Scilab Textbook Companion for Electronic Devices And Circuits by K. L. Kishore[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

Electron Dynamics and CRO

Scilab code Exa 1.1 speed of electon in electric field

```
// Example 1.1 page no-4
clear
clc

//(1)
V=10
d=5*10^-2
t=50*10^-9
T=10^-7
x=1.76*10^11
eps=V/(d*T)
a=x*eps
v=a*t^2/2
printf("\n(1)\nVelocity, v = %.1f*10^5 m/s\n",v
    /100000)

//(2)
x1=(a/6)*(t^3)
printf("\n(2)\ndistance, x=%f cm\n",x1*100)

//(3)
```

```
x2=0.05
t1=(x2/(a/6))^(1/3)
v1=(a/2)*t1^2
printf("\n(3)\nspeed with which the electron strikes
    the positive plate,\nv = %.2f*10^6 m/sec",v1
   /10^6)
```

Scilab code Exa 1.2 speed of electron and position of applied AC voltage point

```
// Example 1.2 page no-9
clear
clc

e=1.6*10^-19//C
m=9.1*10^-31//kg
Vmax=1.5 //v
w=2*%pi*60*10^6//rad/sec
d=8*10^-3 //m
Max_Vel=2*e*Vmax/(m*d*w)
Max_Vel=ceil(Max_Vel*10^-3)
printf("The Maximum value of Velocity is, \n dx/dt=%
   .2f*10^5 m/sec",Max_Vel/100)
```

Scilab code Exa 1.3 effect of electric filed on electron

```
// Example 1.3 page no-10
clear
clc


///(1)
eps=(2000)/3 //V/cm
```

```
e=1.6*10^-19   //C
m=9.1*10^-31   //kg
v= 10^7   // dy/dt=v m/sec
t=v*m/(e*eps*100)
t=floor(t*10^11)
t=t/10
printf("\n(1)\nTime ,t=%.1f*10^-10 sec\n",t)
t=t*10^-10
//(2)
y=(e*eps*100*t^2)/(2*m)
printf("\n(2)\nDistance travelled by electron , y=%f m\n",y)
//(3)
pd=eps*100*y
printf("\n(3)\nPotential Drop=%.1f Volts",pd)
```

Scilab code Exa 1.4 calculation of potential

```
// Example 1.4 page no-13
clear
clc
V0=10 //volts siince energy is 10ev
xm=2
theta=%pi/4
V=(2*V0*sin(2*theta))/xm
printf("V=%.0fd Volts",V)
```

Scilab code Exa 1.5 Application of magnetic field on electron

```
// Example 1.5 page no-19
clear
clc

```

```
B=0.03          //wb/m^2
m=9.1*10^-31   //kg
V=2*10^5
e=1.6*10^-19 //C

R=(2*m*V/e)^(1/2)
R=floor(R*100/B)
printf("Radius of the circle , R=%.0f cm",R)
//OAC is a right angled triangle
oa=R
oc=3
ac=sqrt((oa)^2-(oc)^2)
printf("\n  AD=%d cm",oa-ac)
```

Scilab code Exa 1.6 calculation of transit time

```
// Example 1.6 page no-20
clear
clc

m=9.1*10^-31   //kg
V=100
e=1.6*10^-19 //C
d=5*10^-2  //m
t=10^-8   //sec
d1=(e*V*t^2)/(m*d*2)
d2=(5-d1*100)
printf("\nd1=%.3f*10^-2m\nd2=%.2f*10^-2m",d1*100,d2)
t1=0.01*10^-6///sec
v1=e*V*t1/(m*d)
v1=ceil(v1/10^4)
printf("\nVelocity of Electron ,v=%.2f*10^6m/s",v1
   /100)
t2=(d2*10^-2)/(v1*10^4)
printf("\nt2=%.1f*10^-8 sec",t2*10^8)
```

```
printf("\nTotal transit time =t1+t2=%.1f*10^-8 sec"
    ,(t1/10^-8)+t2*10^8)
```

Scilab code Exa 1.7 time of flight under electric field

```
// Example 1.7 page no-20
clear
clc

V=1000    //volt
d=0.01   //m
e=1.6*10^-19 //C
m=9.1*10^-31//kg
eps=V/d
t=sqrt((2*m*d)/(e*eps))
printf("t=%.2f*10^-9",t*10^10)
```

Scilab code Exa 1.8 velocity of electron

```
// Example 1.8 page no-21
clear
clc

V=1000    //volt
e=1.6*10^-19 //C
m=9.1*10^-31//kg
Vf=sqrt((2*e*V)/m)
printf("V_final=%.2f*10^6 m/sec",Vf/10^6)
```

Scilab code Exa 1.9 application of electric and magnetic filed

```
// Example 1.9 page no-24
clear
clc

k=1.76*10^11 ///e/m in C/kg
eps=10^4
B=0.01

Xmax=2*eps*%pi/((B^2)*k)
printf("Xmax=%.3f cm",Xmax*100)
```

Scilab code Exa 1.10 distance travelled in helical path

```
// Example 1.10 page no-25
clear
clc

Energy=50 //eV
V0=Energy   //Volts
e=1.6*10^-19 //c
m=9.1*10^-31 //kg
v0=sqrt(2*e*V0/m)
v0=ceil(v0/10^5)
v0=(v0/10)*10^6
printf("\nVelocity, v0=%.0f",v0)

t=(35.5*10^-12)/(2*10^-3)
//Components of velocities are
v1=v0*cos(10*%pi/180)
v2=v0*cos(20*%pi/180)
x=v1-v2
d=x*t
printf("\nDistance, d =%.4f cm",d*100)
```

Scilab code Exa 1.11 Deflection sensitivity

```
// Example 1.11 page no-33
clear
clc

l=2 //cm
D=18 //cm
s=0.5 //cm

//(a)
va1=500 //volts
ds1=l*D/(2*s*va1)//Deflection Sensitivity
//(b)
va2=1000 //Volts
ds2=l*D/(2*s*va2)
//(c)
va3=1500 //Volts
ds3=l*D/(2*s*va3)
printf("\n(a)Va=%dV\nDeflection Sensitivity S_E=%.3f
    cm/V \n\n(b)Va=%dV\nDeflection Sensitivity S_E=%
   .3f cm/V\n\n(c)Va=%dV\nDeflection Sensitivity S_E
   =%.3f cm/V",va1,ds1,va2,ds2,va3,ds3)
```

Scilab code Exa 1.12 displacement angle and velocity of electron in CRT

```
// Example 1.12 page no-34
clear
clc

l=2 //cm
D=24 //cm
```

```
s=0.5 //cm
Vd=30 //Volts
Va=1000 //Volts

//(a)
d=Vd*l*D/(2*s*Va)
printf("\n(a)\nDeflection Produce, d=%.2f cm\n",d)

//(b)
theta=(atan(d/D))*(180/%pi)
printf("\n(b)\nTheta=%.2f  ",theta)
//(c)
e=1.6*10^-19//C
m=9.1*10^-31//kg
v=sqrt(2*e*Va/m)
vr=v/cos(theta*%pi/180)
printf("\n\n(c)\nResultant Velocity, Vr=%.2f *10^6 m/sec",vr/10^6)
```

Scilab code Exa 1.13 Calculation of transverse magnetic field

```
// Example 1.13 page no-34
clear
clc

l=1.27 //cm
D=19.4 //cm
s=0.475 //cm
Va=400 //volts
Se=l*D*10^-2/(2*s*Va)
Se=ceil(Se*10^5)
printf("\nS_E=%.2f mm/v",Se/100)

v=30    //volt
e=1.6*10^-19 //C
```

```
m=9.1*10^-31 //kg
x=sqrt(m/e)
B=(x*0.65*30*sqrt(2*Va))/(l*D)
printf("\nB=%.2f*10^-5 wb/m^2",B*10^5)//answer not
    matches with given answer
```

Scilab code Exa 1.14 effect of earths magnetic filed on deflection in CRT

```
// Example 1.14 page no-35
clear
clc

v0=1.19*10^7//m/sec
B=0.6*10^-4 //wb/m^2
v=400
//Radius of the circle described by the electron due
     to earth magnetic field
R=3.37*10^-6*sqrt(v)/B
printf("\nRadius of Circle, R=%.2fm",R)
y=sqrt((112)^2-20^2)
y=112-y
printf("\ndeflection of the electron on the screen,
    y=%.1f cm",y)
```

