 100; // unit less
24 Zinbase = Beta*(rdase+RdasE); // in ohm
25 Zin = R1*R2*Zinbase/(R1*R2+R2*Zinbase+Zinbase*R1); //
    in ohm
26 Zin = Zin*10^-3; // in k ohm
27 disp(Zin,"The input impedance in k ohm is");
```

---

# Chapter 7

## Oscillators

Scilab code Exa 7.1 Frequency of oscillation

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

---

Scilab code Exa 7.2 Range of required capacitor

```
1 // Exa 7.2
2 clc;
```

```

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

```

---

### Scilab code Exa 7.3 Transformer winding turn ratio

```

1 // Exa 7.3
2 clc;
3 clear;
4 close;
5 format('v',7)
6 // Given data
7 V_CC = 12; // in V
8 Pout = 88; // in mW
9 Plosses = 8; // in mW
10 Pin = Pout+Plosses; // in mW
11 Pin = Pin * 10^-3; // in W
12 I_C = Pin/V_CC; // in A
13 Gm = 10; // in mA/V
14 Gm = Gm * 10^-3; // in A/V
15 V_B = I_C/Gm; // in V

```

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

---

#### Scilab code Exa 7.4 Operating frequency

```
1 // Exa 7.4
2 clc;
3 clear;
4 close;
5 format('v',5)
6 // Given data
7 L = 100;// in H
8 L = L * 10^-6;// in H
9 C1 = 0.001;// in F
10 C1 = C1 * 10^-6;// in F
11 C2 = 0.01;// in F
12 C2 = C2 * 10^-6;// in F
13 f = (1/(2*%pi))*(sqrt( (1/(L*C1))+(1/(L*C2)) ));//
    in Hz
14 f = f * 10^-3;// in kHz
15 disp(f,"The operating frequency in kHz is");
16 Beta = C1/C2;// feedback fraction
17 disp(Beta,"The feedback fraction is");
18 Amin = 1/Beta;// minimum gain to sustain
    oscillations
19 disp(Amin,"The minimum gain to sustain oscillations
    is");
20 // A = R_C/R_E ;
21 R_C = 2.5;// in k ohm
22 R_C = R_C * 10^3;// in ohm
23 R_E = R_C/Amin;// in ohm
24 disp(R_E,"The emitter resistance in ohm is");
```

---

### Scilab code Exa 7.5 Range of inductance

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

---

### Scilab code Exa 7.6 Frequency of oscillation

```
1 // Exa 7.6
2 clc;
3 clear;
4 close;
5 format('v',5)
6 // Given data
```



```

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

```

---

#### Scilab code Exa 7.7 Frequency of oscillations

```

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

```

---

#### Scilab code Exa 7.8 Resonance frequencies

```

1 // Exa 7.8
2 clc;
3 clear;
4 close;
5 format('v',5)
6 // Given data
7 Rs = 5; // in k ohm
8 Rs =Rs * 10^3; // in ohm
9 Ls = 0.8; // in H
10 Cs = 0.08; // in pF
11 Cs = Cs * 10^-12; // in pF
12 C_P = 1; // in pF
13 C_P = C_P * 10^-12; // in F
14 f_s = 1/(2*pi*(sqrt( Ls*Cs ))); // in Hz
15 f_s = f_s * 10^-3; // in kHz
16 disp(f_s,"The series resonant frequency in kHz is");
17 f_p = (1/(2*pi)) * (sqrt( (1+(Cs/C_P))/(Ls*Cs) ));
    // in Hz
18 f_p = f_p * 10^-3; // in kHz
19 disp(f_p,"The parallel resonant frequency in kHz is"
    );

```

---

#### Scilab code Exa 7.9 Value of inductance

```

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

```

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

---

**Scilab code Exa 7.10** Percentage by parallel resonant frequency greater than series

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

---

**Scilab code Exa 7.11** Frequency of oscillations

```
1 // Exa 7.11
2 clc;
3 clear;
4 close;
5 format('v',5)
6 // Given data
7 R1 = 800; // in k ohm
8 R1 = R1 * 10^3; // in ohm
9 R2 = R1; // in ohm
10 R3 = R1; // in ohm
11 R = R1; // in ohm
```

```

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

```

---

#### Scilab code Exa 7.12 Value of resistances

