Scilab Textbook Companion for Principles Of Electronic Instrumentation by D. Patranabis[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 Concepts

Scilab code Exa 1.1 unknown resistance

```
//chapter1,Example1_1,pg 481

Ir=10*10^-3//current drawn by resistor

Vr=100//voltage across resistor

Rv=40*10^3//voltmeter resistance

Ru=(Vr/Ir)*(1/(1-(Vr/(Ir*Rv))))//unknown resistance

printf("output resistance\n")

printf("\nRu=%.2f ohm",Ru)
```

Scilab code Exa 1.2 unknown resistance

```
//chapter1,Example1_2,pg 481

```

```
Ir=10*10^-3//current drawn by resistor

Vr=100//voltage across resistor

Rv=40*10^3//voltmeter resistance

Ra=1//ammeter resistance

Ru=(Rv/Ir)-Ra//unknown resistance

printf("output resistance\n")

printf("\nRu=%.2f ohm",Ru)
```

Scilab code Exa 1.3 find ammeter reading

```
//chapter1,Example1_3,pg 481

Rv=40*10^3//voltmeter resistance

Ra=1//ammeter resistance

Vr=40//voltmeter reading

Ru=10*10^3//unknown resistance

Ir=(Vr*(Rv+Ru))/(Ru*Rv)//current reading-case1

printf("ammeter reading case1\n")

printf("\nIr=%.4f A",Ir)

Ir1=(Vr/(Ru+Ra))//current reading -case2

printf("\nammeter reading case2\n")
```

```
printf("\nIr1=%.4f A",Ir1)
```

Scilab code Exa 1.4 unknown resistance

```
//chapter1,Example1_4,pg 482

Vs=3//supply voltage

Vu=2.75//voltmeter reading

Rp=10*10^3//parallel resistance

Ru=Rp*((Vs/Vu)-1)//unknown resistance

printf("unknown resistance\n")

printf("\nRu=%.2f ohm",Ru)
```

Scilab code Exa 1.5 find input vlotage

```
//chapter1,Example1_5,pg 482

//with input voltage exceding 2Vd,diodes conduct and
    the voltage divider circuit with diodes can
   allow only a Vi given by Vi=2Vd

printf("\ninput voltage to amplifier\n")

printf("\nVi=2Vd")
```

Scilab code Exa 1.6 find shunt resistance

```
//chapter1,Example1_6,pg 482

Rm=1000//meter resistance

Is=900*10^-6//shunt current

Vm=100*10^-3//drop across meter

Rs=Vm/Is//ohm's law

It=1*10^-3

//Is=It*(Rm/(Rs+Rm))

Rs=(Rm*(It-Is))/Is

printf("\nshunt resistance\n")

printf("\nRs=%.2f ohm",Rs)
```

Scilab code Exa 1.7 find series resistor

```
//chapter1,Example1_7,pg 483

If=100*10^-6//full scale current

Rm=1000//meter resistance

Vf=10//full scale voltage

Rs=(Vf/If)-Rm//series resistance

printf("\nseries resistance\n")
```

```
printf("\Rs=%.2f ohm",Rs)
```

Scilab code Exa 1.8 sensitivity

```
//chapter1,Example1_8,pg 483

If=100*10^-6

S=1/If

printf("\nsensitivity\n")

printf("\nS=%.2f ohm/volt",S)
```

Scilab code Exa 1.9 error in measurment

```
//chapter1,Example1_9,pg 483

//assume that the voltmeter full scale reading is 12
   V which gives its resistance as 1.2*10^6 ohm
   which is in parallel with 10*10^6 ohm making as
   equivalent of Rq given as

R=1.2*10^6//voltmeter resistance

R1=10*10^6//voltage divider resistance

Rq=(R*R1)/(R+R1)//equivalent resistance

Vin=12//input voltage to divider network

Rs=4*10^6//series resistance
```

```
Vq=(Rq*Vin)/(Rq+Rs)//voltage across equivalent combination

Va=(R1*Vin)/(R1+Rs)//actual volatge

er=(Vq-Va)/Va//error

printf("\nerror in measurement\n")

printf("\ner=%.3f ",er)
```

Chapter 2

Measurement Of Electrical Quantities

Scilab code Exa 2.1 output voltage

```
//chapter2,Example2_1,pg 23

//for fig. 2.7

ic=1*10^-3//constant current source

Rf=15*10^3//feedback resistance

Rs=10*10^3//input resistance

Rx=1*10^3//unknown resistance

Vo1=ic*Rf*(Rx/(1+(Rx*Rs)))//output voltage case-1

printf("output voltage for case-1\n")

printf("\nVo1=%.4f V\n",Vo1)

//for fig. 2.8
```

```

R1=10//unknown resistance

R2=1*10^3//input resistance

Vo2=ic*Rx*(R1/(1+R1*R2))//output voltage case-2

printf("output voltage for case-2\n")

printf("\nVo2=%.4f V\n",Vo2)
```

Scilab code Exa 2.2 find Ad CMRR and Acm

```
//chapter2,Example2_2,pg 22

V1=5//input-1

V2=5//input-2

V12=50*10^-3//difference input

Vo=2//output voltage

acc=0.01//accuracy

Ad=(Vo/V12)//diffrential gain

//error at the output should be less than (2/100)V
    or 20mV. if common mode gain is the only source of
     error then

err=Vo*acc//error

Acm=(err/V1)//common mode gain

```

```
CMRR=20*log10(Ad/Acm)//common mode rejection ratio
   in dB

printf("diffrential gain \n")

printf("\nAd=%.1f \n",Ad)

printf("common mode gain \n")

printf("\nAcm=%.4f \n",Acm)

printf("\nCMRR=%.1f dB\n",CMRR)
```

Scilab code Exa 2.3 find full scale output and input min

```
//chapter-2,Example2_3,pg 484

Aol=10*10^4//open loop gain

R2=10*10^3

R3=10*10^3

R1=100*10^3//input resistance

Vac=24//maximum input

Vo=(R2/R1)*Vac//output full scale

printf("output FS voltage\n")

printf("Vo=%.2f V\n",Vo)

Vth=0.6//threshold voltage

```

```
Vn=(Vth/Aol)//minimum input

printf("minimum input voltage\n")

printf("Vn=%.8f V\n",Vn)
```

Scilab code Exa 2.4 output voltage

```
//chapter-2,Example2_4,pg 484

Vp=1//peak input voltage

f=50//frequency

//R1=R2

//since halfwave rectification is done,integration
    gives the value

Vo=0.5*((2*Vp)/3.14)//output voltage,pi=3.14

printf("output voltage\n")

printf("Vo=%.4f V\n",Vo)
```

Scilab code Exa 2.5 find unknown resistance

```
//chapter-2,Example2_5,pg 484

ic=0.1*10^-3//constant current source

Vo=2//output voltage

```

```
Rf=22*10^3//feedback resistance

Rs=10*10^3//input resistance

Rx=(1/(((ic*Rf)/(Vo*Rs))-(1/Rs)))//unknown
    resistance

printf("unknown resistance\n")

printf("Rx=%.2f ohm\n",Rx)
```

Scilab code Exa 2.6 find CMRR

```
//chapter-2,Example2_6,pg 484

a=0.9//parameter of diff. amplr.

b=1.1//parameter of diff. amplr.

CMRR=0.5*(((1+a)*b+(1+b)*a))/((1+a)*b-(1+b)*a)//
    common mode rejection ratio

printf("CMRR=%.2f \n",CMRR)
```

Scilab code Exa 2.7 tolerance in parameters

```
//chapter-2,Example2_7,pg 485

CMRR=10*10^4//common mode rejection ratio

//set a=beta+k1*delbeta and b=beta(-/+)k2*delbeta

```

```
//CMRR=0.5*((4(+/-)3*delbeta*(k1-k2))/((+/-)delbeta
    *(k1-k2)))

//CMRR=0.5*((4(+/-)3*(a1-a2))/((+/-)(a1-a2)))

//a1->k1*delbeta, a2->k2*delbeta

delalpha=(2/CMRR)//a1-a2=delalpha

printf("tolerance in parameters\n")

printf("delalpha=%.7f \n",delalpha)

printf("Therefore, if a varies by 1 percent, b
    should not vary more than 2*10^-3 percent of
    variation of a")
```

Scilab code Exa 2.8 output voltage

```
//chapter-2,Example2_8,pg 485

R1=10*10^3

R2=10*10^3

V1=10//input voltage-1

V2=10//input voltage-2

R31=10*10^3//R3,case-1

Vo1=((1+(R2/R1)+(R2/R31))*V1)-(R2/R1)*V2//output
    voltage case-1

printf("output voltage case-1\n")
```

```
printf("Vo1=%.2f V\n",Vo1)

R32=100*10^3//R3,case-2

Vo2=((1+(R2/R1)+(R2/R32))*V1)-(R2/R1)*V2//output
    voltage case-2

printf("output voltage case-2\n")

printf("Vo2=%.2f V\n",Vo2)

R33=1000*10^3//R3,case-3

Vo3=((1+(R2/R1)+(R2/R33))*V1)-(R2/R1)*V2//output
    voltage case-3

printf("output voltage case-3\n")

printf("Vo3=%.2f V",Vo3)
```

