Scilab Textbook Companion for A Textbook Of Applied Electronics by R S Sedha[1]

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July 31, 2019

[1]Funded by a grant from the National Mission on Education through ICT, http://spoken-tutorial.org/NMEICT-Intro. This Textbook Companion and Scilab codes written in it can be downloaded from the "Textbook Companion Project" section at the website http://scilab.in

Book Description

Title: A Textbook Of Applied Electronics

Author: R S Sedha

Publisher: S Chand & Company Ltd. New Delhi

Edition: 3

Year: 2008

ISBN: 8121927838

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

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

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

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

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Chapter 3

Electricity and Ohms Law

Scilab code Exa 3.1 number of upperclass students who will go to the party

```
clear//

//Variables

W = 75.0       //Work done (in Joules)
Q = 50.0       //Charge produced (in Coulomb)

//Calculation
V = W/Q     //Voltage between battery terminals (in
    Volts)

//Result
printf("\n Terminal voltage of a battery is  %0.3f
   V.",V)
```

Scilab code Exa 3.2 number of upperclass students who will go to the party

```
clear//
```

```
//Variables

V = 1.5     //Voltage (in Volts)
E =7.5      //Energy produced (in Joules)

//Calculation
Q = E/V     //Charge separated ( in Coulomb )

//Result
printf("\n The Amount of charge separated by the
    battery is  %0.3f  C.",Q)
```

Scilab code Exa 3.3 `A1unionA2unionA3unionA4`

```
clear//

//Variables

Q = 7.5           //Charge (in Coulomb)
t = 0.5           //Time (in minute)

//Calculation

t = 0.5 * 60      //Time (in seconds)
I= Q/t            //Current (in Ampere)

//Result

printf("\n The current in the element is  %0.3f  A."
    ,I)
```

Scilab code Exa 3.4 `cars that do not have any options`

```
clear//

//Variables

I = 5                  //Current (in Ampere)
Q = 4 * 10**-3         //Charge (in Coulomb)

//Calculation
t = Q/I                //time (in seconds)

//Result
printf("\n Time in which the 4 mC of charge flows
    through this element is %0.3f ms.",t * 10**3)
```

Scilab code Exa 3.5 Total number of ways to paint 12 offices so that 3 of them

```
clear//

//Variables

I = 0.3      //Current (in Ampere)
W = 9.45     //Heat (in Joules)
t = 5        //Time (in seconds)

//Calculation

Q = I * t
V = W/Q      //Voltage (in Volts)

//Result

printf("\n The voltage across filament is %0.3f
    volts.",V)
```

Scilab code Exa 3.6 A1unionA2unionA3unionA4

```
clear//

//Variables

p = 2.83 * 10**-8     //Resistivity (in ohm-meter)
w = 0.5               //width (in meter)
t = 2 * 10**-3        //thickness (in meter)
l = 1                 //length (in meter)

//Calculation

A = w * t             //Area of cross-section (in
    metersquare)
R = p*l/A             //Resistance (in ohm)

//Result

printf("\n The resistance between left end and right
     end is  %0.3f  micro-ohm.",R * 10**6)
```

Scilab code Exa 3.7 Number of possible ways in which a house keeper can serve spag

```
clear//

//Case 1:

//Variables

w = 0.01               //width (in meter)
h = 0.01               //height (in meter)
```

```
l = 0.50                  //length (in meter)
p = 3.5 * 10**-5          //Resistivity (in ohm-meter)

//Calculation

A = w * h                 //Area of cross section (in
    metersquare)
R = p*l/A                 //Resistance (in ohm)

//Result 1:

printf("\n Resistance in case 1 is :  %0.3f  ohm.",R
    )

//Case 2:

//Variables

w = 0.50                  //width (in meter)
h = 0.01                  //height (in meter)
l = 0.01                  //length (in meter)

//Calculation

A = w * h                 //Area of cross section (in
    metersquare)
R = p*l/A                 //Resistance (in ohm-meter)

//Result

printf("\n Resistance in case 2 is:  %0.3f  ohm.",R)
```

Scilab code Exa 3.8 Total number of ways

```
clear//
```

```
//Variables

l = 120                   //length of wire (in meter)
d = 0.25 * 10**-2         //Diameter of cross section (
    in meter)
p = 1.7 * 10**-8          //Resistivity (in ohm−meter)

//Calculation

r = d/2                   //Radius of cross section (in
    meter)
A = %pi *r*r          //Area of cross section (in
    metersquare)
R = p*l/A                 //Resistance (in ohm)

//Result

printf("\n Resistance of the wire is  %0.3f  ohm.",R
    )
```

Scilab code Exa 3.9 The probability of getting an even number

```
clear//

//Variables

p = 2.8 * 10**-8          //Resistivity (in ohm−meter)
d = 0.15 * 10**-2         //Diameter of wire (in meter)
R = 10                    //Resistance (in ohm)

//Calculation

A = %pi *d*d/4        //Area of cross section (in
    metersquare)
```

```
l = R*A/p                  //Length of wire (in meter)

//Result

printf("\n Length of the wire is  %0.0f  meter.",l)
```

Scilab code Exa 3.10 Total number of ways to paint 12 offices so that 3 of them

```
clear//

//Variables

p = 1.7 * 10**-8                  //Resistivity (in ohm-meter)
l = 2 * 150                       //Length (in meter)
R = 0.722                         //Resistance (in ohm)

//Calculation

A = p*l/R                         //Area of cross section (in metersquare)
d = (A * 4 / %pi)**0.5    //diameter of wire (in meter)

//Result

printf("\n  Diameter of the wire is :  %0.0f  mm.",d * 10**3)
```

Scilab code Exa 3.11 The resistance of silver wire

```
clear//

```

```
//Variables

lc = 200                        //Length of copper wire (in meter)
Rc = 1.5                        //Resistance of Copper wire(in ohm)
pc = 1.7 * 10**-8               //Resistivity of  (in ohm-meter)
ls = 10                         //Length of silver wire (in meter)
ps = 1.6 * 10**-8               //Resistivity of Silver (in ohm-meter)

//Calculation

A = pc * lc / Rc                //Area of cross section (in metersquare)
Rs = ps * ls / A                //Resistance of silver wire(in ohm)

//Result

printf("\n The resistance of silver wire is  %0.2f ohm.",Rs)
```

Scilab code Exa 3.12 Resistance at 800 degree celsius

```
clear//

//Variables

T1 = 800                                         //Temperature (in celsius degeree)
T2 = 2250                                        //Temperature (in celsius degeree)
```

```
R20 = 3.49                                   //Resistance at 20 degree celsius (in ohm)
alpha20 = 4.5 * 10**-3                       //Temperature coefficient at 20 degree celsius (in per degree Celsius)

//Calculation

R800 = R20 * (1 + alpha20*(T1 - 20))         //Resistance at 800 degree celsius (in ohm)
R2250 = R20 * (1 + alpha20*(T2-20))          //Resistance at 2250 degree celsius (in ohm)

//Result

printf("\n Resistance at 800 degree celsius is %0.1f ohm.\n\nResistance at 2250 degree celsius is %0.3f",R800,R2250)
```

Scilab code Exa 3.13 Resistance at 80 degree celsius

```
clear//

//Variables

T1 = 20                                  //Temperature (in degree celsius)
R1 = 10000                               //Resistance at 20 degree celsius (in ohm)
T2 = -25                                 //Temperature (in degree celsius)
alpha = 0.0039                           //Temperature coefficient at 20 degree celsius (in per degree Celsius)

```

```
//Calculation

R80 = R1*(1 + alpha*(80 - T1))        //Resistance at 80 degree celsius (in ohm)
RT2 = R1*(1 + alpha*(-25 - T1))       //Resistance at -25 degree celsius (in ohm)

//Result

printf("\n Resistance at 80 degree celsius is  %0.1f kilo-ohm.\nResistance at -25 degree celsius is %0.1f  kilo-ohm.",R80*10**-3,RT2*10**-3)
```

Scilab code Exa 3.14 Resistance of wire at 200 degree celsius

```
clear//

//Variables

p = 14 * 10**-8                    //Resistivity of gold (in ohm-meter)
alpha = 5.8 * 10**-4               //Temperature coefficient (in per degree celsius)
l = 3                              //Length (in meter)
d = 13 * 10**-6                    //diameter of wire

//Calculation

A = %pi * d * d / 4            //Area of cross-section (in metersquare)
R = p * l /A                       //Resistance of wire at 20 degree celsius(in ohm)
R1 = R*(1 + alpha*(200-20))
//Result
```

```
printf("\n Resistance of wire at 200 degree celsius
    is  %0.1f  ohm.",R1)
```

Scilab code Exa 3.15 The conductance of gold conductor

```
clear//

//Variables

R = 10*10**-3          //Resistance (in ohm)

//Calculation

G = 1/R                //Conductance (in siemens)

//Result

printf("\n The conductance of gold conductor is  %0
    .3f  siemens.",G)
```

Scilab code Exa 3.16 The conductance of gold conductor

```
clear//

//Variables

R = 10.0*10**3          //Resistance (in ohm)

//Calculation

G = 1/R                 //Conductance (in siemens)

```

```
//Result

printf("\n The conductance of gold conductor is %0.3f siemens.",G)
```

Scilab code Exa 3.17 The Resistance

```
clear//

//Variables

G = 50*10**-6          //Conductance (in siemens)

//Calculation

R = 1/G                //Resistance (in ohm)

//Result

printf("\n The Resistance is %0.3f kilo-ohm.",R * 10**-3)
```

Scilab code Exa 3.18 The conductance

```
clear//

//Variables

V = 18                 //Voltage (in volts)
I = 60*10**-6          //current (in Ampere)

//Calculation

```

```
R = V/I                         //Resistance (in ohm)
G = 1/R                         //Conductance (in siemens)

//Result

printf("\n The conductance is  %0.2f  micro−siemens.
   ",G * 10**6)
```

Scilab code Exa 3.19 Current in the power line

```
clear//

//Variables

R = 600.00                      //Resistance (in ohm)
V = 230.00                      //Voltage (in volts)

//Calculation

I = V/R                         //Current (in Ampere)

//Result

printf("\n Current in the power line is  %0.3f  A.",
   I)
```

Scilab code Exa 3.20 The maximum safe voltage

```
clear//

//Variables

R = 8                       //Resistance (in ohm)
```

```
I = 2.5                    //Current (in Ampere)

//Calculation

V = I*R                    //Voltage (in volts)

//Result

printf("\n The maximum safe voltage is %0.3f volts
    .",V)
```

Scilab code Exa 3.21 The voltage that must be applied to the relay coil to energiz

```
clear//

//Variables

R = 1.5 * 10**3            //Resistance (in ohm)
I = 16 * 10**-3            //Current (in Ampere)

//Calculation

V = I*R                    //Voltage (in volts)

//Result

printf("\n The voltage that must be applied to the
    relay coil to energize it is %0.3f volts." ,V)
```

Scilab code Exa 3.22 Resistance that must be inserted into the circuit of each seg

```
clear//

```

```
//Variables

I = 20 * 10**-3                      //Current per segment (
    in Ampere)
V = 5                                //Voltage (in volts)

//Calculation

R = V/I                              //Resistance (in ohm)

//Result

printf("\n Resistance that must be inserted into the
      circuit of each segment is %0.3f ohm.",R)
```

Scilab code Exa 3.23 The value of resistance

```
clear//

//Variables

V = 7 * 2                         //Voltage : 7 div * (2 V/
    div) (in volts)
I = 5 * 5 * 10**-3                //Current : 5 div * (5 *
    10**-3) (in Ampere)

//Calculation

R = V/I                           //Resistance (in ohm)

//Result

printf("\n The value of resistance is %0.3f ohm.",
    R)
```

Scilab code Exa 3.24 The rate at which electrical energy

```
clear//

//Variables

W = 64000                    //Heat produced (in
    Joules)
t = 40                       //time (in seconds)

//Calculation

P = W/t                      //Rate at which
    electrical energy is converted into heat energy (
    in watt)

//Result

printf("\n The rate at which electrical energy is
    converted into heat energy is : %0.3f W.",P)
```

Scilab code Exa 3.25 The power consumed by the toaster

```
clear//

//Variables

I = 5                   //Current (in Ampere)
V = 230                 //Voltage (in volts)

//Calculation

```

```
P = V*I                     //Power consumed (in watt)

//Result

printf("\n The power consumed by the toaster is:  %0
    .3f  watt.",P)
```

Scilab code Exa 3.26 `Current through filament`

```
clear//

//Variables

P = 36.0                    //Power consumed (in watt)
V = 230.0                   //Voltage (in volts)

//Calculation

I = P/V                     //Current (in Ampere)

//Result

printf("\n Current through filament is  %0.3f  A.",I
    )
```

Scilab code Exa 3.27 `The energy used`

```
clear//

//Variables

P = 150 *12/1000.0          //Power consumed by 12
    bulbs (in kilowatt)
```

```
t = 10.0                          //Time (in hours)

//Calculation

W = P * t                         //Energy used (in kWh)

//Result

printf("\n The energy used is  %0.3f  kWh.",W)
```

Scilab code Exa 3.28 The energy used

```
clear//

//Variables

Ps = 500.0                           //Power of stereo
    system (in watt)
Pa = 2400.0                          //Power of air
    conditioner (in watt)
t = 3                                //time (in hours)

//Calculation

P = (Ps + Pa)/1000                   //Total power consumed
    (in kilowatt)
W = P * t                            //Energy used (in
    kilowatthour)

//Result

printf("\n The energy used is  %0.3f  kWh.",W)
```

Scilab code Exa 3.29 The input current

```
clear//

//Variables

V = 230.0                    //Voltage (in volts)
P = 180.0                    //Power (in watt)

//Calculation

I = P/V                      //Current (in Ampere)

//Result

printf("\n The input current is %0.3f A.",I)
```

Scilab code Exa 3.30 The number of bulbs required

```
clear//

//Variables

V = 24.0                          //Voltage (in volts)
I = 2.0                           //Current (in Ampere)
Pb = 0.5                          //Power rating of each
    light bulb (in watt)

//Calculation

P = V * I                         //Maximum power (in
   watt)
P80 = P * 0.8                     //80percentageof power
    rating (in watt)
n = (P80/Pb)                     //Number of bulbs
```

```
    required

//Result

printf("\n The number of bulbs required is  %0.3f ."
    ,n)
```

Scilab code Exa 3.31 Power consumed by relay coil

```
clear//

//Variables

R = 750.0                //Resistance (in ohm)
I = 32.0                 //Current (in milliAmpere)

//Calculation

P = I**2 * 10**-6 * R    //Power (in watt)

//Result

printf("\n Power consumed by relay coil is  %0.3f
  mW.",P*1000)
```

Scilab code Exa 3.32 Power rating

```
clear//

//Variables

R = 36.0                   //Resistance (in ohm)
V = 230.0                  //Voltage (in volts)
```

```
//Calculation

P = V**2/R                    //Power (in watt)

//Result

printf("\n Power rating is  %0.3f  kW.",P/1000)
```

Scilab code Exa 3.33 Resistance of the heating element

```
clear//

//Variables

P = 36              //Power (in watt)
V = 230.0           //Voltage (in volts)

//Calculation

R = V**2/P          //Resistance (in ohm)

//Result

printf("\n Resistance of the heating element is  %0
   .0f  ohm.",R)
```

Scilab code Exa 3.34 Maximum new current

```
clear//

//Case a :

```

```
//Variables

R = 8.0              //Resistance (in ohm)
P1 = 60.0            //Power (in watt)

//Calculation

I1 = (P1/R)**0.5     //Current (in Ampere)

//Case b :

//Variables

R = 8.0              //Resistance (in ohm)
P2 = 120.0           //Power (in watt)

//Calculation

I2 = (P2/R)**0.5     //Current (in Ampere)

//Result

printf("\n Maximum new current is %0.2f A.\
   nMaximum new current is %0.2f A.",I1,I2)
```

Scilab code Exa 3.36 `Battery will last for`

```
clear//

//Variables

V = 6.0                    //voltage (in volts)
C = 2.0                    //Capacity of battery (in
   Ampere-hour)
P = 1.2                    //Power rating (in watt)
```

```

//Calculation

R = V**2 / P                    //Resistance (in ohm)
I = V/R                         //Current  (in Ampere)
t = C/I                         //time (in hour)

//Result

printf("\n Battery will last for  %0.3f  hours.",t)
```

Chapter 4

DC Resistive Circuits

Scilab code Exa 4.1 `Total resistance of circuit`

```
clear//

//Variables

R1 = 220                    //Resistance (in ohm)
R2 = 470                    //Resistance (in ohm)
R3 = 560                    //Resistance (in ohm)
R4 = 910                    //Resistance (in ohm)

//Calculation

R = R1 + R2 + R3 + R4       //Net Resistance (in ohm)

//Result

printf("\n Total resistance of circuit is %0.3f
   ohm.",R)
```

Scilab code Exa 4.2 `Equivalent Resistance`

```
clear//

//Variables

R1 = 4                    //Resistance (in kilo-ohm)
R2 = 6                    //Resistance (in kilo-ohm)
R3 = 2                    //Resistance (in kilo-ohm)

//Calculation

R = R1 + R2 + R3          //Equivalent Resistance(in
    kilo-ohm)

//Result

printf("\n Equivalent Resistance is %0.3f kilo-ohm
    ." ,R)
```

Scilab code Exa 4.4 Resistance must be added in order to accomplish the reduction

```
clear//

//Variables

I = 250 * 10**-3              //Current (in Ampere)
R = 1.5 * 10**3               //Resistance (in ohm)

//Calculation

Vs = I * R                    //Source voltage (in
    volts)
I1 = 0.75 * I                 //New current (in Ampere
    )
R1 = Vs / I1                  //New Resistance (in ohm
    )
```

```
R2 = R1 - R                    //Resistance to be added (in ohm)

//Result

printf("\n  %0.3f ohm Resistance must be added in order to accomplish the reduction in current.",R2)
```

Scilab code Exa 4.5 `The voltage drop across R1`

```
clear//

//Variables

R1 = 2.2                       //Resistance (in kilo-ohm)
R2 = 1                         //Resistance (in kilo-ohm)
R3 = 3.3                       //Resistance (in kilo-ohm)
V2 = 6                         //Voltage drop across R2 (in volts)

//Calculation

I = V2 / R2                    //Current in the circuit (in milli-Ampere)
V1 = R1 * I                    //Voltage drop across R1 (in volts)
V3 = R3 * I                    //Voltage drop across R3 (in volts)

//Result
printf("\n The voltage drop across R1 is  %0.3f V and the voltage drop across R3 is  %0.3f  V.",V1,V3)
```

Scilab code Exa 4.7 The power dissipated by R1

```
clear//

//Variables

R2 = 100                    //Resistance R2 (in ohm)
I = 0.3                     //Current (in Ampere)
VT = 120                    //Voltage (in volts)

//Calculation

RT = VT / I                 //Total Resistance (in ohm)
R1 = RT - R2                //Resistance R1 (in ohm)
P1 = I**2 * R1              //Power dissipated by R1 (in watt)
P2 = I**2 * R2              //Power dissipated by R2 (in watt)

//Result

printf("\n The power dissipated by R1 is %0.3f W.\nThe power dissipated by R2 is %0.3f W.",P1,P2)
```

Scilab code Exa 4.8 Power dissipated in the circuit when R3 and R2

```
clear//

//Variables

V = 6                       //Voltage (in volts)
R1 = 1                      //Resistance (in ohm)
```

```
R2 = 2                       //Resistance (in ohm)
R3 = 3                       //Resistance (in ohm)

//Case (a):

//Calculation

RT = R1 + R2 + R3            //Equivalent Resistance (in ohm)
I = V / RT                   //Current (in Ampere)
P = I**2 * RT                //Power dissipated (in watt)

//Result

printf("\n Power dissipated in the entire circuit is %0.3f W.",P)

//Case (b):

//Calculation

RT = R1 + R2                 //Equivalent Resistance (in ohm)
I = V / RT                   //Current (in Ampere)
P = I**2 * RT                //Power dissipated (in watt)

//Result

printf("\n Power dissipated in the circuit when R2 is shortened is %0.3f W.",P)

//Case (c):

//Calculation

R = R1                       //Resistance (in ohm)
I = V / R                    //Current (in Ampere)
P = I**2 * R                 //Power dissipated (in watt)
```

```
printf("\n Power dissipated in the circuit when R3
   and R2 is shortened is %0.3f  W.",P)
```

Scilab code Exa 4.9 `Current through circuit when R2`

```
clear//

//Variables

V = 10.0                      //Voltage (in volts)
R1 = 10**6                    //Resistance (in ohm)
R2 = 10 * 10**3               //Resistance (in ohm)

//Case (a):

//Calculation

RT = R1 + R2                  //Total Resistance (in ohm)
I = V / RT                    //Current (in Ampere)

//Result

printf("\n Current through the circuit is  %0.3f  A.
   ",I)

//Case (b):

//Calculation

RT = R1                       //Total Resistance (in ohm)
I = V / RT                    //Current (in Ampere)

//Result

```

```
printf("\n Current through circuit when R2 is
    shortened is  %0.3f  A.",I)
```

Scilab code Exa 4.10 `Current drawn by R2 branch`

```
clear//

//Variables

IT = 750                    //Current (in milli-Ampere)
I1 = 200                    //Current (in milli-Ampere)
I3 = 150                    //Current (in milli-Ampere)

//Calculation

I2 = IT - (I1 + I3)    //Current through R2 (in milli
    -Ampere)

//Result

printf("\n Current drawn by R2 branch is  %0.3f  mA.
    ",I2)
```

Scilab code Exa 4.11 `The Equivalent Resistance`

```
clear//

//Variables

V = 12.0                            //Voltage (in volts)
R1 = 4.0                            //Resistance (in ohm)
R2 = 6.0                            //Resistance (in ohm)
R3 = 12.0                           //Resistance (in ohm)
```

```

//Calculation

Req = 1/(1/R1 + 1/R2 + 1/R3)    //Equivalent resistance (in ohm)
I1 = V/R1
I2 = V/R2
I3 = V/R3

//Result

printf("\n The Equivalent Resistance is %0.3f ohm.\nThe Current through R1 , R2 , R3 are %0.3f A , %0.3f A, %0.3f A.",Req,I1,I2,I3)
```

Scilab code Exa 4.12 The equivalent resistance

```
clear//

//Variables

R1=10;R2=10;

//Calculation

Req = R1*R2 / (R1 + R2)    //Equivalent Resistance (in kilo-ohm)

//Result

printf("\n The equivalent resistance is %0.3f kilo-ohm.",Req)
```

Scilab code Exa 4.14 `Current in the circuit`

```
clear//

//Variables

PR1 = 1.0/8                  //1/8 watt resistor (in watt)
PR2 = 1.0/4                  //1/4 watt resistor (in watt)
PR3 = 1.0/2                  //1/2 watt resistor (in watt)
RT = 2400.0                  //total resistance (in ohm)

//Calculation

PT = PR1 + PR2 + PR3         //Total power dissipated (in watt)
I = (PT/RT)**0.5             //Current (in Ampere)
Vs = I * RT                  //Applied voltage (in volts)
R1 = PR1 / I**2              //R1 resistor (in ohm)
R2 = PR2 / I**2              //R2 resistor (in ohm)
R3 = PR3 / I**2              //R3 resistor (in ohm)

//Result

printf("\n Current in the circuit is %0.3f A.\nApplied Voltage is %0.3f V.\nValue of R1 is %0.3f ohm.\nValue of R2 is %0.3f ohm.\nValue of R3 is %0.3f ohm.",I,Vs,R1,R2,R3)
```

Scilab code Exa 4.15 `Power supplied in case of Short acorss DE`

```
clear//

```

```
//Variables

V = 6.0                                   //Applied voltage (in volts)
R0 = 0.2                                  //Resistance (in ohm)
R1 = 2.0                                  //Resistance (in ohm)
R2 = 3.0                                  //Resistance (in ohm)
R3 = 6.0                                  //Resistance (in ohm)

//Calculation

Req = 1 / (1/R1 + 1/R2 + 1/R3)            //Equivalent Resistance (in ohm)
R = R0 + Req                              //Total Resistance (in ohm)
I = V/R                                   //Current (in Ampere)
V0 = I * R0                               //Voltage drop across R0 (in volts)
Veq = V - V0                              //Voltage drop across Req (in volts)
I1 = Veq / R1                             //Current through R1 (in Ampere)
I2 = Veq / R2                             //Current through R2 (in Ampere)
I3 = Veq / R3                             //Current through R3 (in Ampere)
P = V * I                                 //Power supplied by the voltage source (in volts)
I0 = V/R0                                 //Current in case of 'Short' across DE (in Ampere)
P0 = V * I0                               //Power dissipated in case of 'Short' (in watt)

```

```
//Result

printf("\n Total Resistance is  %0.3f  ohm.",R)
printf("\n Branch Currents :\nThrough R1 =  %0.3f  A
   .\nThrough R2 =  %0.3f  A.\nThrough R3 =  %0.3f
   A.",I1,I2,I3)
printf("\n Current supplied by voltage source is  %0
   .3f  A.",I)
printf("\n Power supplied by the voltage source is
   %0.3f  W.",P)
printf("\n Current supplied in case of Short across
   DE is  %0.3f  A.",I0)
printf("\n Power supplied in case of Short acorss DE
    is  %0.3f  A.",P0)
```

Chapter 5

Kirchhoffs Laws and Network Theorems

Scilab code Exa 5.1 `Value of the current I1`

```
clear//

//Variables

IT = 20             //Total current (in milli-Ampere)
I2 = 4              //Current (in milli-Ampere)

//Calculation

I1 = IT - I2        //Current (in milli-Ampere)

//Result

printf("\n Value of the current I1 is %0.3f mA.",
    I1)
```

Scilab code Exa 5.2 Value of R

```
clear//

//Variables

I = 1                    //Current (in Ampere)

//Calculation

//Applying Kirchoff's voltage law:
//(1 *3) + (1 * R) + (1 * 4) - 12 =0

R = 5                    //Resistance (in ohm)

//Result

printf("\n Value of R is  %0.3f  ohm.",R)
```

Scilab code Exa 5.3 The value of R

```
clear//

//Variables

Vs = 100               //Source Voltage (in volts)
I = 5                  //Current entering the circuit (in
    Ampere)
IL = 5                 //Current leaving the circuit (in
   Ampere)
R15 = 15                //Resistor of 15 ohm (in ohm)
V15 = 30               //Voltage across 15 ohm resistor (
   in ohm)

//Calculation
```

```
I1 = V15 / R15     //Current through 15 ohm resistor (in Ampere)
IA = I + I1        //Current entering junction A (in Ampere)
//Applying Kirchoff's current law
I2 = I + I1        //Current through 5 ohm resistor (in Ampere)
IB = I2            //Current entering juction B (in Ampere)
IR = IA - IL       //Current through R (in Ampere)
//Applying Kirchoff's voltage law
//(7 * 5) + (2 *R) - 100 + 30 =0
R = 35.0/2

//Result

printf("\n The value of R is  %0.3f  ohm.",R)
```

Scilab code Exa 5.4 Value of IB

```
clear//

//Variables

V = 25            //Source voltage (in volts)
RB = 99           //Resistance (in kilo-ohm)
RC = 2            //Resistance (in kilo-ohm)
RE = 1            //Resistance (in kilo-ohm)
VCE = 5           //Voltage across C and E (in volts)

//Calculation

//Applying Kirchoff's Voltage law:
//IB*RB + VBE + IE*RE -V = 0
```

```
//IB*RB + VBE + (IB + IC)*RE − VCC = 0
//100*IB + IC = 24
//IB + 3*IC = 20
IC = 1976.0/299
IB = 20 - (3 * 6.61)

//Result

printf("\n Value of IB is %0.3f mA.\nValue of IC
    is %0.3f mA.",IB,IC)
```

Scilab code Exa 5.5 Thevenins equivalent Voltage

```
clear//

//Variables

VS1 = 5                //Voltage source 1 (in volts)
VS2 = 3                //Voltage source 2 (in volts)
V6  = 0                //Voltage drop across 6 ohm
    resistor when AB is open (in volts)
R1 = 6                 //Resistor (in ohm)
R2 = 4                 //Resistor (in ohm)

//Calculation

I = 5.0/4              //Current through 4 ohm resistor
    (in Ampere)
V = I * R2             //Voltage drop across 4 ohm
    Resistor (in volts)
VOC = VS2 + V6 + V //Open circuit voltage (in volts)
Rth = R1

//Result

```

```
printf("\n Thevenins equivalent Voltage is %0.3f V
    .\nThevenins equivalent resistance is %0.3f ohm
    .",VOC,Rth)
```

Scilab code Exa 5.6 Current through load resistance

```
clear//

//Variables

V = 25.0                                        //Source
    voltage (in volts)
R1 = 100.0                                      //
    Resistance (in ohm)
R2 = 75.0                                       //
    Resistance (in ohm)
R3 = 50.0                                       //
    Resistance (in ohm)
R4 = 25.0                                       //
    Resistance (in ohm)
RL = 250.0                                      //Load
    resistance (in ohm)

//Calculation

I = V / (R1 + R2 + R3)                         //Series
    curren (in Ampere)
VR2 = I * R2                                   //Voltage
    drop across R2
VOC = VR2                                      //Open
    circuit voltage (in volts)
Vth = VOC                                      //Thevenin's
     equivalent voltage (in volts)
Rth = R4 + R2*(R1 + R3)/(R1 + R2 + R3)   //Thevenin's
     equivalent resistance (in ohm)
```

```
IL = Vth/(Rth + RL)

//Result

printf("\n Thevenins equivalent voltage is %0.3f V
    . and resistance in %0.3f ohm.",Vth,Rth)
printf("\n Current through load resistance is %0.3f
     A.",IL)
```