```

1 // Exa 7.12
2 clc;
3 clear;
4 close;
5 format('v',6)
6 // Given data
7 C1 = 0.016; // in F
8 C1 = C1 * 10^-6; // in F
9 C2 = C1; // in F
10 C3 = C1; // in F
11 C = C1; // in F
12 //f_o = 1/(2*%pi*R*C*sqrt(10));
13 f_o = 1; // in kHz
14 f_o = f_o * 10^3; // in Hz
15 R = 1/(2*%pi*f_o*C*sqrt(10)); // in ohm
16 disp(R,"The value of resiatnce in ohm is");
17 disp("Standard value : 3.3 kohm")

```

---

#### Scilab code Exa 7.13 RC elements of a Wien bridge oscillator

```

1 // Exa 7.13
2 clc;
3 clear;

```

```

4 close;
5 format('v',5)
6 // Given data
7 f_o = 10;// in kHz
8 f_o = f_o * 10^3;// in Hz
9 R = 200;// in k ohm
10 R = R * 10^3;// in ohm
11 C = 1/(2*pi*f_o*R);// in F
12 C=C*10^12;// in pF
13 disp(C,"The value of C in pF is");
14 R4 = R;// in ohm
15 R4= R4*10^-3;// in k ohm
16 disp(R4,"The value of R4 in k ohm is");
17 R3 = R4*2;// in k ohm
18 disp(R3,"The value of R3 in k ohm is");

```

---

Scilab code Exa 7.14 RC elements of a Wien bridge oscillator

```

1 // Exa 7.14
2 clc;
3 clear;
4 close;
5 format('v',4)
6 // Given data
7 f = 15;// in kHz
8 f = f * 10^3;// in Hz
9 R = 200;// in k ohm
10 R = R * 10^3;// in ohm
11 C = 1/(2*pi*f*R);// in F
12 C= C*10^12;// in pF
13 disp(C,"The value of C in pF is");
14 R4 = R;// in ohm
15 R4= R4*10^-3;// in k ohm
16 disp(R4,"The value of R4 in k ohm is");
17 R3 = R4*2;// in k ohm

```

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

---

#### Scilab code Exa 7.15 Frequency of oscillations

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

---

#### Scilab code Exa 7.16 Pulse repetition frequency

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

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

---

# Chapter 8

## Multistage Amplifiers

Scilab code Exa 8.1 Overall voltage gain in dB

```
1 // Exa 8.1
2 clc;
3 clear;
4 close;
5 format('v',8)
6 // Given data
7 Av1 = 60; // voltage gain of first stage
8 Av2 = 100; // voltage gain of second stage
9 Av3 = 160; // voltage gain of third stage
10 Av = Av1*Av2*Av3; // overall voltage gain
11 Av_indB = 20*log10(Av); // overall voltage gain in dB
12 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

```
1 // Exa 8.2
2 clc;
```



```

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

```

---

**Scilab code Exa 8.3** Overall voltage gain

```

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

```

---

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

```

1 // Exa 8.4
2 clc;

```

```

3 clear;
4 close;
5 format('v',6)
6 // Given data
7 R11 = 4; // in k ohm
8 R21 = 20; // in k ohm
9 h_ie = 1.1; // in k ohm
10 R_C1=4; // in k ohm
11 R22= 10; // in k ohm
12 R12= 2; // in k ohm
13 Zb = h_ie; // in k ohm
14 Zin = (R11*R21*Zb)/( (R11*R21)+(R21*Zb)+(Zb*R11) );
    // in k ohm
15 disp(Zin,"The input impedance in k ohm is");
16 h_oe = 0; // unit less
17 Q2 = %inf; // output impedance of transistor
18 R_C2 = 2; // in k ohm
19 // Zout= 1/h_oe || R_C2 = R_C2
20 Zout = R_C2; // in k ohm
21 disp(Zout,"The output impedance in k ohm is");
22 h_fe = 50; // unit less
23 R_L = 10; // in k ohm
24 Av2= -h_fe/h_ie*(R_C2*R_L/(R_C2+R_L)); // voltage
    gain of second stage
25 Rac1= 1/(1/R_C1+1/R22+1/R12+1/h_ie); // in k ohm
26 Av1= -h_fe/h_ie*Rac1; // voltage gain of first stage
27 Av= Av1*Av2; // overall voltage gain
28 disp(Av,"The overall voltage gain is : ")