Scilab code Exa 2.9 difference in output voltage

```
//chapter-2,Example2_9,pg 486

//(R3/R1)=0.98^-1(R2/R4)

R1=10*10^3

R3=10*10^3

I1=130*10^-6

Vo1=R1*(1+0.98)*I1//output for case-1, (R2/R4)=0.98

```

```
//(R1/R3)=(R4/R2)

Vo2=R1*(1+(R3/R1))*I1//output for case-2

Vo12=((Vo2-Vo1)/Vo2)*100//percent difference

printf("difference in output voltage\n")

printf("Vo12=%.4f ohm",Vo12)
```

Scilab code Exa 2.10 find crest factor

```
//chapter-2,Example2_10,pg 486

dutcyc=0.4//duty cycle

CF=sqrt((1-dutcyc)/dutcyc)//crest factor

printf("crest factor\n")

printf("CF=%.4f ",CF)
```

Scilab code Exa 2.11 find unknown resisance

```
//chapter-2,Example2_11,pg 486

R1=10*10^3

R4=10*10^3

Idss=1*10^-3//drain saturation current

Vp=2.2//peak voltage
```

```
Vo=10//output voltage

V2=2//input-1

V1=-2//input-2

R5=((R1*R4)/Vo)*((-2*Idss/(Vp^2)))*V1*V2

printf("R5=%.2f ohm",R5)

//R5 should satisfy the condition R5=((1+R1*(-2*Idss
    *Vp)/R2)*R3*R6) and with Vp negative it is
    obiviously possible
```

Chapter 3

Digital Elements and Features

Scilab code Exa 3.1 equivalence comparator

```
//chapter-3,Example3_1,pg 487

in1=1//input-1

in2=bitcmp(in1,1)//input-2

out=(bitcmp(in1,1)*bitcmp(in2,1))+(in1*in2)//output

printf("output of comparator\n")

printf("out=%.2f",out)
```

Scilab code Exa 3.2 antivalence comparator

```
//chapter-3,Example3_2,pg 487

in1=1//input-1

```

```
in2=bitcmp(in1,1)//input-2

out=(bitcmp(in1,1)+bitcmp(in2,1))*(in1+in2)//output

printf("output of comparator\n")

printf("out=%.2f",out)
```

Scilab code Exa 3.3 simplify Boolean function

```
//chapter-3,Example3_3,pg 487

//Fabc=m6+m4+m2+m7+m5+m3

//Fabc=abc'+ab'c'+a'bc'+abc+ab'c+a'bc

//a'=bitcmp(a,1)

//Fabc=ac'(b+b')+a'bc'+ac(b+b')+a'bc

//Fabc=ac'+a'bc'+ac+a'bc

//Fabc=c'(a+a'b)+c(a+a'b)

//Fabc=(a+b)c'+(a+b)c

//Fabc=(a+b)(c+c')

printf("boolean function in simplified form\n")

printf("a+b")
```

Scilab code Exa 3.4 simplify Boolean function

```
//chapter-3,Example3_4,pg 487

//Fabc=M7*M6

//Fabc=M7*M6=(a+b+c)(a+b+c')

//Fabc=a+ab+ac'+ab+b+bc'+ac+bc+cc'

//Fabc=(a+b)+(a+b)c'+(a+b)c+ab+ab+cc'

//Fabc=((a+b)+c)((a+b)+c')

//Fabc=(a+b)(a+b)+(a+b)c'+(a+b)c

printf("boolean function in simplified form\n")

printf("a+b")
```

Scilab code Exa 3.5 obtain truth table

```
//chapter-3,Example3_5,pg 488

//enter binary values only(1bit)

a=input("enter value of a")//input-1

b=input("enter value of b")//input-2

c=input("enter value of c")//input-3

x=bitcmp(bitand(a,b),1)

y=bitor(x,c)//final output

printf("\noutput\n")
```

```
printf("y=%.2f\n",y)

printf(" verify from truth table\n")

printf("a   b   c           y\n")

printf("0   0   0           1\n")

printf("0   0   1           1\n")

printf("0   1   0           1\n")

printf("0   1   1           1\n")

printf("1   0   0           1\n")

printf("1   0   1           1\n")

printf("1   1   0           0\n")

printf("1   1   1           1\n")
```

Scilab code Exa 3.6 scheme of gates

```
//chapter-3,Example3_6,pg 488

printf("it is an EX-OR gate\n")

printf("scheme using AND/OR gates\n")

printf("AND(A*,B) OR AND(A,B*)")//A*=bitcmp(A)
```

Chapter 4

Combinational And Sequential Logic Circuits

Scilab code Exa 4.1 find output and carry

```
//chapter-4,Example4_1,pg 488

//it is a half-adder circuit with the output 'a' and
    carry 'c' given by the boolean equations

b1=1//input-1

b2=1//input-2

a=bitand(b1,bitcmp(b2,1))+bitand(bitcmp(b1,1),b2)//
   sum

c=bitand(b1,b2)//carry

printf("sum\n")

printf("a=%.f\n",a)

printf("carry\n")
```

```
printf("c=%.f",c)
```

Scilab code Exa 4.2 find difference and borrow

```
//chapter-4,Example4_2,pg 489

//the circuit is that of a half subtractor

//case-1

b1=1//input-1

B1=0//input-2

d1=bitand(b1,bitcmp(B1,1))+bitand(B1,bitcmp(b1,1))//
    difference

r1=bitand(b1,bitcmp(B1,1))//borrow

//case-2

b2=1

B2=1

d2=bitand(b2,bitcmp(B2,1))+bitand(B2,bitcmp(b2,1))

r2=bitand(b2,bitcmp(B2,1))

printf("difference case-1\n")

printf("d1=%.f\n",d1)

printf("difference case-2\n")
```

```
printf("d2=%.f\n",d2)

printf("borrow case-1\n")

printf("r1=%.f\n",r1)

printf("borrow case-2\n")

printf("r2=%.f\n",r2)
```

Scilab code Exa 4.3 find final output

```
//chapter-4,Example4_3,pg 489

b=1//input-1

B=0//input-2

y=bitor((bitcmp(bitor(b,B),1)),bitand(b,B))//final
    output

printf("final output\n")

printf("y=%.f",y)
```

Scilab code Exa 4.4.a decoder output

```
//chapter-4,Example4_4_a,pg 489

//initial conditions

b=0
```

```
Bi=0//initial value
Bf=1//final value
//initial state of outputs
y1i=bitcmp(bitor(b,Bi),1)
y2i=bitcmp(bitor(b,bitcmp(Bi,1)),1)
y3i=bitcmp(bitor(Bi,bitcmp(b,1)),1)
y4i=bitcmp(bitor(bitcmp(Bi,1),bitcmp(b,1)),1)
//final state of outputs
y1f=bitcmp(bitor(b,Bf),1)
y2f=bitcmp(bitor(b,bitcmp(Bf,1)),1)
y3f=bitcmp(bitor(Bf,bitcmp(b,1)),1)
y4f=bitcmp(bitor(bitcmp(Bf,1),bitcmp(b,1)),1)
printf("first: ")
printf("y1=%.f ",y1i)
printf("y2=%.f ",y2i)
printf("y3=%.f ",y3i)
printf("y4=%.f\n",y4i)
printf("next: ")
printf("y1=%.f ",y1f)
```

```
printf("y2=%.f  ",y2f)

printf("y3=%.f  ",y3f)

printf("y4=%.f",y4f)
```

Scilab code Exa 4.4.b decoder output

```
//chapter-4,Example4_4_b,pg 489

//initial conditions

b=1

Bi=0//initial value

Bf=1//final value

//intial state of outputs

y1i=bitcmp(bitor(b,Bi),1)

y2i=bitcmp(bitor(b,bitcmp(Bi,1)),1)

y3i=bitcmp(bitor(Bi,bitcmp(b,1)),1)

y4i=bitcmp(bitor(bitcmp(Bi,1),bitcmp(b,1)),1)

//final state of outputs

y1f=bitcmp(bitor(b,Bf),1)

y2f=bitcmp(bitor(b,bitcmp(Bf,1)),1)

```

```
y3f=bitcmp(bitor(Bf,bitcmp(b,1)),1)

y4f=bitcmp(bitor(bitcmp(Bf,1),bitcmp(b,1)),1)

printf("first: ")

printf("y1=%.f ",y1i)

printf("y2=%.f ",y2i)

printf("y3=%.f ",y3i)

printf("y4=%.f\n",y4i)

printf("next: ")

printf("y1=%.f ",y1f)

printf("y2=%.f ",y2f)

printf("y3=%.f ",y3f)

printf("y4=%.f",y4f)
```

Scilab code Exa 4.5 convert 8421 to2421 code

```
//chapter-4,Example4_5,pg 489

//if A8,B8,C8,D8 is the binary in 8421 code, for 12
   this would be 1100(DCBA)

//in 8421-code
A8=0

B8=0
```

```
C8=1

D8=1

//in 2421-code

D2=D8

C2=bitor(C8,D8)

B2=bitor(B8,D8)

A2=A8

printf("2421-code for 12 is\n")

printf("%.f ",D2)

printf("%.f ",B2)

printf("%.f ",C2)

printf("%.f ",A2)
```