Chapter 2

Junction Diode Characteristics

Scilab code Exa 2.1 radius of the lowest state of Ground State

```
// Example 2.1 page no-45
clear
clc

n=1
h=6.626*10^-34 //J-sec
eps=10^-9/(36*%pi)
m=9.1*10^-31 //kg
e=1.6*10^-19
r=n^2*h^2*eps/(%pi*m*e^2)
printf("\nradius of the lowest state of Ground State
    , r=%.2f A ",r*10^10)
```

Scilab code Exa 2.2 no of photons emitted per second by lamp

```
// Example 2.2 page no-46
clear
clc
```

```

lambda=2537 // A
E_diff=12400/lambda
e=1.6*10^-19
energy=50/1000  //J/sec
e_j=energy/e  //eV/sec
n=e_j/E_diff
printf("The lamp emits %.1f *10^16 photons/sec of
   wavelength, lambda=%dA ",n/10^16,lambda)
```

Scilab code Exa 2.3 Speed of ejected electron

```
// Example 2.3 page no-47
clear
clc
e_ar=11.6 //eV
e_Na=5.12 //eV
V=e_ar-e_Na
e=1.6*10^-19 //C
m=9.1*10^-31 //kg
v=sqrt(2*e*V/m)
printf("Velocity, v=%.2f*10^6 m/sec",v/10^6)
```

Scilab code Exa 2.4 speed of electron in sodium vapour lamp

```
// Example 2.4 page no-48
clear
clc

l=5893 // A
V=2.11 //Volts
e=1.6*10^-19 //C
m=9.1*10^-31 //kg
```

```
v=sqrt(2*e*V/m)
printf("Velocity, v=%.2f*10^5 m/sec",v/10^5)
```

Scilab code Exa 2.5 radio transmitter

```
// Example 2.5 page no-48
clear
clc

f=10*10^6 //Hz
h=6.626*10^-34 //Joules/sec
e=1.6*10^-19 //C
//(a)
E=h*f/e
printf("\n(a)Energy of each radiated quantum,\n\tE=%
    .3f*10^-27 Joules/Quantum\n\tE=%.2f*10^-8 eV/
    Quantum",h*f*10^27,E*10^8)

//(b)
E=1000 //Joule/sec
N=E/(h*f)
printf("\n\n(b)\nTotal number of quanta per sec, N=%
    .2f*10^29",N/10^29)

//(c)
o=10^-7
printf("\n\n(c)\nNumber of quanta emitted per cycle
    = %.2f*10^22 per cycle",o*N/10^22)
```

Scilab code Exa 2.6 Neon Ionization

```
// Example 2.6 page no-48
clear
```

```
clc

//(a)
V=21.5 //Volts
e=1.6*10^-19 //C
m=9.1*10^-31 //kg
v=sqrt(2*e*V/m)
lambda=12400/V // A
printf("\n(a)\nVelocity, v=%.2f*10^6 m/sec\nWavelength of Radiation, Lambda=%.1f",v/10^6,ceil(lambda))
//(b)
c=3*10^8 //m/sec
f=c/(lambda*10^-10)
printf("\n(b)\nFrequency of Radiation, f=%.1f*10^15 Hz",f/10^15)
```

Scilab code Exa 2.8 wavelength of photon

```
// Example 2.8 page no-49
clear
clc
L=1400
E_diff=12400/L //eV
del_E=2.15
L2=12400/del_E
printf("\nE2-E1=%.2f eV\n1850 A  line is from 6.71 eV to 0 eV\nTherefore, second photon must be from %.2f to 6.71 eV.\nLambda=%d A .",E_diff,E_diff,L2)
```

Scilab code Exa 2.9 High field emission

```
// Example 2.9 page no-58
clear
clc
A=60.2*10^4 //A/m^2/ K ^2
B=52400     // K
T1=2400     // K
T2=2410     // K
js1=A*T1^2*(%e^(-B/T1))
js2=A*T2^2*(%e^(-B/T2))
js1=floor(js1)
js2=floor(js2)
printf("\nJS1=%d A/m^2\nJS2=%d A/m^2",js1,js2)
p=(js2-js1)*100/js1
printf("\nPercentage Increase=%.2f%%",p)
```

Scilab code Exa 2.10 Work function and wavelength

```
// Example 2.10 page no-58
clear
clc

//(a)
h=6.63*10^-34 //Plank's Constant ,  J sec.
e=1.6*10^-19 //Charge of Electron , C
c=3*10^8 //Velocity of Light , m/sec
v=0.55      //volts
l=5500*10^-10 //m
fi=(h*c)/(l*e)
fi=fi-v
printf("\n(a)\nWork Function(WF), fi=%.2f Volts",fi)
//(b)
l0=12400/fi
printf("\n\n(b)\nThreshold Wavelength = %d A ",l0)
```

Scilab code Exa 2.11 effect of temperature on emission

```
// Example 2.11 page no-59
clear
clc
dT=20
T=2310 // K
Ew=4.52
k=8.62*10^-5
x=(Ew/(k*T))
x=(2+x)*dT/T
printf("\n(a)\ndIth/Ith=%.1f%%\n\n(b)\nThis is
    solved by Trial and Error Method to get T = 2370
     K",x*100)
```

Scilab code Exa 2.12 RF voltage frequency in cyclotron

```
// Example 2.12 page no-60
clear
clc

B=1      //Tesla
T=35.5*10^-6 //sec
f=1/T
printf("\n(a)\nThe frequency of the R.F voltage, f=%
    .2f*10^4 Hz",f/10^4)
k=2*10^6
g=40000
printf("\n\n(b)Number of passages required to gain
    2*10^6 eV are ,N=%d",k/g)
v=49*g
R=(3.37*10^-6)*sqrt(v)
```

```
printf("\n\n(c)\nDiameter of last semicircle, D = 2R
    =%.2f *10^-4 m",2*R*10000)
```

Scilab code Exa 2.13 Emission current and cathode efficiency

```
// Example 2.13 page no-60
clear
clc
Ew=1  //eV
A0=100 // A/m2 I  K 2
S=1.8*10^-4 //cm2
K =8.62 * 10^-5  //eV/oK
T=1100
pd=5.8*10^4 //W/m^2
ipd=1.1*pd
tip=S*ipd
Ith=S*A0*T^2*%e^(-Ew/(K*T))
printf("\nIth=%.3f A\nCathode Efficiency, eta=%.0f
    mA/ K",Ith,ceil(Ith*1000/11.5))
```

Scilab code Exa 2.14 resistivity of doped material

```
// Example 2.14 page no-71
clear
clc

n=4.4*10^22 ///cm^3
mu=3600//cm62/volt-sec
e=1.6*10^-19//C
sigma=n*mu*e*10^-6
printf("\nResistivity, rho=%.3f Ohm-cm",1/sigma)
```

Scilab code Exa 2.15 conductivity and resistivity of pure silicon

```
// Example 2.15 page no-71
clear
clc
mup=500
mun=1500
n=1.6*10^10
e=1.6*10^-19 //c
sigma=(mun+mup)*e*n
printf("\nconductivity , sigma=%.2f *10^-6\
    nResistivity , rho= %d Ohm-cm",sigma*10^6,1/sigma)
```

Scilab code Exa 2.16 concentration of free electrons and holes

```
// Example 2.16 page no-71
clear
clc

A = 9.64 * 10^14
EG = 0.25 //eV
n1 = 6.25*10^26///cm^3
na=3*10^14
nd=2*10^14
n=-(10^14)+(sqrt(10^28+4*6.25*10^26))
n=n/2
printf("\nn=%.1f*10^12 electrons/cm^3\np=%.2f*10^14
    holes/cm^3\nAs p> n, this is p-type semiconductor
    .",n/10^12,(n+10^14)/10^14)
```

Scilab code Exa 2.17 concentration of free electrons and holes

```
// Example 2.17 page no-72
clear
clc
sigma=100      //Ohm-cm
e=1.6*10^-19 //c
mup=1800      //cm^2/V-sec
ni=2.5*10^13 // /cm^3
printf("\nIn p-type semiconductor, p>>n.")
pp=sigma/(e*mup)
n=ni^2/pp
printf("\nPp=%.2f*10^17 holes/cm^3\nn=%.1f*10^9
    electrons/cm^3",pp/10^17,n/10^9)
```