```

---

### Scilab code Exa 8.5 Input and output impedance voltage gain

```

1 // Exa 8.5
2 clc;
3 clear;
4 close;

```

```

5 format('v',6)
6 // Given data
7 R1 = 10; // in k ohm
8 R2 = 5; // in k ohm
9 Zb = 1; // in k ohm
10 Zin = (R1*R2*Zb)/((R1*R2)+(R2*Zb)+(Zb*R1)); // in k
    ohm
11 disp(Zin,"The input impedance in k ohm is");
12 R_C1 = 2; // in k ohm
13 R_E1 = 2; // in k ohm
14 R_C2 = 2; // in k ohm
15 R_E2 = 2; // in k ohm
16 h_oe = 0; // unit less
17 Q2 = %inf; // output impedance of transistor
18 //Zout= 1/h_oe || R_C2
19 Zout = R_C2; // in k ohm
20 disp(Zout,"The output impedance in k ohm is");
21 h_fe = 100; // unit less
22 h_ie = 1; // in k ohm
23 R_ac=0.222; // in k ohm
24 Av2= -h_fe/h_ie*R_C2; // voltage gain of second stage
25 Rac1= 1/(1/R_C1+1/R1+1/R2+1/h_ie); // in k ohm
26 Av1= -h_fe/h_ie*R_ac; // voltage gain of first stage
27 Av= Av1*Av2; // overall voltage gain
28 disp(Av,"The overall voltage gain is : ")

```

---

### Scilab code Exa 8.7 Transformer turn ratio

```

1 // Exa 8.7
2 clc;
3 clear;
4 close;
5 format('v',5)
6 // Given data
7 Z_L = 16; // in ohm

```

```

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

```

---

### Scilab code Exa 8.8 Transformer turn ratio

```

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

```

---

### Scilab code Exa 8.9 Transformer turn ratio and load voltage

```

1 // Exa 8.9
2 clc;
3 clear;
4 close;
5 format('v',5)
6 // Given data
7 Z_L = 25; // in ohm

```

```

8 Z_S = 10; // in k ohm
9 Z_S = Z_S * 10^3; // in k ohm
10 // Z_S = (a^2)*Z_L;
11 a = sqrt(Z_S/Z_L); //turn ratio of the transformer
12 disp(a,"The transformer turn ratio is");
13 //V2 = V1/a = Vs/a;
14 Vs = 8; // in V
15 V2 = Vs/a; // in V
16 V_L =V2; // in V
17 disp(V_L,"The load voltage in V is");

```

---

**Scilab code Exa 8.10** Av2 and Av1 and Av in dB

```

1 // Exa 8.10
2 clc;
3 clear;
4 close;
5 format('v',5)
6 // Given data
7 V_CC = 12; // in V
8 r_e = 25; // in mV
9 r_e = r_e * 10^-3; // in V
10 R1 = 1.2; // in Mohm
11 R1 = R1 * 10^6; // in ohm
12 R3 = 1.2; // in Mohm
13 R3 = R3 * 10^6; // in ohm
14 R4 = 8; // in k ohm
15 R4 = R4 * 10^3; // in ohm
16 R5 = 24; // in k ohm
17 R5 = R5 * 10^3; // in ohm
18 Beta1 = 100; // unit less
19 Beta2 = 100; // unit less
20 I_B2 = V_CC/R3; // in A
21 I_C2 = Beta2*I_B2; // in A
22 I_E2 = I_C2; // in A

```

```

23 r_e2 = r_e/I_E2; // in ohm
24 Rac2 = (R4*R5)/(R4+R5); // in ohm
25 Av2 = -(Rac2/r_e2); //voltage gain of second stage
26 disp(Av2,"The voltage gain of second stage is");
27 Rac1 = (R3*(Beta2*r_e2))/(R3+(Beta2*r_e2)); // in
    ohm
28 L = 1; // in H
29 f = 4; // in kHz
30 f = f * 10^3; // in Hz
31 X_L = 2*%pi*f*L; // in ohm
32 r_e1 = r_e2; // in ohm
33 Av1 = round(-Rac1/r_e1 ); // voltage gain of first
    stage
34 disp(Av1,"The voltage gain of first stage at 4 kHz
    is");
35 Av = Av1*Av2; // overall voltage gain
36 Av = 20*log10(Av); // in dB
37 disp(Av,"The overall voltage gain in dB is");

