Scilab Textbook Companion for Problems in Electrical Engineering by P. Smith [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

Appendix Solved problems

Scilab code Exa 1.2 Voltage Gradients

```
// Ex 2 Page 340

clc;clear;close;
// Given
t1=2; // mm
t2=5; // mm
t3=7; // mm
eps1=3;// dielectric constant
eps2=4;// dielectric constant
eps3=6; // dielectric constant
eps0=1/36/%pi*10^-9; // dielectric constant
d=10/100 ;// m
V=1500 // V
//E1*t1+E2*t2+E3*t3=V
//Voltage Gradients :
// using eps1*E1=eps2*E2=eps3*E3
E1=V/(t1+(eps1/eps2)*t2+(eps1/eps3)*t3)// V/mm
E1=E1*10 // V/cm
E2=eps1*E1/eps2 // V/cm
E3=eps1*E1/eps3 // V/cm
printf("Voltage Gradients :\n    for A : %.f V/cm\n
```

```
    for B : %.f V/cm\n    for C : %.f V/cm",E1,E2,E3
  )

A = %pi*d^2
W1=1/2*eps0*eps1*E1^2*10^4*A*t1*10^-3; // J
W2=1/2*eps0*eps2*E2^2*10^4*A*t2*10^-3; // J
W3=1/2*eps0*eps3*E3^2*10^4*A*t3*10^-3; // J
W1=W1*10^6 ; // uJ
W2=W2*10^6 ; // uJ
W3=W3*10^6 ; // uJ
printf("\nEnergy stored :\n    for A : %.1f uJ\n
   for B : %.1f uJ\n    for C : %.1f uJ",W1,W2,W3)


// Answer in the textbook are not accurate
```

Scilab code Exa 1.3 Current required

```
// Ex 3 Page 341

clc;clear;close;
// Given
N=680; // turns
fi=1.6*10^3 ;// Wb
d1=4/100 ;// m
d2=24/100;//m
l=0.6;//m
mu0=4*%pi/10^7 ;// constant


// For air gap :
A=d1^2 ;// m^2
Bg=fi/A ;//weber/m^2
Hg=Bg/mu0;//AT/m
mmf1=0.001/mu0 ;// AT
```

```

// For central limb :
A=d1^2;// m^2
Bc=fi/A ;//weber/m^2
Hc=900;//AT/m (from magnetization curve)
mmf2=Hc*d2 ;// AT


// For side limb :
fi=1/2*fi ;// Wb
A=d1^2;// m^2
Bc=fi/A ;//weber/m^2
Hc=520;//AT/m (from magnetization curve)
mmf3=Hc*l ;// AT

mmf_total = mmf1+mmf2+mmf3;// AT
i=mmf_total/N ;// A
printf("Current required  = %0.2f A",i)


// Answer in the textbook are not accurate
```

Scilab code Exa 1.4 Exciting current

```
// Ex 4 Page 343

clc;clear;close;
// Given

D=15/100 ;// m
A=10/10**-4;//m^2
N=200; // turns
fi=1.6*10^3 ;// Wb
B=1 ;//weber/m^2
mu0=4*%pi/10^7 ;// constant
```

```
mur=500 ;// constant
lg=2/1000;//m


// without air gap
l=%pi*D;//m
R=l/mu0/mur/A;//A/Wb
fi=B*A;//Wb
mmf=fi*R;//AT
I=mmf/N;//A
L=N**2/R/10**6;//mH
E=1/2*L*I^2/100;//J


// with air gap
Rg=lg/mu0/A;//A/Wb
Rt=R+Rg;//A/Wb
fi=B*A;//Wb
mmf=fi*Rt;//AT
I2=mmf/N;//A
L2=N**2/Rt/10**6;//mH
E2=1/2*L2*I2^2/100;//J

printf("\t\t\tWithout air gap       With air gap")
printf("\nExciting current          %.2f A
                  %.1f A",I,I2)
printf("\nInductance                %.1f mH
                  %.1f mH",L,L2)
printf("\nStored Energy             %.3f J
                  %.2f J",E,E2)


// Answer in the textbook are not accurate
```

Scilab code Exa 1.5 Voltage acroos 100 ohm

```
// Ex 5 Page 344

clc;clear;close;
// Given

VA=60;//V
I=0.6;//A
// (VB-VA)/20+(VB-VC)/20+VB/20-I=0
//3*VB-VC=72 for node B eqn(1)
//(VC-VA)/50+(VC-VB)/30+(VC-12)/50+VC/100=0
//-5*VB+10*VC=144 eqn(2)
A=[3 -1;-5 10];
B=[72;144];
X=A**-1*B;
VB=X(1);//V
VC=X(2);//V
printf("Voltage acroos 100 ohm = %.1f V",VC)
VC=24;//V
VB=(72+VC)/3 ;// from eqn(1)
// Node C
// (VC-VA)/50+(VC-VB)/20+(VC-12)/50+VC/100+VC/R=0
   eqn(3)
R=100*VC/(144+5*VB-10*VC);//ohm
printf("\nR=%.1f ohm",R)
```

Scilab code Exa 1.6 frequency for attenuation

```
// Ex 6 Page 346

clc;clear;close;
// Given

Ro=600;//ohm
fc=2*1000;//Hz
alfa=10;//dB
```

```
L=Ro/%pi/fc*1000;//mH
C=1/(%pi*Ro*fc)*10**6;//uF
alfa=alfa/8.686;//nepers
f=fc*cosh(alfa/2)/1000;//kHz
printf("\nat f = %.2f kHz, the above filter will
    have required attenuation.",f)
```

Scilab code Exa 1.7 Voltage across capacitor

```
// Ex 7 Page 347

clc;clear;close;
// Given
//v=100*sin(314*t)
R=25;//ohm
C=80;//uF
omega=314;//radian
Vm=100;//V

Xc=1/omega/(C*10**-6);//ohm
Z=sqrt(R**2+Xc**2);//ohm
Im=Vm/Z;//A
theta=atan(Xc/R);//radian
printf("equation for instant current:")
mprintf("\n i=%.2f*sin(%d*t+%.2f)",Im,omega,theta)
P=(Im/sqrt(2))**2*R;//W
mprintf("\n Power consumed = %.1f W",P)
Vcm=Im*Xc;//V
//(when i=Im/2)
i=0.5*Im;//A
//vc=Vcm*sin(314*t+theta-%pi/2)
//i=Im*sin(314*t+theta)
tt=asin(i/Im) ;//radian tt=314*t+theta
```

```
vcm=Vcm*sin(tt-%pi/2)
mprintf("\n Voltage across capacitor = %.1f V(+ve &
    -ve)",abs(vcm))
```

Scilab code Exa 1.8 Circuit current

```
// Ex 8 Page 348

clc;clear;close;
// Given

Z1=(6.25+%i*1.25);//ohm
Z2=(5+%i*0);//ohm
//Z3=(5-%i*XC);//ohm
V=100;//V
f=50;//Hz
//Z23=(250+5*Xc**2)/(100+Xc**2)-%i*(25*Xc)/(100+Xc
    **2)
//for in phase condition imag part must be zero
//5*Xc**2-100*Xc+5*100=0
A=[5 -100 500];//polynomal
XC=roots(A);
XC=XC(1);//ohm
C=1/(2*%pi*f*XC)*10**6;//uF
printf("Capacitance of XC = %.f uF",C)
Z=XC;//ohm
I=V/Z;//A
P=I**2*Z/1000;//kW
printf("\n Circuit current = %.f A and power = %.f
    kW",I,P)
```

Scilab code Exa 1.9 Value of L

```
// Ex 9 Page 349

clc;clear;close;
// Given

omega_o=600;//rad/s
omega=400;//rad/s
R=3;//ohm
IBYIo=1/2;//ratio


fo=omega_o/2/%pi;//Hz
f=omega/2/%pi;//Hz
//I/Io=1/(sqrt(1+Q**2*(f/fo-fo/f)**2))
Q=sqrt(1/IBYIo**2-1)/(fo/f-f/fo)
//Q=1/omega_0/R/C
C=1/omega_o/R/Q*10**6;//uF
//Q=omega_0*L/R
L=Q*R/omega_o*1000;//mH
printf("L = %.1f mH\n C=%.f uF",L,C)
```

Scilab code Exa 1.10 Star and Delta Connection

```
// Ex 10 Page 350

clc;clear;close;
// Given

V=400;//V
f=50;//Hz
n=3;//no of phase
R=100;//ohm

//Star connection
Vph=V/sqrt(n);//V
```

```
Iph=Vph/R;//A
IL=Iph;//A
cos_fi=1;// for only resitor load
P=sqrt(3)*V*IL*cos_fi/1000;//kW
printf("Star Connection : P=%.1f kW",P)
//Delta Connection

Vph=V;//V
Iph=Vph/R;//A
IL=sqrt(3)*Iph;//A
VL=Vph;//V
P=sqrt(3)*VL*IL*cos_fi/1000;//kW
printf("\n Delta Connection : P=%.1f kW",P)
```

Scilab code Exa 1.11 Line current and power

```
// Ex 11 Page 351

clc;clear;close;
// Given
Rab=6;Rbc=8;Rca=4;//ohm
Vab=100*expm(%i*0);//V
Vbc=100*expm(%i*-120*%pi/180);//V
Vca=100*expm(%i*120*%pi/180);//V
Zab=6+%i*8;//ohm
Zbc=8+%i*6;//ohm
Zca=4-%i*3;//ohm

//Phase current
Iab=Vab/Zab;//A
Ibc=Vbc/Zbc;//A
Ica=Vca/Zca;//A
printf("Phase Current:")
[r,t]=polar(Iab)
printf("\n Iab=%.f angle=%.2f degree ",r,t*180/%pi)
```

```
[r,t]=polar(Ibc)
printf("\n Ibc=%.f angle=%.2f degree ",r,t*180/%pi)
[r,t]=polar(Ica)
printf("\n Ica=%.f angle=%.2f degree ",r,t*180/%pi)
//Line current
Iaa=Iab-Ica;//A
Ibb=Ibc-Iab;//A
Icc=Ica-Ibc;//A
printf("\n\n  Line Current:")
[r,t]=polar(Iaa)
printf("\n Iaa=%.1f angle=%.2f degree ",r,t*180/%pi)
[r,t]=polar(Ibb)
printf("\n Ibb=%.2f angle=%.2f degree ",r,t*180/%pi)
[r,t]=polar(Icc)
printf("\n Icc=%.2f angle=%.2f degree ",r,t*180/%pi)
//Power Consumed
Wab=abs(Iab)^2*Rab;//W
Wbc=abs(Ibc)^2*Rbc;//W
Wca=abs(Ica)^2*Rca;//W
W=Wab+Wbc+Wca;//W
W=W/1000;//kW
printf("\n\n Total Power, W=%.f kW",W)
//Answer wrong for line current in the textbook.
```