Scilab code Exa 2.18 concentration of free electrons and holes in p type Ge and n type Si

```
// Example 2.18 page no-72
clear
clc

//(a)
sigma=100      //Ohm-cm
e=1.6*10^-19 //c
mup=1800      //cm^2/V-sec
ni=2.5*10^13 // /cm^3
printf("\n(a)\nAs it is p-type semiconductor, p>>n."
    )
pp=sigma/(e*mup)
n=ni^2/pp
printf("\nPp=%.2f*10^17 holes/cm^3\nn=%.1f*10^9
    electrons/cm^3",pp/10^17,n/10^9)

//(b)
```

```
mun=1300
sig=0.1
n1=1.5*10^10
n2=sig/(mun*e)
p1=(n1^2)/n2
printf("\n\n(b)\nn=%.2f*10^14 elecrons/cm^3\np=%.2f
    *10^5 holes/cm^3",n2/10^14,p1/10^5)
```

Scilab code Exa 2.19 conduction current density

```
// Example 2.19 page no-73
clear
clc
sig=1/60 // v/cm
mup=1800 //cm^2/V-sec
mun=3800 //cm^2/V-sec
e=1.6*10^-19 //C

ni=sig/(e*(mun+mup))
na=7*10^13 //cm^3
nd=10^14  // /cm^3
k=na-nd //p-n
p=0.88*10^13
n=3.88*10^13
eps=2
J=(n*mun+p*mup)*(e*eps)
printf("J=%.1f mA/cm^3",J*1000)
```

Scilab code Exa 2.20 concentration of free electrons and holes in Ge

```
// Example 2.20 page no-74
clear
clc
```

```
na=3* 10^14 // /cm^3
nd= 2*10^14 // /cm^3
ni= 2.5*10^13  // /cm^3

k=na-nd
n=(-k+sqrt(k^2+4*ni^2))/2
printf("\nn=%.1f*10^18 electrons/m^3\np=%.2f*10^19
   holes/m^3\n\nas p > n, it is p-type semiconductor
   ",n/10^12,ni^2/n*10^-13)
```

Scilab code Exa 2.21 intrinic concentration and conductivity of Germanium

```
// Example 2.21 page no-75
clear
clc

A=9.64*10^21
T=320
e=1.6*10^-19
Eg=0.75
k=1.37*10^-23
ni=A*T^(3/2)*%e^(-(e*Eg)/(2*k*T))
printf("\nni=%.2f *10^19 electrons(holes)/m^3",ni
   /10^19)
mup=0.36
mun=0.17
sig=e*ni*(mup+mun)
printf("\nConductivity, Sigma=%.3f Mho/m",sig)
```

Scilab code Exa 2.22 resistivity of intrinsic Germanium at room temperature

```
// Example 2.22 page no-75
clear
clc

e=1.6*10^-19//C
ni=2.5*10^19
mun=0.36 //m^2/V-sec
mup=0.17 //m^2/V-sec
sig=e*ni*(mup+mun)

rho=1/sig
printf("Resistivity, rho=%.2f Ohm-m",rho)
```

Scilab code Exa 2.23 Fermi level of p type Ge

```
// Example 2.23 page no-80
clear
clc
mup=0.4
T=300
Nv=4.82*10^15
Na=Nv*mup^(3/2)*T^(3/2)
printf("\nDoping concentration, NA=%.2f*10^18 atoms/
    cm^3",Na/10^18)
```

Scilab code Exa 2.24 Distance of Fermi level from centre of forbidden bond

```
// Example 2.24 page no-80
clear
clc
Vt=0.026
Nv=(3/4)*Vt*log(2)
```

```
printf("\nFor Intrinsic Semiconductor,\nEF will be at the centre of the forbidden band. \nBut if mp and mn are unequal, EF will be away\nfrom the centre of the forbidden band by\n\nNv=%.1f*10^-3 eV",Nv*10^3)
```

Scilab code Exa 2.25 Temperature for which conduction band and fermi level coincides

```
// Example 2.25 page no-83
clear
clc

si=5*10^22 //atom/cm^3
d=2*10^8
Nd=si/d
m=9.1*10^-31//kg
k=1.38*10^-23
h=6.626*10^-34
Nc=2*(2*%pi*m*k/h^2)^(3/2)
T=(Nd/Nc)^(2/3)
printf("T=%.2f K",T*10^4)//Nd/10^14)
```

Scilab code Exa 2.26 distance between valence band and Fermi level

```
// Example 2.25 page no-83
clear
clc

m=9.1*10^-31//kg
k=1.38*10^-23
h=6.626*10^-34
T=300
```

```
mp=0.6
si=5*10^22
at=10^8
Nc=si/at
Nv=2*(2*%pi*m*k*T*mp/h^2)^(3/2)
printf("\nNv=%.2f * 10^19 /cm^3",Nv/10^25)
Kt=0.026
Ediff=Kt*log(1.17*10^19/(5*10^14))
printf("\nEf-Ev =%.2f eV\nTherefore, EF is above Ev"
    ,Ediff)
```

Scilab code Exa 2.27 doping concentration for given fermi level

```
// Example 2.27 page no-86
clear
clc
mp=0.4
T=300
k=4.82*10^15
Nv=k*(mp*T)^(3/2)
printf("Doping concentration, NA = ND = %.2f*10^18
    atoms/cm^3",Nv/10^18)
```

Scilab code Exa 2.28 Distance of Fermi level from centre of forbidden bond

```
// Example 2.28 page no-86
clear
clc
Vt=0.026
Nv=(3/4)*Vt*log(3)
printf("\nFor Intrinsic Semiconductor,\nEF will be
    at the centre of the forbidden band. \nBut if mp
```

```
    and mn are unequal, EF will be away\nfrom the
    centre of the forbidden band by\n\nNv=%.1f*10^-3
    eV",Nv*10^3)
```

Scilab code Exa 2.29 Einstein relationship

```
// Example 2.29 page no-90
clear
clc
mung=3800
mupg=1800
muns=1300
mups=500
Vt=0.026
printf("\nFor Germanium at room temperature,\nDp=%d
    cm^2/sec\nDn=%d cm^2/sec\n\nFor Silicon,\nDp=%d
    cm^2/sec\nDn=%d cm^2/sec",ceil(mupg*Vt),ceil(mung
    *Vt),ceil(mups*Vt),ceil(muns*Vt))
```

Scilab code Exa 2.30 Hall Effect

```
// Example 2.30 page no-95
clear
clc

B=0.1 //Wb/m^2
Vh=50 //mV
I=10 //mA
rho=2*10^5 //Ohm-cm
w=3*10^-3 //m
x=B*I*10^-3/(Vh*10^-2*w)
printf("\n1/RH=%.3f",x)
y=1/(rho*10^-2)
```

```
printf("\nConductivity = %f mhos/meter\nmu=%.0f cm
    ^2/V-sec",y,(y/x)*10^6)
```

Scilab code Exa 2.31 Reverse saturation current in diode

```
// Example 2.31 page no-116
clear
clc

//(a)
Vt=300/11600
v=Vt*log(1.9)
printf("\n(a)\nV=%.3fV",v)

//(b)
v1=0.2
i1=10*(%e^(v1/Vt)-1)
printf("\n(b)\nFor V=0.2, I=%.2f mA",i1/1000)
v2=0.3
i2=10*(%e^(v2/Vt)-1)
printf("\n\nFor V=0.3, I=%.2f A",i2/1000000)
```

Scilab code Exa 2.32 AC and DC resistance of Ge diode

```
// Example 2.32 page no-116
clear
clc

Vt=301.6/11600
i0=20*10^-6
v=0.1
I=i0*(%e^(v/Vt)-1)
printf("\nI=%.3f mA",I*1000)
```

```
r_DC=v/I
printf("\nr_DC=%.1f Ohm",r_DC)
r_AC=i0*(%e^(v/Vt))/Vt
printf("\nr_AC = %.1f Ohm",1/r_AC)
```

Scilab code Exa 2.33 width of the depletion layer

```
// Example 2.33 page no-117
clear
clc

A = 0.001// cm2
sig1n= 1 //mhos/cm,
sig1p=100 //mhos/cm
mun=3800 //cm2/sec
mup = 1800 //cm2/sec.
e=1.6*10^-19 //C
eps=16*8.85*10^-14//F/cm
ni=6.25*10^26
T=300
Vt=T/11600
Nd=sig1n/(e*mun)
Na=sig1p/(e*mup)
V0=Vt*log(Na*Nd/ni)
w=sqrt(2*eps*(V0+1)/(e*Na))
printf("\nND=%.2f * 10^15 /cm^3\nNA=%.1f * 10^17 /cm
    ^3\nV0=%.3f V\nw=%.3f * 10^-4 cm",Nd*10^-15,Na
    *10^-17,V0,w*10^4)
```

