Scilab Textbook Companion for Electronic Devices and Circuits by D. C. Kulshreshtha[1]

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Book Description

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

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

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

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

Contents

List of Scilab Codes

Chapter 1

Introduction to Electronics

Scilab code Exa 1.1 Find the range of tolerance

```
//Find the range of tolerance
clear;
clc;
//soltion
//given

//color coding
orange=3;
gold=5;
yellow=4;
violet=7;
//band pattern
band1=yellow;
band2=violet;
band3=orange;
band4=gold;
//resistor color coding
r=(band1*10+band2)*10^(band3);
tol=r*(band4/100)//tolerance
ulr=r+tol;//upper limit of resistance
llr=r-tol;//lower limit of resistance
```

```
printf('The Range of resistance is %.2f k  to %.2f k ',llr/1000,ulr/1000);
```

Scilab code Exa 1.2 Find the range of tolerance

```
//Find the range of tolerance
clear;
clc;
//soltion
//given

//color coding
blue=6;
gold=-1;
gray=8;
silver=10;
//band pattern
band1=gray;
band2=blue;
band3=gold;
band4=silver;
//resistor color coding
r=(band1*10+band2)*10^(band3);
tol=r*(band4/100)//tolerance
ulr=r+tol;//upper limit of resistance
llr=r-tol;//lower limit of resistance
printf('The Range of resistance is %.2f  to %.2f ',llr,ulr);
```

Scilab code Exa 1.3 Find the equivalent current source

```

//Find the equivalent current source
```

```
clear;
clc;
//soltion
//given
Vs=2;//Volts                    //dc voltage source
Rs=1;//ohm                      //internal resistance
Rl=1;//ohm                     //load resistance
Ise=Vs/Rs;//ampere             //equivalent current source

// In accordance to figure 1.23a
Il1=Ise*(Rs/(Rs+Rl));//using current divider concept
Vl1=Il1*Rl;
printf("\nIn accordance to figure 1.23a \n");
printf("The Load current (current source) Il= %dA\n",Il1);
printf("The Load voltage (current source) Vl= %dV\n\n",Vl1);

// In accordance to figure 1.23b
Vl2=Vs*(Rs/(Rs+Rl));//using voltage divider concept
Il2=Vl2/Rl;
printf("\nIn accordance to figure 1.23b \n");
printf("The Load voltage (voltage source) Vl= %dV\n",Vl2);
printf("The Load current (voltage source) Il= %dA\n\n",Il2);
printf("Therefore they both provide same voltage and current to load");
```

Scilab code Exa 1.4 Find percentage variation in load current and load voltage

```

//Find percentage variation in load current and load voltage
```

```
clear;
clc;
//soltion
//given
Vs=10;//volt//Supply voltage
Rs=100;//ohm//internal resistance

// In accordance to figure 1.24a
//For 1  - 10
Rl11=1;//ohm//min extreme value of Rl
Rl12=10;//ohm//max extreme value of Rl
Il11=Vs/(Rs+Rl11);
Il12=Vs/(Rs+Rl12);
Pi1=(Il11-Il12)*100/Il11;//Percentage variation in current
Vl11=Il11*Rl11;
Vl12=Il12*Rl12;
Pv1=(Vl12-Vl11)*100/Vl12;//Percentage variation in voltage
printf("\nIn accordance to figure 1.24a \n");
printf("Percentage variation in Current(1-10  ) %.2f percent\n",Pi1);
printf("Percentage variation in Voltage(1-10  ) %.1f percent\n\n",Pv1);

// In accordance to figure 1.24b
//For 1 k  - 10 k
Rl21=1000;//ohm//min extreme value of Rl
Rl22=10000;//ohm//max extreme value of Rl
Il21=Vs/(Rs+Rl21);
Il22=Vs/(Rs+Rl22);
Pi2=(Il21-Il22)*100/Il21;//Percentage variation in current
Vl21=Il21*Rl21;
Vl22=Il22*Rl22;
Pv2=(Vl22-Vl21)*100/Vl22;//Percentage variation in voltage
printf("\nIn accordance to figure 1.24b \n");
```

```
printf("Percentage variation in Current(1-10 ) %d percent \n",Pi2);
printf("Percentage variation in Voltage(1-10 ) %.1f percent \n\n",Pv2);
// In book the percentage variation in voltage(1k-10k ) is 9 percent due to
// the incorrect value of Il22 i.e. 0.000999 Amp correct value is 0.0009901 Amp
```

Chapter 2

Semiconductor Physics

Scilab code Exa 2.1 Calculate the conductivity and resistivity of germanium

```
//Calculate the conductivity and resistivity of
   germanium
clear;
clc;
//soltion
//given
q=1.6*10^-19;//Coulomb          //charge of an
   electron
ni=2.5*10^19;//per m^3          //concentration
un=0.36;//m^2/Vs                //mobility of electron
up=0.17;//m^2/Vs               //mobility of holes
con=q*ni*(un+up);             //conductivity
res=(1/con);                  //resistivity
printf("The conductivty is %.2f S/m \n",con);
printf("The resistivity is %.2f  m",res);
```

Scilab code Exa 2.2 Determine the conductivity of extrinsic semiconductor

```
//Determine the conductivity of extrinsic semiconductor
clear;
clc;
//soltion
//given
e=1.6*10^-19;//Coulomb          //charge of an electron
ni=1.5*10^16;//per m^3          //concentration
un=0.13;//m^2/Vs                //mobility of electron
up=0.05;//m^2/Vs               //mobility of holes
Si=5*10^28;//per m^3           //atomic density in silicon
dop=(1/(2*10^8));              //concentration of an antimony per silicon atoms
Nd=dop*Si;//per m^3           //donor concentraion
n=Nd;//per m^3                //free electron concentration
p=(ni^2/Nd);//per m ^3    // hole concentration
con=e*(n*un+p*up);
printf("The conductivty is %.1f S/m \n",con);
```

Chapter 3

Semiconductor Diode

Scilab code Exa 3.1 find the value of threshold voltage

```
//find the value of threshold voltage
clear;
clc;
//soltion
//given
t1=25;// C //initial temperature
t2=100;// C //final temperature
V=2*10^-3;//V per celsius degree//decrease in barrier potential per degree
V0=0.7//V//Potential at normal temperature
Vd=(t2-t1)*V;//decrease in barrier potential
Vt=V0-Vd;//threshold volatge at 100 C
printf("Threshold volatge at 100 C = %.2f V",Vt);
```

Scilab code Exa 3.2 detrenmine dc resistance of silicon diode

```
//detrenmine dc resistance of silicon diode
clear;
```

```
clc;
//soltion
//given

//At Id = 2 mA
Id=2*10^-3;//Ampere//diode current
Vd=0.5;//V//voltage(from given curve)
Rf=(Vd/Id);
printf("The dc resistance is %d  \n",Rf);

//At Id = 20 mA
Id=20*10^-3;//Ampere//diode current
Vd=0.75;//V//voltage(from given curve)
Rf=(Vd/Id);
printf("The dc resistance is %.1f  \n",Rf);

//At Vd = - 10 V
Id=-2*10^-6;//Ampere//diode current(from given curve
    )
Vd=-10;//V//voltage
Rf=(Vd/Id);
printf("The dc resistance is %d M \n",Rf/10^6);
```

Scilab code Exa 3.3 determine dc and ac resistance of silicon diode

```
//determine dc & ac resistance of silicon diode
clear;
clc;
//soltion
//given
Id=20*10^-3;//A//diode current
Vd=0.75;//V// as given in the V-I graph
Rf=Vd/Id;
printf("The dc resistance of diode is %.1f  \n",Rf)
    ;
```

```
//From Graph the values of dynamic voltage and current are
//which is equal to MN and NL repectively (in graph)
del_Vd=(0.8-0.68);//V
del_Id=(40-0)*10^-3;//A
rf=del_Vd/del_Id;
printf("The ac resistance of the diode is %d   ",rf)
```

Scilab code Exa 3.4 determine ac resistance of silicon diode

```
//determine ac resistance of silicon diode
clear;
clc;
//soltion
//given

//At Id =10mA
Id=10;//mA
rf=25/Id;
printf("The ac resistance of the diode is(At Id= 10 mA) %.1f   \n",rf)

//At Id =20mA
Id=20;//mA
rf=25/Id;
printf("The ac resistance of the diode is(At Id= 20 mA) %.2f   ",rf)
```

Scilab code Exa 3.5 Find current through diode

```
//Find current through diode
clear;
```

```
clc;
//soltion
//given
Vt=0.3;//V//Threshold voltage
rf=25;//ohm// average resistance

//assuming it to be ideal
//from fig 3.19
Vaa=10;//V//supply
R1=45;//ohm
R2=5;//ohm
Vab=Vaa*R2/(R1+R2);
//Vab>Vt therefore diode is forward bias and no
    current flow through R2
Idi=Vaa/R1;        //for ideal
printf("The diode current (for ideal) is %.0f mA\n",
    Idi*1000);

//assuming it to be real
//Thevenin's equivalent circuit parameters of fig
    3.19
Vth=Vaa*R2/(R1+R2);
Rth=R1*R2/(R1+R2);
Idr=(Vth-Vt)/(Rth+rf);          //for real
printf("The diode current (for real) is %.1f mA",Idr
    *1000);
```

Scilab code Exa 3.6 Find current through resistance in given figure

```
//Find current through resistance in given figure
clear;
clc;
//soltion

//From fig
```

```
Vaa=20;//V//supply
Vt=0.7;//V//threshold voltage of diode
rf=5;//ohm //forward resistance
R=90;//ohm//given resistor

//Diode D1 and D4 are forward bias and D2 and D3 are
    reverse biased

Vnet=Vaa-Vt-Vt;
Rt=R+rf+rf;
I=Vnet/Rt;
printf("Current through 90 ohm resistor is %.0f mA",
   I*1000);
```

