Scilab Textbook Companion for Elements Of Electrical Science by P. Mukhopadhyay, A. K. Pant, D. S. Chitore And V. Kumar[1]

Created by
Ankit Kumar
B.TECH
Electrical Engineering
Krishna Institute Of Engineering And Technology
College Teacher
Swati
Cross-Checked by
Prathan Mehta

June 3, 2016

[1]Funded by a grant from the National Mission on Education through ICT, http://spoken-tutorial.org/NMEICT-Intro. This Textbook Companion and Scilab codes written in it can be downloaded from the "Textbook Companion Project" section at the website http://scilab.in

Book Description

Title: Elements Of Electrical Science

Author: P. Mukhopadhyay, A. K. Pant, D. S. Chitore And V. Kumar

Publisher: Nem Chand & Bros, Roorkee

Edition: 2

Year: 1997

ISBN: 81-85240-65-5

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 2

ELECTRIC CIRCUITS

Scilab code Exa 2.1 current

```
// Example 2.1 :current
clc;
close;
clear;
format('v',7)
// given :
//15*I1-5*I2=10 loop 1 equation
//20*I2-5*I1-5*I3=0 loop 2 equation
//10*I3-5*I2=0 loop 3 equation
vs=10;//voltage in volts
R1=10;//resistance in ohm
R2=5;//resistance in ohm
R3=10;//resistance in ohm
R4=5;//resistance in ohm
R5=4;//resistance in ohm
Ra=1;//resistance in ohm
A=[R1+R2 R2-R1 0;R2-R1 R2+R3+R4 -R4;R4-(R5+Ra) -R4 R4+R5+Ra];//making equations
nb=7;//number of branches
nn=5;//number of nodes
nl=nb-(nn-1);//number of loops
```

```
nvs=1;//number of voltage sources
nivs=nn-1-nvs;//number of independent voltage variables
B=[vs;0;0];//making equations
X=A\B;//solving equations
I3=X(3,1);//calculating currrent
disp(I3,"current in resistance Ra=1.0 ohm is ,(A)=")
//directions of the current are 2 to 3 and 3 to 4 respectively
```

Scilab code Exa 2.2 current

```
// Example 2.2 :current
clc;
close;
clear;
// given :
vs1=72;//voltage in volts
vs2=40;//voltage in volts
R1=36;//resistance in ohm
R2=10;//resistance in ohm
ig=2;//current in amperes
Rx=8;//resistance in ohm
//(va-72)/36+(va-40)/10 -2 +va/8=0 node equation at 1
va=((R2*Rx*vs1)+(R1*Rx*vs2)+(R1*R2*Rx*ig))/((R2*Rx)+(R1*Rx)+(R1*R2));//voltage in volts
ix1=va/Rx;//current in amperes
//(R1+R2)*I1-R2*I2+vs2=vs1 loop equation 1
//R2*I2-R2*I1+Ix*Rx=vs2 loop equation 2
//Ix=I2+2
A=[R1+R2 -R2;-R2 R2+Rx];//making equations
B=[vs1-vs2;vs2-2*Rx];//making equations
X=A\B;//solving equations
ix2=X(2,1)+ig;//current in amperes
```

```
disp(ix1,"current through Rx is(by node voltage
   method), (A)=")
disp(ix2,"current through Rx is (by loop current
   method),(A) =")
```

Scilab code Exa 2.3 current

```
// Example 2.3 :current
clc;
close;
clear;
format('v',7)
// given :
vs1=10;//voltage in volts
i5=2;//current in amperes
i2=i5;//current
r1=1;//resistance in ohms
r2=5;//resistance in ohms
r3=5;//resistance in ohms
rl=10;//resistance in ohms
r4=5;//resistance ohms
//(r1+r2+r3)*i1-r2*i2-r3*i3=vs1 loop equaion 1
//-r2*i1 -(r1+r2)*i2+(rl+r2+r3)*i3=0 loop equation 2
A=[4*(r1+r2+r3) -r2*4;-r2 (rl+r2+r3)];//making
   equations
B=[4*(vs1+r2*i2) ; i2*(r2+r3)];//making equations
X=A\B;//solving equations
il=i2-X(2,1);//calculating current
disp(il,"current through Rl is (from b to a),(A)=")
```

Scilab code Exa 2.4 current

```
// Example 2.4 :current
```

```
clc;
close;
clear;
format('v',7)
// given :
vs1=72;//voltage in volts
vs2=40;//voltage in volts
R1=36;//resistance in ohms
R2=10;//resistance in ohms
ig=2;//current in amperes
Rx=8;//resistance in ohms
disp("Applying Thevenins Theorem ")
//(vs1-voc)/R1+(v40-voc)/R2 +2 =0 node equation at 1
voc=(R2*vs1+R1*vs2+R1*R2*ig)/(R1+R2);//voltage in volts
req=(R1*R2)/(R1+R2);//resistance in ohms
ix1=(voc)/(req+Rx);//resistance in ohms
disp(ix1,"current through Rx is, (A)")
disp("Applying Nortons Theorem ")
Is=(vs1/R1)+(vs2/R2)+ig;//current in amperes
ix2=(req*(Is/(Rx+req)));//current in amperes
disp(ix2,"current through Rx is, (A) =")
```

Scilab code Exa 2.5 Norton and Thevenine Euivalent Components

```
// Example 2.5 :Thevenin's and Norton's Equivalent
clc;
close;
format('v',7)
clear;
// given :
vs1=10;//voltage in volts
R1=50;//resistance in ohms
R2=50;//resistance in ohms
R3=25;//resistance in ohms
```

```
disp("(a) Applying Thevenins Theorem ")
voc=(R1/(R1+R2))*vs1;//voltage in volts
req=((R1*R2)/(R1+R2))+R3;//resistance in ohms
disp(voc,"Thevenin equivalent open circuit voltage
   is , (V)=")
disp(t=req,"Thevenin equivalent resistance is ,(Ohm)=
   ")
disp("(b) Applying Nortons Theorem ")
Isc=((vs1)/(R1+(R1*R3)/(R1+R3)))*(R1/(R1+R3));//
req=((R1*R2)/(R1+R2))+R3;//resistance in ohms
disp(Isc,"Norton short circuit current is ,(A)=")
disp(t=req,"Norton equivalent resistance is ,(Ohm)=")
```