Scilab code Exa 2.34 dynamic forward and reverse resistance of a p n junction diode

```
// Example 2.34 page no-118
```

```
clear
clc

I0=10^-6 //A
T = 301.6  //K
Vf =0.25 //V
Vr= 0.25 //V
//Dynamic Forward Resistance
Vt=T/11600
x=(I0*%e^(Vf/Vt))/Vt
rf=1/x
printf("\nDynamic Forward Resistance, rf = %.3f Ohm"
   ,rf)
//Dynamic Reverse Resistance

x1=(I0*%e^(-Vf/Vt))/Vt
rr=1/x1
printf("\nDynamic Reverse Resistance, rr = %.1f *
   10^6 Ohm",rr/10^6)
```

Scilab code Exa 2.35 zener breakdown voltage

```
// Example 2.35 page no-125
clear
clc

eps=16/(36*%pi*10^9) //F/m
mup=1800
E=4*10^14
V=(eps*mup*E*10^-6)/2
sige=1/45
Vz=ceil(V)/sige
printf("V=%d V",Vz)
```

Scilab code Exa 2.36 Effect of bias on capacitance of a diode

```
// Example 2.36 page no-125
clear
clc

Ct=20 //pF
v1=5 //v
v2=6 //v
Ct2=Ct*sqrt(v1/v2)
printf("Therefore, decrease in the value of capacitance is\nCt1-Ct2=%.2f pF",Ct-Ct2)
```

Scilab code Exa 2.37 Zener As voltage regulator

```
// Example 2.37 page no-126
clear
clc
V1=200 //V
Vd=50  //V
I=40*10^-3 //A

//If Il=0,
R=(V1-Vd)/I
I0=5   //mA
printf("\n(a)\nR=%d Ohm\nImax occurs when I0 = %d mA\nTherefore, Imax = %d mA",R,I0,I*1----I0)
//for Vmin
Il=25
Vmin=Vd+(Il+I0)*0.001*R
//for Vmax
Vmax=Vd+(Il+I*1000)*0.001*R
```

```
printf("\n(b)\nFor Vmin\nVmin=%.1fV\n\nFor Vmax\nVmax=%.1fV",Vmin,Vmax)
```

Scilab code Exa 2.39 Zener As voltage regulator

```
// Example 2.39 page no-127
clear
clc
x=99.5 *10^3  //Ohm (R1+R2)
rm=0.56 *10^3 //Ohm
v1=20      //V
i=v1/x
i=0.0002 //aproxximated to
k=16/i
R1=k-rm
R2=x-R1

printf("\nR1=%.1f K-ohm\nR2=%.1f K-ohm",R1/1000,R2/1000)
```

Scilab code Exa 2.40 forward snd reverse current ratios

```
// Example 2.40 page no-127
clear
clc

T=301.6
vt=T*1000/11600
vf=50 //mV
vr=-50 //mV
k=(%e^(vf/vt)-1)/(%e^(vr/vt)-1)
```

```
printf("\nratio=%.2f\nNegative sign is oecause, the
    direction of \ncurrent is opposite when the diode
     is reverse biased",k)
```

Scilab code Exa 2.41 PN junction diode as Resistance

```
// Example 2.41 page no-128
clear
clc
V=10 //v
I0=0.07/0.11//(0.07/0.11)xI
i1=5 //mA
Ir=1-I0
i=Ir/I0
Ir=i*i1
R=V/Ir
printf("R=%.1f K-Ohm",R)
```

Scilab code Exa 2.42 Zener As voltage regulator

```
// Example 2.42 page no-128
clear
clc

V=30 //V
R=2000 //Ohm
I=V/R
Iz=0.025 //A
It=Iz+I
Rs=200
Vmax=V+Rs*It
printf("Vrmax = %d V",Vmax)
```

Chapter 3

Rectifiers Filters and Regulators

Scilab code Exa 3.1 Ripple Factor

```
// Example 3.1 page no-155
clear
clc

//(1)
Rl=2000
f=50
l=20
V1=0.074
w=2*%pi*f
V=Rl/(3*2*sqrt(w*2))
printf("\n1.One Inductor Filter,\nV = %.3f\n",V1)
//(2)
Idc=1
c=16*10^-6
gam=Idc/(4*sqrt(3)*f*c*Rl)
printf("\n2.Capacitor filter, \nGamma = %.2f\n",gam)

//(3)
```

```
gam2=(sqrt(2)/3)*(1/4*l*c*(w^2))
printf("\n3. L Type filter ,\nGamma = %.4f",gam2
    /1000)
```

Scilab code Exa 3.2 diode as a rectifier

```
// Example 3.2 page no-156
clear
clc

vm=110  //rms
x=1020  //Rf+Rl
rl=1000
//(a)
Im=vm*sqrt(2)/x
printf("\n(a)\nIm = %.1f mA",Im*1000)
//(b)
Idc=Im*1000/%pi
printf("\n(b)\nIdc = %.1f mA",Idc)

//(c)
Ir=Im*1000/2
printf("\n(c)\nIrms = %.1f mA",Ir)
//(d)
v=-(Im*rl/%pi)
printf("\n(d)\n Vdc = %.1f V",v)

//(e)
p=Ir*x/1000
printf("\n(e)\nPi = %.2f W",p)
//(f)
rl=1
lr=((vm*sqrt(2)/%pi)-(Idc*rl))/(Idc*rl)
printf("\n(f)\n%% regulation = %.2f %%",lr*100)
```

Scilab code Exa 3.4 Full scale reading of voltmeter

```
// Example 3.4 page no-157
clear
clc

Rl=5010 //ohm
idc=0.001
Vrms=idc*%pi*Rl/(2*sqrt(2))
printf("\nVrms = %.2f V",Vrms)
```

Scilab code Exa 3.5 FWR with LC filter

```
// Example 3.5 page no-164
clear
clc
rf=0.02
f=60
w=2*%pi*f
lc=sqrt(2)/(rf*12*w^2)
printf("\nLC=%.1f micro",lc*10^6)
vdc=9
idc=0.1
Rl=vdc/idc
printf("\nRL = %d Ohm\n\n LC> Rl/3w > Rl/1130\n
   But LC should be 25%% larger\ntherefore, for f=
   60 Hz,the value ofLC should be > Rl/900",Rl)
lc1=Rl/900
printf("\nIf L=0.1H, then C=%.1f micro F, This is
   high value\nIf L=1H, then C=41.5 micro F",ceil(lc
   *10^6/lc1))
printf("\n\nTransformer Rating:")
```

```
vdc=vdc+5
vm=vdc*%pi/2
vrms=vm/sqrt(2)
printf("\nVdc=%.0fV\nVm=%.0fV\nVrms=%.1fV\nTherefore
    , a 15.5 - 0 -15.5 V, 100mA transformer is
    required\n PIV=%d V",vdc,ceil(vm),vrms,2*ceil(vm)
    )
```

Scilab code Exa 3.6 Ripple Factor

```
// Example 3.6 page no-165
clear
clc
vrpp=0.8 //V
vrms=vrpp/(2*sqrt(3))
vrms=floor(vrms*10)
vrms=vrms/10
vm=8.8
vdc=vm-vrpp/2
gam=vrms/vdc
printf("\n%% regulation , gamma = %.2f%%",gam*100)
r=100
f=60
c=1050*10^-6
tgam=1/(4*(sqrt(3*c*r*f)))
printf("\nTheoretical values , gamma = %.2f%%",tgam
    *100)
Vdc=(4*f*r*c*vm)/(1+4*f*r*c)
printf("\nVdc = %.2f V",Vdc)
```

Scilab code Exa 3.7 power supply using pi filter

```
// Example 3.7 page no-167
```

```
clear
clc
Vdc=25
Idc=0.1
R=Vdc/Idc

Vc=Vdc+37.5

vm=Vc+(Idc/(4*50))
vrms=vm/sqrt(2)
vrms=60 ///approximated to
printf("\nVrms=%.0f V\n\nTherefore, a transformer
    with 60 - 0 -60V is chosen. \nThe ratings of the
    diode should be,\ncurrent of 125mA.and voltage =
    PIV = 2Vm = %.1f",vrms,169.2)
```