Scilab code Exa 3.7 Find current drawn by the battery

```
//Find current drawn by the battery
clear;
clc;
//soltion

//From fig
Vaa=10;//V//supply
R1=100;//ohm
R2=100;//ohm

//Forward Bias
Id=Vaa/R1;
printf("Current drawn from battery (forward bias) %
   .1f A\n",Id);

//Reverse Bias
Rnet=R1+R2;
Id=Vaa/Rnet;
printf("Current drawn from battery (reverse bias) %
```

```
.2f A",Id);
```

Scilab code Exa 3.8 determine dc current through load and rectification efficiency and peak inverse voltage

```
//determine dc current through load and rectification efficiency and peak inverse voltage
clear;
clc;
//soltion
//given
TR=31/2;//Turn ratio of the transformer
rf=20;// //Dynamic forward resistance
Rl=1000;// //Load resistance
Vt=0.66;//V//Threshold voltage of diode
V=220;//V//input voltage of transformer
Vp=sqrt(2)*220//V//peak value of primary voltage
Vm=(1/TR)*Vp;
Im=(Vm-Vt)/(rf+Rl);
Idc=Im/%pi;
n=40.6/(1+rf/Rl);
printf("The dc current through load is %d mA\n",Idc*1000);
printf("The rectification efficiency is %.1f percent\n",n);
printf("Peak inverse voltage =Vm = %.2f V\n",Vm)
```

Scilab code Exa 3.9 determine dc voltage across load and peak inverse voltage across each diode

```
//determine dc voltage across load and peak inverse voltage across each diode
clear;
```

```
clc;
//soltion
//given
TR=12/1;//Turn ratio of the transformer
V=220;//V//input voltage of transformer
Vp=sqrt(2)*220//V//peak value of primary voltage
Vm=(1/TR)*Vp;
Vdc=(2*Vm)/%pi;
printf("The dc voltage across load %.1f V\n",Vdc);
printf("Peak inverse voltage (for bridge rectifier) = %.1f V\n",Vm);
printf("Peak inverse voltage (for centre tap rectifier) = %.2f V\n",2*Vm);
```

Scilab code Exa 3.10 find dc power supplied to load and efficiency and PIV rating of the diode

```
//find dc power supplied to load and efficiency and PIV rating of the diode
clear;
clc;
//soltion
//given
rf=2;//  //Dynamic forward resistance
Rs=5;//  //resistaqnce of secondary
Rl=25;//  //Load resistance
Idc=0.1;//A//dc current to a load
Pdc=Idc^2*Rl;       //dc power
n=(81.2*Rl)/(Rl+rf+Rs);         //efficiency
Im=(%pi*Idc)/2;                 //peak value current
Vm=Im*(Rl+rf+Rs);                 //peak voltage
Vlm=Vm-Im*(rf+Rs);                 //peak voltage across load
PIV=Vm+Vlm;
printf("The dc power supplied to the load is %.2f W\
```

```
   n",Pdc);
printf("Efficiency = %.2f percent\n",n);
printf("The peak inverse voltage is %.2f V",PIV);
```

Scilab code Exa 3.11 Calculate output voltage and current through load and voltage across series resistor and current and power dissipated in zener diode

```
//Calculate output voltage and current through load
   and voltage across series resistor and current
   and power dissipated in zener diode
clear;
clc;
//soltion
//given
Vi=110;//V          //input voltage
Rl=6*10^3;// ohm     //load resistance
Rs=2*10^3;//ohm        //series resistance
Vz=60;//V           //Zener voltage
V=Vi*Rl/(Rs+Rl);

//This V>Vz therefore Zener diode is ON

Vo=Vz;              //output voltage
Il=Vo/Rl;           //Current through load resistance
Vs=Vi-Vo;           //Voltage drop across the series
   resistor
Is=Vs/Rs             //current through the series
   resistor
Iz=Is-Il            ///By applying kirchhoff's law
Pz=Vz*Iz            //Power dissipated accross zener
   diode

printf("The output voltage is %.0f V\n",Vo);
printf("The current through load resistance is %.0f
```

```
mA\n",Il*1000);
printf("Voltage across series resistor is %.0f V\n",Vs)
printf("Current in zener diode is %.0f mA\n",Iz*1000)
printf("Power dissipated by zener diode %.0f mW",Pz*1000);
```

Scilab code Exa 3.12 Calculate max and min values of zener diode current

```

//Calculate max and min values of zener diode current
clear;
clc;
//soltion
//given
Vimin=80;//V        //minimum input voltage
Vimax=120;//V        //maximum input voltage
Rl=10*10^3;// ohm     //load resistance
Rs=5*10^3;//ohm        //series resistance
Vz=50;//V          //Zener voltage
V=Vimin*Rl/(Rs+Rl);

//This V>Vz therefore Zener diode is ON

//For minimum value of zener diode

Vo=Vz;            //output voltage
Vs=Vimin-Vo;        //Voltage drop across the series resistor
Is=Vs/Rs          //current through the series resistor
Il=Vo/Rl;         //Current through load resistance
Izmin=Is-Il;
```

```
printf("\nMinimum values of zener diode current is %
    .0f mA\n",Izmin*1000);

//For maximum value of zener diode

Vo=Vz;             //output voltage
Vs=Vimax-Vo;          //Voltage drop across the series
    resistor
Is=Vs/Rs            //current through the series
    resistor
Il=Vo/Rl;          //Current through load resistance
Izmax=Is-Il;
printf("Maximum values of zener diode current is %.0
    f mA",Izmax*1000);
```

Scilab code Exa 3.13 determine value of the series resistor and wattage rating

```
//determine value of the series resistor and wattage
     rating
clear;
clc;
//soltion
//given
Vi=12;//V          //input voltage
Vz=7.2;//V           //Zener voltage
Izmin=10*10^-3;//A                  //min current through
     zener diode
Ilmax=100*10^-3;//A                 //max current through
     load
Ilmin=12*10^-3;//A                 //min current through
    load

Vs=Vi-Vz;          //Voltage drop across the series
    resistor
```

```
Is=Izmin+Ilmax;       //Current through the series
    resistor
Rs=Vs/Is;
printf("The series resistor so that 10mA current
    flow through zener diode is %.1f   \n",Rs);

Izmax=Is-Ilmin;        //max zener through zener diode
Pmax=Izmax*Vz;
printf("The maximum wattage rating is %.1f mW",Pmax
    *1000);
```

Scilab code Exa 3.14 Find the capacitance of a varactor diode

```
//Find the capacitance of a varactor diode
clear;
clc;
//soltion
//given
C=5;//pf//capcitance of varactor diode at V=4V
V=4;//V
K=C*sqrt(4);

//When bias voltage is increased upto 6 V
Vn=6;//V//new bias voltage
Cn=K/(sqrt(Vn));
printf("Capacitance (At 6 V ) = %.3f pf",Cn);
```

Chapter 4

Bipolar Junction Transistors

Scilab code Exa 4.1 determine the collector and base current

```
//determine the collector and base current
clear;
clc;
//soltion
//given
a=0.98;//dc alpha
Ie=5*10^-3;//A//emitter current
Ico=2*10^-6;//A//collector reverse leakage current
Ic=a*Ie+Ico;
Ib=Ie-Ic;
printf("The collector current is %.3f mA\n",Ic*1000)
    ;
printf("The base current is %.0f uA",Ib*10^6);
```

Scilab code Exa 4.2 determine the base and collector current and exact and approax dc alpha

```
//determine the base and collector current and exact
    and approax dc alpha
```

```
clear;
clc;
//soltion
//given
Ie=8.4*10^-3//A//emitter current
Icbo=0.1*10^-6;//A//reverse leakage current
Ib=0.008*Ie;//A//base current
Ic=Ie-Ib;
Icinj=Ic-Icbo;
a0=Icinj/Ie;
a=Ic/Ie;
printf("Base current is %.1f uA\n",Ib*10^6);
printf("Collector current %.4f mA\n",Ic*1000);
printf("Exact value of alphha = %.7f\n",a0);
printf("Approax value of alpha = %.3f",a);
```

Scilab code Exa 4.3 Determine the base current

```
//Determine the base current
clear;
clc;
//soltion
//given
a=0.96;              //dc alpha
Rc=2*10^3;//ohm       //resistor across collector
Vc=4;//V              //Voltage drop across the
   collector resistor
Ic=Vc/Rc;           //Colletor current
Ie=Ic/a;            //Emmiter current
Ib=Ie-Ic;           //Base current
printf("The base current is %.0f uA",Ib*10^6)
```

Scilab code Exa 4.4 determine dynamic input resistance

```
//determine dynamic input resistance
clear;
clc;
//soltion
//given
Ie=2;//mA
Vcb=10;//V

//Taking points around Ie & Vcb from graph
del_Ie=(2.5-1.5)*10^-3;//A

//corresponding change in Veb
del_Veb=(0.9-0.8);//V
rib=del_Veb/del_Ie;
printf("The dynamic input resistance of transistor is %.0f   ",rib);
```

Scilab code Exa 4.5 find dc current gain in common emitter configuration

```
//find dc current gain in common emitter configuration
clear;
clc;
//soltion
//given
a=0.98;//dc current gain in common base configuration
B=a/(1-a);
printf("The dc current gain in common emitter configuration is %.0f",B);
```

Scilab code Exa 4.6 calculate ac alpha and beta

```
//calculate ac alpha and beta
clear;
clc;
//soltion
//given
ic=0.995//mA//Emitter current change
ie=1//mA//collector current change
a=ic/ie;
B=a/(1-a);
printf("The ac alpha is %.3f\n",a)
printf("The common emitter ac current gain is %.0f",
    B);
```

Scilab code Exa 4.7 Calculate beta and Iceo and exact and approax collector current

```
//Calculate beta and Iceo and exact and approax
    collector current
clear;
clc;
//soltion
//given
a0=0.992;//dc current gain in common base
    configuration
Icbo=48*10^-9;//A
Ib=30*10^-6;//A//base current
B=a0/(1-a0);
Iceo=Icbo/(1-a0);
printf("Beta= %.0f\n",B);
printf("Iceo= %0.f uA\n",Iceo*10^6);
Ic=B*Ib+Iceo;
Ica=B*Ib;//approax
printf("Exact collector current %.3f mA\n",Ic*1000);
printf("Approax collector current %.2f mA",Ica*1000)
    ;
```

