Scilab Textbook Companion for Electronic Devices And Circuits by D. A. Bell[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

Basic Semiconductor and pn - Junction Theory

Scilab code Exa 1.1 Charge densities of free electrons and holes

```
//chapter 1
//example 1.1
//page 15
printf("\n")
printf("given")
Nd=3*10^14;Na=.5*10^14;//all in atom/cm^3
ni=1.5*10^10;
disp("resultant densities of free electrons and hole
   ")
ne=(-(Na-Nd)+(sqrt(((Na-Nd)^2)+4*ni^2)))/2;
disp(ne)//electron densities in electron/cm^3
Nd>Na;
n=Nd-Na;
disp(n)
p=(ni^2)/n
printf("densities of hole is %dhole/cm3\n",p)
```

Scilab code Exa 1.2 `Drift current velocities for electrons and holes`

```
//chapter 1
//example 1.2
//page 18
printf("\n")
printf("given")
l=1*10^-3;E=10;
un=1500*10^-4;up=500*10-4;
Vn=-(un*E)/l;
printf("drift current is %dm/s\n",Vn)
disp("drift current of hole")
Vp=(up*E)/l;
printf("drift current is %dm/s\n",Vp)
```

Scilab code Exa 1.3 `Conductivity and Resistance of a given material`

```
//chapter 1
//example 1.3
//page 19
printf("\n")
printf("given")
l=1*10^-3;a=.1*10^-4;
ni=1.5*10^10;p=1.5*10^10;
disp("a)")
un=1500;up=500;//in cm3/V.s
q=1.6*10^-19;
m=q*((ni*un)+(p*up))*10^6;
printf( "mobility is %3.2fmicro/ohmcm\n",m)
R=l/(m*a);
printf(" resistance is %3.2fMohm\n",R)
disp("b)")
//for doped material
n=8*10^13;
p=(ni^2)/n
```

```
m=q*((n*un)+(p*up));
printf("mobility is %3.4f/ohmcm\n",m)
R=l/(m*a);
printf(" resistance is %dohm\n",R)
```

Scilab code Exa 1.4 Levels of reverse saturation current at different temperatures

```
//chapter 1
// eaxample 1.4
//page 26
printf("\n")
printf("given")
T1=25;T2=35;T3=45;
I0=30//nA
disp("I0(35)=I0*2^(T2-T1)/10")
//on solving
I0(35)=I0*2^((T2-T1)/10);
printf("current at 35c is %dnA\n",I0(35))
disp("I0(45)=I0*2^(T3-T1)/10")
//on solving
I0(45)=30*2^2;
printf("current at 45c is %dnA\n",I0(45))
```

Scilab code Exa 1.5 Junction Current of silicon pn-junction

```
//chapter 1
//example 1.5
//page 28
printf("\n")
printf("given")
I0=30;Vd=.7;n=2;Vt=26*10^-3;
k=Vd/(n*Vt);
disp("junction current")
```

```
Id=I0*((2.7^k)-1)*10^-6
printf(" forward bais current is %dmA\n",Id)
disp("b)")
Vd=-10// reverse bais
k=Vd/(n*Vt);
Id=I0*((2.7^k)-1)
printf(" forward bais current is %dnA\n",Id)
```

Scilab code Exa 1.6 Forward bias voltage of a silicon pn - Junction

```
//chapter 1
//example 1.6
//page 29
printf("\n")
printf("given")

Id=.1*10^-3;n=2;
Vt=26*10^-3;
I0=30*10^-9;
disp("a)")
Vd=(n*Vt)*log(Id/I0)*10^3;
printf(" forward bais current is %dmV\n",Vd)
disp("b)")
Id=10*10^-3
Vd=(n*Vt)*log(Id/I0)*10^3;
printf(" forward bais current is %dmV\n",Vd)
```

Chapter 2

Semiconductor Diodes

Scilab code Exa 1.1 Forward and reverse resistances of a silicon diode

```
//chapter 2
//example 2.1
//page 37
printf("\n")
printf("given")
disp("a)")
If=100*10^-3;Vf=.75;//given
disp("forward resistance")
Rf=Vf/If;
printf("forward resistnace is %3.1fohm\n",Rf)
disp("b)")
Vr=50;Ir=100*10^-9;
Rr=(Vr/Ir);
printf("reverse resistnace is %3.0fohm\n",Rr)
```

Scilab code Exa 2.1 Dynamic resistance of a diode

```
//chapter 2
```

```
//example 2.2
//page 39
printf("\n")
printf("given")
If=70*10^-3;
rd=(26*10^-3)/If;
printf("dynamic resistance is %3.2fohm\n",rd)
disp("a)")
If=60*10^-3;Vf=.025;
rd=Vf/If;
printf("dynamic resistance is %3.2fohm\n",rd)
```

Scilab code Exa 2.3 Diode current

```
//chapter 2
//example 2.3
//page 40
printf("\n")
printf("given")
R1=4.7*10^3;E=15;Vf=.7;
disp("diode current is E=If*R1+Vf")
If=((E-Vf)/R1)*10^3;
printf(" diode current is %3.2fmA\n",If)
```

Scilab code Exa 2.5 Forward current of a diode

```
//chapter 2
//example 2.5
//page 41
printf("\n")
printf("given")
E=1.5;Vf=.7;R1=10;rd=.25;
disp("a)")
```

```
If=(E-Vf)/R1;
printf(" forward current is %3.3fmA\n",If)
disp("b)")
If=(E-Vf)/(R1+rd);
printf(" forward current is %3.3fmA\n",If)
```

Scilab code Exa 2.6 DC load line for forward biased diode

```
//chapter 2
//example 2.6
//page 43
printf("\n")
printf("given")
If=0;Vf=5;R1=100;
E=(If*R1)+Vf
disp("E")
disp("B)")
Vf=0;E=5;R1=100;
If=(E/R1)*1000;
printf("resistance is %dmA\n",If)
```

Scilab code Exa 2.8 Calculating supply voltage from given Q - point

```
//chapter 2
//example 2.8
//page 45
printf("\n")
printf("given")
If=50*10^-3;Vf=1.1;R1=100;
Vf1=If*R1;
disp("Vf1")
E=Vf1+Vf
printf(" new supply voltage is %3.1fV\n",E)
```

Scilab code Exa 2.9 Maximum forward current of a diode at a given temperature

```
//chapter 2
//example 2.9
//page 48
printf("\n")
printf("given")
P1=700*10^-3;Vf=.7;
//at 25C
If=P1/Vf;
disp("If")
//at 65C
D=5*10^-3;T=65-25;
P2=P1-D*T
If=P2/Vf;
printf( "maximum forward current at 65C is %3.3fA\n"
   ,If)
```

Scilab code Exa 2.10 Forward voltage drop and junction dynamic resistance of a dio

```
//chapter 2
//example 2.10
//page 49
printf("\n")
printf("given")
Vf1=.7;Vf=-1.8*10^-3;If=26*10^-3;
T=100-25;
Vf2=Vf1+(T*Vf);
printf(" voltage at 100C is %3.3fV\n",Vf2)
disp("At 25C")
T1=25;
```

```
rd=(26*10^-3/If)*((T1+273)/298);
printf(" resistance at 25 C is %dohm\n",rd)
disp(" At 100C")
T2=100;
rd=(26*10^-3/If)*((T2+273)/298);
printf(" resistance at 100 C is %3.2fohm\n",rd)
```

Scilab code Exa 2.11 Diffusion capacitance of a Si diode

```
//chapter 2
//example 2.11
//page 51
printf("\n")
printf("given")
If=10*10^-3;Vf=.7;t=70*10^-9;
Cd=((t*If)/Vf)*10^9;
printf(" diffusion capacitance is %dnF\n",Cd)
```

Scilab code Exa 2.12 Minimum fall times for 1N915 and 1N917 diodes

```
//chapter 2
//example 2.12
//page 53
printf("\n")
printf("given")
disp("A")
trr=10*10^-9;
tf=10*trr*10^9
printf("minimum fall times is %dns\n",tf)
disp("B)")
trr=3;
tf=10*trr;
printf("minimum fall times is %dns\n",tf)
```

Scilab code Exa 2.14 Plotting Diode charecterstics

```
//chapter 2
//example 2.14
//page 58
printf("\n")
printf("given")
Io=75*10^-3;
//vertical scale of 5mA/cm
If=Io/5*10^-3
R1=15/(75*10^-3)
P=((Io)^2)*R1
```

Scilab code Exa 2.15 Maximum current through the Zener diode

```
//chapter 2
//example 2.15
//page 63
printf("\n")
printf("given")
Vz=7.5;Pd=400*10^-3;D=3.2*10^-3;
Izm=Pd/Vz
printf("current at 50C is %3.3fA\n",Izm)
disp("At 100C")
P2=Pd-((100-50)*D)
printf(" power at 100C is %3.3fW\n",P2)
Izm=P2/Vz;
printf(" current at 100C is %3.3fA\n",Izm)
```

Scilab code Exa 2.16 `Maximum diode current and power dissipation of 1N755`

```
//chapter 2
//example 2.16
//page 64
printf("\n")
printf("given")
E=20;R1=620;Vz=7.5;
Vr1=E-Vz
Iz=Vr1/R1;
printf(" diode current is %3.5fA\n",Iz)
Pd=Vz*Iz;
printf( "power dissipation is %3.3fW\n",Pd)
```

Scilab code Exa 2.17 `Upper and Lower limits of Zener voltage(Vz)`

```
//chapter 2
//example 2.17
//page 64
printf("\n")
printf("given")
Vz=4.3;Zz=22;Iz=20*10^-3;
Iz1=5*10^-3;//change in current
Vz1=Iz1*Zz;
Vzmax=Vz+Vz1;
printf(" maximum voltage is %3.3fV\n",Vzmax)
Vzmin=Vz-Vz1;
printf("minimum voltage is %3.3fV\n",Vzmin)
```

Chapter 3

Diode applications

Scilab code Exa 3.1 Peak output voltage(Vpo), Peak load current(Ip) and peak rever

```
//chapter 3
//example 3.1
//page 73
printf("\n")
printf("given")
Vf=.7;Rl=500;Vi=22;
Vpi=1.414*Vi;
disp("Vpi")
Vpo=Vpi-Vf;
printf(" peak vouput voltage is %3.2fV\n",Vpo)
Ip=Vpo/Rl;
printf("peak load current is %3.4fA\n",Ip)
PIV=Vpi;
printf("diode paek reverse voltage %3.2fV\n",PIV)
```

Scilab code Exa 3.2 Peak output voltage and current of a Bridge rectifier

```
//chapter 3
```

```
//example 3.2
//page 779
printf("\n")
printf("given")
Vi=30;Rl=300;Vf=.7;
Vpi=1.414*Vi;
Vpo=Vpi-2*Vf;
printf(" peak output voltage %dV\n",Vpo)
Ip=Vpo/Rl;
printf(" current bridge is %3.3fA\n",Ip)
```

Scilab code Exa 3.3 Peak to Peak ripple voltage of HWR

```
//chapter 3
//example 3.3
//page 83
printf("\n")
printf("given")
C1=680*10^-6;Eo=28;Rl=200;f=60;
Il=Eo/Rl;
T=1/f;
t1=T;
Vr=(Il*t1)/C1;
printf("peak to peak ripple voltage is %3.2fV\n",Vr)
```

Scilab code Exa 3.4 Required reservoir capacitance of a HWR

```
//chapter 3
//example 3.4
//page 84
printf("\n")
printf("given")
Eo=20;Rl=500;f=60;
```

```
Vr=(10*Eo)/100//10% of Eo
Il=Eo/Rl
T=1/f;
t1=T
C1=((Il*t1)/Vr)*10^6;
printf("reservior capacitance is %duF\n",C1)
```

Scilab code Exa 3.5 Charging and Discharging time of Half -Wave Rectifier(HWR)

```
//chapter 3
//example 3.5
//page 85
printf("\n")
printf("given")
Eo=20;f=60;Rl=500;
Il=Eo/Rl;
Vr=(10*Eo)/100;
printf("10percent of Eo is %dV\n",Vr)
Eomin=Eo-.5*Vr
Eomax=Eo+.5*Vr
Q1=sin(inv(Eomin/Eomax));
Q1=65
Q2=90-Q1
T=1/f;
t2=(Q2*T)/360;
printf(" charging time is %3.4fs\n",t2)
t1=T-t2
printf("discharging time is %3.4fs\n",t1)
C1=((Il*t1)/Vr)*10^6;
printf("reservior capacitance is %duF\n",C1)
```

Scilab code Exa 3.6 Surge limiting resistance of HWR

```
//chapter 3
//example 3.6
//page 88
printf("\n")
printf("given")
Eo=21;Vf=.7;
t1=1.16*10^-3;t2=15.54*10^-3;
Vp=Eo+Vf
Vr=2*Vp
Il=40*10^-4;
Ifrm=(Il*(t1+t2))/t2;
Ifsm=30;
Rs=Vp/Ifsm
printf(" surge limiting resistance is %3.2fohm\n",Rs
    )
```

Scilab code Exa 3.7 `RMS voltage(Vrms), RMS current(Irms) and Transformer primary c`

```
//chapter 3
//example 3.7
//page 89
printf("\n")
printf("given")
Vf=.7;Eo=21;Il=40*10^-3;Vp=115;
Vs=.707*(Vf+Eo);
printf(" Vrms voltage is %3.3fV\n",Vs)
Is=3.6*Il;
printf(" rms current is %3.3fA\n",Is)
Ip=(Vs*Is)/Vp;
printf("primary current is %3.3fA\n",Ip)
```

Scilab code Exa 3.8 `Required reservoir capacitance value for full- wave rectifier`

```
//chapter 3
//example 3.8
//page 92
printf("\n")
printf("given")
Vr=2;T=16.7*10^-3;t2=1.16*10^-3;Il=40*10^-3; //from
    example 3.5
t1=(T/2)-t2
C1=(Il*t1)/Vr;
printf(" resrvior capacitor is %3.6fF\n",C1)
```

Scilab code Exa 3.9 Reservoir capacitor value for full - wave rectifier

```
//chapter 3
//example 3.9
//page 93
printf("\n")
printf("given")
Vr=2;T=16.7*10^-3;Il=40*10^-3;
t1=T/2
C1=(Il*t1)/Vr;
printf(" reservior capacitance is %3.6fF\n",C1)
```

Scilab code Exa 3.10 Surge limiting resistance of bridge rectifier

```
//chapter 3
//example 3.10
//page 93
printf("\n")
printf("given")
Eo=21;Vf=.7;Il=40*10^-3;t1=7.19*10^-3;t2=1.16*10^-3;
Vp=Eo+(2*Vf)
Vr=Vp
```

```
If=Il/2
Ifrm=Il*(t1+t2)/t2
Ifsm=30;
Rs=Vp/Ifsm
printf("surge limiting resistance is %3.3fohm\n",Rs)
```

Scilab code Exa 3.11 Transformer selection for a full-wave bridge rectifier

```
//chapter 3
//example 3.11
//page 73
printf("\n")
printf("given")
Eo=21;Vf=.7;Il=40*10^-3;Vp=115;
Vs=.707*(Eo+2*Vf)
Is=1.6*Il
Ip=(Vs*Is)/Vp;
printf(" supply current is %3.3fA\n",Ip)
```

Scilab code Exa 3.12 DC output voltage and peak to peak voltage of given ripple wa

```
//chapter 3
//example 3.12
//page 97
printf("\n")
printf("given")
Eo=20;Il=40*10^-3;R1=22;Vr=2;C1=150*10^-6;C2=C1;fr
   =120;
Vo=Eo-Il*R1;
vi=Vr/3.14
Xc2=1/(2*3.14*fr*C2)
vo=(vi*Xc2)/sqrt((R1^2) + (Xc2^2))
printf(" dc output voltage is %3.3fV\n",vo)
```

```
Vpp=2*vo;
printf(" peak to peak voltage is %3.3fV\n",Vpp)
```

Scilab code Exa 3.13 Suitable capacitor and inductor values of LC pi filter

```
//chapter 3
//example 3.13
//page 98
printf("\n")
printf("given")
C1=150*10^-6;C2=C1;vi=4;vo=1;f=120;
Xc2=8.84;//FROM EXAMPLE 3.12
Xl=Xc2*((vi/vo)+1)
L1=Xl/(2*3.14*f);
printf(" suitable value of L1 is %3.3fH\n",L1)
```

Scilab code Exa 3.14 Peak output voltage, value of inductor (L1)and capacitor(C1)

```
//chapter 3
//example 3.14
//page 101
printf("\n")
printf("given")
Edc=20;vo=.24;Vo=20;Il=40*10^-3;fr=120;
Eomax=(3.14*Edc)/2
Epeak=(4*Eomax)/(3*3.14)
vi=Epeak;
Rl=Vo/Il
Xlc=(2*Rl)/3
Lc=Xlc/(2*3.14*fr)
L=1.25*Lc;
Xl=2*3.14*fr*L
Xc=Xl/((vi/vo)+1)
```

```
C1=1/(2*3.14*fr*Xc)
```

Scilab code Exa 3.15 Load regulation,Source effect, line regulation of FWR

```
//chapter 3
//example 3.15
//page 105
printf("\n")
printf("given")
Eo=20
E0=20-19.7//load effect
loadregulation  =(E0*100)/Eo//percentage
sourceeffect=20.2-20
lineregulation =(sourceeffect*100)/Eo
```

Scilab code Exa 3.16 Parameters of Zener diode as voltage regulator

```
//chapter 3
//example 3.16
//page 108
printf("\n")
printf("given")
Vz=9.1;Izt=20*10^-3;Es=30;
R1=(Es-Vz)/Izt
Pr1=(Izt^2)*R1
Es=27;
Iz=(Es-Vz)/R1
```

Scilab code Exa 3.17 Maximum load current of Load regulator circuit

```
//chapter 3
//example 3.17
//page 110
printf("\n")
printf("given")
Vz=6.2;Pd=400*10^-3;Es=16;
Izm=Pd/Vz
R1=(Es-Vz)/Izm
Pr1=(Izm^2)*R1
Izmin=5*10^-3;
Izmax=Izm-Izmin;
printf("maximum current is %3.4fA\n",Izmax)
```

