Scilab Textbook Companion for Basic Electronics by D. De[1]

Created by
Adithya R.k
B.E (pursuing)
Electronics Engineering
The National Institute Of Engineering
College Teacher
M.S Vijaykumar
Cross-Checked by
TechPassion

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Book Description

Title: Basic Electronics

Author: D. De

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Edition: 1

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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

Semiconductor Fundamentals

Scilab code Exa 1.1 Calculate wave vector carried by photon

```
// Calculate wave vector carried by photon
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 1-1 in page 7

clear; clc; close;

// Given data
c=3*10^8; // Speed of light in m/s
h=6.64*10^-34;// Planks constant in Js
E_photon=2*1.6*10^-19; // Energy of photon in J

//Calculations
lambda=(c*h)/E_photon;
k=(2*%pi/lambda);

printf("The wavelenght of a 2.0eV photon = %0.3e m\n
   ",lambda);
printf("The magnitude of k vector = %0.2e m^-1",k);
```

```

// Results
// The wavelength of a 2.0 eV photon is 6225 Angstrom
// The magnitude of k-vector is 1.01 * 10^7 m^-1
```

Scilab code Exa 1.2 Calculate semiconductor band gap

```
// Calculate semiconductor band gap
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 1-2 in page 7

clear; clc; close;

// Data given
lambda=0.5*10^-6; // Wavelength of emitted light in m
c=3*10^8; // Speed of light in vacuum in m/s
h=1.05*10^-34;// Constant of calculation

// Calculation
E_g= (2*%pi*h*c)/lambda;
A= E_g*10^19/1.6;

printf("The material band gap has to be %0.3f eV",A);

// Result
//The material band gap is 2.474 eV
// Semiconductors like C,BN,GaN,SiC meet this
```

```
criterion
```

Scilab code Exa 1.3 Calculate E k relation of conduction electrons

```
// Calculate E-k relation of conduction electrons
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 1-3 in page 20

clear; clc; close;

// Data given
m_c=0.1*0.91*10^-30; // Effective mass of conduction electron in kg
k=0.3*10^10; // Wave vector in /m
h=1.05*10^-34; // Constant of calculation in Js

// Calculation
E= (h^2*k^2)/(2*m_c);
A= E/(1.6*10^-19);

printf("Energy of conduction electrons = %0.1f eV",A);

// Result
//Energy of the conduction electrons in vertically upward direction is 3.4 eV
```

Scilab code Exa 1.4 Energies of electrons in conduction band

```
// Energies of electrons in conduction band
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 1-4 in page 21

clear; clc; close;

// Data given
k=0.01*10^10; // k-vector value /m
h=1.05*10^-34; // Constant of calculation Js
m_0=0.91*10^-30; // Mass of conduction electron Kg
m_c1=0.067*m_0; // Effective mass of GaAs conduction electron Kg
m_c2=0.01*m_0; // Effective mass if InAs conduction electron Kg

// Calculation
E_1=(h^2*(9*k^2))/(2*m_c1);
A_1=(E_1)/(1.6*10^-19);

printf(”(a)Energy of conduction electron in GaAs = %0.2e eV\n”,A_1);

E_2=(h^2*(9*k^2))/(2*m_c2);
A_2=(E_2)/(1.6*10^-19);

printf(”(b)Energy of conduction electron in InAs = %0.3e eV”,A_2);
```

```

// Results
// (a) Energy of conduction electron in GaAs is 50.9 meV
// (b) Energy of conduction electron in InAs is 340.7 meV
```

Scilab code Exa 1.5 Energies of electrons in conduction band

```
// Energies of electrons in conduction band
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 1-5 in page 21

clear; clc; close;

// Data given
h=1.05*10^-34; // Constant of calculation Js
k=0.1,0.1,0,0; // Values of k-vector
m_c=0.067*0.091*10^-30; // Effective mass of conduction electron

// Calculation
E=(h^2*(((0.1*10^10)^2)+((0.1*10^10)^2)))/(2*m_c);
A= E/(1.6*10^-19);

printf("Energy of conduction electron is %0.3f eV",A);

// Result
// Energy of conduction electron in the vertically
```

```
upward direction = 11.302 eV
// The non parabolic E-k dispersion relation is more appropriate here
```

Scilab code Exa 1.6 Estimation of smallest k vector along x direction

```
// Estimation of smallest k-vector along x-direction
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 1-6 in page 21

clear; clc; close;

// Data given
x=1; // x-coordiante
y=1; // y-coordinate
z=1; // z-coordinate
E=0.3*1.6*10^-19; // Energy separation in eV
m_c=0.067*0.91*10^-30; // Effective mass of conduction electron in kg
h=1.05*10^-34; // Constant of calculation in Js

// Calculation
k_x=(2*m_c*E)/(3*h^2);
A=sqrt(k_x);

printf("K vector along (111) direction is %0.1e m^-1",A);

// Result
//Value of k-vector along (111) direction is
```

```
4.2*10^8 m^-1
//Parabolic expression has been used to compute the k-vector
```

Scilab code Exa 1.7 Energies of electrons in conduction band

```
// Energies of electrons in conduction band
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 1-7 in page 22

clear; clc; close;

// Data given
k=0.01*10^10; // k-vector value /m
h=1.05*10^-34; // Constant of calculation Js
m_0=0.91*10^-30; // Mass of conduction electron Kg
m_c1=0.067*m_0; // Effective mass of GaAs conduction electron Kg
m_c2=0.01*m_0; // Effective mass if InAs conduction electron Kg

// Calculation
E_1=(h^2*(9*k^2))/(2*m_c1);
A_1=(E_1)/(1.6*10^-19);

printf("(a)Energy of conduction electron in GaAs = %0.2e eV\n",A_1);

E_2=(h^2*(9*k^2))/(2*m_c2);
A_2=(E_2)/(1.6*10^-19);
```

```

printf("(b)Energy of conduction electron in InAs = %0.3e eV",A_2);

// Results
// (a) Energy of conduction electron in GaAs is 50.9 meV
// (b) Energy of conduction electron in InAs is 340.7 meV
```

Scilab code Exa 1.8 Find position of Fermi level

```
// Find position of Fermi level
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 1-8 in page 33

clear; clc; close;

// Data given
n_0=6*10^17; // Electron concentration in the conduction band /cm^3
k_bT=0.026; // Expressed in eV at room temperature
N_c=4.45*10^17; // Constant of Calculation /cm^3

// Calculation
E_f=k_bT*log(n_0/N_c);
A=E_f*10^3;

printf("Position of Fermi level is %0.2f meV",A);

```

```
// Result
// Position of Fermi level is 7.77 meV
// Intrinsic carrier density is lesser than dopant density
// Hence semiconductor is non-degenerate
```

Scilab code Exa 1.9 Find Fermi level at room temperature

```
// Find Fermi level at room temperature
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 1-9 in page 34

clear; clc; close;

// Data given
k=1; // Assumed constant
m_e=2*k; // Effective mass of an electron in Kg
m_h=k; // Effective mass of only heavy hole in Kg
k_bT=0.026; // Expressed in eV at room temperature

// Calculation
E_f=(3/4)*0.026*log(m_e/m_h);
printf("E_f = ((-E_g/2) - %0.3f) eV\n",E_f);
printf("Thus Fermi level is below center of forbidden gap by 0.014 eV");

// Result
// Fermi level in the intrinsic semiconductor is ((-E_g/2) - 0.014) eV
```

Scilab code Exa 1.10 Position of Fermi energy at 0K

```
//Position of Fermi energy at 0K
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 1-10 in page 34

clear; clc; close;

// Data given
h=1.5*10^-34; // Constant of calculation in Js
m_c=0.067*0.91*10^-30; // Effective mass of
    conduction electron in Kg
n_0=10^24; // Electron concentration at 0K /m^3

// Calculation
E_f= ((h^2*(3*%pi^2*n_0)^(2/3))/(2*m_c));
A=E_f/(1.6*10^-19);

printf("Position of Fermi level at 0K is %0.4f eV",A
    );

// Result
// Fermi energy at 0K as measured from edge of
    conduction band is 0.11 eV
// Fermi energy is placed 0.11 eV above the edge of
    conduction band
// Fermi energy is within the conduction band
```

Scilab code Exa 1.11 Time taken to reach Brillouin zone

```
// Time taken to reach Brillouin zone
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 1-11 in page 46

clear; clc; close;

// Data given
h=1.05*10^-34; // Constant of calculation in Js
Kb=1.112*10^8; // Wave vector at Brillouin xone along x-axis /cm
E_0=10^4; // External electric field applied in V/cm
e=1.6*10^-19; // Charge on an electron in C

// Calculation
tou=(h*Kb)/(e*E_0);

printf(”Time taken by electron is %0.3e s”,tou);

// Result
// Time taken by electron to reach Brillouin zone is 7.297 ps
```

Scilab code Exa 1.12 Calculate drift velocity

```
// Calculate drift velocity
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 1-12 in page 46

clear; clc; close;

// Data given
m_c=0.067*0.91*10^-30; // Effective electron mass in Kg
e=1.6*10^-19; // Charge on an electron in C
E_0=10^5; // External electric field in KV/m
tou1=10^-13; // First Brillouin zone time in s
tou2=10^-12; // Second Brillouin zone time in s
tou3=10^-11; // Third Brillouin zone time in s

// Calculation
v_01=(e*tou1*E_0)/m_c;
v_02=(e*tou2*E_0)/m_c;
v_03=(e*tou3*E_0)/m_c;

printf("(a)Drift velocity in first case is %0.2e m/s\n",v_01);
printf("(b)Drift velocity in second case is %0.2e m/s\n",v_02);
printf("(c)Drift velocity in third case is %0.2e m/s",v_03);

// Result
// (a) Drift velocity in first case is 2.62*10^4 cm/s
// (b) Drift velocity in second case is 2.62*10^5 cm/s
// (c) Drift velocity in third case is 2.62*10^6 cm/s
```

Scilab code Exa 1.13 Compute conductivity drift velocity current density

```
// Compute conductivity,drift velocity,current density
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 1-13 in page 47

clear; clc; close;

// Data given
mu=35.2*10^-4; // Mobility of electrons in m^2/Vs
n_0=7.87*10^28; // Number of free electrons per cubic meter
e=1.6*10^-19; // Charge on an electron in C
E_0=30*10^2; // External electric field applied in V/m

// Calculation
sigma=n_0*e*mu;
printf("(a)Mobility = %0.1e m^2/Vs\n",mu);
printf("Conductivity of the specimen is %0.2e s/m\n\n",sigma);
V_0=mu*E_0;
J=sigma*E_0;
printf("(b)Electric field Eo = %0.0e V/m\n",E_0);
printf("Drift velocity of free electrons is %0.2f m/s\n",V_0);
printf("Current density is %0.2e A/meter^3",J);

```

```
// Result
// (a) Conductivity of specimen is 4.43*10^7 s/m
// (b) Drift velocity of free electrons is 10.56 m/s
// (c) Current density is 13.3*10^10 A/meter cube
```

Scilab code Exa 1.14 Calculate drift velocity in copper conductor

```
// Calculate drift velocity in copper conductor
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 1-14 in page 47

clear; clc; close;

// Data given
A=10^-5; // Cross sectional area in m^2
I=100; // Current flowing in  A
n_0=8.5*10^28; // Free electron concentration of
   copper per cubic meter
e=1.6*10^-19; // Charge on an electron in C

// Calculation
V_d=I/(n_0*A*e);

printf("The drift velocity in copper is %0.3e m/s",
   V_d);

// Result
// Drift velocity in copper is 7.353*10^-4 m/s
```

Scilab code Exa 1.16 Calculate drift velocity in copper

```
// Calculate drift velocity in copper
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 1-16 in page 47

clear; clc; close;

// Data given
tou=10^-14; // Relaxation time in s
m_c=0.02*9.1*10^-31; // Effective mass of electron
    in Kg
E_0=0.1; // Electric field across conductor in V/m
e=1.6*10^-19; // Charge on an electron in C

// Calculation
V_0=(e*E_0*tou)/m_c;

printf("The drift velocity of electrons in copper is
    %0.3f m/s",V_0);

// Result
// Drift velocity of electrons in copper is 0.009 m/
    s
```

Scilab code Exa 1.17 Equilibrium hole concentration in Si

```
// Equilibrium hole concentration in Si
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 1-17 in page 48

clear; clc; close;

// Data given
n_0=10^17; // Free electron concentration /cm^3
n_i=1.5*10^10; // Constant of calculation
// Calculation
p_0= n_i^2/n_0;

printf("Equilibrium hole concentration is %0.2e cm^-3",p_0);

// Result
// Equilibrium hole concentration in Si sample is 2.25*10^3 cm^-3
```

Scilab code Exa 1.18 Time taken to reach Brillouin zone

```
// Time taken to reach Brillouin zone
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 1-18 in page 48

```

```
clear; clc; close;

// Data given
h=1.05*10^-34; // Constant of calculation in Js
kB=1.112*10^8; // Brillouin zone edge along x-axis
e=1.6*10^-19; // Charge on an electron in C
E_0=10^4; // External electric field in V/m

// Calculation
tou=(h*kB)/(e*E_0);
printf("Time taken to reach Brillouin zone is %0.3e s",tou);

// Result
// Time taken by GaAs electron to reach Brillouin zone is 7.298 ps
```

Scilab code Exa 1.20 Electron hole concentration at minimum conductivity

```
// Electron,hole concentration at minimum conductivity
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 1-20 in page 49

clear; clc; close;

// Data given
mu_n=1350; // Mobility of electrons in cm^2/Vs
mu_p=450; // Movility of holes in cm^2/Vs
```

```
n_i=1.5*10^10; // Intrinsic carrier concentration /
    cm^3

// Calculation\
//Minimum conductivity of Si when slightly p-type
    has been proved in text
//Thus the electron and hole concentrations are
    derived as below
n_0=n_i*sqrt(mu_p/mu_n);
p_0=n_i*sqrt(mu_n/mu_p);

printf("(a)Electron concentration is %0.2e cm^-3\n",
    n_0);
printf("(b)Hole concentration is %0.2e cm^-3",p_0);

// Result
// (a) Electron concentration is 8.66*10^9 cm^-3
// (b) Hole concentration is 2.6*10^10 cm^-3
```

Scilab code Exa 1.21 Position of Fermi level at room temperature

```
// Position of Fermi level at room temperature
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 1-22 in page 50

clear; clc; close;

// Data given
C_Ge=4.41*10^22; // Concentration of Ge atom /cm^3
N_D=4.41*10^15; // Number of free donor atoms
```

```
N_C=8.87*10^18; // Number of conduction electrons assuming full ionization
K_BT=0.026; // Measured in eV at room temperature

// Calculation
E_F=K_BT*log(N_D/N_C);

printf("Position of fermi level is %0.4f",E_F);

// Result
// Position of Fermi level from edge of conduction band is -0.1977
// Thus E_F is below E_C
```

Scilab code Exa 1.22 Mobility of free electrons in Alluminium

```
// Mobility of free electrons in Alluminium
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 1-22 in page 50

clear; clc; close;

// Data given
n_0=18*10^28; // Derived from the given formula in textbook
rho=3.44*10^-6; // Resistivity in ohm-cm
e=1.6*10^-19; // Charge on an electron in C

// Calculation
mu=10^2/(n_0*e*rho);
```

```

printf("Mobility of free electrons is %0.0e m^2/V-s"
   ,mu);

// Result
// Mobility of free electrons in Alluminium is 10^-3
    m^2/V-s
```

Scilab code Exa 1.23 Percentage of increse in carrier concentration

```
// Percentage of increse in carrier concentration
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 1-23 in page 51

clear; clc; close;

// Data given
kT=0.026; // Value at T=300K
T=300; // Room temperature in K
dT=1/300; // Rate of change of temperature
E_g=0.785; // Band gap energy in germanium in eV

// Calculation
dni=((1.5+(E_g/(2*kT)))*dT)*100;

printf("Rise in intrinsic carrier concentration is
   %0.1f percent/degree",dni);

// Result
// Percentage rise in intrinsic carrier
```

```
concentration is 5.5 %/degree
```

Scilab code Exa 1.24 Previous problem calculated for intrinsic silicon

```
// Previous problem calculated for intrinsic silicon
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 1-24 in page 51

clear; clc; close;

// Data given
kT=0.026; // Value at T=300K
T=300; // Room temperature in K
dT=1/300; // Rate of change of temperature
E_g=1.21; // Band gap energy in silicon in eV

// Calculation
dni=((1.5+(E_g/(2*kT)))*dT)*100;

printf("Rise in intrinsic carrier concentration is %0.1f percent/degree",dni);

// Result
// Percentage rise in intrinsic carrier concentration is 8.3 %/degree
```

Scilab code Exa 1.25 Find drift velocity mobility conductivity

```
// Find drift velocity,mobility,conductivity
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 1−25 in page 51

clear; clc; close;

// Data given
A=0.835*10^-6; // Cross section of wire in mˆ2
J=2.4*10^6; // Current density in A/mˆ2
n_0=8.4*10^27; // Concentration of electrons in copper in electrons/mˆ3
e=1.6*10^-19; // Charge on an electron in C
ohm=0.0214; // Resistance per meter
E_0=2*ohm; // Electric field in V/m

// Calculations
v_0=(J)/(n_0*e);
printf(”(a)The drift velocity is %0.2e m/s\n”,v_0);
mu=v_0/E_0;
printf(”(b)The mobility of electrons is %0.2e mˆ2/V−s\n”,mu);
sigma=(n_0*10*e*mu);
printf(”(c)Therefore the conductivity is %0.2e /ohm−m”,sigma);

// Result
// (a) The drift velocity is 1.78*10ˆ−3 m/s
// (b) Mobility in this case is 4.16*10ˆ−2 mˆ2/V−s
// (c) Conductivity is 5.61*10ˆ8 1/ohm−m
```

Scilab code Exa 1.26 Determine concentration of electrons and holes

```
// Determine concentration of electrons and holes
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 1-26 in page 52

clear; clc; close;

// Data given
N_D=2*10^14; // Number of donor atoms in atoms/cm^2
N_A=3*10^14; // Number of acceptor atoms in atoms/cm^2
ni=2.5*10^19; // number of intrinsic atoms in atoms/cm^2

// Calculation
p_0=(0.5*10^14)+sqrt(0.25*10^28 + 6.25*10^26);
n_0=-(0.5*10^14)+sqrt(0.25*10^28 + 6.25*10^26);
printf("(a)Concentration of free electrons is %0.3e cm^-3\n",n_0);
printf("(b)Concentration of holes is %0.3e cm^-3\n",p_0);
printf("since p_0>n_0 the sample is p-type\n");
printf("When N_A=N_D=10^15,\n n_0=p_0 from the neutrality equation\n");
printf("Thus the germanium sample in this question is intrinsic by compensation");
printf("When N_D=10^16,\n");
p_0=(6.25*10^26)/10^16;
```

```
printf("(c)p_0=%0.2e cm^-3\n",p_0);
printf("Since n_0>p_0,germanium sample in this case is n-type");

// Result
// (a) Number of free electrons are 0.058*10^14 cm^-3
// (b) Number of holes are 1.058*10^14 cm^-3
// Semiconductor can be made intrinsic without doping or by equal doping
```