Scilab code Exa 2.6 current

```
// Example 2.6 :current
clc;
close;
format('v',7)
clear;
// given :
vs1=10;//voltage volts
r1=100;//resistance in ohms
r2=600;//resistance in ohms
r3=150;//resistance in ohms
r4=850;//resistance in ohms
rx=50;//resistance in ohms
voc=vs1*((r3/(r1+r3))-(r4/(r2+r4)));//open circuit
   voltage in volts
req=((r1*r3)/(r1+r3))+((r2*r4)/(r2+r4));//equivalent
    resistance in ohms
ix=voc/(req+rx)*10^3;//current in amperes
disp(ix,"current through Rx is (from A to B) ,(mA)=")
```

Scilab code Exa 2.7 Nortoan Euivalent Components

```
// Example 2.7 :Norton's Equivalent
clc;
close;
clear;
// given :
vs1=40;//volts
vs2=20;//volts
r1=2;//resistance in ohms
r2=6;//resistance in ohms
r3=2;//resistance in ohms
r4=2;//resistance in ohms
iab=((r1*vs1)/(r2+(r1/2))*((r1+(r3/2))/(r1+r3)));//
   current in amperes
iab1=-vs2/r1;//current amperes
it=iab+iab1;//current amperes
req1=r1+((r1*r2)/(r1+r2));//equivalent resistance in
    ohms
req=(req1*r3)/(req1+r3);//equivalent resistance in
   ohms
disp(it,"current is,(A)")
disp(req,"equivalent resistance is,(ohm)=")
```

Scilab code Exa 2.8 current equation and time

```
// Example 2.8:equation of current and time
clc;
close;
clear;
format('v',6)
// given :
```

```
v=100;//voltage in volts
r=100;//resistance in ohms
l=0.2;//inductance in henrty
T=1/(l/r);//calculating time in seconds
t=500;//time in micro seconds
i1=1-exp(-T*t*10^-6);//current in amperes
disp(i1,"current is (when t=500 micro seconds),(A)="
    )
v2=50;//voltage in volts
x=v2/r;//variab;e
x1=x*((v2/r)+i1);//variable
t1=t+(10^6*(x1/500));//time in seconds
disp(ceil(t1),"time at which current will be zero is
    ,(micro-seconds)=")
//time is caluclated wrong in the textbook as they
    had not added the values
```

Scilab code Exa 2.9 time

```
// Example 2.9 :time
clc;
close;
format('v',6)
clear;
// given :
v=10;//voltage in volts
r1=500;//resistance in ohms
is=0;//current in amperes
r=700;//resistance in ohms
c=100;//capacitance in micro farads
x=1/(r*c*10^-6);//variable
i=30;//current in mA
y=(i*10^-3)-(v/r1);//variable
t=-((log(y*(r/v))));//time in seconds
t1=t/x;//time in seconds
```

```
disp(t1,"time is ,(seconds)=")
```

Scilab code Exa 2.10 current

```
// Example 2.10 :current equation
clc;
close;
clear;
// given :
format('v',5)
v=100;//volts
r=50;//in ohms
l=0.1;//henry
c=50;//mf
d=poly(0,"d")
p=2*10^5+500*d+d^2;
x=roots(p)
c1=0;//at t=0 i=0
c2=1000/imag(x(1,1));//
disp("it= "+string(c2)+"*e^"+string(real(x(1,1)))+"t
    *sin"+string(imag(x(1,1)))+"t A")
```

Scilab code Exa 2.11 average and rms value of current

```
// Example 2.11 :average & rms value
clc;
close;
format('v',6)
clear;
// given :
vm=10;//voltage in volts
e=vm/2;//voltage in volts
t=0:2;//time range
```

```
x=intsplin(t,(5*t)^2);//variab;e
rms=sqrt(x/2);//rms value of voltage in volts
av=vm/2;//average value of voltage in volts
disp("parts (a) saw tooth wave")
disp(rms,"rms value of e is ,(V)=")
disp(av,"average value of e is ,(V)=")
t1=0;//initial time in seconds
t2=%pi;//final time in seconds
t3=2*%pi;//time interval
x=integrate('(sin(t))^2','t',t1,t2);//variable
rms=sqrt((1/(2*%pi))*x*vm^2);//rms value of voltage
    in volts
av=(10/(2*%pi))*integrate('sin(t)','t',t1,t2);//
    average value of voltage in volts
disp("parts (b) half wave rectified sine wave form")
disp(rms,"rms value of e is ,(V)=")
disp(av,"average value of e is ,(V)=")
```

Scilab code Exa 2.12 circuit elements

```
// Example 2.12 :Circuit constants
clc;
close;
format('v',6)
clear;
// given :
//v=194*cos(800*t+150)V Voltage equation
//I=11.6*cos(800*t+140)A Current equation
vm=194/sqrt(2);//voltage in volts
va=150;//angle in degree
im=11.6/sqrt(2);//current in amperes
ia=140;//angle in degree
zm=vm/im;//resistance in ohms
za=va-ia;//resistance in ohms
z1=zm*cosd(za);//reactance in ohms
```

```
z2=zm*sind(za);//reactance in ohms
z=z1+%i*z2;//resistance in ohms
disp("part (a)")
disp(z,"Impedance is ,(Ohm)=")
disp("part (b)")
//v=6*sin(1000*t+45)V  Voltage equation
//I=12*cos(1000t-90)A current equation
vm1=60/sqrt(2);//voltage in volts
va1=45;//angle in degree
im1=12/sqrt(2);//current in amperes
ia1=0;//angle in degree
zm1=vm1/im1;//resistance in ohms
za1=va1-ia1;//resistance in ohms
z11=zm1*cosd(za1);//reactance in ohms
z21=zm1*sind(za1);//reactance in ohms
z22=z11+%i*z21;//impedance in ohms
disp(z22,"Impedance is ,(Ohm)=")
```

Scilab code Exa 2.13 voltmeter reading

```
// Example 2.13 :reading
clc;
close;
format('v',8)
clear;
// given :
v1=230;//voltage in volts
v2=100;//voltage in volts
v2=sqrt(v1^2-v2^2);//voltage in volts
v3=300;//voltage in volts
disp(v2,"reading V2 is ,(V)")
disp("reading V4 is "+string(v3+v2)+" V or "+string(
   v3-v2)+" V")
```