Scilab code Exa 3.18 Line regulation, load regulation and ripple rejection ratio o

```
//chapter 3
//example 3.18
//page 112
printf("\n")
printf("given")
Zz=7;Es=16;Vo=6.2;Il=59.5*10^-3;
es=(10*Es)/100//10% os Es
Rl=Vo/Il;
disp("es*Zz||Rl/R1+Zz||Rl")
V0=es*((Zz*Rl)/(Zz+Rl))/(Rl+((Zz*Rl)/(Zz+Rl)))
lineregulation=(V0*100)/Vo;
printf("line regulation voltage is %3.3fpercentage\n",lineregulation)
V0=Il*((Zz*Rl)/(Zz+Rl))
loadregulation=(V0*100)/Vo;
printf("loadregulation voltage is %3.3fpercentage\n",loadregulation)
Rr=((Zz*Rl)/(Zz+Rl))/(Rl+(Zz*Rl)/(Zz+Rl));
printf("ripple rejection is %3.3f\n",Rr)
```

Scilab code Exa 3.19 Load resistance (R1), forward and reverse currents of Voltage

```
//chapter 3
//example 3.19
//page 114
printf("\n")
printf("given")
E=9;Vf=.7;If=1*10^-3;
Vo=E-Vf
R1=Vo/If
Vr=E;
printf("diode forward voltage is %3.2fohm\n",Vr)
printf("diode forward current is %3.3fA\n",If)
```

Scilab code Exa 3.20 Forward and reverse currents for diode as Negative shunt clip

```
//chapter 3
//example 3.20
//page 117
printf("\n")
printf("given")
E=5;Vo=4.5;Il=2*10^-3;Vf=0.7;
R1=(E-Vo)/Il;
printf(" suitable resistance is %dohm\n",R1)
Vr=E
disp("when diode is forward baised")
If=(E-Vf)/R1;
printf(" diode forward current is %3.3fA\n",If)
```

Scilab code Exa 3.21 `Suitable resistor for biased shunt clipper`

```
//chapter 3
//example 3.21
//page 119
printf("\n")
printf("given")
Vo=2.7;Vf=.7;E=9;If=1*10^-3;Il=If;
Vb=Vo-Vf;
R1=(E-Vo)/(Il+If);
printf("resistance is %3.3fOhm\n",R1)
```

Scilab code Exa 3.22 `Zener diode as shunt clipper`

```
//chapter 3
//example 3.22
//page 120
printf("\n")
printf("given")
Vo=5;Vf=.7;Iz=5*10^-3;Il=1*10^-3;E=20;
Vz=Vo-Vf
R1=(E-Vo)/(Il+Iz);
printf("zener diode resistance si %dohm\n",R1)
```

Scilab code Exa 2.23 `Tilt on the output waveform of a diode clamping circuit`

```
//chapter 3
//example 3.21
//page 119
printf("\n")
printf("given")
E=10;R1=56*10^3;f=1000;C1=1*10^-6;
Vo=2*E
```

```
Ic=Vo/R1
t=1/(2*f);
Vc=(Ic*t)/C1;
printf(" tilt output voltage is %3.3fV\n",Vc)
```

Scilab code Exa 3.24 Component determination of negative voltage clamping circuit

```
//chapter 3
//example 3.24
//page 124
printf("\n")
printf("given")
f=500;Rs=600;E=8;
t=1/(2*f)
PW=t;
C1=PW/Rs
Vo=2*E
Vc=(1*Vo)/100;//1% of  the Vo
Ic=(Vc*C1)/t
R1=(2*E)/Ic;
printf("suitable value of R1 is %dohm\n",R1)
```

Scilab code Exa 3.25 Upper and lower voltages for biased clamping circuits

```
//chapter 3
//example 3.25
//page 125
printf("\n")
printf("given\n")
Vf=.7;E=6;Vb1=3;
Vc=Vb1-Vf-(-E)
Vo=Vb1-Vf
disp("when input is +E")
```

```
Vo=E+Vc
Vc=E-Vb1-Vf
Vo=Vb1+Vf
disp("when input is -E")
Vo=-E+(-Vc)
```

Scilab code Exa 3.26 Capacitor (C1, C2) values for voltage doubling circuit

```
//chapter 3
//example 3.26
//page 130
printf("\n")
printf("given")
E=12;Vf=.7;Rl=47*10^3;f=5000;
Vo=2*(E-Vf)
Il=Vo/Rl
disp(" capacitor discharge time")
t=1/(2*f)
disp(" for 1% ripple allow .5% due to discharge of
   C2 ,.5%due to discharge of C1")
Vc=(.5*Vo)/100
C2=((Il*t)/Vc)*10^6;
printf(" value of capacitor C2 is %3.2fuF\n",C2)
C1=2*C2;
printf("value of capacitor C1 is %3.2fuF\n",C1)
```

Scilab code Exa 3.27 Diode forward current for AND logic circuit

```
//chapter 3
//example 3.21
//page 119
printf("\n")
printf("given")
```

```
Vcc=5;Vf=.7;R1=3.3*10^3;
disp("A)")
Ir1=(Vcc-Vf)/R1;
printf("diode forward current when all input are low
    is %3.4fA\n",Ir1)
disp("for each diode")
If=Ir1/3
disp("B)")
If2=Ir1/2
If3=If2;
printf(" forward current when input A is high is %3
    .5fA\n",If3)
disp("C)")
If3=Ir1;
printf(" forward current when input A and B are high
    and C is low %3.5fA\n",If3)
```

Chapter 4

Bipolar Junction Transistors

Scilab code Exa 4.1 Determine the emitter (Ie) and base (Ib) currents of a transis

```
//chapter 4
//example 4.1
//page 153
printf("\n")
printf("given")
Adc=.98;Ib=100*10^-6;
Ic=(Adc*Ib)/(1-Adc);
printf("value of Ic is %3.3fA\n",Ic)
Ie=Ic/Adc;
printf(" value of Ie is %3.3fA\n",Ie)
Bdc=Adc/(1-Adc);
disp(Bdc)
```

Scilab code Exa 4.2 Common base current gain (Adc), Common-emitter current gain (B

```
//chapter 4
//example 4.2
//page 153
```

```
printf("\n")
printf("given")
Ic=1*10^-3;Ib=25*10^-6;
Bdc=Ic/Ib
Ie=Ic+Ib
Adc=Ic/Ie
Ib=Ic/Bdc
```

Scilab code Exa 4.3 DC collector voltage and circuit voltage gain of CE amplifier

```
//chapter 4
//example 4.1
//page 153
printf("\n")
printf("given")
Bdc=80;Bac=Bdc;Vcc=18;R1=10*10^3;
Ib=15*10^-6;//for Vb=.7
Ic=Bdc*Ib;
Vc=Vcc-(Ic*R1);
printf("dc collector voltage is %dV\n",Vc)
disp(" when vi=50mV")
Ib=3*10^-6;Vi=50*10^-3;
Ic=Bdc*Ib
Vo=Ic*R1
Av=Vo/Vi
```

Scilab code Exa 4.4 Collector current (Ic), Base current (Ib) and hFE of BJT as sw

```
//chapter 4
//example 4.4
//page 160
printf("\n")
printf("given")
```

```
Vcc=5;Vce=.2;R2=4.7*10^3;Vi=2;Vbe=.7;R1=12*10^3;
Ic=(Vcc-Vce)/R2
Ib=(Vi-Vbe)/R1
hFE=Ic/Ib
```

Scilab code Exa 4.6 Base current (Ib) and collector current (Ic) from output chare

```
//chapter 4
//example 4.6
//page 169
printf("\n")
printf("given")
Vbe=.7;Vce=-6;
Ib=20*10^-6
Ic=2.5*10^-3//from output characteristics
Bdc=Ic/Ib
```

Chapter 5

BJT biasing

Scilab code Exa 5.1 DC load line

```
//chapter 5
//example 5.1
//page 182
printf("\n")
printf("given")
Rc=12*10^3;Vcc=20;
disp(" When Ic=0")
Ic=0;
Vce=Vcc-Ic*Rc
disp(" At point A Ic=0 nad Vce=20")
disp("When Vce=0")
Vce=0;
Ic=Vcc/Rc
disp(" At point B Ic=1.7mA and Vce=0")
```

Scilab code Exa 5.2 DC Bias point (Q-Point)

```
//chapter 5
```

```
//example 5.2
//page 186
printf("\n")
printf("given")
Vcc=18;Rc=2.2*10^3;Ib=40*10^-6;
disp("when Ic=0")
Ic=0;
Vce=Vcc-Ic*Rc
disp("At point A Ic=0 and Vce=18")
disp("when Vce=0")
Ic=Vcc/Rc
disp(" at point B Ic=8.2mA and Vce=0")
```

Scilab code Exa 5.3 DC analysis of common-base amplifier

```
//chapter 5
//example 5.1
//page 182
printf("\n")
printf("given")
Rb=470*10^3;Rc=2.2*10^3;Vcc=18;hfe=100;
Vee=.7;
Ib=(Vcc-Vee)/Rb
Ic=hfe*Ib
Vce=Vcc-Ic*Rc
```

Scilab code Exa 5.4 Maximum and Minimum levels of Ic and Vce for base bias circuit

```
//chapter 5
//example 5.4
//page 189
printf("\n")
printf("given")
```

```
Rc=12.0*10^3;
hFEmin=50;hFEmax=200;Vcc=18;Vbe=.7;Rb=470*10^3;
Ib=(Vcc-Vbe)/Rb
Ic=hFEmin*Ib
Vce=Vcc-Ic*Rc
Ic=hFEmax*Ib
Vce=Vcc-Ic*Rc
```

Scilab code Exa 5.5 DC analysis of collector-base bias circuit

```
//chapter 5
//example 5.5
//page 193
printf("\n")
printf("given")
Rb=270*10^3;Rc=2.2*10^3;Vcc=18;
hFE=100;Vbe=.7;
Ib=(Vcc-Vbe)/(Rb+Rc*(hFE+1))
Ic=hFE*Ib
Vce=Vcc-Rc*(Ic+Ib)
```

Scilab code Exa 5.7 DC analysis of voltage -divider bias circuit

```
//chapter 5
//example 5.7
//page 197
printf("\n")
printf("given")
R1=33*10^3;R2=12*10^3;Rc=1.2*10^3;Re=1*10^3;
Vcc=18;Vbe=.7;
Vb=(Vcc*R2)/(R1+R2)
Ve=Vb-Vbe
Ie=(Vb-Vbe)/Re
```

```
Ic=Ie;
Vc=Vcc-(Ic*Rc)
Vce=Vc-Ve
```

Scilab code Exa 5.8 Precise circuit analysis of voltage-divider bias circuit

```
//chapter 5
//example 5.8
//page 199
printf("\n")
printf("given")
Vcc=18;Vbe=.7;hfe=100;
R1=33*10^3;R2=12*10^3;Re=1*10^3;Rc=1.2*10^3;
Vt=(Vcc*R2)/(R1+R2)
Rt=(R1*R2)/(R1+R2)
Ib=(Vt-Vbe)/(Rt+Re*(1+hfe))
Ic=hfe*Ib
Ie=Ib+Ic
Ve=Ie*Re
Vc=Vcc-(Ic*Rc)
Vce=Vc-Ve
```

Scilab code Exa 5.9 Accurate analysis of voltage-divider bias circuit for minimum

```
//chapter 5
//example 5.9
//page 200
printf("\n")
printf("given")
Vcc=18.0;
Rc=1.2*10^3;
hfe=50;Vt=4.8;Rt=8.8*10^3;//from example 5.7
Re=1*10^3;Vbe=.7;
```

```
Ib=(Vt-Vbe)/(Rt+Re*(1+hfe))
Ic=hfe*Ib
Ie=Ib+Ic
Ve=Ie*Re
Vc=Vcc-(Ic*Rc)
Vce=Vc-Ve
```

Scilab code Exa 5.10 Analyze voltage divider bias circuit for a maximum hFE of 200

```
//chapter 5
//example 5.10
//page 201
printf("\n")
printf("given")
Vcc=18.0;
Rc = 1.2*10^3;
Vt=4.8;Rt=8.8*10^3;//from example 5.8
Re=1*10^3;Vbe=.7;hfe=200;
Ib=(Vt-Vbe)/(Rt+Re*(1+hfe))
Ic=hfe*Ib
Ie=Ib+Ic
Ve=Ie*Re
Vc=Vcc-(Ic*Rc)
Vce=Vc-Ve
```

Scilab code Exa 5.11 Base bias circuit design

```
//chapter 5
//example 5.11
//page 208
printf("\n")
printf("given")
Vce=5;Ic=5*10^-3;Vcc=15;hfe=100;Vbe=0.7;
```

```
Rc=(Vcc-Vce)/Ic
Ib=Ic/hfe
Rb=(Vcc-Vbe)/Ib
```

Scilab code Exa 5.12 Collector to base bias circuit design

```
//chapter 5
//example 5.12
//page 209
printf("\n")
printf("given")
Vce=5;Ic=5*10^-3;Vcc=15;hfe=100;Vbe = 0.7;
Ib=Ic/hfe
Rc=(Vcc-Vce)/(Ic+Ib)
Rb=(Vce-Vbe)/Ib
```

Scilab code Exa 5.13 Voltage divider bias circuit design

```
//chapter 5
//example 5.13
//page 211
printf("\n")
printf("given")
Vce=5;Ve=Vce;Ic=5*10^-3;hFE=100;Vcc=15;Vbe=.7;
Ie=Ic;
Re=Ve/Ie
Rc=(Vcc-Vce-Ve)/Ic
I2=Ic/10
Vb=Ve+Vbe
R2=Vb/I2
R1=(Vcc-Vb)/I2
```

Scilab code Exa 5.14 Design voltage divider bias circuit with given bias parameter

```
//chapter 5
//example 5.14
//page 212
printf("\n")
printf("given")
Vce=3;Ve=5;Ic=1*10^-3;Vcc=12;Vbe=0.7;
Ie=Ic;
R4=Ve/Ie
disp(" with Ic=1mA and R4=4.7Kohm")
R4=4.7*10^3;
Ve=Ic*R4
Vc=Ve+Vce
Vr3=Vcc-Vc
R3=Vr3/Ic
Vb=Ve+Vbe
I2=Ic/10
R2=Vb/I2
disp(" with R2=56Kohm and Vb=5.4V")
R2=56*10^3;
I2=Vb/R2
R1=(Vcc-Vb)/I2
```

Scilab code Exa 5.15 Design voltage divider bias circuit to operate from 18V suppl

```
//chapter 5
//example 5.15
//page 214
printf("\n")
printf("given")
Vce=9;Ve=4;Ic=4*10^-3;Vcc=18;Vbe = 0.7;
```

```
Ie=Ic;
R4=Ve/Ie
Vb=Ve+Vbe
I2=Ic/10
R2=Vb/I2
disp(" with R2=12Kohm standard")
R2=12*10^3;
I2=Vb/R2
R1=(Vce+Ve-Vb)/I2
disp(" with R1=22kohm standard")
R1=22*10^3;
Vr3=Vcc-Vce-Ve
R3=Vr3/(Ic+I2)
```

Scilab code Exa 5.16 Design voltage divider bias circuit to operate from 9V supply

```
//chapter 5
//example 5.16
//page 216
printf("\n")
printf("given")
Vc=5;Ic=1*10^-3;hFE=70;Vbe=.7;Vee=9;Vcc=Vee;Re
    =8.2*10^3;
Ve=Vee-Vbe
Ie=Ic;
R3=Ve/Ie
disp(" with R3=8.2kohm standard value")
R3=8.2*10^3;
Ie=Ve/R3
Vr2=Vcc-Vc
R2=Vr2/Ic
Ib=Ic/hFE
Vr1=Vbe/10
R1=Vr1/Ib
disp(" use 4.7Kohm as standard")
```

```
//the transistor emitter terminal is .7 below ground
    and voltage across Re is
Ve=Vee-Vbe
Ie=Ve/Re
Vc=Vcc-(Ie*3.9*10^3)
```

Scilab code Exa 5.17 Stability factors for three bias circuit

```
//chapter 5
//example 5.17
//page 220
printf("\n")
printf("given")
hFE=100;
Rc=2.2*10^3;Rb=270*10^3;Re=1*10^3;R1=33*10^3;R2
   =12*10^3;
S=1+hFE
disp("for collector to base bias")
S=(1+hFE)/(1+(hFE*Rc)/(Rc+Rb))
disp(" for voltage divider bias")
disp("S=(1+hFE)/(1+hFE*Re(Re+R1||R2))")
S=(1+hFE)/(1+(hFE*Re)/(Re+(R1*R2)/(R1+R2)))
```

Scilab code Exa 5.18 Change in collector current (Ic) when temperature increases

```
//chapter 5
//example 5.18
//page 221
printf("\n")
printf("given")
Icbo1=15*10^-9;// at 25C
S=101;
disp("chnage in temp")
```

```
T=105-25
disp(" n=T in 10 step")
n=T/10
Icbo2=Icbo1*2^n
Icbo=Icbo2-Icbo1
disp(" for base bais")
Ic=S*Icbo
disp("  for collector to base bais")
S=56;
Ic=S*Icbo
disp(" for voltage divider bais")
S=8.2;
Ic=S*Icbo
```

Scilab code Exa 5.19 Effect of base-emitter voltage (Vbe) changes on collector cur

```
//chapter 5
//example 5.19
//page 223
printf("\n")
printf("given")
Re=4.7*10^3;
T=125-25
Vbe=T*(1.8*10^-3)
Ie=Vbe/Re
```

Scilab code Exa 5.20 DC analysis of BJT biased as switching circuit

```
//chapter 5
//example 5.20
//page 2
printf("\n")
printf("given")
```

```
Vcc=10;Rc=1*10^3;Rb=6.8*10^3;Vs=5;
T=125-25

Vbe=T*(1.8*10^-3)
disp(" hFE calculation")
Ic=Vcc/Rc
Ib=(Vs-Vbe)/Rb
hFE=Ic/Ib
disp("when hFE=10")
hFE=10
Ic=hFE*Ib
Vce=Vcc-(Ic*Rc)
```