Scilab code Exa 5.8 The value of Rth

```
clear//

//Variables

R1 = 0.6                                          //
    Resistance (in ohm)
R2 = 0.6                                          //
    Resistance (in ohm)
R3 = 0.8                                          //
    Resistance (in ohm)
R4 = 0.8                                          //
    Resistance (in ohm)

//Calculation

Rth = R3 + R4*(R1 + R2)/(R4 + (R1 +R2))          //
    Thevenin's resistance (in ohm)

//Result

printf("\n The value of Rth is %0.3f ohm.",Rth)
```

Scilab code Exa 5.11 Maximum load resistance

```
clear//

//Variables

Vth = 100                          //Thevenin Voltage (
    in micro-volts)
Rth = 50                           //Thevenin Resistance
    (in ohm)

//Calculation

RL = Rth                           //Maximum Load
    Resistance (in ohm)
PL = (Vth/(Rth + RL))**2 *RL       //Maximum load power
    (in pico-watt)

//Result
printf("\n Maximum load resistance is %0.3f ohm.\
    nMaximum load power is %0.3f pW.",RL,PL)
```

Scilab code Exa 5.12 The value of power transmitted to the receiver

```
clear//

//Variables

VTH = 20.0 * 10**-3                  //Thevenin's
    Voltage (in volts)
RTH = 300.0                          //Thevenin's
    Resistance (in ohm)
RL = 300.0                           //Load Resistance (
    in ohm)

```

```
//Calculation

PL = (VTH/(RTH + RL))**2 * RL      //Power across load
    resistance (in watt)

//Result

printf("\n The value of power transmitted to the
   receiver is  %0.2f  micro-watt.",PL*10**6)
```

Scilab code Exa 5.13 Load resistance

```
clear//

//Variables

R1 = 5.0                               //resistance (in ohm)
R2 = 2.0                               //resistance (in ohm)
R3 = 3.0                               //resistance (in ohm)

//Calculation

Req = R2 * R3 / (R2 + R3)    //Equivalent resistance
   (in ohm)
RL = R1 + Req

//Result

printf("\n Load resistance is  %0.3f  ohm.",RL)
```

Chapter 6

A C Fundamentals

Scilab code Exa 6.1 `Time period by one cycle`

```
clear//

//Variables

t = 1.0            //time (in milliseconds)
n = 10.0           //number of cycles

//Calculation

T = t/n            //Time period (in milliseconds)

//Result

printf("\n Time period by one cycle is  %0.3f  ms.",
   T)
```

Scilab code Exa 6.2 `Time period of rectified input`

```
clear//

//Variables

t = 0.01            //Time period of positive half
    cycle (in seconds)

//Calculation

t1 = 0.01           //Time period of negative half
    cycle (in seconds)
T = t + t1          //Time period of one complete
    cycle (in seconds)

//Result

printf("\n  Time period of rectified input is  %0.3f
     s.",T)
```

Scilab code Exa 6.3 Frequency and Time period of the sine wave

```
clear//

//Variables

n = 5.0                    //number of cycles
t = 10.0                   //time period (in micro-
    seconds)

//Calculation

f = n / t                  //frequency (in Mega-hertz)
T = 1/f                    //Time period (in micro-
    seconds)

```

```
//Result

printf("\n Frequency and Time period of the sine
   wave is  %0.3f  MHz and  %0.3f  micro-seconds.",f
   ,T)
```

Scilab code Exa 6.4 Time period

```
clear//

//Variables

f = 69.0                    //frequency (in Mega-hertz)

//Calculation

T = 1/f                     //Time period (in micro-
   seconds)

//Result

printf("\n Time period is  %0.2f ns.",T * 10**3)
```

Scilab code Exa 6.5 RMS value

```
clear//

//Variables

Vmax = 20.0                 //Voltage (in milli-volts)

//Calculation

```

```
Vrms = 0.707 * Vmax      //Rms Voltage (in milli-volts
    )
Vdc = 0.637 * Vmax       //Average value of signal (in
     milli-volts)

//Result

printf("\n RMS value is  %0.3f  mV.\nAverage value
    is  %0.3f  mV.",Vrms,Vdc)
```

Chapter 7

Passive Circuit Elements

Scilab code Exa 7.4 The coil inductance

```
clear//

//Variables

N = 150.0                       //Number of turns
mur = 3540.0                    //Relative
    permeability (in H/m)
mu0 = 4*%pi * 10 **-7       //Absoulte permeability
    (in H/m)
l = 0.05                        //coil length (in
    meter)
A = 5 * 10**-4                  //Area of cross -
    section (in metersquare)

//Calculation

L = (mur * mu0 * A * N**2)/l    //Coil inductance (
    in Henry)

//Result

```

```
printf("\n The coil inductance is  %0.2f  Henry.",L)
```

Scilab code Exa 7.5 `Coefficient of coupling`

```
clear//

//Variables

L1 = 40.0                            //Inductance (in micro-Henry)
L2 = 80.0                            //Inductance (in micro-Henry)
M = 11.3                             //Mutual Inductance (in micro-Henry)

//Calculation

k = M/(L1 * L2)**0.5                 //Coefficient of Coupling

//Result

printf("\n Coefficient of coupling is  %0.2f .",k)
```

Scilab code Exa 7.6 `d c resistance of coil`

```
clear//

//Variables

Q = 90.0                      //Q-factor
L = 15.0 * 10**-6             //Inductance (in Henry)
f = 10.0 * 10**6              //Frequency (in Hertz)
```

```
//Calculation

Ro = 2*%pi*f*L/Q       //d.c. resistance (in ohm)

//Result

printf("\n d.c. resistance of coil is  %0.1f  ohm.",
   Ro)
```

Scilab code Exa 7.7 `Capacitance of parallel plate capacitor`

```
clear//

//Variables

k = 5.0                       //dielectric constant
A = 0.04                      //Plate area (in meter-
   square)
d = 0.02                      //Thickness of dielectric(
   in meter)
eps0 = 8.85 * 10**-12         //Absolute permittivity (
   in kg*m**3*s**-3*A**-2)

//Calculation

C = eps0 * k * A / d          //Capacitance (in Farad)

//Result

printf("\n Capacitance of parallel plate capacitor
   is  %0.3f pF." ,C * 10**12)
```

Scilab code Exa 7.8 Thickness of dielectric

```
clear//

//Variables

k = 1200.0                      //dielectric constant
A = 0.2                         //Plate area (in meter-
    square)
eps0 = 8.85 * 10**-12           //Absolute permittivity
    (in kg*m**3*s**-3*A**-2)
C = 0.428                       //Capacitance (in micro
    -farad)

//Calculation

d = eps0 * k * A / C            //thickness of
    dielectric (in meter)

//Result

printf("\n Thickness of dielectric is %0.2f mm.",d
    * 10**9)
```

Chapter 9

Voltage and Current Sources

Scilab code Exa 9.1 `Voltage drop across internal resistance`

```
clear//

//Variables

V = 1.5                          //Source Voltage (in volts)
RS = 0.2                         //Resistance (in ohm)
RL = 1                           //Load Resistance (in ohm)

//Calculation

RT = RS + RL                     //Total Resistance (in ohm)
I = V / RT                       //Current (in Ampere)
VAB = I * RL                     //Voltage drop across AB (in volts)
VR = V - VAB                     //Voltage drop due to internal resistance (in volts)

//Result
```

```

printf("\n Voltage drop across internal resistance
    is %0.3f volts.",VR)
```

Scilab code Exa 9.2 Terminal Voltage

```
clear//

//Variables

VS = 1.5                        //Source Voltage (in
    volts)
RS = 0.4                        //Resistance (in ohm)
RL = 2.0                        //Load Resistance (in
    ohm)

//Calculation

RT = RS + RL                    //Total Resistance (in
    ohm)
I = VS/ RT                      //Current (in Ampere)
VT = I * RL                     //Terminal Voltage (in
    volts)
PL = I**2 * RL                  //Power dissipated by
    load resistance (in watt)
PS = I**2 * RT                  //Power Supplied by the
    voltage source (in watt)
eff = PL / PS                   //Efficiency of the
    circuit

//Result

printf("\n Terminal Voltage is %0.3f V.\nPower
    dissipated by 2 ohm resistor is %0.2f W.\
    nEfficiency of the circuit is %0.2f .",VT,PL,eff
```

)

Scilab code Exa 9.3 `Variation in terminal voltage`

```
clear//

//Case a.1:

//Variables
VT = 1.25
VS = 6.0                          //Source Voltage (in volts)
RS = 2.0                          //Resistance (in ohm)
//When RL is 2 ohm
RL = 2.0                          //Load Resistance (in ohm)

//Calculation

RT = RS + RL                      //Total Resistance (in ohm)
I = VS / RT                       //Current in the Circuit (in Ampere)
VT1 = I * RL                      //Terminal Voltage (in volts)

//Result

printf("\n Terminal voltage when RL is 2 ohm :  %0.3f V.",VT1)

//Case a.2:

//Variables

```

```
//When RL is 20 ohm
RL = 20.0                           //Load Resistance (in ohm)

//Calculation

RT = RS + RL                        //Total Resistance (in ohm)
I = VS / RT                         //Current in the Circuit (in Ampere)
VT2 = I * RL                        //Terminal Voltage (in volts)

//Result

printf("\n Terminal voltage when RL is 20 ohm :  %0.2f  V.",VT)
printf("\n Variation in terminal voltage is  %0.3f  V.",(VT2-VT1)/VT2)

//Case b.1:

//Variables

RS = 100.0                           //Resistance (in ohm)
//When RL is 10 kilo-ohm
RL = 10.0 * 10**3                    //Load Resistance (in ohm)

//Calculation

RT = RS + RL                         //Total Resistance (in ohm)
I = VS / RT                          //Current in the circuit (in Ampere)
VT = I * RL                          //Terminal Voltage (in volts)

```

```
//Result

printf("\n Terminal voltage when RL is 100 kilo-ohm
    is:  %0.2f  V.",VT)

//Case b.2:

//Variables

//When RL is 100 kilo-ohm
RL = 100.0 * 10**3              //Load Resistance (in
   ohm)

//Calculation

RT = RS + RL                    //Total Resistance (in
    ohm)
I = VS / RT                     //Current in the
    circuit (in Ampere)
VT1 = I * RL                    //Terminal Voltage (in
    volts)

//Result

printf("\n Terminal voltage when RL is 100 kilo-ohm
    is : %0.3f  V.",VT1)
printf("\n Variation in terminal voltage is  %0.3f
   V.",(VT1-VT)/VT1)
```

Scilab code Exa 9.4 The internal resistance of the source

```
clear//

//Variables

```

```
VS = 12.0                        //Source Voltage (in volts)
VT = 10.0                        //Terminal Voltage (in volts)
RL = 10.0                        //Load resistance (in ohm)

//Calculation

RS = RL*(VS / VT - 1)            //Internal Resistance (in ohm)

//Result

printf("\n The internal resistance of the source is %0.3f ohm.",RS)
```

Scilab code Exa 9.5 Variation of current from the short cicuit current

```
clear//

//Variables

IS = 30.0                  //Current (in milli-Ampere)
RS = 15.0                  //Source resistance (in kilo-ohm)

//Calculation

RL = RS / 20.0             //Load Resistance (in kilo-ohm)
IL = IS * RS/(RL +RS)      //Load Current (in Ampere)


//Result
```

```

printf("\n Largest value of load resistance to
    provide constant current is %0.3f ohm.",RL
    *10**3)
printf("\n Variation of current from the short-
    cicuit current is %0.4f .",(IS-IL)/IS)
```

Scilab code Exa 9.6 Current source value

```
clear//

//Variables

VS = 12.0                    //Source Voltage (in
    volts)
RS = 3.0                     //Source resistance (in
    ohm)

//Calculation

IS = VS / RS                 //Source current (in
    Ampere)

//Result

printf("\n Current source value is %0.3f A.",IS)
```

Scilab code Exa 9.7 Equivalent voltage source

```
clear//

//Variables

```

```
IS = 5.0                        //Source current (in milli-Ampere)
RS = 2.0                        //Source resistance (in kilo-ohm)

//Calculation

VS = IS * RS                    //Voltage source (in volts)

//Result

printf("\n Equivalent voltage source is %0.3f V.",VS)
```

Scilab code Exa 9.8 `Equivalent volage source`

```
clear//

//Variables

IS =1.5                   //Source current (in milli-Ampere)
RS = 2                    //Source resistance (in kilo-ohm)

//Calculation

RL = 10*40/(10+40)        //Load Reistance (in kilo-ohm)
IL = IS * RS/(RL +RS)     //Load current (in milli-Ampere)
IL2 = IL * 10/(10 +40)    //Current through part 2 (in milli-Ampere)
VS = IS * RS              //Souce voltage (in volts)
```

```

//Result

printf("\n current through 40 kilo-ohm resistor is
   %0.3f  mA.",IL2)
printf("\n Equivalent volage source is  %0.3f  V.",
   VS)
```

Chapter 10

Semiconductors

Scilab code Exa 10.1 `Length of wire`

```
clear//

//Variables

R = 1000.0                              //Resistance (in ohm)
sig = 5.8 * 10**7                       //Conductivity in (Siemen per meter)
d = 10**-3                              //diameter (in meter)
E = 10 * 10**-3                         //Eletric field (in Volt per meter)

//Calculation

l = R *sig * %pi * d**2 /4        //length (in meter)
J = sig * E                             //Current density (in Ampere per metersquare)

//Result

```

```
printf("\n Length of wire is %0.2f km.\nCurrent desity is %0.3f A/(m*m).",l/1000,J)
```

Scilab code Exa 10.3 Mobility of electrons

```
clear//

//Variables

n = 5.8 * 10**28                    //number of free electrons (in per cubic-meter)
p = 1.54 * 10**-8                   //resistivity (in ohm-meter)
q = 1.6 * 10**-19                   //charge (in Coulomb)
m = 9.1 * 10**-31                   //mass of electron (in kg)

//Calculation

sig = 1/p                           //conductivity (in siemen per meter)
mu = sig /(q * n)                   //mobility (in meter-square/volt-second)
t = mu * m / q                      //time (in second)

//Result

printf("\n Mobility of electrons is %0.6f m**2/V-s.\nRelaxation time is %0.6f ps.",mu,t*10**12)
```

Scilab code Exa 10.5 Contribution by electron

```
clear//

//Variables

ni = 1.41 * 10**16                          //intrinsic
   concentration (in per cubic-metre)
un = 0.145                                  //mobility of
   electrons in germanium (in metre-square/volt-
   second)
up = 0.05                                   //mobility of
   holes in germanium (in metre-square/volt-second)
q = 1.6 * 10**-19                           //charge of
   electron (in Coulomb)

//Calculation

sig = q * ni * (un + up)                    //Conductivity
    of germanium (in siemen per metre)

//Result

printf("\n Intrinsic conductivity of silicon is %0
   .3f S/m.",sig)
printf("\n Contribution by electron is %0.3f S/m."
   ,q*ni*un)
printf("\n Contribution by electron is %0.3f S/m."
   ,q*ni*up)
```

Scilab code Exa 10.6 Concentration of free electrons

```
clear//

//Variables

l = 0.2 * 10**-3                        //length (in
```

```
meter)
A = 0.04 * 10**-6                    //Area of cross section (in square-meter)
V = 1                                //Voltage (in volts)
I = 8 * 10**-3                       //current (in Ampere)
un = 0.13                            //mobility of electron (in m**2 per volt-second)
q = 1.6 * 10**-19                    //charge on electron (in Coulomb)

//Calculation


R = V/I                               //Resistance (in ohm)
p = R * A/l                           //Resistivity (in ohm-meter)
sig = 1/p                             //Conductivity (in siemen per meter)
n = sig / (q * un)                    //concentration (in per cubic-meter)
J = I/A                               //current density (in Ampere per square-meter)
v = J/(n*q)

//Result

printf("\n Concentration of free electrons is %e m**-3.\nDrift velocity is %0.3f m/s.",n,v)
```

Scilab code Exa 10.7 `Intrinsic concentration`

```
clear//
```

```
//Variables

p = 0.47                        //Resistivity (in
   ohm-meter)
q = 1.6 * 10**-19               //charge on
   electron (in Coulomb)
un = 0.39                       //mobility of
   electron in germanium (in m**2 per volt-second)
up = 0.19                       //mobility of hole
   in germanium (in m**2 per volt-second)

//Calculation

sig = 1/p                       //Conductivity (in
   siemen per meter)
ni = sig / (q *(un +up))        //intrinsic
   concentration (in per cubic-meter)

//Result

printf("\n Intrinsic concentration is %0.3f m**-3.
   ",ni)
```

Scilab code Exa 10.8 Conductivity of silicon

```
clear//

//Variables

ND = 10**21                 //Donor concentration (
   in per cubic-meter)
NA = 5 * 10**20             //Acceptor concentration
    (in per cubic-meter)
un = 0.18                   //mobility of electron
```

```
    in silicon (in m**2 per volt-second)
q = 1.6 * 10**-19               //charge on electron (in
     Coulomb)


//Calculation

n = ND -NA                      //net donor density (in
    per cubic-meter)
sig = n * q * un                //Conductivity (in
    Siemen per meter)

//Result

printf("\n Conductivity of silicon is %0.3f (ohm-
    meter)**-1." ,sig)
```

Scilab code Exa 10.9 `Donor concentration`

```
clear//

//Variables

p = 100.0               //resistivity (in ohm-meter)
q = 1.6 * 10**-19       //Charge on a electron (in
    Coulomb)
un = 0.36               //donor concentration (in per
     cubic-meter)

//Calculation

sig = 1/p               //conductivity (in siemen per
     meter)
n = sig /(q * un)       //intrinsic concentration (in
     per cubic-meter)
```

```
ND = n                    //Donor concentration (in per
    cubic-meter)

//Result

printf("\n Donor concentration is  %0.3f  m**-3.",ND
  )
```

Scilab code Exa 10.10 Electron concentration

```
clear//

//Variables

ND = 2 * 10**14                           //Donor atom
   concentration (in atoms per cubic-centimeter)
NA = 3 * 10**14                           //Acceptor atom
   concentration (in atoms per cubic-centimeter)
ni = 2.3 * 10**19                         //intrinsic
   concentration (in atoms per cubic-centimeter)

//Calculation

n = ni**2 / NA                            //concentration
   of electrons (in electrons per cubic-centimeter)
p = ni**2 / ND                            //concentration
   of holes (in holes per cubic-centimeter)

//Result

printf("\n Electron concentration is  %0.3f
   electrons/cm**3.\nHole concentration is  %0.3f
   holes/cm**3.",n,p)
```

Scilab code Exa 10.11 Density of electrons

```
clear//

//Variables

ND = 5 * 10**8                          //Donor atom concentration (in atoms per cubic-centimeter)
NA = 6 * 10**16                         //Acceptor atom concentration (in atoms per cubic-centimeter)
ni = 1.5 * 10**10                       //intrinsic concentration (in atoms per cubic-centimeter)

//Calculation

n = ni**2/NA                            //number of electrons (in per cubic-centimeter)
p = ni**2/ND                            //number of holes (in per cubic-centimeter)

//Result

printf("\n Density of electrons is %0.3f cm**-3.\nDensity of holes is %0.3f cm**-3.",n,p)
```

Scilab code Exa 10.12 Length of the silicon would be

```
clear//

//Variables

d = 0.001                    //diameter (in meter)
```

```
ND = 10**20                          //Number of
    phosphorus ions (in per cubic-meter)
R = 1000                             //Resistance (in ohm)
un = 0.1                             //mobility (in meter-
    square per volt-second)
q = 1.6 * 10**-19                    //charge on electron
    (in Coulomb)

//Calculation

n = ND                               //Number of free
    electron (in per cubic-meter)
sig = q*n*un                         //conductivity (in
    Siemen per meter)
A = %pi * d**2 / 4               //Area of cross section (
    in meter-square)
l = R * sig * A                      //length (in meter)

//Result

printf("\n Length of the silicon would be %0.3f mm
    .",l*1000)
```

Scilab code Exa 10.13 For n type silicon hole concentration

```
clear//

//Variables

q = 1.6 * 10**-19                  //Charge on electron (
    in Coulomb)
sig = 100.0                        //Conductivity of Ge (
    in per ohm-centimeter)
sig1 = 0.1                         //Conductivity of Si (
    in per ohm-centimeter)
```

```
ni = 1.5 * 10**10            //intrinsic conductivity for Si (in per cubic-centimeter)
un = 3800.0                  //mobility of electrons for Ge (in square-centimetermeter per volt-second)
up = 1800.0                  //mobility of holes for Ge (in square-centimeter per volt-second)
un1 = 1300.0                 //mobility of electrons for Si (in square-centimetermeter per volt-second)
up1 = 500.0                  //mobility of holes for Si (in square-centimeter per volt-second)
ni1 = 2.5 * 10**13           //intrinsic concentration for Ge (in per cubic-centimeter)

//Calculation

p = sig / (q * up)           //Concentration of p-type germanium (in cubic-centimeter)
n = ni1**2 / p               //Concentration of electrons in germanium (in cubic-centimeter)
n1 = sig1 / (q * un1)        //Concentration of N-type silicon (in cubic-centimeter)
p1 = ni**2 / n1              //Concentration of holes in silicon (in cubic-centimere)

//Result

printf("\n For p-type germanium, hole concentration is %0.3f /cm**3.\nFor p-type germanium, electron concentration is %0.3f /cm**3.",p,n)
printf("\n For n-type silicon , hole concentration is %0.3f /cm**3.\nFor n-type silicon , electron concentration is %0.3f /cm**3.",p1,n1)
```

Scilab code Exa 10.15 Resistivity of doped silicon

```
clear//

//Variables

un = 1350                              //mobility of electrons (in centimeter-square per volt-second)
up = 480                               //mobility of holes (in centimeter-square per volt-second)
ni = 1.52 * 10**10                     //intrinsic concentration (in per cubic-centimeter)
Nsi = 4.96 * 10**22                    //concentration of silicon (in per cubic-centimeter)
q = 1.6 * 10**-19                      //charge on electron (in Coulomb)

//Calculation

sigi = q * ni * (un + up)              //conductivity of intrinsic silicon (in per ohm-centimeter)
ND = Nsi/(50 * 10**6)                  //Number of donor atoms (per cubic-centimeter)
n = ND                                 //NUmber of free electrons (in per cubic-centimeter)
p = ni**2/n                            //number of holes (in per cubic-centimeter)
sig = q * n * un                       //conductivity of doped silicon (in per ohm-centimeter)
p = 1/sig                              //resistivity (in ohm-centimeter)

//Result

printf("\n Resistivity of doped silicon is %0.2f ohm-cm.",p)
```

Scilab code Exa 10.16 `Conductivity of intrinsic silicon`

```
clear//Variables

up = 0.048                          //hole mobility (in meter-square per volt-second)
un = 0.135                          //electron mobility (in meter-square per volt-second)
q = 1.602 * 10**-19                 //charge on electron (in Coulomb)
Nsi1 = 5 * 10**28                   //concentration of intrinsic silicon (in atoms per cubic-meter)
ni = 1.5 * 10**16                   //number of electron-hole pairs (per cubic-meter)
alpha = 0.05                        //temperature coefficient (in per degree Celsius)
dT = 14                             //change in temperature (in degree celsius)

//Calculation

sig1 = q * ni * (un + up)           //conductivity of intrinsic silicon (in per ohm-meter)
NA = Nsi1/10**7                     //Number of indium atoms (in per cubic-meter)
p = NA                              //Number of holes (in per cubic meter)
n = ni**2/p                         //Number of free electrons (in per cubic-meter)
sig2 = q * p * up                   //Conductivity of doped silicon (in per ohm-meter)
sig34 = sig1*(1 + alpha * dT)       //Conductivity at 34 degree Celsius (in per ohm-meter)

```

```
//Result

printf("\n Conductivity of intrinsic silicon is %0.5f per ohm-meter.\nConductivity of doped Silicon is %0.2f per ohm-meter.\nConductivity of silicon at 34 degree Celsius is %0.5f per ohm-meter.",sig1,sig2,sig34)
```

Scilab code Exa 10.17 Coefficient of holes

```
clear//

//Variables

un = 3600.0 * 10**-4                 //mobility of electrons (in meter-square per volt-second)
up = 1700.0 * 10**-4                 //mobility of holes (in meter-square per volt-second)
k = 1.38 * 10**23                    //Boltzmann constant
T = 300.0                            //Temperature (in kelvin)

//Calculation

VT = T/11600                         //Voltage (in volts)
Dp = up * VT                         //Coefficient of holes (in meter-square per second)
Dn = un * VT                         //Coefficient of electrons (in meter-square per second)

//Result

printf("\n Coefficient of holes is %0.6f m**2/s.\
```

```
nCoefficient of electrons is %0.4f m**2/s.",Dp,
Dn)
```

Scilab code Exa 10.18 Electron mobility

```
clear//

//Variables

RH = 160                    //Hall coeffficient (in
   cubic-centimeter per Coulomb)
p = 0.16                    //Resistivity (in ohm-
   centimeter)

//Calculation

sig = 1/p                   //Conductivity (in per ohm-
   centimeter)
un = sig * RH               //Electron mobility (in
   cmentimeter-square per volt-second)

//Result

printf("\n Electron mobility is %0.3f cm**2/V-s.",
   un)
```

Scilab code Exa 10.19 Number of conduction electrons

```
clear//

//Variables

I = 50                        //Current (in Ampere)
```

```
B = 1.2                       //Magnetic field (in Weber
    per meter-square)
t = 0.5 * 10**-3              //thickness (in meter)
VH = 100                      //Hall coltage (in volts)
q = 1.6 * 10**-19             //Charge on electron (in
    Coulomb)

//Calculation

n = B * I / (VH * q * t)  //number of conduction
    electrons (in per cubic-meter)

//Result

printf("\n Number of conduction electrons is  %0.3f
    m**-3.",n)
```

Scilab code Exa 10.20 `Number of electron carriers`

```
clear//

//Variables

p =  20 * 10**-2                //Resistivity (in ohm-
    meter)
u = 100 * 10**-4                //mobility (in meter-
    square per volt-second)
q = 1.6 * 10**-19                        //charge on
    electron (in Coulomb)

//Calculation

sig = 1/p                       //Conductivity (in per
    ohm-meter)
n = sig / (q * u)               //number of electron
```

```
carriers (in per cubic-meter)

//Result

printf("\n Number of electron carriers is %0.1f m**-3.",n)
```

Scilab code Exa 10.21 `Mobility of charge carriers`

```
clear//

//Variables

RH = 3.66 *10**-4                    //Hall coefficient (in cubic-meter per Coulomb)
p = 8.93 * 10 **-3                   //Resistivity (in ohm-meter)
q = 1.6 * 10**-19                    //Charge on electron (in Coulomb)

//Calculation

sig = 1/p                            //Conductivity (in per ohm-meter)
u = sig * RH                         //mobility (in meter-square per volt-second)
n = 1 / (RH * q)                     //Density of charge carriers (in per cubic-meter)

//Result

printf("\n Mobility of charge carriers is %0.3f m**2/V-s.\nDensity of charge carriers is %0.3f m**-3.",u,n)
```

Scilab code Exa 10.22 `Value of Hall coefficient`

```
clear//

//Variables

p = 9 * 10**-3                //Resistivity (in ohm-meter)
up = 0.03                     //Mobility (in meter-square per volt-second)

//Calculation

sig = 1/p                     //Conductivity (in per ohm-meter)
RH = up / sig                 //Hall coefficient (in cubic-meter per Coulomb)

//Result

printf("\n Value of Hall-coefficient is  %0.3f  m**3/C.",RH)
```

Chapter 12

PN Junction Diode

Scilab code Exa 12.1 `Current throrough diode`

```
clear//

//Variables

I0 = 2 * 10**-7                    //Current (in Ampere)
VF = 0.1                           //Forward voltage (in
    volts)

//Calculation

I = I0 * (exp(40*VF)-1)            //Current through diode
     (in Ampere)

//Result

printf("\n Current throrough diode is %0.2f micro-
    Ampere.",I*10**6)
```

Scilab code Exa 12.2 `Diode current`

```
clear//

//Variables

VF = 0.22                       //Forward voltage (in volts)
T = 298.0                       //Temperature (in kelvin)
I0 = 10**-3                     //Current (in Ampere)
n = 1

//Calculation

VT = T/11600                    //Volt equivalent of temperature (in volts)
I = I0*(exp(VF/(n*VT))-1)       //Diode Current (in Ampere)

//Result

printf("\n Diode current is %0.1f A.",I)
```

Scilab code Exa 12.3 `Value of n`

```
clear//

//Variables

I1 = 0.5 * 10**-3           //Diode current1 (in Ampere)
V1 = 340 * 10**-3           //Voltage1 (in volts)
I2 = 15 * 10**-3            //Diode current2 (in Ampere)
V2 = 440 * 10**-3           //Voltage2 (in volts)