Scilab code Exa 1.12 Wattmeter reading

```
// Ex 12 Page 353

clc;clear;close;
// Given
VRY=200*expm(%i*0);//V
VYB=200*expm(%i*-120*%pi/180);//V
VBR=200*expm(%i*120*%pi/180);//V


```

```
ZA=10*expm(%i*60*%pi/180);//ohm
ZB=10*expm(%i*0*%pi/180);//ohm
ZC=10*expm(%i*60*%pi/180);//ohm

//Phase current
IRY=VRY/ZA;//A
IYB=VYB/ZB;//A
IBR=VBR/ZC;//A

IR=IRY-IBR;//A
PVA=conj(VRY)*IR;//W
printf("Wattmeter W1 reading=%.f W",real(PVA))
IB=IBR-IYB;//A
PVB=conj(-VYB)*IB;//W
printf("\n Wattmeter W2 reading=%.f W or %.f kW",
    real(PVB),real(PVB)/1000)
```

Scilab code Exa 1.13 Current and power

```
// Ex 13 Page 354

clc;clear;close;
// Given
//v=250*sin(omega*t)+50*sin(3*omega*t+%pi/3)+20*sin
    (5*omega*t+5*%pi/6)
V1=250;V3=50;V5=20;//V
fi1=0;fi3=60;fi5=150;//degree
R=20;//omh
L=0.05;//H
omega=314;//rad/s

X1=omega*L;//ohm
Z1=R+%i*X1;//ohm
X3=3*omega*L;//ohm
Z3=R+%i*X3;//ohm
```

```
X5=5*omega*L;//ohm
Z5=R+%i*X5;//ohm
[r1,t1]=polar(Z1);
[r3,t3]=polar(Z3);
[r5,t5]=polar(Z5);
printf("expression for current:")
printf("\n i = %.2f*sin(omega*t-%.1f)+%.1f*sin(3*
    omega*t%.1f)+%.2f*sin(5*omega*t-%.1f)",V1/r1,fi1-
    t1*180/%pi,V3/r3,fi3-t3*180/%pi,V5/r5,fi5-t5*180/
    %pi)

I1m=V1/r1;//A
I3m=V3/r3;//A
I5m=V5/r5;//A
Irms=sqrt(I1m^2/2+I3m^2/2+I5m^2/2);//A
Vrms=sqrt(V1^2/2+V3^2/2+V5^2/2);//A
printf("\n Irms=%.f A\n Vrms=%.f V",Irms,Vrms)
P=Irms^2*R;//W
printf("\n Total Power, P=%.f W",P)
cosfi=P/Vrms/Irms;//Power factor
printf("\n Power factor = %.2f",cosfi)
```

Scilab code Exa 1.14 transient component of current

```
// Ex 14 Page 355

clc;clear;close;
// Given
f=50;//Hz
Vm=400;//V
R=10;//ohm
L=0.1;//H
t=0.02;//sec
XL=2*%pi*f*L;//ohm
Z=R+%i*XL;//ohm
```

```
Im=Vm/abs(Z);//A
fi=atan(XL/R);//degree
lambda=L/R;//sec
printf("expression for current:")
printf("\n i = %.1f*sin(314*t-%.3f)+0.95*e**(-100*t)
    ",Im,fi)
i = Im*sin(314*t-fi)+0.95*%e**(-100*t);//A
printf("\n current after 0.02 sec is : %0.1f A",i)
i2=Im*(0.95*%e**(-100*t));//A
printf("\n transient component is : %0.2f A",i2)
```

Scilab code Exa 1.15 Additional resistance required

```
// Ex 15 Page 356

clc;clear;close;
// Given
C=5*10**-6;//F
L=2;//H
R=200;//ohm

if R<2*sqrt(L/C) then
    printf("Since R<2sqrt(L/C), the circuit is
        originally oscillatory.")
end

a=R/2/L
omega = sqrt(1/L/C-R^2/4/L^2);//rad/s
//i=Im*%e**(-a*t)*sin(omega*t+fi)
//at t=0 sec
i0=0;//A
vc=10;//V
fi=asin(i0);//degree
//L*di/dt=vc at t=0
Im=poly([0],'Im')
```

```
function i=current(t)
    i=Im*expm(-a*t)*sin(omega*t+fi)
endfunction
//i=Im*expm(-a*t)*sin(omega*t+fi)
LdiBYdt=L*numderivative(current,0)
temp = coeff(LdiBYdt)
Im=vc/temp(2)
printf("\n Expression for current :\n  i = %.3f*exp
   (-%dt)*sin(%.1ft)",Im,a,omega)
Rn=2*sqrt(L/C);//ohm
Rad=Rn-R;//ohm
printf("\n\n Additional resistance required = %d ohm
   ",Rad)
```

Scilab code Exa 1.16 Reading of electrostatic voltmeter

```
// Ex 16 Page 357

clc;clear;close;
// Given
//i=0.5+0.3*sin(omega*t)-0.2*sin(2*omega*t)
I0=0.5;I1m=0.3;I2m=-0.2;//from above expression
Iav=I0;//A
R=1000;//ohm
L=1/1000;//H

Irms=sqrt(I0**2+(I1m/sqrt(2)**2+(I2m/sqrt(2)**2)));
   //A
printf("Reading of hot wire instrument = %.3f A",
   Irms)
VR=Irms*R;//V
printf("\n Reading of electrostatic voltmeter across
    1000 ohm = %d V",VR)
//vl_dash=L*di/dt=300*cos(w*t)-400*cos(2*w*t)
vl1=300;vl2=4;//V
```

```
vl=sqrt((300/sqrt(2))**2+(400/sqrt(2))**2)
printf("\n Reading of electrostatic voltmeter across
    1 mH inductor = %d V",vl)
```

Scilab code Exa 1.17 Deflection

```
// Ex 17 Page 358

clc;clear;close;
// Given
R=80;//ohm
V=2;//V
l=50;//cm
vd=.1;//V
emf=1.43;//V
Rc=850;//ohm
sg=17.5;//mm/uA
df=1;//mm


I=R/V;//A
Rw=vd/I;//ohm (Resistance of side wire)
Id=df/sg*10**-6;//A (current for 1mm deflection)
el=1/sg*Rc;//uV
printf("The limit of error = %.1f uV",el)
Rw1=0.2/l*Rw;//ohm (for 2cm slide wire)
dV=I*Rw1*1000;//mV (Change in voltage from null
   point)
r1=emf/I;//ohm (tapped portion)
r2=r1*22.8/R;//ohm
Ig=dV/1000/(Rc+r2);//A
d=dV/1000/(Rc+r2)/Id;//mm
printf("\n Deflection  = %.1f mm",d)
```

Scilab code Exa 1.18 Power dissipated

```
// Ex 18 Page 359

clc;clear;close;
// Given
R=50;//ohm
Vrms=100;//V
Rd1=50;//ohm
Rd2=100;//ohm

Vm=Vrms/sqrt(2);//V
//v=Vm*sin(theta)
Rf=R+Rd1;//ohm
Rb=R+Rd2;//ohm
//i_f=v/Rf;//A
//i_b=v/Rb;//A
Irms=1/2/%pi*(integrate('(sqrt(2)*sin(theta))**2','
    theta',0,%pi)+integrate('(sqrt(2)/3*sin(theta))
    **2','theta',%pi,2*%pi))
Iav=1/2/%pi*(integrate('sqrt(2)*sin(theta)','theta'
    ,0,%pi)+integrate('sqrt(2)/3*sin(theta)','theta',
    %pi,2*%pi))
printf("reading of hot wire ammeter = %.2f A",Irms)
printf("\n reading of moving coil ammeter = %.2f A",
    Iav)
P=1/2*(Vrms**2/Rf+Vrms**2/Rb);//W
printf("\n\n Power taken from the mains = %.1f W",P)
Pc=Irms**2*R;//W
Pd=P-Pc;//W
printf("\n Power dissipated in rectifying device =
    %d W",Pd)
//Answer wrong in the textbook.
```

Scilab code Exa 1.19 `potential difference`

```
// Ex 19 Page 361

clc;clear;close;
// Given
d=1/100;//m
S=-1/100;//m
Ve=2;//kV
theta=30;//degree
e=1.6*10**-19;//C
m=9.67*10**-31;//kg

u=sqrt(2*e*Ve*1000/m);//m/s
uy=u*sind(theta);//m/s
vy=0;//since final velocity =0
//vy**2-uy**2=2*ay*S
ay=(vy**2-uy**2)/2/S;//m**2/s
//ay=e/m*V/d
V=ay*m*d/e;//V
printf("Required potential difference = %.f V",V)
```