Scilab code Exa 5.21 Minimum hFE of a transistor biased in saturation region

```
//chapter 5
//example 5.21
//page 227
printf("\n")
printf("given")
Vcc=15;Rc=3.3*10^3;Vbe=.7;Rb=56*10^3;
Ic=Vcc/Rc
Ib=(Vcc-Vbe)/Rb
hFE=Ic/Ib;
printf(" minimum hFE is %3.2f\n",hFE)
```

Scilab code Exa 5.22 Suitable resistances for capacitor coupled switching circuit

```
//chapter 5
//example 5.22
//page 229
printf("\n")
printf("given")
```

```
Vcc=12;Ic=1.5*10^-3;Vs=5;hFE=10;Vbe=.7;
Rc=Vcc/Ic
Ib=Ic/hFE
Rb=(Vs-Vbe)/Ib
```

Scilab code Exa 5.23 Base and collector resistors for capacitor coupled switching

```
//chapter 5
//example 5.23
//page 229
printf("\n")
printf("given")
Vcc=9;Ic=2*10^-3;hFE=10;Vbe=.7;
Rc=Vcc/Ic
Ib=Ic/hFE
Rb=(Vcc-Vbe)/Ib
```

Chapter 6

AC Analysis of BJT Circuits

Scilab code Exa 6.1 DC analysis of voltage divider circuit

```
//chapter 6
//example 6.1
//page 240
printf("\n")
printf("given")
Vcc=12;R2=15*10^3;R1=33*10^3;rs=600;
disp("with no signal source")
Vb=(Vcc*R2)/(R1+R2);
printf(" base bais voltage when no signal source is
   present %3.2fV\n",Vb)
disp(" signal source directly connected")
Vb=(Vcc*((rs*R2)/(rs+R2))/(R1+((rs*R2)/(rs+R2))));
printf("base bais voltage is %3.2fV\n",Vb)
```

Scilab code Exa 6.2 DC and AC load line for transistor circuit

```
//chapter 6
//example 6.2
```

```
//page 244
printf("\n")
printf("given")
Rc=2.2*10^3;Re=2.7*10^3;R1=18*10^3;R2=8.2*10^3;Vbe=.7
disp("drawing dc load line")
Rldc=Rc+Re
disp(" for Vce")
Ic=0;Vcc=20;
Vce=Vcc-Ic*(Rc+Re)
disp("plot point A at")
Ic=Vcc/(Rc+Re)
disp("plot point B Ic=4.08mA and Vce=0")
disp(" draw dc laod line through point A nad B")
Vb=(Vcc*R2)/(R1+R2)
Ve=Vb-Vbe
Ic=Ve/Re
Ie=Ic
disp("drawing the ac load line")
Rlac=Rc//when there is no external Rl
Vce=Ic*Rc
```

Scilab code Exa 6.3 `h-parameters of CE transistors`

```
//chapter 6
//example 6.2
//page 251
printf("\n")
printf("given")
Vce=4.5;Ib=40*10^-6;
disp("from current characteristic at Vce=4.5V and Ib=40uA")
Ic=4*10^-3;Ib=30*10^-6;
hFE=Ic/Ib;
printf(" the value of hFE is %d\n",hFE)
```

```
disp("from output characteristic at Vce=4.5 and Ib=40uA")
Ic=400*10^-3;Vce=6;
hoe=(Ic/Vce)*10^6;
printf("tye value of hoe is %3.2fuS\n",hoe)
```

Scilab code Exa 6.4 CE h-parameters

```
//chapter 6
//example 6.4
//page 253
printf("\n")
printf("given")
hfe=133;hoe=33.3*10^-6;
hfc=1+hfe
hob=hoe/(1+hfe)
A=hfe/(1+hfe)
```

Scilab code Exa 6.5 Estimate the CE input resistance and determine the h-parameter

```
//chapter 6
//example 6.5
//page 253
printf("\n")
printf("given")
Ib=20*10^-6;Ic=1*10^-3;
Ie=Ic;
re=(26*10^-3)/Ie
hfe=Ic/Ib
hie=(1+hfe)*re
r=hie
B=hfe
```

Scilab code Exa 6.6 Input and Output impedances and voltage gain of CE circuit

```
//chapter 6
//example 6.6
//page 258
printf("\n")
printf("given")
hie=2.1*10^3;hfe=75;hoe=1*10^-6;R1=68*10^3;R2
   =56*10^3;Rc=3.9*10^3;Rl=82*10^3;
disp(" input impedance Zi=R1||R2||hie")
Zi=((R1*R2*hie)/(R1+R2+hie))*10^-3;
printf(" input impedance is %3.2fKohm\n",Zi)
disp("output impedance is Zo=Rc||(1/hoe)")
Zo=((Rc*(1/hoe))/(Rc+(1/hoe)))*10^-3;
printf(" output impadance is %f3.2fKohm\n",Zo)
Av=-(hfe*((Rc*Rl)/(Rc+Rl)))/hie;
printf(" voltage gain is %d\n",Av)
```

Scilab code Exa 6.7 Calculate re and voltage gain of CE circuit

```
//chapter 6
//example 6.7
//page 259
printf("\n")
printf("given")
Ic=1.5*10^-3;Rc=4.7*10^3;Rl=56*10^3;
Ie=Ic;
re=(26*10^-3)/Ie
Av=-(((Rc*Rl)/(Rc+Rl))/re);
printf(" voltage gain is %d\n",Av)
```

Scilab code Exa 6.8 Input and output impedance and voltage gain of CE circuit

```
//chapter 6
//example 6.8
//page 262
printf("\n")
printf("given")
hie=2.1*10^3;hfe=75;hoe=1*10^-6;Re=4.7*10^3;R1
    =68*10^3;R2=56*10^3;Rc=3.9*10^3;Rl=82*10^3;
Zb=hie+Re*(1+hfe)
disp(" input impedance is Zi=R1||R2||Zb")
Zi=((R1*R2*Zb)/(R1+R2+Zb));
printf(" input circuit resistance is %3.3fKohm\n",Zi
    )
Zo=Rc

Av=-hfe*((Rc*Rl)/(Rc+Rl))/(hie+Re*(1+hfe));
printf("voltage gain is %3.3f\n",Av)
```

Scilab code Exa 6.9 h-parameter of CC circuit with and without load resistor (Rl)

```
//chapter 6
//example 6.9
//page 267
printf("\n")
printf("given")
hie=2.1*10^3;hfe=75;R1=10*10^3;R2=10*10^3;Re
    =4.7*10^3;Rl=12*10^3;rs=1*10^3;
disp(" Rl is not connected")
hic=hie
hfc=1+hfe
Zb=hic+hfc*(Re)
```

```
Zi=(R1*R2*Zb)/(R1+R2+Zb)
Ze=(hic+(R1*R2*rs)/(R1+R2+rs))/hfc
ZO=(Ze*Re)/(Ze+Re)
disp(" when Rl is connected")
Zb=hic+hfc*((Re*Rl)/(Re+Rl))
Zi=(R1*R2*Zb)/(R1+R2+Zb)
hib=hie/(1+hfe)
Av=((Re*Rl)/(Re+Rl))/(hib+((Re*Rl)/(Re+Rl)))
```

Scilab code Exa 6.10 Input and output impedance and voltage gain of transistor in

```
//chapter 6
//example 6.10
//page 273
printf("\n")
printf("given")
hie=2.1*10^3;hfe=75;Re=4.7*10^3;Rc=3.9*10^3;Rl
   =82*10^3;
hib=hie/(1+hfe)
hfb=hfe/(1+hfe)
Zi=(hib*Re)/(Re+hib);
printf("input impedance is %3.2fohm\n",Zi)
Zo=Rc;
printf(" output impedance is %3.2fohm\n",Zo)
Av=(hfb*((Rc*Rl)/(Rc+Rl)))/hib;
printf(" voltage gain is %3.2f\n",Av)
```

Scilab code Exa 6.11 Input impedance and voltage gain of CB circuit without coupli

```
//chapter 6
//example 6.11
//page 273
printf("\n")
```

```
printf("given")
hib=27.6;hfb=.987;R1=68*10^3;R2=56*10^3;Re=4.7*10^3;
   Rc=3.9*10^3;Rl=82*10^3;
Rb=(R1*R2)/(R1+R2);
Ze=hib+Rb*(1-hfb)
Zi=(Ze*Re)/(Ze+Re)
Av=(hfb*((Rc*Rl)/(Rc+Rl)))/(hib+Rb*(1-hfb))
```

Scilab code Exa 6.12 Output voltage (Vo) for CE, CB transistor circuits

```
//chapter 6
//example 6.12
//page 277
printf("\n")
printf("given")
Rc=5.6*10^3;Rl=33*10^3;rs=600;R1=68.0*10^3;
R2=56.0*10^3;Re=4.7*10^3;
hfe=100;hie=1.5*10^3;vs=50*10^-3;
disp(" CE circuit operation with vs at transistor
   base and Re bypassed")
Av=(hfe*((Rc*Rl)/(Rc+Rl)))/hie
Zb=hie
Rb=(R1*R2)/(R1+R2);
Zi=(Rb*Zb)/(Rb+Zb)
vi=(vs*Zi)/(rs+Zi)
vo=Av*vi
disp("Cb circuit operation with vs at emitter and
   the base resistor bypassed")
Av=(hfe*((Rc*Rl)/(Rc+Rl)))/hie
Ze=hie/(1+hfe)
Zi=(Ze*Re)/(Ze+Re)
vi=(vs*Zi)/(rs+Zi)
vo=Av*vi
```

Scilab code Exa 6.13 DC analysis of Eber-Moll's BJT model

```
//chapter 6
//example 6.13
//page 279
printf("\n")
printf("given")
Io=50*10^-9;Vbe=.7;Vbc=-10;Af=.995;Ar=.5;Vt
    =26*10^-3;n=2;Vd=-10;
x=Vd/(n*Vt);
Idc=(Io*((2.73^-x)-1))*10^9;
Idc=Io*(-1)
y=Vbe/(n*Vt);
Ide=Io*((2.73^y)-1)
I1=Af*Ide
I2=Ar*Idc
Ic=I1-Idc
Ie=Ide-I2
Ib=Ie-Ic
```

Chapter 8

BJT specifications and performance

Scilab code Exa 8.2 `Output power change of an amplifier in dB`

```
//chapter 8
//example 8.2
//page 313
printf("\n")
printf("given")
P2=25*10^-3;//when frequency increase to 20KHz
P1=50*10^-3;//when signal frequency is 5KHz
Po=10*log10(P2/P1);
printf(" output power change in decibels is %ddB\n",
    Po)
```

Scilab code Exa 8.3 `Output power change of voltage amplifier in dB`

```
//chapter 8
//example 8.3
//page 314
```

```
printf("\n")
printf("given")
v1=1;// output voltage measured at 5KHz
v2=.707;// output voltage measure at 20kHz
Po=20*log10(v2/v1);
printf(" output power change is %ddB\n",Po)
```

Scilab code Exa 8.4 Miller capacitance of CE amplifier

```
//chapter 8
//example 8.4
//page 317
printf("\n")
printf("given")
Ic=1*10^-3;hfe=50;hie=1.3*10^3;fT=250*10^6;Cbc
   =5*10^-12;Rc=8.2*10^3;Rl=100*10^3;
Ie=Ic;
Av=(hfe*((Rc*Rl)/(Rc+Rl)))/hie
Cbe=(6.1*Ie)/fT;
Cin=(Cbe+(1+Av)*Cbc)*10^9;
printf(" input capacitance when the circuit operated
    as CE is %3.3fnF\n",Cin)
```

Scilab code Exa 8.5 Input capacitance effect on CE and CB circuits

```
//chapter 8
//example 8.5
//page 319
printf("\n")
printf("given")
R1=100*10^3;R2=47*10^3;Re=4.7*10^3;
Cbc=5*10^-12;Cbe=24.4*10^-12;hfe=50;hie=1.3*10^3;hib
   =24.5;rs=hib;rs=600;
```

```
disp(" common emitter circuit")
Rb=(R1*R2)/(R1+R2);
Zi=(Rb*hie)/(Rb+hie)
Cin=1.48*10^-9;
f2=1/(2*3.14*Cin*((rs*Zi)/(rs+Zi)));
printf("input-capacitance upper cutoff frequency is
   %dHz\n",f2)
disp("common base circuit")
Zi=(Re*hib)/(Re+hib)
Cin=(Cbe+Cbc)
f2=(1/(2*3.14*Cin*((rs*Zi)/(rs+Zi))))*10^-6;
printf(" input capacitance upper cutoff when
   operating as CB circuit with base bypassed to
   ground is %dMHz\n",f2)
```

Scilab code Exa 8.6 Input capacitance effects on Emitter follower circuit

```
//chapter 8
//example 8.6
//page 322
printf("\n")
printf("given")
fT=50*10^6;hfe=50;f2o=60*10^3;Rc=10*10^3;
fae=fT/hfe
C4=(1/(2*3.14*f2o*Rc))*10^12;
printf("capacitance required for C4 to give 60kHz
   upper cutoff frequency is %dpF\n",C4)
```

Scilab code Exa 8.8 Transistor switching times

```
//chapter 8
//example 8.8
//page 326
```

```
printf("\n")
printf("given")
ton=100*10^-9;Rs=600;Rb=4.7*10^3;
C1=(ton/Rs)*10^12;
printf(" suitable speed up capacitor is %dpF\n",C1)
C1=160*10^-12;//standard value
PWmin=(5*Rs*C1);
SWmin=5*Rb*C1;
fmax=1/(PWmin+SWmin);
printf("maximum signal frequency is %dHz\n",fmax)
```

Scilab code Exa 8.9 Noise output voltage for an amplifier

```
//chapter 8
//example 8.9
//page 330
printf("\n")
printf("given")
R1=30*10^3;R2=30*10^3;rs=30*10^3;f2=40*10^3;f1=100;k
   =1.37*10^-23;R=10*10^3;Av=600;Ri=3*10^3;
Rb=(R1*R2)/(R1+R2);
Rg=(rs*Rb)/(rs+Rb);
T=(273+25)
B=f2-f1;
en=sqrt(4*k*T*B*R)
eni=en*((Ri/(Ri+Rg)))
eno=(Av*eni)*10^6;
printf(" noise output voltage is %duV\n",eno)
```

Scilab code Exa 8.10 Noise and output voltage of transistor circuit

```
//chapter 8
//example 8.10
```

```
//page 331
printf("\n")
printf("given")
Ic=30*10^-6;Vce=5;eno=354*10^-6;
NF=10;
F=2.51;//F=antilog(NF/10)
Vn=((sqrt(F))*eno)*10^6;
printf("total noise output volateg for amplifier is
    %duV\n",Vn)
```

Scilab code Exa 8.11 Transistor Power dissipation

```
//chapter 8
//example 8.11
//page 333
printf("\n")
printf("given")
Pd25=625*10^-3;D=5*10^-3;Vce=10;
T2=55;
Pdt2=Pd25-D*(T2-25)
Pd=Pdt2;
Ic=Pd/Vce;
printf(" maximum Ic level is %3.5fA\n",Ic)
```

Scilab code Exa 8.13 Maximum power dissipation of 2N3055

```
//chapter 8
//example 8.13
//page 335
printf("\n")
printf("given")
Pd=80;
Vce=60;
```

```
Ic=Pd/Vce
disp("point 1 Vce=60 and Ic=1.3A")
Vce=40;
Ic=Pd/Vce
disp("point 2 Vce=40 and Ic=2A")
Vce=20;
Ic=Pd/Vce
disp(" point 3 Vce=20 and Ic=4A")
Vce=10;
Ic=Pd/Vce
disp(" point 4 Vce=10 and Ic=8A")
```

Scilab code Exa 8.14 Thermal resistance for heat sink

```
//chapter 8
//example 8.14
//page 339
printf("\n")
printf("given")
Vce=20;Ic=1;T2=90;T1=25;
Q=Vce*Ic;
Qcs=.4;Qjc=1;//from table
Qsa=((T2-T1)/Q)-(Qjc+Qcs)
```

Chapter 10

FET biasing

Scilab code Exa 10.1 DC load line using FET charecterstics

```
//chapter 10
//example 10.1
//page 381
printf("\n")
printf("given")
Vdd=22;Rd=2*10^3;
disp("when Id=0")
Id=0;
Vds=Vdd-Id*Rd
disp(" at point A Id=0 nad Vds=22")
Vds=0;
Id=Vdd/Rd
disp(" at point B Id=11mA and Vds=0")
```

Scilab code Exa 10.4 DC circuit analysis

```
//chapter 10
//example 10.4
```

```
//page 387
printf("\n")
printf("given")
Idss=8*10^-3;Vpmax=6;Vgs=2.3;Vgsmax=6;
Id=Idss*(1-(Vgs/Vgsmax))^2
Idss=4*10^-3;Vp=3;
Idmin=Idss*(1-(Vgs/Vp))^2
```

Scilab code Exa 10.6 `DC Analysis of Voltage Divider Bias FET circuit`

```
//chapter 10
//example 10.6
//page 393
printf("\n")
printf("given")
Vdd=25;R2=1*10^6;R1=3.8*10^6;Rs=2.5*10^3;Rd=2.5*10^3;
Vg=(Vdd*R2)/(R1+R2)
disp("when Id=0")
Id=0;
Vgs=Vg-Id*Rs
disp(" plot point A at Id=0 and Vgs=5.2")
Vgs=0;
Id=Vg/Rs
disp(" plot point B at Id=2.08mA and Vgs=0")
disp(" where the base line intersect the transfer characteristics ")
Idmax=3*10^-3;Idmin=2.3*10^-3;
Vdsmin=Vdd-Idmax*(Rd+Rs)
Vdsmax=Vdd-Idmin*(Rd+Rs)
```

Scilab code Exa 10.7 `Transfer charecterstics of gate bais circuit`

```
//chapter 10
//example 10.7
//page 401
printf("\n")
printf("given")
Id=3*10^-3;Vgs=-2.3;Vdsmin=10;Vdd=25;Vgsoff=-6;Idss
    =8*10^-3;
Vgs=Vgsoff*(1-sqrt(Id/Idss))
Rd=(Vdd-Vdsmin)/Id
```