Scilab code Exa 4.8 determine dynamic input resistance

```
//determine dynamic input resistance
clear;
clc;
//soltion
//given
Vbe=0.75;//V
Vce=2;//V

//Taking points around Vbe=0.75V from graph
del_Vbe=(0.98-0.9);//V

//corresponding change in ib
del_ib=(68-48)*10^-6;//A

rie=del_Vbe/del_ib;
printf("The dynamic input resistance of transistor
    is %.0f k ",rie/1000);
```

Scilab code Exa 4.9 determine dynamic input resistance and dc and ac current gain

```
//determine dynamic input resistance and dc and ac
    current gain
clear;
clc;
//soltion
//given
Ib=30*10^-6;//A
Vce=10;//V
```

```
Ic=3.6*10^-3;//A          //from graph

//Taking points around Vce = 10V from graph
del_Vce=(12.5-7.5);//V

//corresponding change in ic
del_ic=(3.7-3.5)*10^-3;//A

roe=del_Vce/del_ic;
printf("The dynamic output resistance of transistor is %.0f k \n",roe/1000);

//dc current gain
Bo=Ic/Ib;
printf("The dc current gain is %.0f\n",Bo);

//ac current gain

del_ic=(4.7-2.5)*10^-3;     //the collector current change is from 3.5mA to 4.7mA as we can see from graph when we change ib from 40mA to 20mA
del_ib=(40-20)*10^-6;
B=del_ic/del_ib;
printf("The ac current gain is %.0f\n",B);
```

Scilab code Exa 4.10 calculate ac current gain in CE and CC configuration

```
//calculate ac current gain in CE and CC configuration
clear;
clc;
//soltion
//given
a=0.99;
```

```
B=a/(1-a);
printf("The ac current gain in CE configuration is %
    .0f\n",B);
y=1+B;
printf("The ac current gain in CC configuration is %
    .0f",y);
```

Chapter 5

Field Effect Transistors

Scilab code Exa 5.1 Calculate saturation voltage and saturation current

```
//Calculate saturation voltage and saturation
   current
clear;
clc;
//soltion
//given
Vp=-4//V           //pinch off voltage
Idss=12*10^-3;//A      //drain to source current
   with gate shorted
Vgs=-2;//V            //gate to source voltage
Vds=Vgs-Vp;
Id=Idss*(Vds/Vp)^2;
printf("Saturation Voltage is %.0f V\n",Vds);
printf("Saturation current is %.0f mA",Id*10^3);
```

Scilab code Exa 5.2 Find the value of drain current

```
//Find the value of drain current
```

```
clear;
clc;
//soltion
//given
Vgso=-5;//V             //gate to source cut off
   voltage
Idss=20*10^-3;//A       //drain to source current with
    gate shorted

//At vgs = -2 V
vgs=-2;//V          input voltage
id=Idss*(1-(vgs/Vgso))^2;             //Schockley's
   equation
printf("Drain current is (At vgs = -2 V) %.1f mA\n",
   id*10^3);

//At vgs = -4 V
vgs=-4;//V          input voltage
id=Idss*(1-(vgs/Vgso))^2;             //Schockley's
   equation
printf("Drain current is (At vgs = -4 V) %.1f mA\n",
   id*10^3);

//At vgs = -8 V
printf("Drain current is 0 A (At vgs = -8 V) because
    gate is biased beyond cut off ");
```

Scilab code Exa 5.3 Calculate Vgs and Vds saturation

```
//Calculate Vgs and Vds saturation
clear;
clc;
//soltion
//given
Vp=5//V              //pinch off voltage
```

```
Idss=-15*10^-3;//A        //drain to source current
   with gate shorted
Id=-3*10^-3;//A           //saturation current
Vgs=Vp*(1-sqrt(Id/Idss));
Vds=Vgs-Vp;
printf("The gate to source voltage (Vgs) is %.3f V\n
   ",Vgs);
printf("The saturation voltage is Vds(sat)= %.3f V",
   Vds);

// THe value of Vgs = 2.115V and Vds= −2.885V in
   book because of the calculation error
```

Scilab code Exa 5.4 Calculate drain current Id for N channel

```
//Calculate drain current Id for N channel
clear;
clc;
//soltion
//given
Vp=5//V              //pinch off voltage
Idss=18*10^-3;//A       //drain to source current with
    gate shorted

//For Vgs= − 3 V
Vgs=-3;//V
Id=Idss*(1-(Vgs/(-Vp)))^2;
printf("The drain current Id(For Vgs= −3V) = %.2f mA
   \n",Id*10^3);

//For Vgs= 2.5 V
Vgs=2.5;//V
Id=Idss*(1-(Vgs/(-Vp)))^2;
printf("The drain current Id(For Vgs= 2.5V) = %.1f
   mA",Id*10^3);
```

Scilab code Exa 5.5 Calculate drain current Id for P channel

```
//Calculate drain current Id for P channel
clear;
clc;
//soltion
//given
Vp=-5//V            //pinch off voltage
Idss=18*10^-3;//A      //drain to source current with
    gate shorted

//For Vgs= -3V
Vgs=-3;//V
Id=Idss*(1-(Vgs/(-Vp)))^2;
printf("The drain current Id (For Vgs= -3V) = %.2f
   mA\n",Id*10^3);

//For Vgs= 2.5V
Vgs=2.5;//V
Id=Idss*(1-(Vgs/(-Vp)))^2;
printf("The drain current Id (For Vgs= 2.5V) = %.1f
   mA",Id*10^3);
```

Scilab code Exa 5.6 Find the value of drain current

```
//Find the value of drain current
clear;
clc;
//soltion
//given
Vt=2;//V        //threshold voltage
```

```
K=0.25*10^-3;// A/V^2       //conductivity parameter
Vgs=3;//V     //gate supply
Vds=2;//V       //saturation voltage
Vdsm=Vgs-Vt;          //minimum voltage required to
    pinch off

// Vds > Vdsm therefore the device is in saturation
    region

Id=K*(Vgs-Vt)^2;
printf("The drain current is %.2f mA",Id*1000);
```

Scilab code Exa 5.7 Find the value of Id

```
//Find the value of Id
clear;
clc;
//soltion
//given
Vt=1.5;//V       //threshold voltage
Id=2*10^-3;//A
Vgs=3;//V     //gate supply
Vds=5;//V       //saturation voltage
Vdsm=Vgs-Vt;          //minimum voltage required to
    pinch off

// Vds > Vdsm therefore the device is in saturation
    region

// Calculating K
K=Id/((Vgs-Vt)^2);         // A/V^2        //
    conductivity parameter

//Calculating Id for Vgs= 5 V and Vds= 6 V
Vgs=5;//V     //gate supply
```

```
Vds=6; //V        //saturation voltage
Id=K*((Vgs-Vt)^2);
printf("The drain current is %.2f mA",Id*1000);
```

Scilab code Exa 5.8 Calculate the dynamic drain resistance

```
//Calculate the dynamic drain resistance
clear;
clc;
//soltion
//given
gm=200*10^-6; //S           trans conductance
u=80; //          amplification factor
rd=u/gm;
printf("The dynamic drain resistance is %.0f k ",rd
   /1000);
```

Chapter 6

Transistor Biasing and Stabilization

Scilab code Exa 6.1 Determine the Q point

```
//Determine the Q point
clear;
clc;
//soltion
//given
B=50;              //dc beta
Rc=2.2*10^3;//ohm       //resistor connected to collector
Rb=270*10^3;//ohm       //resistor connected to base
Vcc=9;//V              //Voltage supply across the collector resistor
Vbe=0.7;//V            //base to emitter voltage
Ib=(Vcc-Vbe)/Rb;           //Base current
Ic=B*Ib;           //Colletor current
Ics=Vcc/Rc;        //Colletor saturation current

//Actual Ic is the smaller of the above two values

Vce=Vcc-Ic*Rc;
```

```
printf("The Q point is (%.2f V, %.1f mA)",Vce,Ic
    *1000);
//In book Vce = 5.7 V because of approaximation
```

Scilab code Exa 6.2 Determine the Q point

```
//Determine the Q point
clear;
clc;
//soltion
//given
B=150;                  //dc beta
Rc=1*10^3;//ohm         //resistor connected to
    collector
Rb=100*10^3;//ohm        //resistor connected to base
Vcc=10;//V               //Voltage supply across the
    collector resistor
Vbe=0.7;//V             //base to emitter voltage
Ib=(Vcc-Vbe)/Rb;             //Base current
Ic=B*Ib;               //Colletor current
Ics=Vcc/Rc;             //Colletor saturation current

//Actual Ic is the smaller of the above two values i
    .e. Ic(sat) and since the transistor is in
    saturation mode therefore Vce will become 0

Vce=0;
printf("The Q point is (%d V, %.0f mA)",Vce,Ics
    *1000);
```

Scilab code Exa 6.3 Determine Rb and percentage change in collector current due to temperature rise

```
//Determine Rb and percentage change in collector current due to temperature rise
clear;
clc;
//soltion
//given

//Calculating the base resistance
B=20;              //dc beta
Rc=1*10^3;//ohm       //resistor connected to collector
Ic=1*10^-3;//A        //collector current
Vcc=6;//V             //Voltage supply across the collector resistor
Vbe=0.3;//V        //for germanium
Icbo=2*10^-6;//A        //collector  to base leakage current

Ib=(Ic-(1+B)*Icbo)/B;
Rb=(Vcc-Vbe)/Ib;

printf("The value of resistor Ib is %.4f k  = 120 k  \n",Rb/1000);

Rb=120*10^3;//ohm         approax

//Now when temperature rise
Icbo=10*10^-6;//A        //collector  to base leakage current
B=25;              //dc beta
Ic1=B*Ib+(B+1)*Icbo;          //changed collector current
perc=(Ic1-Ic)*100/Ic;         //percentage increase
printf("The percentage change in collector current is %.0f percent",perc);
```