Scilab code Exa 1.27 Concentration of holes and electrons

```
// Concentration of holes and electrons
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 1-27 in page 52

clear; clc; close;

// Data given
sigma=100; // Conductivity of p-type germanium
e=1.6*10^-19; // Charge on an electron in eV
mu_p=1800; // Mobility of holes in cm^2/Vs
ni=2.5*10^13; // Number of intrinsic atoms in germanium
mu_n=1300; // Mobility of electrons in cm^2/Vs
sigma1=0.1; // Conductivity in n-type silicon in /ohm-cm
ni1=1.5*10^10; // Number of intrinsic atoms in silicon
```

```
P_p=3.47*10^17; // Constant of calculation

// Calculation
printf(”For Germanium:\n”);
p_0=sigma/(e*mu_p);
n_0=(ni^2)/P_p;
printf(”(a)Concentration of holes is %0.2e cmˆ−3\n”,p_0);
printf(”(b)Concentration of electrons is %0.2e mˆ−3\n”,n_0);
printf(”For Silicon:\n”);
n_0=sigma1/(e*mu_n);
p_0=(ni1^2)/(4.81*10^14);
printf(”(c)Concentration of electrons is %0.2e cmˆ−3\n”,n_0);
printf(”(d)Concentration of holes is %0.2e mˆ−3”,p_0);

// Result
// (a) For Ge,Hole conc. = 3.47∗10ˆ17 cmˆ−3, Electron conc. = 1.8∗10ˆ15 mˆ−3
// (b) For Si,Hole conc. = 4.68∗10ˆ5 cmˆ−3, Electron conc. = 4.81∗10ˆ14 cmˆ−3
```

Scilab code Exa 1.28 To prove resistivity is 45 ohm cm

```
// To prove,resistivity is 45 ohm−cm
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 1−28 in page 53

```

```
clear; clc; close;

// Data given
ni=2.5*10^13; // Intrinsic concentration /cm^3
mu=5600; // Sum of mobilities of holes and electrons
e=1.6*10^-19; // Charge on an electron in C

// Calculation
sigma=e*ni*mu;
printf("Conductivity of germanium is %0.3f (s/cm)
   ^-1\n",sigma);
rho=1/sigma;
printf("Therefore resistivity is %0.1f ohm-cm",rho);

// Result
// Conductivity of germanium = 0.0232 (s/cm)^-1
// Resistivity = 44.6 ohm-cm
```

Scilab code Exa 1.29 Find conductivity of intrinsic germanium

```
// Find conductivity of intrinsic germanium
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 1-29 in page 53

clear; clc; close;

// Data given
ni=2.5*10^13; // Intrinsic concentration /cm^3
e=1.6*10^-19; // Charge on an electron in C
mu_n=3800; // Mobility of electrons in cm^2/Vs
```

```
mu_p=1800; // Mobility of holes in cm^2/Vs
N_D=4.41*10^15; // Concentration of donor atoms in Ge /cm^3

// Calculation
sigma=(ni*e)*(mu_n+mu_p);
printf("(a)Intrinsic conductivity=%0.4f s/cm\n",sigma);
p_0=(ni^2)/N_D;
printf("p_0=%0.2e /cm^3\n",p_0);
sigma1=N_D*e*mu_n;
printf("(b)Since n_0>p_0, Conductivity=%0.2f s/cm\n",sigma1);
n_0=(ni^2)/N_D;
printf("With given acceptor impurity,\nn_0=%0.2e /cm^3\n",n_0);
sigma2=N_D*e*mu_p;
printf("(c)Since p_0>n_0, Conductivity=%0.2f s/cm",sigma2);

// Result
// (a) Conductivity in first case is 0.0224 s/cm
// (b) Conductivity in second case is 2.68 s/cm
// (c) Conductivity in third case is 1.27 s/cm
```

Chapter 2

Diode Fundamentals

Scilab code Exa 2.1 Calculate width of depletion layer

```
// Calculate height of potential-energy barrier
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 2-1 in page 77

clear; clc; close;

// Given data
rho1=1.5; // Resistivity of p-side of Ge diode in
    ohm-cm
rho2=1; // Resistivity of n-side of Ge diode in ohm-
    cm
e=1.6*10^-19; // Charge on an electron in C
mu_p=1800; // Mobility of holes
mu_n=3800; // Mobility of electrons

// Calculation
N_A=1/(rho1*e*mu_p);
N_D=1/(rho2*e*mu_n);
```

```
printf(”(a) rho = 2 ohm−cm\n”);
printf(”N_A=%0.2e /cmˆ3\n”,N_A);
printf(”N_D=%0.2e /cmˆ3\n”,N_D);
printf(”The height of the potential energy barrier is:\n”);
V_0=0.026*log((N_A*N_D)/(2.5*10^13)^2);
printf(”V_0=%0.3f eV\n\n”,V_0);
printf(”(b)For silicon:\n”);
N_A1=1/(rho1*e*500);
N_D1=1/(2*e*1300);
printf(”N_A=%0.2e /cmˆ3\n”,N_A1);
printf(”N_D=%0.2e /cmˆ3\n”,N_D1);
V_01=0.026*log((N_A1*N_D1)/(1.5*10^10)^2);
printf(”The height of the potential energy barrier is:\n”);
printf(”V_0=%0.3f eV”,V_01);

// Result
// (a) For Ge, V_0 = 0.226 eV
// (b) For Si, V_0 = 0.655 eV
```

Scilab code Exa 2.2 Width of depletion zone at 300K

```
// Width of depletion zone at 300K
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 2−2 in page 83

clear; clc; close;

// Given data
```

```
N_d=10^16; // Donor concentration /cm^3
N_a=5*10^18; // Acceptor concentration /cm^3
ni=1.5*10^10; // Intrinsic concentration /cm^3
e=1.6*10^-19; // Charge on an electron in C
epsln=11.8*8.85*10^-14; // Constant of calculation

// Calculation
V_0=0.0259*log((N_d*N_a)/(ni^2));
printf("The height of the barrier energy is %0.2f V\n",V_0);

W=sqrt(2*((epsln*V_0)/(e)*((1/N_a)+(1/N_d))));
printf("Width of depletion zone is %0.3e cm",W);

// Result
// The height of the barrier energy is 0.86 V
// Width of depletion zone in n-type Si is 3.354*10^-5 cm
```

Scilab code Exa 2.3 Find thermal and barrier volatge

```
// Find thermal and barrier volatge
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 2-3 in page 84

clear; clc; close;

// Given data
T=303; // Temperature in K
ni=1.5*10^16; // Intrinsic concentration /cm^3
```

```
e=1.6*10^-19; // Charge on an electron in C
k_BT=1.38*10^-23; // Measured in eV at 303K
N_A=10^22; // Acceptor concentration /cm^3
N_D=1.2*10^21; // Donor concentration /cm^3

// Calculation
V_T=(k_BT*T)/e;
printf("Thermal voltage = %0.2e V\n",V_T);
ni1=ni^2;
printf("ni^2 = %0.3e\n",ni1);
V_0=V_T*log((N_A*N_D)/(ni1));
printf("Barrier voltage = %0.3f V",V_0);

// Result
// Thermal voltage = 26.1 mV
// Barrier voltage = 0.635 V
```

Scilab code Exa 2.4 Barrier potential for silicon junction

```
// Barrier potential for silicon junction
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 2-4 in page 84

clear; clc; close;

// Given data
t=[70 0]; // Declaring the variables
t1=25; // Given temperature in K

// Calculation
```

```
alp=[1 2];
for i=1:2
delta_V=-0.002*(t(i)-t1);
Vb=0.7+delta_V;
printf("(%0.0f)delta_V at %d degrees = %0.2f V\n",alp(i),t(i),delta_V);
printf("Thus the barrier potential at %d degress = %0.2f V\n",t(i),Vb);
end

// Result
// (a) Barrier potential at 70 degrees is 0.61 V
// (b) Barrier potential at 0 degrees is 0.75 V
```

Scilab code Exa 2.5 Find depletion layer capacitance

```
// Find depletion layer capacitance
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 2-5 in page 86

clear; clc; close;

// Given data
epsln=12/(36*%pi*10^11); // Constant for Si in F/cm
A=8.11058*10^-1; // Cross sectional area in m^2
mu_p=500; // Mobility of holes
e=1.6*10^-19; // Charge on an electron in C
V_j=4.9; // Junction potential in V

// Calculation
```

```
printf("(a)We have C_t/A = sqrt((e*epsnl)/2)*sqrt(Na/Vj)\n");
K=sqrt((e*epsln)/2);
printf("sqrt((e*epsln)/2) = %0.2e\n",K);
printf("Hence C_t = %0.2e * sqrt(Na/Vj) F/cm^2\n",K);
K1=K*10^12;
printf("Or C_t = %0.2e * sqrt(Na/Vj) pF/cm^2\n",K1);
N_A=1/(3*mu_p*e);
C_T=(2.9*10^-4)*sqrt(N_A/V_j)*(8.14*10^-3);
printf("(b)The depletion layer capacitance = %0.2f pF",C_T);

// Result
// (a) The expression for depletion layer capacitance is proved
// (b) The depletion layer capacitance in silicon is 68.84 pF
```

Scilab code Exa 2.6 Compute decrease in capacitance

```
// Compute decrease in capacitance
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 2-6 in page 87

clear; clc; close;

// Given data
V=6.5; // Incresed bias voltage in V
lambda=(20*sqrt(5)); // Constant of calculation
```

```

// Calculation
C_T=lambda/sqrt(V);

printf("Transition capacitance of abrupt junction at 6.5 V = %0.2f pF\n",C_T);
printf("This corresponds to a decrese of 2.46 pF");

// Result
// Transition capacitance = 17.54 pF
// This corresponds to a decrese of 2.46 pF
```

Scilab code Exa 2.7 Calculate barrier capacitance of Ge

```
// Calculate barrier capacitance of Ge
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 2-7 in page 87

clear; clc; close;

// Given data
epsln=1.41*10^-12; // Dielectric constant
A=0.0225; // Junction area in cm^2
W=2*10^-4; // Space-charge thickness in cm

// Calculation
C_T=epsln*(A/W);

printf("Barrier capacitance = %0.2e F",C_T);

```

```
// Result
// Barrier capacitance = 159.3 pF
```

Scilab code Exa 2.8 Calculate width of depletion layer

```
// Calculate width of depletion layer
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 2-8 in page 87

clear; clc; close;

// Given data
V=[10.2 0.3 0.1]; // Applied voltages in V
epsln=16; // Constant of calculation
A=1*10^-6; // Cross sectional area in m^2

// Calculation
alp=[1 2 3];
for i=1:3
    W=sqrt((V(i)*10^-10)/14.3);
    printf("(%0.0f)Width of depletion layer for %0.2f V = %0.2e mu-m\n\n",alp(i),V(i),W);
end
W=[8.5 1.45];
alp1=[1 2];
for j=1:2
    C_T=(epsln*10^-9)/(36*%pi*W(j));
    printf("(%0.0f)Space charge capacitance for %0.2f mu-m = %0.2e F\n\n",alp(j),W(j),C_T);
end
```

```

// Result
// Widths of depletion layer are:
// (a) 8.5 mu-m
// (b) 1.45 mu-m
// (c) 0.84 mu-m respectively
// Space charge capacitances are:
// (a) 16.65 pF
// (b) 97.6 pF respectively
```

Scilab code Exa 2.10 Reverse saturation point of current

```
// Reverse saturation point of current
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 2-10 in page 93

clear; clc; close;

// Given data
b=2.11; // Constant
Lsigma=3*10^-4; // Constant
Vt=0.026; // Threshold voltage in V
A=1.5*10^-6; // Cross sectional area in mm^2
sigmai=2.24; // Intrinsic conductivity /ohm-cm

// Calculation
I_0=((A*Vt*b*sigmai^2)/(1+b)^2)*((1/0.45)+(1/0.015))
    ;

printf("Reverse saturation point of current is %0.2e
```

```
A”,I_0);

// Result
// Reverse saturation point of current is 2.94 mu–A
```

Scilab code Exa 2.12 Find reverse saturation current

```
// Find reverse saturation current
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 2–12 in page 94

clear; clc; close;

// Given data
A=5*10^-2; // Cross sectional area in m^2
b=2.6; // Constant of calculation
Lsigma=10^-4; // Constant of calculation
sigmai=4.32*10^-6; // Intrinsic conductivity in ohm/cm
Vt=0.026; // Constant in eV

// Calculation
I_0=A*Vt*(b/(1+b)^2)*sigmai^2*(2*10^4);

printf(”The reverse saturation current = %0.2e A”,I_0);

// Result
// The reverse saturation current = 97.25 pA
```

Scilab code Exa 2.13 Ratio of reverse saturation current

```
// Ratio of reverse saturation current
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 2-13 in page 95

clear; clc; close;

// Given data
b1=2.6; // Constant of calculation
b2=2.11;// Constant of calculation
sigmai1=4.32*10^-6; // Intrinsic conductivity for Si
    /ohm-cm
sigmai2=2.24*10^-2; // Intrinsic conductivity for Ge
    /ohm-cm

// Calculation
printf("For Si:\n");
Y1=((b1*sigmai1^2)/(1+b1)^2)*(2*10^4);
printf("Y_Si = %0.2e ohm-cm^2\n",Y1);
printf("For Ge:\n");
Y2=((b2*sigmai2^2)/(1+b2)^2)*(2*10^2);
printf("Y_Ge = %0.2e ohm-cm^2\n",Y2);
Y=Y2/Y1;
printf("Therefore the ratio is %0.1e",Y);


// Result
// Y_Si = 7.49*10^-8 ohm-cm^2
```

```
// Y_Ge = 2.189*10^-2 ohm-cm^2
// Ratio = 0.29*10^6
```

Scilab code Exa 2.14 Calculate the current flowing

```
// Calculate the current flowing
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 2-14 in page 96

clear; clc; close;

// Given data
I_0=9*10^-7; // Current flowing in A
V=0.1; // Applied forward bias in V

// Calculation
I=I_0*(exp(40*V)-1);
printf("Current flowing through diode = %0.2e A",I);

// Result
// Current flowing through the diode under forward
   bias = 48.15 mu-A
```

Scilab code Exa 2.15 Find voltage to be applied

```
// Find voltage to be applied
```

```
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 2-15 in page 96

clear; clc; close;

// Given data
J_0=500*10^-3; // Saturation current density in mA/m^2
J=10^5; // Forward current density in A/m^2
e=1.6*10^-19; // Charge on an electron in C
etaK=1.38*10^-23; // Constant of calculation
T=350; // Temperature in K

// Calculation
A=2.303*log10(2*10^5);
V=(A*etaK*T)/e;

printf("Voltage to be applied = %0.4f V",V);

// Result
// The voltage to be applied = 0.3685 V
```

Scilab code Exa 2.16 Find current when forward biased

```
// Find current when forward biased
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 2-16 in page 97
```

```

clear; clc; close;

// Given data
k_T=1.38*10^-23; // Constant of calculation
T=293; // Temperature in K
I_s=1.5*10^-13; // Saturation current in A
e=1.6*10^-19; // Charge on an electron in C
V=0.55; // Forward bias voltage in V

// Calculation
printf("At T = 20 degrees:\n");
V_T=(k_T*T)/e;
I=I_s*(exp(V/0.02527)-1);
printf("V_T = %0.4f V\n",V_T);
printf("(a)I = %0.3e A\n",I);
printf("At T = 100 degrees:\n");
V_T=(k_T*373)/e;
printf("V_T = %0.4f V\n",V_T);
printf("I_s doubles 8 times ie I_s = 256.Therefore,\n");
I=1.5*256*10^-13*(exp(0.55/0.032)-1);
printf("(b)I = %0.3f A",I);

// Result
// (a) At T=20 degrees, I = 4.251*10^-4 A
// (b) At T=100 degrees, I = 0.001 A
```

Scilab code Exa 2.17 Calculate current and voltage

```
// Calculate current and voltage
// Basic Electronics
// By Debashis De
```

```
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 2-17 in page 97

clear; clc; close;

// Given data
I1=2*10^-6; // Saturation current in A
I2=4*10^-6; // Saturation current in A
Vz=100; // Breakdown voltages are equal
eta=2; // Constant of calculation

// Calculation
printf("At V=90V,none of the diodes will break down. I is determined by the diode with the smallest I_0\n");
printf("Thus for D1,I = 1 mu-A and for D2,I = -1 mu-A\n");
V2=eta*0.026*log(1-(I1/I2));
printf("(a)V2 = %0.1e V\n",V2);
printf("(b)V1 = -89.964 V");

// Result
// (a) V2 = -36 mV
// (b) V1 = -89.964 V
```

Scilab code Exa 2.18 Calculate forward currents for voltages

```
// Calculate forward currents for voltages
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
```

```
// Example 2-18 in page 98

clear; clc; close;

// Given data
Vt=0.026; // Thermal voltage at room temperature in eV
V=[0.1 0.2 0.3]; // Given voltages in V

// Calculation
V1=0.026*-2.3;
printf(”(a)V=%0.2f V\n”,V1);
R=(exp(1.92)-1)/(exp(-1.92)-1);
printf(”(b)Ration of forward bias current to reverse bias current=%0.2f\n”,R);
printf(”(c):\n”)
for i=1:3
    I=15*(exp(V(i)/0.026)-1);
    printf(”I = %0.3e A\n”,I);
end

// Result
// (a) V = -0.060 V
// (b) Ratio = -6.83
// (c) Forward currents = 0.687 mA, 32.86 mA and 1.539 A respectively
```

Scilab code Exa 2.19 Factor to be multiplied with reverse saturation current

```
// Factor to be multiplied with reverse saturation current
// Basic Electronics
```

```
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 2–19 in page 98

clear; clc; close;

// Given data
T1=25; // Initial temperature for Ge in degree celcius
T2=70; // Final temperature for Ge in degree celcius
T_2=150; // Final temperature for Si in degree celcius

// Calculation
printf(”(a)Let the reverse saturation current for Ge at 25 degrees be Io(25)\n”);
A=2^((T2-T1)/10);
printf(”The factor to be multiplied when temperature is raised to 70 degrees is %0.0f\n”,A);
printf(”Therefore, Io(70) = %0.0f*Io(25)\n\n”,A);
printf(”(b)Let the reverse saturation current for Si at 25 degrees be Io(25)\n”);
A1=2^((T_2-T1)/10);
printf(”The factor to be multiplied when temperature is raised to 150 degrees is %0.0f\n”,A1);
printf(”Therefore, Io(150) = %0.0f*Io(25)”,A1);

// Results
// (a) Io(70) = 23*Io(25)
// (b) Io(150) = 5793*Io(25)
```

Scilab code Exa 2.20 Leakage resistance shunting the diode

```
// Leakage resistance shunting the diode
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 2-20 in page 99

clear; clc; close;

// Given data
// Kirchoff's law has been applied and equations
   solved to get final expression

// Calculation
I_R=(0.08*5*10^-6)/0.15;
R=10/I_R;
printf("Leakage resistance = %0.2e Mohm",R);

// Result
// Leakage resistance shunting the diode = 3.75 Mohm
```