Scilab code Exa 2.14 circuit elements

```
// Example 2.14 :circuit elements
clc;
close;
format('v',6)
// given :
//v=311*sin(2500*t+170) V voltage equation
//I=15.5*sin(2500*t-145)A current equation
vm=311/sqrt(2);//voltage in volts
va=170;//angle in degree
im=15.5/sqrt(2);//current in amperes
ia=-145;//angle in degree
zm=vm/im;//resistance in ohms
za=(va-ia)-360;//resistance ohms
z1=zm*cosd(za);//resistance in ohms
z2=zm*sind(za);//resistance in ohms
z=z1+%i*z2;//resistance in ohms
t=2500;//time in seconds
c=(1/(real(z)*t));//capacitance in farads
disp(z,"Impedance is ,(Ohm)=")
disp(c*10^6,"capacitance is ,(micro-farads)=")
```

Scilab code Exa 2.15 circuit constants

```
// Example 2.15 :parameters
clc;
close;
format('v',6)
// given :
z=40+%i*30;//resistance in ohms
zph=sqrt(real(z)^2+imag(z)^2);//resistance in ohms
```

```
pf=real(z)/zph;//power factor
v=400;//voltage in volts
vp=v/(sqrt(3));//voltage in volts
pc=vp/zph;//current in amperes
lv=v;//voltage in volts
lc=pc;//current om amperes
p=sqrt(3)*v*lc*pf;//power in watts
disp("part (a) Star")
disp(round(vp),"phase voltage ,(V)=")
disp(round(pc),"phase current ,(A)=")
disp(lv,"line voltage ,(V)=")
disp(lc,"line current ,(A)=")
disp(p,"power ,(W)=")
z1=40+%i*30;//ohms
zph1=sqrt(real(z1)^2+imag(z1)^2);//ohms
pf1=real(z1)/zph1;//power factor
v1=400;//volts
vp1=v1;//volts
pc1=vp1/zph1;//amperes
lv1=v1;//volts
lc1=pc1*sqrt(3);//amperes
p1=sqrt(3)*v1*lc1*pf1;//watts
disp("part (b) Delta")
disp(round(vp1),"phase voltage ,(V)=")
disp(round(pc1),"phase current ,(A)=")
disp(lv1,"line voltage ,(V)=")
disp(lc1,"line current ,(A)=")
disp(p1,"power ,(W)=")
```

Chapter 3

MAGNETIC CIRCUITS

Scilab code Exa 3.1 ampere turns

```
// Example 3.1;amper−turns
clc;
close;
clear;
// given :
format('v',7)
bt=[2;2.5;3.0];//making equations from Table
H=[400 ;600;800];//making equations from Tble
fsl=10^-3;//Flux in Wb
cal=4*10^-4;//area in m^2
fdl=fsl/cal;//magnetic field in Tesla
hl=H(2);//AT/m
pll=0.57;//lenth in meter (path length 2345)
at2345=pll*hl;//ampere turns
fcl=2*10^-3;//magnetic field in Wb
fdcl=fcl/cal;//in Tesla
hcl=H(1);//in AT/m
lcl=169;//length in mm
atcl=(lcl*10^-3)*hcl;//ampere turns
l=1;//length mm
Hl=((4*%pi))*10^-7;//AT/m
```

```
atrg=fcl/Hl;//AT
tat=at2345+atcl+atrg;//total ampere turns
disp(tat,"total ampere-turns required is, (AT)=")
```

Scilab code Exa 3.2 kb and ke and hysteresis and eddy current loss

```
// Example 3.2;Kb , Ke and hystresis and eddy
   current loss
clc;
close;
clear;
// given :
format('v',7)
f1=50;//frequency in Hz
f2=25;//frequency in Hz
p1=30.1;//power in W
p2=12.4;//power in W
A=[f1 f1^2;f2 f2^2];//making equations
B=[p1;p2];////making equations
X=A\B;//calculating parameters
disp("part (a) Kb and Ke")
disp(X(1,1),"Kh is")
disp(X(2,1),"Ke is")
h25=X(1,1)*f2;//calculating parameters
e25=X(2,1)*f2^2;//calculating parameters
h50=X(1,1)*f1;//calculating parameters
e50=X(2,1)*f1^2;//calculating parameters
disp("part (b) hystresis and eddy current loss ")
disp(h25,"hysteresis loss at 25 Hz is , (W)=")
disp(e25,"eddy current loss at 25 Hz is ,(W)=")
disp(h50,"hysteresis loss at 50 Hz is ,(W)=")
disp(e50,"eddy current loss at 50 Hz is ,(W)=")
W=40;//kg
h50=X(1,1)*f1;//calculating parameters
e50=X(2,1)*f1^2;//calculating parameters
```

```
disp("part (c) hystresis and eddy current loss ")
disp(h50/W,"hysteresis loss per kg at 50 Hz is ,(W)=
    ")
disp(e50/W,"eddy current loss per kg at 50 Hz is ,(W
    )=")
```

Scilab code Exa 3.3 hysteresis loss

```
// Example 3.3;hystresis  loss per Kg
clc;
close;
clear;
// given :
format('v',7)
l=10;//lengh in mm
atm=200;//AT/m
a=4800;//area in m^2
loss=atm*(l*10^-2)*(a/100);//loss in J/m^3/cycle
d=7.8*10^3;//kg/m^3
vikg=1/d;//m^3
loss1=loss*vikg;//J/cycle
f=50;//Hz
tl=loss1*f;//J/s
disp(tl,"hystersis loss is ,(W/kg)=")
```

Scilab code Exa 3.4 ampere turns

```
// Example 3.4;amper-turns
clc;
close;
clear;
// given :
format('v',7)
```

```
r=150;//length in mm
t=12;//torque in N-m
f=t/(r*10^-3);//force in N
np=2;//no. of poles
fp=f/np;//force per pole in N
A=400;//area mm^2
mu=4*%pi*10^-7;//
b=sqrt((fp*2*mu)/(A*10^-6));//magnetic field in Tesla
H=b/mu;//in AT/m
tar=2*0.6*10^-3;//length in meter
atr=H*tar;//AT
disp(atr,"ampere turn required is, (AT)=")
//answer is wrong in the textbook
```

