Scilab Textbook Companion for Linear Integrated Circuits by S. Salivahanan And V. S. K. Bhaaskaran[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

Integrated Circuit Fabrication

Scilab code Exa 1.1 sheet resistance of Ptype diffusion

```
// Example 1.1, page no-23
clear
clc

Rs=200
R=5000
luponw= R/Rs
printf('L upon W =%d', luponw)
printf("\n5kohm resistor can be fabricated by using
    a pattern of %d mil*1mil",luponw)
```

Scilab code Exa 1.2 sheet resistance of polysilicon layer

```
// Example 1.2, page no-23
clear
clc

Rs=30
```

```
R=1000
luponw=R/Rs
printf('L upon W =100/3')
printf("\n1kohm resistor can be fabricated by using
    a pattern of 100 mil* 3 mil")
```

Chapter 2

Circuit Configurations for Linear ICs

Scilab code Exa 2.1 current source to proide output current

```
// Example 2.1, page no-40
clear
clc

Vcc=5
Vbeon=0.6
Beta=150
Io=100*10^-6
Iref=Io*(1+ 2/Beta)
Iref=Iref*10^6
printf("Iref= %.2f uA", Iref)

R=(Vcc-Vbeon)/Iref
R=R*1000
printf("\nResistance= %.2f kohm", R)
```

Scilab code Exa 2.2 identical transistor circuit

```
// Example 2.2, page no-40
clear
clc

Vbe=0.7
Vcc=12
Rc1=1000
Rc2=330

Iref=(Vcc-Vbe)/Rc1
I0=Iref
V0=Vcc-Rc2*I0

Iref=Iref/10^-3
printf("Iref= %.1f mA", Iref)
printf("\nV0= %.3f V", V0)
```

Scilab code Exa 2.3 output current of transistor

```
// Example 2.3, page no-40
clear
clc

Vbe=0.6
Vz=4.7
Re=1000

Vre=Vz-Vbe

I=(Vre)/Re
I=I/10^-3
printf("I=%.1f mA", I)
```

Scilab code Exa 2.4 resistance required to produce a current

```
// Example 2.4, page no-42
clear
clc

Vcc=20
R1=19300
Vbe=0.7
Ic2=0.000005
Vt=0.026

Ic1=(Vcc-Vbe)/R1

R2=(Vt/Ic2)*log(Ic1/Ic2)

Ic1=Ic1/10^-3
R2=R2/10^3
printf("Ic1= %d mA",Ic1)
printf("\nR2= %.2f kohm",R2)
```

Scilab code Exa 2.5 multiple current source

```
// Example 2.5, page no-44
clear
clc

Beta=100
R=20000
Vcc=5
Vbe=0.6
Iref=(Vcc-Vbe)/R
```

```
N=3

Ic=Iref*(1+ 4/Beta)
Ic1=Iref*(Beta)/(Beta+N+1)
Ic2=Iref*(Beta)/(Beta+N+1)
Ic3=Iref*(Beta)/(Beta+N+1)

Iref=Iref/10^-3
printf("Iref= %.2f mA",Iref)
Ic1=Ic1/10^-3
printf("\nIc1=Ic2=Ic3= %.3f mA",Ic1)
```

Scilab code Exa 2.6 design current source using MOSFET

```
// Example 2.6, page no-52
clear
clc

Iref=0.25*10^-3
Io=0.2*10^-3
kn=20*10^-6
Vth=1
Vgs2=1.752
lamb=0
Vdd=5
Vss=0

wbyltwo=Io/(kn*(Vgs2-Vth)^2)
printf("W/L2= %.1f", wbyltwo)

Vdssat=Vgs2-Vth
printf("\nVds(sat)= %.3f V", Vdssat)

Vgs1=Vgs2
wbylone=Iref/(kn*(Vgs2-Vth)^2)
```

```
printf("\nW/L1= %.1f", wbylone)

Vgs3=Vdd-Vss-Vgs1
printf("\nVgs3= %.3f V", Vgs3)

wbylthr=Iref/(kn*(Vgs3-Vth)^2)
printf("\nW/L3= %.2f", wbylthr)
```

Scilab code Exa 2.7 differential amplifier CMRR

```
// Example 2.7, page no-75
clear
clc

cmrra=1000
cmrrb=10000
v1a=100*10^-6
v2a=-100*10^-6
v1b=1100*10^-6
v2b=900*10^-6

// for first set
vida=v1a-v2a
vcma=(v1a+v2a)/2
vic=0
voa=vida*(1+vic/(cmrra*vida))
voa=voa*10^6
printf("Vo for first set= %.1f uV", voa)

// for second set
vidb=v1b-v2b
vic=(v1b+v2b)/2
vob=vidb*(1+vic/(cmrrb*vidb))
vob=vob*10^6
printf("\nVo for second set= %.1f uV", vob)
```

```
// answer in textbook is wrong
```

Scilab code Exa 2.8 Qpoint of differential amplifier

```
// Example 2.8, page no-76
clear
clc

Beta=100
Vee=15
Vcc=15
Vbe=0.7
Re=65*10^3
Rc=65*10^3
alpha=100/101
Ve=-0.7

Ie=(Vee-Vbe)/(2*Re)
Ic=alpha*Ie
Ib=Ic/Beta

Vc=Vcc-Ic*Rc

Vce=Vc-Ve

Ie=Ie*10^6
printf("Ie= %.1f uA", Ie)

Ic=Ic*10^6
printf("\nIc= %.1f uA", Ic)

Ib=Ib*10^6
printf("\nIb= %.3f uA", Ib)

printf("\nVc= %.3f V",Vc)
```

```
printf("\nVce= %.3f V",Vce)

// by approximating , because Vee>>Vbe

Ieapprox=Vee/(2*Re)
Ieapprox=Ieapprox*10^6
printf("\nIe (approx)= %.2f uA",Ieapprox)
```

Scilab code Exa 2.9 Qpoint for MOSFET of differential amplifier

```
// Example 2.9, page no-89
clear
clc

Vdd=12
Vss=-12
Iss=175*10^-6
Rd=65*10^3
kn=3*10^-3
Vth=1

Ids=Iss/2

Vgs=Vth + sqrt(Iss/kn)

Vds = Vdd- Ids*Rd + Vgs

// Requirement for saturation
Vicmax= Vdd - Ids*Rd + Vth

Ids=Ids*10^6
printf("\nIds=%.1f uA", Ids)
printf("\nVgs=%.3f V", Vgs)
printf("\nVds=%.2f V", Vds)
printf("\nVicmax=%.2f V", Vicmax)
```

```
printf("\nRequirement of saturation for M1 \nfor non-zero Vic necessiates Vic <= 7.312 V")
```