Scilab code Exa 4.6 Xcess 3 code

```
//chapter-4,Example4_6,pg 490

add="0011"//binary-3 to be added

x="0010"//binary-2

x=bin2dec(x)

```

```
add=bin2dec(add)

XS31=x+add

XS31=dec2bin(XS31)

y="0100"//binary-4

y=bin2dec(y)

XS32=y+add

XS32=dec2bin(XS32)

z="0111"//binary-7

z=bin2dec(z)

XS33=z+add

XS33=dec2bin(XS33)

printf("XS-3 for 2\n")

disp(XS31)

printf("XS-3 for 4\n")

disp(XS32)

printf("XS-3 for 7\n")

disp(XS33)
```

Scilab code Exa 4.7 8 to 1 MUX

```
//chapter-4,Example4_7,pg 490

//one can see from relations of AND gate outputs in
   terms of address bits and input bit that there
   are possibilities depending on which input is low

//if I7=0, by making all address bits s1,s2,s3 as 1
   one can have the conditions satisfied

printf("this requires all the outputs from AND gates
    should be low")
```

Scilab code Exa 4.8 truth table of RS flip flop

```
//chapter-4,Example4_8,pg 490

//enter binary 1-bit values only

printf("RS flip-flop truth table\n")

S=input("enter value of S")

R=input("enter value of R")

Qn=input("Enter previous value of Q")

En=input("enter enable value")

if En==0  then

op=Qn

printf("op=%.f",op)

else if S==0&R==0 then
```

```

op=Qn

printf("op=%.f",op)

else if S==0&R==1 then

op=0

printf("op=%.f",op)

else if S==1&R==0 then

op=1

printf("op=%.f",op)

else if (S==1&R==1) then

printf("output not determinable\n")

end

end

end

end

printf("the relations are\n")

printf("Qn=(R+Qn*)*\n") //Q*=bitcmp(Q)

printf("Qn*=(S+Qn)*")
```

Scilab code Exa 4.9 JK flip flop

```
//chapter-4,Example4_9,pg 491

//Q=(Q*+Q.K)* and Q*=(Q+Q*.J)*

//with J=K=0 Q=Q and Q*=Q*

//Q* is bitcmp(Q)

printf("operational equations\n")

printf("Q=(Q*+Q.K)* and Q*=(Q+Q*.J)*\n")

printf("hold good where Q and Q* should be given
    appropriate values")
```

Scilab code Exa 4.10 3 bit binary counter

```
//chapter-4,Example4_10,pg 491

printf("it remains positive from the falling edge of
     pulse-2, then falling edge of 4th, 6th and 8th
    pulses and so on....")
```

Scilab code Exa 4.11 6 modulo counter

```
//chapter-4,Example4_11,pg 491

printf("all modulo counters are basically scalars.A
    6-modulo counter is a 6-scaler so that after 6-
    input pulses the content of counter becomes 000(
    reset)")
```

Scilab code Exa 4.12 3 bit 5 modulo counter

```
//chapter-4,Example4_12,pg 491

printf("normal count would be 2^3=8, while 5-modulo
    counter would limit it to 5, so that illegitimate
     states are 8-5=3")
```

Chapter 5

ADC and DAC

Scilab code Exa 5.1 output voltage

```
//chapter-5,Example5_1,pg 491

Vref=12//ref. voltage

n=4//no. of binary weighted resistors

n1=3//input-1

n2=1//input-2

Vo=-(Vref/2^n)*(2^n1+2^n2)

printf("output voltage\n")

printf("Vo=%.2f V",Vo)
```

Scilab code Exa 5.2 voltage division ratio and feedback resistor

```
//chapter-5,Example5_2,pg 491

//serie arm resistance=10k, since the divider arm
   resistance Rsh=2Rse therefore for straight binary
    code, one should have section voltage ratio as
   Vos/Vis=0.5

printf("voltage section ratio=0.5\n")

//Vo/Vref=0.5

Rse=10*10^3//series resistance(Rsh/2)

Rf=0.5*(16*Rse)/15//feedback resistor

printf("feedback resistor\n")

printf("Rf=%.3f ohm",Rf)
```

Scilab code Exa 5.3 output voltage

```
//chapter-5,Example5_3,pg 492

Rse=1*10^3//series resistance

Rsh=2*10^3//shunt resistance

Vref=5//ref. voltage

n1=0//input-1

n2=3//input-2

Ro=0.22*10^3//load resistance

```

```
Vo=(Vref*(2^n1+2^n2)/16)*(Ro/(Ro+Rsh))//output
    voltage

printf("output voltage\n")

printf("Vo=%.4f V",Vo)
```

Scilab code Exa 5.4 find count

```
//chapter-5,Example5_4,pg 492

Vref=5//ref. voltage

t=1*10^-3//sawtooth wave time

f=100*10^3//clock frequency

Vi=1//input voltage

N=((t*f*Vi)/Vref)//count

printf("count=%.2f \n",N)
```

Scilab code Exa 5.5 find integrator output voltage

```
//chapter-5,Example5_5,pg 492

Tu=1*10^-3//wave time

Vi=0.2//input voltage

t=4*10^-3//integration time constant(1/RC)

```

```
V1=((Vi*Tu)/t)//integrator output voltage

printf("integrator output voltage\n")

printf("V1=%.2f V",V1)
```

Scilab code Exa 5.6 find rise in output voltage and charging time

```
//chapter-5,Example5_6,pg 493

Tz=0.6*10^-3//discharge time

Vref=1//ref. voltage

t=4*10^-3//integrator time const.

Vk=((Vref*Tz)/t)//rise in output integrator

printf("rise in integrator output\n")

printf("Vk=%.2f V\n",Vk)

Vi=0.2//input voltage

Tu=Vref*(Tz/Vi)//charging time

printf("charging time\n")

printf("Tu=%.4f sec",Tu)
```

Scilab code Exa 5.7 find count of counter

```
//chapter-5,Example5_7,pg 493
```

```
Vref=1//ref. voltage

Vi=0.2//input voltage

n=15//no. of counts before reset(n+1)

N=((n+1)*Vi)/Vref//no.of counts over charging time

printf("no. of counts over charging time\n")

printf("N=%.2f ",N)
```

Scilab code Exa 5.8 find input voltage

```
//chapter-5,Example5_8,pg 493

Nx=64//2^6, 6 bit counteer register

Vref=2.2//ref. voltage

N=32//SAR output

Vi=(N/(Nx+1)*Vref)//input voltage

printf("input voltage\n")

printf("Vi=%.2f V",Vi)
```

Scilab code Exa 5.9 conversion number

```
//chapter-5,Example5_9,pg 493

```

```
n=3//3-bit ADC

Vref=2.2//ref.voltage

Vi=1//input voltage

N=(((2^n)-1)*Vi)/Vref//SAR output

printf("SAR conversion no.\n")

printf("N=%.2f ",N)
```

Scilab code Exa 5.10 signal to noise ratio

```
//chapter-5,Example5_10,pg 493

n=3//3-bit ADC

SbyN=(((2^(n-1)*12^0.5)/2^0.5))//S/N ratio

printf("S/N ratio\n")

printf("SbyN=%.4f \n",SbyN)

printf("this produces an error due to noise nearly
    0.10")
```

Chapter 6

Cathode Ray Oscilloscope

Scilab code Exa 6.1 calculate ADC speed

```
//chapter-6,Example6_1,pg 169

n=8//8-bit resolution(conversion of 1 in 256)

Tr=10*10^-6//total trace time(256 conversions in
   10*10^-6 s)

Nc=256//total conversions

S=(Nc/Tr)//speed of ADC

printf("speed of ADC\n")

printf("S=%.2f conversions/sec",S)
```

Scilab code Exa 6.2 find frequency at horizontal plate

```
//chapter-6,Example6_2,pg 178
```

```
fy=1.8*10^3//frequency at vertical plates

Nv=2//vertical tangencies

Nh=3//horizontal tangencies

fx=fy*(Nv/Nh)//frequency at horizontal plates

printf("frequency of other wave\n")

printf("fx=%.2f Hz",fx)
```

Scilab code Exa 6.3 find length of vertical axis of ellipse

```
//chapter-6,Example6_3,pg 178

phi=(%pi/180)*30//conversion into radian

bplus=3//ellipse cutting +ve minor axis

bminus=-3//ellipse cutting -ve minor axis

theta=atan(2/1)//angle of major axis of ellipse(Vy/
    Vh=2:1)

y1=(bplus/sin(phi))//length of vertical axis

printf("length of vertical axis \n")

printf("y1=%.2f cm",y1)
```

Scilab code Exa 6.4 find voltage applied between plates

```
//chapter-6,Example6_4,pg 493

d=1*10^-3//separation between plates

fe=300//acceleration of electron

e=1.6*10^-19//charge of 1 electron

me=9.1*10^-31//mass of 1 electron

Vp=((me*fe*d)/e)//voltage apllied between plates

printf("voltage applied between plates\n")

printf("Vp=%.14f Kgm^2/s^2C",Vp)
```

Scilab code Exa 6.5 deflection sensitivity

```
//chapter-6,Example6_5,pg 494

l=1*10^-2//axial length of plates

D=22*10^-2//distance between centre of plate and
    screen

Vap=1.3*10^3//acceleration mode voltage

del=1*10^-3//output in mm

Sd=500*l*(D/(del*Vap))//deflection senstivity

printf("deflection sensitivity\n")

printf("Sd=%.2f mm/V",Sd)
```