Chapter 4

TRANSFORMERS

Scilab code Exa 4.1 number of turns

```
// Example 4.1;NUMBER OF TURNS
clc;
close;
clear;
// given :
format('v',7)
e1=2200;//voltage in volts
f=50;//frequency in Hz
e2=220;//voltage in volts
fd=1.6;//magnetic field in Tesla
a=3600;//area in mm^2
n1=(e1/(4.44*f*fd*a*10^-6));//number  of turns
n2=(e2/(4.44*f*fd*a*10^-6));//number of turns
disp(round(n1),"number of primary winding turns are"
  )
disp(round(n2),"number of secondary winding turns
  are")
```

Scilab code Exa 4.2 two components of no load current and magnetising and working components of esciting current

```
// Example 4.2;components of no load currents ,
   magnetising and working components of exciting
   current
clc;
close;
clear;
// given
format('v',6)
disp("part (a)")
nlw=2000;//no load input watts
pv=11000;//primary voltage
Iw=nlw/pv;//current in amperes
Io=0.6;//current in amperes
Imu=sqrt(Io^2-Iw^2);//current in amperes
disp(Iw,"iron loss current is, (A)=")
disp(Imu,"magnetising component is, (A)=")
pf=0.2;//power factpr
Io=0.5;//current in amperes
Iw=Io*(pf);//current in amperes
Imu=Io*sqrt(1-pf^2);//magnetising component in
   amperes
disp(" part (b)")
disp(Iw,"iron loss current is, (A)=")
disp(Imu,"magnetising component  is, (A)=")
```

Scilab code Exa 4.3 current

```
// Example 4.3;current
clc;
close;
clear;
// given
```

```
format('v',6)
pf1=0.866;//power factor
pf2=0.1736;//power factor
ph1=acosd(pf1);//phase angle in degree
ph2=acosd(pf2);//phase angle in degree
ir=120;//current in amperes
n2=110;//number of turns
n1=440;//number of turns
i2d=(n2/n1)*ir;//current in amperes
io=5;//current in amperes
aioi2=ph2-ph1;//change in angle in degree
i1=sqrt(io^2+i2d^2+(2*io*i2d*cosd(aioi2)));//current
    in amperes
disp(i1,"current is , (A)=")
```

Scilab code Exa 4.4 core losses

```
// Example 4.4;core losses
clc;
close;
clear;
format('v',6)
// given
f=50;//frquency in Hz
hl=650;//hystresis loss
edl=400;//eddy current loss
A=hl/f;//parameter
B=edl/f^2;//parameter
Ph=A*2*f;//loss in watts
Pe=B*(2*f)^2;//loss in watts
pt=Ph+Pe;//total loss in watts
disp(pt,"total core losses is ,(W)")
```

Scilab code Exa 4.5 efficiency and percentage of full load

```
// Example 4.5; efficiency and load for maximum
    efficiency
clc;
close;
clear;
format('v',5)
// given
cl=125;//copper losses
fcl=2^2*cl;//full load copper losses
il=457;//iron losses
pf=0.8;//power factor
kba=30;//loss
disp("part (a)")
fle=((kba*pf)/((kba*pf)+(fcl+il)*10^-3))*100;//full
    load efficiency in %
disp(fle,"full load efficiency at 0.8 pf is,(%)=")
lme=kba*sqrt(il/fcl);//variable
pfl=(lme/kba)*100;//percentage of full load on which
     efficiency will be maximum
disp("part (b)")
disp(pfl,"percentage of full load on which
    efficiency will be maximum is,(%)=")
```

Scilab code Exa 4.6 all day efficiency

```
// Example 4.6;all day efficiency
clc;
close;
clear;
//given
format('v',5)
ef=0.98;//efficiency in %
kva=15;//kVA
```

```
pf=1;//power factor
op=kva*pf;//output power in kW
ip=op/ef;//input power in kW
loss=ip-op;//loss in kW
cl=(loss*10^3)/2;//copper loss in W
il=cl;//iron loss in W
t1=12;//time in hours
p1=2;//power in kW
pf1=0.5;//power factor
y1=(p1)/pf1;//kVA
il1=il*t1;//loss in Wh
cl1=cl*((y1)/kva)^2*t1;//copper loss in Wh
top1=p1*t1;//kWht1=12;//time in hours
t2=6;//time in hours
p2=12;//power in kW
pf2=0.8;//power factor
y2=(p2)/pf2;//kVA
il2=il*t2;//iron loss in Wh
cl2=cl*((y2/kva)^2)*t2;//copper loss in Wh
top2=p2*t2;//kWh
t3=6;//time in hours
il3=il*t3;//iron loss Wh
tol=top1+top2;//iron loss kWh
til=(il1+il2+il3)*10^-3;//total iron loss in kWh
tcl=(cl1+cl2)*10^-3;//total copper loss in kWh
ade=((tol)/(tol+til+tcl))*100;//efficiency in %
disp(ade,"all day efficiency is,(%)=")
```

Scilab code Exa 4.7 iron losses

```
// Example 4.7;iron losses
clc;
close;
clear;
//given
```

```
format('v',6)
kva=200;//kVA
pf=0.8;//power factor
rflo=kva*pf;//kW
ef=0.96;//efficiency
ip=rflo/ef;//kW
tl=ip-rflo;//kW
e2=800;//volts
e1=6600;//volts
n21=((e2/sqrt(3))/e1);//turn ratiom
r1=4;//ohms
r2=0.05;//ohms
roe=(r1)*n21^2+r2;//ohms
fli=((kva*10^3)/(sqrt(3)*e2));//amperes
fcl=3*fli^2*roe;//kW
il=tl-(fcl)*10^-3;//kW
disp(il,"iron losses is ,(kW)=")
```