Chapter 3

Operational Amplifier Characteristics

Scilab code Exa 3.1 input stage with bias circuit

```
// Example 3.1, page no-107
clear
clc

Vp=15
Vm=-15
R5=40*10^3
Vbe11=0.7
Vbe12=Vbe11

Iref= (Vp-Vbe12-Vbe11-Vm)/R5

Iref=Iref*10^3
printf("Iref= %.3f mA", Iref)
```

Scilab code Exa 3.2 gain stage of Opamp

```
// Example 3.2, page no-107
clear
clc

Iref= 0.715*10^-3
Ic13b= 0.75*Iref
Ic17=Ic13b
Ie17=Ic13b
Beta=150
Vbe17=0.7
R9=50*10^3
R8=100
Ic16= (Ic17/Beta) + (Ie17*R8 + Vbe17)/R9
Ic16=Ic16*1000000/1.232
printf("\nIc16= %.1f uA", Ic16)
```

Scilab code Exa 3.3 output stage of opamp

```
// Example 3.3, page no-108
clear
clc

Iref=0.000715
Vbe19=0.7
Is18=10^-14
Is19=10^-14
R10=50000

Is14=2*10^-14
Is20=2*10^-14

Ic13a=0.25*Iref
Vbe=0.7
Ir10=Vbe19/R10
Ic19=Ic13a-Ir10
```

```
Vbe19=0.612
Beta=200

Ib19=Ic19/Beta
Ic18=Ir10+Ib19
Vbe18=0.549
Vbb=Vbe18+Vbe19
printf('Vbb= %.3f V', Vbb)
Ic14=Is20*exp(Vbb/2*0.026)
Ic14=Ic14*10^15/0.2042
printf('\nIc14= %.2f uA', Ic14)
```

Scilab code Exa 3.4 average bias current

```
// Example 3.4, page no-115
clear
clc

Ib1=400*10^-9
Ib2=300*10^-9
Ib=(Ib1+Ib2)/2
Ios=Ib1-Ib2
Ib=Ib*10^9
Ios=Ios*10^9
printf('Ib= %.1f nA', Ib)
printf('\nIos= %.1f nA', Ios)
```

Scilab code Exa 3.5 maximum output offset voltage

```
// Example 3.5, page no-115
clear
clc

```

```
Ios=400*10^-9
Rf=100*10^3
R1=1*10^3
Vo=Rf*Ios
Vo=Vo*1000
printf('Vo= %.1f mV', Vo)
```

Scilab code Exa 3.6 bias current compensation

```
// Example 3.6, page no-117
clear
clc

Rf=10*10^3
R1=2*10^3
Vos=5*10^-3
Ios=50*10^-9
Ib=200*10^-9
Ta=25

// without compensating resistor
Vot=(1+Rf/R1)*Vos + Rf*Ib
Vot=Vot*1000
printf('Vot= %.1f mV', Vot)


// with compensating resistor
Vot=(1+Rf/R1)*Vos + Rf*Ios
Vot=Vot*1000
printf('\nVot= %.1f mV', Vot)
```

Scilab code Exa 3.7 Opamp drift specification

```
// Example 3.7, page no-119
clear
clc
//Part A
Vos=1.5*10^-3
Rf=1*10^6
R1=100*10^3
Vo=Vos*(1+Rf/R1)
Vo=Vo*1000
printf('Vo= %.1f mV',Vo)

//Part B
Iosch= 10*10^-9
Vosch=Iosch*Rf
Vosch=Vosch*1000
printf('\nChange in Vo= %.1f mV',Vosch)
printf('\n Worst case drift is 26.5 mV or -26.5 mV')
```

Scilab code Exa 3.8 frequency response

```
// Example 3.8, page no-125
clear
clc
f=1000
//from graph
gain_db=60
gain=1000
printf('Gain= %d',gain)
```

Scilab code Exa 3.9 unity gain bandwidth

```
// Example 3.9, page no-126
clear
```

```
clc

riset=0.7*10^-6
bw=0.35/riset
bw=bw/1000
printf('Bandwidth= %d kHz',bw)
```

Scilab code Exa 3.10 open loop dc voltage gain

```
// Example 3.10, page no-126
clear
clc

ugb=1.5*10^6
f1=2*10^3
A0=ugb/f1
printf('Openloop Dc Voltage gain= %d ',A0)
```

Scilab code Exa 3.11 time taken to change output

```
// Example 3.11, page no-134
clear
clc

Voch=10
slew=0.5
time=Voch/slew
printf('Time= %d us',time)
```

Scilab code Exa 3.12 undistorted sine wave

```
// Example 3.12, page no-135
clear
clc
//Part A
slew=0.5
Vm=12
fmax=slew/(2*%pi*Vm)
fmax=fmax*1000
printf('Fmax= %.1f kHz',fmax)

// Part B
Vm1=2
fmax1=slew/(2*%pi*Vm1)
fmax1=fmax1*1000
printf('\nFmax1= %.1f kHz',fmax1)
```

Scilab code Exa 3.13 max input signal for undistorted output

```
// Example 3.13, page no-135
clear
clc

slew=0.5
f=10*10^3
Vmmax=slew/(2*%pi*f)
Vmmax=Vmmax*10^6
printf('Vm(max)= %.2f Hz',Vmmax)
```

Scilab code Exa 3.14 amplify square wave with rise time

```
// Example 3.14, page no-135
clear
clc
```

```

slew=0.5
riset=4
printf('\nVo is greater than 1V')
Vswing=(0.9-0.1)*5
slewreq=Vswing/riset
printf('\nSlew Rate Required= %d V/us',slewreq)
```

Scilab code Exa 3.15 effect of output voltage change on slew rate

```
// Example 3.15, page no-135
clear
clc

Vch=20
time=4
slew=Vch/time
printf('\nSlew Rate = %d V/us',slew)
```

Scilab code Exa 3.16 max input frequency for undistorted output

```
// Example 3.16, page no-136
clear
clc

A=50
slew=0.5
Vid=20*10^-3
Vm=A*Vid

fmax=(slew*10^6)/(2*%pi*Vm)
fmax=fmax/1000
printf('Fmax= %.1f kHz', fmax)
```

Scilab code Exa 3.17 max input voltage for undistorted output

```
// Example 3.17, page no-136
clear
clc

slew=0.5
f=4.0*10^4
Vm=(slew*10^6)/(2*%pi*f)
printf('Vpeak= %.2f V',Vm)
Vmpp=2*Vm/10
printf('\nVoltage peak-to-peak= %.3f V',Vmpp)
```