Scilab code Exa 2.21 Maximum reverse bias voltage to be maintained

```
// Maximum reverse-bias voltage to be maintained
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 2-21 in page 99

clear; clc; close;

// Given data
```

```
Rt=0.15*10^-3; // Thermal resistance of mechanical contact between diode and surroundings in mW/degree celcius
T1=25; // Ambient temperature in degree celcius
T2=35; // Rise in ambient temperature in degree celcius
I_25=5*10^-6; // Reverse saturation current at 25 degrees in mu-A

// Calculation
Po=Rt*(T2-T1);
printf("P_out = %0.2e mW\n",Po);
printf("We know that reverse saturation current doubles for every 10 degree rise in temperature\n");
I_35=2*I_25;
V=Po/I_35;
printf("Thus the maximum reverse bias voltage to be maintained is %0.0f V",V);

// Result
// Maximum reverse bias voltage that can be maintained across diode is 150V
```

Scilab code Exa 2.22 Factor to be multiplied with current

```
// Factor to be multiplied with current
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 2-22 in page 100

```

```
clear; clc; close;

// Given data
V_T=0.0364; // Thermal voltage in V
// Simplified expression for I has been derived
I_25=0.01; // Current at 25 degrees in mA
I_150=2.42; // Current at 150 degrees in mA

// Calculation
printf("At 150 degrees:\n");
I=5792*(exp(0.4/0.0728)-1);
printf("I = %0.0f * Io(25)\n",I);
printf("At 25 degrees:\n");
I=exp(0.4/0.0514)-1;
printf("I = %0.0f * Io(25)\n",I);
R=I_150/I_25;
printf("Factor to be multiplied with current = %0.0f",R);

// Result
// When temp is increased from 25-150 degrees, current has to be multiplied by 242
```

Scilab code Exa 2.24 Find the diffusion length

```
// Find the diffusion length
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 2-24 in page 101

clear; clc; close;
```

```

// Given data
C_D=1.5*10^-6; // Diffusion capacitance in F
D_p=13; // Constant
eta=2; // Constant
V_t=0.026; // Voltage at room temperature in V
I=1*10^-3; // Current in mA

// Calculation
L_p=sqrt((C_D*D_p*eta*V_t)/I);

printf("Diffusion length = %0.3e m",L_p);

// Result
// Diffusion length = 31.84*10^-3 m
```

Scilab code Exa 2.25 Find static resistance

```
// Find static resistance
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 2-25 in page 103

clear; clc; close;

// Given data
I_0=20*10^-6; // Current in micro A
V_F=0.2; // Forward voltage in V

// Calculation
I=I_0*(exp(40*V_F)-1);
```

```
r_dc=(0.0343/(80*10^-6))*exp(0.2/0.0343);

printf("Forward current through the diode = %0.3e A\n",I);
printf("Static resistance = %0.3e ohm",r_dc);

// Result
// Forward current = 59.599 mA
// Static resistance = 0.146 Mohm
```

Scilab code Exa 2.26 Dynamic resistance in Forward Reverse direction

```
// Dynamic resistance in forward,reverse direction
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 2-26 in page 103

clear; clc; close;

// Given data
T=398; // Temperature in K
I_0=80*10^-6; // Current in micro A
eta=1; // Constant
V_F=[-0.2 0.2]; // Forward voltages in Volts
V_T=0.0343; // Thermal voltage in volts

// Calculation
alp=[1 2];
for i=1:2
    R_ac=(V_T/I_0)*exp(V_F(i)/V_T);
    printf("(%0.0f)Dynamic resistance = %0.3e ohm\n"
```

```
        ,alp(i),R_ac);
end

// Result
// (a) Dynamic resistance in forward direction =
   1.258 ohm
// (b) Dynamic resistance in reverse direction =
   0.146 Mohm
```

Scilab code Exa 2.27 Dynamic resistance at forward bias

```
// Dynamic resistance at forward bias
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 2–27 in page 103

clear; clc; close;

// Given data
k_BT=25.86*10^-3; // Constant
I_0=1.5*10^-6; // Current in microA
V=0.15; // Forward bias voltage in volts
V_T=0.02586; // Thermal voltage in volts

// Calculation
R_ac=k_BT/(I_0*exp(V/V_T));

printf("Dynamic resistance = %0.2f W",R_ac);

// Result
// Dynamic resistance at forward bias = 52.17 W
```

Scilab code Exa 2.28 Maximum forward current forward resistance

```
// Maximum forward current,forward resistance
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 2-28 in page 104

clear; clc; close;

// Given data
P_max=2.5; // Maximum power in watt
V_f=0.9; // Forward voltage in V
I_max=2.2; // Maximum current in A

// Calculation
I_fmax=P_max/V_f;
R_f=P_max/(I_max)^2;

printf("(a)Maximum forward current = %0.2f A\n",
   I_fmax);
printf("(b)Forward diode resistance = %0.3f ohm",R_f
   );

// Result
// Forward current = 2.78 A
// Diode forward resistance = 0.517 ohm
```

Scilab code Exa 2.29 Height of potential energy barrier

```
// Height of potential energy barrier
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 2-29 in page 104

clear; clc; close;

// Given data
rho1=2; // Resistivity of p-side in ohm-cm
rho2=1; // Resistivity of n-side in ohm-cm
e=1.6*10^-19; // Charge on an electron in C

// Calculation
N_A1=1/(rho1*e*1800);
N_D1=1/(rho2*e*3800);
N_A2=1/(rho1*e*500);
N_D2=1/(rho2*e*1300);
V_01=0.026*log((N_A1*N_D1)/(2.5*10^13)^2);
V_02=0.026*log((N_A2*N_D2)/(1.5*10^10)^2);
printf("(a)For Ge:\n");
printf("N_A = %0.2e /cm^3\nN_D = %0.2e /cm^3\n",N_A1,N_D1);
printf("Therefore barrier potential energy for Ge = %0.2f eV\n\n",V_01);
printf("(b)For Si:\n");
printf("N_A = %0.2e /cm^3\nN_D = %0.2e /cm^3\n",N_A2,N_D2);
printf("Therefore barrier potential energy for Si =
```

```
%0.3f eV”,V_02);

// Result
// (a) Height of barrier potential energy for Ge = 0.22 eV
// (b) Height of barrier potential energy for Si = 0.667 eV
```

Scilab code Exa 2.30 Dynamic resistance in forward reverse direction

```
// Dynamic resistance in forward,reverse direction
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 2-30 in page 105

clear; clc; close;

// Given data
V_T=0.0343; // Thermal voltage at 398K in V
eta=1; // Constant for Ge

// Calculation
// Final expression for r derived after differentiating w.r.t V
r1=((35*10^-6)/(34.3*10^-3))*exp(5.83);
A1=1/r1;
r2=3.185*10^-6
A2=1/r2;

printf(”(a)Dynamic resistance in forward direction = %0.3f ohm\n”,A1);
```

```
printf(”(b)Dynamic resistance in reverse direction = %0.3e ohm”,A2);

// Result
// (a) Resistance in forward direction = 2.879 ohm
// (b) Resistance in reverse direction = 0.314 Mohm
```

Scilab code Exa 2.31 Maximum and minimum Zener currents

```
// Maximum and minimum Zener currents
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 2–31 in page 110

clear; clc; close;

// Given data
V_z=10; // Zener voltage in V
R_s=1*10^3; // Shunt resistance in K–ohm
R_l=10*10^3; // Load resistance in K–ohm
Vi_max=40; // Maximum input voltage in V
Vi_min=25; // Minimum input voltage in V

// Calculation
I_zmax=((Vi_max-V_z)/1000)-(5*10^-3);
I_zmin=((Vi_min-V_z)/R_s)-(5*10^-3);

printf(”Maximum value of zener current = %0.2e A\n”,I_zmax);
printf(”Minimum value of zener current = %0.2e A”,I_zmin);
```

```

// Result
// Maximum zener current = 25 mA
// Minimum zener current = 10 mA
```

Scilab code Exa 2.32 Find the range for R

```
// Find the range for R
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 2-32 in page 110

clear; clc; close;

// Given data
P=250; // Maximum power dissipation in mW
V=15; // Supply voltage in V

// Caluclation
I=(250*10^-3)/5;
printf("Maximum permissible current = %0.3e A\n",I);
printf("10 percent of 50mA = 5mA\n");
I1=I-(5*10^-3);
printf("Maximum current through diode to maintain
   constant voltage = %0.1e A",I1);

// Result
// Maximum current to maintain constant voltage = 45
   mA
```

Scilab code Exa 2.33 Find breakdown voltage

```
// Find breakdown voltage
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 2–33 in page 111

clear; clc; close;

// Given data
E=1.5*10^5; // Electric field in V/cm
epsln=11.9*8.854*10^-16; // Constant
e=1.6*10^-19; // Charge on an electron in eV
N_d=2*10^15; // Doping concentration /cm^3

// Calculation
W=(E*epsln)/(e*N_d);
V_b=(W*E)/2;

printf("Width of depletion region = %0.3e m\n",W);
printf("Therefore,breakdown voltage Vbr = %0.4f V",
   V_b);

// Result
// Breakdown voltage = 0.3704 V
```

Scilab code Exa 2.35 Calculate Vz

```
// Calculate V_z
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 2-35 in page 112

clear; clc; close;

// Given data
// (a) Proof of V_z=51/sigma has been given
sigmai=1/45; // Intrinsic conductivity in 1/ohm-cm
sigmap=1/3.9; // Conductivity of p material in1/ohm-
   cm
I_0=6*10^-6; // Current in microA

// Calculation
Vz1=51/sigmai;
Vz2=51/sigmap;
I=I_0*(exp(100/26)-1);
printf("(a)Proof of V_z=51/sigmap has been given\n")
   ;
printf("(b)When material is intrinsic, Vz = %0.3f V\
   n",Vz1);
printf("(c)When resistivity drops, Vz = %0.1f V\n",
   Vz2);
printf("(d)I = %0.3e A",I);

// Result
// (a) Vz = 51/sigmap is proved
// (b) Vz1 = 2300V
// (c) Vz2 = 198.9V
// (d) I = 0.274 mA
```

Scilab code Exa 2.37 Find the ideality factor

```
// Find the ideality factor
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 2-37 in page 112

clear; clc; close;

// Given data
I1=0.5*10^-3; // Diode current in mA at 340mV
I2=15*10^-3; // Diode current in mA at 465mV
kb_T=5*10^-3; // Constant in mV

// Calculation
// After simplifying the current equation we get an
   expression for eta
eta=5/(2.303*log10(30));

printf("Ideality factor = %0.2f",eta);

// Result
// Ideality factor = 1.47
```

Scilab code Exa 2.38 Temperature coefficient of Avalanche diode

```
// Temperature coefficient of Avalanche diode
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 2-38 in page 113

clear; clc; close;

// Given data
V=12; // Voltage of avalanche diode in V
T=1.7*10^-3; // Temperature coeff of Si diode

// Calculation
A=(T/V)*100;
printf("Temperature coeff in percentage = %0.4f
    percent/degree-C",A);

// Result
// Temperature coeff in percentage = 0.0142 %/degree
    -C
```

Scilab code Exa 2.39 Limits for varying V

```
// Limits for varying V
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 2-39 in page 113

clear; clc; close;

```

```
// Given data
I_d=5*10^-3; // Diode current in mA
R=2.5*10^3; // Resistance in K–ohm
I_T=40*10^-3; // Diode current in mA

// Calculation
I_max=I_T-I_d;
printf(”(a)I_max = %0.2e A\n”,I_max);
printf(”(b)Minimum I_d for good regulation is 5 mA, hence I_T=30 mA\n”);
V_max1=(30*3.5)+60;
printf(”V_max = %0.0f V\n”,V_max1);
printf(”Maximum I_d for good regulation is 40 mA, hence I_T=65 mA\n”);
V_max2=(65*3.5)+60;
printf(”V_max = %0.1f V”,V_max2);

// Result
// (a) I_max = 35 mA
// (b) V_max1 = 165 V
// (c) V_max2 = 287.5 V
```

Chapter 3

Diode Circuits

Scilab code Exa 3.1 Calculate the dc load current

```
// Find current if diode is forwar-biased
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 3-1 in page 143

clear; clc; close;

// Given data
I=29.8*10^-3; // Current in mA
V=0.208; // Voltage in V

// Calculation
I=(45-V)/(1.5*10^3);
printf("I = %0.2e A\n",I);
printf("For this current,V = 0.2 V\n");
printf("(a)Therefore I = 29.8 mA\n");
printf("(b)If battery is inserted with reverse polarity,voltage drop across the 1.5 K resistors is only 15 mV and may be neglected\n");
```

```
printf("(c)In forward direction , I=29.8 mA\n");
printf("In reverse direction we draw a load line from V=-30 V to I=-30 mA\n");
y=[-30 -25 -20 -15 -10 -5 0];
x=[-30 -25 -20 -15 -10 -5 0];
x=-30-y;
plot(x,y);
xlabel('Voltage');
ylabel('Current');
title('Current in forward direction');
I=-30*(20/30);
printf("Then,I = %0.0f mA\n",I);
printf("Current=20 mA as there is a 10 V drop");

// Result
// Graph shows current in reverse direction
// I' = -20 mA
// Set axis positions to 'origin' in axis properties to view the graph correctly
```

Scilab code Exa 3.2 Find the diode currents

```
// Find the diode currents
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 3-2 in page 144

clear; clc; close;

// Given data
R=10*10^3; // Resistance in K-ohms
```

```

// Calculation
printf("(a) R = 10K.Assume both diodes are conducting.We have:\n");
printf("100 = 10.02*I1 + 10*I2 + 0.2\n 100 = 10.01*I2 + 10*I1 + 0.6\n");
function y=f(i);
    y(1)=10.02*i(1)+10*i(2)+0.2-100
    y(2)=10.015*i(2)+10*i(1)+0.6-100
endfunction
ans=fsolve([0.1;0.1],f);
I1=ans([1]);
I2=ans([2]);
printf("I1 = %0.3f A,I2 = %0.3f A\n",I1,I2);
printf("Solving,we find I2<0.Thus D is not ON\n");
I1=(100-0.2)/10.02;
printf("I1 = %0.2e A and I2 = 0\n\n",I1);
printf("(b) R=1K.Assume both diodes are ON,we have:\n");
printf("100 = 1.52*I1 + 1.5*I2 + 0.2\n 100 = 1.515*I2 + 1.5*I1 + 0.6\n");
function y1=g(j);
    y1(1)=1.52*j(1)+1.5*j(2)+0.2-100
    y1(2)=1.515*j(2)+1.5*j(1)+0.6-100
endfunction
ans1=fsolve([0.1;0.1],g);
I1=ans1([1]);
I2=ans1([2]);
printf("Solving,we find\nI1 = %0.3f A and I2 = %0.3f A.Hence assumption is valid",I1,I2);

// Result
// Since both currents are positive,assumption is valid for I1 = 39.717 mA and I2 = 26.287 mA
```

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

Scilab code Exa 3.3 Calculate break region

```
// Calculate break region
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 3-3 in page 145

clear; clc; close;

// Given data
R=10^4; // Factor multiplied with dynamic resistance of diode
Vt=26; // Thermal voltage in volts
eta1=2; // Constant at room temperature for Si
eta2=1; // Constant at room temperature for Ge

// Calculation
printf("r1/r2 = 10^4\n");
V1=eta1*Vt*4*2.3;
V2=eta2*Vt*4*2.3;
printf("Break region for silicon = %0.0f mV\n",V1);
printf("Break region for Germanium = %0.0f mV",V2);

// Result
// Break region for silicon = 478 mV
// Break region for Germanium = 239 mV
```

Scilab code Exa 3.4 Calculate the peak load current

```
// Calculate the peak load current
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 3-4 in page 153

clear; clc; close;

// Given data
Rf=30; // Internal resistance in ohms
Rl=990; // Load resistance in ohms
Vm=110; // Rms supply voltage in in V

// Calculation
Im=(Vm/2)/(Rf+Rl);
I_dc=Im/%pi;
I_rms=Im/2;
V_dc=(Im*Rl)/%pi;
Pi=I_rms^2*(Rf+Rl);
R=(((Vm/%pi)-(I_dc*Rl))/(I_dc*Rl))*100;

printf("(a)Im = %0.2e A\n",Im);
printf("(b)I_dc = %0.2e A\n",I_dc);
printf("(c)I_rms = %0.2e A\n",I_rms);
printf("(d)V_dc = %0.3e V\n",V_dc);
printf("(e)Input power = %0.2f W\n",Pi);
printf("(f)Percentage regulation = %0.3f percent",R)
    ;

```

```
// Result
// (a) Im=53.9mA
// (b) Idc=17.2mA
// (c) Irms=27mA
// (d) Vdc=16.99V
// (e) Pi=0.74W
// (f) Percentage regulation=106%
```

Scilab code Exa 3.8 Calculate the dc load current

```
// Calculate the dc load current
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 3-8 in page 157

clear; clc; close;

// Given data
Vm=280; // Supply voltage in V
Rl=2000; // Load resistance in ohms
Rf=500; // Internal resistance of the diodes in ohms

// Calculation
Idc=(2*Vm)/(%pi*2500);
Idc_t=Idc/2;
printf("(a)I_dc = %0.2e A\n(b)I_dc(tube) = %0.2e A\n
  ",Idc,Idc_t);
printf("(c)Voltage across conducting diode is
  sinusoidal with a peak value 0.2 Vm\n");
V_rms=0.905*(280*sqrt(2));
Pdc=Idc^2*Rl;
```

```
R=(Rf/Rl)*100;
printf("Rms voltage V_rms = %0.0f V\n",V_rms);
printf("(d)DC output power = %0.1f W\n",Pdc);
printf("(e)Percentage regulation = %0.0f percent",R);

// Result
// (a) Idc = 71 mA,
// (b) Idc_tube = 35.7 mA,
// (c) V_rms = 358 V,
// (d) P_dc = 10.167W,
// (e) Percentage regulation = 25%
```

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

Scilab code Exa 3.10 Full scale reading of dc meter

```
// Full scale reading of dc metere
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 3-10 in page 158

clear; clc; close;

// Given data
R=5020; // Total resistance in ohm
Vrms=5.58; // Input rms voltage in V
// Calculation
I_dc=(2*sqrt(2)*Vrms)/(%pi*5020);
V_0=R*I_dc;
```

```
printf("Full scale reading = %0.2f V",V_0);

// Result
// Full scale reading = 5.58 V
```

Scilab code Exa 3.11 Find dc output Peak inverse voltage

```
// Find dc output,Peak inverse voltage
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 3-11 in page 159

clear; clc; close;

// Given data
Vi=220; // AC input voltage in V
N=10; // Turn ratio of transformer

// Calculation
V2=Vi/N;
Vm=sqrt(2)*V2;
V_dc=0.318*Vm;
PIV=Vm;

printf("(a)DC output voltage = %0.2f V\n",V_dc);
printf("(b)PIV = %0.2f V",Vm);

// Result
// (a) Dc output voltage = 9.89V
// (b) PIV = 31.11 V
```