```

```
//Calculation

n = 4/log(30)                     //By solving both the
    given equations

//Result

printf("\n Value of n is  %0.2f .",n)
```

Scilab code Exa 12.4 `Current at 400 k`

```
clear//

//Variables

I300 = 10 * 10**-6                 //Current at 300
    kelvin (in Ampere)
T1 = 300                           //Temperature (in
    kelvin)
T2 = 400                           //Temperature (in
    kelvin)

//Calculation

I400 = I300 * 2**((T2-T1)/10)   //Current at 400
    kelvin (in Ampere)

//Result

printf("\n Current at 400 k is  %0.1f  mA.",I400
    *10**3)
```

Scilab code Exa 12.5 `Voltage drop across a silicon diode`

```
clear//

//Variables

rb = 2                  //bulk resistance (in ohm)
IF = 12 * 10**-3        //FOrward current (in Ampere)

//Calculation

VF = 0.6 + IF * rb      //Voltage drop (in volts)

//Result

printf("\n Voltage drop across a silicon diode is %0.3f V.",VF)
```

Scilab code Exa 12.6 `Dynamic resistance in forward direction`

```
clear//

//Variables

T = 398.0                       //Temperature (in kelvin)
I0 = 30 * 10**-6                //Reverse saturation current (in Ampere)
V = 0.2                         //Voltage (in volts)

//Calculation

VT = T/11600                    //Volt equivalent of temperature (in volts)
I = I0 * (exp(V/VT)-1)          //Diode current (in Ampere)
rac = VT/I0 * exp(-V/VT)        //dynamic resistance in
```

```
forward direction (in ohm)
rac1 = VT/I0 * exp(V/VT)      //dynamic resistance in reverse direction (in ohm)

//Result

printf("\n Dynamic resistance in forward direction is  %0.2f  ohm.\nDynamic resistance in backward direction is  %0.3f  Mega-ohm.",rac,rac1/10**6)
```

Scilab code Exa 12.8 Maximum forward current

```
clear//

//Variables

PDmax = 0.5                 //power dissipation (in watt)
VF = 1                      //Forward voltage (in volts)
VBR = 150                   //Breakdown voltage (in volts)

//Calculation

IFmax = PDmax/VF            //Maximum forward current (in Ampere)
IR = PDmax/VBR              //Breakdwon current that burns out the diode (in Ampere)

//Result

printf("\n Maximum forward current is  %0.3f  A.\nBreakdwon current that burns out the diode is %0.2f  mA.",IFmax,IR*10**3)
```

Scilab code Exa 12.9 `Voltage drop across the diode`

```
clear//

//Variables

R = 330                    //Resistance (in ohm)
VS = 5                     //Source voltage (in volts
   )

//Calculation

VD = VS                    //Voltage drop across
   diode (in volts)
VR = 0                     //Voltage drop across the
   resistance (in volts)
I = 0                      //Current through circuit

//Result

printf("\n Voltage drop across the diode is %0.3f
   V.\nVoltage drop across the resistance is %0.3f
    V.\nCurrent through the circuit is %0.3f A.",
   VD,VR,I)
```

Scilab code Exa 12.10 `Value of VD`

```
clear//

//Variables

```

```
VS = 12.0                              //Source coltage (in volts)
R = 470.0                              //Resistance (in ohm)

//Calculation

VD = 0                                 //Voltage drop across diode (in volts)
VR = VS                                //Value of VR (in volts)
I = VS/R                               //Current (in Ampere)

//Result

printf("\n Value of VD is %0.3f V.\nValue of VR is %0.3f V.\nCurrent through the circuit is %0.2f mA.",VD,VR,I*10**3)
```

Scilab code Exa 12.11 `Current through the circuit`

```
clear//

//Variables

VS = 6                       //Source voltage (in volts)
R1 = 330                     //Resistance (in ohm)
R2 = 470                     //Resistance (in ohm)
VD = 0.7                     //Diode voltage (in volts)

//Calculation

RT = R1 + R2                 //Total Resistance (in ohm)
I = (VS - 0.7)/RT            //Current through the diode

//Result

```

```
printf("\n Current through the circuit is %0.3f mA
    .",I * 10**3)
```

Scilab code Exa 12.12 Voltage across the resistor

```
clear//

//Variables

VS = 5                    //Source voltage (in volts)
R = 510                   //Resistance (in ohm)
VF = 0.7                  //Forward voltage drop (in
    volts)

//Calculation

VR = VS - VF              //Net voltage (in volts)
I = VR / R                //Current through the diode

//Result

printf("\n Voltage across the resistor is %0.3f V
    .\nThe circuit current is %0.2f mA.",VR,I
    *10**3)
```

Scilab code Exa 12.13 Total current through the circuit

```
clear//

//Variables

VS = 6                            //Source voltage (in
    volts)
```

```
VD1=0.7;VD2=0.7;
R = 1.5 * 10**3                          //Resistance (in ohm)

//Calculation

I = (VS - VD1 - VD2)/R                   //Current (in Ampere)

//Result

printf("\n Total current through the circuit is  %0
    .3f  mA." ,I * 10**3)
```

Scilab code Exa 12.14 Total current through the circuit

```
clear//

//Variables

VS = 12                                   //Source voltage (
    in volts)
R1 = 1.5 * 10**3                          //Resistance (in
    ohm)
R2 = 1.8 * 10**3                          //Resistance (in
    ohm)
VD1=0.7;VD2=0.7;

//Calculation

RT = R1 + R2                              //Total Resistance
    (in ohm)
I = (VS - VD1 - VD2)/RT                   //Current (in
    Ampere)

//Result

```

```
printf("\n Total current through the circuit is %0
    .3f mA.",I * 10**3)
```

Scilab code Exa 12.15 Output Voltage in case 1

```
clear//

//Variables

R = 3.3 * 10**3                    //Resitance (in ohm)

//Calculation

//Case (a)

V11=0;V21=0;
V01 = 0                            //Output Voltage (in
    volts)

//Case (b)

V21 = 0                            //Voltage (in volts)
V22 = 5                            //Voltage (in volts)
V02 = V22 - 0.7                    //Output voltage (in
    volts)

//Case (c)

V31 = 5                            //Voltage (in volts)
V32 = 0                            //Voltages (in volts)
V03 = V31 - 0.7                    //Output voltage (in
    volts)

//Case (d)

```

```
V41=5;V42=5;
V04 = V41 - 0.7                    //Output voltage (in
    volts)

//Result

printf("\n Output Voltage in case 1 is  %0.3f  V.\
    nOutput Voltage in case 2 is  %0.3f  V.\nOutput
    Voltage in case 3 is  %0.3f  V.\nOutput Voltage
    in case 4 is  %0.3f  V.",V01,V02,V03,V04)
```

Chapter 13

Special Purpose Diodes and Opto Electornic Devices

Scilab code Exa 13.1 `THe value of IZM for the device`

```
clear//

//Variables

PZM = 500                              //Power rating of zener diode (in milli-watt)
VZ = 6.8                               //Zener voltage rating (in volts)

//Calculation

IZM = PZM / VZ                         //Maximum value of zener current (in milli-Ampere)

//Result

printf("\n THe value of IZM for the device is  %0.1f mA.",IZM)
```

Scilab code Exa 13.2 The maximum power dissipation for the device

```
clear//

//Variables

PZM = 500                                    //Power rating
     of zener diode (in milli-watt)
df = 3.33                                    //derating
   factor (in milli-watt)
T1 = 75                                      //Temperature
   (in degree Celsius)
T2 = 50                                      //Temperature
   (in degree Celsius)

//Calculation

Tdf = df * (T1 - T2)                         //Total
   derating factor (in milli-watt)
PZ = PZM - Tdf                               //Maximimum
   power dissipating for the device (in milli-watt)

//Result

printf("\n The maximum power dissipation for the
   device is %0.3f mW.",PZ)
```

Scilab code Exa 13.3 Resistance of the zener diode

```
clear//

//Variables
```

```
IZ1 = 20                          //Reverse current (in
    milli-Ampere)
IZ2 = 30                          //Reverse current (in
    milli-Ampere)
VZ1 = 5.6                         //Zener voltage (in
   volts)
VZ2 = 5.65                        //Zener voltage (in
   volts)

//Calculation

dIZ = IZ2 - IZ1                   //Change in reverse
   current (in milli-Ampere)
dVZ = VZ2 - VZ1                   //Change in zener
   voltage (in volts)
rZ = dVZ / (dIZ * 10**-3)         //Resistance of
   device (in ohm)

//Result

printf("\n Resistance of the zener diode is  %0.3f
   ohm.",rZ)
```

Scilab code Exa 13.4 Terminal voltage of the zener diode

```
clear//

//Variables

VZ = 4.7                             //Zener voltage (
   in volts)
rZ = 15                              //Resistance (in
   ohm)
IZ = 20 * 10**-3                     //Current (in
```

```
Ampere)

//Calculation

VZ1 = VZ + IZ * rZ                    //Terminal voltage of a zener diode (in volts)

//Result

printf("\n Terminal voltage of the zener diode is %0.3f  V.",VZ1)
```

Scilab code Exa 13.5 `Tuning range for the circuit`

```
clear//

//Variables

C1min=5;C2min=5;Cmin=5;
C1max=50;C2max=50;Cmax=50;
L = 10                                          //Inductance (in milli-Henry)

//Calculation

CTmin = C1min * C2min / (C1min + C2min)         //Total minimum capacitance (in pico-farad)
CTmin = CTmin * 10**-12                         //Total minimum capacitance (in farad)
L = 10 * 10**-3                                 //Inductance (in Henry)
f0max = 1/(2*%pi*(L*CTmin)**0.5)              //Maximun resonant frequency (in Hertz)
CTmax = C1max * C2max / (C1max + C2max)         //Total maximum capacitance (in pico-farad)
```

```
CTmax = CTmax * 10**-12                              //
   Total minimum capacitance (in farad)
f0min = 1/(2*%pi*(L*CTmax)**0.5)                 //
   Minimum resonant frequency (in Hertz)

//Result

printf("\n Tuning range for the circuit is between
   %0.0f  kHz and  %0.0f  MHz.",f0min*10**-3,f0max
   *10**-6)
```

Scilab code Exa 13.6 Frequency of 5th harmonic

```
clear//

//Variables

T = 0.04 * 10**-6                        //Time period
   (in seconds)

//Calculation

f = 1/T                                  //Frequency (
   in Hertz)
f = f * 10**-6                           //Frequency (
   in Mega-Hertz)
f5 = 5 * f                               //%th -
   harmonic (in Mega-Hertz)

//Result

printf("\n Frequency of 5th harmonic is  %0.3f  MHz.
   ",f5)
```

Chapter 14

Bipolar Junction Transistor

Scilab code Exa 14.1 `Base current`

```
clear//

//Variables

IE = 10                          //Emitter current (in
    milli-Ampere)
IC = 9.8                         //Collector current (in
    milli-Ampere)

//Calculation

IB = IE - IC                     //Base current (in milli
   -Ampere)

//Result

printf("\n Base current is %0.3f mA.",IB)
```

Scilab code Exa 14.2 `Common Base current gain`

```
clear//

//Variables

IE = 6.28                         //Emitter current (in
    milli-Ampere)
IC = 6.20                         //Collector current (
    in milli-Ampere)

//Calculation

alpha = IC / IE                   //Common base current
    gain

//Result

printf("\n Common-Base current gain is %0.3f ." ,
    alpha)
```

Scilab code Exa 14.3 `Base current`

```
clear//

//Variables

alpha = 0.967                     //common base current
    gain
IE = 10                           //Emitter current (in
    milli-Ampere)

//Calculation

IC = alpha * IE                   //Collector current (
    in milli-Ampere)
IB = IE - IC                      //Base current (in
```

```
milli-Ampere)

//Result

printf("\n Base current is %0.3f mA." ,IB)
```

Scilab code Exa 14.4 IC

```
clear//

//Variables

IE = 10                          //Emitter current (in milli-Ampere)
alpha = 0.987                    //common base current gain

//Calculation

IC = alpha * IE                  //Collector current (in milli-Ampere)
IB = IE - IC                     //Base current (in milli-Ampere)

//Result

printf("\n IC is %0.3f mA.\nIB is %0.3f mA.",IC,IB)
```

Scilab code Exa 14.5 Value of beta when alpha is 0 975

```
clear//

```

```
//Variables

alpha1 = 0.975                      //common base
    current gain
beta1 = 200.0                       //common emitter
    current gain

//Calculation

beta = alpha1 / (1-alpha1)          //common emitter
    current gain
alpha = beta1 / (beta1 + 1)         //common base
    current gain

//Result

printf("\n Value of beta when alpha = 0.975 is %0.3
    f .\nValue of alpha when beta = 200 is %0.3f .",
    beta,alpha)
```

Scilab code Exa 14.6 The value of emitter current

```
clear//

//Variables

beta = 100.0                        //common emitter
    current gain
IC = 40.0                           //Collector current (
    in milli-Ampere)

//Calculation

IB = IC / beta                      //Base current (in
    milli-Ampere)
```

```
IE = IB + IC                    //Emitter current (in
    milli-Ampere)

//Result

printf("\n The value of emitter current is  %0.3f
  mA.",IE)
```

Scilab code Exa 14.7 Collector current

```
clear//

//Variables

beta = 150.0                    //common emitter
   current gain
IE = 10                         //Emitter current (in
    milli-Ampere)

//Calculation

alpha = beta / (beta + 1)       //common base current
    gain
IC = alpha * IE                 //Collector current (
   in milli-Ampere)
IB = IE - IC                    //Base current (in
   milli-Ampere)

//Result

printf("\n Collector current is  %0.2f  mA.\nBase
   current is  %0.2f  mA.",IC,IB)
```

Scilab code Exa 14.8 `Base current`

```
clear//

//Variables

beta = 170.0                        //common emitter
   current gain
IC = 80.0                           //Collector current (
   in milli-Ampere)

//Calculation

IB = IC / beta                      //Base current (in
   milli-Ampere)
IE = IB + IC                        //Emitter current (in
    milli-Ampere)

//Result

printf("\n Base current is %0.2f mA.\nEmitter
   current is %0.2f mA.",IB,IE)
```

Scilab code Exa 14.9 `Value of collector current`

```
clear//

//Variables

IB = 0.125                            //Base current (in
   milli-Ampere)
beta = 200.0                          //common emitter
   current gain

//Calculation
```

```
IC = IB * beta                    //Collector current (in milli-Ampere)
IE = IC + IB                      //Emitter current (in milli-Ampere)

//Result

printf("\n Value of collector current is %0.3f mA.\nValue of emitter current is %0.3f mA.",IC,IE)
```

Scilab code Exa 14.10 Collector current

```
clear//

//Variables

IE = 12.0                         //Emitter current (in milli-Ampere)
beta = 140.0                      //common emitter current gain

//Calculation

IB = IE / (1 + beta)              //Base current (in milli-Ampere)
IC = IE - IB                      //Collector current (in milli-Ampere)

//Result

printf("\n Collector current is %0.3f mA.\nBase current is %0.3f mA.",IC,IB)
```

Scilab code Exa 14.11 Beta of the transistor

```
clear//

//Variables

IB = 105 * 10**-3                    //Base current (in milli-Ampere)
IC = 2.05                            //Collector current (in milli-Ampere)

//Calculation

beta = IC / IB                       //Common base current gain
alpha = beta / (1 + beta)            //Common emitter current gain
IE = IB + IC                         //Emitter current (in milli-Ampere)
IC1 = IC + 0.65                      //New collector current (in milli-Ampere)
IB1 = IB + 27 * 10**-3               //New base current (in milli-Ampere)
beta1 = IC1 / IB1                    //New value of beta

//Result

printf("\n Beta of the transistor is %0.1f .\nalpha of the transistor is %0.2f .\nEmitter current is %0.3f mA.\nNew value of beta is %0.2f .",beta,alpha,IE,beta1)
```

Scilab code Exa 14.12 Value of collector current

```
clear//

//Variables

alpha = 0.98                                //common base current gain
ICO = 5 * 10**-3                            //Leakage current (in milli-Ampere)
IB = 100 * 10**-3                           //Base current (in milli-Ampere)

//Calculation

IC = (alpha * IB + ICO)/ (1 - alpha)        //Collector current (in milli-Ampere)
IE = IC + IB                                //Emitter current (in milli-Ampere)

//Result

printf("\n Value of collector current is %0.3f mA.\nValue of emitter current is %0.3f mA.",IC,IE)
```

Scilab code Exa 14.13 Collector current when IB is 0 25 mA

```
clear//

//Variables

```

```
ICBO = 10 * 10**-3                        //Leakage
   current (in milli-Ampere)
beta=50;hFE=50;
T2 = 50.0                                 //Temperature
   (in degree Celsius)
T1 = 27.0                                 //Temperature
   (in degree Celsius)

//Calculation

//Case (a)

IB = 0.25                                 //Base current
    (in milli-Ampere)
IC = beta * IB + (1 + beta)* ICBO        //Value of new
    collector current (in milli-Ampere)

//Case (b)

ICBO1 = ICBO * 2**((T2 - T1)/10)         //ICBO at 50
   degree celsius (in milli-Ampere)
IC1 =  beta * IB + (1 + beta)* ICBO1    //Value of new
    collector current (in milli-Ampere)

//Result

printf("\n Collector current when IB = 0.25 mA is
   %0.3f  mA.\nCollector current at 50 degree
   Celsius is  %0.2f  mA.",IC,IC1)
```

Chapter 15

BJT Characteristics

Scilab code Exa 15.1 Maximum power dissipation at 70 degree Celsius

```
clear//

//Variables

PDmax = 500                              //Maximum
   Power dissipation at 25 degree Celsius (in milli-
   watt)
DF = 2.28                                //derating
   factor (in milli-watt per degree Celsius)
T = 70                                   //Temperaure
   (in degree Celsius)

//Calculation

PDmax70 = PDmax - DF * (T - 25)          //Maximum
   Power dissipation at 70 degree Celsius (in milli-
   watt)

//Result

printf("\n Maximum power dissipation at 70 degree
```

```
    Celsius is %0.0f mW.",PDmax70)
```

Chapter 16

Field Effect Transistor

Scilab code Exa 16.4 `The value of transconductance`

```
clear//

//Variables

VGS1 = -3.1                                //Gate-Source
   voltage (in volts)
VGS2 = -3.0                                //Gate-Source
   voltage (in volts)
ID1 = 1.0                                  //Drain current
    (in milli-Ampere)
ID2 = 1.3                                  //Drain current
    (in milli-Ampere)

//Calculation

dVGS = VGS2 - VGS1                         //Change in
   Gate-Source voltage (in volts)
dID = ID2 - ID1                            //Change in
   Drain current (in milli-Ampere)
gm = dID / dVGS                            //
   Transconductance (in milli-Ampere per volt)
```

```

//Result

printf("\n The value of transconductance is  %0.3f mA/V.",gm)
```

Scilab code Exa 16.6 The value of ID when VGS is 6 V

```
clear//

//Variables

IDon = 10.0                         //Drain current (in milli-Ampere)
VGS = -12.0                         //Gate-Source voltage (in volts)
VGSth = -3.0                        //Threshold Gate-Source voltage  (in volts)
VGS1 = -6.0                         //Gate-Source voltage in another case (in volts)

//Calculation

K = IDon/(VGS - VGSth)**2           //Transconductance (milli-Ampere per volt)
ID = (K) * (VGS1 - VGSth)**2   //Drain current (in milli-Ampere)


//Result

printf("\n Since the value of VGS is negative for the enhancement-type MOSFET ,this indicated that device is P-channel.")
printf("\n The value of ID when VGS = -6 V is  %0.3f
```

mA.",ID)

Chapter 17

Thyristors

Scilab code Exa 17.1 Therefore the device will not be destroyed

```
clear//

//Variables

I = 40                        //Current (in milli-
   Ampere)
t = 15 * 10**-3               //time (in seconds)
CFS = 93                      //Circuit fusing rate (
   in Ampere-square second)

//Calculation

SCR = I**2 * t                //Surge in the device (
   in Ampere-square second)

//Result

printf("\n Since value of SCR i.e. %0.3f A**2s is
   less than CFS i.e. %0.3f A**2s.",SCR,CFS)
printf("\n Therefore the device will not be
   destroyed.")
```

Scilab code Exa 17.2 Maximum allowable time

```
clear//

//Variables

SCR=75.0;I2t=75.0;
IS = 100.0                          //Current (in Ampere)

//Calculation

tmax = I2t / IS**2                  //Maximum allowable time
    (in seconds)

//Result

printf("\n Maximum allowable time is %0.3f ms.",
   tmax * 10**3)
```

Scilab code Exa 17.3 Peak point voltage of the circuit

```
clear//

//Variables

VD = 0.7                            //Voltage (in volts)
n = 0.75                            //Intrinsic stand-off
   ratio
VBB = 12                            //Base Voltage (in
   volts)

```

```
//Calculation

VP = n * VBB + VD                  //Peak−point voltage (
    in volts)

//Result

printf("\n Peak − point voltage of the circuit is
    %0.3f  V.",VP)
```

Scilab code Exa 17.4 Intrinsic stand off ratio

```
clear//

//Variables

rB1 = 4.0                          //Resistance (in kilo−
    ohm)
rB2 = 2.5                          //Resistance (in kilo−
    ohm)
VBB = 15.0                         //Base voltage (in
    volts)
VD = 0.7                           //Voltage (in volts)

//Calculation

n = rB1 / (rB1 + rB2)              //Intrinsic stand−off
    ratio
VP = n * VBB + VD                  //Peak−point voltage (
    in volts)

//Result

printf("\n Intrinsic stand off ratio is  %0.4f .\
    nPeak−point voltage is  %0.f ",n,VP)
```

Chapter 19

Rectifiers and Filters

Scilab code Exa 19.2 The value of dc load current

```
clear//

//Variables

RL = 20                         //Load resistance (in
    kilo-ohm)
V2 = 24                         //Secondary voltage (
   in volts)

//Calculation

Vm = 2**0.5 * V2                //Maximum value of
   secondary voltage (in volts)
Im = Vm / RL                    //Maximumj value of
   load current (in milli-Ampere)
Idc = 0.318 * Im                //dc current (in
   milli-Ampere)

//Result

printf("\n The value of dc load current is  %0.3f
```

```
mA.",Idc)
```

Scilab code Exa 19.3 Average value of load power

```
clear//

//Variables

V1 = 230                    //Primary voltage (in volts)
N2byN1 = 1.0/2.0            //Turns ratio
RL = 200                    //Resistance (in ohm)

//Calculation

V2 = V1 * N2byN1            //Secondary voltage (in volts)
Vm = 2**0.5 * V2            //Maximum value of secondary voltage (in volts)
Im = Vm / RL                //Maximum value of load current (in Ampere)
Pm = Im**2 * RL             //Maximum value of load power (in watt)
Vdc = 0.318 * Vm            //Average value of load power (in watt)
Idc = Vdc / RL              //Average value of load current (in Ampere)
Pdc = Idc**2 * RL           //Average value of load power (in watt)

//Result

printf("\n Maximum value of load power is %0.1f W.",Pm)
printf("\n Average value of load power is %0.1f W.
```

```
",Pdc)
```

Scilab code Exa 19.4 Maximum a c voltage required at the input

```
clear//

//Variables

Vdc = 30.0                    //Average value of
    voltage (in volts)
RL = 600.0                    //Load resistance (in
    ohm)
Rf = 25.0                     //forward resistance (
    in ohm)

//Calculation

Idc = Vdc / RL                //Average value of
    load current (in Ampere)
Im = (%pi * Idc)    //Maximum value of load current (
    in Ampere)

Vinmax = Im * (Rf + RL)       //Maximum a.c. voltage
     required at the input (in volts)

//Result

printf("\n Maximum a.c. voltage required at the
    input is  %0.3f  V.",Vinmax)
```

Scilab code Exa 19.6 The dc output voltage

```
clear//
```

```

//Variables

V1 = 230.0                    //primary voltage (in
    volts)
N2byN1 = 1.0/4.0              //Turns ratio
RL = 200                      //Load resistance (in ohm)
fin = 50                      //Frequency (in hertz)

//Calculation

V2 = V1 * N2byN1              //Secondary voltage (in
    volts)
Vm = 2**0.5 * V2              //Maximum value of voltage
     (in volts)
Vdc = 0.636 * Vm              //Average value of voltage
     (in volts)
PIV = Vm                      //peak inverse voltage (in
     volts)
fout = 2 * fin                //Output frequency (in
    volts)

//Result

printf("\n The dc output voltage is %0.1f V.\nPeak
     inverse Voltage of a diode is %0.1f V.\nOutput
     frequency is %0.3f HZ.",Vdc,PIV,fout)
```

Scilab code Exa 19.7 The dc output voltage

```
clear//

//Variables

V1 = 230.0                    //primary voltage (in
```

```
volts)
N2byN1 = 1.0/5.0          //Turns ratio
RL = 100                  //Load resistance (in ohm)

//Calculation

V2 = V1 * N2byN1          //Secondary voltage (in
   volts)
VS = V2 / 2               //Voltage between center-
   tap and either end of secondary winding (in
   volts)
Vm = 2**0.5 * VS          //Maximum value of voltage
   (in volts)
Vdc = 2/%pi * Vm      //Averaage value of Voltage (
   in volts)
PIV = 2 * Vm              //Peak inverse voltage (in
   volts)
n = 0.812                 //Efficiency of full wave
   rectifier

//Result

printf("\n The dc output voltage is %0.1f V.\nPeak
   inverse voltage is %0.0f V.\nRectification
   efficiency is %0.3f .",Vdc,PIV,n)
```

Scilab code Exa 19.9 The value of Vdc

```
clear//

//Variables

Vs = 150.0            //Voltage (in volts)
Idc = 2.0             //Average value of current (in
   Ampere)
```

```
//Calculation

Vdc = 2.34 * Vs          //Average calue of voltage (in volts)
Ipi = 1/0.955 * Idc      //Peak current per diode (in Ampere)
Iavg = 2.0/3.0           //Average current per diode (in AMpere)
Pdc = Vdc * Idc          //Average power delievered to the load (in watt)

//Result

printf("\n The value of Vdc is %0.3f V.\nPeak current through each diode is %0.1f A.\nAverage current through each diode is %0.2f A.\nAverage power delievered to the load is %0.3f W.",Vdc,Ipi,Iavg,Pdc)
```

Scilab code Exa 19.10 `New Value of inductance`

```
clear//

//Case (a):

//Variables

f = 50.0                              //Frequency (in Hertz)
g = 0.05                              //Ripple factor
RL = 100.0                            //Resistance (in ohm)
w = 2 * %pi * f                       //Angular frequency (in radians per second)
```

```
//Calculation

L = RL / (3 * 2**0.5 * w * g)          //Inductance (
    in Henry)

//Result

printf("\n Value of inductance is  %0.1f  H.",L)

//Case (b):

//Variables

f = 400.0                                   //Frequency (in
     Hertz)
g = 0.05                                    //Ripple factor
RL = 100.0                                  //Resistance (
    in ohm)
w = 2 * %pi * f                          //Angular frequency
     (in radians per second)

//Calculation

L = RL / (3 * 2**0.5 * w * g)          //Inductance (
    in Henry)

//Result

printf("\n New Value of inductance is  %0.3f  H.",L)
```

Scilab code Exa 19.11 `Value of capacitance`

```
clear//

```

```
//Variables

Vdc = 30.0                          //Average value of voltage (in volts)
RL = 1.0                            //Resistance (in kilo-ohm)
gamma = 0.01                        //Ripple factor
f = 50                              //Frequency (in Hertz)
//Calculation

C = 2890.0 / (gamma * RL)           //Capacitance (in nano Farad)

//Result

printf("\n Value of capacitance is %0.3f micro-Farad.",C * 10**-3)
```

Scilab code Exa 19.12 Capacitance

```
clear//

//Variables

Vdc = 12.0                      //Average value of voltage (in volts)
Idc = 100.0                     //Average value of current (in milli-Ampere)
gamma = 0.01                    //Ripple factor
L = 1.0                         //Inductance (in Henry)

//Calculation

```

```
C = 1.195 / (gamma * L)          //Capacitance

//Result

printf("\n Capacitance is  %0.3f  micro-Farad.",C)
```

Scilab code Exa 19.13 Ripple factor for 50 Hz supply

```
clear//

//Variables

Idc = 0.2                          //Average value of current (in Ampere)
Vdc = 30.0                         //Average value of voltage (in volts)
C1=100.0;C2=100.0;
L = 5.0                            //Inductance (in Henry)
f = 50.0                           //Frequency (in Hertz)

//Calculation

RL = Vdc / Idc                     //Load resistance (in ohm)
gamma = 5700.0 / (C1 * C2 * RL * L)  //Ripple factor

//Result

printf("\n Ripple factor for 50 Hz supply is  %0.3f.",gamma)
```

Chapter 20

Regulated Power Supplies

Scilab code Exa 20.1 The value of line regulation

```
clear//

//Variables

dVL = 100.0 * 10**-6                    //Change in
    output voltage (in volts)
dVin = 5.0                              //Change in
    input voltage (in volts)

//Calculation

LR = dVL / dVin                         //Line
    regulation (in volt per volt)

//Result

printf("\n The value of line regulation is %0.3f
    micro-volt/volt.",LR * 10**6)
```