Scilab code Exa 10.8 Designing a self bais circuit

```
//chapter 10
//example 10.8
//page 403
printf("\n")
printf("given")
Id=3*10^-3;Vds=10;Vdd=25;Vgs=2.3;
Rs=Vgs/Id
Rd=((Vdd-Vds)/Id)-Rs
```

Scilab code Exa 10.9 Designing a voltage divider bais circuit

```
//chapter 10
//example 10.9
//page 405
printf("\n")
printf("given")
Id=3*10^-3;Vds=10;Vdd=25;Vg=5.2;Vgsoff=-6;Idss
    =8*10^-3;R2=1*10^6;
R=(Vdd-Vds)/Id//R=(Rs+Rd)/2
Rd=R/2
Rs=Rd
```

```
Vgs=Id*Rs
Vgs=Vgsoff*(1-sqrt(Id/Idss))
Vs=Id*Rs
Vg=Vs-(-Vgs)
R1=((Vdd-Vg)*R2)/Vg
```

Scilab code Exa 10.11 Designing a constant current bias circuit

```
//chapter 10
//example 10.11
//page 412
printf("\n")
printf("given")
Vee=20;Id=3*10^-3;Vds=9;Vbe=.7;Vb=0;
Ve=Vee-Vbe
Re=Ve/Id
Re=6.8*10^3;//satnadard value
Id=Ve/Re;
Idss=16*10^-3;Vgsoff=-8;
Vgs=Vgsoff*(1-sqrt(Id/Idss))
Vs=Vb-Vgs
Vrd=Vee-Vds-Vs
Rd=Vrd/Id
```

Scilab code Exa 10.12 Transfer characteristics of JFET

```
//chapter 10
//example 10.12
//page 415
printf("\n")
printf("given")
Idss=5*10^-3;Vgsoff=6;Rs=3.3*10^3;Vdd=20;Rd=Rs;
disp("when Id=0, Vgs=Vs=0")
```

```
Id=0;Vgs=0;Vs=0;
disp(" at point A universal transfer characteristic
   Id/Idss and Vgs/Vgsoff=0")
Id=1.5*10^-3;
Vgs=Id*Rs
y=Id/Idss;
x=Vgs/Vgsoff;
disp(" point B the universal transfer charecteristic
    x=.825 and y=.3")
Id=.2*Idss
Vds=Vdd-Id*(Rd+Rs)
```

Scilab code Exa 10.13 FET universal transfer charecterstics

```
//chapter 10
//example 10.13
//page 416
printf("\n")
printf("given")
Idss=9*10^-3;Vgsoff=7;Vdd=22;R1=4.7*10^6;R2=1*10^6;
   Rs=2.7*10^3;Rd=Rs;
Vg=(Vdd*R2)/(R1+R2)
disp("when Vgs=0, Vgs/Vgsoff=0")
Id=Vg/Rs
disp("when Vgs/Vgsoff=.5")
Vgs=.5*(-Vgsoff)
Id=(Vg-Vgs)/Rs
x=Id/Idss
disp(" point Y on universal characteristic x=.3 and
   Vgs/Vgsoff=.5")
disp("draw voltage divider bias line through X nad Y
    where bisa line intersect transfer curve")
Id=.29*Idss
Vds=Vdd-Id*(Rd+Rs)
```

Scilab code Exa 10.14 Transfer characteristics of MOSFET

```
//chapter 10
//example 10.14
//page 419
printf("\n")
printf("given")
Vdd=40;R2=1*10^6;R1=5.6*10^6;Rd=4.7;
Vg=(Vdd*R2)/(R1+R2)
disp("from the point where the bias line intersect
   the transfer curve")
Id=6.2
Vds=Vdd-Id*Rd
```

Scilab code Exa 10.16 Biasing JFET switching circuit

```
//chapter 10
//example 10.16
//page 422
printf("\n")
printf("given")
rDS=25;Vgsoff=10;Vds=200*10^-3;Vdd=12;
Id=Vds/rDS
Rd=Vdd/Id
Vi=-(Vgsoff+1)
```

Scilab code Exa 10.17 Transfer characteristics of MOSFET in switching bias

```
//chapter 10
```

```
//example 10.17
//page 424
printf("\n")
printf("given")
Vdd=50;Rd=10;R2=1*10^6;rDS=.25;
Id=Vdd/Rd
disp(" from transfer curve at Id=5 and Vgs=5.7")
Vgs=5.7;
R1=((Vdd-Vgs)*R2)/Vgs//use 6.8Mohm to make Vgs>5.7V
    to ensure that the FET is biased on
Vds=Id*rDS
```

Chapter 11

AC Analysis of FET circuits

Scilab code Exa 11.2 CS circuit performance parameters

```
//chapter 11
//example 11.2
//page 443
printf("\n")
printf("given")
Yos=10*10^-6;Yfs=3000*10^-6;R1=1*10^6;R2=5.6*10^6;Rd=2.7*10^3;Rl=Rd;
rd=1/Yos
Zi=((R1*R2)/(R1+R2))*10^-3;
printf("input impedance is %dKohm\n",Zi)
Zo=(Rd*rd)/(Rd+rd);
printf(" output inpedance is %dohm\n",Zo)
Av=-Yfs*((Rl*rd)/(Rl+rd))
```

Scilab code Exa 11.3 Performance parameters of CS circuit with Unbypassed source r

```
//chapter 11
//example 11.3
```

```
//page 447
printf("\n")
printf("given")
Yos=10*10^-6;Yfs=4000*10^-6;Ig=1*10^-9;Vgs=15;Rs
    =3.3*10^3;Rg=1*10^6;Rd=4.7*10^3;Rl=33*10^3;
rd=1/Yos
Rgs=(Vgs/Ig)
Zg=(Rgs*(1+Yfs*Rs))
Zi=Rg;
Zd=rd+Rs+(Yfs*Rs*rd)
Zo=(Rd*Zd)/(Rd+Zd)
Av=-(Yfs*((Rd*Rl)/(Rd+Rl)))/(1+Yfs*Rs)
Av=-((Rd*Rl)/(Rd+Rl))/Rs
```

Scilab code Exa 11.4 Common Drain circuit analysis

```
//chapter 11
//example 11.4
//page 451
printf("\n")
printf("given")
Yfs=3000*10^-6;Rgs=100*10^6;rd=50*10^3;Rs=5.6*10^3;
    Rl=12*10^3;R1=1.5*10^6;R2=1*10^6;
Zg=Rgs*(1+Yfs*((Rs*Rl)/(Rs+Rl)))
Zi=(R1*R2)/(R1+R2)
Zs=((1/Yfs)*rd)/((1/Yfs)+rd)
Zo=(Rs*Rl*(1/Yfs))/(Rs*Rl+Rs*(1/Yfs)+Rl*(1/Yfs))
Av=-(Yfs*((Rs*Rl)/(Rs+Rl)))/(1+Yfs*((Rs*Rl)/(Rs+Rl))
    )
```

Scilab code Exa 11.5 Common Gate circuit analysis

```
//chapter 11
```

```
//example 11.5
//page 456
printf("\n")
printf("given")
Yfs=3000*10^-6;rd=50*10^3;Rs=3.3*10^3;Rd=4.7*10^3;Rl=50*10^3;rs=600;
Zs=1/Yfs
Zi=((1/Yfs)*Rs)/((1/Yfs)+Rs)
Zd=rd
Zo=(Rd*rd)/(Rd+rd)
Av=Yfs*((Rd*Rl)/(Rd+Rl))
disp("overall volateg gain")
Av=(Yfs*((Rd*Rl)/(Rd+Rl))*Zi)/(rs+Zi)
```

Scilab code Exa 11.6 AC output voltage with and without bypassed source resistor

```
//chapter 11
//example 11.6
//page 459
printf("\n")
printf("given")
Yfs=6000*10^-6;R1=100*10^3;R2=47*10^3;vs=50*10^-3;Rd=2.7*10^3;Rl=33*10^3;vs=50*10^-3;rs=600;Rs=Rd;
disp(" CS circuit")
Av=-Yfs*((Rd*Rl)/(Rd+Rl))
Zi=(R1*R2)/(R1+R2)
vi=(vs*Zi)/(rs+Zi)
vo=Av*vi
disp("CG circuit")
Av=Yfs*((Rd*Rl)/(Rd+Rl))
Zi=((1/Yfs)*Rs)/((1/Yfs)+Rs)
vi=(vs*Zi)/(rs+Zi)
vo=Av*vi
```

Scilab code Exa 11.7 Input capacitance limited cutoff frequency for a CS circuit

```
//chapter 11
//example 11.7
//page 462
printf("\n")
printf("given")
Crss=1*10^-12;Ciss=5*10^-12;Yfs=2500*10^-6;Yos
   =75*10^-6;Rd=5.6*10^3;Rl=100*10^3;R1=3.3*10^6;R2
   =1*10^6;rs=600;
Cgd=Crss;
Cgs=Ciss-Crss
Av=Yfs*(((1/Yos)*Rd*Rl))/((Rd*Rl+(1/Yos)*Rd+(1/Yos)*
   Rl))
Cin=Cgs+(1+Av)*Cgd
Zi=(R1*R2)/(R1+R2)
f2=1/(2*3.14*Cin*((rs*Zi)/(rs+Zi)))
```

Chapter 12

Small signal Amplifiers

Scilab code Exa 12.1 Required capacitance and voltage gain at different frequencie

```
//chapter 12
//example 12.1
//page 474
printf("\n")
printf("given")
hfe=50;hie=1*10^3;hib=20;f1=100;Rc=3.3*10^3;Re=Rc;
disp(" required capacitance")
Xc2=hib;
C2=1/(2*3.14*f1*Xc2)
disp(" voltage gain with emitter terminal completely bypassed to ground")
Av=-(hfe*Rc)/hie
disp("voltage gain  when f=100")
Av=-(hfe*Rc)/sqrt(((hie^2)+((1+hfe)*Xc2)^2))
disp(" voltage gain when C2 is incorrectly selected as Xc2=Re/10")
Avx=-(hfe*Rc)/sqrt(((hie^2)+((1+hfe)*(Re/10))^2))
```

Scilab code Exa 12.2 Suitable resistor values for common emitter amplifier

```
//chapter 12
//example 12.2
//page 477
printf("\n")
printf("given")
Vcc=24;Ve=5;Vce=3;Rl=120*10^3;Vbe=.7
Rc=Rl/10
Vrc=Vcc-Vce-Ve
Ic=Vrc/Rc
Re=Ve/Ic//use 3.9Kohm standard value to make Ic
    littel less than design level
Re=3.9*10^3;
R2=10*Re
I2=(Ve+Vbe)/R2
R1=(Vcc-Ve-Vbe)/I2
```

Scilab code Exa 12.3 Suitable capacitor for CE amplifier circuit

```
//chapter 12
//example 12.3
//page 477
printf("\n")
printf("given")
hfe=100;Ie=1.3*10^-3;f1=100;R1=120*10^3;R2=39*10^3;
    rs=600;Rl=R1;
re=(26*10^-3)/Ie
Xc2=re;
C2=1/(2*3.14*f1*Xc2)
hie=(1+hfe)*re
Zi=(R1*R2*hie)/(R1*R2+R1*hie+R2*hie)
C1=1/((2*3.14*f1*((Zi+rs)/10)))
C3=1/(2*3.14*f1*((Rc+Rl)/10))
```

Scilab code Exa 12.4 Suitable resistor for common source circuit

```
//chapter 12
//example 12.5
//page 485
printf("\n")
printf("given")
rs=600;f1=100;Yfs=6000*10^-6;R1=4.7*10^6;R2=1*10^6;
   Rd=6.8*10^3;Rl=120*10^3;
Xc2=1/Yfs
C2=1/(2*3.14*f1*Xc2)
Zi=(R1*R2)/(R1+R2)
C1=1/(2*3.14*f1*(Zi+rs)/10)
C3=1/(2*3.14*f1*(Rd+Rl)/10)
```

Scilab code Exa 12.5 Suitable resistor for common source amplifier

```
//chapter 12
//example 12.5
//page 485
printf("\n")
printf("given")
rs=600;f1=100;Yfs=6000*10^-6;R1=4.7*10^6;R2=1*10^6;
   Rd=6.8*10^3;Rl=120*10^3;
Xc2=1/Yfs
C2=1/(2*3.14*f1*Xc2)
Zi=(R1*R2)/(R1+R2)
C1=1/(2*3.14*f1*(Zi+rs)/10)
C3=1/(2*3.14*f1*(Rd+Rl)/10)
```

Scilab code Exa 12.7 Analysis of two stage amplifier

```
//chapter 12
```

```
//example 12.7
//page 489
printf("\n")
printf("given")
R1=120*10^3;R2=39*10^3;hie=2*10^3;R7=12*10^3;Zo=R7;R5=R1;R6=R2;hfe=100;R3=R7;Zl=R1;
Zi=(R1*R2*hie)/(R1*R2+R1*hie+R2*hie)
Zi2=(R1*R2*hie)/(R1*R2+R1*hie+R2*hie)
Av1=-(hfe*((R3*Zi2)/(R3+Zi2)))/hie
Av2=-(hfe*((R7*Zl)/(R7+Zl)))/hie
Av=Av1*Av2
```

Scilab code Exa 12.8 Analysis of direct coupled two stage amplifier

```
//chapter 12
//example 12.8
//page 491
printf("\n")
printf("given")
Ve1=5;Vce1=3;Vce2=3;Vbe=.7;Vcc=14;Rl=40*10^3;
Vb2=Ve1+Vce1
Vc1=Vb2;
Ve2=Vb2-Vbe
Vr5=Vcc-Ve2-Vce2
R5=Rl/10//use 3.9Kohm satandard value
R5=3.9*10^3;
Ic2=Vr5/R5
R6=Ve2/Ic2//use 8.2Kohm as standard and recalculate
R6=8.2*10^3;
Ic2=Ve2/R6
Vr3=Vcc-Vc1
disp(" Ic1>>Ib2,select Ic1=1mA")
Ic1=1*10^-3;
R3=Vr3/Ic1//use standard value as 5.6Kohm and recalculate Ic1 in order ti keep Vb2=8V
```

```
R3=5.6*10^3;
Ic1=Vr3/R3
R4=Ve1/Ic1
Vr2=Ve1+Vbe
Vr1=Vcc-Ve1-Vbe
R2=10*R4
I2=(Ve1+Vbe)/R2
R1=(Vr1*R2)/Vr2
```

Scilab code Exa 12.9 capacitor for two stage direct coupled amplifier

```
//chapter 12
//example 12.9
//page 493
printf("\n")
printf("given")
hfe=50;re=26;R1=68*10^3;R2=47*10^3;rs=600;f1=75;R5
    =3.9*10^3;Rl=40*10^3;
hie=(1+hfe)*re
Zi=(R1*R2*hie)/(R1*R2+R1*hie+R2*hie)
Xc1=(Zi+rs)/10
C1=1/(2*3.14*f1*Xc1)
Xc2=.65*re
Xc3=Xc2;
C2=1/(2*3.14*f1*Xc2)
C3=C2;
Xc4=(R5+Rl)/10
C4=1/(2*3.14*f1*Xc4)
```

Scilab code Exa 12.10 Minimum overall voltage gain for direct coupled CE amplifier

```
//chapter 12
//example 12.10
```

```
//page 494
printf("\n")
printf("given")
hfe=50;hie=1.3*10^3;R3=5.6*10^3;R5=3.9*10^3;Rl
   =40*10^3;
Av1=-(hfe*((R3*hie)/(R3+hie)))/hie
Av2=-(hfe*((R5*Rl)/(R5+Rl)))/hie
disp(" overall voltage gain is Av=Av1*Av2")
Av=Av1*Av2
```

Scilab code Exa 12.11 CE input and CC output two stage amplifier analysis

```
//chapter 12
//example 12.11
//page 497
printf("\n")
printf("given")
Vp=100*10^-3;Rl=100;Vbe=.7;Vcc=20;
ip=Vp/Rl
disp("select Ie2>ip")
Ie2=2*10^-3;
Ve1=5;Vce1=3;
Vb2=Ve1+Vce1
Vc1=Vb2;
Ve2=Vb2-Vbe;
Vr2=Ve1+Vbe;
R5=Ve2/Ie2//use 3.3Kohm standard value
R5=3.3*10^3;
Ic1=1*10^-3;
Vr3=Vcc-Vb2
R3=Vr3/Ic1
R4=Ve1/Ic1//use 4.7Kohm standard value
R4=4.7*10^3;
Vb1=Ic1*R4+Vbe
R2=10*R4
```

```
R1=((Vcc-Vb1)*R2)/Vr2
```

Scilab code Exa 12.12 Suitable capacitor for circuit

```
//chapter 12
//example 12.11
//page 498
printf("\n")
printf("given")
rs=600;Ie1=1*10^-3;hfe=50;R1=120*10^3;R2=47*10^3;f1=150;Ie2=2*10^-3;R5=3.3*10^3;R3=12*10^3;Rl=100;
re=26*10^-3/Ie1
hie=(1+hfe)*re
Zi=(R1*R2*hie)/(R1*R2+R1*hie+R2*hie)
Xc1=(Zi+rs)/10
C1=1/(2*3.14*f1*Xc1)//use 6*10^-6 as standard value
Xc2=.65*re
C2=1/(2*3.14*f1*Xc2)
re2=26*10^-3/Ie2
Zo=(R5*(re2+R3/hfe))/(R5+(re2+R3/hfe))
Xc3=.65*(Rl+Zo)
C3=1/(2*3.14*f1*Xc3)
```

Scilab code Exa 12.13 analyze two stage amplifier and determine minimum voltage ga

```
//chapter 12
//example 12.13
//page 499
printf("\n")
printf("given")
Ie2=2*10^-3;hfe=50;R5=3.3*10^3;Rl=100;hfc2=51;R3=12*10^3;
re=26*10^-3/Ie2
```

```
hic=hfe*re;
hie=2*(1+hfe)*re
Zi2=hic+hfc2*((Rl*R5)/(Rl+R5))
Av1=-(hfe*((R3*Zi2)/(R3+Zi2)))/hie
Av2=1
disp("overall voltage gain is Av=Av1*Av2")
Av=Av1*Av2
```