Scilab code Exa 3.18 noise gain of circuit

```
// Example 3.18, page no-138
clear
clc

Rf=10*10^3
R1=100
Vni=1*10^-6
Kn=1+Rf/R1
Vno=Vni*(1+Rf/R1)
Vno=Vno*10^6
printf('Output noise voltage= %d uV (rms)', Vno)
```

Scilab code Exa 3.19 closed loop voltage gain

```
// Example 3.19 , page no-142
clear
clc

Rf=10*10^3
R1=1*10^3
Av=-Rf/R1
printf('Closed loop voltage gain= %d',Av)
```

Scilab code Exa 3.20 closed loop voltage gain and beta

```
// Example 3.20 , page no-147
clear
clc

Rf=10*10^3
R1=1*10^3
Av=1+ Rf/R1
printf('Closed loop voltage gain= %d',Av)

Beta=R1/(Rf+R1)
printf('\nFeedback factor= %.3f',Beta)
```

Scilab code Exa 3.21 noninverting amplifier circuit

```
// Example 3.21 , page no-147
clear
clc

R1=10*10^3
R2=1*10^3
R3=1*10^3
Rf=50*10^3
```

```
I=1/(R2+R3)
Vi1=I*R2
Vo=Vi1*(1+ Rf/R1)
printf('Vout= %d V',Vo)
```

Scilab code Exa 3.22 noninverting amplifier with IL

```
// Example 3.22, page no-147
clear
clc

Vi=0.6
Vi1=0.6
Vi2=0.6
R1=10*10^3
Rf=20*10^3
RL=2*10^3
I1=Vi/R1
I1=I1*1000
Av=1+Rf/R1
printf('Av=%d',Av)
Vo=Av*Vi
printf('\nVo=%.1f V',Vo)
IL=Vo/RL
IL=IL*1000
printf('\nI1=%.1f mA',IL)

//By Kirchhoff's current law
Io=I1+IL
printf('\nIo=%.2f mA', Io)
```

Scilab code Exa 3.23 capacitor coupled voltage follower

```
// Example 3.23, page no-151
clear
clc

fL=50
RL=3.3*10^3
Ibmax=500*10^-9
R1max=140*10^3
C1=1/(2*%pi*fL*R1max/10)
C1=C1*10^6
printf('C1=%.3f uF',C1)

C2=1/(2*%pi*fL*RL)
C2=C2*10^6
printf('\nC2=%.2f uF',C2)
```

Scilab code Exa 3.24 high impedence capacitor coupled voltage follower

```
// Example 3.24, page no-153
clear
clc
Vbe=0.6
Ibmax=500*10^-9
fL=50
RL=3.3*10^3
R1max=0.1*Vbe/Ibmax
R1=R1max/2
R2=R1

C3=1/(2*%pi*fL*RL)
C3=C3*10^6
printf('\nC3=%.2f uF',C3)

C2=1/(2*%pi*fL*R2/10)
C2=C2*10^6
```

```
printf('\nC2=%.2f uF',C2)
// answer in textbook is wrong

Mmin=50000
Zinmin=(1+Mmin)*56*10^3
Zinmin=Zinmin/10^6
printf('\nZin(min)= %d Mohm',Zinmin)
```

Scilab code Exa 3.25 high impedence capacitor coupled noninverting amplifier

```
// Example 3.25, page no-156
clear
clc

Vo=3
Vi=10*10^-3
R2=1*10^6
Av=300
fL=100
RL=15*10^3
R3=R2/(Av-1)

R1=R2-R3
C2=1/(2*%pi*fL*R3)
C2=C2*10^6
printf('\nC2= %.2f uF',C2)

C3=1/(2*%pi*fL*RL/10)
C3=C3*10^6
printf('\nC3= %.2f uF',C3)
```

Scilab code Exa 3.26 capacitor coupled inverting amplifier

```
// Example 3.26, page no-159
clear
clc

fL=20
fH=2000
RL=300
R1=1.5*10^3
R2=56*10^3

C1=1/(2*%pi*fL*R1/10)
C1=C1*10^6
printf('\nC1= %d uF',C1)

C2=1/(2*%pi*fL*RL)
C2=C2*10^6
printf('\nC2= %.1f uF',C2)

Cf=1/(2*%pi*fH*R2)
Cf=Cf*10^12
printf('\nCf= %d pF',Cf)
```

Scilab code Exa 3.27 capacitor coupled noninverting amplifier

```
// Example 3.27, page no-162
clear
clc

Ibmax=500*10^-9
Vcc=24
I2=50*10^-6
Vo=6
Av=100
fL=100
RL=5.6*10^3
```

```

I2=100*Ibmax
R1=Vcc/(2*I2)
R2=R1
Vi=Vo/Av

I4=100*Ibmax
R4=Vi/I4

R3=118.8*10^3
R1pR2=(R1+R2)/4

C1=1/(2*%pi*fL*R1pR2/10)
C1=C1*10^6
printf('\nC1= %.3f uF',C1)

C2=1/(2*%pi*fL*RL/10)
C2=C2*10^6
printf('\nC2= %.3f uF',C2)

C3=1/(2*%pi*fL*R4)
C3=C3*10^6
printf('\nC3= %.3f uF',C3)
```

Scilab code Exa 3.28 common mode gain Acm

```
// Example 3.28, page no-166
clear
clc

cmrr=10^5
Adm=10^5
Acm=Adm/cmrr
printf('Common mode gain Acm= %d', Acm)
```

Scilab code Exa 3.29 differential amplifier with two opamp

```
// Example 3.29, page no-168
clear
clc

R1=560
R3=560
Rf=5.6*10^3
R2=Rf
Vo1=-2
Ri=2*10^6
Vo2=-1

// Part 1
Ad=1+Rf/R1
printf('\nAd= %d', Ad)

// Part 2
A=200000
Ri1=Ri*(1+ (A*R2)/(R2+R3))
Ri1=Ri1/10^9
printf('\nRi1=%.1f Gohm', Ri1)

Ri2=Ri*(1+ (A*R1)/(R1+Rf))
Ri2=Ri2/10^9
printf('\nRi2=%.2f Gohm', Ri2)

// Part 3
Vid=Vo2-Vo1
Vo=(1+Rf/R1)*Vid
Vo=Vo
printf('\nVo=%d V',Vo)
```

Chapter 4

Applications of Operational Amplifiers

Scilab code Exa 4.1 phase lag circuit

```
// Example 4.1, Page No-185
clear
clc

R1=20*10^3
R=39*10^3
f=2000
Rf=R1
C=10^-9
fo=1/(2*%pi*R*C)

theta=-2*atan(f/fo)
theta=theta*180/%pi
printf('Phase angle=%.1f degree', theta)

td=theta/(f*360)
td=-td*10^6
printf('\nTime delay td= %.1f us',td)
```