Scilab code Exa 1.20 `Plate resistance`

```
// Ex 20 Page 361

clc;clear;close;
// Given
//Ia=0.0004*(Va+40*Vg)**(3/2);// mA --eqn(1)
Va=250;//V
Vg=-3;//V
//mu=delVa/delVg
```

```
//differentiation wrt Vg eqn(1)
//(4*10**-6*3/2*(Va+40*Vg))**(1/2)*(mu+40)=0
mu=-40;//constant
printf("Amplification factor, mu = %.f",mu)
//differentiation wrt Va eqn(1)
//delIa/delVa=(4*10**-6*3/2*(Va+40*Vg))**(1/2)*(0+40)
gm=(4*10**-6*3/2)*(Va+40*Vg)**(1/2)*(0+40)*1000;//mA/V or S
printf("\n Mutual conductance, gm = %.2f S",gm)
//differentiation wrt Ia eqn(1) keeping Vg constant
//1=(4*10**-6)*3/2*(Va+40*Vg)**(1/2)*(delVa/delIa+0)
//ra=delVa/delIa
ra=1/((4*10**-6)*3/2*(Va+40*Vg)**(1/2))
printf("\n Plate resistance, ra = %.1f kohm",ra/1000)
```

Scilab code Exa 1.21 `equation of FM wave`

```
// Ex 21 Page 363

clc;clear;close;
// Given
fc=25*10**6;//Hz
fm=400;//Hz
Vm=4;//V
del=10*10**3;//Hz
wc=2*%pi*fc;//rad/s
wm=2*%pi*fm;//rad/s
m=del/fm;//modulation index
mf=m;mp=m;//modulation index
printf("General equation of FM wave is:")
printf("\n v=%d*sin(%.2e*t+%d*sin(%d*t)",Vm,wc,mf,wm)
printf("\n\n General equation of PM wave is:")
```

```
printf("\n v=%d*sin(%.2e*t+%d*sin(%d*t)",Vm,wc,mp,wm)
// Changing modulating frequency
fm_new=2*10**3;//Hz
a=fm_new/fm;//increase in angular frequency
printf("\n\n Now equation of FM wave is:")
printf("\n v=%d*sin(%.2e*t+%d*sin(%d*t)",Vm,wc,mf,a*wm)
printf("\n\n Now equation of PM wave is:")
printf("\n v=%d*sin(%.2e*t+%d*sin(%d*t)",Vm,wc,mp,a*wm)
```

Scilab code Exa 1.22 carrier power and efficiency

```
// Ex 22 Page 363

clc;clear;close;
// Given
Ebb=300;//V
Ibb=20;//A
Emm=150;//V
Po=4.5*10**3;//W

m=Emm/Ebb;//modulation index
Pbb=Ebb*Ibb
eta=Po/Pbb*100;//%
P=Po*(1+m**2/2);//W
Pdo=Pbb-Po;//W
Pd=Pdo*(1+m**2/2);//W
printf("modulation index = %.1f",m)
printf("\n carrier power under modulated condition = %0.2f kW",P/1000)
printf("\n plate circuit efficiency = %.f percent",eta)
printf("\n plate dissipation under unmodulated
```

```
    condition = %.1f kW",Pdo/1000)
printf("\n plate dissipation under modulated
    condition = %.2f kW",Pd/1000)
```

Scilab code Exa 1.23 Series and Parallel equivalent circuit

```
// Ex 23 Page 364

clc;clear;close;
// Given
Zo=50;//ohm
VSWR=2;//ratio
//lm=0.2*lamda
lmBYlamda=0.2
betaINTOlamda=2*%pi
rho=(VSWR-1)/(VSWR+1);//reflection coefficient
theta=2*betaINTOlamda*lmBYlamda;//radian
//exp(j*theta)=cos(theta)+%i*sin(theta)
ZL=Zo*(1-rho*(cos(theta)+%i*sin(theta)))/(1+rho*(cos
    (theta)+%i*sin(theta)));//ohm
Rs=real(ZL);//ohm
Xs=abs(imag(ZL));//ohm(capacitive)
printf("Series equivalent circuit:")
printf("\n Rs = %0.1f ohm",Rs)
printf("\n Xs = %0.1f ohm",Xs)
YL=(1/ZL)*1000;//mS
Rp=1000/real(YL);//ohm
Xp=1000/imag(YL);//ohm
printf("\n\n Parallel equivalent circuit:")
printf("\n Rp = %0.1f ohm",Rp)
printf("\n Xp = %0.f ohm",Xp)
```

Scilab code Exa 1.24 Characteristic wave impedence

```
// Ex 24 Page 366

clc;clear;close;
// Given
b=3;//cm
a=4.5;//cm
f=9*10**9;//Hz
v=3*10**10;//cm/s
lamda=v/f;//cm

printf("\n For TE10 mode:")
m=1;// for TE10 mode
lamda_c = 2*a/m;//cm
rho=sqrt(1-(lamda/lamda_c)**2)
lamda_g=lamda/rho;//cm
vg=rho*v;//cm/s
vp=v/rho;//cm/s
ZTE=120*%pi/rho;//ohm

printf("\n cutoff wavelength = %.f cm",lamda_c)
printf("\n guide wavelength = %.2f cm",lamda_g)
printf("\n Group velocity = %.1e m/s",vg/100)
printf("\n Phase velocity = %.1e m/s",vp/100)
printf("\n Characteristic wave impedence = %.f ohm",
    ZTE)

printf("\n\n For TM11 mode:")
m=1;n=1// for TE10 mode
lamda_c = 2/sqrt((m/a)**2+(n/b)**2);//cm
rho=sqrt(1-(lamda/lamda_c)**2)
lamda_g=lamda/rho;//cm
vg=rho*v;//cm/s
vp=v/rho;//cm/s
ZTM=120*%pi*rho;//ohm
printf("\n cutoff wavelength = %.f cm",lamda_c)
printf("\n guide wavelength = %.2f cm",lamda_g)
printf("\n Group velocity = %.1e m/s",vg/100)
printf("\n Phase velocity = %.1e m/s",vp/100)
```

```
printf("\n Characteristic wave impedence = %.f ohm",
    ZTM)
```

Scilab code Exa 1.25 capacitance ratio

```
// Ex 25 Page 367

clc;clear;close;
// Given
fs_max=1600;//kHz
fs_min=500;//kHz
IF=465;//kHz

fr=fs_max/fs_min;//ratio
C_ratio = fr**2;//Cs_max/Cs_min
//Part (a)
fo_min=IF+fs_min;//kHz
fo_max=IF+fs_max;//kHz
fr_o=fo_max/fo_min;//frequency ratio for oscillator
C_ratio_o = fr_o**2;//Cs_max/Cs_min
printf("part(a):")
printf("\n For fo>fs, the range of fo : %.f to %.f
    kHz",fo_min,fo_max)
printf("\n frequency ratio = %.2f",fr_o)
printf("\n capacitance ratio = %.2f",C_ratio_o)

//Part (b)
fo_min=-IF+fs_min;//kHz
fo_max=-IF+fs_max;//kHz
fr_o=fo_max/fo_min;//frequency ratio for oscillator
C_ratio_o = fr_o**2;//Cs_max/Cs_min
printf("\n\n part(b):")
printf("\n For fo>fs, the range of fo : %.f to %.f
    kHz",fo_min,fo_max)
printf("\n frequency ratio = %.1f",fr_o)
```

```
printf("\n capacitance ratio = %.1f",C_ratio_o)
//ans wrong for part b in the book.
```

Scilab code Exa 1.26 `Resistor values`

```
// Ex 26 Page 368

clc;clear;close;
// Given
Ic=3;//mA
hfe=45;//unitless
Vcc=12;//V
VBE=0.5;//V
S=0.05;//stability factor
Beta=45;//unitless

RR=Vcc/2/(Ic*10**-3);//ohm (let RL+Re=RR)
//Re=20% of (Re+Rl)
Re=RR*20/100;//ohm
RL=RR-Re;//ohm
Ve=(Ic+Ic/Beta)*10**-3*Re;//V
Vb=Ve+VBE;//V
//S=Re/Rb=0.5 => Rb=Re/S
R1=Vcc*Re/S/Vb/1000;//kohm
// Vb/Vcc = R2/(R2+R1)
R2=Vb*R1/(Vcc-Vb);//kohm
printf("Resistor values are : ")
printf("\n RL=%.2f kohm",RL/1000)
printf("\n Re=%.2f kohm",Re/1000)
printf("\n R1=%.2f kohm",R1)
printf("\n R2=%.2f kohm",R2)
```

Scilab code Exa 1.27 `conversion efficiency`

```
// Ex 27 Page 369

clc;clear;close;
// Given
Vcc=50;//V
Vmin=10;//V
Pd=40;//W


Vo=Vcc-Vmin;//V
K=Vo/Vcc;//constant
Rdash=2*Vcc**2/%pi/Pd*(K-%pi*K**2/4);//ohm
Po=K**2*Vcc**2/2/Rdash;//W
eta=%pi*K/4*100;//%

printf("load presented by transformer = %.1f ohm",
   Rdash)
printf("\n load power output = %.1f W",Po)
printf("\n conversion efficiency = %.1f percent",eta
   )
```

Scilab code Exa 1.28 Cyrrent and Voltage gain

```
// Ex 28 Page 370

clc;clear;close;
// Given
Rs=1000;//ohm
Rc1=2*1000;//ohm
Re2=2*1000;//ohm
//CE configuration
hie=1100;//ohm
hre=2.5*10**-4;
hfe=50;
hoe=25*10**-6;//s
```

```
//CC configuration
hic=1.1;//kohm
hrc=1;
hfc=-51;
hoc=25*10**-6;//s

printf("for 2nd stage(CC stage)")
AI2=-hfc/(1+hoe*Re2);//current gain
Ri2=hic+hrc*AI2*Re2;//kohm
Av2=AI2*Re2/Ri2;//Voltage Gain
printf("\n current gain = %0.2f",AI2)
printf("\n Input impedence = %0.2f kohm",Ri2/1000)
printf("\n Voltage gain = %0.2f",Av2)

printf("\n\n for 1st stage(CE stage)")
RL1=Rc1*Ri2/(Rc1+Ri2);//kohm
AI1=-hfe/(1+hoe*RL1);//current gain
printf("\n current gain = %.2f",AI1)
Ri1=hie+hre*AI1*RL1;//kohm
printf("\n Input impedence = %0.2f kohm",Ri1/1000)
Av1=AI1*RL1/Ri1;//Voltage gain
printf("\n Voltage gain = %0.2f",Av1)
Ro1=1/(hoe-hfe*hre/(hie+100));//ohm
printf("\n Output impedence = %.2f kohm",Ro1/1000)
Ro1dash=Ro1*Rc1/(Ro1+Rc1);///ohm
printf("\n Output impedence taking Rc1 into account = %.2f kohm",Ro1dash/1000)

printf("\n\n for overall amplifier")
Ro=1/(hoc*100-hfc*hrc/(hic+Ro1dash));//ohm
printf("\n Output impedence = %.2f ohm",Ro)
Rodash=Ro*Re2*1000/(Ro1+Re2*1000);///ohm
printf("\n Output impedence taking Re2 into account = %.2f ohm",Rodash)
AI=AI1*AI2*Rc1/(Ri2+Rc1);// current gain
printf("\n current gain = %.2f",AI)
Av=Av1*Av2;//voltage gain
printf("\n Voltage gain = %.2f",Av)
```

```
//answer is wrong for overall amplifier in the book.
```