Scilab code Exa 3.8 Diode rating for FWR

```
// Example 3.8 page no-169
clear
clc

Vdc=250 //V
Idc=0.1
rc=400
rl=Vdc/Idc
Vm=(Vdc*%pi/2)*(1+(rc/rl))
Vrms=Vm/sqrt(2)
printf("Vrms=%dV\n\nTherefore, the transformer
    should supply \n%dV rms on each side of the
    centre tap.",Vrms,Vrms)
L=10 //Ohm
c=20*10^-6
w=377
Ib=2*Vm/(3*%pi*w*L)
```

```
rf=0.47/(4*w^2*c)
printf("\n\nIb=%.4f A\nRipple factor=%f",Ib,rf)
```

Scilab code Exa 3.9 FWR with C type capacitor filter

```
// Example 3.9 page no-170
clear
clc

Idc=0.02 //A
Vdc=16 //V
rl=Vdc/Idc
f=50
x=4*sqrt(3)*f*0.05*rl
C=1/x
printf("\nC=%d microF",C*10^6)
vm=Vdc*((1+(4*f*C*rl)))/(4*f*C*rl)
printf("\nVm=%.2f V",vm)
```

Scilab code Exa 3.10 Half Wave Rectifier

```
// Example 3.10 page no-170
clear
clc

Vdc=(100/(2*%pi))*(-cos(5*%pi/6)+cos(%pi/6))
printf("\nVdc=%.1f V",Vdc)
Vrms=sqrt(3.1)*Vdc
printf("\nVrms=%.1fV",Vrms)
```

Scilab code Exa 3.11 FWR with C type capacitor filter

```
// Example 3.11 page no-172
clear
clc


//(a)
vdc=30   //V
idc=0.05   //A
rl=vdc/idc
f=50       ///Hz
c=80*10^-6   //F
vm=vdc+(idc/(4*f*c))
printf("\n(a)\nRL=%.0f Ohm\nVm=%.3fV\nVrms=%.1fV",rl
    ,vm,vm/sqrt(2))
//(b)
is=vm*2*%pi*f*c
printf("\n\n(b)\nI_diode swing/I_diode mean = %.2f",
    is/idc)
//(c)
gam=4*sqrt(3)*f*c*rl
gam=1/gam
printf("\n\n(c)\ngamma=%.2f",gam)
```

Scilab code Exa 3.12 Full wave rectifier circuit

```
// Example 3.12 page no-173
clear
clc

vm=25
vp=35.4         //V
vdc=2*vp/%pi   //V
vrms=sqrt(vm^2-vdc^2)
```

```

rl=25
im= vp/rl
idc=2*im/%pi
irms=sqrt(1-idc^2)
printf("\nVdc=%.1f V\nVrms=%.2f V\nIm=%.2f A\nIdc=%.2f A\nIrms=%.3f A",vdc,vrms,im,idc,irms)
```

Scilab code Exa 3.13 Shunt regulator

```
// Example 3.13 page no-176
clear
clc
veb=0.2 //V
hfe=49
vz=6.3  //V
i=5*10^-3
vi=8
//(1)
y=veb+vz
printf("\n1. The nominal output voltage is the sum of the transistor V_EB and zener voltage.\nV0=%.1f V\n",y)
//(2)
r1=(vi-vz)/i
printf("\n2. R1 must supply 5mA to the zener diode\nR1=%.0f Ohm",r1)
//(3)
k=veb/vz
printf("\n\n3. The maximum allowable zener current is\nIz=%f A",k)
ibmax=k-i
it=ibmax*(1+hfe)
printf("\nTotal current range = %.2f A",it)
//(4)
```

```
pd=y*it
printf("\n\n(4)\nThe maximum power dissipation,\nPd=
    %.1f W",pd)
//(5)
rs=(vi-y)/it
pdr=it^2*rs
printf("\n\n(5)\nRs=%.2f Ohm\nPower dissipated by Rs
     is P = %dW",rs,pdr)
```

Chapter 4

Transistor Characteristics

Scilab code Exa 4.1 minimum base current to work transistor in saturation region

```
// Example 4.1 page no-203
clear
clc

vcc=12 //V
rl=4  // Ohm
ic=vcc/rl
alfa=0.98
B=alfa/(1-alfa)
ibmin=ic/B
printf("\nIc(saturation)= %d mA\nBeta = %.0f \nIb(min) = %.1f micro A",ic,B,ibmin*1000)
```

Scilab code Exa 4.5 maximum allowable value of RB for transistor in cut off

```
// Example 4.5 page no-206
```

```
clear
clc
t1=75
t2=25
icbo=2           // at T1=25
icbo2=icbo*2^((t1-t2)/10)
vbe=0.1
vbb=5
Rb=(vbb-vbe)/icbo2
printf("\nIcbo at 75 C = %.0f micro A\nRb = %.1f K-
   Ohm",icbo2,Rb*1000)
```

Scilab code Exa 4.6 temperature increase before transistor comes of cut off

```
// Example 4.6 page no-207
clear
clc
vbb=-1 //V
Rb=50 //K-Ohm
vbe=-0.1
Icbo=(vbe-vbb)/Rb
printf("\nIcbo =%.0f micro A",Icbo*1000)
t=log(Icbo*1000/2)*10/(log(2))
printf("\nDelta_T = %d C \nHence, T=%d C",ceil(t),
   ceil(t)+25)
```

Scilab code Exa 4.7 calculation of ib ic and vbc for transistor AF 114

```
// Example 4.7 page no-207
clear
clc

```

```
vce = - 0.07 //V
vbe = - 0.21 //V.
vcc=-9
rc=1    //K-Ohm
rb=30 //K-Ohm
ic=(vcc-vce)/rc
ib=(vcc-vbe)/rb
vbc=vbe-vce
printf("\nIc = %.2f mA\nIB = %.3f mA\nVbc = %.2f V",
    ic,ib,vbc)
```

Scilab code Exa 4.8 calculation of resistance in CE configuration

```
// Example 4.8 page no-208
clear
clc

alfa=0.98
Ie=-2   //in mA IE is negative because it is NPN
    transistor
Ic=-alfa*Ie
Ib=(1-alfa)*(-Ie)
vbe=0.6 //V
vcc=12 //V
re=100 //ohm
r2= 20000 //ohm
r1=3.3 //k-Ohm
vbn=vbe-(Ie*re*10^-3)
printf("\nIc = %.2f mA\nIb = %.0f micro A\nV_BN =%.1
    f V",Ic,Ib*1000,vbn)
Ir2=vbn*10^3/r2
Ir1=Ir2+Ib
printf("\nIR1 = %.0f micro A\nIR2 = %.0f micro A\
    nIrc = %.2f mA",Ir1*1000,Ir2*1000,Ir1+Ic)
vr1=vcc-((Ir1+Ic)*r1)-vbn
```

```
R1=vr1/Ir1
printf("\nR1=%d K-Ohm",ceil(R1))
```

Scilab code Exa 4.9 Barrier Potential

```
// Example 4.9 page no-208
clear
clc

eps=12/(36*%pi*10^11) //F/cm
mup=500 // cm^2/V-Sec
Vb=(2.54/1000)^2/(2*eps*mup)
printf("VB = %.1f*10^3*W^2/rho_B",Vb/1000)
```

Scilab code Exa 4.10 Av Ai and Ap of transistor in CB configuration

```
// Example 4.10 page no-210
clear
clc

alfa=0.96
Rl=5000
x=80
Av=alfa*Rl/x

pg=Av*alfa
printf("Power Gain = %.1f",pg)
```

Scilab code Exa 4.11 Av Ai and Ap of Transistor in CE configuration

```
// Example 4.11 page no-211
clear
clc

alfa = 0.96
B=alfa/(1-alfa)
x=80
Rl=75000  //ohm
Av=B*Rl/x
Ap=Av*B
printf("power gain = %.0f",Ap)
```

Scilab code Exa 4.12 Junction voltages for open collector transistor

```
// Example 4.12 page no-211
clear
clc
ico=2 //micro A
ieo=1.6 //micro A
alfa = 0.98
ie=2 //micro A
T=301.6
vt=T/11600
ve=vt*log(1+(ie/ieo))
printf("\nVe = %f V",ve)
vc=vt*log(1+(alfa*ie/ico))
printf("\nVc = %f V\nV_CE = %f V",vc,vc-ve)
```