Scilab code Exa 3.12 Determine maximum and average values of power

```
// Determine maximum and average values of power
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 3-12 in page 159

clear; clc; close;

// Given data
V1=230; // Input voltage in V
N=1/3; // Turn ratio
Rl=200; // Load resistance in ohms

// Calculation
V2=V1*N;
Vm=sqrt(2)*V2;
Im=Vm/Rl;
P=Im^2*Rl;
Vdc=0.318*Vm;
Idc=Vdc/Rl;
Pdc=Idc^2*Rl;
printf("Maximum load power = %0.2f W\n",P);
printf("Average load power = %0.2f W",Pdc);

// Result
// Maximum power = 58.78 W
// Average power = 5.94 W
```

Scilab code Exa 3.13 Find maximum value of ac voltage

```
// Find maximum value of ac voltage
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 3-13 in page 160

clear; clc; close;

// Given data
Vdc=30; // DC voltage in V
Rf=25; // Internal resistance in ohms
Rl=500; // Load resistance in ohms

// Calculation
Idc=Vdc/Rl;
Im=%pi*Idc;
Vi=Im^2*(Rf+Rl);
printf("Voltage required at the input = %0.2f V",Vi)
    ;

// Result
// Voltage required at the input is = 18.65 V
```

Scilab code Exa 3.14 Calculate ac voltage rectification efficiency

```
// Calculate ac voltage,rectification efficiency
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 3-14 in page 160

clear; clc; close;

// Given data
Vdc=100; // DC voltage in V
Rl=500; // Load resistance in ohms
Rf=20; // Internal resistance in ohms

// Calculation
Idc=Vdc/Rl;
Im=Idc*%pi;
Vm=Im*(Rl+Rf);
eta=(0.406/(1+(Rf/Rl)))*100;

printf("(a)AC voltage required = %0.2f V\n",Vm);
printf("(b)Rectification efficiency = %0.0f percent"
   ,eta);

// Result
// (a) Vm = 326.73V
// (b) Rectification efficiency = 39 percent
```

Scilab code Exa 3.15 Find current dc voltage voltage across load

```
// Find current,dc voltage,voltage across load
// Basic Electronics
// By Debashis De
```

```
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 3-15 in page 150

clear; clc; close;

// Given data
Vm=50; // Maximum voltage in V
f=50; // Frequency in Hz
Rf=20; // Internal resistance in ohms
Rl=5000; // Load resistance in ohms

// Calculation
Im=Vm/(Rl+Rf);
printf("Since diode conducts only during pisitive half of the input,Im = %0.0e A\n",Im);
printf("(a)Hence i = 10*sin100*pi*t\n");
Vdc=(Im/%pi)*Rl;
printf("(b)V_dc = %0.1f V\n",Vdc);
printf("Hence V_0v=15.9sin100*pi*t\n");
printf("(c)When diode is reverse biased,voltage across diode = %0.1f*sin100*pi*t for 0<100*pi*t<pi and 0 for pi,100*pi*t<2*pi",Vdc);

// Result
// (a) Current in the circuit = 10sin100*pi*t
// (b) DC output voltage across load = 15.9sin100*pi*t
// (c) Voltage across diode = 15.9sin100*pi*t for 0<100*pi*t and 0 for pi<100*pi*t<2*pi
```

Scilab code Exa 3.16 Estimate value of capacitance needed

```
// Estimate value of capacitance needed
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 3-16 in page 161

clear; clc; close;

// Given data
Vrms=230; // RMS voltage in V
f=50; // Frequency in Hz
gamma_hwr=0.003; // Ripple factor assumed
I=0.5; // Load current in A

// Calculation
Vm=sqrt(2)*Vrms;
Vdc=(Vm/%pi);
Rl=Vdc/I;
C=1/(2*sqrt(3)*f*gamma_hwr*Rl);
printf("Capacitance needed = %0.2e F",C);

// Result
// Capacitance needed = 9.29 mF
```

Scilab code Exa 3.17 Calculate the ripple factor

```
// Calculate the ripple factor
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 3-17 in page 161
```

```

clear; clc; close;

// Given data
Rl=3.15*10^3; // Load resistance in K-ohms
Rf=20; // Internal resistance in ohms
Vm=230; // Maximum voltage in volts
f=50; // Frequency in Hertz

// Calculation
Irms=0.707*(Vm/(Rl+Rf));
Idc=0.637*(Vm/(Rl+Rf));
gamma_fwr=sqrt((Irms/Idc)^2-(1));

printf("Ripple factor = %0.2f",gamma_fwr);

// Result
// Ripple factor = 0.48
```

Scilab code Exa 3.18 Find DC output voltage pulse frequency

```
// Find DC output voltage,pulse frequency
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 3-18 in page 162

clear; clc; close;

// Given data
Vp=230; // Peak voltage in V
f=50; // Frequency in Hz
```

```
Rl=200; // Load resistance in ohms
N=1/4; // Turn ratio

// Calculation
Vs=Vp*N;
Vm=Vs*sqrt(2);
Idc=(2*Vm)/(%pi*Rl);
Vdc=Idc*Rl;
fout=2*f;
printf("(a)DC output voltage = %0.2f V\n",Vdc);
printf("(b)Pulse frequency of output = %0.0f Hz",fout);

// Result
// (a) Vdc = 51.77 V
// (b) F_out = 100 HZ
```

Scilab code Exa 3.19 Find maximum dc voltage

```
// Find maximum dc voltage
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 3-19 in page 162

clear; clc; close;

// Given data
Vp=220; // Peak voltage in V
f=50; // Frequency in Hz
Rl=1.5*10^3; // Load resistance in ohms
N=0.1; // Turn ratio
```

```

// Calculation
Vs=Vp*N;
Vrms=Vs*sqrt(2);
Vm=Vrms/2;
Idc=(2*Vm)/(%pi*Rl);
Vdc=Idc*Rl;
printf("Maximum dc output voltage = %0.2f V",Vdc);

// Result
// Dc output voltage = 9.9 V
```

Scilab code Exa 3.20 Calculate input voltage value of filter

```
// Calculate input voltage,value of filter
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 3-20 in page 163

clear; clc; close;

// Given data
Vdc=30; // DC voltage in volts
Rl=1000; // Load resistance in ohms
gamma_fwr=0.015; // Ripple factor

// Calculation
Idc=Vdc/Rl;
C=2900/(gamma_fwr*Rl);
Vm=Vdc+((5000*Idc)/C);
Vi=(2*Vm)/sqrt(2);
```

```
printf("Value of capacitor filter = %0.0f mu-F",C);
printf("Input voltage required = %0.2f V\n",Vi);


// Result
// V_in = 43.52 V
// C = 193 mu-F
```

Scilab code Exa 3.21 Calculate inductance for L section filter

```
// Calculate inductance for L-section filter
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 3-21 in page 163

clear; clc; close;

// Given data
C=40*10^-6; // Capacitance in micro-F
r=0.0001; // Ripple factor
Vm=40; // Maximum voltage in V
Idc=0.1; // DC current in A
R=40; // Circuit resistance in ohms

// Calculation
L=(1.76/C)*sqrt(0.472/r);
Vdc=((2*sqrt(2)*Vm)/%pi)-(Idc*R);

printf("(a)Inductance L = %0.2e H\n",L);
printf("(b)Output voltage = %0.0f V",Vdc);

```

```
// Result
// (a) L = 3.02*10^6 H
// (b) V_dc = 32 V
```

Scilab code Exa 3.22 DC output voltage and ripple voltage

```
// DC output voltage and ripple voltage
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 3-22 in page 164

clear; clc; close;

// Given data
C=4; // Capacitances in micro-F
L=20; // Inductance choke in H
Il=50*10^-6; // Load current in micro-A
R=200; // Resistance of choke in ohm

// Calculation
Vdc=(300*sqrt(2))-((4170/C)*0.05)-(0.05*R);
r=(3300*0.05)/(4*4*20*353);
Vrms=r*Vdc;

printf("(a)Output voltage = %0.2f V\n",Vdc);
printf("(b)Ripple voltage = %0.3f V",Vrms);

// Result
// (a) Output voltage = 362.13 V
// (b) Ripple voltage = 0.529 V
```

Scilab code Exa 3.23 Sketch steady state output

```
// Sketch steady state output
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 3-23 in page 168

clear; clc; close;

// Given data
Rf=0; // Forward resistance of diode
Rr=2*10^6; // Reverse resistance of diode

// Calculation
printf("Diode conducts when Vi<2.5 V\n");
printf("Diode is open when Vi>2.5 V and Vo = 2.5+((
    Vi-2.5)/3)\n");
printf("Diode conducts when Vi>2.5 V");

// Result
// Diagram shows the output of the clipping circuit
    to a sinusoidal input
```

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

Scilab code Exa 3.24 Sketch output voltage Vo

```
// Sketch output voltage Vo
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 3-24 in page 169

clear; clc; close;

// Given data
// Data is provided in the diagrams

// Calculation
printf("(a)When Vi<50 V, Second diode conducts\n");
Vo=100-((2/3)*27);
printf("Vo = %0.0f V\n",Vo);
printf("When 50<Vi<100 both diodes conduct and Vo=Vi
   .When Vi>100, only the first diode conducts.Hence
    Vo = 100 V\n");
printf("(b)When Vi<25 V,neither diodes conduct and
   Vo = 25 V.When Vi>25,upper diode conducts\n");
Vi=((100-25)*(3/2))+25;
printf("When Vo reaches 100 V, Vi rises to %0.1f V",
   Vi);

// Result
// The output voltage is shown in the xcos diagrams
```

Scilab code Exa 3.25 Devise a circuit

```
// Devise a circuit
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 3-25 in page 169

clear; clc; close;

// The xcos diagram shows the devised circuit
```

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

Scilab code Exa 3.27 Find currents and voltages

```
// Find currents and voltages
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 3-27 in page 179

clear; clc; close;

// Given data
//Diode acts as short circuited.Both diodes are
   forward biased
V1=0; // Voltage at junction 1 in V
V2=0; // Voltage at junction 2 in V

//Calculation
I1=(20-V1)/(20*10^3);
```

```
I2=(V2-(-10))/(20*10^3);

printf("I1 = %0.0e A\n",I1);
printf("I2 = %0.1e A",I2);

// Result
// I1 = 1 mA
// I2 = 0.5 mA
```

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

Scilab code Exa 3.28 Find voltage across diode

```
// Find voltage across diode
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 3-28 in page 180

clear; clc; close;

// Given data
I=0.1075; // Cirremt across diode in A
Rd=1; // Internal resistance of diode in ohm

// Calculation
Vd=I*Rd;
printf("Voltage across diode = %0.4f V",Vd);

// Result
// Voltage across diode = 0.1075 V
```

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

Scilab code Exa 3.30 Calculate R Il max

```
// Calculate R, I_l(max)
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 3-30 in page 181

clear; clc; close;

// Given data
V_0=50; // Zener diode voltage in V
I_L=0; // Load current in A

// Calculation
R=(150)/(40*10^-3);
printf("(a)R = %0.2e ohm\n",R);
printf("I_L = I_max when Id = Id_min = 10mA\n");
I_Lmax=40-10;
printf("(b)Maximum load current = %0.0f mA",I_Lmax);

// Result
// (a) R = 3.75 K-ohms
// (b) I_Lmax = 30 mA
```

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

Chapter 4

BJT Fundamentals

Scilab code Exa 4.1 Calculate Base and Collector Currents

```
// Calculate Base and Collector Currents
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 4-1 in page 208

clear; clc; close;

// Given Data
alpha=0.90; // Current Gain in CB mode
Ico=15*10^-6; // Reverse saturation Current in micro-A
Ie=4*10^-3; // Emitter Current in mA

// Calculations
Ic=Ico+(alpha*Ie);
Ib=Ie-Ic;

printf("(a)The value of the Base Current is %0.2e A\n",Ib);
```

```
printf(”(b)The value of the Collector Current is %0.3e A \n”,Ic);

// Results
// (a) The value of the Base Current is 385 mu–A
// (b) The value of the Collector Current is 3.615 mA
```

Scilab code Exa 4.2 Calculate alpha using beta

```
// Calculate alpha using beta
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 4–2 in page 209

clear; clc; close;

// Given Data
beta_bjt=90; // beta gain for the BJT
Ic=4*10^-3; // Collector Current in mA

// Calculations
alpha=beta_bjt/(1+beta_bjt);
Ib=Ic/beta_bjt;
Ie=Ic+Ib;

printf(”(a)The Current gain alpha for BJT is %0.3f \n”,alpha);
printf(”(b)The value of the base Current is %0.2e A \n”,Ib);
printf(”(c)The value of the Emitter Current is %0.2e
```

```
A \n",Ie);

// Results
// (a) The Current Gain alpha for BJT is 0.989
// (b) The value of the Base Current is 44.44 mu-A
// (c) The value of the Emitter Current is 4.04 mA
```

Scilab code Exa 4.3 Collector Current in C E mode

```
// Collector Current in C-E mode
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 4-3 in page 209

clear; clc; close;

// Given Data
alpha=0.90; // Current Gain of BJT
Ico=15*10^-6; // Reverse Saturation Current of BJT in micro-A
Ib=0.5*10^-3; // Base Current in C-E mode in mA

// Calculations
beta_bjt=alpha/(1-alpha);
Ic=(beta_bjt*Ib)+(beta_bjt+1)*Ico;

printf("(a)The value of Current gain beta for BJT is %0.0f \n",beta_bjt);
printf("(b)The value of the Collector Current is %0.2e A \n",Ic);

```

```
// Results
// (a) The value of Current Gain beta for BJT is 9
// (b) The value of the Collector Current is 4.65 mA
```

Scilab code Exa 4.4 Calculate beta for the BJT

```
// Calculate beta for the BJT
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 4-4 in page 209

clear; clc; close;

// Given Data
Ib=20*10^-6; // Base current in micro-A
Ic=5*10^-3; // Collector Current in mA

// Calculations
beta_bjt=Ic/Ib;

printf("The Current gain beta for the Device is %0.0
   f \n",beta_bjt);

// Results
// The Current Gain beta for the Device is 250
```

Scilab code Exa 4.5 To Compute Alpha Beta and Emitter Current

```
// To Compute alpha, beta and Emitter Current
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 4-5 in page 209

clear; clc; close;

// Given Data
Ib=50*10^-6; // Base Current in mu-A
Ic=5*10^-3; // Collector Current in mA

// Calculations
Ie=Ic+Ib;
beta_bjt=Ic/Ib;
alpha=Ic/Ie;

printf("(a)The value of the Emitter Current is %0.2e A \n",Ie);
printf("(b)The value of beta gain of the BJT is %0.0f \n",beta_bjt);
printf("(c)The value of alpha gain of the BJT is %0.3f \n",alpha);

// Results
// (a) The value of the Emitter Current is 5.05 mA
// (b) The value of beta gain of the BJT is 100
// (c) The value of alpha gain of the BJT is 0.990
```

Scilab code Exa 4.6 Calculate alpha reverse and beta reverse

```
// Calculate alpha reverse and beta reverse
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 4-6 in page 210

clear; clc; close;

// Given Data
Ie=10*10^-3; // Emitter Current in mA
Ib=5*10^-3; // Base Current in mu-A

// Calculations
Ic=Ie-Ib;
beta_reverse=Ib/Ic;
alpha_reverse=Ie/Ic;

printf("The value of inverse beta of the BJT is %0.0
   f \n",beta_reverse);
printf("The value of inverse alpha of the BJT is %0
   .0f \n",alpha_reverse);

// Results
// The value of inverse beta of the BJT is 1
// The value of inverse alpha of the BJT is 2
```

Scilab code Exa 4.7 Calculate Labeled Currents and Voltages

```
// Calculate Labeled Currents and Voltages
// Basic Electronics
// By Debashis De
// First Edition, 2010
```

```
// Dorling Kindersley Pvt. Ltd. India
// Example 4-7 in page 210

clear; clc; close;

// Given Data
beta_bjt=100; // beta gain of BJT
Vbe=0.7; // Base-Emitter voltage of BJT in V

//Calculation
Vcc1=10;
Vee1=-10;
Ve1=-0.7;
R1=10*10^3;
Ie1=(Vcc1-Vbe)/R1;
Ib1=Ie1/(beta_bjt+1);
Vc1=Vcc1-R1*(Ie1-Ib1);
Vcc2=10;
Vee2=-15;
Ve2=-0.7;
R2=5*10^3;
Ie2=(Vcc2-Vbe)/R2;
Ic2=(beta_bjt/(beta_bjt+1))*Ie2;
Vc2=Vee2+R2*(Ie2);
printf("Circuit 1:\n(a)Emitter Current=%0.2e A\n(b)
   Base Current=%0.2e A\n(c)Collector Voltage=%0.3f
   V\n\n",Ie1,Ib1,Vc1);
printf("Circuit 2:\n(a)Emitter Current=%0.2e A\n(b)
   Collector Current=%0.3e A\n(c)Collector Voltage=
   %0.3f V\n",Ie2,Ic2,Vc2);

// Results
// (a) Circuit 1 : Emitter Current = 0.93 mA
// (b) Circuit 1 : Base Current = 9.2 mu-A
//(c) Circuit 1 : Collector Voltage = 0.792 V

//(a) Circuit 2 : Emitter Current = 1.86 mA
//(b) Circuit 2 : Collector Current = 1.842 mA
```

```
//(c) Circuit 2 : Collector Voltage : -5.7 V
```

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

Scilab code Exa 4.8 Calculate labeled Voltages

```
// Calculate labeled Voltages
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 4-8 in page 211

clear; clc; close;

// Given Data
Vbe=0.7; // Base-Emitter voltage of BJT in V
Vcc2=10; // DC voltage across Collector in V
Vee2=-15; // DC voltage across Emitter in V
Rc2=5*10^3; // Collector Resistance in K-ohms
// Beta Current Gain of BJT is Infinity

// Calculations
Vb1=0;
Ve1=-0.7;
Ve2=0.7;
Vc2=Vee2+Rc2*((Vcc2-Vbe)/Rc2);

printf("Circuit 1:\n(a)Base Voltage = %0.1f V\n(b)Emitter Voltage = %0.1f V\n",Vb1,Ve1);
printf("Circuit 2:\n(a)Emitter Voltage = %0.1f V\n(b)Collector Voltage = %0.1f V\n",Ve2,Vc2);
```

```

//Results
// Circuit 1 : Base Voltage = 0 V
// Circuit 1 : Emitter Voltage = -0.7 V
// Circuit 2 : Emitter Voltage = 0.7 V
// Circuit 2 : Collector Voltage = -5.7 V
```