Scilab code Exa 1.29 Current gain BW product

```
// Ex 29 Page 372

clc;clear;close;
// Given
fT=6*10**6;//Hz
hfe=50;
Rs=500;//ohm
gm=0.04;//S
rbb_dash=100;//ohm
Cc=10*10**-12;//F
RL=1;//kohm

rbe=hfe/gm;//ohm
Ce=gm/2/%pi/fT;//F
C=Ce+Cc*(1+gm*RL);//F
hie=rbb_dash+rbe;//ohm
R=(Rs+rbb_dash)*rbe/((Rs+rbb_dash)+rbe);//ohm
f2=1/2/%pi/R/C;//Hz
printf("Voltage gain upper BW frequency = %.2f MHz",
    f2/10**6)
AIS=-hfe*Rs/(Rs+hie);//current gain
printf("\n Current gain = %.2f",AIS)
AVS=-hfe*RL*1000/(Rs+hie);//voltage gain
printf("\n Voltage gain = %.2f",AVS)
AVSf2=AVS*f2;//Hz
printf("\n Voltage gain BW product = %.2f MHz",abs(
    AVSf2/10**6))
AISf2=AIS*f2;//Hz
printf("\n Current gain BW product = %.2f MHz",abs(
    AISf2/10**6))

```

```
//answer in the textbook are wrong.
```

Scilab code Exa 1.30 `Vgs and gm`

```
// Ex 30 Page 373

clc;clear;close;
// Given
VP=-2;//V
IDSS=1.75/1000;//A
VDD=24;//V
ID=1/1000;//A
VP=0.2;//V (pinch off voltage)

VGS=(1-sqrt(ID/IDSS))*VP;//V
gmo=-2*IDSS/VP;//S
gm=gmo*(1-VGS/VP);//S
Rs=-VGS/ID;//ohm

printf("VGS=%.2f V",VGS)
printf("\n gm = %.2f mS",gm*1000)
printf("\n Rs = %.f ohm",Rs)
//Ans are wrong in the book.
```

Scilab code Exa 1.31 `Bandwidth of redesigned amplifier`

```
// Ex 31 Page 374

clc;clear;close;
// Given
G=37;//dB
f1=50;//Hz
f2=18.7*1000;//Hz
```

```
BW1=f2;//Hz (f2-f1~=f2)


A1=10**(G/20);//Gain
A3=sqrt(A1);//Gain
RL1BYRL2=A1/A3;//ratio
RL2BYRL1=A3/A1;//ratio
//BW=2*%pi*Cd*RL
BW1BYBW2=RL2BYRL1;
BW2BYBW1=RL1BYRL2;
f2dash=f2*sqrt(sqrt(2)-1);
BW2=BW2BYBW1*f2dash;//Hz
printf("Bandwidth of redesigned amplifier, BW=%.f
    kHz",BW2/1000)
```

Scilab code Exa 1.32 Critical inductance

```
// Ex 32 Page 375

clc;clear;close;
// Given
L=30;//H
C=10*10**-6;//F
RL=8*10**3;//ohm
f=50;//Hz

r=sqrt(2)/12/(2*%pi*f)**2/L/C*100;//%
Lc=2*RL/6/(2*%pi*f);//H
printf("ripple factor = %.1f percent",r)
printf("\n Critical inductance, Lc=%.1f H",Lc)
```

Scilab code Exa 1.33 Current in each armature

```
// Ex 33 Page 376

clc;clear;close;
// Given
V=500;//V
Pp=1500*10**3;//W (+ve side)
Pn=2000*10**3;//W (-ve side)

P=Pp+Pn;//W
I=P/V;//A
Ip=Pp/(V/2);//A
In=Pn/(V/2);//A
Iob=In-Ip;//A
Ia=Iob/2;//A
printf("Current supplied by the main generator = %.f
    A",I)
printf("\n Current supplied on +ve side = %.f A",Ip)
printf("\n Current supplied on -ve side = %.f A",In)
printf("\n out-off balance Current = %.f A",Iob)
printf("\n Current in each armature = %.f A",Ia)
```

Scilab code Exa 1.34 Efficiency and regulation

```
// Ex 34 Page 377

clc;clear;close;
// Given
l=20;//km
P=10000;//kW
V=11;//kV
pf=0.707;//lagging
R=0.02;//ohm/km/phase
X=0.07;//ohm/km/phase

//for pf = 0.707
```

```
IL=P*10**3/sqrt(3)/(V*1000)/pf;//A
VRphase=V*1000/sqrt(3);//V
R_phase=l*R;//ohm
X_phase=l*X;//ohm
Z_phase=R_phase+%i*X_phase;//ohm
Vd_phase=IL*(pf-%i*pf)*Z_phase;//V
VS=(Vd_phase+VRphase);//V
regulation=(VS-VRphase)/VRphase*100;//%
printf("regulation = %.f percent",regulation)
PL=3*IL^2*R_phase/1000;//kW
Po=P+PL;//kW
eta=P/Po*100;//%
printf("\n Efficiency = %.f percent",eta)

//for pf2=0.9;//lagging
pf=0.9;//lagging
IL=P*10**3/sqrt(3)/(V*1000)/pf;//A
VRphase=V*1000/sqrt(3);//V
R_phase=l*R;//ohm
X_phase=l*X;//ohm
Z_phase=R_phase+%i*X_phase;//ohm
Vd_phase=IL*(pf-%i*.435)*Z_phase;//V
VS=(Vd_phase+VRphase);//V
regulation=(VS-VRphase)/VRphase*100;//%
printf("\n\n regulation = %.1f percent",regulation)
PL=3*IL^2*R_phase/1000;//kW
Po=P+PL;//kW
eta=P/Po*100;//%
printf("\n Efficiency = %.f percent",eta)
//ans wrong for 2nd part in the book.
```

Scilab code Exa 1.35 load factor

```
// Ex 35 Page 378
```

```

clc;clear;close;
// Given
C1=1.2;//Rs
C2=5;//Rs
P1=100;//W
P2=30;//W
t=1000;//hours
Ce=60;//Rs/kW/annum for max demand
Cee=3 ;//paise/unit for extra

//first lamp
Cl1=C1*100/t;// paise / hour
dmax1=P1/1000;//kW/hour
Cmax1=Ce*100*dmax1/(24*365);//paise/hour
CE1=Cee*dmax1;///paise / hour
CT1=Cl1+Cmax1+CE1;//paise (total cost per hour)
printf("lamp1 : Total cost/hour = %.3f paise",CT1)
//second lamp
Cl2=C2*100/t;// paise / hour
dmax2=P2/1000;//kW/hour
Cmax2=Ce*100*dmax2/(24*365);//paise/hour
CE2=Cee*dmax2;///paise / hour
CT2=Cl2+Cmax2+CE2;//paise (total cost per hour)
printf("\n lamp2 : Total cost/hour = %.2f paise",CT2)
printf("\n on comparing cost it is clear lamp1 will be more economical. ")
//let load factor = x
//Cl1+Cmax1/x+CE1=Cl2+Cmax2/x+CE2
x=(Cmax1-Cmax2)/(Cl2+CE2-Cl1-CE1)*100;// % load factor
printf("\n\n load factor = %.f percent",x)
```

Scilab code Exa 1.36 `shunt field turns`

```
// Ex 36 Page 379

clc;clear;close;
// Given
p=4;//pole
I1=143;//A
Z=492;//armature conductors
theta=10;//degree
I2=10;//A

Ia=I1+I2;//A
Iw=Ia/2;//A for wave sound
Il=Ia/4;//for lap sound
//part(a)
ATw=Z*Iw*theta/360;//AT
nw=ATw/theta;//turns
printf("(a) extra shunt field turns required = %d",
    nw)

//part(b)
ATl=Z*Il*theta/360;//AT
nl=ATl/theta;//turns
printf("\n (b) extra shunt field turns required = %d
    ",nl)
//answer wrong for part(a) in the book.
```

Scilab code Exa 1.37 New speed

```
// Ex 37 Page 380

clc;clear;close;
// Given
Wh=250;//W
We=100;//W
N=1000/60;//rps
```

```
A=Wh/N;//constant
B=We/N**2;//constant
Wnew=1/2*(Wh+We);//W
//Wnew=A*N1+B*N1**2
p=[B,A,-Wnew];//polynomial for N1
N1=roots(p);//rps
N1=N1(2)*60;//rpm//discarding -ve value
printf("New speed will be %.f rpm",N1)
```

Scilab code Exa 1.38 Speed of the machine

```
// Ex 38 Page 381

clc;clear;close;
// Given
P=50;//kW
V=250//V
N1=400;//rpm
Ra=0.02;//ohm
Rf=50;//ohm
Pi=50;//kW
Vin=250;//V
Vd=1;//V per Brush

I=P*10**3/V//A
Ish=V/Rf;//A
Ia=I+Ish;//A
Va=Ia*Ra;//V
Vbd=2*Vd;//V
Eb1=V+Va+Vbd;//V


//as motor
I=P*10**3/V//A
```

```
Ish=V/Rf;//A
Ia=I-Ish;//A

Va=Ia*Ra;//V
Vbd=2*Vd;//V
Eb2=V-Va-Vbd;//V
N2=(Eb2/Eb1)*N1;//rpm
printf("Speed of the machine running as shunt motor
   = %.f rpm",N2)
```