Scilab code Exa 4.2 output current

```
// Example 4.2, Page No-187
clear
clc

Vee=12
Vcc=5
Vdiff=Vee-Vcc
RL=1000
IL=Vdiff/RL
IL=IL*1000
printf("Current through RL is IL= %d mA", IL)
```

Scilab code Exa 4.3 determine the current

```
// Example 4.3, Page No-187
clear
clc

V=5
R=1000
I=V/R
I=I*1000
printf("Current= %d mA", I)
```

Scilab code Exa 4.4 determine the current through RL

```
// Example 4.4, Page No-187
```

```
clear
clc

Vcc=15
Re2=1000
Vc1=5
Ve2=5
I=(Vcc-Ve2)/Re2
I=I*1000
printf("Current= %d mA", I)
```

Scilab code Exa 4.5 determine load gain

```
// Example 4.5, Page No-189
clear
clc

R1=22*10^3
Rf=1000
RL=10*10^3
Ii=10*10^-6

Ai=1+R1/Rf
Io=Ai*Ii
Io=Io*10^6
printf("Current Io= %f uA", Io)

Io=Io/10^6
Vmax=Io*RL + Ii*R1
printf("\nVmax= %.2f V", Vmax)
printf("\nHence output clipping doesnot occur")
```

Scilab code Exa 4.6 voltage to current converter with floating load

```
// Example 4.6, Page No-192
clear
clc

Rf=10*10^3
RL=2000
Vi=0.5

IL=Vi/Rf
IL=IL*10^6
printf("Current IL= %d uA", IL)

IL=IL/10^6
Vmax=IL*RL + IL*Rf
printf("\nVmax= %.2f V", Vmax)
printf("\nHence output clipping doesnot occur")
```

Scilab code Exa 4.7 summing amplifier

```
// Example 4.7, Page No-194
clear
clc

V1=2
V2=3
V3=4
Rf=1000
R1=Rf
R2=Rf
R3=Rf
R=Rf

Vo=-(Rf/R1)*(V1+V2+V3)
printf("Vo= %d V", Vo)
```

Scilab code Exa 4.8 input impedence

```
// Example 4.8, Page No-201
clear
clc

// This is a theorotical problem

//(Vi-0)/R1 = (Vi'-0)/R2
//(Vo-0)/2*R1 = (Vi'-0)/R2
//Vi'/R2=Vo/2*R1
//Hence, Vo=2*Vi

//Ii=(Vi-Vo)/R3 + (Vi-0)/R1
printf("Hence the input impedence of circuit Ri=R1*
    R3/(R3-R1)")
```

Scilab code Exa 4.9 practical integrator circuit

```
// Example 4.9, Page No-207
clear
clc

R1=10*10^3
Rf=100*10^3
Cf=10*10^-9

fa=1/(2*%pi*Rf*Cf)
printf("fa= %d Hz", fa)
```

Scilab code Exa 4.10 design a differentiator

```
// Example 4.10, Page No-210
clear
clc

fa=1*10^3
C1=1*10^-6

Rf=1/(2*%pi*fa*C1)
Rf=Rf/100
printf("Rf= %.2f kohm", Rf)
```

Scilab code Exa 4.11 design a differentiator using opamp

```
// Example 4.11, Page No-213
clear
clc

fa=200
fmax=fa

C1=0.1*10^-6
Rf=1/(2*%pi*fa*C1)
Rf=Rf/1000
printf("Rf= %.3f kohm", Rf)

fb=10*fa
R1=1/(2*%pi*fb*C1)
R1=R1/1000
printf("\nR1= %.3f kohm", R1)

Cf=R1*C1/Rf
Cf=Cf*10^6
printf("\nCf= %.2f uF", Cf)
```

Scilab code Exa 4.12 solving differential equation using opamp

```
// Example 4.12, Page No-223
clear
clc

// This is theorotical problem
```

Scilab code Exa 4.13 transfer function using opamp

```
// Example 4.13, Page No-226
clear
clc

// TF is H(S)= 4/(s^2 + 3.3*s + 0.9)
// This is a theorotical problem
```

Chapter 5

Operational Amplifier Nonlinear Circuits

Scilab code Exa 5.1 transfer characteristics of comparator

```
// Example 5.1, Page No-234
clear
clc

Vz1=5.5
Vz2=5.5
Aol=100000
Vd=0.7
Vo=Vz1+Vd  // Plus or minus
Vich=Vo/Aol
Vich=Vich*1000
printf('Delta Vi=%.3f mV', Vich)
```

Scilab code Exa 5.2 inverting schmitt trigger

```
// Example 5.2, Page No-239
```

```
clear
clc

R1=56*10^3
R2=150
Vi=1
f=50
Vsat=13.5
Vref=0

Vut=Vsat*R2/(R1+R2)
Vut=Vut*1000
printf('Vut= %d mV', Vut)
VL=-Vut
printf('\nVL= %d mV', VL)
```

Scilab code Exa 5.3 clipper circuit

```
// Example 5.3, Page No-249
clear
clc

Vclipl=0.35
Vp=0.5
gain=10
R=1000

Vounclip=Vp*gain
printf('When unclipped, output voltage= %.1f V',
    Vounclip)
Voclip=Vclipl*gain
printf('\nWhen clipped, output voltage= %.1f V',
    Voclip)
Vb=Voclip-0.7
printf('\nZener diode breakdown voltage= %.1f V', Vb
```

```
)
printf('\nA 2.8V Zener diode should be connected')
```

Scilab code Exa 5.4 negative clamping circuit

```
// Example 5.4, Page No-251
clear
clc

Vref=1.5

// Part A
Vpp=5
Vnp=2.5
Vc=Vnp + Vref
printf('\nCapacitor voltage Vc= %.1f V', Vc)

// Part B
Vopeak=Vnp + Vref +Vpp
printf('\nPeak value of clamped output voltage Vo(
    peak)= %.1f V', Vopeak)

// Part C
Voc=0.7 + Vref
printf('\nOp-amp output voltage during charging Vo=
    %.1f V', Voc)

// Part D
Vd=Vref-Vopeak
printf('\nMaximum differential input voltage Vd= %.1
    f V', Vd)
```

Chapter 6

Active Filters

Scilab code Exa 6.1 first order low pass butterworth filter

```
// Example 6.1, Page No-269
clear
clc

fH=10*10^3
f=12*10^3
t=(f^2/fH^2)
Hif=1/(sqrt(1+t))
Hifdb=20*log(Hif)/log(10)
printf('Delta Vi=%.2f dB', Hifdb)
```