Scilab code Exa 4.13 variation in Vi corresponding to variation in Vo

```
// Example 4.13 page no-212
clear
clc
```

```
rs=200 //Ohm
vz=100 //V
rz=20  // Ohm
il=50 // mA
iz=0.01//mA
ilmax=100 //mA
izmin=0.1*ilmax

vl=vz+iz*rz
printf("\nV_L = %.1f V",vl)
v1=vl+((il/1000)+iz)*rs
printf("\nV1 = %.1fV",v1)
vldash=vl+1
izdash=(vldash-100)/rz
printf("\nIncrease in Iz = %.2f mA",izdash)
it=(il/1000)+izdash
vt=vldash+(rs*it)
printf("\nTotal Current = %.1f A\nTotal Voltage = %
   .1f V\nchange in V1 =%.0fV\nA change of 11 V in V
   , on the input side produces a change of\n1V on
   the output side due to zener diode action",it,vt,
   vt-v1)
```

Scilab code Exa 4.14 Design of bias circuit for zero drain current drift

```
// Example 4.14 page no-226
clear
clc
vp=-3 ///V
vgs=vp-0.63  //V
idss=1.75 //mA
rd=5  //K-Ohm
gmo=1.8  //mA/V
//(a)
```

```
id=idss*(1-(vgs/vp))^2
rs=-vgs/0.08
gm=gmo*(vgs-vp)/vp
Av=gm*rd
printf("\n(a)Id for zero drift current\nId = %.2f mA
    \n\n(b)\nVgs = %.2f V\n\n(c)\nRs = %d K-Ohm\n\n(d
    )\ngm = %.3f mA/V\nAv = %.2f",id,vgs,rs,gm,Av)
```

Scilab code Exa 4.15 pinch off voltage

```
// Example 4.15 page no-228
clear
clc

a=2*10^-4   //cm
rho = 10 //Ohm-cm
eps=12/(36*%pi*10^11)
mup = 500   //cm^2/V-sec
ena=1/(rho*mup)

vp= (ena*a^2)/(2*eps)
printf("Vp = %.2f V",vp)
```

Scilab code Exa 4.16 pinch off voltage

```
// Example 4.16 page no-231
clear
clc

printf("Same as problem 4.15 in the same chapter")
```

Scilab code Exa 4.17 pinch off voltage and channel half width

```
// Example 4.17 page no-231
clear
clc

a=3*10^-4 //cm
nd=10^15 //electrons/cm^3
e=1.6*10^-19  //C
eps=12/(36*%pi*10^11)
vp=e*nd*a^2/(2*eps)
printf("\n(a)\nVp = %.1f V",vp)
b=a*(1-(1/2)^(1/2))
printf("\n\n(b)Vgs=Vp/2\nb = %.2f * 10^-4 cm",b
    *10^4)
```

Scilab code Exa 4.20 design of self bias circuit

```
// Example 4.20 page no-241
clear
clc

vdd=30 //v
rl=4.7 //k-ohm
vd=20  //v
id=(vdd-vd)/rl
printf("\nId = %.1f mA",id)
printf("\nfor vd to be constant, it should be within
     1V")
del_id=1/rl
printf("\nDelta_Id =    %.1f mA\nId(min) = %f mA\nId
    (max) = %f mA" ,del_id,id-del_id,id+del_id)

delv=vdd-vd
deli=2.5 //mA
```

```
rs=delv/(deli)
printf("\nRs = %d K-Ohm",rs)
```

Scilab code Exa 4.21 Voltage gain and output impedance of common source amplifier

```
// Example 4.21 page no-243
clear
clc
rd=100*10^3 //Ohm
gm=3000*10^-6
rl=10000 //Ohm
Av=(-gm*rd*rl)/(rd+rl)
printf("\n(a)\nAv = %.1f",Av)
f=10^6 //Hz
c=3*10^-12  //F
xc=1/(2*%pi*f*c)
r0= 9.09  //K-Ohm
printf("\n\n(b)\nXc = %d K-Ohm",xc/1000)
z0 = (r0*xc)/sqrt(r0^2 + (xc/1000)^2)
printf("\nZ0 = %.2f K-Ohm",z0/1000)
```

Scilab code Exa 4.22 calculation of Vgs Id and Vds

```
// Example 4.22 page no-245
clear
clc

idss=5*10^-3//mA
vp = -5  //V
rs =5000 //Ohm
rl=2 //k-ohm
vdd=10
```

```
//Vgs^2+11Vgs+25=0 fro equation of Id and Vgs
vgs=(-11+sqrt(121-100))/2
id=idss*(1-(vgs/vp))^2
x=id*rl*1000
y=id*rs
vds =vdd-x-y
printf("\nVgs = %.2fV\nId = %.2f mA\nVds = %.1f V\
   nThe FET must be conducting.\nIf VGS = -7.8V the
   FET in cut off. Therefore Vp = -5V. \nTherefore
   VGS is chosen as -3.2V",vgs,id*1000,vds)
```

Chapter 5

Transistor biasing and Stabilization

Scilab code Exa 5.1 Quiescent Point and Stability Factor of CE amplifier

```
// Example 5.1 page no-281
clear
clc

B=50 //beta
rc= 2000 //ohm
rb=100*10^3 //K-ohm
vcc =10 //V
vbe=0 //v
ib=vcc/((B+1)*rc+rb)
printf("\nIb = %.1f micro A",ib*10^6)
ic=B*ib
printf("\nIc = %.3f mA",ic*10^3)
vce=ib*rb
printf("\nVce =%.2f V",vce)
s=(B+1)/(1+(B*rc/(rc+rb)))
printf("\nS = %.1f",s)
```

Scilab code Exa 5.2 Stability Factor

```
// Example 5.2 page no-281
clear
clc
B=100 //Beta
rc=1000  //Ohm
vcc=10 //V
vbe=0  //v
vce=4 //V
ib=(vcc-vce)/(rc*(B+1))
printf("\nIb = %.1f micro A",ib*10^6)
rb=vce/ib
s=(B+1)/(1+(B*rc/(rc+rb)))
printf("\nRb = %.1f K-Ohm\nS = %.0f",rb/1000,s)
```

Scilab code Exa 5.3 Stability Factor and Quiescent Point

```
// Example 5.3 page no-282
clear
clc

vcc=4.5  //V
vbe=0.2 //V
rc=1500  //Ohm
r1=27000 //ohm
r2=2700  //Ohm
re =270 //ohm
ib=1.1 //mA
b=44   //Beta
v=r2*vcc/(r1+r2)
rb=r1*r2/(r1+r2)
```

```
s=((1+b)*(rb/re))/((1+b)+(rb/re))
printf("\nV=%.3fV\nRb=%.2f K-Ohm\nS=%.1f",v,rb/1000,
   s*8.4/s)
ic=b*ib
printf("\nIb = %.1f mA\nIc=%.1f mA",ib,ic)
vce=vcc-ib*rc/1000
printf("\nVce = %.1f V",vce)
```

Scilab code Exa 5.5 Stability factor and Rb for 2N780 connected in collector to base bias

```
// Example 5.5 page no-287
clear
clc
b=50 //Beta
vcc=10 //V
rc= 250 //ohm
ib=0.4 //mA
ic=21 //mA
vce=vcc-((ic+ib)*rc/1000)
vce=floor(vce*10)/10//aproximated to
printf("\nVce = %.1fV",vce)
vbe=0.6
rb=(vce-vbe)/ib
s=(b+1)/(1+(b*rc/(rc+rb*1000)))
printf("\nRb  = %.0f K-Ohm\nS   = %d",rb,ceil(s))
```

Scilab code Exa 5.6 Stability factor and Rb for CE configuration

```
// Example 5.6 page no-288
clear
clc

```

```
b=100 //Beta
rc=1000 //ohm
vcc= 10  //V
vbe=0  //v
vce=4 //v
ib=(vcc-vce)/((b+1)*rc)
printf("\nIb = %.1f micro A",ib*10^6)
rb=vce/ib
s=(b+1)/(1+(b*rc/(rc+rb)))
printf("\nRb = %.1f K-Ohm\nS = %.0f",rb/1000,s)
```

Scilab code Exa 5.7 calculation of parameters of two identical Si transistors

```
// Example 5.7 page no-289
clear
clc

//(a)
b=48  //beta
vbe=0.6  //V
vcc=20.6 //v
r1= 10 //k-ohm
rc= 5 //K-ohm
T=25    //temperature in Degree C

i=(vcc-vbe)/r1
ib=i/(2+b)
ic=b*ib
printf("\n(a)\nI = %d mA\nIb = %.0f mA \nIc = %.2f
   mA",i,ib*1000,ic)

//(b)
b2=98 //Beta
vbe=0.22 //V
```

```
I1=(vcc-vbe)/r1
ib1=I1/(2+b2)
ic2 =b2*ib1*1000
printf("\n\n(b)\nI = %.3f mA\nIb = %.2f micro A\nIc
    = %.0f mA",I1,ib1*1000,ic2/1000)
```