Scilab code Exa 1.39 Generator efficiency

```
// Ex 39 Page 383

clc;clear;close;
// Given
VL=250;//V
Is=50;//A
Ia=380;//A
If1=5;//A
If2=4.2;//A
ra=0.02;//ohm

//Machine Losses:
ma_cu_loss=Ia**2*ra;//W (motor armature cu loss)
ga_cu_loss=(Ia-Is)**2*ra;//W (generator armature cu
   loss)
P=VL*Is;//W
stray_loss=P-ma_cu_loss-ga_cu_loss;//W
stray_loss_per_machine=stray_loss/2;//W

//Motor efficiency
field_cu_loss=VL*If2;//W
total_loss=ma_cu_loss+field_cu_loss+
   stray_loss_per_machine;//W
```

```
Pin_motor=(VL*Ia)+(VL*ra);//W
Pout_motor=Pin_motor-total_loss;//W
Eff=Pout_motor/Pin_motor*100;//%
printf("Motor efficiency = %.f percent",Eff)


//Generator efficiency
field_cu_loss=VL*If1;//W
total_loss=ga_cu_loss+field_cu_loss+
    stray_loss_per_machine;//W
Pout_generator=VL*(Ia-Is);//W
Pin_generator=Pout_generator+total_loss;//W
Eff=Pout_motor/Pin_motor*100;//%
printf("\n Generator efficiency = %.f percent",Eff)
```

Scilab code Exa 1.40 Voltage drop

```
// Ex 40 Page 384

clc;clear;close;
// Given
KVA=4;//kVA
V1=200//V
V2=400//V
f=50;//Hz
Io1=0.8;//A
P1=70;//W
Vs2=17.5;//V
Is2=9;//A
P2=50;//W

//full load
I_loss=P1;//W
I2=KVA*1000/V2;//A
Cu_loss=(I2/Is2)**2*P2;//W
```

```
Zo2=Vs2/Is2;//ohm
Ro2=P2/Is2**2;//ohm
Xo2=sqrt(Zo2**2-Ro2**2);//ohm

//(a)
printf("Full load efficiency : ")
//unity pf
pf=1;//power factor
Output=KVA*pf;//kW
Losses=Cu_loss+I_loss;//W
eta=Output*1000/(Output*1000+Losses)*100;//%
printf("\n at unity power factor = %.1f percent",eta)
//0.8 pf
pf=0.8;//power factor
Output=KVA*pf;//kW
eta=Output*1000/(Output*1000+Losses)*100;//%
printf("\n at 0.8 power factor = %.1f percent",eta)

//(b)
//(i) unity pf
Vd=I2*Ro2;//V
V22=V2-Vd;//V
printf("\n\n Voltage drop at unity pf = %.1f V",V22)
//(i) 0.8 pf lagging
pf=0.8;//power factor
Vd=I2*(Ro2*pf+Xo2*sqrt(1-pf**2));//V
V22=V2-Vd;//V
printf("\n Voltage drop at 0.8 pf lagging = %.1f V",V22)
//(i) 0.8 pf leading
pf=0.8;//power factor
Vd=I2*(Ro2*pf-Xo2*sqrt(1-pf**2));//V
V22=V2-Vd;//V
printf("\n Voltage drop at 0.8 pf leading = %.f V",V22)
```

Scilab code Exa 1.41 `All day efficiency`

```
// Ex 41 Page 385

clc;clear;close;
// Given
KVA=15;//kVA
pf=1;
eff=98/100;//efficiency

L1=2;//kW
pf1=0.5;//lagging
t1=12;//hours
L2=12;//kW
pf2=0.8;//lagging
t2=6;//hours
L3=18;//kW
pf3=0.9;//lagging
t3=6;//hours

Po=KVA*pf;//kW
Pin=Po/eff;//kW
Losses=Pin-Po;//kW
Cu_loss=Losses/2;//kW
I_loss=Losses/2;//kW

KVA1=L1/pf1;//kVA
KVA2=L2/pf2;//kVA
KVA3=L3/pf3;//kVA
Cu_loss1=Cu_loss*(KVA1/KVA2)**2;//kW
Cu_loss2=Cu_loss*(KVA2/KVA2)**2;//kW
Cu_loss3=Cu_loss*(KVA3/KVA2)**2;//kW

Cu_loss_t1=Cu_loss1*t1;//kW
```

```
Cu_loss_t2=Cu_loss2*t2;//kW
Cu_loss_t3=Cu_loss3*t3;//kW
Cu_loss_total=Cu_loss_t1+Cu_loss_t2+Cu_loss_t3;//kW
I_loss24=I_loss*24;//Wh

Po24=L1*t1+L2*t2+L3*t3;//kWh
Pi24=Po24+Cu_loss_total+I_loss24;//kWh
eff_allday=Po24/Pi24*100;//%
printf("All day efficiency = %.f percent",eff_allday
    )
```

Scilab code Exa 1.42 Current drawn by the transformer

```
// Ex 42 Page 386

clc;clear;close;
// Given
V1=250;//V
V2=150;//V
Vs1=200;//V
Load1=5;//kW
pf1=0.8;//lagging
Load2=2;//kW
pf2=1;//unity
Vs2=100;//V

I1=Load1*1000/V1/pf1;//A
t1_ratio=V1/Vs1;//
Ip1=I1*t1_ratio;//A at 0.8 pf (current drawn by
    primary)

I2=Load2*1000/Vs2/pf2;//A
t2_ratio=Vs2/V2;//
Ip2=I2*t2_ratio;//A at 0.8 pf (current drawn by
    primary)
```

```

Ipx=Ip1*pf1+Ip2;//A
Ipy=Ip1*sqrt(1-pf1**2);//A
I3=sqrt(Ipx**2+Ipy**2);//A
printf("Current drawn by the transformer=%.2f A",I3)
pf=Ipx/I3;//power factor
printf("\n power factor = %.1f lagging",pf)
```

Scilab code Exa 1.43 Percentage reduction in stator voltage

```
// Ex 43 Page 387

clc;clear;close;
// Given
R2=0.03;//ohm
X2=0.18;//ohm
Ns=100;//rpm
s1=3;//%


Nfl=(100-s1);//rpm (full load speed)
N2=Nfl/2;//rpm
s2=(Ns-N2)/Ns*100;//%
V1BYV2=sqrt(s2/s1*(R2**2+(s1/100*X2)**2)/(R2**2+(s2/100*X2)**2));//from torque equation
//let V1=V12BYV1 V2=1
V1=V1BYV2;//V
V2=1;//V
V12BYV1=(V1-1)/V1*100;// % reduction in the stator (V12=V1-V2)
printf("Percentage reduction in stator voltage = %.f percent",V12BYV1)
fi=atan(s2/100*X2/R2);//radian
pf=cos(fi);//power factor
printf("\n power factor = %.1f",pf)
```

Scilab code Exa 1.44 Torque ratio

```
// Ex 44 Page 388

clc;clear;close;
// Given
zo=1+%i*1;//ohm
zi=0.2+%i*4;//ohm
Ri=real(zi) ;//ohm
Ro=real(zo) ;//ohm

//at standstill
s=1;//% at standstill
Zo=sqrt(real(zo)**2+imag(zo)**2);//ohm
Zi=sqrt(real(zi)**2+imag(zi)**2);//ohm
ToBYTi=Ro/Ri*(Zi/Zo)**2;//torque ratio
printf("(a) at standstill , To:Ti = %d:1",ToBYTi)

//at s=0.5
s=0.05;//%
Zo=sqrt(real(zo)**2/s**2+imag(zo)**2);//ohm
Zi=sqrt(real(zi)**2/s**2+imag(zi)**2);//ohm
ToBYTi=Ro/Ri*(Zi/Zo)**2;//torque ratio
printf("\n (b) at s=0.05, To:Ti = %.1f:1",ToBYTi)
```

Scilab code Exa 1.45 cross section of windings

```
// Ex 45 Page 389

clc;clear;close;
// Given
```

```
Edc=500; //V
fim=.085; //Wb
f=50; //Hz
E1=11000; //V
P=1500; //kW
p=8; //pole
pf=0.9
V=500; //V
J=3; //A/mm^2

E2=Edc/sqrt(2) //V
N2=E2/4.44/f/fim; //no. of turns
N1=E1/E2*N2; //no. of turns
printf("no. of turns in primary = %d",N1)
printf("\n no. of turns in secondary = %d",N2)
Idc=P*10**3/V; //A
eta=1; //because of no loss
ISR=0.472*Idc/(eta*pf)
A1=ISR/J*10**-6; //m^2 (cross section area)
I1=N2/N1*ISR; //A
A2=I1/J*10**-6; //m**2 (cross section area of primary
    winding)
printf("\n\n cross section of primary winding=%.2e m
    ^2",A1)
printf("\n cross section of secondary winding=%.1e m
    ^2",A2)
//ans in the book are not accurate.
```

Scilab code Exa 1.46 Starting torque

```
// Ex 46 Page 391

clc;clear;close;
// Given
IscBYIfl=5; // as Isc=5*Ifl
```

```
ILByIfl=3;// as IL <= 3*Ifl
sf=5;//%

//IL=K**2*ISC
//dividing by Ifl
K=sqrt(ILByIfl/IscBYIfl)*100;//%
TstBYTf=(K/100)**2*IscBYIfl*sf/100*100;// % //ratio of torque
printf("Suitable auto transformation ratio = %.1f",K)
printf("\n Starting torque Tst = %.f percent of full-load torque",TstBYTf)
//ans wrong in the textbook.
```