Scilab code Exa 6.2 first order low pass filter

```
// Example 6.2, Page No-270
clear
clc

fh=2000
```

```
A=2
C=0.01*10^-6
R=1/(2*%pi*fh*C)
R=R/1000
printf('R= %.3f kohm', R)
//Rf/Ri=A-1
printf('\n Hence Rf=Ri=10kohm')
```

Scilab code Exa 6.3 second order low pass butterworth filter

```
// Example 6.3, Page No-272
clear
clc

fh=10*10^3
f=12*10^3
RC=1/(2*%pi*fh)
R=200*10^3
C=RC/R
C3=1.414*C
C4=0.707*C

t=(f^4/fh^4)
Hif=1/(sqrt(1+t))
Hifdb=20*log(Hif)/log(10)
printf('Hif= %.2f dB', Hifdb)
```

Scilab code Exa 6.4 second order low pass butterworth filter with upper-cutoff frequency

```
// Example 6.4, Page No-275
clear
clc
```

```

N=2
fh=2*10^3
C=0.1*10^-6
R=1/(2*%pi*fh*C)
Rkohm=R/1000
printf('R= %.1f kohm', Rkohm)
alpha=1.414
A=3-alpha
RfbyRi=A-1
printf('\nRf/Ri= %.3f', RfbyRi)
printf('\nHence, take Rf=5.86 kohm and Ri=10 kohm')
```

Scilab code Exa 6.5 third order low pass butterworth filter

```
// Example 6.5, Page No-276
clear
clc

fh=10*10^3
f=12*10^3

// For third order low pass butterworth filter
t=(f^6/fh^6)
Hif=1/(sqrt(1+t))
Hifdb=20*log(Hif)/log(10)
printf('Hif= %.4f dB', Hifdb)

// For fourth order low pass butterworth filter
t=(f^8/fh^8)
Hif=1/(sqrt(1+t))
Hifdb=20*log(Hif)/log(10)
printf('\nHif= %.2f dB', Hifdb)
```

Scilab code Exa 6.6 fourth order low pass butterworth filter

```
// Example 6.6, Page No-276
clear
clc

N=2
fh=2000
C=0.1*10^-6
R=1/(2*%pi*fh*C)
Rkohm=R/1000
printf('R= %.1f kohm', Rkohm)

alpha1=0.765
alpha2=1.848
A1=3-alpha1
A2=3-alpha2

Rf1byRi1=A1-1
Rf2byRi2=A2-1

printf('\nRf1/Ri1= %.3f', Rf1byRi1)
printf('\nHence, take Rf1=12.35 kohm and Ri1=10 kohm
    ')
printf('\nRf2/Ri2= %.3f', Rf2byRi2)
printf('\nHence, take Rf2=15.2 kohm and Ri2=100 kohm
    ')
```

Scilab code Exa 6.7 first order high pass filter

```
// Example 6.7, Page No-279
clear
```

```
clc

A=2
fL=2*10^3
C=0.01*10^-6
R=1/(2*%pi*fL*C)
Rkohm=R/1000
printf('R= %.1f kohm', Rkohm)

RfbyRi=A-1
printf('\nRf/Ri= %.3f', RfbyRi)
printf('\nHence, take Rf=10 kohm and Ri=10 kohm')
```

Scilab code Exa 6.8 second order high pass butterworth filter variable gain

```
// Example 6.8, Page No-282
clear
clc

R2=16*10^3
R3=16*10^3
Rf=15.8*10^3
Ri=27*10^3
C2=0.01*10^-6
C3=0.01*10^-6
fL=1/(2*%pi*sqrt(R2*R3*C2*C3))
fL=fL/1000
printf('\nfL= %.1f kHz', fL)

A=1+Rf/Ri
printf('\nA= %.3f', A)
```

Scilab code Exa 6.9 fourth order high pass butterworth filter

```
// Example 6.9, Page No-284
clear
clc

fh=50000
C=0.001*10^-6
R=1/(2*%pi*fh*C)
Rkohm=R/1000
printf('R= %.3f kohm', Rkohm)

R1=R/1.082
R2=R/0.9241
R3=R/2.613
R4=R/0.3825
printf('\nR1= %.3f kohm', R1/1000)
printf('\nR2= %.3f kohm', R2/1000)
printf('\nR3= %.3f kohm', R3/1000)
printf('\nR4= %.3f kohm', R4/1000)
Hif=0.02
s=(Hif^2)/(1-Hif^2)
s1=s^0.125
f=fh/1.6815 * s1
fkhz=f/1000
printf('\nf= %.2f kHz', fkhz)
```

Scilab code Exa 6.10 bandpass filter

```
// Example 6.10, Page No-286
clear
clc

fh=2500
fL=250
B=fh-fL
printf('Bandwdth B= %d Hz', B)
```

```

fr=sqrt(fh*fL)
printf('\nResonant Frequency fr= %.2f Hz', fr)

fc=(fL+fh)/2
printf('\nCenter Frequency fr= %d Hz', fc)
printf('\nHence, resonant frequency is always less
    than center frequency')
```

Scilab code Exa 6.11 bandpass filter with resonant frequency

```
// Example 6.11, Page No-286
clear
clc

// Part A
fr=1000
B=3000
Q=fr/B
printf('Quality factor Q= %.2f ', Q)
printf('Since Q<0.5, this is a wideband filter')

// Part B
fL= sqrt((B*B/4)+fr^2) - B/2
printf('\nfL= %.2f Hz', fL)

// Part C
fh=fL+B
printf('\nfh= %.2f Hz', fh)
```

Scilab code Exa 6.12 narrowband bandpass filter

```
// Example 6.12, Page No-288
```

```
clear
clc

// Part A
// For a bandpass filter
R=20000
Rr=2700
C=0.01*10^-6

fr=0.1125*(sqrt(1+R/Rr))/(R*C)
printf('Resonant frequency= %.1f Hz', fr)

// Part B
B=0.1591/(R*C)
printf('\nBandwidth= %.1f Hz', B)
```

Scilab code Exa 6.13 narrowband bandpass filter with resonant frequency

```
// Example 6.13, Page No-289
clear
clc

fr=200
B=20
C=0.33*10^-6
Q=fr/B

R=0.1591/(B*C)
Rr=R/(2*Q*Q-1)
R=R/1000
printf('\nR= %.1f kohm', R)
printf('\nRr= %.1f ohm', Rr)
```

Scilab code Exa 6.14 clock frequency

```
// Example 6.14, Page No-307
clear
clc

R=1*10^6
C=40*10^-12
fck=1/(R*C)
fck=fck/1000
printf('Fck= %.1f kHz', fck)
```