Scilab code Exa 6.4 Determine the Q point at two different B

```
//Determine the Q point at two different B
clear;
clc;
//soltion
//given

//At B=50

B=50;               //dc beta
Rc=2*10^3;//ohm       //resistor connected to collector
Rb=300*10^3;//ohm       //resistor connected to base
Vcc=9;//V               //Voltage supply across the collector resistor
Ib=Vcc/Rb;            //Base current
Ic=B*Ib;            //Colletor current
Ics=Vcc/Rc;          //Colletor saturation current

//Actual Ic is the smaller of the above two values

Vce=Vcc-Ic*Rc;
printf("The Q point (At B=50) is (%.0f V, %.1f mA)\n",Vce,Ic*1000);

//At B=150

B1=150;               //dc beta
Ic1=B*Ib;            //Colletor current
Ics1=Vcc/Rc;          //Colletor saturation current

//Actual Ic is the smaller of the above two values i.e. Ic(sat) and since the transistor is in
```

```
    saturation mode therefore Vce will become 0

Vce=0;
printf("The Q point (At B=150) is (%d V, %.1f mA)\n"
    ,Vce,Ics*1000);

printf("The factor at which collector current
    increases %.0f",Ics1/Ic);
```

Scilab code Exa 6.5 determine Q point in collector to base bias circuit

```
//determine Q point in collector to base bias
    circuit
clear;
clc;
//soltion
//given
B=100;                    //dc beta
Rc=500;//ohm              //resistor connected to collector
Rb=500*10^3;//ohm              //resistor connected to base
Vcc=10;//V                   //Voltage supply across the
    collector resistor
Ib=Vcc/(Rb+B*Rc);                //Base current
Ic=B*Ib;                //Colletor current
Ics=Vcc/Rc;               //Colletor saturation current

//Actual Ic is the smaller of the above two values

Vce=Vcc-(Ic+Ib)*Rc;
printf("The Q point is (%.1f V, %.1f mA)",Vce,Ic
    *1000);
```

Scilab code Exa 6.6 Calculate the collector current and change in it if B is changed by three times of previous B

```
//Calculate the collector current and change in it
   if B is changed by three times of previous B
clear;
clc;
//soltion
//given
B=50;                //dc beta
Rc=2*10^3;//ohm        //resistor connected to
   collector
Rb=300*10^3;//ohm        //resistor connected to base
Vcc=9;//V                //Voltage supply across the
   collector as it is PNP so taking positive
Ib=Vcc/(Rb+B*Rc);            //Base current
Ic=B*Ib;             //Colletor current
printf("Collector current (B=50)= %.3f mA\n",Ic
   *1000);
//Now B=150
B=3*B;        //three times of previous B
Ib1=Vcc/(Rb+B*Rc);            //Base current
Ic1=B*Ib1;            //Colletor current
printf("Collector current (B=150)= %.2f mA\n",Ic1
   *1000);
printf("The factor at which collector current
   increases %.0f",Ic1/Ic);
```

Scilab code Exa 6.7 Calculate the value of all three current Ie and Ic and Ib

```
//Calculate the value of all three current Ie and Ic
    and Ib
clear;
clc;
```

```
//soltion
//given
B=90;                //dc beta
Rc=1*10^3;//ohm      //resistor connected to
    collector
Rb=500*10^3;//ohm       //resistor connected to base
Re=500;//ohm       //resistor connected to emitter
Vcc=9;//V              //Voltage supply across the
    collector resistor
Ib=Vcc/(Rb+B*Re);          //Base current
Ic=B*Ib;           //Colletor current
Ie=Ic+Ib;          //Emitter current
printf("Base current = %.1f uA \nCollector current =
    %.3f mA \nEmitter current = %.4f mA",Ib*10^6,Ic
   *10^3,Ie*10^3);
```

Scilab code Exa 6.8 Calculate max and min value of emitter current

```
//Calculate max and min value of emitter current
clear;
clc;
//soltion
//given

//At B=50

B=50;                //dc beta
Rc=75;//ohm       //resistor connected to collector
Re=100;//ohm       //resistor connected to emitter
Rb=10*10^3;//ohm       //resistor connected to base
Vcc=6;//V              //Voltage supply across the
    collector resistor
Vbe=0.3;//V        //for germanium
Ib=(Vcc-Vbe)/(Rb+(1+B)*Re);          //Base current
Ie=(1+B)*Ib;
```

```
Vce=Vcc-(Rc+Re)*Ie
printf("Minimum emitter current %.2f mA\n",Ie*10^3);
printf("The collector to emitter volatge is %.2f V\n",Vce);

//At B=300

B1=300;              //dc beta
Ib1=(Vcc-Vbe)/(Rb+(1+B1)*Re);          //Base current
Ie1=(1+B1)*Ib1;
Vce1=Vcc-(Rc+Re)*Ie1
//Here Vce1= -1.4874 V but can never have negative voltage because Ie1 is wrong as it can't be more than saturation value therefore
Ie1=Vcc/(Rc+Re);

//And Vce=0 V

Vce1=0;//V
printf("Maximum emitter current %.2f mA\n",Ie1*10^3);
printf("The collector to emitter volatge(saturation) is %.0f V\n",Vce1);
```

Scilab code Exa 6.9 Determine the value of base resistance

```
//Determine the value of base resistance
clear;
clc;
//soltion
//given

B=100;              //dc beta
Rc=200;//ohm        //resistor connected to collector
Re=500;//ohm        //resistor connected to emitter
```

```
Vcc=9;//V          //Voltage supply across the
    collector as it is PNP so taking positive
Vce=4.5;//V        //Collector to emitter voltage
Ic=(Vcc-Vce)/(Rc+Re);
Ib=Ic/B;
Rb=(Vcc-B*Re*Ib)/Ib;
printf("The value of base resistance is %.0f k ",Rb
    /1000);
```

Scilab code Exa 6.10 Determine the collector current at two different B

```
//Determine the collector current at two different B
clear;
clc;
//soltion
//given

//At B=50

B=50;               //dc beta
Rc=2;//ohm        //resistor connected to collector
Re=1000;//ohm       //resistor connected to emitter
Rb=300*10^3;//ohm       //resistor connected to base
Vcc=9;//V               //Voltage supply across the
    collector resistor
Ib=Vcc/(Rb+B*Re);           //Base current
Ic=B*Ib;            //Colletor current
printf("the collector current at (B=50)= %.3f mA\n",
    Ic*1000);

//At B=150

B1=150;              //dc beta
Ib1=Vcc/(Rb+B1*Re);          //Base current
Ic1=B1*Ib1;           //Colletor current
```

```
printf("the collector current at (B=150)= %.0f mA\n",Ic1*1000);
printf("The factor at which collector current increases %.2f",Ic1/Ic);

//IN BOOK Ic(AT B=50)= 1.25 mA and Ic1/Ic=2.4 DUE TO APPROAXIMATION
```

Scilab code Exa 6.11 Calculate Q point in voltage divider

```
//Calculate Q point in voltage divider
clear;
clc;
//soltion
//given
B=100;                  //dc beta
Rc=2*10^3;//ohm         //resistor connected to collector
R1=10*10^3;//ohm        //voltage divider resistor 1
R2=1*10^3;//ohm         //voltage divider resistor 2
Re=200;//ohm            //resistor connected to emitter
Vcc=10;//V              //Voltage supply across the collector resistor
Vbe=0.3;//V             //base to emitter voltage

I=Vcc/(R1+R2);          //current through voltage divider
Vb=I*R2;                //voltage at base
Ve=Vb-Vbe;
Ie=Ve/Re;
Ic=Ie           //approaximating Ib is nearly equal to 0
Vc=Vcc-Ic*Rc;
Vce=ceil(Vc)-Ve;
printf("The Q point is (%.1f V, %.0f mA)",Vce,Ic
```

```
    *1000);

Ibc=I/20;      //critical value of base current
Ib=Ic/B;       //actual base current

//Since Ib < Ibc, hence assumption is alright
```

Scilab code Exa 6.12 Solve the voltage divider accurately by applying thevenins theorem

```

//Solve the voltage divider accurately by applying
    thevenin's theorem
clear;
clc;
//soltion
//given
B=100;                //dc beta
Rc=2*10^3;//ohm       //resistor connected to
    collector
R1=10*10^3;//ohm       //voltage divider resistor 1
R2=1*10^3;//ohm       //voltage divider resistor 2
Re=200;//ohm       //resistor connected to emitter
Vcc=10;//V             //Voltage supply across the
    collector resistor
Vbe=0.3;//V           //base to emitter voltage

Vth=Vcc*R2/(R1+R2);
Rth=R1*R2/(R1+R2);

printf("\nThevenin equivalent voltage Vth = %.5f V",
    Vth);
printf("\nThevenin equivalent resistance Rth = %.2f
    ohm",Rth);

```

```
Ib=(Vth-Vbe)/(Rth+(1+B)*Re);
Ic=B*Ib;
Ie=Ic+Ib;
Vce=Vcc-Ic*Rc-Ie*Re;
printf("\nThe accurate value of Ic = %.5f mA",Ic*10^3);
printf("\nThe accurate value of Vce = %.6f V",Vce);
Icp=3*10^-3; // Current calculated by voltage divider in previous example
Vcep=3.4; // Voltage calculated by voltage divider in previous example
Err_Ic=(Ic-Icp)*100/Ic;
Err_Vce=(Vce-Vcep)*100/Vce;
printf("\nError in Ic= %.1f percent\n",Err_Ic);
printf("Error in Vce= %.0f percent",Err_Vce);

// The errors and The accurate values are different
// because of the approaximation in Vth and Rth in book

// In Book Ic = 2.8436 mA and Vce = 3.73839 V
// Error in Ic = -5.5%
// Error in Vce = +9%
```