Scilab code Exa 12.14 Dc feedback pair with an emitter follower output

```
//chapter 12
//example 12.14
//page 503
printf("\n")
printf("given")
vp=50*10^-3;Rl=50;Ve2=5;Vcc=12;Vbe=.7;hFE=70;hfe=100;R2=120*10^3;f1=150;R3=150*10^3;R1=5.6*10^3;R4=2.2*10^3;
ip=vp/Rl
disp("select Ie2>ip")
Ie2=2*10^-3;
R4=Ve2/Ie2//use standard 2.2Kohm
R4=2.2*10^3;
Ie2=Ve2/R4
Ic1=1*10^-3;
Vr1=Vcc-(Vbe+Ve2)
R1=Vr1/Ic1//use 5.6kohm and recalculate
R1=5.6*10^3;
Ic1=Vr1/R1
Ib1=Ic1/hFE
hie=hfe*(26*10^-3/Ic1)
hie2=hfe*((26*10^-3)/(2.27*10^-3))
Zi1=(R2*hie)/(R2+hie)
Xc1=Zi1/10
C1=1/(2*3.14*f1*Xc1)
```

```
Xc2=R3/100
C2=1/(2*3.14*f1*Xc2)
Zo=(((hie2+R1)/hfe)*R4)/(((hie2+R1)/hfe)+R4)
Xc3=Rl+Zo
C3=1/(2*3.14*f1*Xc3)
```

Scilab code Exa 12.15 suitable resistor for BIBET amplifier

```
//chapter 12
//example 12.15
//page 407
printf("\n")
printf("given")
Vgsoff=-6;Idss=20*10^-3;Yfs=4000*10^-6;Id=2*10^-3;
    Vcc=20;Zi=500*10^3;R2=560*10^3;Rl=80*10^3;Vbe=.7;
    Vce=3;
Vgs=Vgsoff*(1-sqrt(Id/Idss))
Vds=(-Vgsoff)+1-(-Vgs)
Vr3=(Vcc-Vds)/2
Vr4=Vr3;
R3=Vr4/Id//use 3.9kohm as standard and recalculate
    Vr3 and Vr4
R4=R3;
R4=3.9*10^3;
Vr3=Id*R4
Vr4=Vr3;
Vr2=Vr4-(-Vgs)
Vr1=Vcc-Vr2
R1=(Vr1*R2)/Vr2
R6=Rl/10
Vr5=Vr3-Vbe
Vr6=Vcc-Vr5-Vce
Ic2=Vr6/R6
R5=Vr5/Ic2
```

Scilab code Exa 12.16 suitable capacitor For BIFET direct coupled amplifier

```
//chapter 12
//example 12.16
//page 508
printf("\n")
printf("given")
R1=2.7*10^6;R2=560*10^3;f1=150;Yfs=8000*10^-6;Ie
    =1.2*10^-3;Rl=80*10^3;R6=8.2*10^3;
Zi=(R1*R2)/(R1+R2)
Xc1=Zi/10
C1=1/(2*3.14*f1*Xc1)
Xc2=.65/Yfs
C2=1/(2*3.14*f1*Xc2)//use 15pF as standard value
re=26*10^-3/Ie
Xc3=.65*re
C3=1/(2*3.14*f1*Xc3)
Xc4=(R6+Rl)/10
C4=1/(2*3.14*f1*Xc4)
```

Scilab code Exa 12.17 determine minimum overall voltage gain

```
//chapter 12
//example 12.17
//page 509
printf("\n")
printf("given")
re=22;hfe=100;R3=3.9*10^3;Yfs=4000*10^-6;R6
    =8.2*10^3;Rl=80*10^3;
Zi2=hfe*re
Av1=-Yfs*((R3*Zi2)/(R3+Zi2))
Av2=-(hfe*((R6*Rl)/(R6+Rl)))/Zi2
```

```
disp("overall voltage is Av=Av1*Av2")
Av=Av1*Av2
```

Scilab code Exa 12.18 suitable resistor for differential amplifier

```
//chapter 12
//example 12.18
//page 516
printf("\n")
printf("given")
hFE=60;hfe=60;hie=1.4*10^3;Rl=70*10^3;Vce=3;Vbe=.7;
    Vcc=10;
Rc2=Rl/10//use 6.8Kohm as standard value
Vrc2=Vcc+Vbe-Vce
Ic=Vrc2/Rc2
Ie=Ic;
Re=(Vcc-Vbe)/(2*Ie)//use 4.7 as standard value
Re=4.7*10^3;
Rb=Vbe/(10*(Ic/hFE))
Rb1=Rb;
```

Scilab code Exa 12.19 suitable capacitor value for amplifier and voltage gain

```
//chapter 12
//example 12.19
//page 517
printf("\n")
printf("given")
f1=60;Ie=1.13*10^-3;hfe=60;Rb=3.9*10^3;Rl=70*10^3;Rc
    =6.8*10^3;
re=26*10^-3/Ie//use 20 as standard value
re=20;
hie=hfe*re
```

```
Zb=2*hie
Zi=(Rb*Zb)/(Rb+Zb)
C1=1/(2*3.14*f1*Zi)
C2=1/(2*3.14*f1*(Rl/10))
Av=(hfe*((Rc*Rl)/(Rc+Rl)))/(2*hie)
```

Scilab code Exa 12.20 suitable resistor for cascode amplifier

```
//chapter 12
//example 12.20
//page 521
printf("\n")
printf("given")
Vcc=20;Rl=90*10^3;hfe=50;hie=1.2*10^3;hib=24;Vce=3;
   Vce1=Vce;Ve=5;Vbe=.7;
Rc=Rl/10//use 8.2kohm as standard value
Rc=8.2*10^3;
Vrc=Vcc-Vce-Vce1-Ve
Ic=Vrc/Rc
Re=Ve/Ic
Re=4.7*10^3;//use 4.7 as standard value
R3=10*Re
Vb1=Ve+Vbe
I3=Vb1/R3
Vb2=Ve+Vce+Vbe
Vr2=Vb2-Vb1
R2=Vr2/I3
R1=(Vcc-Vb2)/I3
```

Scilab code Exa 12.21 suitable capacitor for cascode circuit

```
//chapter 12
//example 12.21
```

```
//page 522
printf("\n")
printf("given")
f1=25;R2=24.7*10^3;R3=47*10^3;hie=1.2*10^3;hib=24;Rc=9*10^3;Rl=90*10^3;
Zi=(R2*R3*hie)/(R2*R3+R2*hie+R3*hie)
C1=1/(2*3.14*f1*(Zi/10))
C2=1/(2*3.14*f1*(hie/10))
C3=1/(2*3.14*f1*hib)
C4=1/(2*3.14*f1*((Rc+Rl)/10))
```

Scilab code Exa 12.22 `resonance frequency, voltage gain, bandwidth of amplifier`

```
//chapter 12
//example 12.22
//page 525
printf("\n")
printf("given")
hie=1*10^3;hfe=50;hoe=10*10^-6;Cc=5*10^-12;Cp=330*10^-12;Lp=75*10^-6;Rw=1;Rl=5*10^3;hfb=50;fo=1*10^6;
fo=1/(2*3.14*sqrt(Lp*(Cp+Cc)))
printf("resonance frequency is %3fHz\n",fo)
Zp=Lp/((Cp+Cc)*Rw)
Rc=1/hoe
RL=(Zp*Rc*Rl)/(Rl*Rc+Rc*Zp+Rl*Zp);
RL=4.7*10^3;//as standard value
Av=(hfb*RL)/hie;
printf(" voltage gain is %d\n",Av)
Qp=((Rc*Rl)/(Rc+Rl))/(2*3.14*fo*Lp)
QL=(2*3.14*fo*Lp)/Rw
disp("since QL>Qp")
B=fo/Qp;
printf("bandwidth is %dHz\n",B)
```

Scilab code Exa 12.23 Determination of resonance frequency, voltage gain, bandwidt

```
//chapter 12
//example 12.23
//page 528
printf("\n")
printf("given")
hie=1*10^3;hfe=50;hoe=10*10^-6;Cc=5*10^-12;Cp
   =330*10^-12;Lp=75*10^-6;Rw=1;Rl=5*10^3;fo=1*10^6;
   K=.015;Ls=50*10^-6;
Zp=Lp/((Cp+Cc)*Rw);
Rc=(1.0/hoe)/1000;
RL=(Zp*Rc)/(Rc+Zp)
disp("voltage gain from the input to the primary
   memory winding")
Avp=(hfe*RL)/hie
Vsp=K*sqrt(Ls/Lp)
disp("overall voltage gain from the input to teh
   secondary winding")
Av=Avp*Vsp
Qp=Rc/(2*3.14*fo*Lp)
Ql=471;
Q=(Ql*Qp)/(Ql+Qp)
B=fo/Q;
printf("bandwidth is %dHz\n",B)
```

Scilab code Exa 12.24 capacitor required to resonate the secondary and overall vol

```
//chapter 12
//example 12.24
//page 530
printf("\n")
```

```
printf("given")
f=1*10^6;L2=50*10^-6;K=.015;L1=75*10^-6;rs=5;Rw=1;Lp=100*10^-6;Cp=330*10^-12;Cc=5*10^-12;Rc=100*10^3;hfe=50;hie=1*10^3;
C2=1/(((2*3.14*f)^2)*L2)
M=K*sqrt(L1*L2)
Rs=(((2*3.14*f)^2)*(M)^2)/rs
Rp=Rs+Rw
Zp=Lp/((Cp+Cc)*Rp)
Rl=(Zp*Rc)/(Zp+Rc)
disp("voltage gain from the input to primary winding ")
Avp=(hfe*Rl)/hie
Vsp=12.2*10^-3;
Vos=((2*3.14*f)*L2)/rs
disp("overall voltage gain from the input to secondary winding ")
Av=Avp*Vos*Vsp
```

Chapter 13

Amplifier with negative feedback

Scilab code Exa 13.1 closed loop gain for negative feedback amplifier

```
//chapter 13
//example 13.1
//page 547
printf("\n")
printf("given")
Av=100000;B=1/100;
disp("when Av=100000")
Acl=Av/(1+Av*B)
disp("when Av is 150000")
Av=150000;
Acl=Av/(1+Av*B)
disp("when Av is 50000")
Av=50000;
Acl=Av/(1+Av*B)
```

Scilab code Exa 13.2 input impedance with negative feedback

```
//chapter 13
//example 13.2
//page 549
printf("\n")
printf("given")
Rf2=560;Rf1=56*10^3;Av=100000;Zb=1*10^3;R1=68*10^3;
   R2=33*10^3;
B=Rf2/(Rf2+Rf1)
Zi=(1+Av*B)*Zb
Zin=(Zi*R1*R2)/(R1*R2+R1*Zi+R2*Zi);
printf("input impedance with negative feedback is
   %dohm\n",Zin)
```

Scilab code Exa 13.3 input and output impedance when negative feedback

```
//chapter 13
//example 13.3
//page 552
printf("\n")
printf("given")
Zb=1*10^3;B=1/100;Av=5562;R1=68*10^3;R2=47*10^3;hoe
   =1/(50*10^3);Rc=3.9*10^3;
Zi=(1+Av*B)*Zb
Zin=(R1*R2*Zi)/(R1*R2+R2*Zi+R1*Zi)
Zo=(1/hoe)/(1+Av*B)
Zout=(Rc*Zo)/(Rc+Zo);
printf(" circuit output impedance is %dohm\n",Zout)
```

Scilab code Exa 13.4 circuit input and output impedance and voltage gain without f

```
//chapter 13
//example 13.4
//page 554
```

```
printf("\n")
printf("given")
Zb=1*10^3;hoe=1/(85*10^3);Av=58000;Rf2=220;Rf1
    =16.2*10^3;R1=120*10^3;R2=39*10^3;R7=12*10^3;
B=Rf2/(Rf2+Rf1)
disp("voltage gain")
Acl=Av/(1+Av*B)
Zi=Zb*(1+Av*B)
Zin=(Zi*R1*R2)/(Zi*R1+R2*R1+R2*Zi)
Zo=(1/hoe)/(1+Av*B)
Zout=(R7*Zo)/(R7+Zo)
printf("output impedance is %dohm\n",Zout)
```

Scilab code Exa 13.5 two stage coupled BJT use as voltage feedback

```
//chapter 13
//example 13.5
//page 558
printf("\n")
printf("given")
Rf2=220;R4=3.9*10^3;Acl=75;f=100;
Rf1=(Acl-1)*Rf2
Xc2=Rf2;
C2=1/(2*3.14*f*Rf2)
Xcf1=Rf1/100;
Cf1=1/(2*3.14*f*Xcf1)
```

Scilab code Exa 13.6 modify direct coupled amplifier to use as series voltage nega

```
//chapter 13
//example 13.6
//page 560
printf("\n")
```

```
printf("given")
Acl=300;Rf2=220;R4=4.7*10^3;f=100;
Rf1=(Acl-1)*Rf2
xc2=Rf2;
C2=1/(2*3.14*f*Rf2)
```

Scilab code Exa 13.7 calculate resistor value

```
//chapter 13
//example 13.7
//page 565
printf("\n")
printf("given")
hfe=100;Vbe=.7;Ic1=1*10^-3;Ic2=Ic1;Ic3=Ic2;Ic4=Ic3;
   Vee=10;Vce=3;Acl=33;
disp("different resistor value of circuit")
R1=Vbe/((10*Ic1)/hfe)
R3=(Vee-Vbe)/(Ic1+Ic2)
Vr2=Vee+Vbe-Vce
R4=Vr2/Ic1
R2=R4;
R7=(Vr2-Vbe)/(Ic3+Ic4)
R8=Vee/Ic3
R6=6.8*10^3;
R5=(Acl-1)*R6
```

Scilab code Exa 13.8 calculate Acm, Zin and Zout

```
//chapter 13
//example 13.8
//page 566
printf("\n")
printf("given")
```

```
Av=25000;hie=2*10^3;hib=25;hoe=1/(100*10^3);R6
   =6.8*10^3;R5=220*10^3;R1=R6;R8=10*10^3;
B=R6/(R5+R6)
Acl=Av/(1+Av*B)
Zi=2*hie*(1+Av*B)
Zin=(Zi*R1)/(Zi+R1)
Zo=(1/hoe)/(1+Av*B)
Zout=(R8*Zo)/(R8+Zo);
printf("output impedance is %dohm\n",Zout)
```

Scilab code Exa 13.9 calculate output impedance for circuit modification

```
//chapter 13
//example 13.9
//page 568
printf("\n")
printf("given")
hic=2*10^3;hie=hic;hfe=100;hfc=100;Av=25000;B
   =1/33.4;R8=10*10^3;R5=R8;
Ze=(hic+R8)/hfc
Zo=Ze/(1+Av*B)
Zout=(R5*Zo)/(R5+Zo);
printf("output impedance is %3.2fohm\n",Zout)
```

Scilab code Exa 13.10 calculate precise value of circuit voltage gain

```
//chapter 13
//example 13.10
//page 570
printf("\n")
printf("given")
hfemin=100;hfemax=400;hiemin=2*10^3;hiemax=5*10^3;Rc
   =12*10^3;Rl=120*10^3;Re1=150
```

```
disp(" voltage gain at extreme value ")
Avmax=(hfemax*((Rc*Rl)/(Rc+Rl)))/(hiemax+Re1*(1+
   hfemax))
Avmin=(hfemin*((Rc*Rl)/(Rc+Rl)))/(hiemin+Re1*(1+
   hfemin))
disp("approximate voltage gain")
Av=((Rc*Rl)/(Rc+Rl))/Re1
```

Scilab code Exa 13.11 modify CE amplifier to use emitter current feedback to give

```
//chapter 13
//example 13.11
//page 571
printf("\n")
printf("given")
Av=70;f=100;rs=600;Rc=12*10^3;Rl=120*10^3;Re2
   =3.9*10^3;hie=2*10^3;hfe=100;R1=Rl;R2=39*10^3;Re1
   =150;
Zb=hie+Re1*(1+hfe)
Zin=(R1*R2*Zb)/(R1*R2+R1*Zb+R2*Zb)
C1=1/(2*3.14*f*((Zin+rs)/10))
C2=1/(2*3.14*f*Re1)
```

Scilab code Exa 13.12 suitable emitter resistor value

```
//chapter 13
//example 13.12
//page 573
printf("\n")
printf("given")
Av=1000;f=100;hie=2*10^3;hfe=100;R8=12*10^3;Rl
   =120*10^3;R10=3.9*10^3;R6=Rl;R7=39*10^3;R3=R8;
Av1=sqrt(Av)
```

```
Av2=Av1;
R9=((R8*Rl)/(R8+Rl))/Av2
R9=330;//use standard value
Av2=((R8*Rl)/(R8+Rl))/R9
Av1=Av/Av2
Zb=hie+R9*(1+hfe)
Zin=(R6*R7*Zb)/(R6*R7+R6*Zb+R7*Zb)
R4=((R3*Zin)/(R3+Zin))/Av1
R5=R10-R4
```

Scilab code Exa 13.13 suitable capacitor for two stage circuit

```
//chapter 13
//example 13.13
//page 574
printf("\n")
printf("given")
f=100;hie=2*10^3;hfe=100;R8=12*10^3;Rl=120*10^3;R10=3.9*10^3;R6=Rl;R7=39*10^3;R3=R8;R4=220;rs=600;Zin2=16*10^3;R9=330;R1=Rl
R2=39.0*10^3;
Zb=hie+R4*(1+hfe)
Zin=(R1*R2*Zb)/(R1*R2+R1*Zb+R2*Zb)
C1=1/(2*3.14*f*((Zin+rs)/10))
Xc2=.65*R4;
C2=1/(2*3.14*f*Xc2)
C3=1/(2*3.14*f*((Zin2+R3)/10))
C4=1/(2*3.14*f*.65*R9)
C5=1/(2*3.14*f*((R8+Rl)/10))
```

Scilab code Exa 13.14 determine current gain and input impedance

```
//chapter 13
```

```
//example 13.14
//page 580
printf("\n")
printf("given")
hfe=100;hie=2*10^3;R4=100;R1=5.6*10^3;R6=2.2*10^3;
Zi=hie+(1+hfe)*R4
disp("open loop current gain")
Ai=(hfe*hfe*R1)/(R1+Zi)
B=R4/(R4+R6)
disp("closed loop gain")
Acl=Ai/(1+Ai*B)
Zi=hie/(1+Ai*B)
```