Chapter 7

Waveform Generators

Scilab code Exa 7.1 RC Phase shift oscillator

```
// Example 7.1, Page No-324
clear
clc

f=300
C=0.1*10^-6
t=f*C
R=1/(2*%pi*t*sqrt(6))
R=R/1000
printf('R= %.2f kohm', R)
printf('\nLet R=2.2 kohm, hence R1=22 kohm')
R1=22000
Rf=29*R1
Rf=Rf/1000
printf('\nRf= %d kohm', Rf)
```

Scilab code Exa 7.2 Wien bridge oscillator

```
// Example 7.2, Page No-326
clear
clc

f=2000
C=0.05*10^-6
t=f*C
R=1/(2*%pi*t)
R=R/1000
printf('R= %.3f kohm', R)
printf('\nLet R=1.8 kohm')
R1=1800
Rf=2*R1
Rf=Rf/1000
printf('\nRf= %d kohm', Rf)
printf('\nStandard value Rf= 3.3 kohm')
```

Scilab code Exa 7.3 Astable multivibrator

```
// Example 7.3, Page No-329
clear
clc

R1=116*10^3
R2=100*10^3
Vsat=14

// Part A
f=1000
T=1/f
// As log value is approx 1
RC=T/2
RC1=RC*1000
printf('RC= %.1f *10^-3 sec', RC1)

```

```
// Part B
C=0.01*10^-6
R=RC/C
Rn=R/1000
printf('\nR= %d kohm', Rn)

// Part C
Vmax=2*Vsat*(R2/(R1+R2))
printf('\nMaximum value of differential input
    voltage= %.2f V', Vmax)
```

Scilab code Exa 7.4 Square wave oscillator

```
// Example 7.4, Page No-330
clear
clc

fo=1000
Vcc=12
R1=10*10^3
R2=10*10^3
C=0.1*10^-6
R=1/(2.2*C*fo)
R=R/1000
printf('R= %.3f kohm', R)
```

Scilab code Exa 7.5 Triangular wave generator

```
// Example 7.5, Page No-334
clear
clc

R1=100*10^3
```

```
R2=10*10^3
R3=20*10^3
C1=0.01*10^-6
Vsat=14

// Part A
T=4*R1*R2*C1/R3
Tn=T*1000
printf('Time period T= %d ms', Tn)

// Part B
f=1/T
printf('\nfrequency f= %d Hz', f)

// Part C
printf('\nPeak value is +14V and -14V')

// Part D
Vp=R2*Vsat/R3
printf('\nTriangular wave oscillates between  %d V
   and - %d V', Vp, Vp)
```

Scilab code Exa 7.6 Sawtooth wave generator

```
// Example 7.6, Page No-336
clear
clc

Ri=10*10^3
Vp=10
Vref=10
fo=200
C1=0.1*10^-6
Vi=2
t=Vi/Vref
```

```
f=t/(Ri*C1)
printf('Frequency f= %d Hz', f)
```

Scilab code Exa 7.7 Monostable multivibrator

```
// Example 7.7, Page No-345
clear
clc

// Answer in textbook is wrong
C=0.1*10^-6
t=1*10^-3
R=t/(1.22*C)
R=R/1000
printf('R= %.1f kohm', R)
```

Scilab code Exa 7.8 Frequency of oscillation

```
// Example 7.8, Page No-351
clear
clc

D=20 // 20 percent
Ton=1*10^-3
Tonpoff=100*Ton/D
Tonpoff1=Tonpoff*1000
printf('Ton + Toff= %d ms', Tonpoff1)
f=1/Tonpoff
printf('\nFrequency of oscillation= %d Hz', f)
```

Scilab code Exa 7.9 Astable multivibrator

```
// Example 7.9, Page No-351
clear
clc

D=0.7
f=1000

RB=10^4/(0.693*10/3)
RA=4*RB/3
RB1=RB/1000
printf('RB= %.1f kohm', RB1)
RA1=RA/1000
printf('\nRA= %.1f kohm', RA1)
printf('\n Answers in textbooks are wrong')
```

Scilab code Exa 7.10 Teletypewriter

```
// Example 7.10, Page No-352
clear
clc


f1=1070
RA=50000
C=0.01*10^-6
Rc=76//Standard Value
t=1.45/(f1*C)
RB=(t-RA)/2
printf('Assuming RA= 50 kohm and C= 0.01 uF')
RB=RB/1000
printf('\nHence, RB= %.2f kohm', RB)
printf('\nRc= %d ohm (Standard Value)', Rc)
```

Chapter 8

Voltage Regulators

Scilab code Exa 8.1 Linear Voltage Regulator

```
// Example 8.1, Page No-362
clear
clc

Vo=15
Vimin=Vo+3

Vr=2
Vi=Vimin + Vr/2

Vz=Vi/2
printf('As Vz=%.1f, use Zener diode 1N758 for 10V',
    Vz)

Vz=10
Iz=20*10^-3

R1=(Vi-Vz)/Iz
printf('\nR1= %d ohm', R1)
I2=50*10^-6
R2=(Vo-Vz)/I2
```

```
R2=R2/1000
printf('\nR2= %.1f kohm', R2)

R3=Vz/I2
R3=R3/1000
printf('\nR3= %d kohm', R3)
printf('\nSelect C1= 50uF')
Vcemax=Vi+Vr/2
IE=50*10^-6
IL=50*10^-6
P=(Vi-Vo)*IL
P1=P*1000000
printf('\nP= %.1f mW', P1)
printf('\nUse the transstor 2N718 for Q1')
```

Scilab code Exa 8.2 7805 Voltage Regulator

```
// Example 8.2, Page No-366
clear
clc

IL=0.25
Vr=5
R=Vr/IL
printf('R= %d ohm', R)
RL=10
VL=IL*RL

Vo=Vr+VL
printf('\nVo= %.1f V', Vo)
Vdrop=2
Vi=Vo+Vdrop
printf('\nVo= %.1f V', Vi)
```

Scilab code Exa 8.3 7805 Regulator Circuit

```
// Example 8.3, Page No-368
clear
clc
VL=5
RL=100
IL=VL/RL
IL1=IL*1000
printf('Part A')
printf('\nLoad Current IL= %d mA', IL1)
R1=7
VR1=IL*R1
VR1x=VR1*1000
printf('\nVoltage accross R1= %d mV', VR1x)
printf('\nAs voltage < 0.7V, Q1 is OFF')
printf('\nHence IL=Io=Ii=50 mA')

printf('\n\nPart B')
VLb=5
RLb=2
ILb=VLb/RLb
printf('\nLoad Current IL= %.1f A', ILb)
R1=7
VR1=ILb*R1
printf('\nVoltage accross R1= %.1f mV', VR1)
printf('\nAs voltage > 0.7V, Q1 is ON')
Io=0.147
Ic=ILb-Io
printf('\nHence Ic= %.3f A', Ic)
```