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

Scilab code Exa 4.9 Calculating BJT parameters assuming Vbe

```
// Calculating BJT parameters assuming Vbe
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 4-9 in page 211

clear; clc; close;

// Given Data
Ve=1; // Emitter Voltage of BJT in V
Vbe=0.7; // Base-Emitter Voltage of BJT in V
Rb=20*10^3; // Base Resistance of Circuit in K-ohms
Rc=5*10^3; // Collector Resistance of Circuit in K-
   ohms
Re=5*10^3; // Emitter Resistance of Circuit in K-
   ohms
Vcc=5; // DC voltage across Collector in V
Vee=-5; // DC voltage across Emitter in V

// Calculations
```

```
Vb=Ve-Vbe;
Ib=Vb/Rb;
Ie=(Vcc-1)/Re;
Ic=Ie-Ib;
Vc=(Rc*Ic)-Vcc;
beta_bjt=Ic/Ib;
alpha=Ic/Ie;

printf("Circuit Parameters:\n(a)Base Voltage = %0.3f
    V\n(b)Base Current = %0.3e A\n(c)Emitter Current
    = %0.3e A\n(d)Collector Current = %0.3e A\n(e)
   Collector Voltage = %0.3f V\n(f)beta gain = %0.3f
   \n(g)alpha gain = %0.3f\n",Vb,Ib,Ie,Ic,Vc,
   beta_bjt,alpha);

// Results
// For the BJT Circuit,
// (a) Base Voltage = 0.3 V
// (b) Base Current = 0.015 mA
// (c) Emitter Current = 0.8 mA
// (d) Collector Current = 0.785 mA
// (e) Collector Voltage = -1.075 volt
// (f) Beta gain = 52.3
// (g) Alpha gain = 0.98
```

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

Scilab code Exa 4.10 Measurement of Circuit Voltage changes

```
// Measurement of Circuit Voltage changes
// Basic Electronics
// By Debashis De
```

```
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 4-10 in page 211

clear; clc; close;

// Given Data
Vb=-5; // Base Voltage of BJT in V
Rc=1*10^3; // Collector Resistance in K-ohms
Ie=2*10^-3; // Emitter Current of BJT in mA
delB=+0.4; // Change in Base Voltage

// Calculations
delE=+0.4;
delC=0;

printf("(a)Change in Emitter voltage is +%0.2f V\n",
   delE);
printf("(b)Change in Collector Voltage is %0.2f V\n"
   ,delC);

// Results
// (a) Change in Emitter Voltage in the Circuit =
   +0.4 V
// (b) Change in Collector Voltage in the Circuit =
   0.0 V
```

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

Scilab code Exa 4.11 To Determine mode of operation of BJT

```
// Determine mode of operation of BJT
```

```
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 4-11 in page 212

clear; clc; close;

// Given Data
Vbe=0.7; // Base-Emitter Voltage in V
beta_bjt=100; // beta gain of BJ

// Calculation
printf("Assume active mode for circuit 1\n");
Vb1=2;
Ve_1=Vb1-Vbe;
Ie1=1*10^-3;
Ic1=Ie1*(beta_bjt/(1+beta_bjt));
Ve1=6-(3*0.99);
printf("(a)Ve = %0.2f V\n(b)Ic = %0.2e A\n(c)Ve = %0
    .2f V\n",Ve_1,Ic1,Ve1);
printf("Thus the circuit operates in an active mode\
    n\n");

printf("For circuit 2,assume active mode\n");
Vcc=1;
Ve2=Vcc+Vbe;
Ie2=(6-Ve2)/(10*10^3);
Vc=0+(10*0.43);
printf("(a)Ve = %0.1f V\n(b)Ie = %0.2e A\n(c)Vc = %0
    .2f V\n",Ve2,Ie2,Vc);
printf("This circuit operates in a saturated mode\n\
    n");

printf("For circuit 3,assume active mode\n");
Ve3=-5+Vbe;
Ie3=(9.5-Ve3)/(200*10^3);
Ic=Ie3*(beta_bjt/(1+beta_bjt));
```

```
Vc3=-50+(0.492*20);
printf("(a)Ve = %0.1f V\n(b)Ie = %0.4e A\n(c)Ic = %0.3e A\n(d)Vc = %0.1f V\n",Ve3,Ie3,Ic,Vc3);
printf("The circuit operates in an active mode\n\n");

printf("For circuit 4,assume active mode\n");
Ve4=-20.7;
Ie4=(30+Ve4)/(5*10^3);
Vc4=(-Ie4*(beta_bjt/(1+beta_bjt))*(2*10^3))-10;
printf("(a)Ie = %0.2e A\n(b)Vc = %0.2f V\n",Ie4,Vc4);
printf("The circuit operates in an active mode");

// Result
// (a) Circuit 1 operates in active mode
// (b) Circuit 2 operates in saturation mode
// (c) Circuit 3 operates in active mode
// (d) Circuit 4 operates in active mode
```

Chapter 5

BJT Circuits

Scilab code Exa 5.1 Calculate BJT parameters using beta gain

```
// Calculate BJT parameters using beta gain
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 5−1 in page 235

clear; clc; close;

// Part 1
// Given Data
beta_bjt=100; // Beta Gain of BJT
Vcc=10; // DC voltage across Collector in V
Rb=100000; // Base Resistance of BJT in ohm
Rc=2000; // Collector Resistance of BJT in ohm
Vbe=0.7; // Base−Emitter voltage of BJT

// Calculations
Ib=(Vcc-Vbe)/((beta_bjt*Rc)+Rc+Rb);
Ic=beta_bjt*Ib;

```

```
Vce=Vcc-(Ib+Ic)*Rc;

printf("Part 1 \n");
printf("(a)The value of Base Current in the BJT
   circuit is %0.3e A \n",Ib);
printf("(b)The value of Collector Current in the BJT
    circuit is %0.3e A \n",Ic);
printf("(c)The value of Collector-Emitter voltage in
    the circuit is %0.3f V \n",Vce);

// Part 2
// Given Data
Vce2=7; // Collector-Emitter voltage of BJT
Vcc=10; // DC voltage across Collector in V
Rc=2000; // Collector Resistance of BJT in ohm
Vbe=0.7; // Base-Emitter voltage of BJT
Rc2=2000; // Collector Resistance of BJT in ohm

// Calculations
constant=(Vcc-Vce2)/Rc;
Ib2=constant/101;
Ic2=100*Ib2;
Rb2=(Vcc-Vbe-(Rc2*constant))/Ib2;

printf("\nPart 2 \n");
printf("(a)The value of the Base Resistance of the
   Circuit is %0.3e ohm \n ",Rb2);

// Results
// Circuit 1: Value of Base Current of circuit =
   0.031 mA
// Circuit 1: Value of Collector Current of circuit
   = 3.1 mA
// Circuit 1: Value of Collector-Emitter voltage of
   BJT circuit = 3.779 V
// Circuit 2: Value of BAse Resistance required =
   424.24 K-ohm
```

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

Scilab code Exa 5.4 To establish Operating Point and Stability Factor

```
// To establish Operating Point & Stability Factor
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 5-4 in page 238

clear; clc; close;

// Given Data
beta_bjt=50; // Beta Gain of the BJT circuit
Vbe=0.7; // Base-Emitter voltage of BJT in V
Vcc=22.5; // DC voltage across Collector in V
Rc=5600; // Resistance across Collector in ohm
Vce=12; // Operating Collector-Emitter voltage of
    circuit in V
Ic=1.5*10^-3; // Operating Collector current of
    circuit in mA
sfactor=3; // Stability factor of the circuit

// Calculations
Re=((Vcc-Vce)/Ic)-Rc;
constant=((beta_bjt+1)*(sfactor-1))/((beta_bjt+1)-
    sfactor);
Rb=constant*Re;
Ib=Ic/beta_bjt;
voltage=(Ib*Rb)+Vbe+((Ib+Ic)*Re);
```

```
R1=Rb*(Vcc/voltage);
R2=(R1*voltage)/(Vcc-voltage);

printf("(a)The value of Emitter Resistance of the
   BJT circuit is %0.2e ohm \n",Re);
printf("(b)The value of Resistance-1 of the BJT
   circuit is %0.2e ohm \n",R1);
printf("(c)The value of Resistance-2 of the BJT
   circuit is %0.2e ohm \n",R2);

// Results
// The value of Emitter Resistance of the BJT
   circuit is 1.4 K-ohm
// The value of Resistance-1 of the BJT circuit is
   22.8 K-ohm
// The value of Resistance-2 of the BJT circuit is
   3.4 K-ohm
```

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

Scilab code Exa 5.5 Design Bias Circuit for given Stability Factor

```
// Design Bias Circuit for given Stability Factor
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 5-5 in page 239

clear; clc; close;

// Given data
```

```
Vcc=20; // Supply DC Voltage in V
Rc=1.5*10^3; // Collector Resistance in ohm
Vce=8; // Collector-Emitter Resistance in V
Ic=4*10^-3; // Collector Current in A
S=12; // Stability Factor of circuit
beta_bjt=50; // Beta Gain of BJT

// Calculations
Ib=Ic/beta_bjt;
Re=(Vcc-Vce-Ic*Rc)/(Ib+Ic);
Rb=Re*((S*beta_bjt)/((beta_bjt+1)-S));
Ie=Ic+Ib;
Vbn=0.2+Ie*Re;
Vth=Vbn+Ib*Rb;
R1=(Vcc*Rb)/Vth;
Ir1=(Vcc-Vbn)/R1;
Ir2=Ir1-Ib;
R2=Vbn/Ir2;

// For S=3
S_2=3;
Rc_2=1.47*10^3;
Re_2=Re;
Rb_2=Re*((S_2*beta_bjt)/((beta_bjt+1)-S_2));
Vth_2=Vbn+(Ib*Rb_2)+6.16;
R1_2=(Vcc*Rb_2)/Vth_2;
Ir1_2=(Vcc-Vbn)/R1_2;
Ir2_2=Ir1_2-Ib;
R2_2=Vbn/Ir2-2;

printf("For S=12 \n");
printf("(a)Ib = %0.2e A \n(b)Ir1 = %0.2e A \n(c)Ir2 = %0.2e A \n",Ib,Ir1,Ir2);
printf("(d)Re = %0.2e ohm \n(e)Rb = %0.2e ohm \n(f)R1 = %0.2e ohm \n(g)R2 = %0.2e ohm \n",Re,Rb,R1,R2);
printf("(h)Base-Ground Voltage Vbn = %0.2f V \n(i)Thevenin Voltage Vth = %0.2f V \n",Vbn,Vth);
```

```
printf("\n For S=3 \n");
printf("(a)Re = %0.2e ohm \n(b)Rb = %0.2e ohm \n(c)R1 = %0.2e ohm \n(d)R2 = %0.2e ohm \n",Re_2,Rb_2,R1_2,R2_2);
printf("(e)Thevenin Voltage Vth = %0.2f V \n(f)Ir1 = %0.2e A \n(g)Ir2 = %0.2e A \n",Vth_2,Ir1_2,Ir2_2);

// Results
//  S=12
// (a) Ib=80 mu-A
// (b) Re=1.47 K-ohm
// (c) Rb=21.17 K-ohm
// (d) Vbn=5.91 V
// (e) Vth=7.60 V
// (f) R1=55.71 K-ohm
// (g) R2=37.16 K-ohm
// (h) IR1=0.253 mA
// (i) IR2=0.173 mA
// S=3
// (a) Rb=3.13 K-ohm
// (b) R1=10.16 K-ohm
// (c) IR1=1.387 mA
// (d) R2=4.52 K-ohm
// (e) IR2=1.307 mA
```

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

Scilab code Exa 5.8 Calculate circuit parameters of a Emitter Follower

```
// Calculate circuit parameters of a Emitter Follower
```

```
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 5-8 in page 251

clear; clc; close;

// Given data
Rs=0.5*10^3; // Source resistance in ohm
Rl=5*10^3; // Load resistance in ohm
hfe=50; // h-parameter value of the BJT
hie=1*10^3; // h-parameter value of the BJT in ohm
hoe=25*10^-6; // h-parameter value of the BJT in A/V

// Calculations
Ai=(1+hfe)/(1+hoe*Rl);
Ri=hie+Ai*Rl;
Av=1-(hie/Ri);
Avs=Av*(Ri/(Ri+Rs));

printf("(a)The current gain of circuit Ai = %0.1f \n",Ai);
printf("(b)The input resistance of circuit Ri = %0.2e ohm \n",Ri);
printf("(c)The voltage gain of circuit Av = %0.4f \n",Av);
printf("(d)The voltage gain of circuit Avs = %0.4f \n",Avs);

// Results
// (a) The current gain of circuit Ai=45.3
// (b) The input resistance of circuit Ri=227 ohm
// (c) The voltage gain of circuit Av=0.9956
// (d) The voltage gain of circuit Avs=0.9934
```

Scilab code Exa 5.9 Design of an Emitter Follower

```
// Design of an Emitter Follower
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 5-9 in page 252

clear; clc; close;

// Given data
Ri=500*10^3; // Input Resistance in ohm
Ro=20; // Output Resistance in ohm
hfe=50; // h-parameter of BJT
hie=1*10^3; // h-parameter of BJT in ohm
hoe=25*10^-6; // h-parameter of BJT in A/V
const=499*10^3; // Product of Ai and Rl in ohm
Av=0.999; // Voltage gain of circuit
const_2=10^6; // Product of Ai and Rl in ohm for Av
   =0.999

// Calculations
Ai=1+hfe-(const*hoe);
Rl=const/Ai;
Rs=((hfe+1)*hoe*Ro)-hie;
Ri_2=hie/(1-Av);
Rl_2=(((1+hfe)/const_2)-1)/hoe;

printf("The current gain of circuit=%0.1f \n",Ai);
printf("When Av=0.999, \n(a)Ri=%0.2e ohm \n(b)Rl=%0
   .2e ohm \n",Ri_2,Rl_2);
```

```

// Results
// The current gain of circuit = 38.5
// For Av = 0.999,
// (a) Ri = 1 M-ohm,
// (b) Rl = -40.0 K-ohm
```

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

Chapter 6

Field Effect Transistor

Scilab code Exa 6.1 Determine approximate drain source resistance

```
// Determine approximate drain-source resistance
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 6-1 in page 274

clear; clc; close;

// Given data
I_ds=10*10^-3; // Drain current in mA
Vp=-2; // Peak voltage in V
Vgs=[0 -0.5]; // Values of Vgs in V

// Calculation
alp=[1 2];
for i=1:2
    r=Vp^2/(2*I_ds*(Vgs(i)-Vp));
    printf("(%0.0f)r_ds when Vgs = %d V is %0.2f ohm\n",alp(i),Vgs(i),r);
end
```

```

// Result
// (a) When Vgs = 0 V, r_ds = 100 ohms
// (b) When Vgs = 0.5 V, r_ds = 133.33 ohms
```

Scilab code Exa 6.2 Find Id and Vds

```
// Find Id and Vds
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 6-2 in page 274

clear; clc; close;

// Given data
Ids=12*10^-3; // Drain current in mA
Vp=-4; // Peak voltage in V
Vgs=-2; // Gate to source voltage in V
Rd=3*10^3; // Drain resistance in K-ohms
Vcc=15; // Supply voltage in V

// Calculation
id=Ids*(1-(Vgs/Vp))^2;
Vds=-id*Rd+Vcc;

printf("(a)Id = %0.0e A\n",id);
printf("(b)Vds = %0.0f V",Vds);

// Result
// (a) Id = 3mA
// (b) Vds = 6V
```

Scilab code Exa 6.3 Find the value of Rd

```
// Find the value of Rd
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 6-3 in page 275

clear; clc; close;

// Given data
Ids=12*10^-3; // Drain current in mA
Vp=-4; // Peak voltage in V
Rs=0; // Source resistance in ohms
Vds=0.1; // Drain-source voltage in V
Vgg=0; // Gate voltage in V

// Calculation
id=Ids*(50*10^-3-625*10^-6);
Rd=(15-Vds)/id;

printf("(a)i_d = %0.3e A\n",id);
printf("(b)Rd = %0.3e ohm",Rd);

// Result
// (a) i_d = 592.6 mu-A
// (b) Rd = 25.15 k-ohm
```

Scilab code Exa 6.4 Find id Vds slope of operation of JFET

```
// Find id,Vds,slope of operation of JFET
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 6-4 in page 275

clear; clc; close;

// Given data
Ids=12*10^-3; // Drain current in mA
Vp=-4; // Peak voltage in V
Rd=1*10^3; // Drain resistance in k-ohm
Vdd=15; // Drain voltage in V

// Calculation
Id=Ids;
Vds=(-Rd*Id)+Vdd;
printf("Id = %0.2e A\n",Id);
printf("Vds = %0.0f V\n",Vds);
printf("Consider it to be operating in the ohmic
    region\n");
Vds1=(7+sqrt(49-45))/(3/2);
Vds2=(7-sqrt(49-45))/(3/2);
printf("Then Vds = %0.2f V,%0.2f V\n",Vds1,Vds2);
printf("6V is neglected since it is lesser than -Vp\
    n");
id=(15-Vds2)/(1*10^3);
Vds=Vds2;
printf("(a)Id = %0.3e A\n",id);
```

```
printf("(b)Vds = %0.2f V",Vds);
printf("Since Vds<Vgs-Vp,operation region is
   confirmed in the ohmic region");

// Result
// (a) Id = 11.67 mA
// (b) Vds = 3.33 V
// (c) Operation region is in the ohmic region
```

Scilab code Exa 6.5 Find id Vgs Rd Vds

```
// Find id,Vgs,Rd,Vds
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 6-5 in page 276

clear; clc; close;

// Given data
Ids=10*10^-3; // Drain current in mA
Vp=-4; // Peak voltage in V
Vdd=12; // Drain voltage in V
Vgg=0; // Gate voltage in V

// Calculation
id=10*10^-3*(1-(2/4))^2;
Vgs=(sqrt(9/10)-1)*4;
Rd=(12-7.5)/(0.625*10^-3);
Vds=12-2-(3*0.625);
printf("(a)Id = %0.2e A\n",id);
printf("(b)Vgs = %0.3f V\n",Vgs);
```

```
printf("(c)Rd = %0.2e ohm\n",Rd);
printf("(d)Vds = %0.3f V",Vds);

// Result
// (a) Id = 2.5 mA
// Vgs = -0.205 V
// (c) Rd = 7.2 k-ohm
// (d) Vds = 8.125 V
```

Scilab code Exa 6.6 Determine Vgs Id Vds operating region

```
// Determine Vgs,Id,Vds,operating region
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 6-6 in page 276

clear; clc; close;

// Given data
Ids=16*10^-3; // Drain current in mA
Vp=-4; // Peak voltage in V
Vdd=18; // Drain voltage in V
Rd=500; // Drain resistance in ohms

// Calculation
vgs1=(-10+sqrt(100-64))/2;
vgs2=(-10-sqrt(100-64))/2;
printf("(a)Vgs = %d V,%d V\n",vgs1,vgs2);
id=-vgs1/500;
Vds=18-((1*10^3)*(4*10^-3));
printf("(b)id = %0.0e A\n",id);
```

```
printf("(c)Vds = %0.0f V\n",Vds);
printf("Saturation region operation is confirmed
   from above results");

// Result
// (a) Vgs = -2V
// (b) Id = 4 mA,
// (c) Vds = 14 V,
```