Scilab code Exa 13.15 calculate total harmonic

```
//chapter 13
//example 13.15
//page 585
printf("\n")
printf("given")
Av=60000;Acl=300;f1=15*10^3;B=1/300;
f2=(Av*f1)/Acl
disp("% distortion with NFB")
NFB=(.1/(1+Av*B))*100;
printf(" percenatge  distortion with NFB is %3.3f\n"
    ,NFB)
```

Chapter 14

IC operational Amplifier and basic Op amp circuits

Scilab code Exa 14.1 `calculate maximum resistance`

```
//chapter 14
//example 14.1
//page 597
printf("\n")
printf("given")
Vbe=.7;Ib=500*10^-9;
R1=Vbe/(10*Ib);
R1=120*10^3//use standard value
R2=R1;
I2=100*Ib
Vr1=15;Vr2=Vr1;
R1=Vr1/I2
R1=270*10^3;//use satndard value
R2=R1;
R3=(R1*R2)/(R1+R2)
```

Scilab code Exa 14.2 suitable resistor for BIFET op amp is used

```
//chapter 14
//example 14.2
//page 599
printf("\n")
printf("given")
R2=1*10^6;Vb=3;Vo=3;Vee=9;
Vr2=Vb-(-Vee)
Vr1=Vee-Vb
I2=Vr2/R2
R1=Vr1/I2
R3=0
```

Scilab code Exa 14.3 typical difference between input and out voltage and Zin and

```
//chapter 14
//example 14.3
//page 601
printf("\n")
printf("given")
Av=200000;ri=2*10^6;ro=75;Vo=1;B=1;
Vd=Vo/Av
Zi=(1+Av*B)*ri
Zo=ro/(1+Av*B)
```

Scilab code Exa 14.4 capacitor coupled voltage follower usin 741 op amp

```
//chapter 14
//example 14.4
//page 603
printf("\n")
printf("given")
```

```
f=70;Rl=4*10^3;Ib=500*10^-9;Vbe=.7;
R1=Vbe/(10*Ib)
R1=120*10^3;//use standard value
R2=R1;
disp(" desire value of capacitor is C=1/2*3.14*f*R")
C2=1/(2*3.14*f*Rl)
C1=1/(2*3.14*f*(R1/10))
```

Scilab code Exa 14.5 `direct coupled non inverting amplifier`

```
//chapter 14
//example 14.5
//page 605
printf("\n")
printf("given")
Ib=500*10^-9;Vi=50*10^-3;Vo=2;
I2=100*Ib;
R3=Vi/I2
R2=(Vo/I2)-R3
R1=(R2*R3)/(R2+R3)
```

Scilab code Exa 14.6 `typical input and output impedances for non inverting`

```
//chapter 14
//example 14.6
//page 606
printf("\n")
printf("given")
Av=200000;ri=2*10^6;ro=75;R3=1*10^3;R2=39*10^3;
B=R3/(R2+R3)
Zi=(1+Av*B)*ri
printf(" typical input impedance for non-inverting
    amplifier is %dohm\n",Zi)
```

```
Zo=ro/(1+Av*B)
```

Scilab code Exa 14.7 voltage gain and lower cutoff frequency

```
//chapter 14
//example 14.7
//page 607
printf("\n")
printf("given")
R2=50*10^3;R3=2.2*10^3;C2=8.2*10^-6;Rl=600;
disp("voltage gain ")
Acl=(R3+R2)/R3
disp("lower cuttoff frequency ")
f=1/(2*3.14*C2*Rl)
```

Scilab code Exa 14.8 direct coupled inverting amplifier

```
//chapter 14
//example 14.8
//page 610
printf("\n")
printf("given")
Acl=144;Vi=20*10^-3;Ib=500*10^-9;
I1=100*Ib
R1=Vi/I1
R1=390;//use standard value
R2=Acl*R1
R3=(R1*R2)/(R1+R2)
```

Scilab code Exa 14.9 design three input summing amplifier

```
//chapter 14
//example 14.9
//page 612
printf("\n")
printf("given")
Acl=3;R4=1*10^6;Vi=1;
R1=R4/Acl
R1=330*10^3;//use standard value
R2=R1;R3=R1;
I1=Vi/R1
I2=I1;I3=I1;
I4=I1+I2+I3
Vo=-I4*R4
```

Scilab code Exa 14.10 suitable resistor for 741 op amp

```
//chapter 14
//example 14.10
//page 615
printf("\n")
printf("given")
Ib=500*10^-9;Vi=1;Acl=10;
I1=100*Ib
R1=Vi/I1
R1=18*10^3;//use standard value
R2=Acl*R1
R4=R1
R3=R1/Acl
```

Scilab code Exa 14.11 overall voltage gain for instrumentation amplifier

```
//chapter 14
//example 14.11
```

```
//page 619
printf("\n")
printf("given")
Vi=10*10^-3;Vn=1;R1=33*10^3;R2=300;R5=15*10^3;R4
   =15*10^3;Vi2=-10*10^-3;R3=R1;R6=15*10^3;R7=R6;
Acl=((2*R1+R2)/R2)*(R5/R4)
disp("at junction of R1 and R2")
Vb=Vi+Vn
disp("at junction of R2 and R3")
Vc=Vi2+Vn
disp(" current through R2")
I2=(Vb-Vc)/R2
disp("at the output of A1")
Va=Vb+(I2*R1)
disp("at output of A2")
Vd=Vc-(I2*R3)
disp("at junction of R6 and R7")
Vf=Vd*(R7/(R6+R7))
disp("at junction of R4 and R5")
Ve=Vf
disp("current through R4")
I4=(Va-Ve)/R4
disp("at output of A3")
Vg=Ve-(I4*R5)
```

Scilab code Exa 14.12 typical output voltage swingand calculate rise time

```
//chapter 14
//example 14.12
//page 623
printf("\n")
printf("given")
Vcc=15;Vee=-15;Av=200000;SR=.5/10^-6;Vo=14;
V=(Vcc-1)-(Vee+1)
Vi=Vo/Av
```

```
disp(" rise time of output is ")
t=(V/SR)*10^6;
printf(" rise time of output is %dus\n",t)
```

Scilab code Exa 14.13 calculate resistor for schmitt trigger circuit

```
//chapter 14
//example 14.13
//page 627
printf("\n")
printf("given")
Ib=500*10^-9;UTP=5;Vcc=15;
I1=100*Ib
R2=UTP/I1
R1=((Vcc-1)-5)/I1
```

Scilab code Exa 14.14 upper and lower trigger for non inverting schmitt trigger

```
//chapter 14
//example 14.14
//page 630
printf("\n")
printf("given")
Vcc=15;Vsat=Vcc;R2=150*10^3;Vf=.7;R1=27*10^3;R3
   =120*10^3;
I2=(Vsat-Vf)/R2
UTP=I2*R1
disp(" LTP calculation including Vf")
I3=(Vsat-Vf)/R3
LTP=-I3*R1
```

Chapter 15

Operational amplifier frequency Response and compensation

Scilab code Exa 15.2 `determine suitable component`

```
//chapter 15
//example 15.2
//page 648
printf("\n")
printf("given")
R2=1*10^6;Acl=4.5;
R1=R2/Acl
R1=220*10^3;//use standard value
R3=(R1*R2)/(R1+R2)
Cf=((R1*30*10^-12)/(R1+R2))*10^12;
printf(" suitable value of capacitor is %3.2fpF\n",
    Cf)
```

Scilab code Exa 15.3 `miller effect capacitor`

```
//chapter 15
```

```
//example 15.3
//page 649
printf("\n")
printf("given")
f=35*10^3;Rf=68*10^3;
Cf=(1/(2*3.14*f*Rf))*10^12;
printf(" suitable miller effect capacitor is %dpF\n"
    ,Cf)
```

Scilab code Exa 15.5 cutoff frequencies using gain bandwidth

```
//chapter 15
//example 15.5
//page 652
printf("\n")
printf("given")
Acl=100;Av=10;
disp(" for Cf=30pF")
GBW=800*10^3;
F2=GBW/Acl
disp(" for Cf=3pF")
GBW=(800*10^3)*Av;
f2=GBW/Acl
```

Scilab code Exa 15.6 full power bandwidth for AD843 op amp circuit

```
//chapter 15
//example 15.6
//page 654
printf("\n")
printf("given")
Vip=1;R2=39*10^3;R3=4.7*10^3;SR=250/10^-6;f
    =100*10^3;
```

```
disp(" for the AD843")
Vop=((R2+R3)/R3)*Vip
fp=SR/(2*3.14*Vop);
printf("full power bandwidth is %dHz\n",fp)
disp(" for a 741")
SR=.5/10^-6;
Vp=SR/(2*3.14*f);
printf(" maximum peak output voltage is %3.2fV\n",Vp
  )
```

Scilab code Exa 15.7 `input terminal stray capacitor`

```
//chapter 15
//example 15.7
//page 656
printf("\n")
printf("given")
rs=600;R1=1*10^3;R2=10*10^3;f=800*10^3;
disp(" stray capacitance")
Cs=1/(2*3.14*f*10*(((rs+R1)*R2)/(rs+R1+R2)))
disp("compensation capacitor")
C2=((Cs*(rs+R1))/R2)*10^12;
printf("compensation capacitor is %3.2fpF\n",C2)
```

Scilab code Exa 15.8 `load capacitance`

```
//chapter 15
//example 15.8
//page 659
printf("\n")
printf("given")
ro=25;f=2*10^6;R2=10*10^3;Rx=25;
Cl=(1/(2*3.14*f*(10*ro)))*10^+12;
```

```
printf(" load capacitance is %3.2fpF\n",Cl)
Cl=.1*10^-6;
C2=((Cl*(ro+Rx))/R2)*10^12;
printf(" compensation capacitance is %dpF\n",C2)
```

Chapter 16

Signal generators

Scilab code Exa 16.1 phase shift oscillator

```
//chapter 16
//example 16.1
//page 6568
printf("\n")
printf("given")
Vcc=10;Ib=500*10^-9;Acl=29;f=1*10^3;
disp(" phase shift  oscillator")
I1=100*Ib
vo=Vcc-1
vi=vo/Acl
R1=vi/I1
R1=5.6*10^3;//use standard value 5.6Kohm
R2=Acl*R1
R2=180*10^3;//use satndard value 180Kohm to give Acl
    >180
R3=R2;R=R1;
C=1/(2*3.14*R*f*sqrt(6))
```

Scilab code Exa 16.2 colpitts oscillator

```
//chapter 16
//example 16.2
//page 672
printf("\n")
printf("given")
f=40*10^3;L=100*10^-3;vp=8;
disp("colpitts oscillator")
Ct=1/(4*3.14*3.14*(f^2)*L)
C1=10*Ct
C2=1/((1/Ct)-(1/C1))
C2=180*10^-12;//use standard value
Xc2=1/(2*3.14*f*C2)
Xc1=1/(2*3.14*f*C1)
R1=10*Xc1
R1=27*10^3;//use standard value
Acl=C1/C2
R2=Acl*R1
R2=270*10^3;//use stabdard value
R3=(R1*R2)/(R1+R2)
f2=Acl*f
SR=2*3.14*f*vp
```

Scilab code Exa 16.3 hartley oscillator

```
//chapter 16
//example 16.3
//page 678
printf("\n")
printf("given")
vo=8;f=100*10^3;
disp(" hartley oscillator")
Vcc=vo+1
Xl2=1*10^3;
L2=Xl2/(2*3.14*f)
L2=1.5*10^-3;//use standard value
```

```
L1=L2/10
Lt=L1+L2//(assuming M=0)
C1=1/(4*(3.14^2)*(f^2)*Lt)
C1=1500*10^-12;//use 1500pF with aadditional
    parallel capacitance if necessary
//C1>>stray capacitance
Xl1=2*3.14*f*L1//R1>>Xl1
R1=1*10^3;
Acl=L2/L1
R2=Acl*R1
R3=(R1*R2)/(R1+R2)
disp("full power bandwidth ")
f2=Acl*f
SR=2*3.14*f*vo
```

Scilab code Exa 16.4 wein bridge oscillator

```
//chapter 16
//example 16.4
//page 680
printf("\n")
printf("given")
f=100*10^3;Vo=9;Acl=3;
disp(" design of wein bridge oscillator")
Vcc=Vo+1
C1=1000*10^-12;//standard value
C2=C1;
R1=1/(2*3.14*f*C1)
R2=R1;R4=R2;
R3=2*R4;
R3=3.3*10^3;//use standard value
disp(" minimum full power bandwidth")
f2=Acl*f
SR=2*3.14*f*Vo
```

Scilab code Exa 16.5 design a phase shift oscillator

```
//chapter 16
//example 16.5
//page 683
printf("\n")
printf("given")
f=5*10^3;vo=5;I1=1*10^-3;Vf=.7;
disp("phase shift oscillator")
R1=(vo/29)/I1
R1=150;//use standard value
R2=29*R1
R4=(2*Vf)/I1
R4=1.5*10^3;//use 1.5kohm standard value
R5=R2-R4
R6=.4*R5
R7=.8*R5
R=R1;
C=1/(2*3.14*R*f*sqrt(6))
```

Scilab code Exa 16.6 amplitude stabilization circuit

```
//chapter 16
//example 16.6
//page 686
printf("\n")
printf("given")
rds=600;Vgs=1;Vd1=.7;f=100*10^3;
disp("wien bridge ocillator")
R4=560;
R3=2*((R4*rds)/(R4+rds))
I5=200*10^-6;Vo=6;
```

```
R6=Vgs/I5
R5=(Vo-(Vgs+Vd1))/I5
disp(" C4 discharge voltage ")
Vc=.1*Vgs
disp("C4 discharge time")
T=1/f
Ic=I5;
C4=(Ic*T)/Vc
Xc3=rds/10//at oscillating frequency
C3=1/(2*3.14*f*Xc3)
```

Scilab code Exa 16.7 square wave generator

```
//chapter 16
//example 16.7
//page 689
printf("\n")
printf("given")
Vo=14;Vr3=.5;Ib=500*10^-9;f=1*10^3;
disp("square wave generator")
Vcc=Vo+1
UTP=Vr3;LTP=UTP;
I2=100*Ib;
R3=Vr3/I2
R2=(Vo-Vr3)/I2
t=1/(2*f)
V=UTP-(-LTP)
C1=.1*10^-6;
I1=(C1*V)/t
R1=Vo/I1
```

Scilab code Exa 16.8 calculate t1 t2 and pulse frequency

```
//chapter 16
//example 16.8
//page 694
printf("\n")
printf("given")
R1=2.2*10^3;R2=2.7*10^3;C2=.5*10^-6;Vcc=15;
t1=.693*C2*(R1+R2)
t2=.693*C2*R2
T=t1+t2
f=1/T
Ic1=(Vcc/3)/(R1+R2)
```

Scilab code Exa 16.10 `triangular wave generator`

```
//chapter 16
//example 16.10
//page 699
printf("\n")
printf("given")
Vcc=9;Vo=3;I1=1*10^-3;f=500;UTP=3;
disp("design the triangular wave")
Vi=Vcc-1
V=Vo-(-Vo)
disp(" I1>>Ibmax for op-amp")
R1=Vi/I1
t=1/(2*f)
C1=(I1*t)/V
disp("schmitt design")
I2=1*10^-3;
R2=UTP/I2
R3=(Vcc-1)/I2
```

Scilab code Exa 16.11 `design a wein bridge oscillator`

```
//chapter 16
//example 16.11
//page 705
printf("\n")
printf("given")
f=100*10^3;Rs=1.5*10^3;
R1=2*Rs
R1=2.7*10^3;//use standard value
R2=R1+Rs
C1=1/(2*3.14*f*R2)
R4=R2;
R3=2*R4
```

Scilab code Exa 16.12 pierce oscillator and peak power dissipated

```
//chapter 16
//example 16.12
//page 705
printf("\n")
printf("given")
fs=1*10^6;Rs=700;C1=1000*10^-12;C2=100*10^-12;R1
    =1*10^6;R2=10*10^3;Rs=700;Vdd=5;
Ct=(C1*C2)/(C1+C2)
disp(" at resonance Xl=Xct     2*pi*f*L=1/2*pi*f*Ct")
L=1/(((2*3.14*fs)^2)*Ct)
ip=Vdd/(R1+R2+Rs)
Pd=(((.707*ip)^2)*Rs)*10^9;
printf(" peak power dissipated is %3.3fnW\n",Pd)
```

Chapter 17

Active filters

Scilab code Exa 17.1 `calculate attenuation`

```
//chapter 17
//example 17.1
//page 716
printf("\n")
printf("given")
rs=600;R1=12*10^3;Rl=100*10^3;C1=.013*10^-6;
disp("when Rl is not connected")
fc=1/(2*3.14*R1*C1)
disp(" when Rl is connected")
fc=1/(2*3.14*((R1*Rl)/(R1+Rl))*C1)
Attn=3//at fc attenuation is =3dB
falloffrate=6
disp("attenuation at 2fc")
Attn=3+6;
printf("attenuation at 2fc is %ddB\n",Attn)
Attn=3+6+6;
printf(" attenuation at 4fc is %ddB\n",Attn)
```

Scilab code Exa 17.2 `first order active low pass filter`

```
//chapter 17
//example 17.2
//page 718
printf("\n")
printf("given")
Ib=500*10^-9;f=1*10^3;
R1=(70*10^-3)/Ib
R1=140*10^3;//use standard value
R2=R1;
C1=(1/(2*3.14*R1*f))*10^12;
printf(" capacitor used is of %dpF\n",C1)
```

Scilab code Exa 17.3 `first order high pass filterand filter bandwidth`

```
//chapter 17
//example 17.3
//page 719
printf("\n")
printf("given")
disp("first order high pass active filter")
f=5*10^3;C1=1000*10^-12;fu=1*10^6;
R1=1/(2*3.14*f*C1)
BW=fu-f;
printf(" bandwidth is %dHz\n",BW)
```