Scilab code Exa 20.2 `The change in output voltage`

```
clear//

//Variables

LR = 1.4                              //Line regulation (in
    micro-volt per volt)
dVS = 10                              //Change in source
   voltage (in volts)

//Calculation

dVL = LR * dVS                        //Change in output
   voltage (in micro-volts)

//Result

printf("\n The change in output voltage is  %0.3f
   micro-volt.",dVL)
```

Scilab code Exa 20.3 `Line regulation`

```
clear//

//Variables

dIL = 40.0                           //Change in current (
   in milli-Ampere)
VNL = 8.0                            //Voltage under no
   load (in volts)
VFL = 7.995                          //Voltage under full
   load (in volts)

//Calculation
```

```
LR = (VNL - VFL)/ dIL          //Line regulation (in milli-volt per milli-Ampere)

//Result

printf("\n Line regulation is  %0.3f mV/mA.",LR * 10**3)
```

Scilab code Exa 20.4 Full load Voltage

```
clear//

//Variables

LR = 10.0                                  //Load regulation (in micro-volt per milli-Ampere)
VNL = 5.0                                  //No load Voltage (in volts)
dIL = 20.0                                 //Change in current (in milli-Ampere)

//Calculation

VFL = VNL - LR * dIL * 10**-6              //Full load Voltage (in volts)

//Result

printf("\n Full load Voltage is  %0.3f  V.",VFL)
```

Scilab code Exa 20.5 Change in output voltage

```
clear//

//Variables

V0 = 10                          //Regulated dc supply (
    in volts)
LR = 0.00002                     //Line regulation

//Calculation

dV = LR * V0                     //Change in output
    voltage (in volts)

//Result

printf("\n Change in output voltage is  %0.3f  mV.",
    dV * 10**3)
```

Scilab code Exa 20.6 Load voltage

```
clear//

//Variables

VS = 30.0                        //Source voltage (in
    volts)
RS = 240.0                       //Series resistance (in
    ohm)
Vz = 12.0                        //Zener voltage (in
    volts)
RL = 500.0                       //Load resistance (in
    ohm)

//Calculation

```

```
VL = Vz                          //Voltage drop across
   load (in volts)
IS = (VS - Vz) / RS              //Current through RS (in
    Ampere)
VRS = IS * RS                    //Voltage drop across
   series resistance (in volts)
IL = VL / RL                     //Load current (in
   Ampere)
IZ = IS - IL                     //Zener current (in
   Ampere)

//Result

printf("\n Load voltage is %0.3f V.\nVoltage drop
   across series resistance is %0.3f V.\nCurrent
   through Zener diode is %0.3f A.",VL,VRS,IZ)
```

Scilab code Exa 20.8 Minimum value of load resistance

```
clear//

//Variables

VS = 24.0                             //Source voltage (
   in volts)
RS = 500.0                            //Series resistance
    (in ohm)
VZ = 12.0                             //Zener Voltage (in
    volts)
IZmin = 3.0                           //Minimum Zener
   current (in milli-Ampere)
IZmax = 90.0                          //Maximum Zener
   current (in milli-Ampere)
rZ = 0.0                              //Zener resistance
   (in ohm)
```

```

//Calculation

IS = (VS - VZ) / RS                    //Current through RS (in Ampere)
ILmax = IS - IZmin * 10**-3            //Maximum value of load Current (in Ampere)
RLmin = VZ / ILmax                     //Minimum value of Load resistance (in ohm)

//Result

printf("\n Minimum value of load resistance is  %0.0f  ohm.",RLmin)
```

Scilab code Exa 20.9 `Maximum value of zener current`

```
clear//

//Variables

VZ = 10.0                                       //Zener voltage (in volts)
RS = 1.0                                        //Series Resistance (in kilo-ohm)
RL = 2.0                                        //Load Resistance (in kilo-ohm)
VSmin = 22.0                                    //Minimum source voltage (in volts)
VSmax = 40                                      //Maximum source voltage (in volts)

//Calculation

IL = VZ / RL                                    //Load
```

```
    current (in milli-Ampere)
IZmax = (VSmax - VZ) / RS - IL                    //
    Maximum value of zener current (in milli-Ampere)
IZmin = (VSmin - VZ) / RS - IL                    //
    Minimum value of zener current (in milli-Ampere)

//Result

printf("\n Maximum value of zener current is  %0.3f
     mA.\nMinimum value of zener current is  %0.3f
    mA.",IZmax,IZmin)
```

Scilab code Exa 20.10 `Maximum value of RS`

```
clear//

//Variables

VZ = 10.0                                      //Zener
    voltage (in volts)
VSmin = 13.0                                   //Minimum
    source voltage (in volts)
VSmax = 16.0                                   //Maximum
    source voltage (in volts)
ILmin = 10.0                                   //Minimum
    load current (in milli-Ampere)
ILmax = 85.0                                   //Maximum
    load current (in milli-Ampere)
IZmin = 15.0                                   //Minimum
    zener current (in milli-Ampere)

//Calculation

RSmax = (VSmin - VZ)/ (IZmin + ILmax)          //Maximum
    value of RS (in kilo-ohm)
```

```
IZmax = (VSmax - VZ)/ RSmax - ILmin      //Maximum
   zener current (in milli-Ampere)
PZmax = IZmax * 10**-3 * VZ              //Maximum
   power dissipation in zener (in watt)

//Result

printf("\n Maximum value of RS is  %0.3f  ohm.\
   nMaximum power dissipation be the zener diode is
    %0.3f  W.",RSmax*10**3,PZmax)
```

Scilab code Exa 20.11 Magnitude of regulating resistance should be between

```
clear//

//Variables

VSmin = 19.5                             //Minimum
   source voltage (in volts)
VSmax = 22.5                             //Maximum
   source voltage (in volts)
RL = 6.0 * 10**3                         //Load
   resistance (in ohm)
VZ = 18.0                                //Zener
   voltage (in volts)
IZmin = 2.0 * 10**-6                     //Minimum
   zener current (in Ampere)
PZmax = 60.0 * 10**-3                    //Maximum
   power dissipation (in watt)
rZ = 20.0                                //Zener
   resistance (in ohm)
VL = VZ                                  //Voltage
   across load resistance (in volt)

//Calculation
```

```
IZmax = (PZmax / rZ)**0.5                    //Maximum
   value of zener current (in milli-Ampere)
IL = VL / RL                                 //Load
   current (in milli-Ampere)
RSmax = (VSmin - VZ) / (IZmin + IL)          //Maximum
   value of regulating resistance (in kilo-ohm)
RSmin = (VSmax - VZ) / (IZmax + IL)          //Minimum
   value of regulating resistance (in kilo-ohm)

//Result

printf("\n Magnitude of regulating resistance should
    be between %0.1f ohm and %0.0f ohm.",RSmin,
   RSmax)
```

Scilab code Exa 20.12 Minimum value of Zener current

```
clear//

//Variables

VSmin = 8.0                        //Minimum source
   voltage (in volts)
VSmax = 12                         //Maximum source
   voltage (in volts)
RS = 2.2                           //Resistance (in kilo
   -ohm)
VZ = 5.0                           //Zener voltage (in
   volts)
RL = 10.0                          //Load resistance (in
    kilo-ohm)
VL = VZ                            //Voltage across load
    (in volts)

```

```
//Calculation

ISmin = (VSmin - VZ)/ RS          //Minimum value of
    input current (in milli-Ampere)
ISmax = (VSmax - VZ)/RS           //Maximum value of
    input current (in milli-Ampere)
IL = VL / RL                      //Load current (in
    milli-Ampere)
IZmin = ISmin - IL                //Minimum Zener
    current (in milli-Ampere)
IZmax = ISmax - IL                //Maximum Zener
    current (in milli-Ampere)

//Result

printf("\n Minimum value of Zener current is  %0.3f
     mA.\nMaximum value of Zener current is  %0.3f
   mA.",IZmin,IZmax)
```

Scilab code Exa 20.13 For safety purpose RS should be 220 ohm

```
clear//

//Variables

VO=5.0;VL=5.0;
IL = 20.0                          //Load current (in
     milli-Ampere)
PZmax = 500.0                      //Maximum power
    dissipation in zener (in milli-watt)
VSmin = 9.0                        //Minimum source
    voltage (in volts)
VSmax = 15.0                       //Maximum source
    voltage (in volts)
VZ = 5
```

```
IZ =20
//Calculation

IZmax = PZmax / VZ                    //Maximum zener
   current (in milli-Ampere)
ISmax = IL + IZ                       //Maximum input
   current (in milli-Ampere)
RSmin = (VSmax - VZ)/(IZmax + IL) //Minimum value of
    regulating resistance (in kilo-ohm)
IZ = (VSmin - VZ)/ RSmin - IL         //Minimum value of
    zener current

//Result

printf("\n Input varies from the normal 12 v within
   the range of +- 3 V.")
printf("\n Zener current vary from %0.3f mA to %0
   .3f mA.",IZ,IZmax)
printf("\n For safety purpose RS should be 220 ohm."
   )
```

Scilab code Exa 20.14 The minimum value of voltage level at input

```
clear//

//Variables

RS = 500.0                                        //
   Series resistance (in ohm)
RL = 1.0                                          //Load
    resistance (in kilo-ohm)
VZ = 10.0                                         //
   Zener voltage (in volts)
IZmin = 5.0                                       //
   Minimum Zener current (in milli-Ampere)
```

```
IZmax = 55.0                                  //
   Maximum Zener current (in milli-Ampere)

//Calculation

IL = VZ / RL                                  //Load
    current (in milli-Ampere)
VSmin = (IL + IZmin) * RS * 10**-3 + VZ       //
   Minimum value of input voltage (in volts)
VSmax = (IL + IZmax) * RS * 10**-3 + VZ       //
   Maximum value of input voltage (in volts)

//Result

printf("\n The minimum value of voltage level at
   input is %0.3f V and the maximum is %0.3f V."
   ,VSmin,VSmax)
```

Scilab code Exa 20.15 Base current

```
clear//

//Variables

VS = 15.0                     //Input voltage (in
    volts)
RS = 33.0                     //Series resistance (in
   ohm)
beta = 100.0                  //common-emitter current
    gain
RL = 100.0                    //Load resistance (in
   ohm)
VZ = 10.0                     //Voltage across zener
    diode (in volts)
VBE = 0.7                     //Voltage across base
```

```
and emitter

//Calculation

VL = VZ + VBE                    //Load voltage (in volts)
IL = VL / RL                     //Load current (in Ampere)
IS = (VS - VL) / RS              //Current through RS (in Ampere)
IC = IS - IL                     //Collector current (in Ampere)
IB=IC/beta;IZ=IC/beta;

//Result

printf("\n Load voltage is %0.3f V.",VL)
printf("\n Load current is %0.3f mA.",IL * 10**3)
printf("\n Current through Rs is %0.1f mA.",IS * 10**3)
printf("\n Collector current is %0.1f mA.",IC*10**3)
printf("\n Base current is %0.0f micro-A." ,IB * 10**6)
```

Scilab code Exa 20.16 `Current through Zener`

```
clear//

//Variables

VS = 15.0                          //Input voltage (in volts)
VZ = 8.3                           //Zener voltage (in volts)
```

```
beta = 100.0                    //Common–emitter current gain
R = 1.8                         //Resistance (in kilo–ohm)
RL = 2.0                        //Resistance (in kilo–ohm)
VBE = 0.7                       //Voltage across base–emitter junction (in volts)

//Calculation

VL = VZ - VBE                   //Voltage across load (in volts)
VCE = VS - VL                   //Collector to emitter voltage (in volts)
IR = (VS - VZ)/ R               //Current through R (in milli–Ampere)
IL = VL / RL                    //Load current (in milli–Ampere)
IB = IL / beta                  //Base current (in milli–Ampere)
IZ = IR - IB                    //Current through Zener (in milli–Ampere)

//Result

printf("\n Load voltage is %0.3f V.",VL)
printf("\n Collector to Emitter voltage is %0.3f V.",VCE)
printf("\n Current through R is %0.2f mA.",IR)
printf("\n Load current is %0.3f mA.",IL)
printf("\n Base current is %0.3f micro–A.",IB * 10**3)
printf("\n Current through Zener is %0.2f mA.",IZ)
```

Scilab code Exa 20.17 Maximum value of R

```
clear//

//Variables

IZmin = 0                          //Minimun Zener current (in Ampere)
ILmax = 2.0                        //Maximum load current (in Ampere)
VL = 12.0                          //Voltage across load (in volts)
VSmin = 15.0                       //Minimum Input voltage (in volts)
VSmax = 20.0                       //Maximum Input Voltage (in volts)
beta = 100                         //common emitter current gain
VBE = 0.5                          //Voltage between base-emitter junction (in volts)
VZ = 12.5                          //Voltage across zener diode (in volts)
IZmin = 1.0 * 10**-3               //Current through Zener diode
ICmax = ILmax                      //Maximum Collector current (in Ampere)

//Calculation

IBmax = ICmax / beta               //Maximum collector current
IR = IBmax + IZmin                 //Current through resistance R (in Ampere)
Rmax = (VSmin - VZ)/ IR            //Maximum value of resistance R (in ohm)
IZmax = (VSmax - VZ)/ Rmax         //Maximum value of Zener current (in Ampere)
PZmax = VZ * IZmax                 //Maximum power
```

```
    dissipation in Zener Diode (in watt)
PRmax = (VSmax - VZ) * IZmax    //Maximum power dissipated in Resistance R (in watt)
VCEmax = VSmax - VL             //Maximum value of collector-to-emitter voltage (in volts)
PDmax = VCEmax * ILmax          //Maximum power dissipation of the transistor (in watt)

//Result

printf("\n Maximum value of R is  %0.0f  ohm.\nMaximum power dissipation of the zener diode is  %0.2f  W.\nMaximum power dissipation of resistance R is  %0.2f  W.\nMaximum power dissipation of the transistor is  %0.3f  W.",Rmax,PZmax,PRmax,PDmax)
```

Scilab code Exa 20.18 `Value of Resistance R3`

```
clear//

//Variables

VL = 12.0                       //Voltage across load (in volts)
IL = 200.0                      //Load current (in milli-Ampere)
VS = 30.0                       //Source voltage (in volts)
RS = 10.0                       //Series resistance (in ohm)
beta1=150.0;hfe1=150.0;
beta2=100.0;hfe2=100.0;
IC1 = 10.0                      //Collector current (in milli-Ampere)
```

```
VBE1 = 0.7                           //Emitter-to-Base voltage1 (in volts)
VBE2 = 0.7                           //Emitter-to-Base voltage2 (in volts)
VZ=6.0;VR=6.0;
RZ = 10.0                            //Resistance of zener diode (in ohm)
IZ = 20.0                            //Current through zener diode (in milli-Ampere)
ID = 10.0 * 10**-3                   //Current (in Ampere)
I1 = 10.0 * 10**-3                   //Current (in Ampere)

//Calculation

RD = (VL - VZ) / ID                  //Resistance (in ohm)
V2 = VZ + VBE2                       //Voltage (in volts)
R1 = (VL - V2)/I1                    //Value of resistance R1 (in ohm)
R2 = R1 * (V2 / (VL - V2))           //Value of resistance R2 (in ohm)
IB1 = (IL + I1 + ID) / beta1         //Base Current IB1 (in Ampere)
I = IB1 + IC1                        //Current through resistance R3 (in Ampere)
R3 = (VS - (VBE1 + VL))/I            //Value of resistance (in ohm)

//Result

printf("\n Value of Resistance RD is %0.3f ohm.\nValue of Resistance R1 and R2 is %0.3f ohm and %0.3f ohm.",RD,R1,R2)
printf("\n Value of Resistance R3 is %0.1f kilo-ohm.",R3)
```

Scilab code Exa 20.19 Vout

```
clear//

//Variables

VS = 25.0                       //Source voltage (in volts)
VZ = 15.0                       //Zener voltage (in volts)
RL = 1.0                        //Load resistance (in kilo-ohm)
VBE = 0.7                       //Emitter-to-Base voltage (in volts)

//Calculation

Vout = VZ/2 + VBE               //Output voltage (in volts)
IL = Vout / RL                  //Load current (in milli-Ampere)
IE1 = IL                        //Current (in milli-Ampere)
VCE1 = VS - Vout                //Collector-To-Emitter voltage (in volts)
P1 = VCE1 * IE1                 //Power dissipated (in watt)

//Result

printf("\n Vout is %0.3f V.\nIL is %0.3f mA.\nIE1 is %0.3f mA.\nP1 is %0.3f W.",Vout,IL,IE1,P1)
```

Scilab code Exa 20.21 Regulated dc output voltage

```
clear//

//Variables

R1 = 220.0                    //Resistance1 (in ohm)
R2 = 1.5 * 10**3              //Resistance2 (in ohm)
VREF = 1.25                   //Reference voltage (in volts)

//Calculation

Vo = VREF * (R2/R1 + 1)   //Regulated dc output voltage (in volts)

//Result

printf("\n Regulated dc output voltage is  %0.2f  V.",Vo)
```

Scilab code Exa 20.22 Regulated dc output voltage

```
clear//

//Variables

R1 = 240.0                    //Resistance1 (in ohm)
R2 = 2.4 * 10**3              //Resistance2 (in ohm)
VREF = 1.25                   //Reference voltage (in volts)

//Calculation

Vo = VREF * (R2/R1 + 1)   //Regulated dc output voltage (in volts)

```

```
//Result

printf("\n Regulated dc output voltage is  %0.3f  V.
   ",Vo)
```

Chapter 21

Controlled Rectifiers

Scilab code Exa 21.1 Angular firing control when load power P is 25 W

```
clear//

//Variables

RL = 100.0                                          //Resistance (in ohm)
Vm = 300.0                                          //Maximum voltage (in volts)
P1 = 25.0                                           //Load power1 (in watt)
P2 = 80.0                                           //Load power2 (in watt)

//Calculation

Vdc = Vm / (2 * %pi)                            //dc voltage (in volts)
//When power is 25 watt
cosinealpha = (P1 * RL / Vdc**2)**0.5 -1        //cos of alpha
alpha = acos(cosinealpha)                      //Value of
```

```
alpha (in radians)

//When power is 80 watt
cosinealpha1 = (P2 * RL / Vdc**2)**0.5 -1     //cos of alpha
alpha1 = acos(cosinealpha1)                  //Value of alpha (in radians)
//Result

printf("\n Angular firing control when load power P = 25 W is %0.2f degree.\nAngular firing control when load power P = 80 W is %0.2f degree.",alpha*180.0/%pi,alpha1*180.0/%pi)
```

Scilab code Exa 21.4 The value of resistance to limit the average current to 0 5 A

```
clear//

//Variables

Idc = 0.5                                    //dc current (in Ampere)
Vrms = 100.0                                 //Rms voltage (in volts)
alpha = 45.0                                 //Firing angle (in degree)
Idc = 0.5                                    //dc current (in Ampere)

//Calculation

alpharad = alpha * %pi / 180.0               //Firing angle (in radians)
Vm = 2**0.5 * Vrms                           //Peak voltage (in volts)
```

```
Vdc = Vm / (2 * %pi)*(1 + cos(alpharad)) //Average
    voltage (in volts)
RL = Vdc / Idc                              //Load
    resistance (in ohm)

//Result

printf("\n The value of resistance to limit the
    average current to 0.5 A is  %0.2f  ohm.",RL)
```

Scilab code Exa 21.5 Chopper duty cycle

```
clear//

//Variables

TON = 30.0              //Chopper ON time (in milli-
    second)
TOFF = 10.0             //Chopper OFF time (in milli-
    second)

//Calculation

T = TON + TOFF          //Total time (in milli-second)
cdc = TON / T           //Chopper duty cycle
f = 1 / T               //Chopping frequency (in Hertz
    )

//Result

printf("\n Chopper duty cycle is  %0.3f .\nChopping
    frequency is  %0.3f  Hz.",cdc,f*10**3)
```

Scilab code Exa 21.6 `Average valuye of dc voltage`

```
clear//

//Variables

TON = 30.0                          //Chopper ON time (in milli-second)
TOFF = 10.0                         //Chopper OFF time (in milli-second)
Vdc = 200.0                         //dc voltage (in volts)

//Calculation

T = TON + TOFF                      //Total time (in milli-second)
cdc = TON / T                       //Chopper duty cycle
VL = Vdc * cdc                      //dc output voltage (in volts)

//Result

printf("\n Average valuye of dc voltage is %0.3f V.",VL)
```

Chapter 22

BJT Biasing and Stabilization

Scilab code Exa 22.3 `The value of base current`

```
clear//

//Variables

VCC = 25.0                       //Source voltage (in volts)
RC = 820.0                       //Collector Resistance (in ohm)
RB = 180.0                       //Base Resistance (in kilo-ohm)
beta = 80.0                      //Common-Emitter current gain

//Calculation

IB = VCC / RB                    //Base current (in milli-Ampere)
IC = beta * IB                   //Collector current (in milli-Ampere)
VCE = VCC - IC * RC * 10**-3     //Collector-to-Emitter voltage (in volts)
```

```
//Result

printf("\n The value of base current is %0.2f mA.\nThe value of Collector current is %0.2f mA.\nTHe value of Collector-to-Emitter voltage is %0.2f V.",IB,IC,VCE)
```

Scilab code Exa 22.4 The collector current

```
clear//Variables

VBB = 2.7                          //Base voltage (in Volts)
RB = 40.0                          //Base resistance (in kilo-ohm)
VCC = 10.0                         //Supply voltage (in volts)
RC = 2.5                           //Collector resistance (in kilo-ohm)
VBE = 0.7                          //Emitter-to-base voltage (in volts)
beta = 100.0                       //Current gain

//Calculation

IB = (VBB - VBE)/RB                //Base current (in milli-Ampere)
IC = beta * IB

//Result

printf("\n The base current is %0.3f mA.",IB)
printf("\n The collector current is %0.3f mA.",IC)
```

Scilab code Exa 22.5 The value of collector current

```
clear//

//Variables

VCC = 5.0                              //Source voltage (in volts)
RC = 5.0                               //Collector resistance (in kilo-ohm)
VBB = 5.0                              //Base voltage (in volts)
RB = 100.0                             //Base Resistance (in kilo-ohm)
VBE = 0.7                              //Emitter-to-Base Voltage (in volts)
beta = 30.0                            //Common-Emitter current gain

//Calculation

IB = (VBB - VBE)/RB                    //Base Current (in milli-Ampere)
IC = beta * IB                         //Collector Current (in milli-Ampere)
IC1 = VCC / RC                         //Collector Current (in milli-Ampere)

//Result

printf("\n The value of collector current is for operation in saturation region is %0.3f mA.\nSince %0.3f mA is greater than %0.3f mA , therefore it will operate in saturation region.",
```

```
IC1,IC,IC1)
```

Scilab code Exa 22.7 VCE of the transistor

```
clear//

//Variables

VCC = 20.0                      //Source voltage (in volts)
RC = 2.0                        //Collector resistance (in kilo-ohm)
RB = 400.0                      //Base Resistance (in kilo-ohm)
beta = 100.0                    //Common-Emitter current gain
RE = 1.0                        //Emitter Resistance (in kilo-ohm)

//Calculation

IB = VCC / (RB + beta * RE)     //Base current (in milli-Ampere)
IC = beta * IB                  //Collector Current (in milli-Ampere)
VCE = VCC - IC * (RC + RE)      //Collector-to-Emitter Voltage (volts)

//Result

printf("\n VCE of the transistor is %0.3f V.\nVCC of the transistor is %0.3f V.\nIB of the transistor is %0.3f mA.\nIC of transistor is %0.3f mA.",VCE,VCC,IB,IC)
```

Scilab code Exa 22.10 `When VBB is 0 V LED`

```
clear//

//Variables

VCC = 5.0                              //Source voltage (
    in volts)
RE = 100.0                             //Emitter
    resistance (in kilo-ohm)
VBE = 0.7                              //Emitter-base
    Voltage (in volts)

//Calculation

//Case 1 : when VBB = 0.2 V ->OFF
//Case 2: when VBB = 3 V ->ON

//Result

printf("\n When VBB = 0 V , LED is in OFF condition
    .\nWhen VBB = 3 V , LED is in ON condition.")
```

Scilab code Exa 22.11 `Collector current`

```
clear//

//Variables

VCC = 25.0                              //Source voltage (
    in volts)
```

```
RC = 820.0                          //Collector resistance (in ohm)
RB = 180.0 * 10**3                  //Base Resistance (in ohm)
beta = 80.0                         //Common-Emitter current gain
VBE = 0.7                           //Emitter-to-Base Voltage (in volts)
RE = 200.0                          //Emitter resistance (in kilo-ohm)

//Calculation

IC = (VCC -VBE)/(RE + RB / beta)    //Collector current (in milli-Ampere)
VCE = VCC - IC * RC                 //Collector-to-Emitter voltage (in volts)
S = 1 + beta                        //Stability factor

//Result

printf("\n Collector current is %0.1f mA.\nCollector-to-Emitter voltage is %0.3f V.\nStability factor is %0.3f .",IC*10**3,VCE,S)
```

Scilab code Exa 22.13 IB

```
clear//

//Variables

VCC = 10.0                          //Source voltage (in volts)
RC = 2.0 * 10**3                    //Collector resistance (in ohm)
```

```
RB = 100.0 * 10**3                    //Base Resistance (in ohm)
beta = 50.0                           //Common−Emitter current gain
VBE = 0.7                             //Emitter−to−Base Voltage (in volts)

//Calculation

IB = (VCC - VBE)/(RB + beta * RC) //Base current (in Ampere)
IC = beta * IB                        //Collector current (in Ampere)
IE = IC                               //Emitter current (in Ampere)
S = 1 + beta                          //Stability factor

//Result

printf("\n IB is %0.3f mA.\nIC is %0.3f mA.\nIE is %0.3f mA.",IB*10**3,IC*10**3,IE*10**3)
```

Scilab code Exa 22.14 `In case 1 Collector junction`

```
clear//

//Variables

//When VC = 0 volts
VCC = 9.0                                    //Source voltage (in volts)
RB = 220.0                                   //Base Resistance (in kilo−ohm)
RC = 3.3                                     //Collector Resistance (in kilo−ohm)
```

```
VBE = 0.3                                   //Emitter-to-Base voltage (in volts)
beta = 100.0                                //Common emitter current gain

//Calculation

IB = (VCC - VBE)/((RB + beta*RC)* 10**3) //Base current (in Ampere)
IC = beta * IB                              //Collector current (in Ampere)
VCE = VCC - IC * RC * 10**3                 //Collector-to-emitter voltage (in volts)
VC = VCE                                    //Collector voltage (in volts)
ICRC = VCC                                  //Voltage (in volts)

//When VC = 9 volts
IB1 = 16.0                                  //Base current (in micro-Ampere)
IC1 = beta * IB1                            //Collector current (in micro-Ampere)
RC1 = 0                                     //Collector Resistance (in ohm)

//Result

printf("\n In case 1, Collector junction is short circuited.\nIn case 2, Collector resistance is short circuited. ")
```

Scilab code Exa 22.15 The value of R1

```
clear//
```

```
//Variables

VCC = 12.0                                    //Source voltage (in volts)
RE = 100.0                                    //Emitter Resistance (in ohm)
RC = 3.3                                      //Collector Resistance (in kilo-ohm)
IE = 2.0                                      //Emitter current (in milli-Ampere)
VBE = 0.7                                     //Emitter-to-Base Voltage (in volts)
alpha = 0.98                                  //Common base current gain
R2 = 20.0                                     //Resistance (in kilo-ohm)

//Calculation

IC = alpha * IE                               //Collector current (in milli-Ampere)
VB = VBE + IE * RE * 10**-3                   //Base voltage (in volts)
VC = VCC - IC * RC                            //Collector voltage (in volts)
IR2 = VC / (R2)                               //Current through resistance 2 (in milli-Ampere)
IB = IE - IC                                  //Base current (in milli-Ampere)
IR1 = IR2 + IB                                //Current through resistance 1 (in milli-Ampere)
R1 = (VC - VB) / IR1                          //Value of the resistance (in kilo-ohm)

//Result

printf("\n The value of R1 is %0.1f kilo-ohm.",R1)
```

Scilab code Exa 22.16 Base resistance

```
clear//

//Variables

VCC = 24.0                                  //Source voltage (in volts)
RE = 270.0                                  //Emitter Resistance (in ohm)
RC = 10.0                                   //Collector Resistance (in kilo-ohm)
VBE = 0.7                                   //Emitter-to-Base Voltage (in volts)
beta = 45.0                                 //Common emitter current gain
VCE = 5.0                                   //Collector-to-Emitter voltage (in volts)

//Calculation

IC = (VCC - VCE) / RC                       //Collector current (in milli-Ampere)
RB = ((VCC - VBE) / IC - RC) * beta         //Base Resistance (in kilo-ohm)

//Result

printf("\n Base resistance is %0.2f kilo-ohm.",RB)
```

Scilab code Exa 22.17 DC bias current

```
clear//

//Variables

VCC = 3.0                                       //Source
   voltage (in volts)
RB = 33.0                                       //Base
   Resistance (in kilo-ohm)
RC = 1.8                                        //Collector
    Resistance (in kilo-ohm)
VBE = 0.7                                       //Emitter-
   to-Base Voltage (in volts)
beta = 90.0                                     //Common
   emitter current gain

//Calculation

IB = (VCC - VBE) / (RB + beta * RC)             //Base
   current (in milli-Ampere)
IC = beta * IB                                  //Collector
    current (in milli-Ampere)
VCE = VCC -IC * RC                              //Collector
   -to-emitter voltage (in volts)
S = (1 + beta)/(1 + beta*RC/(RC + RB))          //Stability
    factor

//Result

printf("\n DC bias current is %0.2f mA.\nDC bias
   voltage is %0.1f V.\nStability factor is %0.1f
    .",IC,VCE,S)
```