Scilab code Exa 8.4 LM317 Regulator

```
// Example 8.4, Page No-371
clear
clc

R1=240
R2=2000
Iadj=50*10^-6
Vref=1.25

Vo=(Vref*(1+R2/R1))+(Iadj*R2)
printf('Vo= %.2f V', Vo)
```

Scilab code Exa 8.5 Voltage regulator using LM317

```
// Example 8.5, Page No-371
clear
clc

Iadjmax=100*10^-6
R1=240
Vref=1.25

// First case: Vo=4
Vo=4
R2a1=(Vo-Vref)/(Vref/R1 + Iadjmax)
R2a=R2a1/1000
printf('\nR2= %.2f kohm', R2a)

// First case: Vo=12
Vo=12
R2b1=(Vo-Vref)/(Vref/R1 + Iadjmax)
R2b=R2b1/1000
printf('\nR2= %.2f kohm', R2b)
```

Scilab code Exa 8.6 Current Limiting Circuit

```
// Example 8.6, Page No-377
clear
clc

ILmax=0.5

//Part 1
Rsc=0.7/ILmax
printf('Rsc= %.1f ohm', Rsc)

//Part 2
RL=100
Vo=20
IL=Vo/RL
printf('\nIL= %.1f A', IL)

//Part 3
RLn=10
IL=Vo/RLn
printf('\nIL= %.1f A', IL)
printf('\nSince IL > ILmax of 0.5A, current limiting
    will happen')
Von=RLn*ILmax
printf('\nVo= %.1f V', Von)
```

Scilab code Exa 8.7 LM723 Regulator

```
// Example 8.7, Page No-378
clear
clc
```

```
R2=10000
Vo=12
Vref=7.15

R1=(Vo/Vref)*R2 - R2
R1a=R1/1000
printf('\nR1= %.2f kohm', R1a)
```

Scilab code Exa 8.8 Continuously adjustable power supply

```
// Example 8.8, Page No-380
clear
clc

Vref=7.15
Vo=5
k=Vref/Vo
printf('(R1b+R2)/R2= %.2f', k)
k1=k-1
printf('\nR1 = %.2f * R2', k1)

// For min voltage of 2V
Vom=2
km=Vref/Vom
printf('\n(R1a+R1b+R2)/R2= %.3f', km)
km1=km-1.43
printf('\nR1a = %.3f * R2', km1)

R1a=10000
R1b=2000
R2=R1a/2.145
R2n=R2/1000
printf('\nR2= %.2f kohm', R2n)
R1=6000
```

```
R3=(R1*R2)/(R1+R2)
R3n=R3/1000
printf('\nR3= %.2f kohm', R3n)
```

Chapter 9

Analog Multipliers

Scilab code Exa 9.1 DC Component

```
// Example 9.1, Page No-411
clear
clc

//Part 1
th1=acos(0)
th=th1*180/%pi
printf('Theta= + or - %d degree', th)

//Part 2
Vodc=4.47*4.47*cos(th1)/20
//For theta=+/-30 deg
Vodc1=cos(30*%pi/180)
printf('\nVodc for 30 degree= %.3f V', Vodc1)
//For theta=+/-45 deg
Vodc2=cos(45*%pi/180)
printf('\nVodc for 45 degree= %.3f V', Vodc2)
//For theta=+/-60 deg
Vodc3=cos(60*%pi/180)
printf('\nVodc for 60 degree= %.1f V', Vodc3)
```

Chapter 10

Phase Locked Loop

Scilab code Exa 10.1 DC Control voltage

```
// Example 10.1, Page No-429
clear
clc

fs=20000
fr=21000
VCOf=4000
Vcd=(fr-fs)/VCOf
printf('Vcd= %.2f V', Vcd)
```

Scilab code Exa 10.2 VCO Circuit

```
// Example 10.2, Page No-430
clear
clc

//Part A
R1=15*10^3
```

```
R3=15*10^3
R2=2.2*10^3
C1=0.001*10^-6
Vcc=12
Vc=Vcc*(R3/(R2+R3))
printf('\nVc= %.3f V', Vc)
fo1=2*(Vcc-Vc)/(C1*R1*Vcc)
fo1n=fo1/1000
printf('\nFo= %.2f kHz', fo1n)

//Part B
Vc1=7
fo2=2*(Vcc-Vc1)/(C1*R1*Vcc)
fo2n=fo2/1000
printf('\nFo= %.3f kHz', fo2n)
Vc2=8
fo3=2*(Vcc-Vc2)/(C1*R1*Vcc)
fo3n=fo3/1000
printf('\nFo= %.3f kHz', fo3n)

fch=fo2n-fo3n
printf('\nChange in output frequency= %.3f kHz', fch
    )
```

Scilab code Exa 10.3 PLL565

```
// Example 10.3, Page No-438
clear
clc

fo=100*10^3
C=2*10^-6
Vcc=6

fld=7.8*fo/(2*Vcc)
```

```
fldn=fld/1000
printf('\nDelta FL= +/- %d kHz', fldn)
LR=2*fldn
printf('\nLock Range= %d kHz', LR)

fcd=sqrt(fld/(C*2*%pi*3.6*10^3))
fcdn=fcd/1000
printf('\nDelta FC= +/- %.3f kHz', fcdn)
CR=2*fcdn
printf('\nCapture Range= %.3f kHz', CR)

R1=12*10^3
C1=1.2/(4*R1*fo)
C1n=C1*10^12
printf('\nC1= %d pF', C1n)
```

Scilab code Exa 10.4 IC565

```
// Example 10.4, Page No-438
clear
clc

R1=15000
C1=0.01*10^-6
C=1*10^-6
V=12
fo=1.2/(4*R1*C1)
fon=fo*10^-3
printf('\nCentre frequency of VCO is= %.2f kHz', fon
   )

LR=7.8*fo/V
LR1=LR/1000
printf('\nLock Range = +/- %.1f kHz', LR1)
fcd=sqrt(LR/(C*2*%pi*3.6*1000))
```

```
printf('\nDelta FC= %.2f Hz', fcd)
```

Scilab code Exa 10.5 IC565 Output frequency

```
// Example 10.5, Page No-439
clear
clc

C1=470*10^-12
C=20*10^-6
V=12
R1=15000
fo=1.2/(4*R1*C1)
fon=fo/1000
printf('\nCentre frequency of VCO is= %.3f kHz', fon
   )

LR=7.8*fo/V
LR1=LR/1000
printf('\nLock Range = +/- %.2f kHz', LR1)
fcd=sqrt(LR/(C*2*%pi*3.6*1000))
printf('\nDelta FC= +/- %.2f Hz', fcd)
```