Scilab code Exa 6.13 determine the Q point for the emitter bias circuit

```
//determine the Q point for the emitter bias circuit
clear;
clc;
//soltion
//given
B=100;                  //dc beta
Rc=5*10^3;//ohm         //resistor connected to collector
Rb=10*10^3;//ohm         //resistor connected to base
```

```
Re=10*10^3;//ohm        //resistor connected to emitter
Vcc=12;//V              //Voltage supply across the collector resistor
Vee=15;//V            //supply at emitter
Ie=Vee/Re;
Ic=Ie;
Vce=Vcc-Ic*Rc;
printf("The Q point is (%.1f V, %.1f mA)",Vce,Ic*1000);
```

Scilab code Exa 6.14 Calculate Vgs and Rs

```
//Calculate Vgs and Rs
clear;
clc;
//soltion
//given

Vp=2;//V
Idss=1.75*10^-3;//A        //drain current at Vgs=0
Vdd=24;//V                 //drain to supply source
Id=1*10^-3;//A         //drain current
Vgs=(-Vp)*(1-sqrt(Id/Idss));
Rs=abs(Vgs)/Id;
printf("Vgs = %.3f V\n",Vgs);
printf("Rs = %.0f   ",Rs);
```

Chapter 7

Small Signal Single Stage Amplifier

Scilab code Exa 7.1 Calculate max current and check will the capacitor act as short for given frequency

```
//Calculate max current and check will the capacitor
    act as short for given frequency
clear;
clc;
//soltion
//given

C=100*10^-6;//Farad
Rs=1*10^3;//ohm
Rl=4*10^3;//ohm
Vs=1;//V
Imax=Vs/(Rs+Rl);
fc=1/(2*%pi*(Rs+Rl)*C)      //critical frequency
fh=10*fc;                   //Border frequency
printf("Maximum current is %.0f uA\n",Imax*10^6);
printf("fh = %.2f Hz\n",fh);
printf("As long as source frequency is greater than
   %.2f Hz, the coupling capacitor acts like an ac
```

```
short for 20Hz to 20kHz.",fh)

//In book Imax is 200mA but there is misprinting of 'm' in mA it should be uA
```

Scilab code Exa 7.2 Check whether the capacitor is an effective bypass for the signal currents of lowest frequency 20 Hz

```
//Check whether the capacitor is an effective bypass for the signal currents of lowest frequency 20 Hz
clear;
clc;
//soltion
//given

C=100*10^-6;//Farad
Rs=1*10^3;//ohm
Rl=4*10^3;//ohm
f=20;//Hz           //lowest frequency
Xc=1/(2*%pi*f*C)          //reactance of capacitor at 20Hz
Rth=Rs*Rl/(Rs+Rl);        //Thevenin's equivalent resistance
printf("Xc < Rth/10 = %.1f    < %.1f     is satisfied \n",Xc,Rth/10);
printf("The capacitor of 100uF will work as a good bypass for frequencies greater than 20 Hz ")
```

Scilab code Exa 7.3 Calculate the value of capacitor required

```
//Calculate the value of capacitor required
clear;
```

```
clc;
//soltion
//given

Rs1=20*10^3;//ohm
Rs2=30*10^3;//ohm
Rl1=40*10^3;//ohm
Rl2=80*10^3;//ohm
Rl3=80*10^3;//ohm
Rth=Rs1*Rs2/(Rs1+Rs2);            //Thevenin's equivalent resistance
Rl_=Rl2*Rl3/(Rl2+Rl3);
Rl=Rl1*Rl_/(Rl1+Rl_);     //Equivalent load
f=50;//Hz             //lowest frequency
R=Rth+Rl;
C=10/(2*%pi*f*R)
printf("The required value of coupling capacitor is %.0f uF",C*10^6);
```

Scilab code Exa 7.4 Calculate voltage and current gain and input and output resistance

```
//Calculate voltage and current gain and input and output resistance
clear;
clc;
//soltion

function [z]=prll(r1,r2)//Function for the parallel combination of resistor
    z=r1*r2/(r1+r2);
endfunction

//given

```

```
//DC analysis
Vcc=12;//V
Rb=200*10^3;//ohm
Rc=1*10^3;//ohm
B=100;// beta
Ib=Vcc/Rb;
Ic=B*Ib;
Icsat=Vcc/Rc;
Vce=Vcc-Ic*Rc;
printf("The Q point of DC analysis= (%.0f V, %.0f mA
    )\n",Vce,Ic*1000);

//AC analysis
Rl=1*10^3;//ohm
hfe=B;
hie=2*10^3;//ohm
hoe_1=40*10^3;//ohm        // 1/hoe
Rac=prll(Rc,Rl);
Av=-hfe*Rac/hie;
printf("The voltage gain = %.0f\n",Av);

//Siince (1/hoe) > Rac therefore entire current will
     flows through Rac
Io=-100*Ib;
Ac=Io/Ib;
printf("The current gain = %.0f\n",Ac);

Ri=prll(Rb,hie);
Ro=prll(Rl,prll(Rc,hoe_1));
printf("The input resistance= %.0f k \n",Ri/1000);
printf("The output resistance= %.1f k ",Ro/1000);

//In book the voltage gain is 25 due to skipping of
    '-' in printing
```

Scilab code Exa 7.5 Solve previous example using hybrid pie model

```
//Solve previous example using hybrid pie model
clear;
clc;
//soltion
function [z]=prll(r1,r2)//Function for the parallel
   combination of resistor
    z=r1*r2/(r1+r2);
endfunction

//given

Vcc=12;//V
Rb=200*10^3;//ohm
Rc=1*10^3;//ohm
Rl=1*10^3;//ohm
B=100;// beta
hie=2*10^3;//ohm
hoe_1=40*10^3;//ohm      // 1/hoe

Ib=Vcc/Rb;
Ic=B*Ib;
Rac=prll(Rc,Rl);
gm=Ic/(25*10^-3);
rpi=B/gm;
ri=hie;
rb=ri-rpi;
ro=hoe_1;
Vi=poly(0,"Vi");      //let the input be Vi
Vpi=Vi*rpi/(rpi+rb);
Vo=-gm*Vpi*Rac;     //output voltage
Av=Vo/Vi;
printf("The voltage gain ");
disp(Av);
//In book voltage gain is -24.96 due to
   appraoximation
```

Scilab code Exa 7.6 Determine the value of output voltage

```
//Determine the value of output voltage
clear;
clc;
//soltion
//given

Vcc=12;//V
Rb=150*10^3;//ohm
Rc=5*10^3;//ohm
B=200;// beta
hie=2*10^3;//ohm
ro=60*10^3;//ohm        // 1/hoe
Vi=1*10^-3;//V
Ib=Vcc/Rb;
Ic=B*Ib;
Icsat=Vcc/Rc;
// Icsat < Ic therefore transistor is in saturation
   mode and outpuut voltage wil be zero
Vo=0;
printf("The output voltage= %.0f V",Vo);
```

Scilab code Exa 7.7 Calculate voltage gain and input resistance

```
//Calculate voltage gain and input resistance
clear;
clc;
//soltion

function [z]=prll(r1,r2)//Function for the parallel
   combination of resistor
```

```
    z=r1*r2/(r1+r2);
endfunction

//given
R1=75*10^3;//ohm
R2=7.5*10^3;//ohm
Rc=4.7*10^3;//ohm
Re=1.2*10^3;//ohm
Rl=12*10^3;//ohm
B=150;
ri=2*10^3;//ohm
Vcc=15;//V
Vb=Vcc*R2/(R1+R2);
Ve=Vb;          //since Vbe=0
Ie=Ve/Re;
Ic=Ie;
Icsat=Vcc/(Rc+Re);
// Ic < Icsat therefore transistor is in active mode
Vce=Vcc-Ic*(Rc+Re);
printf("The Q point of DC analysis= (%.1f V, %.3f mA)\n",Vce,Ic*1000);

Rac=prll(Rc,Rl);
Av=-B*Rac/ri;
printf("The voltage gain = %.1f\n",Av);
Ri_=prll(ri,R2);
printf("The input resistance= %.2f k \n",Ri_/1000);
```

Scilab code Exa 7.8 Calculate the value of gm at different values of Vgs

```

//Calculate the value of gm at different values of Vgs
clear;
clc;
```

```
//soltion
//given

Idss=8*10^-3;//A
Vp=4;//V
//At Vgs= -0.5 V
Vgs= -0.5;//V
gmo=2*Idss/(abs(Vp));
gm=gmo*(1-(Vgs/(-Vp)));
printf("gmo = %.0f mS\n",gmo*1000);
printf("gm (At Vgs = -0.5V) =%.1f mS\n",gm*1000);

//At Vgs= -1.5 V
Vgs= -1.5;//V
gmo=2*Idss/(abs(Vp));
gm=gmo*(1-(Vgs/(-Vp)));
printf("gm (At Vgs = -1.5V) =%.1f mS\n",gm*1000);

//At Vgs= -2.5 V
Vgs= -2.5;//V
gmo=2*Idss/(abs(Vp));
gm=gmo*(1-(Vgs/(-Vp)));
printf("gm (At Vgs = -2.5V) =%.1f mS\n",gm*1000);
```

Scilab code Exa 7.9 Find the output signal voltage of the amplifier

```
//Find the output signal voltage of the amplifier
clear;
clc;
//soltion
//given

Rd=12*10^3;//ohm
Rg=1*10^6;//ohm
Rs=1*10^3;//ohm
```

```
Cs=25*10^-6;//F
u=80;       //amplification factor
rd=200*10^3;//ohm
Vi=0.1;//V
f=1*10^3;//Hz       //input frequency
Xcs=1/(2*%pi*f*Cs);
//This is much smaller than Rs therefore it is bypassed

gm=u/rd;
Av=gm*(rd*Rd/(rd+Rd));
Vo=Av*Vi;
printf("The output voltage is %.3f V",Vo);
```