```

---

### Scilab code Exa 8.11 Voltage gain and input resistance

```

1 // Exa 8.11
2 clc;
3 clear;
4 close;
5 format('v',6)
6 // Given data
7 V_CC = 25; // in V
8 R1 = 180; // in k ohm
9 R1 = R1*10^3; // in ohm
10 R2 = 20; // in k ohm
11 R2 = R2 * 10^3; // in ohm
12 R_C2 = 20; // in k ohm
13 R_C2 = R_C2 * 10^3; // in ohm
14 R_C1 = R_C2; // in ohm

```

```

15 R_E1 = 1.8; // in k ohm
16 R_E1 = R_E1 * 10^3; // in ohm
17 R_E2 = 4.3; // in k ohm
18 R_E2 = R_E2 * 10^3; // in ohm
19 R_L = 30; // in k ohm
20 R_L = R_L * 10^3; // in ohm
21 V_BE = 0.7; // in V
22 Beta2 = 50; // unit less
23 Beta1 = 50; // unit less
24 V_Th1 = (V_CC/(R1+R2))*R2; // in V
25 R_Th1 = (R1*R2)/(R1+R2); // in ohm
26 I_B = (V_Th1-V_BE)/( R_Th1+((Beta1+1)*R_E1) ); // in
    A
27 I_E1 = (Beta1+1)*I_B; // in A
28 V_T = 25; // in mV
29 V_T = V_T * 10^-3; // in V
30 r_e1 = V_T/I_E1; // in ohm
31 I_C1 = I_E1; // in A
32 V_C1 = V_CC-(I_C1*R_C1); // in V
33 //V_E2 = V_B2-V_BE = V_C1-V_BE; // in V
34 V_E2 = V_C1-V_BE; // in V
35 I_E2 = V_E2/R_E2; // in A
36 r_e2 = V_T/I_E2; // in ohm
37 Rac2 = (R_C1*R_L)/(R_C1+R_L); // in ohm
38 Av2 = -Rac2/(r_e2+R_E2); // voltage gain of second
    stage
39 Rac1 = (R_C1*(Beta1*(r_e2+R_E2)))/(R_C1+(Beta1*(r_e2
    +R_E2))); // in ohm
40 Av1 = -Rac1/(r_e1+R_E1); // voltage gain of first
    stage
41 Av = Av1*Av2; // voltage gain
42 disp(Av,"The voltage gain is");
43 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
44 r_in= r_in*10^-3; // in k ohm
45 disp(r_in,"The input resistance in k ohm is");

```

---

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

```
1 // Exa 8.12
2 clc;
3 clear;
4 close;
5 format('v',6)
6 // Given data
7 I_DSS = 15; // in mA
8 I_DSS = I_DSS * 10^-3; // in A
9 V_P = -4; // in V
10 g_mo = (-2*I_DSS)/V_P; // in S
11 V_GSQ = -2; // in V
12 g_m = g_mo*(1-(V_GSQ/V_P)); // in S
13 R_D = 2.7; // in k ohm
14 R_D = R_D * 10^3; // in ohm
15 Av1 = -g_m*R_D; // voltage gain of first stage
16 Av2 = Av1; // voltage gain of second stage
17 Av = Av1*Av2; // overall voltage gain
18 disp(Av,"The overall voltage gain is");
19 R_G = 2; // in Mohm
20 Rin = R_G; // in Mohm
21 disp(Rin,"The input impedance in Mohm is");
22 Rout = R_D; // in ohm
23 Rout = Rout*10^-3; // in k ohm
24 disp(Rout,"The output impedance in k ohm is");
25 Rout = Rout*10^3; // in ohm
26 Vin = 15; // in mV
27 Vin = Vin * 10^-3; // in V
28 Vout = Av*Vin; // in V
29 disp(Vout,"The output voltage in V is");
30 R_L = 15; // in k ohm
31 R_L = R_L * 10^3; // in ohm
```



```

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

```

---

**Scilab code Exa 8.13** Upper and lower 3dB frequency

```

1 // Exa 8.13
2 clc;
3 clear;
4 close;
5 format('v',7)
6 // Given data
7 f2 = 100; // in kHz
8 f_H = f2/(sqrt(2^(1/3)-1)); // in kHz
9 disp(f_H,"The upper 3-dB frequency of each stage in
    kHz is");
10 f1 = 25; // in kHz
11 f_L = f1/(sqrt(2^(1/3)-1)); // in kHz
12 disp(f_L,"The lower 3-dB frequency of each stage in
    kHz is");
13
14 // 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 identical T1 and T2