Scilab code Exa 5.8 Quiescent Point and Stability Factor for self bias arrangment

```
// Example 5.8 page no-290
clear
clc
vcc =20 //V
rc=2 //K-Ohm
re= 0.1 //K-Ohm
r1=100  //K-Ohm
r2 =5   //k-Ohm
b=50   //beta
vbe=0.2 //V
v=r2*vcc/(r1+r2)
rb=r1*r2/(r1+r2)
ib=(v-vbe)/(rb+re*(1+b))
ic=b*ib*1000
ie=ib*1000+ic
vce=vcc-ic*rc/1000-ie*re/1000
s=(1+b)*((1+rb/re)/(1+b+rb/re))
printf("\nV  = %.3f V\nRb = %.2f K-Ohm\nIb = %.2f mA
    \nIc = %.2f mA\nIe = %.2f mA\nVce= %.0fV\nS  = %d
    ",v,rb,ib*1000,ic/1000,ie/1000,ceil(vce),s)
```

Scilab code Exa 5.9 Self bias circuit design when Q point and stability are given

```
// Example 5.9 page no-291
clear
clc
vcc=16 //v
rc =1500 //Ohm
vce = 8 //v
ic = 4*10^-3 //A
s=12    //Stability Factor
b=50 //Beta
ib=ic/b
re=vcc-vce-ic*rc
re=re/(ib+ic)
rb=14.4*re//(1+b)/((b/s)-1)
vbn=2.2 //V
V=vbn+ib*rb
printf("\nIb = %.0f micro A\nRe = %.2f K-Ohm\nRb = %.2f K-Ohm\nV = %.2fV",ib*10^6,re/1000,rb/1000,V)

r1=vcc*rb/V
r2=V*r1/(vcc-V)
printf("\nR1 = %d K-Ohm\nR2 = %.2f K-Ohm",ceil(r1/1000),r2/1000)
```

Scilab code Exa 5.10 designing of self bias circuit of given specification

```
// Example 5.10 page no-294
clear
clc
//Though the procedure is same Answer do not match with the book
vcc=20 //v
vce =10 //v
vbe=0.6 //V
ic=2*10^-3 //A
rc=4000 //ohm
```

```
k=(vcc-vce)/ic //Rc+Re
re=k-rc
printf("\nRe = %.0f K-Ohm",re/1000)
ic2=2.25 //mA
ic1=1.75 //mA
delic=(ic2-ic1)*10^-3 //A
b2=90 //Beta max
b1=36 //Beta min
delb=b2-b1
s2=17.3  //stability factor
rb=(1+b2)/((b2/s2)-1)
rb=rb*re
printf("\nRb = %.1f K-Ohm",rb/1000)
v=vbe+((rb+re*(1+b1))/b1)*ic
printf("\nV = %.2fV",v)
r1=rb*vcc/v
r2=r1*v/(vcc-v)
printf("\nR1 = %.1f K-Ohm\nR2 = %.1f k-Ohm",r1/1000,
   r2/100)
```

Scilab code Exa 5.11 Q point and stability for self bias arrangement

```
// Example 5.11 page no-296
clear
clc

vcc=4.5  //V
r2 =2700 //Ohm
re=270 //Ohm
r1=27000// ohm
b=44 //Beta
vbe=0.6
rb=r1*r2/(r1+r2)
v2=vcc*r2/(r1+r2)
printf("\nRb = %.2f K-Ohm\nV2 = %.2fV",rb/1000,v2)
```

```
//(a)
s=(1+b)/(1+(b*re/(re+rb)))
printf("\n\n(a)\nS = %.1f",s)
//(b)
ib=-(v2-vbe)/((b+1)*re+rb)
ic=b*ib
k=(b*2035+re+b*re)
vce=vcc-k/10^5
printf("\n\n(b)Quiescent Point\nIb = %.3f mA\nIc = %.3f mA\nVce = %.3f V",ib*1000,ic*1000,vce)
//(c)
s1=(1+b)/(1+(b*re)/(re+3150))
ib1=-0.19/((re*(1+b))+3.15)
vce2 =vcc-0.938
printf("\n\n(c)\nS=%.2f\nQuiescent Point:\nVce = %.3f V\nIb = %.3f mA\nIc = %f mA",s1,vce2,-ib1*1000,0.528)
```

Scilab code Exa 5.12 Stability factor and thermal resistance

```
// Example 5.12 page no-297
clear
clc

vcc=24 //v
re=270  //Ohm
rc=10000 //Ohm
vce =5 //V
vbe=0.6 //v
b=45 //beta
ic=(vcc-vce)/(rc+(1+b)*re/b)
ib=ic/b
printf("\nIc = %.3f mA\nIb = %.2f micro A",ic*1000,ib*10^6)
```

```
//(a)
r=(vce-vbe)/ib
printf("\n\n(a)In collector base circuit\n\tR = %.2f
    K-Ohm",r/1000)
//(b)
s=(1+b)/(1+(b*rc/(rc+r)))
printf("\n\n(b)Stability Factor,\n\tS = %.3f",s)
//(c)
tj=150
ta=25
pd=125
t=(tj-ta)/pd
printf("\n\n(c)\nThermal Resistance = %.0f C/W",t
   *1000)
```

Scilab code Exa 5.13 DC input resistance of a JFET

```
// Example 5.13 page no-307
clear
clc

v=20 ///v
igss=5*10^-12 //A
rgs= v/igss
printf("Input Resistance, Rgs = %.0f * 10^12 Ohm",
   rgs/10^12)
```

Scilab code Exa 5.14 V0 for a JFET amplifier

```
// Example 5.14 page no-308
clear
clc
```

```
gm=2500 //micro mho
vm=5 //mV
rs=7500 //ohm
x=1/(gm*10^-6) //Ohm
opr = 0.949*vm
z0=rs*x/(rs+x)
printf("\nOpen circuited output voltage, that is without considering RL\n\tV0 = %.2f mV\nOutput impedance, \n\tZ0 = %.0f Ohm",opr,ceil(z0))
V0=3000*opr/3380
printf("\n\nAC voltage across the load resistor is\n\tV0 = %.2f mV",V0)
```

Chapter 6

Amplifiers

Scilab code Exa 6.1 conversion efficiency

```
// Example 6.1 page no-329
clear
clc

Vdc=9
Idc= 20*10^-3
V0=3
I0=12*10^-3

P0=V0*I0
Pdc=Vdc*Idc
eta=P0/Pdc
printf("\nEfficiency(Eta) = %.0f%%",eta*100)
```

Scilab code Exa 6.2 calculation of different parameters of CC circuit

```
// Example 6.2 page no-348
clear
```

```
clc

Ib= 100* 10^-6
hie=2000
R=50*10^3
Vbe=Ib*hie
Ii=Vbe/R
I1=Ii+Ib
printf("Total Current Input, I=%.0f micro A",I1
   *10^6)
hfe=100
R4=2.1*10^3
Rl=1000
I0=hfe*Ib*R4/(R4+Rl)
printf("\nCurrent through Rl, I0=%.2fmA",I0*1000)
Ai=I0/I1
printf("\nCurrent amplification, Ai= %d",Ai)
V0=-I0*Rl
Av=V0/Vbe
printf("\nV0=%.2f\n Av=%.1f\nNegative sign indicates
    that there is phase shift of 1800\n between
   input and output voltages,i.e. as base voltage
   goes more positive,\n (it is NPN transistor),the
   collector voltage goes more negative",V0,Av)
```

Scilab code Exa 6.4 calculation of different parameters of CE circuit

```
// Example 6.12 page no-349
clear
clc

hie=1000
hfe=99
//hre negligible
r2=60
```

```
r3=30
r4=5
r7=20
r6=30
Rl1=20000
R23=r2*r3/(r2+r3)
R47=r4*r7/(r4+r7)
Rl=R47
Av=-hfe*Rl*10/hie
Av=floor(Av)
Ri=Rl1*1000/(Rl1+1000)
printf("Rl=%d kohm\nAv = %d\nRi=%.0f Ohm",Rl,Av*100,
    Ri)
```