Scilab code Exa 6.6 find deflection of electron

```
//chapter-6,Example6_6,pg 494

Vp=0.1*10^3//deflection plate voltage

e=1.6*10^-19//charge of electron

l=1*10^-2//axial length of plates

del1=1*10^-3//output in mm

m=9.1*10^-31//mass of electron

D=0.22*10^-2//distance between centre of plates and
    screen

t=0.1*10^-6//time of flight

del=((Vp*e*l*D)/(del1*m))*(10^-10)//deflection of
    electron beam from null pos.

printf("deflection of electron beam from null pos.\n
    ")

printf("del=%.2f cm",del)
```

Scilab code Exa 6.7 cutoff frequency of filter

```
//chapter-6,Example6_7,pg 494

R=10*10^5//scope input impedance
```

```

C1=0.31*62*10^-12//probe capacitance

C2=22*10^-12//probe input impedance

fcut=(1/(2*%pi*R*(C1+C2)))//cutoff frequency of
    filter

printf("cutoff frequency\n")

printf("fcut=%.2f Hz",fcut)
```

Scilab code Exa 6.8 phase difference

```
//chapter-6,Example6_8,pg 494

bplus=3//ellipse parameter

bminus=-3//ellipse parameter

aplus=1.5//ellipse parameter

aminus=-1.5//ellipse parameter

//case-1

y=6//y-intercept

x=3//x-intercept

phi1=asin(3/6)//phase difference

phi1=(180/%pi)*phi1//conversion into degree

//case-2
```

```
phi2=180-phi1//major axis in 2 and 4 quad.

//case-3

phi3=asin(0)//y2=0

//case-4

phi4=180-phi3//y2=0 (major axis in 2 and 4 quad.)

printf("phi1=%.2f \n",phi1)

printf("phi2=%.2f \n",phi2)

printf("phi3=%.2f \n",phi3)

printf("phi4=%.2f \n",phi4)
```

Scilab code Exa 6.9 rise time of pulse

```
//chapter-6,Example6_9,pg 495

B=25*10^6//bandwidth of scope

tr=(3.5/B)//rise time of scope

printf("rise time of scope \n")

printf("tr=%.8f s",tr)
```

Scilab code Exa 6.10 find speed of conversion

```
//chapter-6,Example6_10,pg 495

Res=(1/2^8)//resolution

T=8*10^-6//total time

n=256//no. of conversions

t=(T/n)//time req. by one conversion

S=(1/t)//speed of conversion

printf("speed of conversion \n")

printf("S=%.2f Hz\n",S)
```

Scilab code Exa 6.11 find total collector resistance

```
//chapter-6,Example6_11,pg 495

C=0.01*10^-6//timing capacitor

T=10*10^-3//time period

Rt=T/(4*C)//total collector resistance

printf("total collector resistance\n")

printf("Rt=%.2f ohm\n",Rt)
```

Scilab code Exa 6.12 deflection plates voltage

```
//chapter-6,Example6_12,pg 495
```

```
d1=1.03*10^-2//separation of plates

theta=(6/5)//deflection of electron(1(deg.)12'=(6/5)
    deg.)

l=2.2*10^-2//length of deflection plate

Vap=2.2*10^3//accelerating potential

x=tan((%pi/180)*(6/5))//x=(d/D)(conversion into
    radian)

Vp=(x/l)*d1*Vap*2//potential between plates

printf("potential between plates\n")

printf("Vp=%.2f V\n",Vp)
```

Chapter 7

Phase Frequency and Time

Scilab code Exa 7.1 find pulse width

```
//chapter-7,Example7_1,pg 496

delt=1*10^-3//pulse width

//w=2wo

//delt at w=2wo

delT=(delt/2)//changed in pulse width

printf("pulse width\n")

printf("delT=%.4f s",delT)
```

Scilab code Exa 7.2 detector senstivity

```
//chapter-7,Example7_2,pg 496

```

```
//senstivity of phase detection

//Sphi=(Vo/sin(B))=(Vo/B)=(+/-)0.5Vmax

Vmax=1//amplitude of cosine waves

//B is phase displacement

Sphi=(1/2)*Vmax

printf("senstivity of phase detection\n")

printf("Sphi=%.2f V/rad",Sphi)
```

Scilab code Exa 7.3 phase measured

```
//chapter-7,Example7_3,pg 496

Vp=1.3//pulse height

delt=0.31*10^-3//pulse width

T=1*10^-3//pulse repetion rate

Vphi=Vp*(delt/T)//phase deviation

phi=2*%pi*(Vphi/Vp)//phase

printf("phase measured\n")

printf("phi=%.4f rad",phi)
```

Scilab code Exa 7.4 measured phase difference

```
//chapter-7,Example7_4,pg 497

delt=0.13*10^-3//time delay

T=1.3*10^-3//time period

n=(1/3)*(1+(delt/T))//order of phase meter

delphi=(n-(1/3))*1080//measured phase difference

printf("measured phase difference\n")

printf("delphi=%.2f deg",delphi)
```

Scilab code Exa 7.5 find phase difference

```
//chapter-7,Example7_5,pg 497

n=8//8-bit counter

N2=64//output digital count

theta=%pi*(N2/(2^n-1))//phase difference

printf("measured phase difference\n")

printf("theta=%.6f radian",theta)
```

Scilab code Exa 7.6 states for stages required

```
//chapter-7,Example7_6,pg 497

```

```
//since the no. is more than 9, the two-stage
   counting is required. the states of the stages
   are

printf("      D      C       B       A      decimal
   equivalent")

a1=[0 0 0 1     1]

a5=[0 1 0 1     5]

disp(a1)

printf("\n")

disp(a5)
```

Scilab code Exa 7.7 find time base division

```
//chapter-7,Example7_7,pg 498

fd=10*10^6//frequency meter input

fc=10*10^3//counter clock

fi=100*10^6//actual input frequency

k=fc*(fd/fi)//division time base

printf("division time base\n")

printf("k=%.2f ",k)
```

Scilab code Exa 7.8 frequency of sinusoid

```
//chapter-7,Example7_8,pg 498

V2=0.130//output-1

V1=0.103//output-2

Vx=0.4//peak amplitude

delt=0.1*10^-3//time delay

f1=(1/(2*%pi*delt))*(asin(V2/Vx)-asin(V1/Vx))//
   frequency of sinusoid

printf("frequency of sinusoid\n")

printf("f1=%.2f Hz",f1)
```

Scilab code Exa 7.9 count of counter

```
//chapter-7,Example7_9,pg 498

//refer fig. 7.30(a),(b),(c)

//N=(2*fc/fs^2)*fi

fs=10*10^2//sampler frequency

fc=10*10^3//counter clock

M=(fs^2)/(2*fc)//multiplication factor

fi=113//input frequency

```

```
N=(1/M)*fi//count of counter

printf("count of counter\n")

printf("N=%.2f ",N)
```

Scilab code Exa 7.10 find time between events

```
//chapter-7,Example7_10,pg 498

n=10*10^2//scale factor=(1/n)

fc=10*10^5//clock frequency

N=10//count

Tp=(n/fc)*N//time between events

printf("time between events\n")

printf("Tp=%.4f s",Tp)
```

Chapter 8

Q factor Power and Power Factor

Scilab code Exa 8.1 inductance and Q factor of coil

```
//chapter-8,Example8_1,pg 234

fr=400*10^3//resonance frequency

C=400*10^-12//tuned capacitance

R=10//resistance of coil

n=40//Cp=nC

Cp=n*(100/400)*10^-12//interwinding capacitance

L=(1/(4*(%pi^2)*(fr^2)*(C+Cp)))//inductance of coil

Q=2*%pi*fr*(L/R)//observed Q-factor

printf("observed Q-factor\n")

printf("Q=%.2f ",Q)
```

Scilab code Exa 8.2 truncation error

```
//chapter-8,Example8_2,pg 240

fs=50*10^3//sampling rate

delt=2//summation interval

f=50//signal frequency

n=(fs/delt)//value of samples for 2s

maxer1=100/(2*n)//max error for synchronous case

maxer2=(100/(2*fs*delt*sin((2*%pi*f)/fs)))//max
    error for asynchronous case

printf("max error for synchronous case\n")

printf("maxer1=%.4f \n",maxer1)

printf("max error for asynchronous case\n")

printf("maxer2=%.2f ",maxer2)
```

Scilab code Exa 8.3 find ratio errror and phase angle

```
//chapter-8,Example8_3,pg 258

//assume no iron loss and magnetizing current=1% of
    10A, i.e 0.01A
```

```
Xs=1.884//reactance of secondary

Rs=0.5//resistance of secondary

Xm=20//reactance of meter

Rm=0.4//reactance of meter

B=atan((Xs+Xm)/(Rs+Rm))

B=B*(180/%pi)//conversion into degree

Im=0.01//magnetizing current

//nominal ratio (n2/n1)=10/1

n2=10

n1=1

R=n2+((Im*sin(B))/n1)//actual impedance

R1=0.0097//practical impedance

perer=(R1/R)*100//percentage error

theta=((Im*cos(B))/n2)//phase angle

theta=theta*(%pi/180)//conversion into radian

printf("percentage error\n")

printf("perer=%.4f \n",perer)

printf("phase angle\n")

printf("theta=%.6f rad",theta)
```