Scilab code Exa 4.8 equivalent value of resistances reactances and impedances and total copper losses

```
// Example 4.8;resistance ,reactances and impedances
   and copper losses
clc;
close;
clear;
//given
r1=3.45;//ohms
r2=0.009;//ohms
x1=5.2;//ohms
x2=0.015;//ohms
kva=100;//kVA
e1=8800;//volts
e2=440;//volts
i1=(kva*10^3)/e1;//in amperes
```

```
i2=(kva*10^3)/e2;//in amperes
k=e2/e1;//transformation ratio
ro1=r1+(r2/k^2);//ohms
xo1=x1+(x2/k^2);//ohms
ro2=r2+(k^2*r1);//ohms
xo2=k^2*xo1;//ohms
zo1=sqrt(ro1^2+xo1^2);//ohms
zo2=sqrt(ro2^2+xo2^2);//ohms
disp("part (a) ")
disp(ro1,"equivalent resistance referred to the
    primary is,(Ohm)=")
disp(xo1,"equivalent reactance referred to the
    primary is,(Ohm)=")
disp(ro2,"equivalent resistance referred to the
    secondary is,(Ohm)=")
disp(xo2,"equivalent reactance referred to the
    secondary is,(Ohm)=")
disp(zo1,"equivalent impedance referred to the
    primary is,(Ohm)=")
disp(zo2,"equivalent impedance referred to the
    secondary is,(Ohm)=")
disp("part (b) ")
tcl=i1^2*r1+i2^2*r2;//in watts
tcl1=i1^2*ro1;//in watts
tcl2=i2^2*ro2;//in watts
disp(tcl,"total copper losses considering individual
     resistance is,(W)=")
disp(tcl1,"total copper losses consdering equivalent
     resistance (for primary) is,(W)=")
disp(tcl2,"total copper losses consdering equivalent
     resistance (for secondary) is,(W)=")
//copper losses are caculated wrong in the textbook
```

Scilab code Exa 4.9 equivalent circuit components regulation of transformer and efficiency

```
// Example 4.9;parameter of primary side ,regulation
    and efficiency
clc;
close;
clear;
//given
format('v',6)
po=100;//watts
v1=200;//volts
io=1;//amperes
ocpf=po/(v1*io);//open circuit power factor
sinpf=sqrt(1-ocpf^2);//
im=io*sinpf;//in amperes
iw=io*ocpf;//current in amperes
rm=v1/iw;//ohms
xm=v1/im;//in ohms
vs=15;//volts
ia=10;//amperes
zo2=vs/ia;//in ohms
wa=85;//watts
ro2=wa/(ia)^2;//ohms
e2=400;//volts
e1=200;//volts
k=e2/e1;//transformation ratio
zo1=zo2/k^2;//ohms
ro1=ro2/k^2;//ohms
xo1=sqrt(zo1^2-ro1^2);//ohms
disp(" part (a)")
disp(im,"magnetising component of no load current (
   Im) is ,(A)=")
disp(iw,"working component of no load current (Iw)
   is ,(A)=")
disp(rm,"resistance for primary side  (Rm) is ,(Ohm)=
   ")
disp(xm,"reactance for primary ohms (Xm) is ,(Ohm)=")
disp(xo1,"impedence for primary side (X01) is ,(Ohm)=
   ")
disp("part (b)")
```

```
kva=4000;//kVA
i2=kva/e2;//in amperes
xo2=sqrt(zo2^2-ro2^2);//ohms
pf=0.8;// power factor
vlag=i2*(ro2*pf+xo2*sqrt(1-pf^2));//in volts
prld=(vlag*po)/e2;//
vlag1=i2*(ro2*pf-xo2*sqrt(1-pf^2));//in volts
prld1=(vlag1*po)/e2;//
disp(prld,"percentage regulation on lagging load is
    ,(%)=")
disp(prld1,"percentage regulation on leading load is
    ,(%)=")
disp("part (c)")
cl=85;//copper losses
nloss=100;//no load losses
fll=cl+nloss;//full load losses
pf=0.8;//power factor
flo=kva*pf;//efficiency
effl=flo/(flo+fll);//efficiency
hll=(1/2)^2*cl+nloss;//loss in watts
op=(1/2)*kva*pf;//ouput power in watts
efhl=op/(hll+op);//efficiency at half load
disp(effl*100,"efficiency at full load is,(%)=")
disp(efhl*100,"efficiency at half load is,(%)=")
```

Chapter 5

ELECTRICAL MEASUREMENTS

Scilab code Exa 5.1 resistance

```
// Example 5.1 : resistance
clc;
clear;
// given :
format('v',9)
n=50;//number of turns
B=1;//magnetic field in tesla
I=1;//current in amperes
L=4;//length in cm
d=3;//dia in cm
Td=n*B*I*L*d*10^-4;//torque in N-m
cd1=2.4*10^-4;//controlling torque
id=cd1/Td;//current in amperes
fsv=100;//full scale voltage
trv=fsv/id;//ohms
adr=10000;//ohms
r=trv-adr;//ohms
disp(r,"required resistance is ,(ohm)=")
```

Scilab code Exa 5.2 resistance

```
// Example 5.2 : resistance
clc;
clear;
// given :
format('v',9)
fsf=20;//full scale deflection current in mA
v=200;//voltage in mV
ri=v/fsf;//resistance in ohms
x=199.98;//current in amperes
rsh=(v*10^-3)/x;//ohms
fs2=1000;//volts
trv=fs2/(fsf*10^-3);//ohms
rse=trv-ri;//reqquired resistance in ohms
disp(rse,"total resistance of the voltmeter is,(ohm)
   =")
//in the text book approximately value of resistance
    is taken as 50000 ohm
```

Scilab code Exa 5.3 power factor

```
// Example 5.3 : power factor
clc;
clear;
// given :
format('v',6)
w1=2000;//power in watts
w2=500;//power in watts
an=atand(sqrt(3)*(((w1-w2)/(w1+w2))));//angle in
   degree
disp("part (a)")
```

```
pf=cosd(an);//power factor
disp(pf,"power factor is ,=")
disp("part (b)")
w1=2000;//power in watts
w2=-500;//power in watts
an=atand(sqrt(3)*(((w1-w2)/(w1+w2))));//angle in degree
pf=cosd(an);//power factor
disp(pf,"power factor is ,=")
```