Scilab code Exa 7.10 Determine the small signal voltage gain and input and output resistance

```
//Determine the small signal voltage gain and input and output resistance
clear;
clc;
//soltion
//given

Rd=2*10^3;//ohm
rd=100*10^3;//ohm
Rg=1*10^6;//ohm
gm=2*10^-3;//S
Av=-gm*(rd*Rd/(rd+Rd));
Ri=Rg;
Ro=rd*Rd/(rd+Rd);
printf("The small signal voltage gain = %.0f\ninput resistance= %.0f M \noutput resistance = %.0f k ",Av,Ri/10^6,Ro/1000);
```

Scilab code Exa 7.11 Determine the small signal voltage gain and input and output resistance

```
//Determine the small signal voltage gain and input
   and output resistance
clear;
clc;
//soltion
//given

R1=500*10^3;//ohm
R2=50*10^3;//ohm
Rd=5*10^3;//ohm
Rs=100;//ohm
Rl=5*10^3;//ohm
gm=1.5*10^-3;//S
rd=200*10^3;//ohm
Rg=R1*R2/(R1+R2);
Rac=Rd*Rl/(Rd+Rl);
Av=-gm*Rac;
Ri=Rg;
Ro=(rd*Rac/(rd+Rac));
printf("The small signal voltage gain = %.2f\ninput
   resistance= %.2f k \noutput resistance = %.1f
   k ",Av,Ri/1000,Ro/1000);
```

Scilab code Exa 7.12 Calculate the voltage gain of the FET

```
//Calculate the voltage gain of the FET
clear;
clc;
//soltion
```

```
//given

Idss=8*10^-3;//A
Vp=4;//V
rd=25*10^3;//ohm
Rd=2.2*10^3;//ohm      //by the help of figure
Vgs=-1.8;//V
gmo=2*Idss/(abs(Vp));
gm=gmo*(1-(Vgs/(-Vp)));
Av=-gm*(rd*Rd/(rd+Rd));
printf("The voltage gain of the FET %.2f",Av);
```

Chapter 8

Multistage Amplifiers

Scilab code Exa 8.1 Express the gain in decibel

```
//Express the gain in decibel
clear;
clc;
//soltion
//given

//Powere gain of 1000
Pg1=1000;
Pgd1=10*log10(Pg1);
printf("Power gain (in dB)= %.0f dB\n",Pgd1);

//Voltage gain of 1000
Vg1=1000;
Vgd1=20*log10(Vg1);
printf("Voltage gain (in dB)= %.0f dB\n",Vgd1);

//Powere gain of 1/100
Pg2=1/100;
Pgd2=10*log10(Pg2);
printf("Power gain (in dB)= %.0f dB\n",Pgd2);

```

```
//Voltage gain of 1/100
Vg2=1/100;
Vgd2=20*log10(Vg2);
printf("Voltage gain (in dB)= %.0f dB\n",Vgd2);
```

Scilab code Exa 8.2 Determine power and voltage gain

```

//Determine power and voltage gain
clear;
clc;
//soltion
//given

//For  Gain = 10 dB
G=10;//dB
Pg1=10^(G/10);         //taking antilog
Vg1=10^(G/20);         //taking antilog
printf("\nFor Gain = %.0f dB",G)
printf("\nPower gain ratio = %.0f \n",Pg1);
printf("Voltage gain ratio = %.2f \n",Vg1);

//For Gain 3 dB
G=3;//dB
Pg2=10^(G/10);         //taking antilog
Vg2=10^(G/20);         //taking antilog
printf("\nFor Gain = %.0f dB\n",G)
printf("Power gain ratio = %.0f \n",Pg2);
printf("Voltage gain ratio = %.3f \n",Vg2);
```

Scilab code Exa 8.3 Calculate the overall voltage gain

```
//Calculate the overall voltage gain
```

```
clear;
clc;
//soltion
//given

A1=80
A2=50
A3=30
Ad=20*log10(A1)+20*log10(A2)+20*log10(A3);;

//Alternatively
A=A1*A2*A3;
Ad=20*log10(A);
printf("The Voltage gain is %.2f dB",Ad);
```

Scilab code Exa 8.4 Calculate quiescent output voltage and small signal voltage gain

```
//Calculate quiescent output voltage and small
   signal voltage gain
clear;
clc;
//soltion
//given

//At input Voltage =3V
Vi1=3;//V       //input voltage
Vbe=0.7;//V
B=250;
Vcc=10;//V      //Supply
Re1=1*10^3;//ohm
Rc1=3*10^3;//ohm
Re2=2*10^3;//ohm
Rc2=4*10^3;//ohm
Vb1=Vi1;          //Voltage at the base of transistor
```

```
T1
Ve1=Vb1-Vbe;       //Voltage at the emitter of transistor T1
Ie1=Ve1/Re1;
Ic1=Ie1;
Vc1=Vcc-Ic1*Rc1;
Vb2=Vc1;
Ve2=Vb2-Vbe;
Ie2=Ve2/Re2;
Ic2=Ie2;
Vo1=Vcc-Ic2*Rc2;
printf("The quiescent output voltage(At input Voltage =3 V ) is %.1f V\n",Vo1);

//At input Voltage =3.2 V
Vi2=3.2;//V      //input voltage
Vb1=Vi2;         //Voltage at the base of transistor T1
Ve1=Vb1-Vbe;       //Voltage at the emitter of transistor T1
Ie1=Ve1/Re1;
Ic1=Ie1;
Vc1=Vcc-Ic1*Rc1;
Vb2=Vc1;
Ve2=Vb2-Vbe;
Ie2=Ve2/Re2;
Ic2=Ie2;
Vo2=Vcc-Ic2*Rc2;
printf("The quiescent output voltage (At input Voltage =3.2 V) is %.1f V\n",Vo2);

//Small Signal input and output voltage
vi=Vi2-Vi1;
vo=Vo2-Vo1;
Av=vo/vi;
printf("The small signal voltage gain is %.0f ",Av)
```

Scilab code Exa 8.5 Calculate the maximum voltage gain and bandwidth of multistage amplifier

```
//Calculate the maximum voltage gain and bandwidth of multistage amplifier
clear;
clc;
//soltion
//FUNCTIONS

function [z]=prll(r1,r2)//Function for the parallel combination of resistor
  z=r1*r2/(r1+r2);
endfunction

//given
rin=10*10^6;//ohm         //input resistance of JFET
Rd=10*10^3;//ohm
Rs=500;//ohm
Rg=470*10^3;//ohm
Rl=470*10^3;//ohm
Cc=0.01*10^-6;//Farad
Csh=100*10^-12;//Farad
Cs=50*10^-6;//Farad
rd=100*10^3;//ohm
gm=2*10^-3;//S
Rac2=prll(Rd,Rl);
Rac1=prll(Rd,Rg);
Req=prll(rd,prll(Rd,Rl));
Am=ceil(gm*Req);
Am2=Am*Am;        //Voltage gain of two stage amplifier
printf("Voltage gain of two stage amplifier= %.0f\n",Am2);
```

```
R_=prll(rd,Rd)+prll(Rg,rin);
f1=1/(2*%pi*Cc*R_);       //lower cutoff frequency
f1_=f1/(sqrt(sqrt(2)-1));
f2=1/(2*%pi*Csh*Req);       //upper cutoff frequency
f2_=f2*(sqrt(sqrt(2)-1));
BW=f2_-f1_;
printf("Bandwidth= %.1f kHz",BW/1000);

//There is a slight error in f1 due to use of R'(here R_)=479 k  and in f2 due to approaximation of Req there is a slight variation
```

Scilab code Exa 8.6 Calculate the midband voltage gain and bandwidth of cascade amplifier

```
//Calculate the midband voltage gain and bandwidth of cascade amplifier
clear;
clc;
//soltion
//given
Am=8;            //midband voltage gain of individual MOSFET
BW=500*10^3//Hz
f2=BW;
n=4;
A2m=Am^n;
f2_=f2*(sqrt((2^(1/n))-1));
printf("Midband voltage gain = %.0f\n",A2m);
printf("Overall Bandwidth= %.1f kHz",f2_/1000);
```

Scilab code Exa 8.7 Calculate the input and output impedance and voltage gain

```
//Calculate the input and output impedance and
   voltage gain
clear;
clc;
//soltion
//FUNCTIONS

function [z]=prll(r1,r2)//Function for the parallel
   combination of resistor
    z=r1*r2/(r1+r2);
endfunction

hie=1.1*10^3;//ohm      = rin
hfe=120;//     = B

//the values of Rac2, Zi, Zo are as per diagram
Rac2=prll(3.3*10^3,2.2*10^3);
Rac1=prll(6.8*10^3,prll(56*10^3,prll
   (5.6*10^3,1.1*10^3)));
Zi=prll(5.6*10^3,prll(56*10^3,1.1*10^3));
Zo=prll(3.3*10^3,2.2*10^3);

printf("Input Resistance = %.3f  k  \nOutput
   Resistance = %.2f  k  \n",Zi/1000,Zo/1000);

Am2=-hfe*Rac2/(hie);
Am1=-hfe*Rac1/(hie);
Am=Am1*Am2;
Am=20*log10(Am);
printf("The Overall Voltage gain is %.2f dB",Am);
```

Chapter 9

Power Amplifiers

Scilab code Exa 9.1 Determine the turns ratio of the transformer

```
//Determine the turns ratio of the transformer
clear;
clc;
//soltion
//given

Rl=8;//ohm
Rl_=5*10^3;//ohm
TR=sqrt(Rl_/Rl);        //Turns ratio
printf("Turns Ratio= %.0f : 1",TR);
```

Scilab code Exa 9.2 Determine the output impedance of the transistor

```
//Determine the output impedance of the transistor
clear;
clc;
//soltion
//given
```

```

TR=16/1;     //turn ratio
Rl=4;//ohm    //loudspeaker impedance
ro=(TR^2)*Rl;
printf("The output impedance of the transistor %.0f
      ",ro);
```