Scilab code Exa 1.47 Resistance of all section

```
// Ex 47 Page 391

clc;clear;close;
// Given
V=500;//V
ns=60;//slots
nc=20;//conductor/slot
ra=1.31;//ohm
Tmax=218;//N-m
fi=23*10**-3;//Wb

Tmin=Tmax/1.5//N-m
Z=ns*nc;//no of conductors
Ia=Tmax/(.159*fi*Z);//A
Imax=1.5*Ia;//A
I1=Imax;//A
I2=Ia;//A
R1=V/I1;//ohm
n= log(R1/ra)/log(I1/I2)+1;//no of studs
```

```
N=n-1;//no of section
printf("no of studs = %d and no. of section = %d",n,N)
R2=R1*(I2/I1);//ohm
R3=R2*(I2/I1);//ohm
R4=R3*(I2/I1);//ohm
R1s=R1-R2;//ohm
R2s=R2-R3;//ohm
R3s=R3-R4;//ohm
R4s=R4-ra;//ohm
printf("\n\n Resistance of 1st section = %.2f ohm",R1s)
printf("\n Resistance of 2nd section = %.2f ohm",R2s)
printf("\n Resistance of 3rd section = %.2f ohm",R3s)
printf("\n Resistance of 4th section = %.2f ohm",R4s)
```

Scilab code Exa 1.48 temperature rise

```
// Ex 48 Page 393

clc;clear;close;
// Given
theta1=20;//degree C
theta2=35;//degree C
t1=0.5;//hour
t2=1;//hour
theta_m_dashBYthetam=80/100;//temperature rise

//theta=theta_m*(1-e**(-t/alfa))
//theta1/theta2=(1-%e**(-t1/alfa))/(1-%e**(-t2/alfa))
ee1=theta2/theta1-1;//let ee1=exp(-1/2/alfa)
```

```
theta_m=theta1/(1-ee1);//degree C
theta_2=theta_m*(1-ee1**4);// degree C (after 2
    hours)
printf("temperature rise after 2 hours full load = %
    .f degree C",theta_2)
alfa=-1/2/log(ee1);//hour
alfa_dash=theta_m_dashBYthetam*alfa;//hour
theta_m_dash=theta_m_dashBYthetam*theta_m
theta_dash=theta_m_dash*(1-%e**(-t2/alfa))
printf("\n temperature rise of cold water after 1
    hour = %.f degree C",theta_dash)
//ans of 2nd part is wrong in the book.
```

Scilab code Exa 1.49 Regulation at full load voltage

```
// Ex 49 Page 394

clc;clear;close;
// Given
u=30;//degree
m=3;//no of phases

//Id=sqrt(2)*Vs*X*(1-cosd(u))*sin(%pi/m)
IdBYVs_dash=m/2/%pi*(1-cosd(u))*sin(%pi/m)*sqrt(2);
    //load current/Vs
//where IdBYVs_dash = m/%pi*IdX/2
EdoBYVs=sqrt(2)*m/%pi*sin(%pi/m);//dc output voltage
    /Vs with no overlap
EduBYVs=EdoBYVs-IdBYVs_dash;//dc output voltage/Vs
    with overlap
//part (a)
Reg1=(EdoBYVs-EduBYVs)/EdoBYVs*100;//% (regulation)
printf("Regulation at no load voltage = %.1f percent
    ",Reg1)
//part (b)
```

```
Reg2=(EdoBYVs-EduBYVs)/EduBYVs*100;//% (regulation)
printf("\n Regulation at full load voltage = %.1f
   percent",Reg2)
```

Scilab code Exa 1.50 Power output

```
// Ex 50 Page 395

clc;clear;close;
// Given
I12=2000;//A (I12=I1+I2)
R1=0.04;//ohm
R2=0.025;//ohm
rf1=25;//ohm
rf2=20;//ohm
E1=440;//V
E2=420;//V

//E-Vad=V where Vad=I1+V/rf1
//V*(1+R1/rf1)+R1*I1=E1//eqn(1)
//V*(1+R2/rf2)-I1*R2=E2-I12*R2// eqn(2)
A=[(1+R1/rf1),R1;(1+R2/rf2),-R2]; // matrix for
   solution
B=[E1;E2-I12*R2];//matrix for solution
X=A**-1*B;//solution
V=X(1);//V
I1=X(2);//A
I2=I12-I1;//A
printf("Current for each machine = %.f A & %.f A ",
   I1,I2)
Po1=V*I1;//W
Po2=V*I2;//W
printf("\n Power output for each machine = %.1f kW &
   %.1f kW",Po1/1000,Po2/1000)
//ans in the book are wrong.
```

Scilab code Exa 1.51 power output

```
// Ex 51 Page 396

clc;clear;close;
// Given
ZA=0.15+0.5*%i;//ohm
ZB=0.1+0.6*%i;//ohm
EA=207;//V
EB=205;//V
ZL=2+1.5*%i;//ohm

IA=(EA*ZB+(EA-EB)*ZL)/(ZA*ZB+ZL*(ZA+ZB));//A
IB=(EB*ZA-(EA-EB)*ZL)/(ZA*ZB+ZL*(ZA+ZB));//A
V2=(IA+IB)*ZL;//V
fi_A=atand(imag(V2)/real(V2))-(atand(imag(IA)/real(
    IA)))
pf_A=cosd(fi_A);//lag
printf("pf transformer A = %.2f lag",pf_A)
fi_B=atand(imag(V2)/real(V2))-(atand(imag(IB)/real(
    IB)))
pf_B=cosd(fi_B);//lag
printf("\n pf transformer B = %.2f lag",pf_B)
PA=abs(V2*IA*pf_A);//W
printf("\n power output transformer A = %.f W",PA)
PB=abs(V2*IB*pf_B);//W
printf("\n power output transformer B = %.f W",PB)
//Power output ans are wrong in the book.
```

Scilab code Exa 1.52 filament diameter

```
// Ex 52 Page 397

clc;clear;close;
// Given
d1=0.05*10**-3;//mm
l1=100*10**-2;//m
i2BYi1=1/4;//current ratio
//(d2/d1)**(3/2)=i2BYi1
d2=(i2BYi1)**(2/3)*d1*10**6;//um
l2=1/2*l1*d1/d2*10**6;//m
printf("filament length = %.2f m",l2)
printf("\n filament diameter = %.f um",d2)
```

Scilab code Exa 1.53 `filament diameter`

```
// Ex 53 Page 398

clc;clear;close;
// Given
d1=0.10*10**-3;//mm
l1=150*10**-2;//m
i2BYi1=1/3;//current ratio
//(d2/d1)**(3/2)=i2BYi1
d2=(i2BYi1)**(2/3)*d1*10**6;//um
l2=1/2*l1*d1/d2*10**6;//m
printf("filament length = %.1f m",l2)
printf("\n filament diameter = %.f um",d2)
```

Scilab code Exa 1.54 `Torque ratio`

```
// Ex 54 Page 398

clc;clear;close;
```

```
// Given
zo=2+%i*2;//ohm
zi=0.5+%i*4;//ohm
Ri=real(zi) ;//ohm
Ro=real(zo) ;//ohm

//at standstill
s=1;//% at standstill
Zo=sqrt(real(zo)**2+imag(zo)**2);//ohm
Zi=sqrt(real(zi)**2+imag(zi)**2);//ohm
ToBYTi=Ro/Ri*(Zi/Zo)**2;//torque ratio
printf("(a) at standstill , To:Ti = %d:1",ToBYTi)

//at s=0.5
s=0.05;//%
Zo=sqrt(real(zo)**2/s**2+imag(zo)**2);//ohm
Zi=sqrt(real(zi)**2/s**2+imag(zi)**2);//ohm
ToBYTi=Ro/Ri*(Zi/Zo)**2;//torque ratio
printf("\n (b) at s=0.05, To:Ti = %.f:10",ToBYTi*10)
```

Scilab code Exa 1.55 cross section of primary winding

```
// Ex 55 Page 400

clc;clear;close;
// Given
Edc=250;//V
fim=.065;//Wb
f=50;//Hz
E1=6000;//V
P=1500;//kW
p=8;//pole
pf=0.9
V=400;//V
J=3;//A/mm^2
```

```
E2=Edc/sqrt(2)//V
N2=E2/4.44/f/fim;//no. of turns
N1=E1/E2*N2;//no. of turns
printf("no. of turns in primary = %d",N1)
printf("\n no. of turns in secondary = %d",N2)
Idc=P*10**3/V;//A
eta=1;//because of no loss
ISR=0.472*Idc/(eta*pf)
A1=ISR/J*10**-6;//m^2 (cross section area)
I1=N2/N1*ISR;//A
A2=I1/J*10**-6;//m**2 (cross section area of primary
    winding)
printf("\n\n cross section of primary winding=%.2e m
    ^2",A1)
printf("\n cross section of secondary winding=%.1e m
    ^2",A2)
```

Scilab code Exa 1.56 auto transformation ratio

```
// Ex 56 Page 400

clc;clear;close;
// Given
IscBYIfl=4;// as Isc=5*Ifl
ILByIfl=3;// as IL <= 3*Ifl
sf=4;//%

//IL=K**2*ISC
//dividing by Ifl
K=sqrt(ILByIfl/IscBYIfl)*100;//%
TstBYTf=(K/100)**2*IscBYIfl*sf/100*100;// % //ratio
    of torque
printf("Suitable auto transformation ratio = %.1f",K
    )
```

```
printf("\n Starting torque Tst = %.f percent of full-load torque",TstBYTf)
```