Scilab code Exa 5.4 current

```
// Example 5.4;reading
clc;
clear;
disp("part (i)")
// given :
format('v',6)
vm=100;//volts
rc=10;//ohms
im=vm/rc;//amperes
t=0:2*%pi;//time rane
x=intsplin(t,(sin(t))^2);//variable
Irms=sqrt((1/(2*%pi))*im^2*x);//current in amperes
disp(Irms,"indication of moving iron instrument is ,(A)=")
disp("part (ii)")
t1=0;//time interval
t2=%pi;//time inerval
x=integrate('sin(t)','t',t1,t2);//variable
Iav=(1/%pi)*x*(im/2);//current in amperes
disp(Iav,"indication of moving coil instrument is ,(A)=")
//answer of part a is calculated wrong in the textbook
```

Scilab code Exa 5.5 resistance and readings

```
// Example 5.5;reading
clc;
clear;
format('v',5)
// given :
fsd=100;//full scale division in amperes
fsd1=100;//full scale division in mA
csh=fsd-(fsd*10^-3);//difference in currents in
    amperes
rx=0.8;//resistance in ohms
r1=((fsd1*10^-3*rx)/csh);//resistance in ohms
rx1=1;//resistance in ohms
r2=((fsd1*10^-3*rx1)/csh);//resistance in ohms
em1=((rx*r1)/(rx+r1));//resistance in ohms
em2=((rx1*r2)/(rx1+r2));//resistance in ohms
crm1=((em2*10^4*fsd)/((em2*10^4)+(em1*10^4)));//
    current in amperes
crm2=((em1*10^4*fsd)/((em1*10^4)+(em2*10^4)));//
    current in amperes
disp(crm1,"current read by meter 1 is,(A)=")
disp(crm2,"current read by meter 2 is,(A)=")
```

Scilab code Exa 5.6 multiplier resistance and voltmeter sensivity

```
// Example 5.6;multiplier and sensivity
clc;
clear;
// given :
format('v',6)
```

```
rm=50;//resistance in ohms
rsh=rm;//shunt resistance in ohms
it=2;//current in mA
erms=10;//rms voltage in volts
ede=0.45*erms;//voltage in volts
rd1=400;//resistance in ohms
x=(rm*rsh)/(rm+rsh);//resistance in ohms
r1=ede/(it*10^-3);//resistance in ohms
rs=r1-x-rd1;//resistance in ohms
disp("part (a)")
disp(rs,"multiplier resistance Rs is ,(Ohm)=")
S=r1/erms;//sensivity in ohms/V
disp("part (b)")
disp(S,"sensivity is ,(Ohm/V)=")
```

Scilab code Exa 5.7 apparent resistance actual resistance and error

```
// Example 5.7;apparent resistance of the unknown
   resistor ,actual resistance of the unknown
   resistor and percentage error
clc;
clear;
// given :
format('v',7)
v=200;//voltage in volts
i=5;//current in mA
tr=v/i;//resistance in kilo ohms
disp("part (a)")
disp(tr,"apparent resistance of unknown resistor is
   ,(kilo-Ohm)=")
S=1000;//sensivity in ohms/V
V1=250;//voltage in volts
rv=V1*S*10^-3;//resistance in kilo ohms
rx=(V1*tr)/(V1-tr);//resistance in kilo ohms
disp("part (b)")
```

```
disp(rx,"actual resistance of unknown resistor is ,(
   kilo-Ohm)=")
per=(rx-tr)/rx;//percentage error
disp("part (c)")
disp(per*100,"percentage error is ,(%)=")
```

Scilab code Exa 5.8 resolution

```
// Example 5.8;resolution
clc;
clear;
format('v',6)
// given :
fsr=200;//full scale reading in volts
d=100;//number of divisions
sc=1/10;//scale
sd1=fsr/d;//one sccale divisions
R=sc*sd1;//resolution
disp(R,"resolution is , (V)=")
```

Scilab code Exa 5.9 resolution

```
// Example 5.9;resolution
clc;
clear;
format('v',6)
// given :
fsr=9.999;//full scale reading in volts
d=9999;//number of divisions
R=(1/d)*fsr*10^3;//resolution
disp(R,"resolution is ,(mV)=")
```

Scilab code Exa 5.10 true resistance of the unknown resistor percentage error and reading voltmeter

```
// Example 5.10;true resistance of the unknown
   resistor  , percentage error and reading
   voltmeter
clc;
clear;
// given :
format('v',7)
disp("part (i)")
ra=0.1;//ohms
vr=18;//voltage in volts
am=0.2;//current in amperes
apr=vr/am;//in ohms
rv=5000;//ohms
im=vr/rv;//amperes
rxi=am-(im);//in amperes
rx=vr/rxi;//ohms
disp(rx,"true value of resistance is,(Ohm)=")
per=((rx-apr)/rx)*100;//percentage error
disp("part (ii)")
disp(per,"percentage error is,(%)=")
rvv=am*(ra+rx);//reading of voltmeter
disp("part (iii)")
disp(rvv,"reading of voltmeter is,(V)=")
```

Scilab code Exa 5.11 resistance

```
// Example 5.11;resistance
clc;
clear;
```

```
// given :
format('v',6)
im=10;//mA
i=100;//mA
m=i/im;//multiplying factor
rm=50;//ohms
rsh=rm/(m-1);//in ohms
disp("part (i)")
disp(rsh,"resistance of shunt (range 0-100mA) Rsh1
    is ,(Ohm)=")
i1=500;//mA
m1=i1/im;//multiplying factor
rm1=50;//ohms
rsh1=rm1/(m1-1);//in ohms
disp("part (ii)")
disp(rsh1,"resistance of shunt (range 0-500mA) Rsh2
    is ,(Ohm)=")
im2=1;//A
i2=100;//A
m2=i2/im2;//multiplying factor
rm2=50;//ohms
rsh2=rm2/(m2-1);//in ohms
disp("part (iii)")
disp(rsh2,"resistance of shunt (range 0-1A) Rsh2 is
    ,(Ohm)=")
im3=1;//A
i3=500;//A
m3=i3/im3;//multiplying factor
rm3=50;//ohms
rsh3=rm3/(m3-1);//in ohms
disp("part (iv)")
disp(rsh3,"resistance of shunt (range 0-5A) Rsh2 is
    ,(Ohm)=")
```