Scilab code Exa 8.4 inductor Q factor and resistance

```
//chapter-8,Example8_4,pg 499

Vc=100//voltage across capacitor

Vi=12//input voltage

Q=(Vc/Vi)//Q-factor

f=100//frequency of operation

Vl=100//Vc=Vl at resonance

Ir=5//current at resonance

Xl=(Vl/Ir)//inductive reactance

L=(Xl/(2*%pi*f))//inductance

Rl=(Xl/Q)//resistance

printf("inductance of coil\n")

printf("L=%.4f Henry\n",L)

printf("Q-factor\n")

printf("Q=%.3f \n",Q)

printf("resistance of coil\n")

printf("Rl=%.2f ohm",Rl)
```

Scilab code Exa 8.5 actual Q factor and resistance

```
//chapter-8,Example8_5,pg 499

//when switch is open

C1=0.011*10^-6//capacitance-1

Q1=10//Q-factor-1

//when switch is closed

C2=0.022*10^-6//capacitance-2

Q2=100//Q-factor-2

Qac=((Q1*Q2)/(Q1-Q2))*((C1-C2)/C1)//actual Q-factor

Rp=((Q1*Q2)/(Q2-Q1))*(1/(2*%pi*C2))//parallel resistance

printf("actual Q-factor\n")

printf("Qac=%.2f \n",Qac)

printf("parallel resistance \n")

printf("Rp=%.2f ohm",Rp)
```

Scilab code Exa 8.6 find Q factor

```
//chapter-8,Example8_6,pg 499
```

```
Cr=0.01*10^-6//capacitance at resonance

Cu=0.014*10^-6//capacitance at upper half

Cl=0.008*10^-6//capacitance at lower half

Qac=((2*Cr)/(Cu-Cl))//actual Q-factor

printf("actual Q-factor\n")

printf("Qac=%.2f \n",Qac)
```

Scilab code Exa 8.7 find lag

```
//chapter-8,Example8_7,pg 499

V=10//v=10sin6280t

I=1//current peak

P=3.1//active power

phi=acos((P*2)/V)//phase in radian

w=6280//v=10sin6280t

lag=(phi/w)//lag

printf("lag=%.5f s\n",lag)
```

Scilab code Exa 8.8 find truncation error

```
//chapter-8,Example8_8,pg 500

V=4//peak voltage

I=0.4//peak current

f=1*10^3//operating frequency

fs=40*10^3//sampling rate

delt=2.2//time interval

phi=((2*%pi*f)/fs)//phase

Et=(V*I*phi)/(4*%pi*f*delt*sin(phi))//truncation
   error

printf("truncation error\n")

printf("Et=%.8f ",Et)
```

Scilab code Exa 8.9 find frequency of PF meter

```
//chapter-8,Example8_9,pg 500

ar=1//gain of rectifier

nc=40//turns ratio (1:40)

Vm=4//peak load voltage

PF=0.85//power factor

f=(1/%pi)*ar*Vm*nc*PF//frequency

```

```
printf("frequency of digital power meter \n")

printf("f=%.2f Hz",f)
```

Scilab code Exa 8.10 calculate ratio error and phase angle

```
//chapter-8,Example8_10,pg 500

Rp=94//primary resistance

Xp=64.3//primary reactance

Rs=0.85//secondary resistance

Im=31*10^-3//magnetizing current

PF=0.4//power factor

B=acos(PF)

R=Rp+Rs//total resistance

n=10//PT ratio

Is=1//load current

Vs=110//n=(Vp/Vs)

nerr=n+((Is/n)*(R*cos(B)+Xp*sin(B)+Im*Xp)/Vs)//ratio
    error

theta=((cos(B)*(Xp/n))-(sin(B)*(R/n))-(Im*Rp))/(Vs*n
   )//phase angle

printf("ratio error\n")
```

```
printf("nerr=%.3f \n",nerr)

printf("phase angle\n")

printf("theta=%.3f ",theta)
```

Scilab code Exa 8.11 calculate ratio error and phase angle

```
//chapter-8,Example8_11,pg 500

n=20//(Vs/Is)

Is=5//n=(Vs/Is)

Vs=100//n=(Vs/Is)

N=0.25//resistance to reactance ratio

Bur=15//burden of CT=15VA (rating)

V=(Bur/Is)//voltage rating

B=atan(N)//cos(B)-> power factor

B=B*(180/%pi)//conversion into degree

IL=0.13//iron loss

I=(Bur/Vs)//current rating

I1=(IL/I)

Im=1.3//magnetizing current

```

```
Rac=0.23//actual value

R=n+((I1*cos(B)+Im*sin(B))/Is)//calculated value

theta=((Im*cos(B)-I1*sin(B))/Vs)//phase angle

nerr=-(Rac/R)*100//ratio error

printf("ratio error\n")

printf("nerr=%.4f \n",nerr)

printf("phase angle \n")

printf("theta=%.4f ",theta)
```

Chapter 9

Analyzers

Scilab code Exa 9.1 variable frequency oscillator

```
//chapter-9,Example9_1,pg 501

fc=1.3*10^6//centre frequency

fsignal=1*10^6//frequency of the signal

fvfo=0.3*10^6//frequency of variable frequency
    oscillator

per=(fvfo/fc)*100

printf("percent variation\n")

printf("per=%.3f",per)
```

Scilab code Exa 9.2 DFT coefficients

```
//chapter-9,Example9_2,pg 502
```

```
N=22//no. of acquistioned data

delt=2*10^-3//time period

n=4//4th DFT coeff.

q=3//no. of discrete points

//An=(2/N)*V(n)*cos((2*%pi*n*q)/N)

printf("A4=(1/11)V(4)cos(12pi/11)\n")

//Bn=(2/N)*V(n)*sin((2*%pi*n*q)/N)

printf("B4=(1/11)V(4)sin(12pi/11)\n")
```

Scilab code Exa 9.3 find improvement ratio

```
//chapter-9,Example9_3,pg 502

N=64//data units

//implimentation steps for DFT=64^2

//for FFT

r=(log2(N)/N)//implimentation ratio

printf("implimentation ratio\n")

printf("r=%.4for(3/32)",r)
```

Scilab code Exa 9.4 find distortion factor

```
//chapter-9,Example9_4,pg 502

D3=1.3*10^-2//3rd harmonic(unit value)

D5=0.31*10^-2//5th harmonic(unit value)

D7=0.04*10^-2//7th harmonic(unit value)

Dt=sqrt((D3^2)+(D5^2)+(D7^2))//distortion ratio

printf("distortion ratio\n")

printf("Dt=%.5f ",Dt)
```

Scilab code Exa 9.5 find percentage change in feedback

```
//chapter-9,Example9_5,pg 502

Q=10//Q-factor

m=5//improvement factor

a=(1/((3*Q)-1))//filter factor

Qr=Q*m//rejection Q-factor

ar=(1/((3*Qr)-1))//rejection filter factor

perf=((a-ar)/a)*100//percent change in feedback

printf("percent change in feedback\n")

printf("perf=%.5f ",perf)
```

Scilab code Exa 9.6 time uncertainity and measurable time

```
//chapter-9,Example9_6,pg 503

fc=100*10^6//clock frequency

Nm=4*10^6//memory size

Te=(1/fc)//timing uncertainity

Tm=(Nm/fc)//measurable time

printf("timing uncertainity\n")

printf("Te=%.11f s\n",Te)

printf("measurable time\n")

printf("Tm=%.4f s",Tm)
```

Chapter 10

Bridge Circuits

Scilab code Exa 10.1 wheatstone bridge

```
//chapter-10,Example10_1,pg 292

Vs=12//source voltage

R=120//resistance of arms

delv=0.3//variation in output voltage(+/-)0.3

delRbyR=(4/Vs)*(delv)*100//percent change in
   resistance

Rm=100//meter resistance

delIm=(delRbyR/100)/(4*R*(1+(Rm/R)))//current
   variation

printf("percent change in resistance\n")

printf("delRbyR=%.2f \n",delRbyR)

printf("current variation\n")
```

```
printf("delIm=%.6f A",delIm)
```

Scilab code Exa 10.2 high resistance measurement bridge

```
//chapter-10,Example10_2,pg 295

//in absence of the guard point arrangement, two
   10^10 ohm resistances in series become parallel
   to the 10^9 ohm resistance, making the effective
   unknown resistance

//case-1

Rh=10^9

Ra1=10^10

Rb1=10^10

Rue1=((Rh*2*Ra1)/(Rh+(2*Ra1)))//effective resistance

err1=((Rh-Rue1)/Rh)*100//percentage error

//case-2

Ra2=10^9

Rb2=10^9

Rue2=((Rh*2*Ra2)/(Rh+(2*Ra2)))//effective resistance

err2=((Rh-Rue2)/Rh)*100//percentage error

printf("percentage error case-1\n")
```

```
printf("err1=%.2f \n",err1)

printf("percentage error case-2\n")

printf("err2=%.2f ",err2)
```