Scilab code Exa 22.18 `Collector current`

```
clear//
```

```

//Variables

VCC = 10.0                                          //Source voltage (in volts)
RE = 500.0                                          //Emitter Resistance (in ohm)
RC = 1.0                                            //Collector Resistance (in kilo-ohm)
R1 = 10.0                                           //Resistance (in kilo-ohm)
R2 = 5.0                                            //Resistance (in kilo-ohm)
VBE = 0.7                                           //Emitter-to-Base Voltage (in volts)
beta = 100.0                                         //Common emitter current gain

//Calculation

VB = VCC * (R2 /(R1 + R2))                          //Base voltage (in volts)
VE = VB - VBE                                       //Emitter voltage (in volts)
IE = VE / RE                                        //Emitter current (in Ampere)
IC = IE                                             //Collector current (in Ampere)
VCE = VCC - IC * (RC * 10**3 + RE)                  //Collector-to-Emitter voltage (in volts)

//Result

printf("\n Collector current is %0.2f mA.\nCollector-to-Emitter voltage is %0.3f V.",IC*10**3,VCE)
```

Scilab code Exa 22.19 Emitter current

```
clear//

//Variables

VCC = 15.0                                    //Source
   voltage (in volts)
RE = 2.0                                      //Emitter
    Resistance (in kilo-ohm)
RC = 1.0                                      //
   Collector Resistance (in kilo-ohm)
R1 = 10.0                                     //
   Resistance (in kilo-ohm)
R2 = 5.0                                      //
   Resistance (in kilo-ohm)
VBE = 0.7                                     //Emitter
   -to-Base Voltage (in volts)

//Calculation

Vth = VCC * (R2 /(R1 + R2))                   //
   Thevenin's voltage (in volts)
Rth = R1 * R2 / (R1 + R2)                     //
   Thevenin's equivalent resistance (in kilo-ohm)
IE = (Vth - VBE)/(RE)                         //Emitter
    current (in milli-Ampere)
VCE = VCC - IE * (RC + RE)                    //
   Collector-to-Emitter voltage (in volts)

//Result

printf("\n Emitter current is %0.3f mA.\nThe value
    of collector-to-emitter voltage is %0.3f V.",
```

```
IE,VCE)
```

Scilab code Exa 22.20 The percentage change in collector current

```
clear//

//Variables

VCC = 12.0                              //Source voltage (in volts)
RE = 100.0                              //Emitter Resistance (in ohm)
RC = 1.0                                //Collector Resistance (in kilo-ohm)
R1 = 25.0                               //Resistance (in kilo-ohm)
R2 = 5.0                                //Resistance (in kilo-ohm)
VBE = 0.7                               //Emitter-to-Base Voltage (in volts)
betamin = 50.0                          //Common emitter current gain (min)
betamax = 150.0                         //Common emitter current gain (max)

//Calculation

Vth = VCC * (R2 /(R1 + R2))             //Thevenin's voltage (in volts)
Rth = R1 * R2 / (R1 + R2) * 10**3       //Thevenin's equivalent resistance (in ohm)
IE1 = (Vth - VBE)/(RE + Rth/betamin)    //Emitter current (in Ampere)
IE2 = (Vth - VBE)/(RE + Rth/betamax)    //Emitter current (in Ampere)
```

```
perc_change = (IE2 - IE1) / IE1 * 100       //
   Percentage change in the value of beta

//Result

printf("\n The percentage change in collector
   current is  %0.1f  .",perc_change)
```

Scilab code Exa 22.21 Operating point values

```
clear//

//Variables

VCC = 9.0                                    //Source
   voltage (in volts)
RE = 680.0                                   //Emitter
    Resistance (in ohm)
RC = 1.0                                     //
   Collector Resistance (in kilo-ohm)
R1 = 33.0                                    //
   Resistance (in kilo-ohm)
R2 = 15.0                                    //
   Resistance (in kilo-ohm)
VBE = 0.7                                    //Emitter
   -to-Base Voltage (in volts)

//Calculation

VB = VCC * R2 / (R1 + R2)                    //Base
   voltage (in volts)
VE = VB - VBE                                //Emitter
    voltage (in volts)
IE = VE / RE                                 //Emitter
    current (in Ampere)
```

```
IC = IE                                        //Collector current (in Ampere)
VRC = IC * RC  * 10**3                         //Voltage across collector resistance (in volts)
VC = VCC - VRC                                 //Collector voltage (in volts)
VCE = VC - VE                                  //Collector-to-emitter voltage (in volts)

//Result

printf("\n Operating point values are IC =  %0.1f mA and VCE =  %0.3f  V.",IC*10**3,VCE)
```

Scilab code Exa 22.22 `The value of R1`

```
clear//

//Variables

VCC = 5.0                                      //Source voltage (in volts)
RE = 0.3                                       //Emitter Resistance (in kilo-ohm)
IC = 1.0                                       //Collector Current (in milli-Ampere)
beta = 100.0                                   //Common emitter current gain
VCE = 2.5                                      //Collector-to-Emitter voltage (in volts)
VBE = 0.7                                      //Emitter-to-Base Voltage (in volts)
ICO = 0                                        //Reverse saturation current (in Ampere)
R2 = 10.0                                      //
```

```
   Resistance (in kilo-ohm)


//Calculation

IE = IC                                   //Emitter current (in milli-Ampere)
RC = (VCC - VCE) / IE - RE                //Collector resistance (in kilo-ohm)
VE = IE * RE                              //Emitter voltage (in volts)
VB = VE + VBE                             //Base voltage (in volts)
R1 = VCC / VB * R2 - R2                   //Resistance1 (in kilo-ohm)

//Result

printf("\n The value of R1 is %0.3f kilo-ohm and value of RC is %0.3f ohm.",R1,RC*10**3)
```

Scilab code Exa 22.23 Emitter current

```
clear//

//Variables

VCC = 20.0                                //Source voltage (in volts)
RE = 5.0                                  //Emitter Resistance (in kilo-ohm)
RC = 1.0                                  //Collector Resistance (in kilo-ohm)
R1 = 10.0                                 //Resistance (in kilo-ohm)
```

```
R2 = 10.0                                    //Resistance (in kilo-ohm)
VBE = 0.7                                    //Emitter-to-Base Voltage (in volts)

//Calculation

VB = VCC * R2 / (R1 + R2)                    //Voltage (in volts)
VE = VB - VBE                                //Emitter voltage (in volts)
IE = VE / RE                                 //Emitter current (in milli-Ampere)
IC = IE                                      //Collector current (in milli-Ampere)
VCE = VCC - IC * RC                          //Collector-to-emitter voltage (in volts)
VC = VCE + VE                                //Collector potential (in volts)

//Result

printf("\n Emitter current is %0.3f mA.\nValue of VCE is %0.3f V.\nValue of collector potential is %0.3f V.",IE,VCE,VC)
```

Scilab code Exa 22.24 `Collector to Emitter VCE`

```
clear//

//Variables

VCC = 8.0                              //Source voltage (in volts)
VRC = 0.5                              //Voltage across
```

```
    collector resistance (in volts)
RC = 800.0                          //Collector
   resistance (in ohm)
alpha = 0.96                        //common base
   current gain

//Calculation

VCE = VCC - VRC                     //Collector-to-
   emitter voltage (in volts)
IC = VRC / RC                       //Collector
   current (in milli-Ampere)
IE = IC / alpha                     //Emitter
   current (in milli-Ampere)
IB = IE - IC                        //Base current (
   in milli-Ampere)

//Result

printf("\n Collector-to-Emitter VCE is %0.3f V.\
   nBase current is %0.3f mA.",VCE,IB*10**3)
```

Scilab code Exa 22.28 The value of emitter current

```
clear//

//Variables

VEE = 10.0                          //Emitter Bias
   Voltage (in volts)
VCC = 10.0                          //Source
   voltage (in volts)
RC = 1.0                            //Collector
   Resistance (in kilo-ohm)
RE = 5.0                            //Emitter
```

```
Resistance (in kilo-ohm)
RB = 50.0                              //Base Resistance (in kilo-ohm)
VBE = 0.7                              //Emitter-to-Base Voltage (in volts)

//Calculation

VE = -VBE                              //Emitter voltage (in volts)
IE = (VEE - VBE)/ RE                   //Emitter current (in milli-Ampere)
IC = IE                                //Collector current (in milli-Ampere)
VC = VCC - IC * RC                     //Collector voltage (in volts)
VCE = VC - VE                          //Collector-to-Emitter voltage (in volts)

//Result

printf("\n The value of emitter current is %0.3f mA.\nTHe value of collector current is %0.3f mA.\nThe value of collector-to-emitter voltage is %0.3f V.",IE,IC,VCE)
```

Scilab code Exa 22.30 `Base voltage`

```
clear//

//Variables

VCC = 12.0                             //Source voltage (in volts)
RE = 1.0                               //
```

```
    Emitter Resistance (in kilo-ohm)
RC = 2.0                                    //
    Collector Resistance (in kilo-ohm)
R1 = 100.0                                  //
    Resistance (in kilo-ohm)
R2 = 20.0                                   //
    Resistance (in kilo-ohm)
VBE = -0.2                                  //
    Emitter-to-Base Voltage (in volts)
beta = 100.0                                //Common
     emitter current gain

//Calculation

VB = -VCC * R2 / (R1 + R2)                  //Base
    voltage (in volts)
VE = VB - VBE                               //
    Emitter voltage (in volts)
IE = -VE / RE                               //
    Emitter current (in milli-Ampere)
IC = IE                                     //
    Collector current (in milli-Ampere)
VC = -(VCC - IC * RC)                       //
    Collector voltage (in volts)
VCE = VC - VE                               //
    Collector-to-emitter voltage (in volts)

//Result

printf("\n Base voltage is %0.3f V.\nEmitter
    voltage is %0.3f V.\nCollector voltage is %0.3
    f V.\nCollector current is %0.3f mA.\nEmitter
    current is %0.3f mA.\nCollector-to-emitter
    voltage is %0.3f V.",VB,VE,VC,IC,IE,VCE)
```

Scilab code Exa 22.32 The operating point values

```
clear//

//Variables

VCC = 4.5                                              //Source voltage (in volts)
RE = 0.27                                              //Emitter Resistance (in kilo-ohm)
RC = 1.5                                               //Collector Resistance (in kilo-ohm)
R1 = 27.0                                              //Resistance (in kilo-ohm)
R2 = 2.7                                               //Resistance (in kilo-ohm)
VBE = 0.3                                              //Emitter-to-Base Voltage for germanium (in volts)
beta = 44.0                                            //Common emitter current gain

//Calculation

VB = - VCC * R2 / (R1 + R2)                            //Base voltage (in volts)
VE = VB - (-VBE)                                       //Emitter voltage (in volts)
IE = VE / RE                                           //Emitter current (in milli-Ampere)
IC = IE                                                //Collector current (in milli-Ampere)
VRC = -IC * RC                                         //Voltage across collector resistance (in volts)
VC = -(VCC - VRC)                                      //Collector voltage (in volts)
VCE = -(-VC - (-VE))                                   //Collector-to-emitter voltage (in volts)

```

```
//Result

printf("\n The operating point values are IC =  %0.3
   f  mA and VCE =  %0.2f  V.",-IC,VCE)
```

Chapter 24

Singly Stage BJT Amplifiers

Scilab code Exa 24.1 Input resistance looking into the base

```
clear//

//Variables

VCC = 10.0                        //Source voltage (in volts)
RC = 10.0                         //Collector resistance (in kilo-ohm)
RB = 1.0 * 10**3                  //Base resistance (in kilo-ohm)
beta = 100.0                      //Common emitter current gain
VBE = 0.7                         //Emitter-to-Base Voltage (in volts)

//Calculation

IB = (VCC - VBE) / RB             //Base current (in milli-Ampere)
IC = beta * IB                    //Collector current (in milli-Ampere)
```

```
IE = IC                               //Emitter current (in milli-Ampere)
r1e = 25.0 / IE * 10**-3              //a.c resistance of emitter diode (in kilo-ohm)
R1 = beta * r1e                       //Input resistance looking directly into the base (in kilo-ohm)
Ris = RB * R1/(RB + R1)               //Stage input resistance (in kilo-ohm)
Ro = RC                               //Output resistance (in kilo-ohm)
Av = RC / r1e                         //Voltage gain

//Result

printf("\n Input resistance looking into the base is %0.2f kilo-ohm.\nInput resistance of the stage is %0.3f kilo-ohm.\nOutput resistance is %0.3f kilo-ohm.\nVoltage gain is %0.3f .",R1,Ris,Ro,Av)
```

Scilab code Exa 24.2 `The base current`

```
clear//

//Variables

Ri = 2.5                              //Input resistance (in kilo-ohm)
Av = 200.0                            //Voltage gain
Vs = 5.0 * 10**-3                     //Input signal voltage (in volts)
beta = 50.0                           //Common emitter current gain

//Calculation
```

```

IB = Vs / Ri                          //Base current (in milli-Ampere)
IC = beta * IB                        //Collector current (in milli-Ampere)
Ai = beta                             //Current gain
Ap = Ai * Av                          //Power gain
Gp = 10 * log10(Ap)                   //dB power gain (in decibel)

//Result

printf("\n The base current is %0.3f mA.\nThe collector current is %0.3f mA.\nThe power gain is %0.3f .\nThe dB power gain is %0.3f dB.",IB,IC,Ap,Gp)
```

Scilab code Exa 24.3 `Input resistance looking into the base`

```
clear//

//Variables

VCC = 20.0                            //Source voltage (in volts)
RC = 5.0                              //Collector resistance (in kilo-ohm)
RE = 1.0                              //Emitter resistance (in kilo-ohm)
RB = 100.0                            //Base resistance (in kilo-ohm)
beta = 150.0                          //Common emitter current gain

//Calculation
```

```
IC = VCC / (RE + RB/beta)          //Collector current (in milli-Ampere)
IE = IC                            //Emitter current (in milli-Ampere)
r1e = 25.0 / IE * 10**-3           //a.c. resistance of emitter diode (in kilo-ohm)
Ri = beta * (r1e + RE)             //Input resistance looking directly into the base (in kilo-ohm)
Ris = RB * Ri / (RB + Ri)          //Input resistance of the stage (in kilo-ohm)
Av = RC / RE                       //Voltage gain
Gp = 10 * log10(Av)                //dB power gain (in decibel)

//Result

printf("\n Input resistance looking into the base is %0.0f kilo-ohm.\nInput resistance of the stage is %0.0f kilo-ohm.\nVoltage gain is %0.3f .\ndB voltage gain is %0.0f dB.",Ri,Ris,Av,Gp)
```

Scilab code Exa 24.4 Input resistance looking into the base

```
clear//

//Variables

VCC = 12.0                         //Source voltage (in volts)
RC = 10.0 * 10**3                  //Collector resistance (in ohm)
RE = 1.0 * 10**3                   //Emitter resistance (in ohm)
RB = 500.0 * 10**3                 //Base resistance (
```

```
    in ohm)
beta = 50.0                        //Common emitter
    current gain

//Calculation

IC = VCC / (RE + RB/beta)          //Collector current
    (in Ampere)
IE = IC                            //Emitter current (
    in Ampere)
r1e = 25.0 / IE * 10**-3           //a.c. resistance
    of emitter diode (in ohm)
Ri = beta * (r1e)                  //Input resistance
    looking directly into the base (in ohm)
Ris = RB * Ri / (RB + Ri)          //Input resistance
    of the stage (in ohm)
Av = RC / r1e                      //Voltage gain
AV1 = RC / RE                      //New voltage gain

//Result

printf("\n Input resistance looking into the base is
     %0.0f ohm.\nInput resistance of the stage is
    %0.1f kilo-ohm.\nVoltage gain is %0.2f .\nNew
    Voltage gain is %0.3f .",Ri,Ris,Av,AV1)
```

Scilab code Exa 24.5 a c output voltage

```
clear//

//Variables

VCC = 30.0                          //Source voltage (
    in volts)
RC = 10.0                           //Collector
```

```
   resistance (in kilo-ohm)
RE = 8.2                            //Emitter resistance (in kilo-ohm)
RL = 3.3                            //Load resistance (in kilo-ohm)
beta = 200.0                        //Common emitter current gain
VBE = 0.7                           //Emitter-to-Base Voltage (in volts)
R1 = 47.0                           //Resistance (in kilo-ohm)
R2 = 15.0                           //Resistance (in kilo-ohm)
Vs = 5.0                            //a.c voltage (in milli-volts)

//Calculation

Vth = VCC * R2 / (R1 + R2)          //Thevenin's voltage (in volts)
Rth = R1 * R2 / (R1 + R2)           //Thevenin's equivalent voltage (in volts)
IE = (Vth - VBE)/(RE + Rth/beta)    //Emitter current (in milli-Ampere)
r1e = 25.0 / IE                     //a.c. resistance of emitter diode (in ohm)
rL = RC * RL/(RC + RL)              //a.c load seen by the amplifier (in kilo-ohm)
Av = rL * 10**3 / r1e               //Voltage gain
vo = Av * Vs                        //Output voltage (in volts)
Ri = beta * r1e * 10**-3            //Input resistance looking directly into the base (in ohm)
Ris = Rth * Ri / (Rth + Ri)         //input resistance of the stage (in ohm)

//Result

```

```
printf("\n a.c output voltage is %0.2f mV.\nInput impedance for the circuit is %0.0f kilo-ohm.",vo,Ris)
```

Scilab code Exa 24.6 The output voltage

```
clear//

//Variables

VCC = 10.0                   //Source voltage (in volts)
RC = 5.0                     //Collector resistance (in kilo-ohm)
RE = 1.0                     //Emitter resistance (in kilo-ohm)
beta = 50.0                  //Common emitter current gain
VBE = 0.7                    //Emitter-to-Base Voltage (in volts)
R1 = 50.0                    //Resistance (in kilo-ohm)
R2 = 10.0                    //Resistance (in kilo-ohm)
Vs = 10.0                    //a.c voltage (in milli-volts)
RS = 600.0 * 10**-3          //Source resistance (in kilo-ohm)

//Calculation

Vth = VCC * R2 / (R1 + R2)   //Thevenin's voltage (in volts)
Rth = R1 * R2 / (R1 + R2)    //Thevenin's equivalent voltage (in volts)
```

```
IE = (Vth - VBE)/(RE + Rth/beta)        //Emitter current (in milli-Ampere)
r1e = 25.0 / IE * 10**-3                //a.c. resistance of emitter diode (in kilo-hm)
Ris = Rth * beta*r1e/(Rth + beta*r1e) //input resistance of the stage (in ohm)
rL = RC * R1/(RC + R1)                  //a.c load seen by the amplifier (in kilo-ohm)
Av = rL / r1e                           //Voltage gain
vin = Vs * Ris / (Ris + RS)             //input voltage (in milli-volts)
vo = Av * vin                           //Output voltage (in milli-volts)
Avs = Av * vin / Vs                     //Overall voltage gain

//Result

printf("\n The output voltage is %0.3f V.\nThe overall voltage gain is %0.2f .",vo*10**-3,Avs)
```

Scilab code Exa 24.7 The voltage gain

```
clear//

//Variables

VCC = 12.0                              //Source voltage (in volts)
RC = 4.0                                //Collector resistance (in kilo-ohm)
RE = 3.3                                //Emitter resistance (in kilo-ohm)
beta = 120.0                            //Common emitter current gain
```

```
VBE = 0.7                                   //Emitter-to-Base Voltage (in volts)
R1 = 60.0                                   //Resistance (in kilo-ohm)
R2 = 30.0                                   //Resistance (in kilo-ohm)

//Calculation

Vth = VCC * R2 / (R1 + R2)                  //Thevenin's voltage (in volts)
Rth = R1 * R2 / (R1 + R2)                   //Thevenin's equivalent voltage (in volts)
IE = (Vth - VBE)/(RE + Rth/beta)            //Emitter current (in milli-Ampere)
r1e = 25.0 / IE * 10**-3                    //a.c. resistance of emitter diode (in kilo-hm)
rL = RC                                     //Load resistance (in kilo-ohm)
Av = RC / r1e                               //Voltage gain

//Result

printf("\n The voltage gain is %0.1f .",Av)
```

Scilab code Exa 24.8 Voltage gain

```
clear//

//Variables

VCC = -18.0                                 //Source voltage (in volts)
RC = 4.3                                    //Collector resistance (in kilo-ohm)
```

```
RE = 1.0                                    //Emitter resistance (in kilo-ohm)
beta = 200.0                                //Common emitter current gain
VBE = -0.7                                  //Emitter-to-Base Voltage (in volts)
R1 = 39.0                                   //Resistance (in kilo-ohm)
R2 = 8.2                                    //Resistance (in kilo-ohm)
RL = 3.0                                    //Load resistance (in kilo-ohm)

//Calculation

Vth = VCC * R2 / (R1 + R2)                  //Thevenin's voltage (in volts)
Rth = R1 * R2 / (R1 + R2)                   //Thevenin's equivalent voltage (in volts)
IC = (Vth - VBE)/(RE + Rth/beta)            //Collector current (in milli-Ampere)
IE = -IC                                    //Emitter current (in milli-Amper)
r1e = 30.0/IE * 10**-3                      //a.ac resistance (in kilo-ohm)
Ris = Rth * beta*r1e/(Rth + beta*r1e)       //input resistance of the stage (in ohm)
rL = RC * RL / (RC + RL)                    //a.c. load resistance (in kilo-ohm)
Av = rL / r1e                               //Voltage gain

//Result

printf("\n Voltage gain is %0.1f .",Av)
```

Scilab code Exa 24.9 Av

```
clear//

//Variables

VCC = 20.0                                    //Source voltage (in volts)
RC = 5.7                                      //Collector resistance (in kilo-ohm)
RE = 1.0                                      //Emitter resistance (in kilo-ohm)
beta = 100.0                                  //Common emitter current gain
VBE = 0.7                                     //Emitter-to-Base Voltage (in volts)
R1 = 100.0                                    //Resistance (in kilo-ohm)
R2 = 10.0                                     //Resistance (in kilo-ohm)
Vs = 10.0 * 10**-3                            //a.c voltage (in volts)
RS = 100.0 * 10**-3                           //Source resistance (in kilo-ohm)

//Calculation

Vth = VCC * R2 /(R1 + R2)                     //Thevenin's voltage (in volts)
Rth = R1 * R2 / (R1 + R2)                     //Thevenin's equivalent resistance (in kilo-ohm)
IE = (Vth - VBE)/(RE + Rth/beta)              //Emitter current (in milli-Ampere)
r1e = 25.0 / IE * 10**-3                      //a.c. resistance of emitter diode (in kilo-hm)
Ris = Rth * beta*r1e/(Rth + beta*r1e) //input resistance of the stage (in ohm)
rL = RC                                       //Load
```

```
resistance (in kilo-ohm)
Av = rL / r1e                         //Voltage gain
vin = Vs * Ris / (Ris + RS)           //input
    voltage (in milli-volts)
vo = Av * vin                         //Output
    voltage (in milli-volts)
Avs = Av * vin / Vs                   //Overall
    voltage gain

//Result

printf("\n Av is %0.3f .\nRi is %0.2f ohm.\nVo is
    %0.2f V.\nAvs is %0.2f .",Av,Ris*10**3,vo,Avs
    )
```

Scilab code Exa 24.11 Input resistance looking directly into the base

```
clear//

//Variables

VCC = 10.0                            //Source
    voltage (in volts)
RC = 5.0                              //Collector
    resistance (in kilo-ohm)
rE = 500 * 10**-3                     //Emitter
    resistance (in kilo-ohm)
beta = 50.0                           //Common
    emitter current gain
VBE = 0.7                             //Emitter-to-
    Base Voltage (in volts)
R1 = 50.0                             //Resistance (
    in kilo-ohm)
R2 = 10.0                             //Resistance (
    in kilo-ohm)
```

```
Vs = 100.0 * 10**-3                    //a.c voltage (in volts)
RS = 600.0 * 10**-3                    //Source resistance (in kilo-ohm)
RL = 50.0                              //Load resistance (in kilo-ohm)
RE1 = 500.0 * 10**-3                   //Resistance (in kilo-ohm)

//Calculation

Vth = VCC * R2 /(R1 + R2)              //Thevenin's voltage (in volts)
Rth = R1 * R2 / (R1 + R2)              //Thevenin's equivalent resistance (in kilo-ohm)
RE = RE1 + rE                          //Emitter total resistance (in kilo-ohm)
IE = (Vth - VBE)/(RE + Rth/beta)       //Emitter current (in milli-Ampere)
r1e = 25.0 / IE * 10**-3               //a.c. resistance (in kilo-ohm)
Ri = beta * (rE + r1e)                 //Input resistance directly into the base (in kilo-ohm)
Ris = Rth * Ri/(Rth + Ri)              //Input resistance of the stage (in kilo-ohm)
rL = RC * RL / (RC + RL)               //a.c. load resistance (in kilo-ohm)
Av = rL/(rE + r1e)                     //Voltage gain
Avs = Av * Ris / (RS + Ris)            //Overall voltage gain
Vo = Avs * Vs                          //Output voltage (in volts)

//Result

printf("\n Input resistance looking directly into the base is %0.1f kilo-ohm.\nInput resistance of the stage is %0.2f kilo-ohm.\nVoltage gain
```

```
is %0.3f .\nOverall voltage gain is %0.2f .\
nOutput voltage is %0.2f V.",Ri,Ris,Av,Avs,Vo)
```

Chapter 25

Hybrid Parameters

Scilab code Exa 25.1 h11

```
clear//

//Variables

R1 = 6.0                        //Resistance (in ohm)
R2 = 4.0                        //Resistance (in ohm)
R3 = 4.0                        //Resistance (in ohm)

//Calculation
//Let i1 = 10 A and v2 = 10 V.
i1 = 10.0                       //Assumed current (in
    Ampere)
v2 = 10.0                       //Assumed voltage (in
    volts)
//Parameters h11 and h21

h11 = R1 + R2 * R3/(R2 + R3) //Input resistance
    looking from the input terminals (in ohm)
i2 = -i1 / 2                    //Current2 (in Ampere)
h21 = i2/i1                     //h21

```

```
//Parameters h12 and h22

v1 = v2/2                        //Voltage1 (in volts)
h12 = v1 / v2                    //h12
rnet = R2 + R3                   //Output resistance (in
    ohm)
h22 = 1/rnet                     //h22 (in mhos)

//Result

printf("\n h11 :  %0.3f \n h21 :  %0.3f \n h12 :  %0
   .3f \n h22 :  %0.3f ",h11,h21,h12,h22)
```

Scilab code Exa 25.2 Input resistance of the amplifier stage

```
clear//

//Variables

hie = 1.0 * 10**3                          //hie (in ohm
   )
hre = 1.0 * 10**-4                         //hre
hoe = 100.0 * 10**-6                       //hoe (in mho
   )
RC = 1.0 * 10**3                           //Collector
   resistance (in ohm)
RS = 1000.0                                //Source
   resistance (in ohm)
hfe=50.0;beta=50.0;

//Calculation

rL = RC                                    //a.c. load
   resistance (in ohm)
Ai = -hfe /(1 + hoe * rL)                  //Current
```

```
gain of a transistor
Ri = hie + hre * Ai * rL                    //Input resistance looking directly into the base (in ohm)
Ris = Ri                                    //Iput resistance of the amplified stage (in ohm)
dh = hie * hoe - hre * hfe                  //Change in h
Ro = (RS + hie)/(RS * hoe + dh)             //Output resistance looking directly into collector (in ohm)
Ros = Ro * rL /(Ro + rL)                    //Output resistance of the amplified stage (in ohm)
Ais = Ai * RS / (RS + Ris)                  //Current gain of amplified stage
Av = Ai * rL / Ri                           //Voltage gain of transistor
Avs = Av * Ris / (RS + Ris)                 //Voltage gain of amplified stage

//Result

printf("\n Input resistance of the amplifier stage is %0.0f ohm.\nOutput resistance of amplifier stage is %0.0f ohm.\nCurrent gain of amplified stage is %0.1f \nVoltage gain of amplifier stage is %0.1f .",Ris,Ros,Ais,Avs)
```

Scilab code Exa 25.3 Current gain

```
clear//

//Variables

hie = 1.1 * 10**3                           //hie (in ohm)
```

```
hre = 2.5 * 10**-4                               //hre
hoe = 25.0 * 10**-6                              //hoe (in mho
    )
RS = 1000.0                                      //Source
    resistance (in ohm)
hfe=50.0;beta=50.0;
rL = 1000.0                                      //ac.c load
    resistance (in ohm)

//Calculation

Ai = hfe /(1 + hoe * rL)                         //Current
    gain of a transistor
Ri = hie + hre * Ai * rL                         //Input
    impedance (in ohm)
Av = Ai * rL / Ri                                //Voltage
    gain

//Result

printf("\n Current gain is %0.2f \nInput impedance
    is %0.1f \nVoltage gain is %0.2f ",Ai,Ri,Av)
```