Scilab code Exa 17.4 `butterworth second order low pass filter`

```
//chapter 17
//example 17.4
//page 724
printf("\n")
printf("given")
f=1*10^3;Ib=500*10^-9;
```

```
disp("butterworth second order filter")
R=(70*10^-3)/Ib
R1=R/2
R1=68.1*10^3;//use standard value
R2=R1;
R3=2*R1
Xc1=sqrt(2)*R2
C1=1/(2*3.14*f*sqrt(2)*R2)
C2=2*C1
fc=1/(2*3.14*(sqrt(R1*R2*C1*C2)));
printf("actual cutoff frequency is %dHz\n",fc)
```

Scilab code Exa 17.5 using BIFET op amp design butterworth second order filter

```
//chapter 17
//example 17.5
//page 7
printf("\n")
printf("given")
f=12*10^3;C1=1000*10^-12;
disp("butterworth second order filter")
C2=C1;
R2=(sqrt(2))/(2*3.14*f*C1)
R1=.5*R2
R3=R2;
fc=1/(2*3.14*(sqrt(R1*R2*C1*C2)));
printf("actual cutoff frequency is %dHz\n",fc)
```

Scilab code Exa 17.6 third order low pass filter

```
//chapter 17
//example 17.6
//page 729
```

```
printf("\n")
printf("given")
f=30*10^3;C1=1000*10^-12;
disp(" third order low pass filter")
disp("−20 dB per decade stage")
fc1=f/.65;
R1=1/(2*3.14*fc1*C1)
R2=R1;
disp("−40dB per decade stage")
C3=1000*10^-12;
C2=2*C3
fc2=f/.8
R4=1/(2*3.14*fc2*C3*(sqrt(2)))
R3=R4;
R5=R3+R4
```

Scilab code Exa 17.7 `third order high pass filter`

```
//chapter 17
//example 17.7
//page 730
printf("\n")
printf("given")
f=20*10^3;
disp("3rd order high pass filter")
disp("−20dB per decade stage")
R1=121*10^3;
fc1=.65*f
C1=1/(2*3.14*fc1*R1)
//this is so small it might be effected by stray capacitor.redesign ,first choosing a suitable capacitance C1
C1=100*10^-12;
R1=1/(2*3.14*f*C1)
R2=R1;
```

```
disp("−40dB per decade stage")
C3=1000*10^-12;
R4=(sqrt(2))/(2*3.14*.8*f*C3)
C2=C3;
R3=.5*R4
R5=R4
```

Scilab code Exa 17.8 single stage band pass filter

```
//chapter 17
//example 17.8
//page 734
printf("\n")
printf("given")
f1=300;f2=30*10^3;
disp(" single stage band pass filter")
C2=1000*10^-12;
R2=1/(2*3.14*f2*C2)
R1=R2;
Xc1=R1;//at voltage gain Av=1
C1=1/(2*3.14*f1*R1)
R3=R2
```

Scilab code Exa 17.9 calculate Q factor for wide band filter

```
//chapter 17
//example 17.9
//page 736
printf("\n")
printf("given")
f1=300;f2=30*10^3;
fo=sqrt(f1*f2)
BW=f2-f1
```

```
Q=fo/BW
```

Scilab code Exa 17.10 `center frequency and bandwidth`

```
//chapter 17
//example 17.10
//page 737
printf("\n")
printf("given")
R1=60.4*10^3;R4=1.21*10^3;C=.012*10^-6;R2=121*10^3;
Q=sqrt((R1+R4)/(2*R4))
fo=Q/(3.14*C*R2);
printf(" center frequency is %3.2fHz\n",fo)
BW=fo/Q;
printf(" bandwidth is %3.1fHz\n",BW)
```

Scilab code Exa 17.12 `state variable band pass filter`

```
//chapter 17
//example 17.12
//page 744
printf("\n")
printf("given")
f1=10.3*10^3;f2=10.9*10^3;
C1=1000*10^-12;C2=C1;
fo=sqrt(f1*f2)
R5=1/(2*3.14*fo*C1)
R1=R5;
Q=fo/(f2-f1)
R2=R1*(2*Q-1)
```

Scilab code Exa 17.13 required resistance to operate one half of an MF10

```
//chapter 17
//example 17.13
//page 750
printf("\n")
printf("given")
f1=10.3*10^3;f2=10.9*10^3;Hobp=34;
fo = sqrt(f1*f2);
sqrt(f1*f2)
Q=fo/(f2-f1)
R3=120*10^3;
R2=R3/Q
R1=R3/Hobp
fck=50*fo
```

Chapter 18

Linear and switching voltage regulators

Scilab code Exa 18.1 `load and source effects and load and line regulation`

```
//chapter 18
//example 18.1
//page 761
printf("\n")
printf("given")
Vs=21;Vo=12;Av=100;
vo=(Vs*.1)/Av;//source effect is 10% of the Vs
printf(" source effect is %3.3fV\n",vo)
vo=(21-20)/100;
printf(" laod effect is %3.3fV\n",vo)
LR=(21*10^-3 *100)/12;
printf("line regulation is %3.3fpercentage\n",LR)
LR=(10*10^-3*100)/12;
printf(" load effect is %3.3fpercentage \n",LR)
RJ=20*log10(1/Av);
printf("ripple rejection is %ddB\n",RJ)
```

Scilab code Exa 18.2 voltage regulator circuit

```
//chapter 18
//example 18.2
//page 762
printf("\n")
printf("given")
Vo=12;Il=40*10^-3;Vs=20;Vbe=.7;
Vz=.75*Vo
disp("for minimum D1 current select")
Ir2=10*10^-3;
R2=(Vo-Vz)/Ir2
Ie1=Il+Ir2
disp("specification for Q")
Vce1=20;Vs=Vce1;
Ic1=50*10^-3;
Pd=(Vs-Vo)*Ie1
hfe=50;
Ib1=Ie1/hfe
Ic2=5*10^-3;
R1=(Vs-(Vo+.7))/(Ic2+Ib1)
Iz=Ie2+Ir2
I4=1*10^-3;
R4=(Vz+Vbe)/I4
R3=(Vo-(Vz+Vbe))/I4
```

Scilab code Exa 18.3 modify voltage regulator

```
//chapter 18
//example 18.3
//page 765
printf("\n")
printf("given")
I4=1*10^-3;Vb2=9.8;
disp(" for Vo=11V moving contact at top of R5")
```

```
Vo=11;
R3=(Vo-Vb2)/I4
R=Vb2/I4//R=R4+R5
disp(" for Vo=13V moving contact at bottom of R5")
Vo=13;
I4=Vo/(R3+R)
R4=Vb2/I4
R5=R-R4
```

Scilab code Exa 18.4 voltage regulator to change the load current

```
//chapter 18
//example 18.4
//page 766
printf("\n")
printf("given")
hFE3=50;hFE1=20;Ie1=200*10^-3+10*10^-3;Ic2=1*01^-3;
    Vs=20;Vb3=13.4;Vo=12;Vbe=.7;
Ib1=Ie1/hFE1
Ib3=Ib1/hFE3
R1=(Vs-Vb3)/(Ic2+Ib3)
disp("select I6=.5*10^-3")
I6=.5*10^-3;
R6=(Vo+Vbe)/I6
Pd=(Vs-Vo)*Ie1
```

Scilab code Exa 18.5 suitable component for preregulator circuit

```
//chapter 18
//example 18.5
//page 769
printf("\n")
printf("given")
```

```
Vo=12.0;
Vr1=3;Ic2=1*10^-3;Ib3=.21*10^-3;Vbe1=.7;Vbe3=Vbe1;Vs
    =20;
R1=Vr1/(Ic2+Ib3)
Vz2=Vo+Vbe1+Vbe3+Vr1
Ir7=5*10^-3;
R2=(Vs-Vz2)/Ir7
```

Scilab code Exa 18.6 differential amplifier

```
//chapter 18
//example 18.6
//page 770
printf("\n")
printf("given")
Vc5=9.8;Vb2=Vc5;Vce5=3;Vbe=.7;Vo=12;
Vr9=Vc5-Vce5
Vz2=Vr9+Vbe
Ic5=1*10^-3;
R8=(Vo-Vc5)/Ic5
Ir9=2*Ic5
R9=Vr9/Ir9
disp(" Iz2>>Ib5 and Iz2>(Izk for the zener diode)")
Iz2=10*10^-3;
R7=(Vo-Vz2)/Iz2
I4=1*10^-3;
Vb6=7.5;Vz2=Vb6;
disp(" when Vo=11V(moving contact at top of R5)")
Vo=11;
R3=(Vo-Vb6)/I4
R3=3.3*10^3;//use standard value
I4=(Vo-Vb6)/R3
R=Vb6/I4//R=R4+R5
disp(" when Vo=13V(moving contact at bottom of R5)")
Vo=13;Vb6=7.5;
```

```
I4=Vo/(R3+R)
R4=Vb6/I4
R5=R-R4
```

Scilab code Exa 18.7 fold back current limiting circuit for voltage regulator

```
//chapter 18
//example 18.7
//page 7
printf("\n")
printf("given")
Isc=100*10^-3;Vr10=.5;Vo=12;
R10=Vr10/Isc
R10=4.7;//use standard value
Il=200*10^-3;
Vr10=Il*R10
Vr11=Vr10-.5
I11=1*10^-3;
R11=Vr11/I11
R12=(Vo+Vr10-Vr11)/I11
```

Scilab code Exa 18.8 adjustable voltage regulator circuit

```
//chapter 18
//example 18.8
//page 778
printf("\n")
printf("given")
Vo=12;hFE1=20;hFE2=50;Il=250*10^-3;
Vz=.75*Vo
Vz=9.1;//use standard value for 1N757 diode
Iz1=10*10^-3;
R1=(Vo-Vz)/Iz1
```

```
I3=1*10^-3;
disp(" when V0=12V(moving contact at top of R5)")
R3=(Vo-Vz)/I3
R=Vz/I3
disp(" when Vo=15V moving contact at bottom of R5")
Vo=15;
I3=Vo/(R+R3)
R4=Vz/I3
R5=R-R4
Ir6=.5*10^-3;
R6=Vo/Ir6
disp(" op-amp output current")
Ib2=Il/(hFE1*hFE2)
```

Scilab code Exa 18.9 input voltage and maximum load current

```
//chapter 18
//example 18.9
//page 782
printf("\n")
printf("given")
I2=1*10^-3;Vr2=7.15;Vref=Vr2;Vo=10;Pdmax=1000*10^-3;
R2=Vref/I2
R2=6.8*10^3;//use standard value and recalculate the
    I2
I2=Vref/R2
R1=(Vo-Vref)/I2
Vs=Vo+5//for satisfactory operation of series pass
    transistor
Iint=25*10^-3;//internal circuit current
Pi=Vs*Iint
disp("maximum power dissipated in series pass
    transistor")
Pd=Pdmax-Pi
disp("maximum load current is ")
```

```
Il=Pd/(Vs-Vo)
```

Scilab code Exa 18.10 calculate regulator power dissipation

```
//chapter 18
//example 18.10
//page 785
printf("\n")
printf("given")
I1=1*10^-3;Vref=1.25;Vo=6;Vs=15;Il=200*10^-3;
R1=Vref/I1
R2=(Vo-Vref)/I1
Pd=(Vs-Vo)*Il;
printf("regulated power dissipation is %3.2fW\n",Pd)
```

Scilab code Exa 18.11 efficiencies of linear regulator and switching regulator

```
//chapter 18
//example 18.11
//page 788
printf("\n")
printf("given")
Vo=10;Io=1;Vce=7;Vf=1;
Po=Vo*Io
disp(" linear regulator")
Pi=Po+(Vce*Io)
n=(Po*100)/Pi//efficiency
disp(" switching regulator")
Vce=1;
Pi=Po+Io*(Vce+Vf)
n=(Po*100)/Pi//efficiency
```

Scilab code Exa 18.12 step down switching regulator

```
//chapter 18
//example 18.12
//page 792
printf("\n")
printf("given")
f=50*10^3;Vo=12;Vf=.7;Vi=30;Vsat=1;Io=500*10^-3;Vr
    =100*10^-3;
T=1/f
t=(Vo+Vf)/(Vi-Vsat-Vo)
toff=T/1.75
ton=T-toff
Ip=2*Io
L1=((Vi-Vsat-Vo)*ton)/Ip
C1=Ip/(8*f*Vr)
```

Scilab code Exa 18.13 determine suitable value for R1 R2 Rsc and Ct

```
//chapter 18
//example 18.13
//page 799
printf("\n")
printf("given")
disp(" an MC34063 controller is for step down
    transformer")
Ib=-400*10^-3;I1=1*10^-3;Vref=1.25;V0=12;Ip=1;ton
    =8.6*10^-6;
R1=Vref/I1
R1=1.2*10^3;//use standard value
I1=Vref/R1
R2=(Vo-Vref)/I1
```

```
Rsc=.33/Ip
Ct=4.8*10^-5 *ton
```

Chapter 19

Power amplifiers

Scilab code Exa 19.1 Dc and Ac load line transistor common emitter characteristics

```
//chapter 19
//example 19.1
//page 810
printf("\n")
printf("given")
Rpy=40;N1=74;N2=14;R2=3.7*10^3;R1=4.7*10^3;Vbe=.7;Re
    =1*10^3;Vcc=13;Rl=56;
disp("Q-point")
Vb=Vcc*(R2/(R1+R2))
Ic=(Vb-Vbe)/Re
Ie=Ic;
Vce=Vcc-Ic*(Rpy+Re)
rl=(N1/N2)^2 *Rl
rl=rl+Rpy
Ic=5*10^-3;
Vce=Ic*rl
```

Scilab code Exa 19.2 maximum efficiency of class A amplifier

```
//chapter 19
//example 19.2
//page 814
printf("\n")
printf("given")
Vcc=13;Icq=5*10^-3;Vceq=8;Vp=Vceq;Ip=Icq;nt=.8;
Pi=Vcc*Icq
Po=.5*Vp*Ip
P0=nt*Po
n=(P0/Pi)*100;
printf(" maximum efficiency is %3.2f percentage\n",n
    )
```

Scilab code Exa 19.4 power deliver to load in class AB amplifier

```
//chapter 19
//example 19.4
//page 821
printf("\n")
printf("given")
N1=60;N2=10;Rl=16;Rpy=0;R6=56;Vcc=27;Vce=.5;n=.79;
disp(" Referred laod")
rl=(N1/N2)^2 *Rl
disp(" tatol ac load line in series with each of Q2
    and Q3")
Rl=rl+R6+Rpy
disp(" peak primary current")
Ip=(Vcc-Vce)/Rl
disp("peak primary voltage")
Vp=Vcc-Vce-(Ip*R6)
disp("power delivered to primary")
Po=.5*Vp*Ip
disp(" power delivered  to the load")
Po=Po*n//n is power efficiency
```

Scilab code Exa 19.5 output transformer and transistor of class B circuit

```
//chapter 19
//example 19.5
//page 824
printf("\n")
printf("given")
Po=4;nt=.8;Vcc=30;Vp=Vcc;Rl=16;
P0=Po/nt
rl=(Vp)^2 /(2*P0)
rl=4*rl
disp("transformer specification Po=4 ,Rl=16 rl=360")
Vce=2*Vcc
Ip=(2*P0)/Vp
Pi=Vcc*.636*Ip
Pt=.5*(Pi-P0)
disp(" transistor specification is Py=.68W  Vce=60
    Ip=333mA")
```

Scilab code Exa 19.6 determine required supply voltage for class AB amplifier

```
//chapter 19
//example 19.6
//page 830
printf("\n")
printf("given")
Rl=50;Po=1;hFE=50;Vbe=.7;Vrc=4;Vre=1;Vd1=.7;Vd2=Vd1;
Vp=sqrt(2*Rl*Po)
Ip=Vp/Rl
Re3=.1*Rl;
Re2=4.7;//use stabdard value
Re2=Re3;
```

```
Icq=.1*Ip
Vb=Vbe+Icq*(Re2+Re3)+Vbe
Vc1=Vrc;
Ib2=Ip/hFE
Irc=Ib2+1*10^-3
Rc=Vrc/Irc
Rc=680;//use standard value
Vcc=2*(Vp+Vre+Vbe+Vrc)
Vcc=32;//use standard value
Vrcdc=.5*(Vcc-Vb)
Ic1=Vrcdc/Rc
Rb=(Vb-Vd1-Vd2)/Ic1
```

Scilab code Exa 19.7 output transistors

```
//chapter 19
//example 19.7
//page 832
printf("\n")
printf("given")
Vcc=32;Vce=32;Ip=200*10^-3;Po=1;
Ic=1.1*Ip
Pi=.35*Vcc*Ip
Pt=.5*(Pi-Po)
```

Scilab code Exa 19.8 capacitor value for Ce and Co

```
//chapter 19
//example 19.8
//page 832
printf("\n")
printf("given")
f=50;hib=2;Rl=50;
```

```
Ce=1/(2*3.14*f*hib)
Co=1/(2*3.14*50*.1*Rl)
```

Scilab code Exa 19.9 determine the value of Vcc Rc and Rb for class AB amplifier

```
//chapter 19
//example 19.9
//page 834
printf("\n")
printf("given")
hFE=2000;Vbe=1.4;Vp=10;Ip=200*10^-3;Icq2=20*10^-3;
   Re3=4.7;Re2=4.7;Vd=.7;
Icq=20.0*10^-3;
Ve1=3;Vc1=15.2;Vrc=Vc1;
Vb=Vbe+Icq*(Re2+Re3)+Vbe
Vcc=Vrc+Vc1+Vb
Ib2=Ip/hFE
Irc=1*10^-3;
Vrcac=4;
Rc=Vrcac/Irc
Ic1=Vrc/Rc
Rb=(Vb-(4*Vd))/Ic1
```

Scilab code Exa 19.10 design Vbe multiplier

```
//chapter 19
//example 19.10
//page 838
printf("\n")
printf("given")
Vb=3.2;Ic1=5*10^-3;Vce=3.2;Vbe=.7;
Vbmin=Vb-.5
Vbmax=Vb+.5
```

```
I10=.1*Ic1
R10=(Vce-Vbe)/I10
R10=4.7*10^3;//use standard value
disp(" for Vce=3.7")
Vce=3.7;
I10max=(Vce-Vbe)/R10
disp("Vce=2.7V")
Vce=2.7;
I10min=(Vce-Vbe)/R10
R=Vbe/I10min
R11=Vbe/I10max
R12=R-R11
```