Scilab code Exa 6.7 Determine Vgs Id Vds

```
// Determine Vgs,Id,Vds
// Determine Vgs,Id,Vds,operating region
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 6-7 in page 277

clear; clc; close;

// Given data
Ids=8*10^-3; // Drain current in mA
Vp=-4; // Peak voltage in V
Vdd=18; // Drain voltage in V
Rd=8*10^3; // Drain resistance in K-ohms

// Calculation
vgs1=(-214+sqrt(214^2-(4*63*180)))/(2*63);
vgs2=(-214-sqrt(214^2-(4*63*180)))/(2*63);
printf("(a)Vgs = %0.2f V,%0.2f V\n",vgs1,vgs2);
id1=-vgs1/(1*10^3);
id2=-vgs2/(1*10^3);
```

```
printf("(b)Id = %0.2e A,%0.2e A\n",id1,id2);
Vds1=((-9*10^3)*id1)+18;
Vds2=((-9*10^3)*id2)+18;
printf("(c)Vds = %0.2f V,%0.2f V",Vds1,Vds2);

// Result
// (a) Vgs = -1.53 V,-1.86 V
// (b) Id = 1.53 mA,1.86 mA
// (c) Vds = 4.23 V,1.26 V
```

Scilab code Exa 6.8 Determine R Ids Vgs

```
// Determine R,Ids,Vgs
// Determine Vgs,Id,Vds,operating region
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 6-8 in page 277

clear; clc; close;

// Given data
Vp=-3; // Peak voltage in V
Vgg=5; // Gate voltage in V
Ids=10*10^-3; // Drain current in mA

// Calculation
R=5/(10*10^-3);
printf("(a)R = %0.0f ohm\n",R);
Ids=5/400;
Vds=(2*Ids*R)+15;
printf("(b)Idss = %0.2e A\n",Ids);
```

```
printf("(c)Vds = %0.0f V\n",Vds);
printf("This confirms active region\n");
Rid=14/2;
Vgs=Vgg-Rid;
printf("(d)Vgs = %0.0f V\n",Vgs);
printf("Vds=2>Vgs-Vp=-1.5+3=1.5 -> Active region");

// Result
// (a) R = 500ohm,
// (b) Ids = 12.5mA,
// (c) Vgs = -2V
```

Scilab code Exa 6.9 Find Id Vgs Vds region of operation

```
// Find Id,Vgs,Vds,region of operation
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 6-9 in page 277

clear; clc; close;

// Given data
Idss=4*10^-3; // Drain current in mA
Vp=-2; // Peak voltage in V
Vdd=10; // Supply voltage in V
Vgs=0; // Gate source voltage in V

// Calculation
Id=Idss*(1-(Vgs/Vp));
printf("(a)Id = %0.0e A\n",Id);
printf("(b)Since Id=Idss, Vgs=0 V\n");
```

```
Vds=10-Vgs;
printf("(c)Vds = %0.0f V\n",Vds);
printf("Since Vds=10V>Vgs-Vp=2V, Active region
   operation of upper JFET is confirmed");

// Result
// (a) Id = 4 mA,
// (b) Vgs = 0 V,
// (c) Vds = 10 V
```

Scilab code Exa 6.10 Find pinch off saturation voltage

```
// Find pinch off, saturation voltage
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 6-10 in page 279

clear; clc; close;

// Given data
Nd=3*10^21; // Donor concentration in /m^3
epsln=12; // Dielectric constant of silicon
epsln_0=12*8.85*10^-12; // Constant of calculation
e=1.6*10^-19; // Charge on an electron in C
a=2*10^-6; // Constant of calculation

// Calculation
Vp=(e*Nd*(a)^2)/(2*epsln_0);
printf("(a)Pinch off voltage = %0.3f V\n",Vp);
Vds=Vp-2;
printf("(b)Saturation voltage = %0.3f V",Vds);
```

```

// Result
// (a) Pinch off voltage = 9.040 V
// (b) Saturation voltage = 7.040 V
```

Scilab code Exa 6.11 Determine drain source resistance

```
// Determine drain-source resistance
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 6-11 in page 287

clear; clc; close;

// Given data
Ids=10*10^-3; // Drain current in mA
Vp=-2; // Peak voltage in V
Vgs=[1 2]; // Gate-source voltage in V

// Calculation
for i=1:2
    rds=Vp^2/(2*Ids*(Vgs(i)-Vp));
    printf("Rds = %0.1f ohm\n",rds);
end

// Result
// Rds = 66.7 ohm, 50 ohm
```

Scilab code Exa 6.12 Determine approximate Rds

```
// Determine approximate Rds
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 6-12 in page 287

clear; clc; close;

// Given data
K=0.25*10^-3; // Constant in mA/V^2
Vt=2; // Voltage in V
Vgs=[4 6 10]; // Drain-source voltage in V

// Calculation
for i=1:3
    rds=1/(2*K*(Vgs(i)-Vt));
    printf("Rds = %0.0f ohm\n",rds);
end

// Result
// Rds = 1 K-ohm, 500 ohm, 250 ohm
```

Scilab code Exa 6.13 Find Vgs operating region Id Rd

```
// Find Vgs,operating region,Id,Rd
```

```
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 6-13 in page 288

clear; clc; close;

// Given data
Vdd=10; // Drain voltage in in V
Vds=6; // Drain-source voltage in V
K=0.2*10^-3; // Constant in mA/V^2
Vt=1; // Voltage given

// Calculation
Vgs=Vds;
printf("(a)Vgs = %0.0f V\n",Vgs);
printf("Vds=6V>Vgs-Vt=5V\n");
Id=K*(Vgs-Vt)^2;
Rd=(Vdd-Vds)/Id;
printf("(b)Id = %0.0e A\n",Id);
printf("(c)Rd = %0.0f ohms",Rd);

// Result
// (a) Vgs = 6 V
// (b) Id = 5 mA
// (c) Rd = 800 ohms
```

Scilab code Exa 6.14 Find operating region Vgs Vds Rd

```
// Find operating region,Vgs,Vds,Rd
// Basic Electronics
// By Debashis De
```

```
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 6-14 in page 288

clear; clc; close;

// Given data
K=0.2*10^-3; // Constant in mA/V^2
Vt=1; // Given voltage in V
Vdd=10; // Drain voltage in V
Id=3.2*10^-3; // Drain current in mA

// Calculation
printf("Vds=Vgs>Vgs-Vt=Active region operation\n");
Vgs=Vt+sqrt(Id/K);
Vds=Vgs;
Rd=(Vdd-Vds)/Id;
printf("(a)Vgs = %0.0f V,\n(b)Vds = %0.0f V,\n(c)Rd = %0.2e ohm",Vgs,Vds,Rd);

// Result
// (a) Vgs = 5 V
// (b) Vds = 5 V
// (c) Rd = 1.56 K-ohms
```

Scilab code Exa 6.15 Find Id when Vgs equals 4V

```
// Find Id when Vgs=4V
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 6-15 in page 288
```

```

clear; clc; close;

// Given data
K=0.15*10^-3; // Constant in mA/V^2
Vt=2; // Given voltgae in V
Vdd=12; // Drain voltage in V
Vgs=4; // Gate-source voltage in V

// Calculation
Vgg=sqrt(5.4/0.15)+2;
Id=K*(Vgs-Vt)^2;
printf("(a)Vgg = %0.0f V,\n(b)Id = %0.1e A",Vgg,Id);

// Result
// (a) Vgg = 8 V
// (b) Id = 0.6 mA
```

Scilab code Exa 6.16 Determine Rd

```
// Determine Rd
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 6-16 in page 289

clear; clc; close;

// Given data
K=0.25*10^-3; // Constant in mA/V^2
Vt=2; // Voltage given in V
Vdd=16; // Drain voltage in V
```

```
Vgg=[4 10]; // Gate voltage values in V

// Calculation
for i=1:2
    id=K*(Vgg(i)-2)^2;
    rd=(16-(Vgg(i)-2))/id;
    printf("Rd when Vgg is %d V = %0.1e ohm\n",Vgg(i),rd);
end

// Result
// (a) Rd = 14 K-ohm
// (b) 500 ohm
```

Scilab code Exa 6.17 Determine Rd

```
// Determine Rd
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 6-17 in page 289

clear; clc; close;

// Given data
K=0.25*10^-3; // Constant in mA/V^2;
Vt=2; // Given voltage in V
Rd=1*10^3; // Drain resistance in ohms
Vdd=16; // Drain voltage in V
Vgg=4; // Gate voltage in V

// Calculation
```

```
id=K*(4-Vt)^2;
Vd=(-1*10^3*id)+16;
printf("(a)Id = %0.0e A,\n(b)Vd = %0.0f V\n",id,Vd);
printf("Since Vds=15>Vgs-Vt=2,active region
   operation is confirmed");

// Result
// (a) Id = 1 mA
// (b) Vds = 15 V
```

Scilab code Exa 6.18 Find Id Vds1 Vds2

```
// Find Id,Vds1,Vds2
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 6-18 in page 289

clear; clc; close;

// Given data
Ids1=8*10-3; // Drain-source current of M1 in mA
Vp=-4; // Peak voltage in V
Ids2=16*10^-3; // Drain-source current of M2 in mA
Vdd=11; // Drain voltage in V
Vgg=10; // Gate voltage in V

// Calculation
Id=Ids2;
printf("(a)Id = %0.2e A\n",Id);
Vds=(28+sqrt(28^2-128))/2;
Vds1=(28-sqrt(28^2-128))/2;
```

```
printf(”(b)Vds1 = %0.2f V, %0.2f V\n”,Vds,Vds1);
printf(”For ohmic operation Vds1 = 1.19 V\n”);
Vds2=Vdd-1.19;
printf(”(c)Vds2 = %0.2f V”,Vds2);

// Result
// (a) Id = 16 mA
// (b) Vds1 = 1.19 V
// (c) Vds2 = 9.81 V
```

Scilab code Exa 6.19 Find operating region Vgs Vds Id

```
// Find operating region,Vgs,Vds,Id
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 6–19 in page 290

clear; clc; close;

// Given data
Ids = 4*10^-3; // Drain–source current in mA
Vp=-4; // Peak voltage in V
Vdd=10; // Drain voltage in V
Rd=1*10^3; // Drain resistance in K–ohms

// Calculation
printf(”(a)Vd=Vgs<Vgs–Vp.Hence ohmic region operation is confirmed\n”);
Vgs1=(-12+sqrt(12^2+160))/2;
Vgs2=(-12-sqrt(12^2+160))/2;
printf(”(b)Vgs = %0.2f V,%0.2f V\n”,Vgs1,Vgs2);
```

```
Vds=Vgs1;
id=(10-Vds)/(1*10^3);
printf("(c)Vds = %0.2f V,\n(d)Id = %0.2e A",Vds,id);

// Result
// (a) Ohmic region operation is confirmed
// (b) Vgs = 2.72V
// (c) Vds = 2.72V
// (d) Id = 7.28mA
```

Scilab code Exa 6.20 Find Vgs Id operating region

```
// Find Vgs,Id,operating region
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 6-20 in page 290

clear; clc; close;

// Given data
Ids=4*10^-3; // Drain-source current in mA
Vp=-4; // Peak voltage in V
Vdd=10; // Drain voltage in V
Vds=6; // Drain-source voltage in V

// Calculation
Vgs=Vds;
printf("(a)Vgs = %0.0f V\n",Vgs);
printf("(b)Vds=Vgs<Vgs-Vp.Hence ohmic region
    operation\n");
Id=4*10^-3*((2*(5/2)*(3/2))-(9/4));
```

```
printf("(c)Id = %0.1e A",Id);

// Result
// (a) Vgs = 6 V
// Ohmic region operation is confirmed
// (c) Id = 21 mA
```

Scilab code Exa 6.21 Find operating region Vgs Vds Id

```
// Find operating region,Vgs,Vds,Id
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 6-21 in page 290

clear; clc; close;

// Given data
K=0.2*10^-3; // Constant in mA/V^2
Vt=1; // Voltage in V
Vdd=10; // Drain voltage in V
Rd=1*10^3; // Drain resistance in ohms

// Calculation
printf("(a)Vds=Vgs>Vgs-Vt.Hence active region operation\n");
printf("0.2*Vgs^2+0.6*Vgs-9.8=0\n");
Vgs1=(-0.6+sqrt(0.6^2-4*0.2*-9.8))/(2*0.2);
Vgs2=(-0.6-sqrt(0.6^2-4*0.2*-9.8))/(2*0.2);
printf("(b)Vgs = %0.2f V or %0.2f V\n",Vgs1,Vgs2);
printf("Since 0<Vgs<10, Vgs = %0.2f V\n",Vgs1);
Id=(Vdd-5.66)/Rd;
```

```
printf("(c)Vds = Vgs = 5.66 V\n(d)Id = %0.2e A",Id);

//Result
// (a) The region of operation is active
// (b) Vgs = 5.66 V
// (c) Vds = 5.66 V
// (c) Id = 4.34 mA
```

Chapter 7

FET Circuits

Scilab code Exa 7.2 Find amplification

```
// Find amplification
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 7-2 in page 312

clear; clc; close;

// Given data
mu=30; // FET parameter
rd=5; // FET parameter
Rd=10; // FET parameter value in ohms
R=50; // Resistor value in ohms

// Calculation
Av=(-299/50)/((1/rd)+(1/Rd)+(1/R));
printf("Amplification Av = %0.1f",Av);

// Result
// Av = -18.7
```

Scilab code Exa 7.3 Find amplification with 40k resistor instead

```
// Find amplification with 40k resistor instead
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 7-3 in page 313

clear; clc; close;

// Given data
Av=-18.7; // Amplification from prev problem
R1=2.54; // Resistance value in ohms
R=40; // Load resistor in K-ohms

// Calculation
Avs=(Av)*(R1/(R1+R));
printf("Amplification Avs = %0.2f",Avs);

// Result
// Avs = -1.11
```

Scilab code Exa 7.6 Find gain if v2 v1 are zero

```
// Find gain if v2,v1 are zero
// Basic Electronics
```

```
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 7-6 in page 315

clear; clc; close;

// Given data
mu=30; // FET parameter
rd=15; // Resistance value in k-ohms
Rd=1; // Drain resistance value in k-ohms
Rs=0.5; // Source resistance in k-ohms

// Calculation
Av1=(-mu*(rd+Rd))/(Rd+((mu+1)^2*Rs)+((mu+2)*rd));
Av2=((mu/(mu+1))*(((mu+1)*Rs)+rd))/(((Rd+rd)/(mu+1))
   +((mu+1)*Rs)+rd);
printf("(a)Av when v2 is zero = %0.3f\n",Av1);
printf("(b)Av when v1 is zero = %0.3f",Av2);

// Result
// (a) Av1 = -0.499
// (b) Av2 = 0.952
```

Scilab code Exa 7.11 Find voltage gain output impedance

```
// Find voltage gain,output impedance
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 7-11 in page 320

```

```
clear; clc; close;

// Given data
// The Thevenin equivalent of fig. is derived

// Calculation
A=(9.5*10)/(10+20);
R_0=(1/(10*10^3))+(1/(20*10^3));
R=1/R_0;
printf("(a)Voltage gain = %0.2f\n",A);
printf("(b)Output impedance = %0.2e",R);

// Result
// (a) A = 3.17
// (b) R_0 = 6.67 K
```

Scilab code Exa 7.12 Find voltage gain A1 and A2

```
// Find voltage gain A1 and A2
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 7-12 in page 321

clear; clc; close;

// Given data
Rd=30*10^3; // Drain resistance in K-ohm
Rs=2*10^3; // Source resistance in K-ohm
mu=19; // Constant for FET
rd=10*10^3; // Dynamic resistance in K-ohm

```

```
// Calculation
A1=(-mu*(Rd+rd+((mu+1)*Rs))*Rd)/((rd+Rd)*(Rd+rd+(2*(
    mu+1)*Rs)));
A2=(mu*(mu+1)*Rs*Rd)/((rd+Rd)*(Rd+rd+(2*(mu+1)*Rs)))
    ;
printf("(a)For the given values of Rd,Rs,rd and mu
    we have:\n");
printf("A1 = %0.2f\nA2 = %0.2f\n\n",A1,A2);
printf("(b)If Rs-->infinity ,\n");
A_1=(-mu*Rd)/(2*(rd+Rd));
printf("A1 = %0.2f = -A2\nOr A1 = -A2 = %0.2f",A_1,
    A_1);

// Result
// (a) A1 = -9.5; A2 = 4.75
// (b) A1 = -A2 = -7.13
```

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

Scilab code Exa 7.13 Determine Vgs Id Vds Av

```
// Determine Vgs,Id,Vds,Av
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 7-13 in page 322

clear; clc; close;

// Given data
Rd=12; // Drain resistance in K-ohms
```

```
Rg=1; // Gate resistance in M-ohms
Rs=0.47; // Source resistance in ohms
Vdd=30; // Drain voltage in volts
Idds=3*10^-3; // Drain-source current in mA

// Calculation
printf("Vgs=-1.41* (1+ 2Vgs/2.4 + Vgs^2/2.4)\n");
Vgs1=(-1.175+sqrt(1.175^2-4*0.245*1.41))/(2*0.245);
Vgs2=(-1.175-sqrt(1.175^2-4*0.245*1.41))/(2*0.245);
printf("(a)Upon solving we get Vgs = %0.3f V or %0.3f V\n",Vgs1,Vgs2);
Id=3*(1-(2.398/2.4))^2;
Vds=Vdd-Id*(Rd+Rs);
gm=((2*Idds)/2.4)*(1-(2.398/2.4));
Av=gm*12;
printf("(b)Drain current Ids = %0.1e A\n",Id);
printf("(c)Vds = %0.2f V\n",Vds);
printf("(d)Small signal voltage gain Av = %0.2e",Av);

// Result
// (a) Vgs = -2.398 V
// (b) Ids = 2.1*10^-6 A
// (c) Vds = 30 V
// (d) Av = 2.5*10^-5
```

Scilab code Exa 7.14 Find the value of R1

```
// Find the value of R1
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
```

```
// Example 7-14 in page 322

clear; clc; close;

// Given data
Idss=2*10^-3; // Drain-source current in mA
Vp=-1; // Voltage in volts
Rd=56*10^3; // Drain resistance in K-ohms
Vdn=10; // Drain to ground voltage in volts
Vdd=24; // Drain voltage in volts

// Calculation
Id=(Vdd-Vdn)/Rd;
Vgs=-0.65;
R1=-Vgs/Id;
printf("R1 = %0.1e ohms",R1);

// Result
// R1 = 2.6 K-ohms
```

Scilab code Exa 7.15 Find Vo for given Vi

```
// Find Vo for given Vi
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 7-15 in page 323

clear; clc; close;

// Given data
Idss=5.6*10^-3; // Drain-source current in mA
```

```
Vp=-4; // Peak voltage in V
Vi=[0 10]; // Input voltage values in V

// Calculation
alp=[1 2];
for i=1:2
    Vg=(-2.8+sqrt(2.8^2-(4*0.35*5.6)))/(2*0.35);
    Id=(Vi(i)+12-Vg)/10;
    Vo=(10*Id)-12;
    printf("(%0.0f)For Vi = %d V, Vo = %0.1f V\n",alp(i),Vi(i),Vo);
end
printf("If Vo = 0,\n");
Vgs=4*(sqrt(0.214)-1);
printf("(3)Then Vi = Vgs = %0.2f V",Vgs);

// Result
// When Vi=0,Vo=4V
// When Vi=10,Vo=14V
// When Vo=0,Vi=-2.15V
```