Scilab code Exa 25.4 Voltage gain

```
clear//

//Variables

RC = 4.0 * 10**3                    //Collector resistance
     (in ohm)
RB = 40.0 * 10**3                   //Base resistance (in
    ohm)
RS = 10.0 * 10**3                   //Source resistance (
    in ohm)
```

```
hie = 1100.0                    //hie (in ohm)
hfe = 50.0                      //hfe
hre=0;hoe=0;dh=0;

//Calculation

RB2 = RB                        //Resistance (in kilo-ohm)
rL = RC * RB2 /(RC +RB2)        //a.c. load resistance (in ohm)
Ai = -hfe                       //Current gain
Ri = hie                        //Input resistance of the amplifier looking into the base (in ohm)
Av = Ai * rL / Ri               //Voltage gain
RB1 = RB/(1 - Av)               //Resistance (in ohm)
Ris = Ri * RB1 / (Ri + RB1)     //Input resistance looking from source terminals (in ohm)
Ro = "infinite"                 //Output resistance (in ohm)
Ros = rL                        //Output resistance of the stage (in ohm)
Avs = Av * Ris / (RS + Ris)     //Voltage gain of the stage

//Result

printf("\n Voltage gain is %0.1f .\nInput resistance is %0.0f ohm.\nOutput resistance is %0.0f ohm.",Avs,Ris,Ros)
```

Scilab code Exa 25.5 Ai

```
clear//

//Variables
```

```
hie = 1.1 * 10**3                              //hie (in ohm)
hre = 2.5 * 10**-4                             //hre
hoe = 25.0 * 10**-6                            //hoe (in mho)
RS = 10000.0                                   //Source resistance (in ohm)
hfe=50.0;beta=50.0;
rL = 1000.0                                    //ac.c load resistance (in ohm)
RB = 200.0 * 10**3                             //Feedback resistor (in ohm)
RC = 5.0 * 10**3                               //Collector resistance (in ohm)

//Calculation

rL = RC * RB / (RC + RB)                       //a.c. load resistance (in ohm)
Ai = hfe /(1 + hoe * rL)                       //Current gain
Ri = hie + hre * Ai * rL                       //Input resistance of the amplifier looking into the base (in ohm)
Av = Ai * rL / Ri                              //Voltage gain
RB1 = RB/(1 - (-17.4))                           //Resistance (in ohm)
Ris = Ri * RB1 / (Ri + RB1)                    //Input resistance  looking from source terminals (in ohm)
Avs = Av * Ris / (RS + Ris)                    //Voltage gain of the stage

//Result

printf("\n Ai is  %0.2f \nAv is  %0.2f \nAvs is  %0
```

```
.1 f \nRi is %0.3 f kilo-ohm.",Ai,Av,Avs,Ri
*10**-3)
```

Scilab code Exa 25.6 The value of input resistance

```
clear//

//Variables

hib = 28.0                     //hib (in ohm)
hfb = -0.98                    //hfb
hrb = 5.0 * 10**-4             //hrb
hob = 0.34 * 10**-6            //hoh (in Siemen)
rL = 1.2 * 10**3               //a.c. load resistance
    (in ohm)
RS = 0.0                       //Source resistance (in
    ohm)

//Calculation

Ai = -(hfb/(1 + hob * rL))     //Current gain
Ri = hib + hrb * Ai * rL       //Input resistance (in
    ohm)
dh = hib * hob - hrb * hfb     //change in h
Ro = (RS + hib)/(RS*hib + dh)//Output resistance (in
    ohm)
Av = Ai * rL / Ri              //Voltage gain

//Result

printf("\n The value of input resistance is %0.1 f
    ohm.\nThe value of output resistance is %0.0 f
    kilo-ohm.\nThe value of current gain is %0.2 f
    .\nThe value of voltage gain is %0.0 f .",Ri,Ro
    *10**-3,Ai,Av)
```

Scilab code Exa 25.7 The value of input resistance of amplified stage

```
clear//

//Variables

hic = 2.0 * 10**3                             //hic (in ohm)
hfc = -51.0                                   //hfe
hrc = 1.0                                     //hrc
hoc = 25.0 * 10**-6                           //hoc (in mho)
rL=5.0*10**3;RE=5.0*10**3;
RS = 1.0 * 10**3                              //Source resistance (in ohm)
R1=10.0*10**3;R2=10.0*10**3;

//Calculation

Ai = -hfc / (1 + hoc * rL)                    //Current gain
Ri = hic + hrc * Ai * rL                      //Input resistance (in ohm)
Ris = (R1*R2*Ri)/(Ri*R1 + Ri*R2 + R1*R2)      //Input resistance of the amplified stage (in ohm)
Ro = -(RS + hic)/hfc                          //Output resistance (in ohm)
Ros = Ro * RE / (Ro + RE)                     //Input resistance of the amplified stage (in ohm)
Ais = Ai * RS / (RS + Ris)                    //Current gain of amplified stage
Av = Ai * rL / Ri                             //Voltage gain
Avs = Av * Ris / (RS + Ris)                   //
```

```
   Voltage gain of amplified stage

//Result

printf("\n The value of input resistance of
   amplified stage is  %0.0f  ohm.\nThe value of
   output resistance of amplified stage is  %0.f
   kilo-ohm.\nThe value of current gain of amplified
    stage is  %0.1f  .\nThe value of voltage gain of
    amplified stage is  %0.3f  .",Ris,abs(Ros),Ais,
   Avs)
```

Scilab code Exa 25.8 Input resistance of the stage

```
clear//

//Variables

hie = 1500.0                                          //hie (
   in ohm)
hfe = 50.0                                            //hfe
hre = 50.0 * 10**-4                                   //hre
hoe = 20.0 * 10**-6                                   //hoe
R1 = 20.0 * 10**3                                     //
   Resistance (in ohm)
R2 = 10.0 * 10**3                                     //
   Resistance (in ohm)
RC = 5.0 * 10**3                                      //
   Collector resistance (in ohm)
RE = 1.0 * 10**3                                      //
   Emitter resistance (in ohm)
RL = 10.0 * 10**3                                     //Load
   resistance (in ohm)
RS = 0                                                //Source
    resistance (in ohm)
```

```

//Calculation

Ai = -hfe
rL = RC * RL /(RC + RL)                              //a.c.
    load resistance (in ohm)
Ri = hie                                             //Input
    resistance (in ohm)
Ris = (R1*R2*Ri)/(Ri*R1 + Ri*R2 + R1*R2)     //Input
    resistance of the amplified stage (in ohm)
Ro = 1 / hoe                                         //Output
     resistance (in ohm)
Ros = Ro * rL /(Ro + rL)                             //Output
     resistance of the stage (in ohm)
Av = Ai * rL / Ri                                    //
    Voltage gain
Avs = Av * Ris / (RS + Ris)                          //
    Voltage gain of the stage
Ais = Ai                                             //
    Current gain of the stage

//Result

printf("\n Input resistance of the stage is  %0.2f
    kilo-ohm.\nOutput resistance of the stage is  %0
    .1f  kilo-ohm.\nVoltage gain of the stage is  %0
    .0f  .\nCurrent gain of the stage is  %0.3f  .",
    Ris*10**-3,Ros*10**-3,Avs,Ai)
```

Scilab code Exa 25.9 `Input impedance`

```
clear//

//Variables

```

```
RC = 12.0 * 10**3                       //Collector resistance (in ohm)
RL = 4.7 * 10**3                        //Load resistance (in ohm)
R1 = 33.0 * 10**3                       //Resistance (in ohm)
R2 = 4.7 * 10**3                        //Resistance (in ohm)
IC = 1.0 * 10**-3                       //Collector current (in Ampere)
hiemin = 1.0 * 10**3                    //hie minimum (in ohm)
hiemax = 5.0 * 10**3                    //hie maximum (in ohm)
hfemin = 70.0                           //Current gain minimum
hfemax = 350.0                          //Current gain maximum

//Calculation

hie = (hiemin * hiemax)**0.5            //hie (in ohm)
hfe = (hfemin * hfemax)**0.5            //current gain
Ri = hie                                //input resistance (in ohm)
Ris = (R1*R2*Ri)/(Ri*R1+Ri*R2+R1*R2)    //Input resistance of the amplified stage (in ohm)
Ai = hfe                                //Current gain of transistor
rL = RC * RL / (RC + RL)                //a.c. load resistance (in ohm)
Avs=Ai*rL/Ri;Av=Ai*rL/Ri;

//Result

printf("\n Input impedance is  %0.2f  kilo-ohm.\
```

```
nOverall voltage gain is  %0.1f .",Ris*10**-3,Avs
)
```

Scilab code Exa 25.10 Input resistance of the circuit

```
clear//

//Variables

RB = 330.0 * 10**3                          //Base
   resistance (in ohm)
RC = 2.7 * 10**3                            //Collector
   resistance (in ohm)
hfe = 120.0                                 //current gain
hie = 1.175 * 10**3                         //hie (in ohm)
hoe = 20 * 10**-6                           //hoe (in
   Ampere per volt)

//Calculation

Ri = hie                                    //Input
   resistance of transistor (in ohm)
Ris = hie * RB /(hie + RB)                  //Input
   resistance of the circuit (in ohm)
Ro = 1 / hoe                                //Output
   resistance of transistor (in ohm)
Ros = Ro * RC / (Ro + RC)                   //Output
   resistance of the circuit (in ohm)
Ai = hfe                                    //Current gain
    of the circuit
Avs = Ai * RC / Ri                          //Overall
   voltage gain

//Result

```

```
printf("\n Input resistance of the circuit is  %0.2f
    kilo-ohm.\nOutput resistance of the circuit is
    %0.2f  kilo-ohm.\nCurrent gain of the circuit is
    %0.3f .\nVoltage gain of the circuit is  %0.1f
    .",Ris*10**-3,Ros*10**-3,Ai,Avs)
```

Scilab code Exa 25.11 `Value of hfb`

```
clear//

//Variables

hfe = 50.0                    //Current gain

//Calculation

hfb = -hfe / (1 + hfe)        //hfb
hfc = -(1 + hfe)              //hfc

//Result

printf("\n Value of hfb =  %0.2f .\nValue of hfc =
    %0.3f .",hfb,hfc)
```

Scilab code Exa 25.12 `Current gain`

```
clear//

//Variables

hie = 1100.0                          //hie (in ohm)
hre = 2.5 * 10**-4                    //hre
hfe = 50.0                            //Current gain
```

```
hoe = 24.0 * 10**-6                          //hoe (in Ampere per volt)
rL=10.0*10**3;RL=10.0*10**3;
RS = 1.0 * 10**3                             //Source resistance (in ohm)

//Calculation

hic = hie                                    //hic (in ohm)
hrc = (1 - hre)                              //hrc
hfc = -(1 + hfe)                             //hfc
Ai = -(hfc/(1 + hoe * rL))                   //Current gain
Ri = hic + hrc * Ai * rL                     //Input resistance (in ohm)
Av = Ai * rL / Ri                            //Voltage gain

//Result

printf("\n Current gain is  %0.1f .\nInput resistance is  %0.1f  kilo-ohm.\nVoltage gain is  %0.3f .",Ai,Ri*10**-3,Av)
```

Chapter 26

Multistage BJT Amplifiers

Scilab code Exa 26.1 `Overall voltage gain`

```
clear//

//Variables

Av1 = 10.0                              //Voltage gain1
Av2 = 20.0                              //Voltage gain2
Av3 = 40.0                              //Voltage gain3

//Calculation

Av = Av1 * Av2 * Av3                    //Voltage gain
Gv1 = 20 * log10(Av1)                   //dB voltage gain1
Gv2 = 20 * log10(Av2)                   //dB voltage gain2
Gv3 = 20 * log10(Av3)                   //dB voltage gain3
Gv = Gv1 + Gv2 + Gv3                    //dB voltage gain

//Result
```

```
printf("\n Overall voltage gain is  %0.3f .\nTotal dB voltage gain is  %0.0f  dB.",Av,Gv)
```

Scilab code Exa 26.2 Overall voltage gain

```
clear//

//Variables

n = 3                          //Number of amplified stages
Vin1 = 0.05                    //Input to first stage (in volts peak-to-peak)
Vout3 = 150.0                  //Output of final stage (in volts peak-to-peak)
Av1 = 20.0                     //Voltage gain of first stage
Vin3 = 15.0                    //Input of final stage (in volts peak-to-peak)

//Calculation

Av = Vout3 / Vin1              //Overall voltage gain
Av3 = Vout3 / Vin3             //Voltage gain of third stage
Av2 = Av / (Av1 * Av3)         //Voltage gain of second stage
Vin2 = Vin3 / Av2              //Input voltage gain of second stage

//Result

printf("\n Overall voltage gain is  %0.3f .\nVoltage gain of 2nd and 3rd stage is  %0.3f  and  %0.3f
```

```
.\nInput voltage of the second stage is %0.3f
Vpk−pk.",Av,Av2,Av3,Vin2)
```

Scilab code Exa 26.3 Input resistance of first and scond stage

```
clear//

//Variables

VCC = 10.0                          //Source voltage (
   in volts)
RC = 5.0 * 10**3                    //Collector
   resistance (in ohm)
RB = 1.0 * 10**6                    //Base resistance
   (in ohm)
RE = 1.0 * 10**3                    //Emitter
   resistance (in ohm)
RL = 10.0 * 10**3                   //Load resistance
   (in ohm)
beta1=100.0;beta2=100.0;

//Calculation

IE = VCC /(RE + RB/beta1)           //Emitter current
   (in Ampere)
r1e = 25.0/IE * 10**-3              //a.c. emitter
   diode resistance (in ohm)
Ri1 = beta1 * r1e                   //Input resistance
    of first stage (in ohm)
Ri2 = beta2 * r1e                   //Input resistance
    of second stage (in ohm)
Ro1 = RC * Ri2 / (RC + Ri2)         //Output
   resistance of first stage (in ohm)
Ro2 = RC * RL / (RC + RL)           //Output resitance
    of second stage (in ohm)
```

```
Av1 = Ro1 / r1e                         //Voltage gain of
    first stage
Av2 = Ro2 / r1e                         //Voltage gain of
    second stage
Av = Av1 * Av2                          //Overall voltage
    gain
Gv = 20 * log10(Av)                     //Overall dB
    voltage gain

//Result

printf("\n Input resistance of first and scond stage
     is %0.0f ohm and %0.0f ohm.\nOutput
    resistance of first and second stage is %0.1f
    ohm and %0.1f ohm.\nVoltage gain of first and
    second stage is %0.0f and %0.1f .\nOverall
    voltage gain and dB voltage gain is %0.0f and
    %0.1f dB.",Ri1,Ri2,Ro1,Ro2,Av1,Av2,Av,Gv)
```

Scilab code Exa 26.4 `Voltage gain of stage one and two`

```
clear//

//Variables

VCC = 15.0                              //Source voltage (
    in volts)
RC = 3.3 * 10**3                        //Collector
    resistance (in ohm)
RE = 1.0 * 10**3                        //Emitter
    resistance (in ohm)
RL = 10.0 * 10**3                       //Load resistance
    (in ohm)
R1 = 33.0 * 10**3                       //Resistance (in
    ohm)
```

```
R2 = 8.2 * 10**3                    //Resistance (in ohm)
beta1=100.0;beta2=100.0;
VBE = 0.7                           //Emitter-to-base voltage (in volts)

//Calculation

Vth = VCC * R2 / (R1 + R2)          //Thevenin's voltage (in volts)
Rth = R1 * R2 / (R1 + R2)           //Thevenin's equivalent resistance (in ohm)
IE = (Vth - VBE)/(RE + Rth/beta1)   //Emitter current (in Ampere)
r1e = 25.0/IE * 10**-3              //a.c. emitter resistance (in ohm)
Ri2 = beta1 * r1e                   //Input resistance of second stage (in ohm)
Ro1 = RC * Ri2 / (RC + Ri2)         //Output resistance of first stage (in ohm)
Ro2 = RC * RL /(RC + RL)            //Output resistance of second stage (in ohm)
Av1 = Ro1 / r1e                     //Voltage gain of the first stage
Av2 = Ro2 / r1e                     //Voltage gain of second stage
Av = Av1 * Av2                      //Overall voltage gain
Gv = 20 * log10(Av)                 //Overall voltage (in decibels)

//Result

printf("\n Voltage gain of stage one and two are as follows %0.2f and %0.2f .\nOverall voltage gain is %0.0f .\nOverall voltage gain in decibels is %0.1f dB.",Av1,Av2,Av,Gv)
```

Scilab code Exa 26.5 Voltage gain of first stage

```
clear//

//Variables

VCC = 10.0                          //Source voltage (
    in volts)
RB = 470.0 * 10**3                  //Base resistance
    (in ohm)
RE = 1.0 * 10**3                    //Emitter
    resistance (in ohm)
RL = 1.0 * 10**3                    //Load resistance
    (in ohm)
a = 4.0                             //Turn's ratio
beta1=50.0;beta2=50.0;
VBE = 0.7                           //Emitter-to-base
    voltage (in volts)

//Calculation

IE = VCC/ (RE + RB/beta1)           //Emitter current
    (in Ampere)
r1e = 25.0 / IE * 10**-3            //a.c. emitter
    diode resistance (in ohm)
Ri1 = RB*beta1*r1e/(RB+beta1*r1e) //Input resistance
     of first stage (in ohm)
Ri2 = RB*beta2*r1e/(RB+beta2*r1e) //Input resistance
     of Second stage (in ohm)
R1i2 = a**2 * Ri2                   //Input resistance
     of the second stage transformed to primary side
    (in ohm)
Ro1 = R1i2                          //Output
    resistance of second stage (in ohm)
```

```
R1o2 = a**2 * RL                          //Output
    resistance of the second stage transformed to the
     primary side (in ohm)
Av1 = Ro1/r1e                             //Voltage gain of
    first stage
Av2 = R1o2/r1e                            //Voltage gain of
    second stage
Av = Av1 * Av2                            //Overall voltage
    gain
Gv = 20 * log10(Av)                       //Overall voltage
    gain (in decibels)

//Result

printf("\n Voltage gain of first stage is %0.1f .\
    nVoltage gain of second stage is %0.1f .\
    nOverall voltage gain is %0.0f .\nOverall
    voltage gain in decibels is %0.0f dB.",Av1,Av2,
    Av,Gv)
```

Scilab code Exa 26.6 Voltage gain of first stage

```
clear//

//Variables

VCC = 12.0                                 //Source voltage
    (in volts)
R1 = 100.0 * 10**3                         //Resistance (in
    ohm)
R2 = 20.0 * 10**3                          //Resistance (in
    ohm)
R3 = 10.0 * 10**3                          //Resistance (in
    ohm)
R4 = 2.0 * 10**3                           //Resistance (in
```

```
ohm)
R5 = 10.0 * 10**3                    //Resistance (in ohm)
R6 = 2.0 * 10**3                     //Resistance (in ohm)
beta1=100.0;beta2=100.0;

//Calculation

Vth = VCC * R2 / (R1 + R2)           //Thevenin's voltage (in volts)
IE1 = Vth / R4                       //Emitter curren1 (in Ampere)
r1e = 25.0 / IE1 * 10**-3            //a.c. emitter diode resistance (in ohm)
VR6 = VCC - IE1 * R3                 //Voltage across resistance6 (in volts)
IE2 = VR6 / R6                       //Emitter current2 (in Ampere)
r1e2 = 25.0 / IE2 * 10**-3           //a.c. emitter diode resistance2 (in ohm)
Ri2 = beta2*(r1e2 + R6)              //Input resistance of second stage (in ohm)
Ro1 = R3 * Ri2 /(R3 + Ri2)           //Output resistance of first stage (in ohm)
Ro2 = R5                             //Output resistance of second stage (in ohm)
Av1 = Ro1/(r1e + R4)                 //Voltage gain of first stage
Av2 = Ro2/(r1e2 + R6)                //Voltage gain of second stage
Av = Av1 * Av2                       //Overall voltage gain

//Result

printf("\n Voltage gain of first stage is %0.1f .\nVoltage gain of second stage is %0.1f .\
```

```
    nOverall voltage gain is %0.2f .",Av1,Av2,Av)
```

Scilab code Exa 26.7 Overall voltage gain

```
clear//

//Variables

VCC = 10.0                          //Source voltage
    (in volts)
R1 = 800.0                          //Resistance (in
    ohm)
R2 = 200.0                          //Resistance (in
    ohm)
R3 = 600.0                          //Resistance (in
    ohm)
R4 = 200.0                          //Resistance (in
    ohm)
R5 = 100.0                          //Resistance (in
    ohm)
R6 = 1000.0                         //Resistance (in
    ohm)
beta1=100.0;beta2=100.0;
VBE = 0.7                           //Emitter-to-
   base voltage (in volts)

//Calculation

VR2 = VCC * (R2 / (R1 + R2))        //Voltage across
    resistance2 (in volts)
IE1 = (VR2 - VBE)/R2                //Emitter
   current of Q1 transistor (in Ampere)
IC1 = IE1                           //Collector
   current of Q1 transistor (in Ampere)
VC1 = VCC - IC1 * R3                //Voltage at the
```

```
collector of Q1 transistor (in volts)
VE1 = IE1 * R4                          //Voltage at the emitter of Q1 transistor (in volts)
VCE1 = VC1 - VE1                        //Collector-to-emitter voltage of Q1 transistor (in volts)
VE2 = VC1 - (-VBE)                      //Voltage at the emitter of Q2 transistor (in volts)
IE2 = (VCC - VE2)/R6                    //Emitter current of Q2 transistor (in Ampere)
IC2 = IE2                               //Collector-current of Q2 transistor (in Ampere)
VC2 = IC2 * R5                          //Voltage at the collector of Q2 transistor (in volts)
VCE2 = VC2 - VE2                        //Collector-to-emitter voltage of Q2 transistor (in volts)

r1e1 = 25.0 / IE1 * 10**-3              //a.c. emitter diode resistance of Q1 transistor (in ohm)
r1e2 = 25.0 / IE2 * 10**-3              //a.c. emitter diode resistance of Q2 transistor (in ohm)
Ri2 = beta2 * (r1e2 + R6)               //Input resistance of second stage (in ohm)
Ro1 = R3 * Ri2 / (R3 + Ri2)             //Output resistance of first stage (in ohm)
Av1 = Ro1 / (r1e1 + R4)                 //Voltage gain of first stage
Av2 = 1.0                               //Voltage gain of second stage
Av = Av1 * Av2                          //Overall voltage gain

//Result

printf("\n Emitter current of Q1 transistor is %0.3f mA.\nCollector current of Q1 transistor is %0.3f mA.\nEmitter current of Q2 transistor is %0.3f mA.\nCollecotr-current of Q2 transistor is %0.3f mA.",IE1*10**3,IC1*10**3,IE2*10**3,IC2
```

```
*10**3)
printf("\n Collector-to-emitter voltage of Q1 transistor is %0.3f v.\nCollector-to-emitter voltage of Q2 transistor is %0.3f .",VCE1,VCE2)
printf("\n Overall voltage gain is %0.2f .",Av)
```

Scilab code Exa 26.8 `Overall voltage gain`

```
clear//

//Variables

VCC = 10.0                          //Source voltage (in volts)
RE = 1.5 * 10**3                    //Emitter resistance (in ohm)
R1 = 30.0 * 10**3                   //Resistance (in ohm)
R2 = 20.0 * 10**3                   //Resistance (in ohm)
beta1 = 150.0                       //Common emitter current gain
beta2 = 100.0                       //Common emitter current gain
VBE = 0.7                           //Emitter-to-base voltage (in volts)

//Calculation

Ai = beta1 * beta2                  //Overall current gain of transistor
VR2 = VCC * R2/(R1 + R2)            //Voltage across resistor2 (in volts)
VB2 = VR2 - VBE                     //Voltage at the base of Q2 (in volts)
```

```
VE2 = VB2 - VBE                       //Voltage at the
    emitter of Q2 (in volts)
IE2 = VE2 / RE                        //Emitter current
    of Q2 (in Ampere)
r1e2 = 25.0/IE2 * 10**-3              //a.c. emitter
    diode resistance of Q2 (in ohm)
IB2 = IE2 / beta2                     //Base current of
    Q2 (in Ampere)
IE1 = IB2                             //Emitter current
    of Q2
r1e1 = 25.0/IE1 * 10**-3              //a.c. emitter
    diode resistance of Q1 (in ohm)
Ri1 = R1 * R2/(R1 + R2)               //Total input
    resistance (in ohm)
Av = RE/(r1e1/beta2 + r1e2 + RE)  //Overall voltage
    gain

//Result

printf("\n The overall current gain is %0.3f .",Ai)
printf("\n The a.c. emitter diode resistance of Q1
    transistor is %0.1f ohm.\nThe a.c. emitter
    diode resistance of Q2 transistor is %0.2f ohm.
    ",r1e1,r1e2)
printf("\n Total input resistance is %0.3f kilo-
    ohm.",Ri1 * 10**-3)
printf("\n Overall voltage gain is %0.2f .",Av)
```

Chapter 27

Power Amplifiers

Scilab code Exa 27.2 Overall compliance PP of the amplifier

```
clear//

//Variables

VCC = 20.0                          //Source voltage (in volts)
R1 = 10.0                           //Resistance (in kilo-ohm)
R2 = 1.8                            //Resistance (in kilo-ohm)
RC = 620.0 * 10**-3                 //Collector resistance (in kilo-ohm)
RE = 200.0 * 10**-3                 //Emitter resistance (in kilo-ohm)
RL = 1.2                            //Load resistance (in kilo-ohm)
beta = 180.0                        //Common emitter current gain
VBE = 0.7                           //Emitter-to-Base voltage (in volts)

```

```
//Calculation

VB = VCC * (R2 /(R1 + R2))          //Voltage drop
    across R2 (in volts)
VE = VB - VBE                       //Voltage at the
    emitter (in volts)
IE = VE / RE                        //Emitter current
    (in milli-Ampere)
IC = IE                             //Collector
    current (in milli-Ampere)
VCE = VCC - IE*(RC + RE)            //Collector-to-
    emitter voltage (in volts)
ICEQ = IC                           //Collector
    current at Q (in milli-Ampere)
VCEQ = VCE                          //Collector-to-
    emitter voltage at Q (in volts)
rL = RC * RL/(RC + RL)              //a.c. load
    resistance (in kilo-ohm)
PP = 2 * ICEQ * rL                  //Compliance of
    the amplifier (in volts)

//Result

printf("\n Overall compliance (PP) of the amplifier
    is %0.2f V.",PP)
```

Scilab code Exa 27.3 Voltage gain

```
clear//

//Variables

r1e = 8.0                          //a.c. load
    resistance (in ohm)
RC = 220.0                         //Collector
```

```
resistance (in ohm)
RE = 47.0                          //Emitter resistance
 (in ohm)
R1 = 4.7 * 10**3                   //Resistance (in ohm
)
R2 = 470.0                         //Resistance (in ohm
)
beta = 50.0                        //Common emitter
current gain

//Calculation

rL = RC                            //Load resistance (
in ohm)
Av = rL / r1e                      //Voltage gain
Ai = beta                          //Current gain
Ap = Av * Ai                       //Power gain

//Result

printf("\n Voltage gain is  %0.3f  and Power gain is
  %0.3f .",Av,Ap)
```

Scilab code Exa 27.4 Collector efficiency

```
clear//

//Variables

Ptrdc = 20.0                            //dc Power (in
watt)
Poac = 5.0                              //ac Power (in
watt)

//Calculation
```

```
ne = Poac / Ptrdc                          //Collector
    efficiency
P = Ptrdc                                  //Power rating
    of the transistor

//Result

printf("\n Collector efficiency is %0.3f percentage
    .\nPower rating of the transistor is %0.3f W.",
    ne*100,P)
```

Scilab code Exa 27.5 The a c power output

```
clear//

//Variables

Pcdc = 10.0                        //dc power (in watt)
ne = 0.32                          //efficiency

//Calculation

Poac = ne * Pcdc / (1 - ne)    //a.c. power output (
    in watt)

//Result

printf("\n The a.c. power output is %0.1f W.",Poac
    )
```

Scilab code Exa 27.6 Total power within the circuit

```
clear//

//Variables

nc = 0.5                              //Efficiency
VCC = 24.0                            //Source voltage (in
   volts)
Poac = 3.5                            //a.c. power output (
   in watt)

//Calculation

Ptrdc = Poac / nc                     //dc power (in watt)
Pcdc = Ptrdc - Poac                   //Power dissipated as
    heat (in watt)

//Result

printf("\n Total power within the circuit is %0.3f
   W.\nThe power Pcdc = %0.3f W is dissipated in
   the form of heat within the transistor collector
   region.",Ptrdc,Pcdc)
```