```

1 // Exa 8.14
2 clc;
3 clear;
4 close;
5 format('v',5)

```

```

6 // Given data
7 R_E= 1; // in k ohm
8 h_ie= R_E; // in k ohm
9 h_fe= 100; // unit less
10 //V1= I1*[h_ie+(1+h_fe)*h_ie+(1+h_fe)^2*R_E]+I2*R_E
      (i)
11 //V2= I1*(1+h_fe)^2*R_E + I2*R_E
                                          (ii)
12 Z= [(h_ie+(1+h_fe)*h_ie+(1+h_fe)^2*R_E) R_E;(1+h_fe)
      ^2*R_E R_E]
13 Z11= Z(1); // k ohm
14 Z21= Z(2); // k ohm
15 Z12= Z(3); // k ohm
16 Z22= Z(4); // k ohm
17 disp(Z11*10^-3,"The value of Z11 in M ohm is : ")
18 disp(Z12,"The value of Z12 in M ohm is : ")
19 disp(Z21*10^-3,"The value of Z21 in M ohm is : ")
20 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

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

---

# Chapter 10

## Multivibrators

Scilab code Exa 10.1 Time period and frequency

```
1 // Exa 10.1
2 clc;
3 clear;
4 close;
5 format('v',5)
6 // Given data
7 R2 = 5; // in k ohm
8 R2 = R2 * 10^3; // in ohm
9 R1 = R2; // in ohm
10 R_B = R2; // in ohm
11 R4 = 0.4; // in k ohm
12 R4 = R4 * 10^3; // in ohm
13 R3 = R4; // in ohm
14 R_C = R4; // in ohm
15 C2 = 0.02; // in F
16 C2 = C2 * 10^-6; // in F
17 C1 = C2; // in F
18 C = C2; // in F
19 T = 1.386*R_B*C; // in sec
20 T = T*10^3; // in ms
21 disp(T,"The time period in ms is");
```

```

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

```

---

### Scilab code Exa 10.2 Astable multivibrator

```

1 // Exa 10.2
2 clc;
3 clear;
4 close;
5 format('v',6)
6 // Given data
7 V_CC = 20; // in V
8 V_BB = 20; // in V
9 R_C2 = 1; // in k ohm
10 R_C2 = R_C2 * 10^3; // in ohm
11 R_C1 = R_C2; // in ohm
12 f = 500; // in Hz
13 h_fe = 50; // unit less
14 PW = 0.2; // in ms
15 PW = PW*10^-3; // in sec
16 V_CEsat = 0.3; // in V
17 V_BEsat = 0.7; // in V
18 I_CEsat = (V_CC - V_CEsat)/R_C1; // in A
19 I_Bmin = I_CEsat/h_fe; // in A
20 I_B = 1.5*I_Bmin; // in A
21 R = (V_BB - V_BEsat)/I_B; // in ohm
22 R = floor(R*10^-3); // in k ohm
23 R1 = R; // in k ohm
24 R2 = R1; // in k ohm
25 T = 1/f; // in sec
26 D_cycle = PW/T;

```

```

27 T2= D_cycle*T; //sec
28 T1= T-T2; // in sec
29 C1= T1/(0.693*R2); // in mF
30 C1= C1*10^3; // in F
31 C2= T2/(0.693*R1); // in mF
32 C2= C2*10^3; // in F
33 disp(R1,"The value of R1 in k ohm is : ")
34 disp(R2,"The value of R2 in k ohm is : ")
35 disp(C1,"The value of C1 in F is : ")
36 disp(C2,"The value of C2 in F is : ")

```

---

**Scilab code Exa 10.3** Check up the saturation of the transistor

```

1 // Exa 10.3
2 clc;
3 clear;
4 close;
5 format('v',7)
6 // Given data
7 V_CC = 12; // in V
8 R_B = 20; // in k ohm
9 R_B = R_B * 10^3; // in ohm
10 R_C = 2; // in k ohm
11 R_C = R_C * 10^3; // in ohm'
12 C = 0.1; // in F
13 C = C * 10^-6; // in F
14 V_CEsat = 0.2; // in V
15 V_BEsat = 0.8; // in V
16 Beta = 50; // unit less
17 T =R_B*C*log( (2*V_CC-V_BEsat)/(V_CC-V_BEsat) ); //
    in S
18 disp(T*10^3,"The input pulse in ms is");
19 I_Csat = (V_CC-V_CEsat)/R_C; // in A
20 I_Csat = I_Csat * 10^3; // in mA
21 // Beta = h_fe;