Scilab code Exa 10.3 capacitance and resistance of AC bridge

```
//chapter-10,Example10_3,pg 297

Z1=complex(20,80)//impedance in first arm

Z2=complex(200)//impedance in second arm

Z3=complex(100,200)//impedance in third arm

f=50//excitation frequency

Zu=((Z2*Z3)/Z1)//impedance of fourth arm

Cu=-(1/(2*%pi*f*imag(Zu)))//capacitance in fourth
    arm

printf("capacitance in fourth arm\n")

printf("Cu=%.9f F\n",Cu)

Ru=real(Zu)//resistance in fourth arm

printf("resistance in fourth arm\n")

printf("Ru=%.2f ohm\n",Ru)
```

Scilab code Exa 10.4 schering bridge

```
//chapter -10,Example10_4 ,pg 301

C3=0.001*10^-6//capacitor

Fd=6*10^-4//dissipation factor

f=1*10^3//schering bridge frequency

Ru=(Fd/(2*%pi*f*C3))//standard resistor

R1=10*10^3

R2=10*10^3

C1=C3*(1/R2)*Ru

printf("standard resistor\n")

printf("Ru=%.3f ohm\n",Ru)

printf("capacitor\n")

printf("C1=%.16f F",C1)
```

Scilab code Exa 10.5 wein bridge

```
//chapter -10,Example10_5 ,pg 303

R=10*10^3//resistor

```

```
C=0.001*10^-6//capacitor

f=(1/(2*%pi*R*C))//supply frequency

R3=10*10^3//reistance in third arm

R4=(R3/2)//reistance in fourth arm

printf("supply frequency\n")

printf("f=%.2f Hz\n",f)

printf("reistance in fourth arm\n")

printf("R4=%.2f ohm",R4)
```

Scilab code Exa 10.6 balance condition in wein bridge

```
//chapter-10,Example10_6,pg 303

f=47.76*10^3//supplu frequency

CR=(1/(2*%pi*f))//resistor capacitor product

C=10^-9//assume

R=(CR/C)//resistor

printf("for (R3/R4)=2 R3 and R4 may be maintained at
    earlier values")
```

Scilab code Exa 10.7 relation between Vo and t for Vi given

```
//chapter-10,Example10_7,pg 309

a1=3.81*10^-3

a2=-6.17*10^-7

//R1=(R2/2),i.e R2/R1=2

R1=10*10^3

R2=20*10^3

R5=4*10^3

R6=20*10^3

B=(R5/(R5+R6))

//using relation 10.68(b)

printf("(Vo/Vi)= (-3.05*10^-3)t/(1+0.76*10^-3)t\n")

printf("thus for, t<=130 C, Vo is approx. linear.
    this however can be extended with proper choice i
    .e R5 and R6 in relation to R1,R3 and R4")
```

Scilab code Exa 10.8 find deflection in galvanometer

```
//chapter-10,Example10_8,pg 503

R1=120//resistance of arm-1

R2=120//resistance of arm-2

R3=120//resistance of arm-3
```

```
R4=121//resistance of arm-4

Rm=100//meter resistance

Vs=6//source voltage

n=1*10^-3//meter sensitivity

Vm=Vs*((R1/(R1+R2))-(R3/(R3+R4)))//voltage across
    meter

Rb=(R1*R2)/(R1+R2)+(R3*R4)/(R3+R4)//thevenised
    bridge resistance

Ig=(Vm/(Rb+Rm))//current through galvanometer

D=Ig*10^6

printf("deflection in meter\n")

printf("D=%.2f mm\n",D)
```

Scilab code Exa 10.9 find insulating post resistance

```
//chapter-10,Example10_9,pg 503

err=0.5*10^-2//(+/-)0.5%

R=100*10^6//test resistance

//Re=((R*2*Rip)/(R+(2*Rip)))

Re1=R-(err*R)//err=+0.5

```

```
Re2=R-(-err*R)//err=-0.5

Rip1=((R*Re1)/(2*(R-Re1)))//err=+0.5

Rip2=((R*Re2)/(2*(R-Re2)))//err=-0.5

printf("resistance of each insulating post-1\n")

printf("Rip1=%.2f ohm\n",Rip1)

printf("resistance of each insulating post-2\n")

printf("Rip2=%.2f ohm",Rip2)
```

Scilab code Exa 10.10 maxwell bridge

```
//chapter-10,Example10_10,pg 504

Ru=130//resistance

Lu=31*10^-3//inductance

R2=10*10^3//resistance in arm-2

C1=0.01*10^-6//capacitance in arm

R3=(Lu/(C1*R2))//resistance in arm-3

R1=((R2*R3)/Ru)//resistance in arm-1

printf("R1=%.2f ohm\n",R1)

printf("R3=%.2f ohm\n",R3)

printf("yes values are unique")
```

Scilab code Exa 10.11 hay bridge

```
//chapter-10,Example10_11,pg 504

f=1000//supply frequency

C1=0.04*10^-6//capacitance

R1=220//resistance in arm-1

Lu=22*10^-3//inductance

Ru=((2*%pi*f)^2)*C1*R1*Lu//resistance

R3=((R1*Ru)+(Lu/C1))/R2//resistance in arm-3

printf("resistance of inductor\n")

printf("Ru=%.2f ohm\n",Ru)

printf("resistance of arm-3\n")

printf("R3=%.2f ohm\n",R3)
```

Scilab code Exa 10.12 find C1 C3 and dissipation factor

```
//chapter-10,Example10_12,pg 505

C4=0.0033*10^-6//lossy capacitor

R2=12*10^3//arm-2 resistance
```

```
R1=10*10^3//arm-1 resistance

C3=((C4*R2)/R1)//standard capacitance

R4=0.1

C1=((R4*C3)/R2)

Fd=2*%pi*f*C4*R4//dissipation factor

printf("capacitance set value\n")

printf("C1=%.16f F\n",C1)

printf("value of standard capacitance\n")

printf("C3=%.14f F\n",C3)

printf("dissipation factor\n")

printf("Fd=%.12f\n",Fd)
```

Scilab code Exa 10.13 wein bridge

```
//chapter-10,Example10_13,pg 505

f=10*10^3//supply frequency

R1=10*10^3//reistance of arm-1

C1=0.01*10^-6

C2=0.01*10^-6

```

```
R3=20*10^3//resistance of arm-3

w=2*%pi*f//angular supply frequency

R2=(1/(w^2))*(1/(C1*C2*R1))//resistance of arm-2

R4=(R3/((R1/R2)+(C2/C1)))//resistance of arm-4

printf("resistance of arm-2\n")

printf("R4=%.2f ohm\n",R2)

printf("resistance of arm-4\n")

printf("R2=%.2f ohm\n",R4)
```

Chapter 11

Test Signal Generation

Scilab code Exa 11.1 limits of duty cycle

```
//chapter-11,Example11_1,pg 343

R1=1*10^3//input resistance

R2=1*10^3//feedback resistor

R3=1*10^3// non inverting ter. resistor

R8=1*10^3//potentiometer

R4=1*10^3

DF1=(R1/((2*R1)+R8))//duty factor lim.-1

DF2=(R1+R4)/((2*R1)+R8)//duty factor lim.-2

//T=(((2*R4*C*((2*R1)+R8)))/R1)*(Vt/Vi)=((6*R4*C*Vt)
    /Vi)

printf("range of duty factor is DF1 to DF2 i.e\n")

```

```
printf("%.2f  to  ",DF1)

printf("%.2f",DF2)

printf("\nlimits of t1 and t2\n")

printf("(T/3)  to  (2T/3)")
```

Scilab code Exa 11.2 determine sinewave amplitude and segment slopes

```
//chapter-11,Example11_2,pg 344

Vtx=5//triangular peak(+/-)5

Vsx=(2/%pi)*Vtx//sinewave peak

//if n=3 then there are 2*3=6 break points these are
    at o/p voltages

n=3//break point parameter

Vs1=(2/%pi)*Vtx*sin((1*%pi)/((2*n)+1))

Vs2=(2/%pi)*Vtx*sin((2*%pi)/((2*n)+1))

Vs3=(2/%pi)*Vtx*sin((3*%pi)/((2*n)+1))

//calculating slopes

ms1=(((2*n)+1)/%pi)*(sin((%pi*(1+1))/((2*n)+1))-sin
    ((%pi*1)/((2*n)+1)))

ms2=(((2*n)+1)/%pi)*(sin((%pi*(2+1))/((2*n)+1))-sin
    ((%pi*2)/((2*n)+1)))

```

```
ms3=(((2*n)+1)/%pi)*(sin((%pi*(3+1))/((2*n)+1))-sin
    ((%pi*3)/((2*n)+1)))

printf("break points\n")

printf("output voltages\n")

printf("Vs1=%.2f V  ",Vs1)

printf("Vs2=%.2f V  ",Vs2)

printf("Vs3=%.2f V\n",Vs3)

printf("segment slopes\n")

printf("ms1=%.2f  ",ms1)

printf("ms2=%.2f  ",ms2)

printf("ms3=%.2f \n",ms3)
```

Scilab code Exa 11.3 find inductance

```
//chapter-11,Example11_3,pg 505

R1=0//resistance

C=0.1*10^-6//capacitance

f=1*10^3//frequency

L=(1/((2*%pi*f)^2))*(1/C)//inductance

printf("inductance of circuit\n")