Scilab code Exa 5.12 load

```
// Example 5.12;load power
clc;
clear;
format('v',6)
// given :
k=600;//in rev./kwh.
nr=5;//number of revolutions
t=20;//time in seconds
lp=(1/k)*nr*((60*60)/t);//power in kW
disp(lp,"load power is ,(kW)=")
```

Chapter 6

ROTATING ELECTRICAL MACHINE

Scilab code Exa 6.1 terminal voltage

```
//Example 6.1// Terminal voltage
clc;
clear;
close;
//given data :
format('v',7)
Z=440;// number of lap
N=900;// revolutions in rpm
fi=0.07;//fluxin Wb
P=4;// number of pole
A=4;//constant
Ia=50;// armature current in Amperes
E=462;//voltage in V
E=(P*fi*Z*N)/(60*A);//general voltage in volts
R=0.002;// resistance in ohm
C=110;// conductors
Re=C*R;//resistance of each path in ohm
Ra=Re/A;//armature resistance in ohm
V=E-(Ia*Ra);//terminal voltage in volts
```

```
disp(V,"Terminal voltage,(V) = ")
```

Scilab code Exa 6.2 induced emf

```
//Example 6.2// e.m.f
clc;
clear;
close;
format('v',6)
//given data :
V=200;//voltage
Ra=0.1;//resistance in ohm
Ia=50;//armature current in Amperes
E=V+(Ia*Ra);//generator voltage in volts
Eb=V-(Ia*Ra);//motor voltage in volts
disp(E,"emf when machine acts as generator,(V) = ")
disp(Eb,"emf when machine acts as motor,(V) = ")
```

Scilab code Exa 6.3 speed torque and efficiency

```
//Example 6.3// spped ,torque and efficiency
clc;
clear;
close;
format('v',6)
v=200;//voltage in volts
r=100;//resistance in ohms
ish=v/r;//shunt current in amperes
i=4;//current in amperes
nla=i-ish;//no load armature current in amperes
w=8;//powerin kW
ifl=(w*10^3)/v;//full load current in amperes
fla=ifl-ish;//full load armature current in amperes
```

```
r1=0.6;//internal resistance in ohms
ebo=(v-(ish*r1));//voltage in volts
eb=(v-(fla*r1));//voltage in volts
no=700;//number of rpm
n=no*(eb/ebo);//number of rpm
ta=((eb*fla*60)/(2*n));//armature torque in N-m
nlpi=v*i;//no load power input in watts
cl=(ish^2*r1);//copper losses in watts
cl=nlpi-cl;//total copper losssses in Watts
flacl=(fla^2*r1);//full load armmature copper losses in Watts
tfll=flacl+cl;//total full load losses in Watts
flo=(w*10^3)-tfll;//full load output in Watts
ef=((flo)/(w*10^3))*100;//efficiency
disp(n,"speed is ,(rpm)=")
disp(ta,"armature torque is , (N-m)=")
disp(ef,"full load motor efficiency is ,(%)=")
//armature torque is calculated wrong in the textbook
```

Scilab code Exa 6.4 speed

```
//Example 6.4// speed
clc;
clear;
close;
//given data :
format('v',6)
fi=0.02// flux in Wb
P=4;// number of poles
A=2;//constant
Z=151*A;//turns
V=200;// in volts
Rsh=50;//shunt resistance in ohm
Ra=0.01;// armature resistance in ohm
```

```
Pr=40000;//power required  in Watts
Il=Pr/V;//load current in amperes
Ish=V/Rsh;//shunt current in amperes
Ia=Il+Ish;//armature current in amperes
E=V+(Ia*Ra);//generated voltage
N=(60*A*E)/(fi*P*Z);//rpm
disp(N,"The speed of the machine,(rpm) = ")
//answer is wrong in the textbook
```

Scilab code Exa 6.5 power absorbed

```
//Example  6.5//  Power
clc;
clear;
close;
//given data :
format('v',6)
fp=0.024;// flux per pole
lf=1.2;// leakage factor
fi=fp/lf;// in Wb
Z=756;//turns
P=4;// number of pole
N=1000;// in rpm
A=4;//constant
E=(fi*Z*N*P)/(60*A);//generated voltage
il=1/10;//load current in amperes
ish=1/100;//shunt current in amperes
ra=1;//armature resistance in ohms
is=il+ish;//current in amperes
v=((E)/(1+(ra*is)));//volts
r2=10;//ohms
il=v/r2;//amperes
pc=il*v;//Watts
disp(pc,"Power consumed is,(W)=")
//answer is wrong in the textbook
```

Scilab code Exa 6.6 emf generated copper losses output and commercial mechanical and electrical efficiencies

```
//Example 6.6: e.m.f ,copper losses ,output of the
    prime mover ,commercial, mechanical and
    electrical efficiencies
clc;
clear;
close;
format('v',6)
//given data :
Il=190;//load current in Amperes
V=250;// voltage in volts
Ra=0.02;//armature resistance in ohm
Rsh=25;//shunt resistance in ohm
Ish=V/Rsh;//shunt current in amperes
Ia=Ish+Il;//armature current in amperes
E=V+(Ia*Ra);//generated voltage
disp("part (a)")
disp(E,"emf genereted,(V) = ")
Cl=(Ia^2*Ra);// armeture copper losses
Sl=Ish*V;// shunt copper losses
T=(Cl+Sl)*10^-3;//copper losses in k-Watt
disp("part (b)")
disp(T,"Total copper losses,(kW) = ")
Eo=V*Il;//output voltage in volts
I_l=950;//iron loss in watt
O=Eo+I_l+(T*10^3);//output in watt
disp(O,"Output of the prime mover,(W) = ")
Ep=O-I_l;// electrical power in W
Me=(Ep/O)*100;//Mechanical efficiency
disp("part (c)")
disp(Me,"Mechanical efficiency,(%) = ")
Ee=(Eo/Ep)*100;//Electrical efficiency
```

```
disp(Ee,"Electrical efficiency ,(%) = ")
Ce=(Eo/O)*100;//Commercial efficiency
disp(Ce,"Commercial efficiency ,(%) = ")
```