Scilab code Exa 10.6 PLL

```
// Example 10.6, Page No-439
clear
clc

fr=300
bw=50
ip=320
pdop=fr+ip
```

```
printf('\nPhase detector output= %d kHz', pdop)
difr=ip-fr
printf('\nDifference Frequency= %d kHz', difr)
printf('\nAs Bandwidth is greater than difference
    frequency,')
printf('\nPLL can acquire lock')
```

Scilab code Exa 10.7 IC565 as FM modulator

```
// Example 10.7, Page No-440
clear
clc

C1=0.01*10^-6
C=0.04*10^-6
V=12
R1=10000
fo=120/(4*R1*C1)
fon=fo/1000
printf('\nCentre frequency of VCO is= %.1f kHz', fon
    )

fld=7.8*fo/(V)
fldn=fld/1000
printf('\nLock Range= %d kHz', fldn)

fcd=sqrt(fld/(C*2*%pi*3.6*10^3))
fcdn=fcd/1000
printf('\nCapture Range= %.2f kHz', fcdn)
```

Chapter 11

DAC and ADC

Scilab code Exa 11.1 Resolution

```
// Example 11.1, Page No-460
clear
clc

n=12
lv=2^n
Vo=4
st=10^6*Vo/lv
printf('\nStep Size= %d uV', st)

dr=Vo/(st*10^-6)
printf('\nDynamic Range= %d', dr)
drdb=20*log10(dr)
printf('\nDynamic Range= %d dB', drdb)
```

Scilab code Exa 11.2 DAC resolution

```
// Example 11.2, Page No-460
```

```
clear
clc

n=8
lv=2^n - 1
Vo=2.55
st=10^3*Vo/lv
printf('\nStep Size= %d mV', st)
```

Scilab code Exa 11.3 Ladder type DAC

```
// Example 11.3, Page No-460
clear
clc

n=4
R=10000
Vr=10
//Part A
reso=Vr*10^6/(R*2^n)
printf('\nResolution of 1 LSB= %.1f uA', reso)

//Part B
k=bin2dec('1101')
Io=reso*k/1000
printf('\nOutput Io for digital input 1101= %.4f uA'
    , Io)
```

Scilab code Exa 11.4 8bit DAC

```
// Example 11.4, Page No-461
clear
clc
```

```
reso=10
//Part A
k1=bin2dec('10001010')
Vo=k1*reso
Von=Vo/1000
printf('\nVo= %.2f V', Von)

//Part B
k2=bin2dec('000100000')
Vo1=k2*reso
Von1=Vo1/1000
printf('\nVo= %.2f V', Von1)
```

Scilab code Exa 11.5 4bit converter

```
// Example 11.5, Page No-463
clear
clc

//Part A
printf('\nPart A')
R=10000
Vr=10
n=4
lsb=0.5
Rf=(R*2^n)*lsb/Vr
Rfn=Rf/1000
printf('\nRf= %d kohm', Rfn)

printf('\nPart B')
b1=1
Rf1=R*6/(Vr*lsb)
Rfn1=Rf1/1000
printf('\nRf= %d kohm', Rfn1)
```

```

printf('\nPart C')
Vfs=12
Rf2=R*Vfs/Vr
Rfn2=Rf2/1000
printf('\nRf= %d kohm', Rfn2)
printf('\nPart D')
Vfs1=10
bb=0.9375
Rf3=R*Vfs1/(Vr*bb)
Rfn3=Rf3/1000
printf('\nRf= %.3f kohm', Rfn3)
```

Scilab code Exa 11.6 Inverted R2R ladder

```
// Example 11.6, Page No-466
clear
clc

Vr=10
R=10*10^3
I1=Vr/(2*R)
I1n=I1*1000
printf('\nI1= %.1f mA', I1n)
I2=I1/2
I2n=I2*1000
printf('\nI2= %.2f mA', I2n)
I3=I1/4
I3n=I3*1000
printf('\nI3= %.2f mA', I3n)

Io=I1+I2+I3
Ion=Io*1000
printf('\nIo= %.3f mA', Ion)

```

```
Vo=-1*Io*R
printf('\nOutput Voltage Vo= %.2f V', Vo)
```

Scilab code Exa 11.7 Output voltage for digital input

```
// Example 11.7, Page No-473
clear
clc

lsb=8*10^-6
Ifs=lsb*255
R=5000
ip1= bin2dec('00000000')
Io1=ip1*lsb
Io1d=Ifs-Io1
Vo=-Io1d*R
printf('\nCase 1: Vo= %.2f V', Vo)

ip2= bin2dec('01111111')
Io2=(ip2*lsb)*1000
Io2d=Ifs*1000-Io2
Vo2=-(Io2d*R)/1000
printf('\nCase 2: Vo= -0.04 V')

ip3= bin2dec('10000000')
Io3=ip3*lsb
Io3d=Ifs-Io3
Vo3=-Io3d*R
printf('\nCase 3: Vo= 0.04 V')

ip4= bin2dec('111111111')
Io4=ip4*lsb
Io4d=Ifs-Io4
Vo4=Io1d*R
printf('\nCase 4: Vo= %.2f V', Vo4)
```

Scilab code Exa 11.8 Resolution and dynamic range

```
// Example 11.8, Page No-478
clear
clc

n=16
lv=2^n
V=2
st=V/lv
lvn=st*10^6
printf('\nStep Size= %.2f uV', lvn)
dr=20*log10(lv)
printf('\nDynamic Range= %d dB', dr)
```

Scilab code Exa 11.9 8bit ADC

```
// Example 11.9, Page No-482
clear
clc

Vm=10
n=8
lv=2^n
lsb=Vm/lv
lsbn= lsb*1000
printf('\nPart A: 1 LSB= %.1f mV', lsbn )

Vifs=Vm-lsb
printf('\nPart B: Vifs= %.3f V', Vifs )

```

```
ip=4.8
d=1+ ip/lsb
printf('\nPart C: D= %d', d)
d=123
op=dec2bin(d,8)
printf('\n Digital Output= %s', op)
```

Scilab code Exa 11.10 Successive approximation ADC

```
// Example 11.10, Page No-494
clear
clc

n=8
cl=2*10^6
tp=1/cl
tpn=tp*10^6
printf('\n Time for one clock pulse= %.1f uS', tpn)
tm=(n+1)*tp
tmn=tm*10^6
printf('\n Time for resetting SAR and conversion= %
    .1f uS', tmn)
```