Scilab code Exa 27.7 `Collector efficiency`

```
clear//

//Variables

VCC = 20.0                              //Supply voltage (
   in volts)
VCEQ = 10.0                             //Collector-to-
   emitter voltage (in volts)
ICQ = 600.0 * 10**-3                    //Collector current
    (in Ampere)
```

```
RL = 16.0                          //Load resistance (in ohm)
Ip = 300.0 * 10**-3                //Output current variation (in Ampere)

//Calculation

Pindc = VCC * ICQ                  //dc power supplied (in watt)
PRLdc = ICQ**2 * RL                //dc power consumed by load resistor (in watt)
I = Ip / 2**0.5                    //r.m.s. value of Collector current (in Ampere)
Poac = I**2 * RL                   //a.c. power across load resistor (in ohm)
Ptrdc = Pindc - PRLdc              //dc power delievered to transistor (in watt)
Pcdc = Ptrdc - Poac                //dc power wasted in transistor collector (in watt)
no = Poac / Pindc                  //Overall efficiency
nc = Poac / Ptrdc                  //Collector efficiency

//Result

printf("\n Power supplied by the d.c. source to the amplifier circuit is %0.3f W.",Pindc)
printf("\n D.C. power consumed by the load resistor is %0.3f W.",PRLdc)
printf("\n A.C. power developed across the load resistor is %0.3f W.",Poac)
printf("\n D.C. power delivered to the transistor is %0.3f W.",Ptrdc)
printf("\n D.C. power wasted in the transistor collector is %0.3f W.",Pcdc)
printf("\n Overall efficiency is %0.3f .",no)
printf("\n Collector efficiency is %0.1f percentage
```

```
    .",nc * 100)
```

Scilab code Exa 27.8 The effective resistance

```
clear//

//Variables

a = 15.0                          //Turns ratio
RL = 8.0                          //Load resistance (in
    ohm)

//Calculation

R1L = a**2 * RL                   //Effective resistance
    (in ohm)

//Result

printf("\n The effective resistance is %0.3f kilo-
    ohm.",R1L * 10**-3)
```

Scilab code Exa 27.9 Turns ratio

```
clear//

//Variables

RL = 16.0                         //Load resistance (in
    ohm)
R1L = 10.0 * 10**3                //Effective resistance
    (in ohm)

```

```
//Calculation

a = (R1L / RL)**0.5          //Turns ratio

//Result

printf("\n Turns ratio is  %0.3f : 1.",a)
```

Scilab code Exa 27.10 The maximum power delievered to load

```
clear//

//Variables

RL = 8.0                       //Load resistance (in
    ohm)
a = 10.0                       //Turns ratio
ICQ = 500.0 * 10**-3           //Collector current (in
    Ampere)

//Calculation

R1L = a**2 * RL                //Effective load (in ohm
    )
Poac = 1.0/2* ICQ**2 * R1L    //Maximum power
    delieverd (in watt)

//Result

printf("\n The maximum power delievered to load is
    %0.3f  W.",Poac)
```

Scilab code Exa 27.11 Maximum undistorted a c output power

```
clear//

//Variables

Ptrdc = 100.0 * 10**-3              //Maximum collector dissipated power (in watt)
VCC = 10.0                          //Source voltage (in volts)
RL = 16.0                           //Load resistance (in ohm)
no=0.5;nc=0.5;

//Calculation

Poac = no * Ptrdc                   //Maximum undistorted a.c. output power (in watt)
ICQ = 2 * Poac / VCC                //Quiescent collector current (in Ampere)
R1L = VCC / ICQ                     //Effective load resistance (in ohm)
a = (R1L / RL)**0.5

//Result

printf("\n Maximum undistorted a.c. output power is %0.3f W.\nQuiescent collector current is %0.3f A.\nTransformer turns ratio is %0.0f .",Poac,ICQ,a)
```

Scilab code Exa 27.13 `Power delivered to the load`

```
clear//

//Variables

```

```
RL = 1.0 * 10**3                          //Load resistance
      (in ohm)
IC = 10.0 * 10**-3                        //Collector
    current (in Ampere)

//Calculation

PL = IC**2 * RL                           //Load power (in
    watt)

//Result

printf("\n Power delivered to the load is  %0.3f  W.
    ",PL)
```

Scilab code Exa 27.14 The power drawn from the source

```
clear//

//Variables

RL = 8.0                        //Load resistance (in ohm
    )
VP = 16.0                       //Peak output voltage (in
      volts)

//Calculation

P = VP**2 / (2 * RL)            //Power drawn from the
    source (in watt)

//Result

printf("\n The power drawn from the source is  %0.3f
     W.",P)
```

Scilab code Exa 27.15 Maximum power output

```
clear//

//Variables

Pcdc = 10.0                 //Power rating of amplifier
    (in watt)
n = 0.785                   //Maximum overall
   efficiency

//Calculation

PT = 2 * Pcdc               //Total power dissipation
   of two transistors (in watt)
Poac = (PT * n) / (1-n)     //Maximum power output (in
   watt)

//Result

printf("\n Maximum power output is %0.2f W.",Poac)
```

Scilab code Exa 27.16 The d c input power

```
clear//

//Variables

no = 0.6                     //efficiency
Pcdc = 2.5                   //Maximum collector
   dissipation of each transistor (in watt)
```

```

//Calculation

PT = 2 * Pcdc              //Total power dissipation
    of two transistors (in watt)
Pindc = PT / (1 - no )     //dc input power (in watt)
Poac = no * Pindc          //ac output power (in watt)

//Result

printf("\n The d.c. input power is  %0.3f  W.\nThe a
    .c. output power is  %0.3f  W.",Pindc,Poac)
```

Chapter 28

Tuned Amplifiers

Scilab code Exa 28.1 The resonant frequency

```
clear//

//Variables

L = 150.0 * 10**-6          //Inductance (in Henry)
C = 100.0 * 10**-12         //Capacitance (in Farad)

//Calculation

fo = 0.159 / (L * C)**0.5   //Resonant frequency (in
    Hertz)

//Result

printf("\n The resonant frequency is %0.1f MHz.",
   fo * 10**-6)
```

Scilab code Exa 28.2 Resonant frequency

```
clear//

//Variables

L = 100.0 * 10**-6              //Inductance (in Henry)
C = 100.0 * 10**-12             //Capacitance (in Farad)
R = 5.0                         //Resistance (in ohm)

//Calculation

fo = 0.159 / (L * C)**0.5       //Resonant frequency (in
    Hertz)
Zp = L / (C*R)                  //Circuit impedance at
   resonance (in ohm)

//Result

printf("\n Resonant frequency is  %0.3f  MHz.\
   nCircuit impedance at resonance is  %0.3f  kilo-
   ohm.",fo*10**-6,Zp*10**-3)
```

Scilab code Exa 28.3 Bandwidth of the circuit

```
clear//

//Variables

fo = 1.0 * 10**6               //Resonant frequency (in
   Hertz)
Qo = 100.0                     //Quality factor

//Calculation

BW = fo / Qo                   //Bandwidth (in Hertz)

```

```
//Result

printf("\n Bandwidth of the circuit is  %0.3f  kHz."
    ,BW * 10**-3)
```

Scilab code Exa 28.4 The Q factor

```
clear//

//Variables

fo = 1600.0 * 10**3          //Resonant frequency (in
    Hertz)
BW = 10.0 * 10**3            //Bandwidth (in Hertz)

//Calculation

Qo = fo / BW                 //Quality factor

//Result

printf("\n The Q-factor is  %0.3f .",Qo)
```

Scilab code Exa 28.5 The Q factor

```
clear//

//Variables

fo = 2.0 * 10**6             //Resonant frequency (in
    Hertz)
BW = 50.0 * 10**3            //Bandwidth (in Hertz)

```

```
//Calculation

Qo = fo / BW                    //Quality factor

//Result

printf("\n The Q-factor is  %0.3f .",Qo)
```

Scilab code Exa 28.6 The value of circuit impedance at resonance

```
clear//

//Variables

fo = 455.0 * 10**3              //Resonant frequency (in
   Hertz)
BW = 10.0 * 10**3               //Bandwidth (in Hertz)
XL = 1255.0                     //Inductive reactance (in
    ohm)

//Calculation

Qo = fo / BW                    //Quality factor
R = XL / Qo                     //Resistance (in ohm)
L = XL / (2*%pi*fo)         //Inductance (in Henry)
C = 1 / (XL*2*%pi*fo)       //Capacitance (in Farad)
Zp = L / (C*R)                  //Circuit impedance (in
   ohm)

//Result

printf("\n The value of circuit impedance at
   resonance is  %0.0f  kilo-ohm.",Zp * 10**-3)
```

Chapter 29

Feedback Amplifiers

Scilab code Exa 29.1 The voltage gain of an amplifier with negative feedback

```
clear//

//Variables

Av = 400.0                          //Voltage gain
beta = 0.1                          //feedback ratio

//Calculation

A1v = Av / (1 + beta * Av)          //Voltage gain with
    negative feedback

//Result

printf("\n The voltage gain of an amplifier with
    negative feedback is  %0.2f .",A1v)
```

Scilab code Exa 29.2 The percentage of the negative feedback

```
clear//

//Variables

Av = 100.0                          //Voltage gain
A1v = 20.0                          //Voltage gain with
   negative feedback

//Calculation

beta = (Av/A1v - 1) / Av            //feedback ratio

//Result

printf("\n The percentage of the negative feedback
   is  %0.3f",beta * 100)
```

Scilab code Exa 29.3 The fraction of the output that

```
clear//

//Variables

Av = 1000.0                          //Voltage gain
A1v = 10.0                           //Voltage gain with
   negative feedback

//Calculation

beta = (Av/A1v - 1) / Av             //feedback ratio

//Result

printf("\n The fraction of the output that is
   feedback to the input is  %0.3f .",beta)
```

Scilab code Exa 29.4 `The value of voltage gain without negative feedback`

```
clear//

//Variables

V1o=12.5;Vo=12.5;
V1in = 1.5                          //Input voltage with
    feedback (in volts)
Vin = 0.25                          //Input voltage
   without feedback (in volts)

//Calculation

Av = Vo / Vin                       //Voltage gain
   without negative feedback
A1v = V1o / V1in                    //Voltage gain with
   negative feedback
beta = (Av/A1v - 1) / Av            //feedback ratio

//Result

printf("\n The value of voltage gain without
   negative feedback is  %0.3f .\nThe value of
   voltage gain with negative feedback is  %0.2f .\
   nThe value of beta is  %0.3f .",Av,A1v,beta)
```

Scilab code Exa 29.5 `Value of feedback ratio`

```
clear//

```

```
//Variables

Av = 60.0                        //Voltage gain
A1v = 80.0                       //Voltage gain with
   negative feedback

//Calculation

beta = (1 - Av/A1v ) / Av        //feedback ratio
beta1 = 1/Av                     //feedback ratio
   which causes oscillation

//Result

printf("\n Value of feedback ratio is  %0.3f .\nThe
   percentage of feedback which causes oscillation
   is  %0.1f percentage.",beta,beta1*100)
```

Scilab code Exa 29.6 The value of voltage gain without feedback

```
clear//

//Variables

A1v = 100.0                       //Voltage gain with
    negative feedback
Vin = 50.0 * 10**-3               //Input voltage
   without feedback (in volts)
V1in = 0.6                        //Input voltage
   with feedback (in volts)

//Calculation

V1o = A1v * V1in                  //Output voltage
   with feedback (in volts)
```

```
Vo = V1o                              //Output voltage
   without feedback (in volts)
Av = Vo / Vin                         //Voltage gain
   without feedback
beta = (Av/A1v - 1) / Av              //feedback ratio

//Result

printf("\n The value of voltage gain without
   feedback is  %0.3f .\nThe value of voltage gain
   with feedback is  %0.3f .",Av,A1v)
```

Scilab code Exa 29.7 The percentage change in closed loop gain

```
clear//

//Variables

Av = 800.0                                      //Voltage
    gain
beta = 0.05                                     //
   Feedback ratio
dAvbyAv = 20.0                                  //
   Percentage change in open loop gain

//Calculation

dA1vbyA1v = 1 / (1 + beta*Av)*dAvbyAv           //
   Percentage change in closed loop gain

//Result

printf("\n The percentage change in closed loop gain
    is  %0.1f percentage.",dA1vbyA1v)
```

Scilab code Exa 29.8 The value of Av

```
clear//

//Variables

A1v = 100.0                              //Voltage gain with feedback
dA1vbyA1v = 0.01                         //Percentage change in closed loop gain
dAvbyAv = 0.20                           //Percentage change in open loop gain

//Calculation

betamultAvplus1 = dAvbyAv/dA1vbyA1v      //Product of feedback ratio and voltage ratio plus one
Av = A1v * betamultAvplus1               //Voltage gain without feedback
beta = betamultAvplus1 / Av              //Feedback ratio

//Result

printf("\n The value of Av is  %0.3f .\nThe value of beta is  %0.3f .",Av,beta)
```

Scilab code Exa 29.9 Amout of feedback required when BW is 1MHz

```
clear//

//Variables
```

```

Av = 100.0                    //Voltage gain without feedback
BW = 200.0 * 10**3            //Bandwidth without feedback (in Hertz)
beta = 0.05                   //Feedback ratio
BWn = 1.0 * 10**6             //New bandwidth without feedback (in Hertz)

//Calculation

BW1 = (1 + beta*Av) * BW      //Bandwidth with feedback (in Hertz)
A1v = Av/(1 + beta*Av)        //Voltage gain with feedback
beta1 = (BWn/BW - 1)/Av       //Amount of feedback required

//Result

printf("\n The new bandwidth is %0.3f kHz.\nThe new gain is %0.1f .",BW1*10**-3,A1v)
printf("\n Amout of feedback required when BW = 1MHz is %0.3f percentage.",beta1 * 100)
```

Scilab code Exa 29.11 `The value of input resistance with feedback`

```
clear//

//Variables

Rin = 4.2 * 10**3                    //Input resistance (in ohm)
Av = 220.0                           //Voltage gain without feedback
```

```
beta = 0.01                              //Feedback
   ratio
f1 = 1.5 * 10**3                         //Cut off
   frequency without feedback (in Hertz)
f2 = 501.5 * 10**3                       //Cut off
   frequency with feedback (in Hertz)

//Calculation

R1i = (1 + beta * Av) * Rin              //Input
   resistance of feedback amplifier (in ohm)
f11 = f1 / (1 + beta * Av)               //New cut off
   frequency without feedback (in Hertz)
f21 = (1 + beta * Av) * f2               //New cut off
   frequency with feedback (in Hertz)

//Result

printf("\n The value of input resistance with
   feedback is %0.3f kilo-ohm.\nNew cut off
   frequency without feedback is %0.0f Hz.\nNew
   cut off frequency with feedback is %0.3f kHz."
   ,R1i*10**-3,f11,f21*10**-3)
```

Scilab code Exa 29.14 `Voltage gain with feedback`

```
clear//

//Variables

Av = 300.0                       //Voltage gain without
    feedback
Ri = 1.5 * 10**3                 //Input resistance (in
    ohm)
Ro = 50.0 * 10**3                //Output resistance (
```

```
in ohm)
beta = 1.0/15.0                    //feedback ratio

//Calculation

A1v = Av/ (1 + beta*Av)            //Voltage gain with feedback
R1i = (1 + beta* Av)* Ri           //Input resistance with feedback (in ohm)
R1o = Ro/(1 + beta * Av)           //Output resistance with feedback (in ohm)

//Result

printf("\n Voltage gain with feedback is  %0.1f .\nInput resistance with feedback is  %0.3f  kilo-ohm.\nOutput resistance with feedback is  %0.1f kilo-ohm.",A1v,R1i*10**-3,R1o*10**-3)
```

Scilab code Exa 29.15 `Voltage gain without feedback`

```
clear//

//Variables

hfe = 100.0                                  //hfe
hie = 2.0 * 10**3                            //hie (in ohm)
Re1 = 100.0                                  //Emitter resistance (in ohm)
R1 = 15.0 * 10**3                            //Resistance (in ohm)
R2 = 5.6 * 10**3                             //Resistance (in ohm)
Rc = 470.0                                   //Collector
```

```
   resistance (in ohm)

//Calculation

Ai = hfe                                 //Current gain
Av = Ai * Rc / hie                       //Voltage gain
Ri = (R1*R2*hie)/(R1*R2+R2*hie+R1*hie)   //Input resistance (in ohm)
beta = Re1 / Rc                          //feedback ratio
A1v = Av / (1 + beta * Av)               //Voltage ratio with feedback
R1i = Ri*(1 + beta * Av)                 //Input resistancewith feedback (in ohm)

//Result

printf("\n Voltage gain without feedback is %0.3f.\nInput resistance without feedback is %0.0f kilo-ohm.\nVoltage gain with feedback is %0.2f.\nInput resistance with feedback is %0.1f kilo-ohm.",Av,Ri,A1v,R1i)
```

Scilab code Exa 29.16 `Voltage gain with feedback`

```
clear//

//Variables

hfe = 99.0                               //hfe
hie = 2.0 * 10**3                        //hie (in ohm)
Rc = 22.0 * 10**3                        //Load
```

```
resistor of frist stage (in ohm)
R4  = 100.0                                //Emitter resistance of first stage (in ohm)
R1 = 220.0 * 10**3                         //Biasing resistor of second stage (in ohm)
R2 = 22.0 * 10**3                          //Biasing resistor of second stage (in ohm)
R1c = 4.7 * 10**3                          //Load resistance of second stage (in ohm)
R3 = 7.8 * 10**3                           //Feedback resistor from collector of second stage to emitter of first stage (in ohm)

//Calculation

Ri = hie                                   //Input resistance of first stage (in ohm)
Ro1 = (1/Rc + 1/R1 + 1/R2 + 1/hie)**-1 //Output resistance of first stage (in ohm)
Ri2 = hie                                  //Input resistance of second stage (in ohm)
Ro2 = R1c * (R3 + R4)/(R1c + R3 + R4)      //Output resistance of second stage (in ohm)
Av1 = hfe * Ro1 / hie                      //Voltage gain of first stage
Av2 = hfe * Ro2 / hie                      //Voltage gain of second stage
Av = Av1 * Av2                             //Overall voltage gain without feedback
beta = R4 / (R3 + R4)                      //Feedback ratio
Ri1 = Ri*(1 + beta*Av)                     //Input resistance with feedback (in ohm)
R1o2 = Ro2 / (1 + beta * Av)               //Output resistance with feedback (in ohm)
A1v = Av / (1 + beta * Av)                 //Overall voltage gain with feedback

```

```
//Result

printf("\n Voltage gain without feedback is %0.1f .\nInput resistance of first stage without feedback is %0.3f kilo-ohm.\nInput resistance of second stage without feedback is %0.3f kilo-ohm.\nOutput resistance of first stage without feedback is %0.2f kilo-ohm.\nOutput resistance of second stage without feedback is %0.2f kilo-ohm .",Av,Ri*10**-3,Ri2*10**-3,Ro1*10**-3,Ro2*10**-3)
printf("\n Voltage gain with feedback is %0.1f .\nInput resistance with feedback is %0.2f kilo-ohm.\nOutput resistance with feedback is %0.3f kilo-ohm.",A1v,Ri1*10**-3,R1o2*10**-3)
```

Chapter 30

Field Effect Transistor Amplifiers

Scilab code Exa 30.1 Value of drain to source voltage

```
clear//

//Variables

ID = 5.0 * 10**-3                       //Drain current (in Ampere)
VDD = 10.0                              //Voltage (in volts)
RD = 1.0 * 10**3                        //Drain resistance (in ohm)
RS = 500.0                              //Source resistance (in ohm)

//Calculation

VS = ID * RS                            //Source voltage (in volts)
VD = VDD - ID * RD                      //Drain voltage (in volts)
VDS = VD - VS                           //Drain-Source
```

```
    voltage (in volts)
VGS = -VS                              //Gate-to-source voltage (in volts)

//Result

printf("\n Value of drain-to-source voltage is %0.3f V.\nValue of Gate-to-source voltage is %0.3f V.",VDS,VGS)
```

Scilab code Exa 30.3 `Value of RS`

```
clear//

//Variables

ID = 1.5 * 10**-3                      //Drain current (in Ampere)
IDSS = 5.0 * 10**-3                    //Drain-to-source current (in Ampere)
Vp = -2.0                              //Voltage (in volts)
VDS = 10.0                             //Drain-to-source voltage (in volts)
VDD = 20.0                             //Supply voltage (in volts)

//Calculation

VGS = (1 - ID/IDSS)*Vp                 //Gate-to-Source voltage (in volts)
VS = -VGS                              //Source voltage (in volts)
RS = VS / ID                           //Source resistance (in ohm)
```

```
RD = (VDD - VDS) / ID - RS          //Drain
    resistance (in ohm)

//Result

printf("\n Value of RS is  %0.0f  ohm.\nValue of RD
    is  %0.1f  kilo-ohm.",RS,RD*10**-3)
```

Scilab code Exa 30.5 `Value of RD`

```
clear//

//Variables

VP=5.0;VGSoff=5.0;
IDSS = 12.0 * 10**-3                //Drain-to-
    source current (in Ampere)
VDD = 12.0                          //Drain voltage
    (in volts)
ID = 4.0 * 10**-3                   //Drain current
    (in Ampere)
VDS = 6.0                           //Drain-to-
    source voltage (in volts)

//Calculation

VGS = (1 - (ID / IDSS)**0.5)*VGSoff //Gate-to-source
     voltage (in volts)
VS = VGS                            //Source voltage
     (in volts)
RS = VS / ID                        //Source
    resistance (in ohm)
RD = (VDD - VDS) / ID               //Drain
    resistance (in ohm)

```

```
//Result

printf("\n Value of RD is %0.3f kilo-ohm.\nValue
    of RS is %0.0f ohm.",RD*10**-3,RS)
```

Scilab code Exa 30.6 `Value of RD`

```
clear//

//Variables

IDSS = 10.0 * 10**-3                          //Drain-to-
    source current (in Ampere)
VDD = 20.0                                    //Drain
    voltage (in volts)

//Calculation

IDQ = IDSS / 2                                //Drain
    current at Q point (in Ampere)
VDSQ = VDD / 2                                //Drain-to-
    source voltage at Q point (in volts)
VGS = -2.2                                    //Gate-to-
    source voltage (in volts)
ID = 5.0 * 10**-3                             //Drain
    current (in Ampere)
RD = (VDD - VDSQ) / ID                        //Drain
    resistance (in ohm)
VS = - VGS                                    //Source
    voltage (in volts)
RS = VS / ID                                  //Source
    resistance (in ohm)

//Result

```

```
printf("\n Operating point is ID = %0.3f mA and
    VDS = %0.3f V.",IDQ*10**3,VDSQ)
printf("\n Value of RD is %0.3f kilo-ohm and RS is
     %0.3f ohm.",RD*10**-3,RS)
```

Scilab code Exa 30.7 `Value of VGS`

```
clear//

//Variables

VDD = 20.0                          //Supply voltage (
    in volts)
RD = 2.5 * 10**3                    //Drain resistance
     (in ohm)
RS = 1.5 * 10**3                    //Source
    resistance (in ohm)
R1 = 2.0 * 10**6                    //Resistance (in
    ohm)
R2 = 250.0 * 10**3                  //Resitance (in
    ohm)
ID = 4.0 * 10**-3                   //Drain current (
    in Ampere)

//Calculation

VG = VDD * R2 / (R1 + R2)           //Gate voltage (in
     volts)
VS = ID * RS                        //Source voltage (
    in volts)
VGS = VG - VS                       //Gate-to-source
    voltage (in volts)
VD = VDD - ID * RD                  //Drain voltage (
    in volts)

```

```
//Result

printf("\n Value of VGS is  %0.1f  V. and value of VDS is  %0.3f  V.",VGS,VD-VS)
```

Scilab code Exa 30.8 Voltage gain

```
clear//

//Variables

gm = 4.0 * 10**-3                              //Transconductance (in Siemen)
RD = 1.5 * 10**3                               //Drain resistance (in ohm)

//Calculation

Av = -gm * RD                                  //Voltage gain

//Result

printf("\n Voltage gain is  %0.3f .",Av)
```

Scilab code Exa 30.9 Voltage gain

```
clear//

//Variables

gm = 2.5 * 10**-3                              //Transconductance (in Ampere per volt)
```

```
rd = 500.0 * 10**3                         //Resistance
    (in ohm)
RD = 10.0 * 10**3                          //Load
    resistance (in ohm)

//Calculation

rL = RD * rd / (RD + rd)                   //a.c.
    equivalent resistance (in ohm)
Av = -gm * rL                              //Voltage
    gain

//Result

printf("\n Voltage gain is  %0.1f .",Av)
```

Scilab code Exa 30.10 Input resistance

```
clear//

//Variables

gm = 2.0 * 10**-3                          //
    Transconductance (in Ampere per volt)
rd = 40.0 * 10**3                          //Resistance
    (in ohm)
RD = 20.0 * 10**3                          //Drain
    resistance (in ohm)
RG = 100.0 * 10**6                         //Gate
    resistance (in ohm)

//Calculation

rL = RD * rd / (RD + rd)                   //a.c.
    equivalent resistance (in ohm)
```

```
Av = -gm * rL                                       //Voltage gain
R1i = RG                                            //input resistance (in ohm)
R1o = rL                                            //output resistance (in ohm)

//Result

printf("\n Voltage gain is %0.1f .",Av)
printf("\n Input resistance is %0.3f Mega-ohm.\nOutput resistance is %0.1f kilo-ohm.",R1i*10**-6,R1o*10**-3)
```

Scilab code Exa 30.11 `Voltage gain`

```
clear//

//Variables

gm = 2.0 * 10**-3                                   //Transconductance (in Ampere per volt)
rd = 10.0 * 10**3                                   //Resistance (in ohm)
RD = 50.0 * 10**3                                   //Drain resistance (in ohm)

//Calculation

rL = RD * rd / (RD + rd)                            //a.c. equivalent resistance (in ohm)
Av = - gm * rL                                      //Voltage gain

//Result
```

```
printf("\n Voltage gain is %0.2f .",Av)
```

Scilab code Exa 30.12 Voltage gain

```
clear//

//Variables

RD = 100.0 * 10**3                          //Drain resistance (in ohm)
gm = 1.6 * 10**-3                           //Transconductance (in Ampere per volt)
rd = 44.0 * 10**3                           //Resistance (in ohm)
Cgs = 3.0 * 10**-12                         //Capacitance gate-to-source (in Farad)
Cds = 1.0 * 10**-12                         //Capacitance drain-to-source (in Farad)
Cgd = 2.8 * 10**-12                         //Capacitance gate-to-drain (in Farad)

//Calculation

rL = RD * rd / (RD + rd)                    //a.c. load resistance (in ohm)
Av = -gm * rL                               //Voltage gain

//Result

printf("\n Voltage gain is %0.1f ",Av)
```

Scilab code Exa 30.13 Output voltage

```
clear//

//Variables

gm = 4500.0 * 10**-6                    //Transconductance (in Ampere per volt)
RD = 3.0 * 10**3                        //Drain resistance (in ohm)
RL = 5.0 * 10**3                        //Load resistance (in ohm)
Vin = 100.0 * 10**-3                    //Input voltage (in volts)
ID = 2.0 * 10**-3                       //Drain current (in Ampere)

//Calculation

rL = RD * RL / (RD + RL)                //a.c. load resistance (in ohm)
vo = -gm * rL * Vin                     //Output voltage (in volts)

//Result

printf("\n Output voltage is %0.3f V.",vo)
```

Scilab code Exa 30.17 Voltage gain

```
clear//

//Variables

vin = 2.0 * 10**-3                       //Input
```

```
voltage (in volts)
gm = 5500.0 * 10**-6                            //Transconductance (in Siemen)
R1=1.0*10**6;R2=1.0*10**6;
RS = 5.0 * 10**3                                //Source resistance (in ohm)
RL = 2.0 * 10**3                                //Load resistance (in ohm)

//Calculation

Av = RS / (RS + 1/gm)                           //Voltage gain
R1i = R1 * R2 / (R1 + R2)                       //Input resistance (in ohm)
R1o = RS * 1/gm /(RS + 1/gm)                    //Output resistance (in ohm)
Vo = RL / (RL + R1o) * Av * vin                 //Output voltage (in volts)

//Result

printf("\n Voltage gain is %0.3f .\nInput resistance is %0.3f Mega-ohm.\nOutput resistance is %0.1f ohm.\nOutput voltage is %0.2f mV.",Av,R1i*10**-6,R1o,Vo*10**3)
```

Scilab code Exa 30.18 Amplifier voltage gain

```
clear//

//Variables

gm = 2500.0 * 10**-6                           //Transconductance (in Amper per volt)
```

```
RD = 10.0 * 10**3                                       //Drain
    resistance (in ohm)
RS = 2.0 * 10**3                                        //Source
    resistance (in ohm)

//Calculation

Av = gm * RD                                            //Voltage
    gain
R1i = RS * 1/gm /(RS + 1/gm)                            //Input
    resistance (in ohm)

//Result

printf("\n Amplifier voltage gain is %0.3f .\
    nInput resistance is %0.0f ohm.",Av,R1i)
```

Scilab code Exa 30.19 Input resistance

```
clear//

//Variables

gmo = 5.0 * 10**-3                                      //Maximum
    transconductance (in Siemen)
RD = 1.0 * 10**3                                        //Drain
    resistance (in ohm)
RS = 200.0                                              //Source
    resistance (in ohm)
ID = 5.0 * 10**-3                                       //Drain
    current (in Ampere)

//Calculation

R1i = RS * 1/gmo /(RS + 1/gmo)                          //Input
```

```
resistance (in ohm)
VS = ID * RS                                //Source voltage (in volts)
VGS = VS                                    //Gate-to-Source voltage (in volts)
IDSS = 2 * ID                               //Supply current (in Ampere)
VGSoff = -2 * IDSS / ID                     //Gate-to-source cut off voltage (in volts)
gm = gmo * (1 - abs(VGS / VGSoff))          //Transconductance (in Siemen)
Av = gm * RD                                //Voltage gain

//Result

printf("\n Input resistance is  %0.3f  ohm.\na.c. voltage gain is  %0.3f .",R1i,Av)
```