Scilab code Exa 9.3 Determine the efficiency of a single ended transformer

```

//Determine the efficiency of a single ended
   transformer
clear;
clc;
//soltion
//given

Vceq=10;//V       //supply voltage

//At Vp=10V
Vp=10;//V
Vce_max1=Vceq+Vp;
Vce_min1=Vceq-Vp;
n1=50*((Vce_max1-Vce_min1)/(Vce_max1+Vce_min1))^2;
printf("Efficiency (At Vp = 10V)= %.0f percent\n",n1
   );

//At Vp=5V
Vp=5;//V
Vce_max2=Vceq+Vp;
Vce_min2=Vceq-Vp;
n2=50*((Vce_max2-Vce_min2)/(Vce_max2+Vce_min2))^2;
printf("Efficiency (At Vp = 5V)= %.1f percent\n",n2)
   ;

```

```
//At Vp=1V
Vp=1;//V
Vce_max3=Vceq+Vp;
Vce_min3=Vceq-Vp;
n3=50*((Vce_max3-Vce_min3)/(Vce_max3+Vce_min3))^2;
printf("Efficiency (At Vp = 1V)= %.1f percent\n",n3)
    ;
```

Scilab code Exa 9.4 Determine input and output power and efficiency

```
//Determine input and output power and efficiency
clear;
clc;
//soltion
//given

Vcc=20;//V      //supply voltage
Rl=4;//
Vp=15;//V
Ip=Vp/Rl;
Idc=Ip/%pi;
Pi=Vcc*Idc;
Po=((Vp/2)^2)/Rl;
n=100*Po/Pi;
printf("Input power %.2f W\n",Pi);
printf("Output power %.2f W\n",Po);
printf("Efficiency = %.0f percent\n",n);
```

Scilab code Exa 9.5 Calculate the percentage increase in output power

```
//Calculate the percentage increase in output power
clear;
clc;
```

```
//soltion
//given

D=0.2;//harmonic distortion
P=(1+D^2);//Total power increase

//percent increase= (Pi*(1+D^2)-Pi)*100/Pi;
//taking out and cancelling Pi
PI=(P-1)*100;
printf("The percentage increase in output power= %.0f percent",PI);
```

Scilab code Exa 9.6 Calculate harmonic distortion and percentage increase in output voltage due to this

```
//Calculate harmonic distortion and percentage increase in output voltage due to this
clear;
clc;
//soltion
//given

I1=60;//A
I2=6;//A
I3=1.2;//A
I4=0.6;//A
D2=I2/I1;
D3=I3/I1;
D4=I4/I1;
printf("The Harmonic distortion of each component\nD2= %.0f percent\nD3= %.0f percent\nD4= %.0f percent\n",D2*100,D3*100,D4*100);

D=sqrt((D2)^2+(D3)^2+(D4)^2);
printf("The Total Harmonic distortion = %.0f percent
```

```
\n",D*100);
P=(1+D^2);//Total power increase

//percent increase= (Pi*(1+D^2)-Pi)*100/Pi;
//taking out and cancelling Pi
PI=(P-1)*100;
printf("The percentage increase in output power= %.0
   f percent",PI);
```

Chapter 10

Feedback in Amplifiers

Scilab code Exa 10.1 Determine the gain of feedback amplifier

```
//Determine the gain of feedback amplifier
clear;
clc;
//soltion
//given

A=100;       //internal gain
B=0.1;//feedback factor
Af=A/(1+A*B);
printf("The gain of feedback amplifier %.2f",Af);
```

Scilab code Exa 10.2 Determine the gain of feedback amplifier in dB

```
//Determine the gain of feedback amplifier in dB
clear;
clc;
//soltion
//given
```

```
Ad=60;//dB        //internal gain in dB
A=10^(Ad/20);     //internal gain
B=1/20;//feedback factor
Af=A/(1+A*B);
Afd=20*log10(Af);
printf("The gain of feedback amplifier %.2f dB",Afd);
```

Scilab code Exa 10.3 Calculate the percentage of output fed back to input

```
//Calculate the percentage of output fed back to input
clear;
clc;
//soltion
//given

A=600;        //internal gain
Af=50;        //gain of feedback amplifier
B=(A/Af-1)/A;
printf("The percentage of output fed back to input= %.3f percent",B*100);
```

Scilab code Exa 10.4 Calculate the internal gain and percentage of output fed back to input

```
//Calculate the internal gain and percentage of output fed back to input
clear;
clc;
//soltion
//given
```

```

Af=80;        //gain of feedback amplifier
Vi=0.05;//V     //input with feedback
Vi_=4*10^-3;//V    //input without feedback
Vo_=Af*Vi;
A=Vo_/Vi_;
printf("The internal gain is %.0f\n",A);
B=(A/Af-1)/A;
printf("The percentage of output fed back to input= %.2f percent",B*100);
```

Scilab code Exa 10.5 Calculate the gain with and without feedback and feedback factor

```
//Calculate the gain with and without feedback and feedback factor
clear;
clc;
//soltion
//given

Vo_=5;//V           //output voltage
Vi=0.2;//V     //input with feedback
Vi_=0.05;//V    //input without feedback
A=Vo_/Vi_;
Af=Vo_/Vi;
printf("The gain without feedback is %.0f\n",A);
printf("The gain with feedback is %.0f\n",Af);
B=(A/Af-1)/A;
printf("The feedback factor= %.0f percent",B*100);
```

Scilab code Exa 10.6 Calculate the gain of feedback amplifier and feedback factor

```
//Calculate the gain of feedback amplifier and
   feedback factor
clear;
clc;
//soltion
//given

A=100;       //internal gain
N=20;//dB    //negative feedback
B=(10^(-N/(-20))-1)/A;      //taking antilog
Af=A/(1+A*B);
printf("The feedback factor= %.0f percent\n",B*100);
printf("The gain of the feedback amplifier is %.0f\n
   ",Af);
```

Scilab code Exa 10.7 Calculate percentage change in the overall gain

```
//Calculate percentage change in the overall gain
clear;
clc;
//soltion
//given

A=1000;       //internal gain
N=40;//dB    //negative feedback
D=10^((-N)/-20);      //D=(1+AB)    desensitivity
dA_A=10;//percent      //dA/A
dAf_Af=dA_A/D;       //dAf/Af
printf("The percentage change in the overall gain= %
   .1f percent",dAf_Af);
```

Scilab code Exa 10.8 Calculate percentage change in the overall gain

```
//Calculate percentage change in the overall gain
clear;
clc;
//soltion
//given

Adb=60;//dB       //internal gain in dB
B=0.005;          //feedback factor
A=10^(Adb/(20));       //taking antilog
dA_A=-12;//percent     //dA/A
D=(1+A*B);       //D=(1+AB)    desensitivity
dAf_Af=dA_A/D;       //dAf/Af
printf("The percentage change in the overall gain reduces by %.1f percent",-dAf_Af);
```

Scilab code Exa 10.9 Determine the input resistance of feedback amplifier

```
//Determine the input resistance of feedback amplifier
clear;
clc;
//soltion
//given

A=250;       //internal gain
B=0.1;//feedback factor
Ri=1.1*10^3;//ohm     //input resistance
Rif=Ri*(1+A*B);
printf("The input resistance of feedback amplifier %.1f k ",Rif/1000);
//The ans in book is incorrect due to use of (2+A*B) instead of (1+A*B) the ans in book is 29.7 k
```

Scilab code Exa 10.10 Calculate the percentage of negative feedback to input

```
//Calculate the percentage of negative feedback to
   input
clear;
clc;
//soltion
//given

Adb=60;//dB      //internal gain in dB
A=10^(Adb/(20));      //taking antilog
Ro=12*10^3;//ohm      //output resistance
Rof=600;//ohm
B=(Ro/Rof-1)/A;
printf("The percentage of negative feedback to input
   = %.1f percent",B*100);
```

Chapter 11

Tuned Voltage Amplifiers

Scilab code Exa 11.1 Calculate frequency and impedance and current and voltage across each element at resonance

```
//Calculate frequency and impedance and current and
   voltage across each element at resonance
clear;
clc;
//soltion
//given

R=12;//ohm
L=200*10^-6;//H
C=300*10^-12;//F
Vs=9;//V
fo=1/(2*%pi*sqrt(L*C));
Z=R;      //impedance
printf("The Resonant frequency= %.1f kHz\n",fo/1000)
   ;
printf("The impedance Z= %.0f    \n",Z);

Io=Vs/R;
printf("The Source current= %.2f A\n",Io);

```

```
Vl=Io*(2*%pi*fo*L);
Vc=Io/(2*%pi*fo*C);
Vr=Io*R;
printf("The voltage across the inductor =%.1f V\n",Vl);
printf("The voltage across the capacitor =%.1f V\n",Vc);
printf("The voltage across the resistor =%.0f V\n",Vr);
//There is a slight variation in voltage across capacitor due to the approaximation
```

Scilab code Exa 11.2 Calculate frequency and impedance and current at resonance and current in coil and capacitor

```
//Calculate frequency and impedance and current at resonance and current in coil and capacitor
clear;
clc;
//soltion
//given

R=10;//ohm
L=100*10^-6;//H
C=100*10^-12;//F
Vs=10;//V
fo=1/(2*%pi*sqrt(L*C));
Zp=L/(C*R);      //impedance
printf("The Resonant frequency= %.3f MHz\n",fo/10^6);
printf("The impedance Z= %.0f k \n",Zp/1000);

Io=Vs/Zp;
printf("The Source current= %.0f uA\n",Io*10^6);

```

```
Xl=(2*%pi*fo*L);
Xc=1/(2*%pi*fo*C);
Z1=sqrt(Xl^2+R^2);
Z2=Xc;
Ic=Vs/Z2;
Il=Ic;
printf("The current in the coil = %.0f mA\n",Il*1000);
printf("The current in the capacitor = %.0f mA\n",Ic*1000);
```