Scilab code Exa 7.16 Calculate quiescent values of Id Vgs Vds

```
// Calculate quiescent values of Id,Vgs,Vds
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 7-16 in page 324

clear; clc; close;

// Given data
```

```
// We find Thevenins equivalent to the left of the gate

// Calculation
Rth=(1/(200*10^3))+(1/(1.3*10^6));
A=1/Rth;
Vth=(200/1500)*60;
printf("(a)Rth = %0.3e ohms and Vth = %0.0f V\n",A,Vth);
Vgs=(8+sqrt(8^2-(4*16)))/2;
Id=-2-(Vgs/4);
printf("(b)Vgs = %0.0f V and Id = %0.2f mA\n",Vgs,Id);
Vds=-60+((18+4)*2.25);
printf("(c)Vds = %0.1f V",Vds);

// Result
// (a) Id = -3 mA
// (b) Vgs = 4 V
// (c) Vds = -10.5 V
```

Scilab code Exa 7.20 Calculate transconductance amplification factor

```
// Calculate transconductance,amplification factor
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 7-20 in page 328

clear; clc; close;

// Given data
```

```
Id=2*10^-3; // Drain current in mA
Vgs=2; // Gate-source voltage in V
Rd=200*10^3; // Drain resistance in K-ohms

// Calculation
gm=Id/Vgs;
mu=gm*Rd;
printf("(a)Transconductance gm = %0.0e A/V\n",gm);
printf("(b)Amplification factor mu = %0.0f",mu);

// Result
// (a) gm = 1 mA/V
// (b) mu = 200
```

Scilab code Exa 7.21 Calculate dynamic resistance

```
// Calculate dynamic resistance
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 7-21 in page 328

clear; clc; close;

// Given data
mu=80; // Amplification factor
gm=400*10^-6; // Transconductance in micro-mho

// Calculation
rd=mu/gm;
printf("Dynamic resistance Rd = %0.1e ohm",rd);

```

```
// Result
// Rd = 0.2*10^6 ohm
```

Scilab code Exa 7.22 Calculate Rd gm mu

```
// Calculate Rd,gm,mu
// Basic Electronics
// By Debashis De
// First Edition , 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 7-22 in page 329

clear; clc; close;

// Given data
Vds1=6; // Drain-source voltage when Vgs is zero
Vds2=16; // Drain-source voltage when Vgs is 0.3
Id1=12*10^-3; // Drain current in mA when Vgs is zero
Id2=12.3*10^-3; // Drain current in mA when Vgs is zero

// Calculation
rd=(Vds2-Vds1)/(Id2-Id1);
gm=(Id2-Id1)/(0-0.3*10^-3);
mu=-gm*rd*10^-4;
printf("(a)Drain resistance Rd = %0.2e ohms\n",rd);
printf("(b)Transconductance gm = %0.0f(neglecting the sign)\n",-gm);
printf("(c)Amplification factor mu = %0.2f",mu);

// Result
// (a) Rd = 33.33k-ohms
```

```
// (b) gm = 1
// (c) mu = 3.33
```

Scilab code Exa 7.23 Find the value of Rs

```
// Find the value of Rs
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 7-23 in page 329

clear; clc; close;

// Given data
Vgs=1.5; // Gate-source voltage in V
Id=2*10^-3; // Drain saturation current in mA

// Calculation
Rs=Vgs/Id;
printf("Rs = %0.0f ohm",Rs);

// Result
// Rs = 750 ohm
```

Scilab code Exa 7.24 Find voltage gain of amplifier

```
// Find voltage gain of amplifier
// Basic Electronics
```

```
// By Debashis De
// First Edition , 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 7-24 in page 329

clear; clc; close;

// Given data
Rl=250; // Load resistance in k-ohms
gm=0.5; // Transconductance in mA/V
rd=200; // Dynamic resistance in k-ohms

// Calculation
mu=rd*gm;
Av=(-mu*Rl)/(rd+Rl);
printf("Voltage gain Av = %0.2f",Av);

// Result
// Voltage gain Av = -55.55
```

Scilab code Exa 7.25 Find pinch off voltage

```
// Find pinch off voltage
// Basic Electronics
// By Debashis De
// First Edition , 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 7-25 in page 330

clear; clc; close;

// Given data
Idss=10; // Drain-source current in mA
```

```
Vp=-4; // Original pinch off voltage in V
Vgs=-2; // Gate−source voltage in V
gm=4; // Transcondonductance in m−mho

// Calculation
Ids=Idss*(1-(Vgs/Vp))^2;
A=(-2*Ids)/gm;
printf("Pinch off voltage Vp = %0.0f V",A);

// Result
// Vp at gm = 4 m−mho is −1V
```

Scilab code Exa 7.26 Calculate quiescent values of Id Vds Vgs

```
// Calculate quiescent values of Id,Vds,Vgs
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 7−26 in page 330

clear; clc; close;

// Given data
Ids=20*10^-3; // Drain−souce current in mA
Vp=-4; // Pinch off voltage in volts

// Calculation
printf("We get the equation:\n0.3125*Id^2−6*Id+20=0\n");
Id1=(6+sqrt(6^2-4*0.3125*20))/(2*0.3125);
Id2=(6-sqrt(6^2-4*0.3125*20))/(2*0.3125);
printf("Id = %0.1f mA and %0.1f mA\n",Id1,Id2);
```

```
printf("We consider only %0.1f mA\n",Id2);
Vgs=-Id2*0.5;
Vds=30-(Id2*(5+0.5));
printf("Vgs = %0.2f V\n(c)Vds = %0.2f V",Vgs,Vds);

// Result
// Id = 4.3 mA
// Vgs = -2.15 V
// Vds = 6.35 V
```

Scilab code Exa 7.27 Find Id Vds Vgs Av

```
// Find Id,Vds,Vgs,Av
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 7-27 in page 331

clear; clc; close;

// Given data
Idss=3; // Drain-source current in mA
Vp=-2.4; // Pinch off voltage in volts

// Calculation
printf("Id^2-6.73*Id+5.76=0\n");
Id1=(6.73+sqrt(6.73^2-4*1*5.76))/2;
Id2=(6.73-sqrt(6.73^2-4*1*5.76))/2;
printf("Id = %0.2f mA or %0.2f mA\n",Id1,Id2);
printf("(a)The possible value is 1.01 mA\n");
Vgs=-Id2*1;
Vds=20-(1.09*(1+10));
```

```
printf("Vgs = %0.2f V\nVds = %0.2f V\n",Vgs,Vds);
gm=(-2/Vp)*sqrt(Id2*Idss);
Av=gm*10;
printf("(b)Voltage gain Av = %0.1f",Av);

// Result
// Id = 1.01 mA
// Vgs = -1.01 V
// (a) Vds = 8.01 V
// (b) Av = 14.5
```

Scilab code Exa 7.28 Calculate Av Zo Zi

```
// Calculate Av,Zo,Zi
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 7-28 in page 332

clear; clc; close;

// Given data
Rd=15; // Drain resistance in k-ohms
Rg=1; // Gate resistance in M-ohms
rd=5; // Dynamic resistance in k-ohms
gm=5; // Transconductance in m-mho
Vdd=20; // Drain voltage in volts

// Calculation
mu=rd*gm;
Av=(mu*Rd)/(rd+Rd);
Zo=rd;
```

```
Zi=Rg;
printf(”(a)Av = %0.2f\n(b)Zo = %0.0f k–ohms\n(c)Zi = %0.0f M–ohms”,Av,Zo,Zi);

// Result
// (a) Av = 18.75
// (b) Zo = 5 K–ohms
// (c) Zi = 1 M–ohms
```

Scilab code Exa 7.29 Calculate Vo Vi

```
// Calculate Vo,Vi
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 7–29 in page 333

clear; clc; close;

// Given data
Idss=5*10^-3; // Drain–source current in mA
Vp=-4.5; // Pinch off voltage in V

// Calculation
printf(”When Vi is zero:\n”);
Vgs1=(-25.67+sqrt(25.67^2-(4*2.963*55)))/(2*2.963);
Vgs2=(-25.67-sqrt(25.67^2-(4*2.963*55)))/(2*2.963);
printf(”(a)Vgs = %0.2f V or %0.2f V\n”,Vgs1,Vgs2);
printf(”Since the gate is connected to ground,Vo = –Vgs.Hence Vo = %0.2f V or %0.2f V\n”,-Vgs1,-Vgs2);
printf(”When Vo is zero:\n”);
```

```
Id=5/(12*10^3);
Vgs=4.5*(0.288-1);
Vi=Vgs;
printf("(b)Vi = %0.1f V",Vi);

// Result
// (a) When Vi is zero, Vo = 4.78V or 3.88V
// (b) When Vo is zero, Vi = -3.2V
```

Scilab code Exa 7.30 Calculate Av Zo

```
// Calculate Av,Zo
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 7-30 in page 334

clear; clc; close;

// Given data
gm=5; // Transconductance in mA/V
rd=10*10^3; // Dynamic resistance in K-ohms
mu=50; // Amplification factor
Rd=5*10^3; // Drain resistance in K-ohms

// Calculation
Av=(-mu*Rd)/(rd+Rd+((mu+1)*0.1*10^3));
Avs=Av*(100/110);
Zo=rd+((mu+1)*0.1*10^3);
Zo1=(1/15.1)+(1/5);
A=1/Zo1;
printf("Av = %0.2f\n",Av);
```

```
printf("Over all voltage gain Avs = %0.1f\n",Avs);
printf("Output impedance = %0.2e K\n",Zo);
printf("Effective output impedance Zo = %0.2f k-ohms
   ",A);

// Result
// (a) Avs = -11.3
// (b) Zo = 3.75 K-ohms
```

Scilab code Exa 7.31 Calculate Vgsq gm Rs Vdsq Rl

```
// Calculate Vgsq,gm,Rs,Vdsq,Rl
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 7-31 in page 335

clear; clc; close;

// Given data
Vp=-4; // Pinch off voltage in V
Idss=1.65*10^-3; // Drain-source current in mA
Idq=0.8*10^-3; // Desired operating point of current
    in mA
Av=10; // Voltage gain in dB

// Calculation
printf("We know that Id = Idss*(1-(Vgs/Vp))^2\n");
Vgs=4*(sqrt(0.485)-1);
gmo=(-2*Idss)/Vp;
gm=gmo*(1-(Vgs/Vp));
Rs=Vgs/-Idq;
```

```
Rl=Av/gm;
Vds=24-(Idq*Rl)-(Idq*Rs);
printf("(a)Vgsq = %0.3f V\n(b)gm = %0.3e A/V\n(c)Rs
   = %0.3e ohms\n(d)Rl = %0.2e ohms\n(e)Vds = %0.3f
   V\n",Vgs,gm,Rs,Rl,Vds);
printf("Therefore,\n(e)Vdsq = 16.48 V");

// Result
// (a) Vgsq = -1.214 V
// (b) gm = 0.575 mA/V
// (c) Rs = 1.518 K-ohm
// (d) Rl = 17.4 K-ohm
// (e) Vdsq = 16.48 V
```

Scilab code Exa 7.32 Calculate Zo for rd equals 50 k ohms

```
// Calculate Zo for rd=50k-ohms
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 7-32 in page 337

clear; clc; close;

// Given data
rd=50*10^3; // Dynamic resistance in K-ohms
Rd=20*10^3; // Drain resistance in K-ohms

// Calculation
Zo=(rd*Rd)/(rd+Rd);
printf("Output impedance Zo = %0.3e ohms",Zo);

```

```
// Result
// Zo = 14.28 K-ohms
```

Scilab code Exa 7.33 Find voltage gain Current gain ratio

```
// Find voltage gain,Current gain ratio
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 7-33 in page 337

clear; clc; close;

// Given data
Rd=5*10^3; // Drain resistance in K-ohms
Rg=500*10^3; // Gate resistance in K-ohms
mu=60; // Amplification factor
rds=30*10^3; // Dynamic resistance in K-ohms

// Calculation
Av=(mu*Rd)/(Rd+rds);
Ai=(mu*Rg)/(rds+Rd);
printf("(a)Voltage gain Av = %0.2f\n(b)Current gain
   Ai = %0.2f",Av,Ai);

// Reuslt
// (a) Av = 8.57
// (b) Ai = 857.14
```

Scilab code Exa 7.34 Determine Zo draw small signal model

```
// Determine Zo,draw small signal model
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 7-34 in page 338

clear; clc; close;

// Given data
gm=1; // Transconductance in m-mho
rd=50*10^3; // Dynamic resistance in K-ohms
Rd=5*10^3; // Drain resistance in K-ohms

// Calculation
printf("The equivalent circuit at low-frequency
   small signal model is as shown in the figure\n");
Zo=(rd*Rd)/(Rd+rd);
printf("Zo = %0.2e ohms",Zo);

// Result
// Zo = 4.54 K-ohms
```

Scilab code Exa 7.35 Find values of R2 Vdd Vds

```
// Find values of R2,Vdd,Vds
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 7–35 in page 338

clear; clc; close;

// Given data
Vp=-5; // Pinch off voltage in V
Idss=12*10^-3; // Drain–source current in mA
Vdd=18; // Drain voltage in V
Rs=2*10^3; // Source resistance in K–ohms
Rd=2*10^3; // Drain resistance in K–ohms
R2=90*10^3; // Original value of R2 in K–ohms

// Calculation
Vgs1=(-5.3+sqrt(5.3^2-(4*0.48*10.35)))/(2*0.48);
Vgs2=(-5.3-sqrt(5.3^2-(4*0.48*10.35)))/(2*0.48);
printf(”Vgs = %0.2f V or %0.2f V\nTherefore Vgs = −2.53 V\n”,Vgs1,Vgs2);
Id=(3.306-Vgs2)/2;
Vds=18-(Id*Rd)-(Id*Rs);
r2=(13.47*400)/4.53;
vdd=((16-2.53)*(400+90))/90;
vds=vdd-16-16;
printf(”(a)The new value of R2 is %0.1f K–ohm\n”,r2);
printf(”(b)The new value of Vdd = %0.2f V\n”,vdd);
printf(”(c)The new value of Vds = %0.2f V”,vds);

// Result
// (a) R2 = 1189.4 K–ohm
// (b) Vdd = 73.34 V
// (c) Vds = 41.34 V
```

Scilab code Exa 7.36 Equation for drain current

```
// Equation for drain current
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 7-36 in page 340

clear; clc; close;

// Given
Idss=12; // Drain source current in mA
Vgs=-5; // Gate source voltage in V when off

// Calculation
printf("Equation for drain current:Id = %0.0f*(1-(
   Vgs/%0.0f))^2",Idss,Vgs);
x=[-5 -4 -3 -2 -1 0];
y=[12 11 10 9 8 7 6 5 4 3 2 1 0];
y=12*(1+(x/5))^2;
plot(x,y);
xlabel('Vgs');
ylabel('Id');
title('Transfer characteristics of FET');

// Result
// Graph shows the transfer characteristics of FET
   for the given values
// Set axis properties to 'origin' to view graph
   correctly
```

Scilab code Exa 7.37 Find Vgs Vp

```
// Find Vgs,Vp
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 7-37 in page 340

clear; clc; close;

// Given data
Idss=12; // Drain-source current in mA
Vgs_off=-6; // Gate-source voltage when FET is off

// Calculation
Vgs=6*(sqrt(5/12)-1);
Vp=Vgs_off;
printf("(a)Vgs = %0.2f V\n(b)Vp = -Vgs(off) = 6V",
    Vgs);

// Result
// (a) Vgs = -2.13 V
// (b) Vp = 6 V
```

Scilab code Exa 7.38 Find the values of Rs and Rd

```
// Find the values of Rs and Rd
```

```
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 7-38 in page 341

clear; clc; close;

// Given data
Id=1.5*10^-3; // Drain current in mA
Vds=10; // Drain-source voltage in V
Idss=5*10^-3; // Drain-source current in mA
Vp=-2; // Pinch off voltage in V
Vdd=20; // Drain voltage in V

// Calculation
Vgs=2*(sqrt(1.5/5)-1);
Vs=-Vgs;
Rs=Vs/Id;
Rd=(20-10.9)/Id;
printf("Rs = %0.1e ohms\nRd = %0.2e ohms",Rs,Rd);

// Result
// Rs = 0.6 K-ohms
// Rd = 6.06 K-ohms
```

Scilab code Exa 7.39 Find the value of Rs

```
// Find the value of Rs
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
```

```
// Example 7-39 in page 341

clear; clc; close;

// Given data
Id=2.5*10^-3; // Drain current in mA
Vds=8; // Drain-source voltage in V
Vdd=30; // Drain voltage in V
R1=1*10^6; // R1 value in M-ohms
R2=500*10^3; // R2 value in K-ohms
Idss=15*10^-3; // Drain-source current in mA
Vp=-5; // Pinch off voltage in volts

// Calculation
Vgs=5*(sqrt(5/30)-1);
V2=(Vdd*R2)/(R1+R2);
Rs=(V2-Vgs)/Id;
printf("Rs = %0.2e ohms\n",Rs);
Rd=(Vdd-Vds-(Id*Rs))/Id;
printf("Rd = %0.2e ohms",Rd);

// Result
// Rs = 5.18 K-ohms
// Rd = 3.62 K-ohms
```

Scilab code Exa 7.40 Calculate voltage gain Av

```
// Calculate voltage gain Av
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 7-40 in page 342
```

```

clear; clc; close;

// Given data
gm=2*10^-3; // Transconductance in mA/V
rd=10*10^3; // Dynamic resistance in K-ohms
Zc=31.83*10^3; // Capacitive impedance in K-ohms
Vth=16.67; // Thevenin voltage in V at 1 KHz

// Calculation
R=(rd*25*10^3)/(rd+(25*10^3));
Av=-gm*R;
printf("(a)Av after neglecting capacitance = %0.2f\n
   ",Av);
Rth=(rd*50*10^3)/(rd+50*10^3);
Av1=(-50*10^3*Vth)/((50*10^3+Rth)-%i*Zc);
printf("(b)Av after considering capacitance = %0.2f"
   ,Av1);

// Result
// Av after neglecting capacitance = -14.28
// Av after considering capacitance = -11.01
```

Scilab code Exa 7.41 Calculate voltage amplification in circuit

```
// Calculate voltage amplification in circuit
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 7-41 in page 343

clear; clc; close;
```

```

// Given data
gfs=2*10^-3; // Transconductance in mS
Rl=10*10^3; // Load resistance

// Calculation
Av=gfs*Rl;
printf("Av = %0.0f",Av);

// Result
// Av = 20
```

Scilab code Exa 7.43 Find the value of Rs

```
// Find the value of Rs
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 7-43 in page 344

clear; clc; close;

// Given data
Idss=10*10^-3; // Drain-source current in mA
Vp=-5; // Pinch off voltage in V

// Calculation
Vgs = 5*(sqrt(6.4/10)-1);
Rs=-Vgs/(6.4*10^-3);
printf("Rs = %0.0f ohms",Rs);

// Result
```

```
// Rs = 156 ohms
```