Scilab code Exa 1.57 `temperature rise`

```
// Ex 57 Page 401

clc;clear;close;
// Given
theta1=30;//degree C
theta2=45;//degree C
t1=0.5;//hour
t2=1;//hour
theta_m_dashBYthetam=60/100;//temperature rise

//theta=theta_m*(1-e**(-t/alfa))
//theta1/theta2=(1-%e**(-t1/alfa))/(1-%e**(-t2/alfa))
ee1=theta2/theta1-1;//let ee1=exp(-1/2/alfa)
theta_m=theta1/(1-ee1);//degree C
theta_2=theta_m*(1-ee1**4);// degree C (after 2 hours)
printf("temperature rise after 2 hours full load = %.f degree C",theta_2)
alfa=-1/2/log(ee1);//hour
alfa_dash=theta_m_dashBYthetam*alfa;//hour
theta_m_dash=theta_m_dashBYthetam*theta_m
theta_dash=theta_m_dash*(1-%e**(-t2/alfa))
printf("\n temperature rise of cold water after 1 hour = %.f degree C",theta_dash)
```

Scilab code Exa 1.58 `Torque ratio`

```
// Ex 58 Page 401

clc;clear;close;
// Given
zo=2+%i*3;//ohm
zi=0.5+%i*5;//ohm
Ri=real(zi) ;//ohm
Ro=real(zo) ;//ohm

//at standstill
s=1;//% at standstill
Zo=sqrt(real(zo)**2+imag(zo)**2);//ohm
Zi=sqrt(real(zi)**2+imag(zi)**2);//ohm
ToBYTi=Ro/Ri*(Zi/Zo)**2;//torque ratio
printf("at slip=0, To:Ti = %d:1",ToBYTi)

//at s=0.5
s=0.05;//%
Zo=sqrt(real(zo)**2/s**2+imag(zo)**2);//ohm
Zi=sqrt(real(zi)**2/s**2+imag(zi)**2);//ohm
ToBYTi=Ro/Ri*(Zi/Zo)**2;//torque ratio
printf("\n at s=0.05, To:Ti = %.f:10",ToBYTi*10)
```

Scilab code Exa 1.59 Regulation

```
// Ex 59 Page 402

clc;clear;close;
// Given
u=45;//degree
m=3;//no of phases

//Id=sqrt(2)*Vs*X*(1-cosd(u))*sin(%pi/m)
IdBYVs_dash=m/2/%pi*(1-cosd(u))*sin(%pi/m)*sqrt(2);
    //load current/Vs
```

```
//where IdBYVs_dash = m/%pi*IdX/2
EdoBYVs=sqrt(2)*m/%pi*sin(%pi/m);//dc output voltage/Vs with no overlap
EduBYVs=EdoBYVs-IdBYVs_dash;//dc output voltage/Vs with overlap
//part (a)
Reg1=(EdoBYVs-EduBYVs)/EdoBYVs*100;//% (regulation)
printf("part(a) Regulation at no load voltage = %.f percent",Reg1)
//part (b)
Reg2=(EdoBYVs-EduBYVs)/EduBYVs*100;//% (regulation)
printf("\n part(b) Regulation at full load voltage = %.f percent",Reg2)
```

Scilab code Exa 1.60 `diameter of filament`

```
// Ex 60 Page 402

clc;clear;close;
// Given
d1=0.15*10**-3;//mm
l1=150*10**-2;//m
i2BYi1=1/4;//current ratio
//(d2/d1)**(3/2)=i2BYi1
d2=(i2BYi1)**(2/3)*d1*10**6;//um
l2=1/2*l1*d1/d2*10**6;//m
printf("length of filament = %.2f m",l2)
printf("\n diameter of filament = %.f um",d2)
```

Scilab code Exa 1.61 `Potential difference`

```
// Ex 61 Page 403

```

```
clc;clear;close;
// Given
d=5/100; //m
S=-4/100; //m
Ve=3; //kV
theta=45; //degree
e=1.6*10**-19; //C
m=9.67*10**-31; //kg

u=sqrt(2*e*Ve*1000/m); //m/s
uy=u*sind(theta); //m/s
vy=0; //since final velocity =0
//vy**2-uy**2=2*ay*S
ay=(vy**2-uy**2)/2/S; //m**2/s
//ay=e/m*V/d
V=ay*m*d/e; //V
printf("Potential difference = %.f V",V)
```

Scilab code Exa 1.62 Power dissipated

```
// Ex 62 Page 403

clc;clear;close;
// Given
R=150; //ohm
Vrms=200; //V
Rd1=65; //ohm
Rd2=140; //ohm

Vm=Vrms/sqrt(2); //V
//v=Vm*sin(theta)
Rf=R+Rd1; //ohm
Rb=R+Rd2; //ohm
//i_f=v/Rf; //A
//i_b=v/Rb; //A
```

```
Irms=1/2/%pi*(integrate('(sqrt(2)*sin(theta))**2','theta',0,%pi)+integrate('(sqrt(2)/3*sin(theta))**2','theta',%pi,2*%pi))
Iav=1/2/%pi*(integrate('sqrt(2)*sin(theta)','theta',0,%pi)+integrate('sqrt(2)/3*sin(theta)','theta',%pi,2*%pi))
printf("reading of ammeter 1= %.2f A",Irms)
printf("\n reading of ammeter 2 = %.2f A",Iav)
P=1/2*(Vrms**2/Rf+Vrms**2/Rb);//W
printf("\n\n Power taken from the mains = %.1f W",P)
Pc=Irms**2*R;//W
Pd=P-Pc;//W
printf("\n Power dissipated in rectifying device = %d W",Pd)
//Answer wrong in the textbook.
```

Scilab code Exa 1.63 `Deflection`

```
// Ex 63 Page 404

clc;clear;close;
// Given
R=180;//ohm
V=4;//V
l=75;//cm
vd=.4;//V
emf=1.9;//V
Rc=850;//ohm
sg=17.5;//mm/uA
df=2;//mm


I=R/V;//A
Rw=vd/I;//ohm
Id=df/sg*10**-6;//A
```

```
el=1/sg*Rc;//uV
printf("error limit = %.1f uV",el)
Rw1=0.2/l*Rw;//ohm (for 2cm slide wire)
dV=I*Rw1*1000;//mV
r1=emf/I;//ohm
r2=r1*22.8/R;//ohm
Ig=dV/1000/(Rc+r2);//A
d=dV/1000/(Rc+r2)/Id;//mm
printf("\n Deflection  = %.1f mm",d)
```

Scilab code Exa 1.64 `Reading on voltmeter`

```
// Ex 64 Page 405

clc;clear;close;
// Given
//i=0.25+0.25*sin(omega*t)-0.25*sin(2*omega*t)
I0=0.25;I1m=0.25;I2m=-0.25;//from above expression
Iav=I0;//A
R=800;//ohm
L=1/1000;//H

Irms=sqrt(I0**2+(I1m/sqrt(2)**2+(I2m/sqrt(2)**2)));//A
printf("Reading on hot wire instrument = %.3f A",Irms)
VR=Irms*R;//V
printf("\n Reading on electrostatic voltmeter across 800 ohm = %d V",VR)
//vl_dash=L*di/dt=300*cos(w*t)-400*cos(2*w*t)
vl1=300;vl2=4;//V
vl=sqrt((300/sqrt(2))**2+(400/sqrt(2))**2)
printf("\n Reading on electrostatic voltmeter across 1 mH inductor = %d V",vl)
```

Scilab code Exa 1.65 Additional resistance

```
// Ex 65 Page 406

clc;clear;close;
// Given
C=6*10**-6;//F
L=2.5;//H
R=300;//ohm


a=R/2/L
omega = sqrt(1/L/C-R^2/4/L^2);//rad/s
//i=Im*%e**(-a*t)*sin(omega*t+fi)
//at t=0 sec
i0=0;//A
vc=10;//V
fi=asin(i0);//degree
//L*di/dt=vc at t=0
Im=poly([0],'Im')
function i=current(t)
    i=Im*expm(-a*t)*sin(omega*t+fi)
endfunction
//i=Im*expm(-a*t)*sin(omega*t+fi)
LdiBYdt=L*numderivative(current,0)
temp = coeff(LdiBYdt)
Im=vc/temp(2)
Rn=2*sqrt(L/C);//ohm
Rad=Rn-R;//ohm
printf("Additional resistance required = %d ohm",Rad
    )
```

Scilab code Exa 1.66 current after t sec

```
// Ex 66 Page 407

clc;clear;close;
// Given
f=50;//Hz
Vm=500;//V
R=20;//ohm
L=0.15;//H
t=0.03;//sec
XL=2*%pi*f*L;//ohm
Z=R+%i*XL;//ohm
Im=Vm/abs(Z);//A
fi=atan(XL/R);//degree
lambda=L/R;//sec
i = Im*sin(314*t-fi)+0.95*%e**(-100*t);//A
printf("\n current after 0.03 sec is : %0.1f A",i)
i2=Im*(0.95*%e**(-100*t));//A
printf("\n transient component is : %0.2f A",i2)
```

Scilab code Exa 1.67 Power factor

```
// Ex 67 Page 407

clc;clear;close;
// Given
//v=350*sin(omega*t)+80*sin(3*omega*t+%pi/3)+40*sin(5*omega*t+5*%pi/6)
V1=350;V3=80;V5=40;//V
fi1=0;fi3=60;fi5=150;//degree
R=20;//omh
L=0.05;//H
omega=314;//rad/s

```

```
X1=omega*L;//ohm
Z1=R+%i*X1;//ohm
X3=3*omega*L;//ohm
Z3=R+%i*X3;//ohm
X5=5*omega*L;//ohm
Z5=R+%i*X5;//ohm
[r1,t1]=polar(Z1);
[r3,t3]=polar(Z3);
[r5,t5]=polar(Z5);
I1m=V1/r1;//A
I3m=V3/r3;//A
I5m=V5/r5;//A
Irms=sqrt(I1m^2/2+I3m^2/2+I5m^2/2);//A
Vrms=sqrt(V1^2/2+V3^2/2+V5^2/2);//A
printf("\n Irms=%.f A\n Vrms=%.f V",Irms,Vrms)
P=Irms^2*R;//W
printf("\n Total Power, P=%.f W",P)
cosfi=P/Vrms/Irms;//Power factor
printf("\n Power factor = %.2f",cosfi)
```