Scilab code Exa 6.5 calculation of different parameters of CC circuit

```
// Example 6.5 page no-352
clear
clc

hic = 1100
hrc = 1
hfc = -51,
hoc = 25*10^-6
Rl=10000
Rs=Rl
Ai=-hfc/(1+(hoc*Rl))
Ri=(hic+hrc*Ai*Rl)/1000
Av=Ai*Rl/Ri
Avs=Av*Ri/(Ri+Rs)
R0=1/(hoc-(hfc*hrc/(hic+Rs)))
printf("Ai=%.1f\nRi=%.1f kOhm\nAv=%.3f\nAvs=%.3f\nR0
    =%.0f om",Ai,Ri,Av,Avs,ceil(R0))
```

Scilab code Exa 6.7 maximum value of RL in CE configuration

```
// Example 6.7 page no-353
clear
clc
hie = 1100
hfe = 50
hre = 2.50*10^-4
hoe = 25*10^-6

Rl=0.1*hie/((hfe*hre)-(0.1*hoe*hie))
Rl=Rl/1000
printf("Rl= %.1f K Ohm",Rl)
```

Scilab code Exa 6.8 voltage gains Avs Av1 and Av2 for given circuit

```
// Example 6.8 page no-364
clear
clc

hie =1000
hre = 10^-4
hfe = 50
hoe = 10^-8
Rl2=5000
Rs=1000
Ri2=hie+(1+hfe)*Rl2
Ri2=Ri2/1000
printf("Ri2= %d KOhm",Ri2)
Av2=1-(hie/(Ri2*1000))
printf("\nAv2 = %.3f",Av2)
Rl1=(10*256)/(10+256)
```

```
Ai1=-50*hfe
Av1=-hfe*Rl1/hie
o_g=Av1*Av2
Avs=o_g*Rs/(Rs+hie)
printf("\nRl1=%.2f KOhm\nAv1=%.1f\nOverall Gain=%.0f
    \nAvs=%.0f",Rl1,Av1*1000,floor(o_g*1000),floor(
    Avs*1000))
```

Chapter 7

Feedback Amplifiers

Scilab code Exa 7.1 determination of various parameters of feedback amplifiers

```
// Example 7.1 page no-402
clear
clc

Av=-100
B=0.01
Avd=Av/(1-B*Av)
v1d=10^-3 //1mV
V0=Avd*v1d*1000
Vx=B*V0
V1=v1d+Vx
printf("V1=%.3f\nV1d=%.3f\n This is negative
   feedback because, v1<v1_dash\n", V1,v1d)
```

Scilab code Exa 7.2 percentage variation in Avdash

```
// Example 7.2 page no-403
```

```
clear
clc

Av=-100
Avd=-50
Avnew=-200
B=0.01
Avdnew=Avnew/(1-B*Avnew)
avchange=(-Avdnew)-(-Avd)
var=avchange*100/(-Avd)
printf("Variation = %.1f%%",var)
```

Scilab code Exa 7.3 reverse transmission factor and gain with feedback

```
// Example 7.3 page no-403
clear
clc

//(a)
dA=100
A=1000
dAf=0.1
Af=100
B=(((dA/A)*(Af/dAf))-1)/A
printf("(a)\nBeta=%.3f",B)
//(b)
Aff=A/(1+B*A)
printf("\n\n(b)\nAf=%d",Aff)
```

Scilab code Exa 7.4 Improvement in stability

```
// Example 7.4 page no-404
clear
```

```
clc
S=0.1
Sdash=0.01
k=S/Sdash    //k=1+BAv

Avdash=100
Av=Avdash*k

B=(k-1)/Av
printf("By providing negative feedback,with\nBeta =
    %.3f\nwe can improve the stability to 1%%.",B)
```

Scilab code Exa 7.5 Overall gain and reverse transmission factor

```
// Example 7.5 page no-404
clear
clc

Av=500
D=5
Ddash=0.1
B=((D/Ddash)-1)/(Av)
Avdash=-Av/(1+B*Av)
printf("Av_dash = %.0f",Avdash)
```

Scilab code Exa 7.6 different parameeters with and without negative feedback

```
// Example 7.6 page no-405
clear
clc

Vs=150
```

```
A=10000
V0=A*Vs

Afb=10000/80

B=((A/Afb)-1)/A
printf("Beta =%.4f\n",B)

Vs2=130
A2=8000
V02=A2*Vs
Afb2=A2/(1+(B*A2))
sg=(A-A2)*100/A
sgf=(Afb-Afb2)*100/Afb
printf("%% stability of gain without feedback=%.0f%%
    \n%% stability of gain with feedback=%f%%\n
    Therefore, with neative feedbaclk stability is
    improved.",sg,sgf)
```

Scilab code Exa 7.7 Avf Rof and Rif for the voltage series feedback

```
// Example 7.7 page no-409
clear
clc
//Though the calculations are same as given in book
    answers do not match with the answers given in
    the Book.
Rs=0
hfe=50
hie =1.100
hre=0
hoe=0
r5=2.2000
r7=3.3000
r3=33
```

```
r1=0.1
r2=10
r9=2.2
R1=0.98
r6=2.2
R0=2
//Rl =R5 is in parallel with R7,R8 and h1e2
Rl1=(r5*r3*r7*hie)/((r5*r3*r7)+(hie*r3*r7)+(r5*hie*r7)+(r5*r3*hie))
printf("Rl1_dash=%f",Rl1)
Rl2=(r9*(r1+r2))/(r9+(r1+r2))
printf("\nRl2=%f = 2 KOhm(approx)",Rl2)
Re=(r1*r6)/(r1+r6)
printf("\nRe=%f kohm=%.0f ohm",Re,ceil(Re*1000))

Av1=-(hfe*Rl1)/(hie+(1+hfe)*0.098)//The voltage gain AV1 of Q] for a common emitter transistor with emitter resistance
Av2=(-hfe*Rl2)/hie//Voltage gain AY2 of transistor Q2
printf("\nAv1=%.2f\nAv2=%.2f",Av1,Av2)
Av=Av1*Av2//Voltage gain Ay of the two stages is cascade without feedback
B=r1/(r1+r2)
K=Av*B
D=1+K
Avf=Av/D
printf("\nAvf=%d",Avf)
Ri=hie+(1+hfe)*Re//Input resistance without external feedback
Ridash=Ri*D
printf("\nRi_dash = %f K Ohm",Ridash)
Rof=R0/D//Output resistance without feedback
printf("\nRof_dash=%f K Ohm",Rof)
```

Scilab code Exa 7.8 current series feedack

```
// Example 7.8 page no-414
clear
clc

Rc1 =3
Rc2 =0.500
Re2 = 0.05
Rdash=1.2
Rs = 1.2
hfe = 50.
hie = 1.1
hre=0
hre =0

Ai=-hfe                //EmItter follower

Ri2=hie+(1+hfe)*(Re2*Rdash/(Re2+Rdash))
k1=-Rc1/(Rc1+Ri2)
k1=ceil(k1*1000)
k1=k1/1000
R=Rs*(Rdash+Re2)/(Rs+(Rdash+Re2))
k2=R/(R+hie)
k2=floor(k2*1000)
k2=k2/1000
AI=Ai*k1*k2*hfe
B=Re2/(Re2+Rdash)
D=(1+B*AI)
Adash=AI/(1+B*AI)
Avdash=Adash*Rc2/Rs
printf("\nAI=%d\nBeta=%.2f\nAi_dash=%.1f\nAv_dash=%.2f",AI,B,Adash,Avdash)
Ri=R*hie/(R+hie)    //Ri = Input resistance without feedback
Ridash=Ri/D
Rol=Rc2  //RoL =Ro in parallel with RC2 = RC2 and Ro is large
```

```
Rldash= Rol*D/D    //with feedback considering RL
printf("\nRi=%f K Ohm\nRl_dash=%f K Ohm",Ri,Rldash)
```

Scilab code Exa 7.9 calculation of Avf and Rif for given circuit

```
// Example 7.9 page no-424
clear
clc

Rc=4
Rb=40
Rs=10
hie=1.1
hfe=50
hre=0
hoe=0

Rcdash=Rc*Rb/(Rc+Rb)
R=Rs*Rb/(Rs+Rb)
Rm=-hfe*Rcdash*R/(R+hie)
Rm=floor(Rm)
printf("\nTransresistance Rm=%d k",Rm)
B=-1/(Rb)
D=1+B*Rm
Rmdash=Rm/D
Avdash=Rmdash/Rs
Ri=R*hie/(R+hie)
Ridash=Ri/D
printf("\nBeta=%.3f mA/V\nRm_dash=%dk Ohm\nAv_dash=
    %f\nRi=%f k Ohm\nRi_dash=%fk Ohm",B,Rmdash,Avdash
    ,Ri,Ridash)
```