Scilab code Exa 11.3 Calculate impedance and quality factor and bandwidth

```
//Calculate impedance and quality factor and bandwidth
clear;
clc;
//soltion
//given

R=10;//ohm
L=150*10^-6;//H
C=100*10^-12;//F
fo=1/(2*%pi*sqrt(L*C));
Zp=L/(C*R);      //impedance
printf("The impedance Z= %.0f k \n",Zp/1000);

Xl=(2*%pi*fo*L);
Q=Xl/R;
BW=fo/Q;
printf("The Quality factor of the circuit =%.1f \n",Q);
printf("The Band width of the circuit =%.1f kHz\n",BW/1000);
```

Chapter 12

Sinusoidal Oscillators

Scilab code Exa 12.1 Calculate frequency of oscillations

```
//Calculate frequency of oscillations
clear;
clc;
//soltion
//given

L=55*10^-6;//H
C=300*10^-12;//F
fo=1/(2*%pi*sqrt(L*C));
printf("The frequency of oscillations= %.0f kHz\n",
   fo/1000);
```

Scilab code Exa 12.2 Calculate frequency of oscillations and feedback factor and voltage gain

```
//Calculate frequency of oscillations and feedback
   factor and voltage gain
clear;
```

```
clc;
//soltion

function [z]=prll(r1,r2)//Function for the parallel combination of resistor
    z=r1*r2/(r1+r2);
endfunction

//given
C1=0.001*10^-6;//F
C2=0.01*10^-6;//F
L=15*10^-6;//H
C=prll(C1,C2);
fo=1/(2*%pi*sqrt(L*C));
printf("The frequency of oscillations= %.2f MHz\n",fo/10^6);
B=C1/C2;
Amin=1/B;
printf("The feedback factor of the circuit =%.1f \n",B);
printf("The circuit needs a minimum voltage gain of %.0f",Amin);
```

Scilab code Exa 12.3 Calculate frequency of oscillations

```
//Calculate frequency of oscillations
clear;
clc;
//soltion
//given

R=10*10^3;//ohm
C=0.01*10^-6;//F
fo=1/(2*%pi*R*C*sqrt(6));
printf("The frequency of oscillations= %.1f Hz\n",fo
```

```
);
```

Scilab code Exa 12.4 Calculate frequency of oscillations

```
//Calculate frequency of oscillations
clear;
clc;
//soltion
//given

R=22*10^3;//ohm
C=100*10^-12;//F
fo=1/(2*%pi*R*C);
printf("The frequency of oscillations= %.2f KHz\n",
   fo/1000);
```

Scilab code Exa 12.5 Determine the series and parallel resonant frequencies

```
//Determine the series and parallel resonant
   frequencies
clear;
clc;
//soltion

function [z]=prll(r1,r2)//Function for the parallel
   combination of resistor
    z=r1*r2/(r1+r2);
endfunction

//given

L=3;//H
```

```
Cm=10*10^-12;//F
Cs=0.05*10^-12;//F
fs=1/(2*%pi*sqrt(L*Cs));
printf("The series resonant frequency =%.0f kHz\n",
   fs/1000);

Cp=prll(Cm,Cs);
fp=1/(2*%pi*sqrt(L*Cp));
printf("The parallel resonant frequency =%.0f kHz",
   fp/1000);
```

Chapter 14

Operational Amplifiers

Scilab code Exa 14.1 Calculate voltage gain and input and output resistance

```
//Calculate voltage gain and input and output resistance
clear;
clc;
//soltion
//given

R1=20*10^3;//ohm
Rf=2000*10^3;//ohm
Acl=-Rf/R1;
Ricl=R1;
Ro=0;
printf("The voltage gain= %.0f\n",Acl);
printf("The input resistance =%.0f k \n",R1/1000);
printf("The output resistance =%.0f  \n",Ro);
```

Scilab code Exa 14.2 Find the output voltage

```
//Find the output voltage
clear;
clc;
//soltion
//given

R1=20*10^3;//ohm
Rf=2000*10^3;//ohm
v1=4;//V
v2=3.8;//V
vo=v2*(1+Rf/R1)-(Rf/R1)*v1;
printf("The output voltage= %.1f V",vo);
```

Scilab code Exa 14.4 Design an adder circuit using an op amp

```
//Design an adder circuit using an op amp
clear;
clc;
//soltion
//given

//Vo=-(V1+10*V2+100*V3)
Rf=100*10^3;//ohm
C1=1;            //coefficient of V1
C2=10;            //coefficient of V2
C3=100;            //coefficient of V3
R1=Rf/C1;
R2=Rf/C2;
R3=Rf/C3;
printf("R1 = %.0f  k  \n",R1/1000);
printf("R2 = %.0f  k  \n",R2/1000);
printf("R3 = %.0f  k  \n",R3/1000);
```

Scilab code Exa 14.5 Calculate CMRR in dB

```
//Calculate CMRR in dB
clear;
clc;
//soltion
//given

Ad=100;              //differential mode gain
Ac=0.01;             //common mode gain
CMRR=20*log10(Ad/Ac);
printf("The CMRR in dB %.0f dB",CMRR);
```

Scilab code Exa 14.6 Calculate the output voltage

```
//Calculate the output voltage
clear;
clc;
//soltion
//given

Ad=2000;              //differential mode gain
CMRR=10000;
V1=10^-3;//V
V2=0.9*10^-3;//V
Vd=V1-V2;
Vc=(V1+V2)/2;
Vo=Ad*Vd*(1+Vc/(CMRR*Vd));
printf("The output voltage is %.2f mV",Vo*1000);
```

Chapter 15

Electronic Instruments

Scilab code Exa 15.1 Calculate shunt resistance and multiplying factor

```
//Calculate shunt resistance and multiplying factor
clear;
clc;
//soltion
//given

Im=5*10^-3;//A
Rm=20;//ohm
I=5;//A
Rsh=Rm*Im/(I-Im);
n=I/Im;
printf("Shunt resistance= %.5f   \n",Rsh);
printf("Multiplying factor= %.0f",n);
```

Scilab code Exa 15.2 Calculate shunt resistance

```
//Calculate shunt resistance
clear;
```

```
clc;
//soltion
//given

//At I= 1 mA
I1=1*10^-3;//A
Im=0.1*10^-3;//A
Rm=500;//ohm
Rsh=Rm*Im/(I1-Im);
printf("Shunt resistance= %.4f \n",Rsh);


//At I= 1 mA
I2=10*10^-3;//A
Rsh=Rm*Im/(I2-Im);
printf("Shunt resistance= %.4f \n",Rsh);


//At I= 1 mA
I3=100*10^-3;//A
Rsh=Rm*Im/(I3-Im);
printf("Shunt resistance= %.4f \n",Rsh);
```

Scilab code Exa 15.3 Caluclate the series resistance to convert it into voltmeter

```
//Caluclate the series resistance to convert it into
    voltmeter
clear;
clc;
//soltion
//given

Im=100*10^-6;//A
Rm=100;//ohm
```

```
V=100; //V
Rs=V/Im-Rm;
printf("The value of series resistance is %.1f k ",
   Rs/1000);
```

Scilab code Exa 15.4 Calculate multiplier resistance and voltage multiplying factor

```
//Calculate multiplier resistance and voltage
   multiplying factor
clear;
clc;
//soltion
//given

Im=50*10^-6; //A
Rm=1000; //ohm
V=50; //V
Rs=V/Im-Rm;
printf("The value of multiplier resistance is %.0f
   k \n",Rs/1000);
Vm=Im*Rm;
n=V/Vm;
printf("Voltage multiplying factor =%.0f",n);
```

Scilab code Exa 15.5 Calculate reading and error of each voltmeter

```
//Calculate reading and error of each voltmeter
clear;
clc;
//soltion

```

```
function [z]=prll(r1,r2)//Function for the parallel combination of resistor
    z=r1*r2/(r1+r2);
endfunction

//given

S_A=1000;//   /V         //sensitivity
S_B=20000;//   /V         //sensitivity
R=50;//V              //range of voltmeter
Vs=150;//V            //Supply
R1=100*10^3;//ohm
R2=50*10^3;//ohm
Vt=Vs*(R2/(R1+R2));

//Voltmeter A
Ri1=S_A*R;
Rxy_A=prll(Ri1,R2);       //total resistance at X and Y
V1=Vs*(Rxy_A/(Rxy_A+R1));
printf("The voltmeter indicates %.0f V\n",V1);

//Voltmeter B
Ri2=S_B*R;
Rxy_B=prll(Ri2,R2);       //total resistance at X and Y
V2=Vs*(Rxy_B/(Rxy_B+R1));
printf("The voltmeter indicates %.2f V\n",V2);

e1=(Vt-V1)*100/Vt;
e2=(Vt-V2)*100/Vt;
printf("The error in the reading of voltmeter A = %.0f percent\n",e1);
printf("The error in the reading of voltmeter A = %.1f percent",e2);
```

Scilab code Exa 15.6 Determine rms value of the ac voltage

```
//Determine rms value of the ac voltage
clear;
clc;
//soltion
//given

l=8.3;//cm          //length of the trace
D=5;// V/cm         //deflection sensitivity
Vpp=l*D;
Vrms=Vpp/(2*sqrt(2));
printf("The rms value of the ac voltage %.2f V",Vrms
  );
```

Scilab code Exa 15.7 Determine rms value and frequency of the sine voltage

```
//Determine rms value and frequency of the sine
  voltage
clear;
clc;
//soltion
//given

l=3.5;//cm          //length of the trace
D=2;// V/cm         //deflection sensitivity
Vpp=l*D;
Vrms=Vpp/sqrt(2);
printf("The rms value of the sine voltage = %.2f V\n
  ",Vrms);
x=4;// cm          //one cycle length on x axis
```

```
t=0.5*10^-3;//  s/cm     //timebase setting
T=x*t;
f=1/T;
printf("The frequency of the sine voltage = %.1f kHz
   ",f/1000);
```