```

```
printf("L=%.6f H ",L)
```

Scilab code Exa 11.4 resonance frequency of crystal

```
//chapter-11,Example11_4,pg 506

C1=4*10^-12

L=94*10^-3//inductance

C=13*10^-9//capacitance

R=91.3//resistance

f1=(1/(2*%pi))*((L*C)^(-1/2))//resonance frequency-1

f2=(sqrt(1+(C/C1))/(2*%pi*sqrt(L*C)))//resonance
    frequency-2

printf("resonance frequency-1\n")

printf("f1=%.2f Hz\n",f1)

printf("resonance frequency-2\n")

printf("f2=%.2f Hz",f2)
```

Scilab code Exa 11.5 find R in CR section

```
//chapter-11,Example11_5,pg 506

f=1*10^3//frequency

```

```
C=0.01*10^-6//capacitance

//f=(1/(2*%pi))*(1/(6^(1/2)*RC))

R=(1/(2*%pi*(6^(1/2)*C*f)))//resistance of circuit

printf("resistance of circuit\n")

printf("R=%.2f ohm",R)
```

Scilab code Exa 11.6 find phase difference in wein network

```
//chapter-11,Example11_6,pg 506

epsi=0.01///detuning parameter

eta1=1//(f/fo)=1

eta2=2.2//(f/fo)=2.2

//case-1

phi1=atan((3*eta1*((eta1^2)-1)*(3+(2*epsi)))/((((eta1^2)-1)^2)*(3+epsi)-(9*epsi*(eta1^2))))//phase difference

//case-2

phi2=atan((3*eta2*((eta2^2)-1)*(3+(2*epsi)))/((((eta2^2)-1)^2)*(3+epsi)-(9*epsi*(eta2^2))))//phase difference

printf("phase difference for case-1\n")

printf("phi1=%.2f rad\n",phi1)
```

```
printf("phase difference for case-2\n")

printf("phi2=%.2f rad\n",phi2)
```

Scilab code Exa 11.7 digital frequency synthesizer

```
//chapter-11,Example11_7,pg 507

N=12//12-bit synthesizer

k1=1//sampling rate at sampler's rate

k2=4//sampling rate at 4 times sampler's rate

//case-1

adv1=(360/(2^N))//advancement of o/p register

//2pi rad=360 deg.

//case-2

adv2=(4*(360)/(2^N))//advancement of o/p register

printf("advancement of o/p register for case-1\n")

printf("adv1=%.4f \n",adv1)

printf("advancement of o/p register for case-2\n")

printf("adv2=%.4f \n",adv2)
```

Scilab code Exa 11.8 find controlling voltage

```
//chapter-11,Example11_8,pg 507

f=1*10^3//frequency

R6=10*10^3//feed-back resistor

R5=22*10^3//feed-in resistor

R4=10*10^3//integrator resistor

C=0.1*10^-6//integrator capacitor

Vsx=2//comparator pulse amplitude

Vi=((f*R4*R5*C)/(R6*4*Vsx))//controlling voltage

printf("controlling voltage\n")

printf("Vi=%.2f V\n",Vi)
```

Scilab code Exa 11.9 find limits of duty factor

```
//chapter-11,Example11_9,pg 507

R1=10*10^3

R8=10*10^3

R4=10*10^3

printf("duty factors are given by (t1/T) and (t2/T).
    the limits are giiven by\n")

```

```
lim1=(R1/((2*R1)+R8))////limit-1 of duty factor

lim2=((R1+R4)/((2*R1)+R8))//limit-2 of duty factor

printf("lim1=%.2f\n",lim1)

printf("lim2=%.2f\n",lim2)
```

Scilab code Exa 11.10 find output voltage V1 and V2

```
//chapter-11,Example11_10,pg 507

Vi=1.3//input voltage

R2=10*10^3

R3=10*10^3

R8=10*10^3//potentiometer

B=1/3//wiper distance

V1=((R3*Vi)/(R3+(B*R8)))//output voltage-1

V2=-((R2*Vi)/(R1+((1-B)*R8)))//output voltage-2

printf("ouput voltage-1\n")

printf("V1=%.4f V\n",V1)

printf("ouput voltage-2\n")

printf("V2=%.4f V\n",V2)
```

Chapter 12

Display Record And Acquisition Of Data

Scilab code Exa 12.1 find excitation voltage and electrode areas

```
//chapter-12,Example12_1,pg 371

E=10^6//electric field

l=10^-6//thickness of LCD

V=E*l//excitation potential

I=0.1*10^-6//current

rho=E/I//crystal resistivity

P=10*10^-6//power consumption

A=(P/(V*I))//area of electrodes

printf("excitation potential\n")

printf("V=%.2f V\n",V)
```

```
printf("crystal resistivity\n")

printf("rho=%.2f ohm-cm\n",rho)

printf("area of electrodes\n")

printf("A=%.2f cm^2",A)
```

Scilab code Exa 12.2 find deviation factor

```
//chapter-12,Example12_2,pg 383

fc=10^6//carrier frequency

m=0.4//modulation index

fs=100//signal frequency

V=2//(+/-)2V range

delfc1=m*fc//frequency deviation for FS(full scale)

//(+/-) 2V corresponds to delfc Hz deviation assuming linear shift, for (+/-)1V

delfc2=delfc1/V//frequency deviation for (+/-)1V range

sig=(delfc1/fs)//deviation factor

printf("frequency deviation for FS\n")

printf("delfc1=%.2f Hz\n",delfc1)

```

```
printf("frequency deviation for given range\n")

printf("delfc2=%.2f Hz\n",delfc2)

printf("deviation factor\n")

printf("sig=%.2f",sig)
```

Scilab code Exa 12.3 find wavelength of radiation

```
//chapter-12,Example12_3,pg 508

h=6.63*10^-34//planck's const.

e=1.6*10^-19//electron charge

c=3*10^8//speed of light

E=2.02//energy gap

lam=((h*c)/E)//wavelength of radiation(m/eV)

//1eV=16.017*10^-20J

lam=(lam/(16.017*10^-20))//conversion in meter

printf("wavelength of radiation\n")

printf("lam=%.12f m\n",lam)
```

Scilab code Exa 12.4 thickness of LCD crystal

```
//chapter-12,Example12_4,pg 508
```

```
V=1.3//excitation voltage

Vgrad=10^5//potential gradient

//10^5 V/mm*thickness in mm=excitation voltage

l=(V/Vgrad)//thickness of LCD

printf("thickness of LCD\n")

printf("l=%.8f m\n",l)
```

Scilab code Exa 12.5 find current density

```
//chapter-12,Example12_5,pg 508

rho=4*10^12//resistivity of LCD

Vgrad=10^6//potential gradient

j=(Vgrad/rho)//current density

printf("current per cm^2\n")

printf("j=%.8f A/cm^2\n",j)
```

Scilab code Exa 12.6 find magnetic flux in tape

```
//chapter-12,Example12_6,pg 508

f=2*10^3//frequency of signal

```

```
v=1//velocity of tape

w=0.05*10^-3//gap width

N=22//no.of turns on head

V=31*10^-3//rms voltage o/p

x=(%pi*f*w)/v

x=x*(%pi/180)

M=((V*w)/(2*v*N*sin(x)))//magnetic flux in tape

printf("magnetic flux in tape\n")

printf("M=%.8f Wb\n",M)
```

Scilab code Exa 12.7 channel accomodation

```
//chapter-12,Example12_7,pg 509

Br=576*10^3//bit rate conversion

n=8//resolution requirement per channel

fs=1000//sampling rate

N=(Br/(fs*3*n))//no. of channels

printf("no. of channels accomodated\n")

printf("N=%.2f \n",N)
```

Scilab code Exa 12.8 sensor signal transmission

```
//chapter-12,Example12_8,pg 509

Rsmax=1*10^3//sensor resistance max.

Rsmin=100//sensor resistance min.

Vs=5//sensor voltage

Io=(Vs/Rsmax)//current source-> ohm's law

Vmin=Rsmin*Io//min. output voltage

printf("current source\n")

printf("Io=%.4f A\n",Io)

printf("min. output voltage\n")

printf("Vmin=%.2f V\n",Vmin)
```

Scilab code Exa 12.9 ROM access time

```
//chapter-12,Example12_9,pg 509

//ROM 22*5*7

N=5//no. of gates in bitand plane

n=22//no.of inputs

```

```
f=913//refresh rate

//considering column display

ts=(1/(N*f*n))//ROM access time

printf("ROM access time\n")

printf("ts=%.6f s\n",ts)
```

Chapter 13

Shielding And Grounding

Scilab code Exa 13.1 find diagnostic ratio

```
//chapter-13,Example13_1,pg 405

t1=0.1*10^-6//time span for voltage

//voltage switching

V1=0.5//level-1

V2=5//level-2

//current switching

I1=0//level-1

I2=10*10^-3//level-2

t2=1*10^-6//time span for current

DR=(((V2-V1)/t1)/((I2-I1)/t2))

printf("dissipation ratio\n")
```

```
printf("DR=%.2f ohm\n",DR)

printf("DR is quite large indicating noise
   interference by capacitive coupling")
```