```

```

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

```

---

#### Scilab code Exa 10.4 Component value of monostable mutivibrator

```

1 // Exa 10.4
2 clc;
3 clear;
4 close;
5 format('v',6)
6 // Given data
7 T= 500*10^-6;// in sec
8 h_femin = 25;// unit less
9 I_CEsat = 5;// in mA
10 I_CEsat = I_CEsat * 10^-3;// in A
11 V_CC = 10;// in V
12 V_BB = 4;// in V
13 V_CEsat = 0.4;// in V
14 V_BEsat = 0.8;// in V
15 V_BEoff = -1;// in V
16 R_C2 = (V_CC-V_CEsat)/I_CEsat;// in ohm
17 R_C1= R_C2;// in ohm
18 disp(R_C1*10^-3,"The value of R_C1 in k ohm is");
19 disp(R_C2*10^-3,"The value of R_C2 in k ohm is");
20 I_B2min = I_CEsat/h_femin;// in A
21 I_B2actual = 1.5*I_B2min;// in A
22 R = (V_CC-V_BEsat)/(I_B2actual);// in ohm
23 disp(R*10^-3,"The value of R in k ohm is");

```

```

24 C= T/(0.693*R); // in F
25 disp(C*10^6,"The value of C in F is : ")
26 R1= poly(0, 'R1');
27 R2= 2.143*R1; // in ohm
28 // I_B1actual= (V_CC-V_BE1sat)/(R_C+R1) - (V_BE1sat+
    V_BB)/R2 and R2= 2.143*R1 so
29 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;
30 R1= roots(R1); // in ohm
31 R1= R1(1); // in ohm
32 R1= R1*10^-3; // in kohm
33 R2= 2.143*R1; // in k ohm
34 disp(R1,"The value of R1 in k is : ")
35 disp(R2,"The value of R2 in k is : ")
36 R1= R1*10^3; // in ohm
37 R1C1= 1*10^-6; // in F
38 C1= R1C1/R1; // in F
39 C1= C1*10^12; // in pF
40 disp(C1,"The value of C1 in pF is : ")

```

---

### Scilab code Exa 10.5 Stable current and voltages

```

1 // Exa 10.5
2 clc;
3 clear;
4 close;
5 format('v',5)
6 // Given data
7 V_CC = 10; // in V
8 V_BB = -10; // in V
9 R_C2 = 1.2* 10^3; // in ohm
10 R_C1 = R_C2; // in ohm
11 R_B1 = 39 * 10^3; // in ohm
12 R_B2 = R_B1; // in ohm
13 R2 = 10* 10^3; // in ohm

```



```

14 R1 = R2; // in ohm
15 h_fe = 30; // unit less
16 V_CE2sat = 0; // in V
17 I1 = (V_CC-V_CE2sat)/R_C2; // in A
18 I2 = (V_CE2sat-V_BB)/(R1+R_B2); // in A
19 I_C2 = I1-I2; // in A
20 I_B2min = I_C2/h_fe; // in A
21 V_C2 = 0; // in V
22 V_B1 = V_C2 - (I2*R1); // in V
23 V_B2 = 0; // in V
24 V_C1 = 10; // in V
25 I3 = (V_CC-V_C1)/R_C1; // in A
26 V_BE2sat = 0; // in V
27 I4 = (V_C1-V_BE2sat)/R2; // in A
28 I_D = I3-I4; // in A
29 I5 = (V_BE2sat-V_BB)/R_B1; // in A
30 I_B2actual = I4-I5; // in A
31 I_B2actual= I_B2actual*10^3; // in mA
32 I_C1 = 0; // in mA
33 I_B1 = 0; // in mA
34 I_C2= I_C2*10^3; // in mA
35 disp(V_C1,"The value of V_C1 in V is");
36 disp(V_C2,"The value of V_C2 in V is");
37 disp(V_B1,"The value of V_B1 in V is");
38 disp(V_B2,"The value of V_B2 in V is");
39 disp(I_C1,"The value of I_C1 in mA is");
40 disp(I_C2,"The value of I_C2 in mA is");
41 disp(I_B1,"The value of I_B1 in mA is");
42 disp(I_B2actual,"The value of I_B2 in mA is");

```

---