Scilab code Exa 7.44 Calculate value of Id Vgs Vds

```
// Calculate value of Id,Vgs,Vds
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 7-44 in page 345

clear; clc; close;

// Given data
Idss=4*10^-3; // Drain-source current in mA
Vp=4; // Pinch off voltage in V

// Calculation
Rth=(200*10^3*1.3*10^6)/((200*10^3)+(1.3*10^6));
Vth=(200/1500)*(1-60);
Vgs=1;
Id=(-8-Vgs)/4;
Vds=-60-((18+4)*Id);
printf("Id = %0.2f mA\nVgs = %0.0f V\nVds = %0.1f V"
   ,Id,Vgs,Vds);

// Result
// Vgs = 1 V
// Vds = -10.5 V
// Id = -2.25 mA
```

Scilab code Exa 7.45 Calculate input admittance

```
// Calculate input admittance
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 7-45 in page 348

clear; clc; close;

// Given data
mu=20; // Amplification factor
rd=10*10^3; // Dynamic resistance in K-ohms
gm=2*10^-3; // Transconductance in mA/V
Cgs=3*10^-12; // Gate-source capacitance in pF
Cds=1*10^-12; // Drain-source capacitance in pF
Cgd=2*10^-12; // Gate-drain capacitance in pF

// Calculation
printf("(a)Rd = 50 K\n");
printf("At f=1000Hz\n");
Ygs=%i*2*%pi*10^3*Cgs;
Yds=%i*2*%pi*10^3*Cds;
Ygd=%i*2*%pi*10^3*Cgd;
Yd=2*10^-6;
gd=10^-4;
Av=(-gm+Ygd)/(gd+Yd+Yds+Ygs);
C1=Cgs+(17.7*Cgd);
printf("Av = %0.1f\nC1 = %0.1e F\n\n",Av,C1);
printf("At f=10^6Hz\n");
Ygs1=%i*1.88*10^-6;
```

```
Yds1=%i*0.628*10^-6;
Ygd1=%i*1.26*10^-6;
Av1=(-gm+Ygd1)/(gd+Yd+Yds+Ygs);
R1=10^6/2.48;
C2=37.6*10^-12;
printf("Av = %0.1f\nR1 = %0.2e ohm\nC1=%0.1e F\n\n",
    Av1,R1,C2);
Zl=%i*5*10^4;
Yl=%i*2*10^-6;
printf("(b)Zl = j5*10^4;Yl = j2*10^-6\n");
printf("For f=1000Hz\n");
Av2=-gm/(gd+Yl);
C3=Cgs+(20.2*Cgd);
R2=20.8*10^6;
printf("Av = %0.2f\nR1 = %0.2e ohm\nC1 = %0.1e F\n\n
    ",Av2,R2,C3);
printf("For f=10^6Hz\n");
Av3=(-200+(%i*1.26))/(10+(%i*3.88));
C4=Cgs+(18.4*Cgd);
R3=10^6/8.64;
printf("Av = %0.2f\nR1 = %0.2e ohm\nC1 = %0.2e F",
    Av3,R3,C4);

// Result
// (a)Rd = 50 K
// At f=1000Hz
// Av = -19.6
// C1 = 3.8e-011 F

// At f=10^6Hz
// Av = -19.6
// R1 = 4.03e+005 ohm
// C1=3.8e-011 F

// (b)Zl = j5*10^4;Yl = j2*10^-6
// For f=1000Hz
// Av = -19.99
// R1 = 2.08e+007 ohm
```

```
// C1 = 4.3e-011 F

// For f=10^6Hz
// Av = -17.34
// R1 = 1.16e+005 ohm
// C1 = 3.98e-011 F
```

Scilab code Exa 7.47 Calculate gain and frequency

```
// Calculate gain and frequency
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 7-47 in page 351

clear; clc; close;

// Given data
gm=2*10^-3; // Transconductance in mA/V
Rs=100*10^3; // Source resistance in K-ohms
rd=50*10^3; // Dynamic resistance in K-ohms
Ct=9*10^-12; // Total capacitance in pF
gd=2*10^-5; // Constant

// Calculation
omega=(gm+gd)/Ct;
f=omega/(2*%pi);
printf("(a)f = %0.1e Hz\n",f);
Av=gm*Rs/(1+(gm+gd)*Rs);
printf("For f=35.6MHz,\n");
Av1=(10^2*(sqrt(4.45)))/(202*sqrt(2));
printf("(b)Av = %0.3f",Av1);
```

```

// Result
// (a) f = 35.6 MHz
// (b) Av = 0.738
```

Scilab code Exa 7.48 Calculate the values of Id Vgs Vds

```
// Calculate the values of Id,Vgs,Vds
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 7-48 in page 351

clear; clc; close;

// Given data
Vp=3; // Pinch off voltage in V
// Id = 0.2(Vgs-3)^2

// Calculation
Id1=(25+7)/10;
Id2=(25-7)/10;
printf("Id = %0.1f mA or %0.1f mA\n",Id1,Id2);
printf("FET will be cut off at Id=3.2mA.Hence Id=1.8
    mA\n");
Vgs=0.5*(30-18);
Vds=30-(1.8*10);
printf("Vgs = %0.0f V\nVds = %0.0f V",Vgs,Vds);

// Result
// Id = 1.8 mA
// Vgs = 6 V
```

```
// Vds = 12 V
```

Scilab code Exa 7.52 Calculate complex voltage gain Input admittance

```
// Calculate complex voltage gain,Input admittance
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 7-52 in page 355

clear; clc; close;

// Given data
mu=100; // Amplification factor
rd=40*10^3; // Dynamic resistance in K-ohms
gm=2.5*10^-3; // Transconductance in mA/V
Cgs=4*10^-12; // Gate-source capacitance in pF
Cds=0.6*10^-12; // Drain-source capacitance in pF
Cgd=2.4*10^-12; // Gate-drain capacitance in pF

// Calculation
Ygs=%i*2*%pi*10^2*4*10^-12;
Yds=%i*2*%pi*10^2*0.6*10^-12;
Ygd=%i*2*%pi*10^2*2.4*10^-12;
gd=2.5*10^-5;
Yd=10^-5;
Av=(-2.5/3.5)*10^2;
Ci=Cgs+(1-Av)*Cgd;
printf("Av = %0.2f\nCi = %0.3e F\n",Av,Ci);
printf("For f=10^6 Hz,\n");
Ygs1=%i*2.51*10^-6;
Yds1=%i*0.377*10^-6;
```

```
Ygd=%i*1.51*10^-6;
Av=((-2.5*3.5*10^2)/12.30)+%i*((2.5*0.188*10^2)/12.30);
C1=Cgs+(72*Cgd);
G1=2*%pi*2.4*10^-12*3.82;
R1=1/G1;
printf(”Av =”);
disp(Av);
printf(”C1 = %0.3e F\nR1 = %0.3e ohms”,C1,R1);

// Result
// Av = −71.4
// Ci = 177.8 pF
// At f=10^6 Hz,
// Av = −71.2+j3.82
// C1 = 177 pF
// R1 = 173.5 K–ohms
```

Scilab code Exa 7.54 Find the maximum transconductance

```
// Find the maximum transconductance
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 7−54 in page 358

clear; clc; close;

// Given data
Idss=1*10^-3; // Drain−source current in mA
Vp=-5; // Pinch off voltage in V

```

```
// Calculation
gm=(2*Idss)/-Vp;
printf("gm = %0.1e mho",gm);

// Result
// gm = 0.4 m-mho
```

Scilab code Exa 7.55 Evaluate Vds and Rd

```
// Evaluate Vds and Rd
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 7-55 in page 358

clear; clc; close;

// Given data
b=10^-4; // Constant in A/V^2
Vdd=10; // Drain voltage in V
Vt=1; // Voltage expressed in volts
Ids=0.5*10^-3; // Drain-source current in mA

// Calculation
Vds=1+sqrt(5);
Rd=(Vdd-Vds)/Ids;
printf("Vds = Vgs = %0.2f V\nRd = %0.2e ohm",Vds,Rd)
    ;

// Result
// Vds = 3.24 V
// Rd = 13.5 K-ohm
```

Scilab code Exa 7.56 Verify FET operation in pinch off region

```
// Verify FET operation in pinch-off region
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 7-56 in page 358

clear; clc; close;

// Given data
Vp=-2; // Pinch off voltage in V
Idss=4*10^-3; // Drain-source current in mA
Rd=910; // Drain resistance in ohms
Rs=3*10^3; // Source resistance in K-ohms
R1=12*10^6; // R1 value in M-ohms
R2=8.57*10^6; // R2 value in M-ohms
Vdd=24; // Drain voltage in V

// Calculation
Vgg = Vdd*R2/(R1+R2);
Id1=(73+sqrt(73^2-(4*9*144)))/(2*9);
Id2=(73-sqrt(73^2-(4*9*144)))/(2*9);
printf("Id = %0.2e A or %0.2e A\n",Id1,Id2);
printf("A value of 3.39 mA is selected\n");
Vgsq=10-(3.39*10^-3*3*10^3);
Vdsq=Vdd-(3.39*10^-3*3.91*10^3);
Vdgq=Vdsq-Vgsq;
printf("Vgsq = %0.2fV\nVdsq = %0.2fV\nVdgq = %0.3f V
    \n",Vgsq,Vdsq,Vdgq);
printf("Vdgq>Vd.Hence the FET is in the pinch off
```

```
   region");

// Result
// FET operates in the pinch off region
```

Scilab code Exa 7.57 Calculate voltage gain Av

```
// Calculate voltage gain Av
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 7-57 in page 359

clear; clc; close;

// Given data
gm=2*10^-3; // Transconductance in mA/V
rd=10*10^3; // Dynamic resistance in K-ohms
C=0.025*10^-6; // Capacitance in microF

// Calculation
Rl=(30*30)/(30+30);
Av=(-gm*rd*Rl*10^3)/(Rl+rd);
f1=1/(2*%pi*37.5*10^3*C);
Avl=Av/sqrt(1+(f1/(5*10^3))^2);
printf("(a)Av = %0.0f\n(b)Avl = %0.2f",Av,Avl);

// Result
// (a) Av = -30
// (b) Avl = -29.94
```

Scilab code Exa 7.59 Design a source follower

```
// Design a source follower
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 7-59 in page 361

clear; clc; close;

// Given data
Vds=14; // Drain-source voltage in V
Idq=3*10^-3; // Drain-source current in mA
Vdd=20; // Drain voltage in V
gm=2*10^-3; // Transconductance in mS
rd=50*10^3; // Dynamic resistance in K-ohms
Vgs=-1.5; // Gate-source voltage in V

// Calculation
R=(20-14)/Idq;
R1=Vgs/-Idq;
R2=R-R1;
Ro=1/gm;
Av=R/(R+Ro);
R_1=1/(1-(Av*(R2/R)));
printf("R1 = %0.1e ohms\nR2 = %0.1e ohms\nRo = %0.1e
    ohms\n",R1,R2,Ro);
printf("Av = %0.1f*Av1\n",Av);
printf("Effective input resistance R1 = %0.1f*R3",
   R_1);
```

```
// Result
// R1 = 0.5 K
// R2 = 1.5 K
// Ro = 0.5 K
// Av = 0.8*Av'
// R1(effective) = 2.5*R3
```

Chapter 8

Special Semiconductor Devices

Scilab code Exa 8.1 Calculate the Gate Source Resistance

```
// Calculate the Gate Source Resistance
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 8-1 in page 376

clear; clc; close;

// Given Data
P=0.5; // Value of Allowable Gate Power Dissipation
   in watt
Es=14; // Trigger Source Voltage in V
slope=130; // Slope of Gate-Cathode Characteristic
   line

// Calculations
Ig=sqrt(P/slope);
Vg=slope*Ig;
Rs=(Es-Vg)/Ig;

```

```
printf("(a)The value of Gate Resistance for the Circuit is %0.2e ohm \n",Rs);
printf("(b)The value of the Gate Voltage is %0.2e V \n",Vg);
printf("(c)The value of the Gate Current is %0.2e A \n",Ig);

// Results
// (a) The value of Gate Resistance for the Circuit is 95.3 ohm
// (b) The value of the Gate Voltage is 8.06 V
// (c) The value of the Gate Current is 62 mA
```

Scilab code Exa 8.2 Firing angle of Thyristor

```
// Firing angle of Thyristor
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 8-2 in page 377

clear; clc; close;

// Given Data
Il=50^10*-3; // Latching current of the Thyristor in mA
t=50^10*-6; // Duration of firing pulse in second
Es=50; // DC voltage of the circuit in V
R=10; // Resistance of the circuit in ohm
L=0.25; // Inductance of the circuit in H
e=2.718282; // Constant of calculation

```

```
// Calculations
tou=0.025;
i=(Es/R)*(1-exp((-(50*10^-6))/tou));
printf("(a) i = %0.3e A\n",i);

if(i<Il)
 printf("Since the Gate current is less than
     Latching Current, SCR will not get fired \n");
else
 printf("Since the Gate current is more than
     Latching Current, SCR will get fired \n");
end

// Results
// SCR will not get fired in the Circuit
```

Scilab code Exa 8.3 Calculate width of Gating pulse

```
// Calculate width of Gating pulse
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 8-3 in page 377

clear; clc; close;

// Given Data
Il=4*10^-3; // Latching current of SCR in A
V=100; // DC voltage of the circuit in V
L=0.1; // Inductance of the circuit in H

// Calculations
```

```
t=(L/V)*Il;

printf("Required width of the gating pulse is %0.2e s",t);

// Results
// Required width of the gating pulse is 4 mu-s
```

Scilab code Exa 8.4 To calculate required Gate source Resistance

```
// To calculate required Gate source Resistance
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 8-4 in page 378

clear; clc; close;

// Given Data
P=0.012; // Value of Allowable Gate Power Dissipation in watt
Es=10; // Trigger Source Voltage in V
slope=3*10^3; // Slope of Gate-Cathode Characteristic line

// Calculations
Ig=sqrt(P/slope);
Vg=slope*Ig;
Rs=(Es-Vg)/Ig;

printf("(a)The value of Gate Resistance for the Circuit is %0.0f ohm \n",Rs);
```

```
printf("(b)The value of the Gate Voltage is %0.2e V
    \n",Vg);
printf("(c)The value of the Gate Current is %0.2e A
    \n",Ig);


// Results
// (a) The value of Gate Resistance for the Circuit
    is 2 K-ohm
// (b) The value of the Gate Voltage is 6 V
// (c) The value of the Gate Current is 2 mA
```

Scilab code Exa 8.5 To calculate series Resistance across SCR

```
// To calculate series Resistance across SCR
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 8-5 in page 378

clear; clc; close;

// Given Data
Ig_min=0.5; // Minimum gate current for quick ON, in
     A
Vs=15; // Gate source voltage in V
slope=16; // Slope of Gate-Cathode Characteristic
    line

// Calculations
Vg=slope*Ig_min;
Rg=(Vs-Vg)/Ig_min;
```

```

printf("The value of Gate Resistance is %0.2f ohm \n",Rg);

// Results
// The value of Gate Resistance is 14 ohm
```

Scilab code Exa 8.6 To determine critical value of dv by dt

```
// To determine critical value of dv/dt
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 8-6 in page 379

clear; clc; close;

// Given Data
ij2=32*10^-3; // Limiting value of the charging current in A
Cj2=40*10^-12; // Capacitance of reverse biased junction J2 in F

// Calculations
dv_dt=ij2/Cj2;

printf("The value of dv/dt of the given SCR is %0.2e volt/second \n",dv_dt);

// Results
// The value of dv/dt of the given SCR is 800 V/mu-s
```

Scilab code Exa 8.7 Calculate surge current and I2t ratings

```
// Calculate surge current & I2t ratings
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 8-7 in page 379

clear; clc; close;

// Given Data
ish=3000; // half cycle surge current rating of SCR
    in A
f=50; // Frequency of operation of supply in Hz

// Calculations
I=ish*sqrt(2*f)/sqrt(4*f);
I2t_rate=(I*I)/(2*f);

printf("(a)The surge current rating of one cycle for
     the SCR is %0.2f A \n",I);
printf("(b)The I2t rating of one cycle for the SCR
    is %0.2f A^2-second \n",I2t_rate);

// Results
// (a) The surge current rating of one cycle for the
     SCR is 2121.32 A
// (b) The I2t rating of one cycle for the SCR is
    45000 A^2-second
```

Scilab code Exa 8.8 Max and Min firing delays

```
// Max and Min firing delays
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 8-8 in page 386

clear; clc; close;

// Given Data
Vc=40; // Breakdown voltage of DIAC in V
C=470*10^-9; // Capacitance in nF
E=240; // Rms voltage at 50 Hz in V
omga=2*%pi*50; // Angular frequency

// Calculation
printf("When DIAC is not conducting:\n")
A=asind(40/335.8)+8.4;
Z=1/(omga*C);
R1=atand(1/(omga*1000*C));
Zd=sqrt(R1^(2+(1/omga^2*C^2)));
printf("Minimum delay = %0.2f degrees\n\n",A);
printf("When DIAC conducts:\n");
A1=asind(40/88.6)+74.84;
printf("Maximum delay = %0.2f degrees",A1);

// Result
// Minimum delay = 15.24 degrees
// Maximum delay = 101.6 degrees
```

Scilab code Exa 8.10 Design of Triggering Circuit for a UJT

```
// Design of Triggering Circuit for a UJT
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 8-10 in page 390

clear; clc; close;

// Given Data
Vs=30; // DC source voltage in V
eta=0.51; // Intrinsic stand off ratio
Ip=10*10^-6; // Peak Emitter current of UJT in mu-A
Vv=3.5; // Valley voltage in V
Iv=10*10^-3; // Valley current in A
f=60; // Source frequency in Hz
tg=50*10^-6; // width of triggering pulse in seconds
C=0.5*10^-6; // Assumption for circuit Capacitance
   in mu-F
Vd=0.5; // Fixed value of Vb in V

// Calculations
Vp=(eta*Vs)+Vd;
Rlow=(Vs-Vp)/Ip;
Rup=(Vs-Vv)/Iv;
tou=1/f;
R=(tou/C)*(1/log(1/(1-eta)));
Rb1=tg/C;
Rb2=10^4/(eta*Vs);

```

```
printf("(a)The value of Base-1 Resistance of UJT is %0.2f ohm \n",Rb1);
printf("(b)The value of Base-2 Resistance of UJT is %0.2f ohm \n",Rb2);
printf("(c)Circuit resistance of the arrangement is %0.2e ohm \n",R);

// Results
// (a) The value of Base-1 Resistance of UJT is 100 ohm
// (b) The value of Base-2 Resistance of UJT is 654 ohm
// (c) Circuit resistance of the arrangement is 46.7 K–ohm
```

Scilab code Exa 8.11 To determine Emitter source voltage of UJT

```
// To determine Emitter source voltage of UJT
// Basic Electronics
// By Debashis De
// First Edition, 2010
// Dorling Kindersley Pvt. Ltd. India
// Example 8-11 in page 391

clear; clc; close;

// Given Data
Re=1*10^3; // Emitter Resistance of UJT in ohm
Iv=5*10^-3; // Valley current of UJT in A
Vv=2; // Valley voltage of UJT in V

// Calculations
Ve=Vv;
```

```
Ie=Iv;
Vee=(Ie*Re)+Ve;

printf("The value of Emitter source voltage of UJT
   for turn-off is %0.2f V",Vee);

// Results
// The value of Emitter source voltage of UJT for
   turn-off is 7 V
```