Scilab code Exa 19.11 required supply voltage and specify output transistors

```
//chapter 19
//example 19.11
//page 843
printf("\n")
printf("given")
Rl=16;Po=6;Vbe=.7;
Vp=sqrt(2*Rl*Po)
Vr14=.1*Vp;Vr15=Vr14;
R14=.1*Rl;R15=R14;
Vce3=1;Vce4=Vce3;
Vr9=3;Vr11=Vr9;
Vcc=(Vp+Vr14+Vbe+Vce3+Vr9)
Vee=-Vcc;
Ip=Vp/Rl
disp(" DC power inpit from supply line")
Pi=(Vcc-Vee)*.35*Ip
disp(" output  transistor specification")
Pt=.5*(Pi-Po)
Vce=2*Vcc
Ic=1.1*Ip
```

Scilab code Exa 19.12 suitable resistor for output and intermediate stage

```
//chapter 19
//example 19.12
//page 844
printf("\n")
printf("given")
hFE7=20;Icbo=50*10^-6;hFE5=70;Vr9=3;Ip=869*10^-3;R15=1.5;R8=15*10^3;Vbe=.7;Vr11=3;Vee=20;
R12=.01/Icbo
R12=220;//use standard value
R13=R12;
Ib5=Ip/(hFE7*hFE5)
Ic3=2*10^-3;
R9=Vr9/Ic3
R11=R9;
Iq78=.1*Ip
Vr14=Iq78*R15
Vr15=Vr14;
Vr10=(Vr14+Vr15)+(Vr14+Vr15)/2
R10=Vr10/Ic3
Ir8=(Vr11+Vbe)/R8
R7=(Vee-(Vr11+Vbe))/Ir8
```

Scilab code Exa 19.13 calculate required supply voltage and suitable DC voltage dr

```
//chapter 19
//example 19.13
//page 848
printf("\n")
printf("given")
```

```
Rl=20;Po=2.5;Rd=4;Vr6=1;Vr9=Vr6;Vth=1;gFS=250*10^-3;
    Vbe=.7;
Vp=sqrt(2*Rl*Po)
Ip=Vp/Rl
Vcc=(Vp+Ip*Rd)
vr6=Ip/gFS
Vr2=vr6+1
Vce=Vr2;
Vce3=1;
Vr2=Vcc-Vce
Vee=Vcc;
Vr3=Vee-Vbe
Vr7=Vr2-Vr6
Vr8=Vcc-(-Vee)-Vr6-Vr7-Vr9
```

Scilab code Exa 19.14 determine resistor value for MOSFET amplifier

```
//chapter 19
//example 19.14
//page 849
printf("\n")
printf("given")
R6=100*10^3;R9=R6;Vth=1;Vr7=8;Vr8=14;Vr3=11.3;Vpout
    =10;Vpin=800*10^-3;
I6=Vth/R6
R7=Vr7/I6
R8=Vr8/I6
Ic1=1*10^-4;Ic2=Ic1;Vr2=9;
R2=Vr2/Ic1
R3=Vr3/(Ic1+Ic2)
R5=4.7*10^3;
Acl=Vpout/Vpin
R4=R5/(Acl-1)
```

Scilab code Exa 19.15 bootstrap capacitor terminal voltage and peak output voltage

```
//chapter 19
//example 19.15
//page 854
printf("\n")
printf("given")
Vce=1.5;Vcc=17;Vd1=.7;R8=1.5*10^3;R9=R8;Rl=100;R6=8.2;
I4=(Vcc-Vd1)/(R8+R9)
Vc3=Vcc-(I4*R8);
printf(" bootstrap capacitance terminal voltage is %3.1fV\n",Vc3)
V=Vcc-Vce//V=Vp+Vr6
Ip=V/(Rl+R6)
Vp=Ip*Rl;
printf(" peak output voltage is %3.1fV\n",Vp)
Po=(Vp)^2 /(2*Rl);
printf(" peak output power is %dW\n",Po)
```

Scilab code Exa 19.16 use BIFET to determine supply voltage and resistor value

```
//chapter 19
//example 19.16
//page 856
printf("\n")
printf("given")
Rl=8;Po=6;vs=.1;hFE=1000;Vce=2;f=50*10^3;Vd1=.7;
Vp=sqrt(2*Rl*Po)
Ip=Vp/Rl
R6=.1*Rl
R7=R6;
```

```
Vcc=Vp+Ip*R6+Vce
Ib=Ip/hFE
I4=2*10^-3;
R4=(Vcc-Vd1-Vd1)/I4
R8=.5*R4
Acl=Vp/vs
R3=100*10^3;
R2=R3/(Acl-1)
SR=(2*3.14*f*Vp)*10^-6;
printf(" slew rate is %3.2fV/us\n",SR)
```

Scilab code Exa 19.17 capacitor value

```
//chapter 19
//example 19.17
//page 858
printf("\n")
printf("given")
f=50;R1=100*10^3;R2=1*10^3;R8=2.7*10^3;R9=R8;
C1=1/(2*3.14*f*.1*R1)
C2=1/(2*3.14*f*R2)
Xc3=.1*((R8*R9)/(R8+R9))
C3=1/(2*3.14*f*Xc3)
C4=C3
```

Scilab code Exa 19.18 MOSFET gate source voltage for complementry common source am

```
//chapter 19
//example 19.18
//page 860
printf("\n")
printf("given")
```

```
Ismin=1.8*10^-3;Ismax=3.4*10^-3;R7=820;R5=390;R6
   =18*10^3;Vi=100*10^-3;Rl=10;
Vgsmin=Ismin*R7
Vgsmax=Ismax*R7
Acl=(R5+R6)/R5
Vp=Acl*Vi
Ip=Vp/Rl;
printf("peak output current is %3.3fA\n",Ip)
Po=(Vp*Ip)/2;
printf("peak output power is %3.2fW\n",Po)
```

Scilab code Exa 19.19 calculate Vgsmax and Vgsmin

```
//chapter 19
//example 19.19
//page 862
printf("\n")
printf("given")
Vbe=.7;R2=560;R3min=0;R3max=1*10^3;Is=2*10^-3;
Ic2max=Vbe/(R2+R3min)
Ic2min=Vbe/(R2+R3max)
Vgsmin=(Is+Ic2min)*820
Vgsmax=(Is+Ic2max)*820
```

Scilab code Exa 19.20 maximum peak output voltage minimum supply voltage at op amp

```
//chapter 19
//example 19.20
//page 865
printf("\n")
printf("given")
Vcc=12;Rl=10;R9 = 100;Rd=.5;gfs=2.5;R7=820;V9
   =1*10^3;R10=R9;Is=2.0*10^-3;
```

```
Vp=(Vcc*Rl)/(Rd+Rl)
Ip=Vp/Rl
Vgs=Ip/gfs
Vr7=Is*R7
Vs=Vcc-Vr7-Vgs
disp(" op-amp peak output voltage is")
Vr9=(Vp*R9)/(R9+R10)
```

Scilab code Exa 19.21 op amp minimum supply voltage and MOSFET maximum gate source

```
//chapter 19
//example 19.21
//page 867
printf("\n")
printf("given")
Vbe=.7;R2=470;R3=1*10^3;Is=.5*10^-3;R7=1.5*10^3;Vcc
   =15;
Ic2max=Vbe/R2
Ic2min=Vbe/(R2+R3)
Vgs=(Is+Ic2max)*R7;
printf(" MOSFET maximum gate source voltage is %3.1
   fV\n",Vgs)
Vs=Vcc-Vgs;
printf(" op-amp minimum suppy is %3.2fV\n",Vs)
```

Scilab code Exa 19.22 determine Po Acl f1 and f2

```
//chapter 19
//example 19.22
//page 868
printf("\n")
printf("given")
```

```
Vcc=15;Rl=15;Rd=.3;R5=2.2*10^3;R6=33*10^3;C2=3.9*10^-6;C4=100*10^-12;
disp(" power output")
Vp=(Vcc*Rl)/(Rd+Rl)
Ip=Vp/Rl
Po=(Vp*Ip)/2
disp(" voltage gain")
Av=(R5+R6)/R5
disp("cutoff frequency")
f1=1/(2*3.14*C2*R5)
f2=1/(2*3.14*C4*R6)
```

Scilab code Exa 19.23 maximum output power voltage gain and low cutoff frequency

```
//chapter 19
//example 19.23
//page 871
printf("\n")
printf("given")
Vcc=23;Rl=8;Rf2=100*10^3;Rf1=5.6*10^3;Cf=1*10^-6;
Vp=Vcc-5
Po=(Vp)^2 /(2*Rl);
printf("maximum output power is %3.2fW\n",Po)
Acl=(Rf1+Rf2)/Rf1;
printf(" voltage gain %3.1f\n",Acl)
f=1/(2*3.14*Cf*Rf1);
printf("lower cutoff frequency is %dHz\n",f)
```

Scilab code Exa 19.24 determine the load power dissipation

```
//chapter 19
//example 19.24
//page 875
```

```
printf("\n")
printf("given")
Rf=15*10^3;R1=5.6*10^3;vs=.5;Vp=2.7;Rl=8.0;
Acl=(2*Rf)/R1
Vo=Acl*vs
Po=(Vp)^2 /(2*Rl);
printf("load power dissipation is %3.2fW\n",Po)
```

Scilab code Exa 19.25 calculate ac output power dc input power conduction angle an

```
//chapter 19
//example 19.25
//page 880
printf("\n")
printf("given")
Vcc=10;Rl=1*10^3;f=3*10^6;Ip=25*10^-3;Vce=.3;
Vp=Vcc-Vce
Po=(Vp)^2 /(2*Rl)
T=1/f
t=(Po*T)/(Ip*Vp)
angle=(t/T)*360;
printf(" conduction angle is %3.1fdegree\n",angle)
Idc=Po/Vp
Pi=Vcc*Idc;
printf( "dc input power is %3.4fW\n",Pi)
n=(Po/Pi)*100//efficiency
```

Scilab code Exa 19.26 for class C amplifier determine tank circuit component value

```
//chapter 19
//example 19.26
//page 882
printf("\n")
```

```
printf("given")
f=1*10^6;Xc=120;Vce=.5;Vcc=30;Rl=1.2*10^3;O=100;
Cp=1/(2*3.14*f*Xc)
Cp=1300*10^-12;//use standard value
Lp=1/(((2*3.14*f)^2)*Cp)
Vp=Vcc-Vce
Po=((Vp)^2) /(2*Rl)
Idc=Po/Vp
T=1/f
t=(O*T)/360
Ip=(Idc*T)/t
```

Scilab code Exa 19.27 for class C amplifier determine Ql Qp and Pl and bandwidth a

```
//chapter 19
//example 19.27
//page 883
printf("\n")
printf("given")
Rw=.1;f=1*10^6;Lp=19.5*10^-6;Rl=1.2*10^3;Vcc=30;Idc
   =12.3*10^-3;Vce=0.5;
Vp=Vcc-Vce;
Po=((Vp)^2) /(2*Rl);
QL=(2*3.14*f*Lp)/Rw
Qp=Rl/(2*3.14*f*Lp)
B=f/Qp
Il=(.707*Vp)/(2*3.14*f*Lp)
Pl=(Il)^2 *Rw
Pi=(Vcc*Idc)+Pl
n=(Po/Pi)*100
```

Chapter 20

Thyristors

Scilab code Exa 20.1 calculate instantaneous supply voltage

```
//chapter 20
//example 20.1
//page 902
printf("\n")
printf("given")
Vs=25;Vtm=1.7;Rl=25;Ih=5*10^-3;
Vspk=1.414*Vs
Ilpk=(Vs-Vtm)/Rl
disp(" for half wave rectifier sinusodial waveform")
Ilrms=.5*Ilpk
disp(" switch-off voltage")
es=Vtm+(Ih*Rl)
```

Scilab code Exa 20.2 determine suitable resistance

```
//chapter 20
//example 20.2
//page 905
```

```
printf("\n")
printf("given")
Vs=30;Vd1=.7;Vg=.8;Ig=200*10^-6;
Vspk=1.414*Vs
disp(" at 5 degree")
es=Vspk*.087//  sin5=.087
disp(" at 90 degree")
es=Vspk
Vt=Vd1+Vg
disp(" to trigger at es=3.7V the R2 moving contact is at the top")
es=3.7;
Vr1=es-Vt
I1=1*10^-3;
R1=Vr1/I1
R=Vt/I1//R=R2+R3
disp(" to trigger at es =42.4 the R2 moving contact at the bottom")
es=42.4;
Vr3=Vt;
I1=es/(R+R1)
R3=Vt/I1
R2=R-R3
```

Scilab code Exa 20.3 determine SCR anode cathode voltage

```
//chapter 20
//example 20.3
//page 906
printf("\n")
printf("given")
R1=2.2*10^3;R2=1.5*10^3;R3=120;Vt=1.5;
disp(" with R2 contact at center")
Vak=Vt*((R1+R2+R3)/(R3+.5*R2))
disp(" with R2 contact at zero")
```

```
Vak=Vt*((R1+R2+R3)/R3)
```

Scilab code Exa 20.4 specify the SCR and suitable components for D1 and R1

```
//chapter 20
//example 20.4
//page 911
printf("\n")
printf("given")
Vs=5;Ilmax=300*10^-3;Vl=7;Vg=.8;
Vz=Vl-Vg
disp(" for D1, select a 1N753 with Vz=6.2")
Izmin=1*10^-3;
R1=Vg/Izmin
```

Scilab code Exa 20.5 smallest conduction angle

```
//chapter 20
//example 20.5
//page 9
printf("\n")
printf("given")
R1=25*10^3;R2=2.7*10^3;C1=3*10^-6;Vg=.8;Vd1=8;Vs
   =115;f=60;
Vc1=Vd1+Vg
//assume the average charging voltage is
Vac=1.414*Vs
E=.636*Vac
//average charging
Ic=E/(R1+R2)
//charging time
t=(C1*Vc1)/Ic
T=1/f
```

```
q=(t*360)/T
disp(" concudtion angle")
a=180-q
```

Scilab code Exa 20.6 determine capacitor charging time

```
//chapter 20
//example 20.6
//page 925
printf("\n")
printf("given")
Vs=10;Vf=1.7;Is=500*10^-6;Ih=1.5*10^-3;E=30;R
   =27*10^3;C=.5*10^-6;
R1max=(E-Vs)/Is
R1min=(E-Vf)/Ih
t=C*R*log((E-Vf)/(E-Vs));
printf(" capacitor charging time is %3.4fs\n",t)
```

Scilab code Exa 20.7 calculate maximum Vb1b2 be used at temperature 100C

```
//chapter 20
//example 20.7
//page 931
printf("\n")
printf("given")
Rbb=4*10^3;Pd25=360*10^-3;D=2.4*10^-3;T2=100;
Pd=Pd25-D*(T2-25)
Vb1b1=sqrt(Rbb*Pd);
printf(" maximum Vb1b1 that should be used at a temp
    100 is %3.1fV\n",Vb1b1)
```

Scilab code Exa 20.8 maximum and minimum triggering voltage

```
//chapter 20
//example 20.8
//page 931
printf("\n")
printf("given")
Vb1b1=25;nmax=.86;nmin=.74;Vd=.7;
Vpmax=Vd+(nmax*Vb1b1)
Vpmin=Vd+(nmin*Vb1b1)
```

Scilab code Exa 20.9 calculate Re for relaxation oscillator and oscillating freque

```
//chapter 20
//example 20.9
//page 933
printf("\n")
printf("given")
Ip=.6*10^-6;Iv=2*10^-3;Veb1=2.5;Vpmin=19.2;Vpmax=22.2;Vbb=25;C=1*10^-6;R=18*10^3;Vp=20;
Vpmin=(Vbb-Vpmax)/Ip
Remax=(Vbb-Veb1)/Iv
t=C*R*log((Vbb-Veb1)/(Vbb-Vp))
f=1/t
```

Chapter 21

Optoelectronic Devices

Scilab code Exa 21.1 `total luminous flux`

```
//chapter 21
//example 21.1
//page 947
printf("\n")
printf("given")
r=3;Os=25;area=.25;
Ea=Os/(4*3.14*(r)^2)
Tf=Ea*area;
printf(" total flux is %3.3fW\n",Tf)
```

Scilab code Exa 21.3 `suitable resistor`

```
//chapter 21
//example 21.3
//page 951
printf("\n")
printf("given")
Vcc=9;Vf=1.6;Vb=7;hFE=100;Vce=.2;Ic=10*10^-3;Vbe=.7;
```

```
R2=(Vcc-Vf-Vce)/Ic
R2=680;//use standard value
Ic=(Vcc-Vf-Vce)/R2
Ib=Ic/hFE
Rb=(Vb-Vbe)/Ib
```

Scilab code Exa 21.4 total power supplied to digit LED

```
//chapter 21
//example 21.4
//page 952
printf("\n")
printf("given")
Vcc=5;
N=(3*7)+(1*2)
It=N*10*10^-3
P=It*Vcc
```

Scilab code Exa 21.5 required series resistance and dark current

```
//chapter 21
//example 21.5
//page 957
printf("\n")
printf("given")
Rc=1*10^3;I=10*10^-3;E=30;
R1=E/I -Rc
R1=1.8*10^3;//use standard value
disp(" when dark Rc=100Kohm")
Rc=100*10^3;
I=E/(R1+Rc)
```

Scilab code Exa 21.6 `minimum light level when transitor is turn off`

```
//chapter 21
//example 21.6
//page 958
printf("\n")
printf("given")
Vee=6;Vbe=.7;Ib=200*10^-6;Vb=.7;Vcc=6;
disp("when cell is dark Rc=100Kohm")
Rc=100*10^3;
Vrc=Vee+Vbe
Irc=Vrc/Rc
Ir1=Irc+Ib
Vr1=Vcc-Vb
R1=Vr1/Ir1
R1=18*10^3;//use standard value
disp(" when Q1 is off")
Vr1=6;Vrc=6;
Ir1=Vr1/R1
Rc=Vrc/Ir1
```