Scilab code Exa 13.2 find diagnostic ratio

```
//chapter-13,Example13_2,pg 509

t1=1*10^-6//time span for voltage

//voltage switching

V1=0.5//level-1

V2=1//level-2

//current switching

I1=1*10^-3//level-1

I2=10*10^-3//level-2

t2=1*10^-6//time span for current

DR=(((V2-V1)/t1)/((I2-I1)/t2))

printf("pseudoimpedance\n")

printf("DR=%.2f ohm\n",DR)

printf("DR is not quite large indicating noise
   interference by inductive coupling")
```

Scilab code Exa 13.3 find ground loop current

```
//chapter -13,Example13_3 ,pg 510

Vi=12//input DC voltage

Vo=3.182//output voltage

Rg=130*10^3//grounding resistance

R2=1*10^3//output resistance

R1=6.8*10^3//divider chain

Ig=((Vo-((R2*Vi)/(R1+R2)))/Rg)//grounding loop
    current

printf("grounding loop current\n")

printf("Ig=%.9f A\n",Ig)
```

Chapter 14

Transducers And The Measurement System

Scilab code Exa 14.1 find percentage change in resistance

```
//chapter-14,Example14_1,pg 421

delVo=120*10^-3//output voltage

Vs=12//supply voltage

R=120//initial resistance

delR=(delVo*2*R)/Vs//change in resistance

per=(delR/R)*100//percent change in resistance

printf("percent change in resistance\n")

printf("per=%.2f",per)
```

Scilab code Exa 14.2 find bridgemann coefficient

```
//chapter-14,Example14_2,pg 423

lam=175//gauge factor

mu=0.18//poisson's ratio

E=18.7*10^10//young's modulus

si=((lam-1-(2*mu))/E)//bridgemann coefficient

printf("bridgemann coefficient\n")

printf("si=%.14f m^2/N",si)
```

Scilab code Exa 14.3 pt100 RTD

```
//chapter-14,Example14_3,pg 428

//pt100 RTD

R4=10*10^3

R2=R4-0.09*R4

Ro=-2.2*10^3//output resistance

R1=(Ro*((R2^2)-(R4^2)))/(R2*(R2+R4))//design
    resistor

printf("resistance R1 and R3\n")

printf("R1=R3=%.2f ohm",R1)
```

Scilab code Exa 14.4 senstivity in measurement of capacitance

```
//chapter-14,Example14_4,pg 435

//assuming eps1=9.85*10^12

x=4//separation between plates

x3=1//thickness of dielectric

eps1=9.85*10^12//dielectric const. of free space

eps2=120*10^12//dielectric const. of material

Sx=(1/(1+((x/x3)/((eps1/eps2)-1))))//sensitivity of measurement of capacitance

printf("sensitivity of measurement of capacitance\n")

printf("Sx=%.2f",Sx)
```

Scilab code Exa 14.5 find max gauge factor

```
//chapter-14,Example14_5,pg 510

//if (delp/p)=0, the gauge factor is lam=1+2u

u=0.5//max. value of poisson's ratio

lam=1+(2*u)

```

```
printf("max. gauge factor\n")

printf("lam=%.2f",lam)
```

Scilab code Exa 14.6 find Young modulus

```
//chapter-14,Example14_6,pg 510

lam=-150//max. gauge factor

si=-9.25*10^-10//resistivity change

mu=0.5//max poisson's ratio

E=((lam-1-(2*mu))/si)//young's modulus

printf("young modulus\n")

printf("E=%.2f N/m^2",E)
```

Scilab code Exa 14.7 find capacitance of sensor

```
//chapter-14,Example14_7,pg 510

d1=4*10^-2//diameter of inner cylinder

d2=4.4*10^-2//diameter of outer cylinder

h=2.2//level of water

H=4//height of tank

```

```
eps1=((80.37*10^11)/((4*%pi*10^8)^2))//dielectric
    const. in free space(SI)

epsv=0.013*10^-5//dielectric const. of medium(SI)

C=(((H*epsv)+(h*(eps1-epsv)))/(2*log(d2/d1)))//
    capacitance of sensor

printf("capacitance of sensor\n")

printf("C=%.8f F",C)
```

Scilab code Exa 14.8 find ratio of collector currents

```
//chapter-14,Example14_8,pg 511

VobyT=0.04//extrapolated bandgap voltage

RE1byRE2=(1/2.2)//ratio of emitter resistances of Q1
    ,Q2

kBbyq=0.86*10^3//kB->boltzman const., q->charge

//(1+a)log(a)=(VobyT/RE1byRE2)*kBbyq, a->ratio of
    collector currents

printf("ratio of collector currents\n")

printf("a=23.094")
```

Scilab code Exa 14.9 find normalized output

```
//chapter-14,Example14_9,pg 511
```

```
//LVDT parameters

Rp=1.3

Rs=4

Lp=2.2*10^-3

Ls=13.1*10^-3

//M1-M2 varies linearly with displacement x, being
   maximum 0.4 cm

//when M1-M2=4mH so that k=(4/0.4)=10mH/cm

k=10*10^-3

f=50//frequency

w=2*%pi*f//angular frequency

tp=(Lp/Rp)//time const.

N=((w*k)/(Rp*sqrt(1+(w^2)*(tp^2))))//normalized
   output

phi=(%pi/2)-atan(w*tp)//phase angle

phi=phi*(180/%pi)//conv. into degree

printf("normalized output\n")

printf("N=%.4f V/V/cm\n",N)

printf("phase angle\n")

printf("phi=%.2f",phi)
```

Scilab code Exa 14.10 find load voltage

```
//chapter-14,Example14_10,pg 511

//for barium titanate, g cost. is taken as 0.04Vm/N.
    (it varies depending in composition and
   processing)

t=1.3*10^-3//thickness

g=0.04//const.

f=2.2*9.8//force

w=4*10^-3//width

l=4*10^-3//length

p=(f/(w*l))//pressure

Vo=g*t*p//voltage along load application

printf("voltage along load application\n")

printf("Vo=%.2f V",Vo)
```

Scilab code Exa 14.11 find error and senstivity parameters

```
//chapter-14,Example14_11,pg 512

//ADC outputs counts
```

```
N11=130

N22=229

N12=220

N21=139

//variable values

v1=4

v2=6.7

//temperatures

theta1=20

theta2=25

//parameters

B2=((N22+N11-N12-N21)/(v2-v1)*(theta2-theta1))//
    temperature coefficient of resistivity

a2=((N22-N21)/(v2-v1))//zero error sensitivity

B1=(N22-N12)/(theta2-theta1)//temperature
    coefficient of zero point

a1=N22-(B1*theta2)-(a2*v2)//zero error

printf("zero error\n")

printf("a1=%.2f\n",a1)

printf("zero error sensitivity\n")

```

```
printf("a2=%.2f\n",a2)

printf("temperature coefficient of zero point\n")

printf("B1=%.2f\n",B1)

printf("temperature coefficient of resistivity\n")

printf("B2=%.2f",B2)
```

Chapter 15

Fibre Optics Sensors And Instrumentation

Scilab code Exa 15.1 find increamental phase

```
//chapter -15,Example15_1 ,pg 470

n1=1.48//refractive index of fibre

mu=0.2//poisson's ratio

p=2.2*10^2//pressure applied

lam=690*10^-9//laser beam wavelength

Y=2.2*10^11//young's modulus

delphi=((4*%pi*n1*mu*p)/(lam*Y))//increamental phase

printf("increamental phase\n")

printf("delphi=%.5f rad",delphi)
```

Scilab code Exa 15.2 find additional length travelled

```
//chapter-15,Example15_2,pg 474

r=4.5//radius of fibre loop

a=%pi*(r^2)//area of fibre loop

Q=1//linear velocity(cm/s)

Co=3*10^10//velocity of light(cm/s)

delL=((4*a*Q)/Co)//additional length travelled

printf("additional length travelled\n")

printf("delL=%.12f cm",delL)
```

Scilab code Exa 15.3 find interacting length

```
//chapter-15,Example15_3,pg 512

//(Po1/Po2)=1/2 and Po1+Po2=3Po2=Pi

Po2byPi=1/3//(Po2/Pi)

kL=acos(sqrt(Po2byPi))//k->coupling coefficient

L=kL//L=kL/k L->interacting length

printf("interacting length\n")

```

```
printf("L=%.3f/k",L)
```

Scilab code Exa 15.4 wavelength suitable for laser light

```
//chapter-15,Example15_4,pg 512

We=7.6*10^-5//speed od gyro

L=490

d=0.094

c=3*10^8

delphi=7.69*10^-5//phase shift

lam=((2*%pi*L*d*We)/(c*delphi))//wavelength of laser light

printf("wavelength of laser light\n")

printf("lam=%.11f m",lam)
```

Scilab code Exa 15.5 find rate of change of RI wrt T

```
//chapter-15,Example15_5,pg 513

//(delphi/delT)=(2pi/lam)(n*(delL/delT)+L*(deln/delT))=(deln/delT)

lam=635*10^-9//wavelength of light beam

delphi=139//phase angle
```

```
delL=0.49*10^-6//change in length

n=1.48//R.I of fibre

k=((lam*delphi)/(2*%pi))-(delL*n)//k=(deln/delT), rate of change of R.I w.r.t T

printf("rate of change of R.I w.r.t T\n")

printf("k=%.8f/C",k)
```