Chapter 31

Sinusoidal Oscillators

Scilab code Exa 31.1 Inductance

```
clear//

//Variables

fo = 22.0 * 10**3                          //Frequency (in Hertz)
C = 2.0 * 10**-9                           //Capacitance (in Farad)

//Calculation

L = (0.159/fo)**2/C                        //Inductance (in Henry)

//Result

printf("\n Inductance is  %0.3f  H.",L)
```

Scilab code Exa 31.2 It will work at frequency of

```
clear//

//Variables

fo = 2.2 * 10**6                              //Frequency
    (in Hertz)

//Calculation

f1o = fo * 2**0.5                             //New
   frequency (in Hertz)

//Result

printf("\n It will work at frequency of %0.2f MHz
   when capacitance is reduced by 50 percentage.",
   f1o * 10**-6)
```

Scilab code Exa 31.3 Frequency of oscillations

```
clear//

//Variables

C = 100.0 * 10**-12                       //Capacitance (
   in Farad)
L1 = 30.0 * 10**-6                        //Inductance1 (
   in Henry)
L2 = 1.0 * 10**-8                         //Inductance2 (
   in Henry)

//Calculation

L = L1 + L2                               //Net
   inductance (in Henry)
```

```
fo = 1/(2*%pi*(L * C)**0.5)       //Frequency of
    oscillations (in Hertz)

//Result

printf("\n Frequency of oscillations is  %0.1f ",fo
    *10**-6)
```

Scilab code Exa 31.4 Frequency of oscillations

```
clear//

//Variables

L1 = 1000.0 * 10**-6                         //Inductance1
    (in Henry)
L2 = 100.0 * 10**-6                          //Inductance2
    (in Henry)
M = 20.0 * 10**-6                            //Mutual
    Inductance (in Henry)
C = 20.0 * 10**-12                           //Capacitance
    (in Farad)

//Calculation

L = L1 + L2 + 2 * M                         //Net
    inductance (in Henry)
fo = 1/(2*%pi*(L * C)**0.5)       //Frequency of
    oscillations (in Hertz)

//Result

printf("\n Frequency of oscillations is  %0.3f ",fo
    *10**-6)
```

Scilab code Exa 31.5 Frequency of oscillations

```
clear//

//Variables

C = 1.0 * 10**-9                                    //Capacitance
    (in Farad)
L1 = 4.7 * 10**-3                                   //Inductance1
    (in Henry)
L2 = 47.0 * 10**-6                                  //Inductance2
    (in Henry)

//Calculation

L = L1 + L2                                         //Net
   inductance (in Henry)
fo = 1/(2*%pi*(L * C)**0.5)                  //Frequency of
   oscillations (in Hertz)

//Result

printf("\n Frequency of oscillations is %0.2f ",fo
   *10**-3)
```

Scilab code Exa 31.6 Range of capacitance required

```
clear//

//Variables

```

```
L1 = 2.0 * 10**-3                                  //Inductance1 (in Henry)
L2 = 20.0 * 10**-6                                 //Inductance2 (in Henry)
fomin = 950.0 * 10**3                              //Frequency minimum (in Hertz)
fomax = 2050.0 * 10**3                             //Frequency maximum (in Hertz)

//Calculation

L = L1 + L2                                        //Net inductance (in Henry)
C1 = 1.0/(4 * %pi**2*(L*fomin**2))     //Capacitance1 (in Farad)
C2 = 1.0/(4 * %pi**2*(L*fomax**2))     //Capacitance2 (in Farad)

//Result

printf("\n Range of capacitance required is %0.2f pF and %0.1f pF.",C2*10**12,C1*10**12)
```

Scilab code Exa 31.7 Capacitance required

```
clear//

//Variables

L1 = 0.1 * 10**-3                                  //Inductance1 (in Henry)
L2 = 10.0 * 10**-6                                 //Inductance2 (in Henry)
M = 20.0 * 10**-6                                  //Mutual Inductance (in Hnery)
```

```
fo = 4110.0 * 10**3                    //Frequency (in Hertz)

//Calculation

L = L1 + L2 + 2*M                      //Net inductance (in Henry)
C = 1.0/(4 * %pi**2 * L*fo**2)         //Capacitance (in Farad)
beta = L2 / L1                         //Feedback ratio
Av = 1/beta                            //Voltage gain

//Result

printf("\n Capacitance required is %0.4f pF.\nVoltage gain for sustained condition is %0.3f .",C*10**12,Av)
```

Scilab code Exa 31.8 Required voltage gain

```
clear//

//Variables

C1 = 0.001 * 10**-6                    //Capacitance (in Farad)
C2 = 0.01 * 10**-6                     //Capacitance (in Farad)
L = 5.0 * 10**-6                       //Inductance (in Henry)

//Calculation

```

```
Av = C2 / C1                                   //Voltage gain
C = C1 * C2 / (C1 + C2)                        //Net capacitance (in Farad)
fo = 1 /(2*%pi*(L * C)**0.5)           //Frequency (in Hertz)

//Result

printf("\n Required voltage gain is  %0.3f .\nFrequency of oscillation is  %0.2f  Mhz.",Av,fo*10**-6)
```

Scilab code Exa 31.9 Frequency of oscillation

```
clear//

//Variables

C1 = 0.1 * 10**-6                          //Capacitance (in Farad)
C2 = 1.0 * 10**-6                          //Capacitance (in Farad)
L = 470.0 * 10**-6                         //Inductance (in Henry)

//Calculation

C = C1 * C2/ (C1 + C2)                     //Net capacitance (in Farad)
fo = 1 /(2*%pi*(L * C)**0.5)       //Frequency (in Hertz)

//Result

```

```
printf("\n Frequency of oscillation is %0.2f kHz."
    ,fo * 10**-3)
```

Scilab code Exa 31.10 The range of inductance required

```
clear//

//Variables

C1 = 100.0 * 10**-12                        //
    Capacitance (in Farad)
C2 = 7500.0 * 10**-12                       //
    Capacitance (in Farad)
fomin = 950.0 * 10**3                       //Frequency
    minimum (in Hertz)
fomax = 2050.0 * 10**3                      //Frequency
    maximum (in Hertz)

//Calculation

C = C1 * C2/ (C1 + C2)                      //Net
    capacitance (in Farad)
L1 = 1.0/(4 * %pi**2*(C*fomin**2))  //Inductance1 (
    in Henry)
L2 = 1.0/(4 * %pi**2*(C*fomax**2))  //Inductance2 (
    in Henry)

//Result

printf("\n The range of inductance required is from
     %0.0f micro-Henry to %0.0f micro-Henry.",L2
    *10**6,L1*10**6)
```

Scilab code Exa 31.11 The oscillation frequency if C2

```
clear//

//Variables

fo = 450.0 * 10**3                       //Frequency(in
    Hertz)
//Let us assume
C1=10.0*10**-6;C2=10.0*10**-6;C=10.0*10**-6;
C21 = 2 * C2                             //Capacitance (in
    Farad)

//Calculation

fo1 = fo * (3.0/4.0)**0.5                //New Frequency (
    in Hertz)

//Result

printf("\n The oscillation frequency if C2 is
    doubled is %0.1f kHz.",fo1 * 10**-3)
```

Scilab code Exa 31.12 Frequency of oscillation

```
clear//

//Variables

C1 = 0.1 * 10**-6                        //Capacitance (
    in Farad)
C2 = 1.0 * 10**-6                        //Capacitance (
    in Farad)
C3 = 100.0 * 10**-12                     //Capacitance (
    in Farad)
```

```
L = 470.0 * 10**-6                    //Inductance (in
    Henry)

//Calculation

C = (1.0/C1 + 1.0/C2 +1.0/C3)**-1    //Capacitance (
    in Farad)
fo = 1/(2*%pi *(L*C)**0.5)        //Frequency (in
    Hertz)

//Result

printf("\n Frequency of oscillation is %0.1f kHz."
    ,fo * 10**-3)
```

Scilab code Exa 31.13 Series resonant frequency

```
clear//

//Variables

L = 0.33                          //Inductance (in
    Henry)
C1 = 0.065 * 10**-12              //Capacitance (in
    Farad)
C2 = 1.0 * 10**-12                //Capacitance (in
    Farad)
R = 5.5 * 10**3                   //Resistance (in ohm)

//Calculation

fs = 1/(2*%pi*(L*C1)**0.5) //Series Resonant
    frequency (in Hertz)
Qfactor = 2*%pi*fs*L/R      //Q-factor

```

```
//Result

printf("\n Series resonant frequency is %0.2f MHz
    .\nQ-factor of the crystal is %0.1f .",fs
    *10**-6,Qfactor)
```

Scilab code Exa 31.14 Value of drain resistance

```
clear//

//Variables

gm = 5000.0 * 10**-6                          //
    Transconductance (in mho)
rd = 40.0 * 10**3                             //Resistance
     (in ohm)
R = 10.0 * 10**3                              //Resistance
     (in ohm)
fo = 1.0 * 10**3                              //Frequency
    (in Hertz)
Av = 40.0                                     //Voltage
    gain

//Calculation

C = 1/(2*%pi*(R)*6**0.5*fo)           //Capacitance (
    in Farad)
rL = Av / gm                                  //a.c. load
    resistance (in ohm)
RD = (rL * rd)/(rd-rL)                        //Drain
    resistance (in ohm)

//Result

printf("\n Value of capacitor is %0.5f micro-Farad
```

```
    .",C* 10**6)
printf("\n Value of drain resistance is %0.3f kilo
    -ohm.",RD * 10**-3)
```

Scilab code Exa 31.18 Value of capacaitor C

```
clear//

//Variables

fo = 2.0 * 10**3                                    //
    Frequency (in Hertz)
hie = 2.0 * 10**3                                   //
    hie (in ohm)
R1 = 20.0 * 10**3                                   //
    Resistance (in ohm)
R2 = 80.0 * 10**3                                   //
    Resistance (in ohm)
RC = 10.0 * 10**3                                   //
    Collector Resistance (in ohm)
R = 8.0 * 10**3                                     //
    Resistance (in ohm)

//Calculation

C = 1/(2*%pi*R)*(1/(6 + 4*RC/R)**0.5)/fo        //
    Capacitance (in Farad)
hfe = 23 + 29 * R/RC + 4* RC /R                     //
    Current gain
Ri = (1/R1 + 1/R2 + 1/hie)**-1                      //
    Input resistance (in ohm)
R3 = R - Ri                                         //
    Feedback resitor (in ohm)

//Result
```

```
printf("\n Value of capacaitor C is  %0.3f  micro-Farad.\nValue of transistor gain is hfe >=  %0.3f .\nValue of feedback resistor R3 is  %0.1f  kilo-ohm.",C*10**6,hfe,R3*10**-3)
```

Scilab code Exa 31.19 Value of the capacitor C

```
clear//

//Variables

fo = 10.0 * 10**3                               //Frequency (in Hertz)
R = 100.0 * 10**3                               //Resistance (in ohm)

//Calculation

C = 1/(2*%pi*R*fo)                          //Capacitance (in Farad)

//Result

printf("\n Value of the capacitor C is  %0.0f  pico-Farad.",C * 10**12)
```

Chapter 32

Non Sinusoidal Oscillators

Scilab code Exa 32.2 Frequency of oscillation

```
clear//

//Variables

R1=20.0*10**3;R2=20.0*10**3;R=20.0*10**3;
C1=100.0*10**-12;C2=100.0*10**-12;C=100.0*10**-12;

//Calculation

f = 1/(1.38 * R * C)                    //Frequency
    (in Hertz)

//Result

printf("\n Frequency of oscillation is %0.0f kHz."
    ,f * 10**-3)
```

Scilab code Exa 32.3 Time period of oscillation

```
clear//

//Variables

R1 = 2.0 * 10**3          //Resistance (in ohm)
R2 = 20.0 * 10**3         //Resistance (in ohm)
C1 = 0.01 * 10**-6        //Capacitance (in Farad)
C2 = 0.05 * 10**-6        //Capacitance (in Farad)

//Calculation

T = 0.69*(R1*C1 + R2*C2) //Time periode of
    oscillation (in seconds)
f = 1/T                   //Frequency of oscillation
    (in Hertz)

//Result

printf("\n Time period of oscillation is %0.1f ms
    .\nFrequency of oscillation is %0.2f kHz.",T
    *10**3,f*10**-3)
```

Scilab code Exa 32.4 `Value of C1 capacitor`

```
clear//

//Variables

T1 = 1.0 * 10**-6                 //Pulse width (in
    seconds)
f = 100.0 * 10**3                 //Frequency (in
    Hertz)
R1=10.0*10**3;R2=10.0*10**3;

//Calculation
```

```
T = 1/f                                 //Time period of oscillation (in seconds)
C1 = T1 / 0.69 / R1                     //Capacitance (in Farad)
T2 = T - T1                             //Time period (in seconds)
C2 = T2 / 0.69 / R2                     //Capacitance (in Farad)

//Result

printf("\n Value of C1 capacitor is %0.0f pico-Farad.\nValue of C2 capacitor is %0.0f pico-Farad.",C1*10**12,C2*10**12)
```

Scilab code Exa 32.8 The pulse width

```
clear//

//Variables

R1 = 2.2 * 10**3                            //Resistance (in ohm)
C1 = 0.01 * 10**-6                          //Capacitance (in Farad)

//Calculation

tp = 1.1 * R1 * C1                          //Pulse width (in seconds)

//Result

printf("\n The pulse width is %0.3f micro-second."
```

```
,tp * 10**6)
```

Scilab code Exa 32.9 Resistance required

```
clear//

//Variables

C = 1000.0 * 10**-12                  //Capacitance (in
    Farad)
tp = 10.0 * 10**-6                    //Pulse width (in
    seconds)
T = 60.0 * 10**-6                     //time period (in
    seconds)

//Calculation

R1 = tp / (1.1 * C)                   //Resistance (in
    ohm)

//Result

printf("\n Resistance required is %0.2f kilo-ohm."
    ,R1 * 10**-3)
```

Scilab code Exa 32.12 Time period

```
clear//

//Variables

f = 50.0 * 10**3                     //Frequency (in Hertz
    )
```

```
duty_cycle = 0.6                        //Duty cycle
C = 0.0022 * 10**-6                     //Capacitance (in Farad)

//Calculation

T = 1/f                                 //Time period (in seconds)
t1 = duty_cycle * T                     //time interval1 (in seconds)
t2 = T - t1                             //time interval2 (in seconds)
R2 = t2 / (0.7 * C )                    //Resistance (in ohm)
R1 = t1 / (0.7 * C) - R2                //Resistance (in ohm)

//Result

printf("\n Time period is  %0.3f ms.\nt1 is  %0.3f ms.\nt2 is  %0.3f  ms.\nR2 is  %0.2f  kilo-ohm.\nR1 is  %0.1f  kilo-ohm.",T*10**3,t1*10**3,t2*10**3,R2*10**-3,R1*10**-3)
```

Chapter 33

Wave Shaping

Scilab code Exa 33.2 Output peak voltage

```
clear//

//Variables

Vpk = 1.0                       //Peak-to-peak voltage
    (in volts)
Tby2 = 0.1                      //Half-period (in
   seconds)
tau = 0.25                      //Time constant (in
   seconds)

//Calculation

Vc = 0.5 * exp(-Tby2/tau)      //Output voltage (in
   volts)

//Result

printf("\n Output peak voltage is %0.1f V.",Vc)
```

Scilab code Exa 33.3 `The peak value of input voltage`

```
clear//

//Variables

RC = 250.0 * 10**-12                                   //Time
    constance (in seconds)
Vomax = 50.0                                           //Maximum
    output voltage (in volts)
tau = 0.05  * 10**-6                                   //time (in
    seconds)

//Calculation

alpha = Vomax / RC                                     //alpha (in
    volt per second)
Vp = alpha * tau                                       //Peak
    voltage (in volts)

//Result

printf("\n The peak value of input voltage is  %0.3f
    kV.",Vp * 10**-3)
```

Chapter 34

Time Base Circuits

Scilab code Exa 34.1 Frequency of sweep

```
clear//

//Variables

R = 100.0 * 10**3                                    //
    Resistance (in ohm)
C = 0.4 * 10**-6                                     //
    Capacitance (in Farad)
n = 0.57                                             //
    Ratio of peak-peak voltage to the supply voltage

//Calculation

f = 1 / (2.3 * R * C * log10(1/(1-n)))         //
    Frequency (in Hertz)

//Result

printf("\n Frequency of sweep is  %0.2f  Hz.",f)
```

Scilab code Exa 34.2 `Value of R with C`

```
clear//

//Variables

n = 0.62                                              //Ratio
    of peak−peak voltage to the supply voltage
R = 5.0 * 10**3                                       //
   Resistance (in ohm)
C = 0.05 * 10**-6                                     //
   Capacitor (in Farad)

//Calculation

T = 2.3 * R * C * log10(1/(1-n))          //Time
   period of oscillation (in seconds)
f = 1/T                                               //
   Frequency of oscillation (in Hertz)
f1 = 50.0                                             //New
   frequency (in Hertz)
T1 = 1/f1                                             //New
   time period of oscillation (in seconds)
R1 = T1 / (2.3 * C * log10(1/(1-n)))      //New
   Resistance (in ohm)
f2 = 50.0                                             //
   Another new frequency (in Hertz)
C2 = 0.5 * 10**-6                                     //
   Capacitance (in Farad)
T2 = 1/f2                                             //
   Another new time period (in seconds)
R2 = T2 / (2.3 * C2 * log10(1/(1-n)))     //New
   Resistance (in ohm)

```

```
//Result

printf("\n The time period and frequency of oscillation in case 1 is %0.2f ms and %0.0f Hz.",T*10**3,f)
printf("\n New value of R is %0.0f kilo-ohm.",R1 * 10**-3)
printf("\n Value of R with C is 0.5 micro-Farad is %0.1f kilo-ohm.",R2 * 10**-3)
```

Chapter 35

Operational Amplifiers OP Amps

Scilab code Exa 35.1 `The common mode rejection ratio`

```
clear//

//Variables

Adm = 200000.0                          //Differential
   gain
Acm = 6.33                              //Common mode gain

//Calculation

CMRR = 20 * log10(Adm / Acm)            //Common−mode
   rejection ratio (in Decibels)

//Result

printf("\n The common−mode rejection ratio is %0.0f
   dB.",CMRR)
```

Scilab code Exa 35.2 `The common mode gain`

```
clear//

//Variables

CMRR = 90.0                         //Common−mode
    rejection ratio (in Decibels)
Adm = 30000.0                       //Differential gain

//Calculation

Acm = 10**(-CMRR/20.0) * Adm    //Common−mode gain

//Result

printf("\n The common−mode gain is  %0.3f .",Acm)
```

Scilab code Exa 35.3 `The maximum operating frequency for the amplifier`

```
clear//

//Variables

Slew_rate = 0.5 * 10**6                       //Slew rate
     (in volt per second)
Vpk = 100.0 * 10**-3                          //Peak−to−
    peak voltage (in volts)

//Calculation

```

```
fmax = Slew_rate / (2 * %pi * Vpk)    //Maximum
   operating frequency (in Hertz)

//Result

printf("\n The maximum operating frequency for the
   amplifier is  %0.0f  kHz.",fmax * 10**-3)
```

Scilab code Exa 35.4 `The maximum operating frequency for TLO 741`

```
clear//

//Variables

Slew_rate1 = 0.5 * 10**6                        //Slew
   rate (in volt per second)
Slew_rate2 = 13.0 * 10**6                       //Slew
   rate (in volt per second)
Vpk = 10.0                                      //Peak-to-
   peak voltage (in volts)

//Calculation

fmax = Slew_rate1 / (2 * %pi * Vpk)    //Maximum
   operating frequency1 (in Hertz)
fmax1 = Slew_rate2 / (2 * %pi * Vpk)   //Maximum
   operating frequency2 (in Hertz)

//Result

printf("\n The maximum operating frequency for TLO
   741 is  %0.3f  kHz.\nThe maximum opearing
   frequency for TLO 81 is  %0.1f  kHz.",fmax
   *10**-3,fmax1*10**-3)
```

Scilab code Exa 35.5 `Maximum allowable input voltage Vin`

```
clear//

//Variables

ACL = 200.0                    //Closed loop voltage
   gain
Vout = 8.0                     //Output voltage (in
   volts)

//Calculation

Vin = - Vout / ACL             //Input a.c. voltage (
   in volts)

//Result

printf("\n Maximum allowable input voltage (Vin) is
    %0.3f mV.",abs(Vin * 10**3))
```

Scilab code Exa 35.6 `The maximum possible output value could be between`

```
clear//

//Variables

ACL = 150.0                    //Closed loop voltage
   gain
Vin = 200.0 * 10**-3           //Input a.c. voltage (
   in volts)
V = 12.0                       //Voltage (in volts)
```

```
//Calculation

Vout = ACL * Vin                    //Output voltage (in
    volts)
Vpkplus = V -2.0                    //maximum positive peak
     voltage (in volts)
Vpkneg = -V + 2.0                   //maximum negative
    peagk voltage (in volts)

//Result

printf("\n The maximum possible output value could
    be between %0.3f V and %0.3f V.",Vpkplus,
    Vpkneg)
```

Scilab code Exa 35.7 The value of output voltage increases from

```
clear//

//Variables

R1 = 1.0 * 10**3                    //Resistance (in
    volts)
R2 = 10.0 * 10**3                   //Resistance (in
    volts)
vinmin = 0.1                        //Input voltage
    minimum (in volts)
vinmax = 0.4                        //Input voltage
    maximum (in volts)

//Calculation

ACL = R2 / R1                       //Closed loop voltage
     gain
```

```
Voutmin = ACL * vinmin            //Minimum output voltage (in volts)
Voutmax = ACL * vinmax            //Maximum output voltage (in volts)

//Result

printf("\n The value of output voltage increases from %0.3f V to %0.3f V.",Voutmin,Voutmax)
```

Scilab code Exa 35.8 Output voltage of the inverting amplifier

```
clear//

//Variables

R1 = 1.0 * 10**3                  //Resistance (in ohm)
R2 = 2.0 * 10**3                  //Resistance (in ohm)
V1 = 1.0                          //Voltage (in volts)

//Calculation

ACL = R2 / R1                     //Closed loop voltage gain
vo = ACL * V1                     //Output voltage (in volts)

//Result

printf("\n Output voltage of the inverting amplifier is %0.3f V.",vo)
```

Scilab code Exa 35.9 `Closed loop gain`

```
clear//

//Variables

R2 = 100.0 * 10**3                  //Resistance (in ohm)
R1 = 10.0 * 10**3                   //Resistance (in ohm)
ACM = 0.001                         //Common-mode gain
Slew_rate = 0.5 * 10**6             //Slew rate (in volt per second)
Vpk = 5.0                           //Peak voltage (in volts)

//Calculation

ACL = R2 / R1                        //Closed loop voltage gain
Zin = R1                             //Input impedance of the circuit (in ohm)
Zout = 80.0                          //Output impedance of the circuit (in ohm)
CMRR = ACL / ACM                     //Common mode rejection ratio
fmax = Slew_rate / (2*%pi*Vpk)   //Maximum frequency (in Hertz)

//Result

printf("\n Closed-loop gain is  %0.3f .\nInput impedance is  %0.3f  kilo-ohm.\nOutput impedance
```

```
is  %0.3f  ohm.\nCommon-mode rejection ratio is %0.3f .\nMaximum operating frequency is  %0.1f kHz.",ACL,Zin*10**-3,Zout,CMRR,fmax*10**-3)
```

Scilab code Exa 35.10 `Closed loop gain`

```
clear//

//Variables

R2 = 100.0 * 10**3                    //Resistance (in ohm)
R1 = 10.0 * 10**3                     //Resistance (in ohm)
Slew_rate = 0.5 * 10**6               //Slew rate (in volt per second)
Vpk = 5.5                             //Peak voltage (in volts)
RL = 10.0 * 10**3                     //Load resistance (in ohm)
ACM = 0.001                           //Common mode gain

//Calculation

ACL = (1 + R2/R1)                     //Closed loop voltage gain
CMRR = ACL / ACM                      //Common-mode rejection ratio
vin = 1.0                             //Voltage (in volts)
Vout = ACL * vin                      //Output voltage (in volts)
Vpk = 5.5                             //Peak-to-peak voltage (in volts)
```

```
fmax = Slew_rate/(2*%pi*Vpk)    //Maximum frequency (in Hertz)

//Result

printf("\n Closed loop gain is  %0.3f .\nCMRR is  %0.3f .\nMaximum operating frequency is  %0.2f  kHz.",ACL,CMRR,fmax*10**-3)
```

Scilab code Exa 35.11 ACL

```
clear//

//Variables

ACL = 1.0                                  //Closed loop gain
Acm = 0.001                                //Common mode gain
Slew_rate = 0.5 * 10**6                    //Slew rate (in Volt per second)

//Calculation

CMRR = ACL / Acm                           //Common-mode rejection ratio
vin = 1.0                                  //Voltage (in volts)
Vout = ACL * vin                           //Output voltage (in volts)
Vpk = 3.0                                  //Peak-to-peak voltage (in volts)
fmax = Slew_rate/(2*%pi*Vpk)    //Maximum frequency (in Hertz)

```

```
//Result

printf("\n ACL is  %0.3f .\nCMRR is  %0.3f .\nfmax
   is  %0.1f  kHz.",ACL,CMRR,fmax*10**-3)
```

Scilab code Exa 35.12 `Output voltage`

```
clear//

//Variables

V1 = 0.1                                          //
   Voltage (in volts)
V2 = 1.0                                          //
   Voltage (in volts)
V3 = 0.5                                          //
   Voltage (in volts)
R1 = 10.0 * 10**3                                 //
   Resistance (in ohm)
R2 = 10.0 * 10**3                                 //
   Resistance (in ohm)
R3 = 10.0 * 10**3                                 //
   Resistance (in ohm)
R4 = 22.0 * 10**3                                 //
   Resistance (in ohm)

//Calculation

Vout = (-R4/R1*V1) + (-R4/R2*V2) + (-R4/R3*V3)    //
   Output voltage (in volts)

//Result

printf("\n Output voltage is  %0.3f  V.",abs(Vout))
```

Scilab code Exa 35.14 Output voltage

```
clear//

//Variables

V1 = -2.0
    //Voltage (in volts)
V2 = 2.0
    //Voltage (in volts)
V3 = -1.0
    //Voltage (in volts)
R1 = 200.0 * 10**3
    //Resistance (in ohm)
R2 = 250.0 * 10**3
    //Resistance (in ohm)
R3 = 500.0 * 10**3
    //Resistance (in ohm)
Rf = 1.0 * 10**6
    //Resistance (in ohm)

//Calculation

Vout = (-Rf/R1*V1) + (-Rf/R2*V2) + (-Rf/R3*V3)
    //Output voltage (in volts)

//Result

printf("\n Output voltage is %0.3f V.",Vout)
```

Chapter 36

Basic Op Amp Applications

Scilab code Exa 36.1 Capacitance required in the circuit

```
clear//

//Variables

R1 = 1.0 * 10**3                    //Resistance (in ohm
    )
R2 = 100.0 * 10**3                  //Resistance (in ohm
    )
f1 = 159.0                          //Frequency (in
    Hertz)

//Calculation

C = 1.0/(2*%pi*R2*f1)        //Capacitance (in Farad)

//Result

printf("\n Capacitance required in the circuit is
    %0.2f  micro-Farad.",C * 10**6)
```

Scilab code Exa 36.2 `Minimum non linear operating frequency`

```
clear//

//Variables

R1 = 1.0 * 10**3                          //Resistance (in ohm)
Rf = 51.0 * 10**3                         //Resistance (in ohm)
Cf = 0.01 * 10**-6                         //Capacitance (in Farad)

//Calculation

f = 1.0/(2*%pi*Rf*Cf)         //Frequency (in Hertz)
fmin = 10* f                              //Minimum frequency required (in Hertz)

//Result

printf("\n The cut-off frequency of an integrator circuit is %0.0f Hz.",f)
printf("\n Minimum non-linear operating frequency is %0.0f Hz.",fmin)
```

Scilab code Exa 36.3 `Maximum linear operating frequency`

```
clear//

//Variables

```

```
R1 = 10.0 * 10**3                              //Resistance (
    in ohm)
C1 = 0.01 * 10**-6                             //Capacitor (
    in Farad)

//Calculation

f2 = 1.0/(2*%pi*R1*C1)                     //Frequency (in
    Hertz)
fmax = f2 / 10.0                               //Maximum
    linear operating freqeuncy (in Hertz)

//Result

printf("\n Cut-off frequency is %0.1f Hz.",f2)
printf("\n Maximum linear operating frequency is %0
    .0f Hz.",fmax)
```

Scilab code Exa 36.4 `The frequency of oscillations`

```
clear//

//Variables

R1=51.0*10**3;R2=51.0*10**3;
C1=0.001*10**-6;C2=0.001*10**-6;C=0.001*10**-6;

//Calculation

fo = 1.0/(2*%pi*R1*C1)                         //Resonant
    frequency (in Hertz)

//Result

printf("\n The frequency of oscillations is %0.1f
```

Hz.",fo)