Scilab code Exa 1.68 Wattmeter reading

```
// Ex 68 Page 408

clc;clear;close;
// Given
VRY=200*expm(%i*0);//V
VYB=200*expm(%i*-120*%pi/180);//V
VBR=200*expm(%i*120*%pi/180);//V


ZA=10*expm(%i*60*%pi/180);//ohm
ZB=10*expm(%i*0*%pi/180);//ohm
ZC=10*expm(%i*60*%pi/180);//ohm

```

```
//Phase current
IRY=VRY/ZA;//A
IYB=VYB/ZB;//A
IBR=VBR/ZC;//A

IR=IRY-IBR;//A
PVA=conj(VRY)*IR;//W
printf("Wattmeter W1 reading=%.f W",real(PVA))
IB=IBR-IYB;//A
PVB=conj(-VYB)*IB;//W
printf("\n Wattmeter W2 reading=%.f W or %.f kW",
   real(PVB),real(PVB)/1000)
```

Scilab code Exa 1.69 Line and Phase Current

```
// Ex 69 Page 409

clc;clear;close;
// Given
Rab=6;Rbc=8;Rca=4;//ohm
Vab=100*expm(%i*0);//V
Vbc=100*expm(%i*-120*%pi/180);//V
Vca=100*expm(%i*120*%pi/180);//V
Zab=6+%i*8;//ohm
Zbc=8+%i*6;//ohm
Zca=4-%i*3;//ohm

//Phase current
Iab=Vab/Zab;//A
Ibc=Vbc/Zbc;//A
Ica=Vca/Zca;//A
printf("Phase Current:")
[r,t]=polar(Iab)
printf("\n Iab=%.f angle=%.2f degree ",r,t*180/%pi)
[r,t]=polar(Ibc)
```

```
printf("\n Ibc=%.f angle=%.2f degree ",r,t*180/%pi)
[r,t]=polar(Ica)
printf("\n Ica=%.f angle=%.2f degree ",r,t*180/%pi)
//Line current
Iaa=Iab-Ica;//A
Ibb=Ibc-Iab;//A
Icc=Ica-Ibc;//A
printf("\n\n  Line Current:")
[r,t]=polar(Iaa)
printf("\n Iaa=%.1f angle=%.2f degree ",r,t*180/%pi)
[r,t]=polar(Ibb)
printf("\n Ibb=%.2f angle=%.2f degree ",r,t*180/%pi)
[r,t]=polar(Icc)
printf("\n Icc=%.2f angle=%.2f degree ",r,t*180/%pi)
//Power Consumed
Wab=abs(Iab)^2*Rab;//W
Wbc=abs(Ibc)^2*Rbc;//W
Wca=abs(Ica)^2*Rca;//W
W=Wab+Wbc+Wca;//W
W=W/1000;//kW
printf("\n\n Total Power, W=%.f kW",W)
//Answer wrong for line current in the textbook.
```

Scilab code Exa 1.70 Wattmeter readings

```
// Ex 70 Page 410

clc;clear;close;
// Given
VRY=300*expm(%i*0);//V
VYB=300*expm(%i*-90*%pi/180);//V
VBR=300*expm(%i*90*%pi/180);//V


ZA=10*expm(%i*60*%pi/180);//ohm
```

```
ZB=10*expm(%i*0*%pi/180);//ohm
ZC=10*expm(%i*60*%pi/180);//ohm

//Phase current
IRY=VRY/ZA;//A
IYB=VYB/ZB;//A
IBR=VBR/ZC;//A

IR=IRY-IBR;//A
PVA=conj(VRY)*IR;//W
printf("W1 reading=%.f W",real(PVA))
IB=IBR-IYB;//A
PVB=conj(-VYB)*IB;//W
printf("\n W2 reading=%.f W or %.f kW",real(PVB),
    real(PVB)/1000)
```

Scilab code Exa 1.71 expression of current

```
// Ex 71 Page 411

clc;clear;close;
// Given
f=50;//Hz
Vm=500;//V
R=20;//ohm
L=0.2;//H
t=0.02;//sec
XL=2*%pi*f*L;//ohm
Z=R+%i*XL;//ohm
Im=Vm/abs(Z);//A
fi=atan(XL/R);//degree
lambda=L/R;//sec
printf("expression for current:")
printf("\n i = %.1f*sin(314*t-%.3f)+0.95*e**(-100*t)
    ",Im,fi)
```

```
i = Im*sin(314*t-fi)+0.95*%e**(-100*t);//A
printf("\n current after 0.02 sec is : %0.1f A",-i)
i2=Im*(0.95*%e**(-100*t));//A
printf("\n transient component is : %0.2f A",i2)
```

Scilab code Exa 1.72 Resistance required

```
// Ex 72 Page 411

clc;clear;close;
// Given
R=200;//ohm
L=2;//H
C=5*10**-6;//F



if R<2*sqrt(L/C) then
printf("Since R<2sqrt(L/C), the circuit is
    originally oscillatory.")
end

a=R/(2*L)
omega = sqrt(1/L/C-R^2/4/L^2);//rad/s
//i=Im*%e**(-a*t)*sin(omega*t+fi)
//at t=0 sec
i0=0;//A
vc=10;//V
fi=asin(i0);//degree
//L*di/dt=vc at t=0
Im=poly([0],'Im')
function i=current(t)
    i=Im*expm(-a*t)*sin(omega*t+fi)
endfunction
//i=Im*expm(-a*t)*sin(omega*t+fi)
```

```
LdiBYdt=L*numderivative(current,0)
temp = coeff(LdiBYdt)
Im=vc/temp(2)
printf("\n\n Expression for current :\n  i = %.3f*
    exp(-%dt)*sin(%.1ft)",Im,a,omega)
Rn=2*sqrt(L/C);//ohm
Rad=Rn-R;//ohm
printf("\n\n Resistance required = %d ohm",Rad)
```

Scilab code Exa 1.73 Reading of electrostatic voltmeter

```
// Ex 73 Page 412

clc;clear;close;
// Given
//i=0.5+0.3*sin(omega*t)-0.2*sin(2*omega*t)
I0=0.5;I1m=0.3;I2m=-0.2;//from above expression
Iav=I0;//A
R=1000;//ohm
L=1/1000;//H

Irms=sqrt(I0**2+(I1m/sqrt(2)**2+(I2m/sqrt(2)**2)));
    //A
printf("Reading of hot wire instrument = %.3f A",
    Irms)
VR=Irms*R;//V
printf("\n Reading of electrostatic voltmeter acroos
     1000 ohm = %d V",VR)
//vl_dash=L*di/dt=300*cos(w*t)-400*cos(2*w*t)
vl1=300;vl2=4;//V
vl=sqrt((300/sqrt(2))**2+(400/sqrt(2))**2)
printf("\n Reading of electrostatic voltmeter acroos
     1 mH inductor = %d V",vl)
```

Scilab code Exa 1.74 Power and Power factor

```
// Ex 74 Page 412

clc;clear;close;
// Given
//v=350*sin(omega*t)+80*sin(3*omega*t+%pi/3)+40*sin
    (5*omega*t+5*%pi/6)
V1=250;V3=50;V5=30;//V
fi1=0;fi3=60;fi5=90;//degree
R=20;//omh
L=0.05;//H
omega=314;//rad/s

X1=omega*L;//ohm
Z1=R+%i*X1;//ohm
X3=3*omega*L;//ohm
Z3=R+%i*X3;//ohm
X5=5*omega*L;//ohm
Z5=R+%i*X5;//ohm
[r1,t1]=polar(Z1);
[r3,t3]=polar(Z3);
[r5,t5]=polar(Z5);
I1m=V1/r1;//A
I3m=V3/r3;//A
I5m=V5/r5;//A
Irms=sqrt(I1m^2/2+I3m^2/2+I5m^2/2);//A
Vrms=sqrt(V1^2/2+V3^2/2+V5^2/2);//A
printf("\n Irms=%.f A\n Vrms=%.f V",Irms,Vrms)
P=Irms^2*R;//W
printf("\n Total Power, P=%.f W",P)
cosfi=P/Vrms/Irms;//Power factor
printf("\n Power factor = %.2f",cosfi)
```

Scilab code Exa 1.75 carrier power under modulated condition

```
// Ex 75 Page 414

clc;clear;close;
// Given
Ebb=400;//V
Emm=250;//V
Ibb=25;//A
Po=2.5*10**3;//W

m=Emm/Ebb;//modulation index
Pbb=Ebb*Ibb
eta=Po/Pbb*100;//%
P=Po*(1+m**2/2);//W
Pdo=Pbb-Po;//W
Pd=Pdo*(1+m**2/2);//W
printf("\n carrier power under modulated condition =
    %0.2f kW",P/1000)
printf("\n plate circuit efficiency = %.f percent",
    eta)
printf("\n plate dissipation under unmodulated
    condition = %.1f kW",Pdo/1000)
printf("\n plate dissipation under modulated
    condition = %.2f kW",Pd/1000)
```

Scilab code Exa 1.76 Resistance and reactance

```
// Ex 76 Page 414

clc;clear;close;
// Given
```

```
Zo=50;//ohm
VSWR=2;//ratio
//lm=0.2*lamda
lmBYlamda=0.2
betaINTOlamda=2*%pi
rho=(VSWR-1)/(VSWR+1);//reflection coefficient
theta=2*betaINTOlamda*lmBYlamda;//radian
//exp(j*theta)=cos(theta)+%i*sin(theta)
ZL=Zo*(1-rho*(cos(theta)+%i*sin(theta)))/(1+rho*(cos
    (theta)+%i*sin(theta)));//ohm
Rs=real(ZL);//ohm
Xs=abs(imag(ZL));//ohm(capacitive)
printf("\n Rs = %0.1f ohm",Rs)
printf("\n Xs = %0.1f ohm",Xs)
YL=(1/ZL)*1000;//mS
Rp=1000/real(YL);//ohm
Xp=1000/imag(YL);//ohm
printf("\n Rp = %0.1f ohm",Rp)
printf("\n Xp = %0.f ohm",Xp)
```