Scilab code Exa 6.7 resistance

```
//Example 6.7// resistance
clc;
clear;
close;
format('v',6)
n=1000;//turns in rpm
ra=0.3;//armature resistance in ohms
rf=40;//field resistance in ohms
it=5;//field current in amperes
if1=4;//field current in amperes
e1=220;//emf in volts
e2=200;//emf in volts
ia=35;//armature current in amperes
eb=(e1-(ia*ra));//emf in volts
x=((eb-e2)/(it*if1));//additional field current in
   amperes
ce=e1-e2;//change in emf in volts
ix=if1+x;//total current in amperes
rt=(e1/ix);//total resistance in ohms
adr=rt-rf;//additional resistance required in ohms
disp(adr,"additional resistance required is ,(Ohm)=")
```

Scilab code Exa 6.8 resistance and speed

```
//Example 6.8// resistance and speed
clc;
clear;
```

```
close;
format('v',7)
v1=240;//primary voltage
r1=0.2;//primary resistance in ohm
i1=40;//primary current in volts
eb1=(v1-i1*r1);//primary emf
n11=1800;//number of turns on primary side in rpm
n21=1600;//number of turns on secondary side in rpm
i2=10;//secondary current in amperes
x=((n21/n11)*(i2/i1)*eb1);//variable
r=((v1-(i2*r1))-x)/i2;//resistance in ohm
disp("part (a)")
disp(r,"resistance to be added is,(Ohm)=")
disp("part (b)")
n11=1800;//number of turns on primary side
n21=900;//number of turns on secondary side in rpm
i2=60;//secondary current in amperes
x=((n21/n11)*(1.18)*eb1);//variable
r=((v1-(i2*r1))-x)/i2;//resistance in ohms
disp(r,"resistance to be added is,(Ohm)=")
eb2=228;//secondary emf in volts
eb1=232;//primary emf in volts
p1=100;//primary power in watt
p2=118;//secondary power in watt
n2=((eb2/eb1)*(p1/p2)*n11);//speed in rpm
disp(ceil(n2),"speed is,(rpm)=")
```

Scilab code Exa 6.9 speed

```
//Example 6.9// speed
clc;
clear;
close;
format('v',6)
i1=50;//primary current in amperes
```

```
i2=i1/(sqrt(2));//secondary current in amperes
r1=0.2;//primary resistance in ohms
v1=220;//primary voltage in volts
eb1=((v1-(i1*r1)));//primary emf in volts
eb2=((v1-(i2*r1)));//secondary emf in volts
n1=1000//primary speed in rpm
n2=(n1*(eb2/eb1)*(i1/i2));//seconadry speed in rpm
disp(n2,"speed is ,(rpm)=")
```

Scilab code Exa 6.10 speed and frequency

```
//Example 6.10// Speed ,motor speed,and frequency
clc;
clear;
close;
format ('v',8)
//given data :
disp("part (a)")
f=50;//frquency  in Hz
P=4;// number of pole
Ns=(120*f)/P;//speed in rom
disp(Ns," The speed of rotating magnetic field ,(rpm) = ")
disp("part (b)")
S=0.035;// slip
N=Ns*(1-S);//motor speed in rpm
disp(N,"Motor speed ,(rpm) = ")
disp("part (c)")
S=0.04;// slip
F=S*f;//frequency in Hz
disp("Frequency "+string (F)+" Hz or "+string(120)+" rpm ")
disp("part (d)")
f=50;// in Hz
F=f;//frequency in Hz
```

```
disp(F,"Frequency of rotor current ,(Hz) = ")
```

Scilab code Exa 6.11 current per phase and power factor

```
//Example 6.11// current per phase and power factor
clc;
clear;
close;
format('v',6)
v1=100;//emf in volts
vi=v1/sqrt(3);//induced emf in volts
r1=1;//rotor resistance ohms per phase
r2=4;//rotor reactance ohms per phase
r=sqrt(r1^2+r2^2);//rotor impedence per phase
rcp=(vi/r);//rotor current per phase
pf=(1/r);//power factor
disp("part (a)")
disp(rcp,"rotor current per phase is ,(A)=")
disp(pf,"power factor is ,=")
r3=3;//ohms
r4=r1+r3;//rotor resistance ohms per phase
r2=4;//rotor reactance ohms per phase
r=sqrt(r4^2+r2^2);//rotor impedence per phase
rcp=(vi/r);//rotor current per phase
pf=(r4/r);//power factor
disp("part (b)")
disp(rcp,"rotor current per phase is ,(A)=")
disp(pf,"power factor is ,=")
```

Scilab code Exa 6.12 emf

```
//Example 6.12// emf
clc;
```

```
clear;
close;
format('v',7)
disp("part (a) generator ")
kva=4;//kVA
v=110;//volts
re=3;//syncronous reacrance in ohms
ip=((kva*10^3)/(sqrt(3)*v));//phase current in Amperes
ep=v/(sqrt(3));//phase voltage in volts
e1=ep+%i*(ip*3);//line voltage in volts
e11=sqrt((real(e1)^2)+imag(e1)^2);//line voltage per phase in volts
pf=0.8;//power factor
e12=(sqrt((real(e1)*pf)^2+(((imag(e1)*sqrt(1-pf^2))+imag(e1)))^2));//
e13=(sqrt((real(e1)*pf)^2+(((imag(e1)*sqrt(1-pf^2))-imag(e1)))^2));//
disp(e11,"emf when the armature current is full load unit pf is,(V)=")
disp(e12,"emf when the armature current is full load 0.8 pf (lag) is,(V)=")
disp(e13,"emf when the armature current is full load 0.8 pf (lead) is,(V)=")
disp("part (b) motor")
kva=4;//kVa
v=110;//volts
re=3;//syncronous reacrance in ohms
ip=((kva*10^3)/(sqrt(3)*v));//phase current in Amperes
ep=v/(sqrt(3));//phase voltage in volts
e1=ep-%i*(ip*3);//line voltage in volts
e11=sqrt((real(e1)^2)+imag(e1)^2);//line voltage per phase in volts
pf=0.8;//power factor
e12=(sqrt((real(e1)*pf)^2+(((imag(e1)*sqrt(1-pf^2))-imag(e1)))^2));//
e13=(sqrt((real(e1)*pf)^2+(((imag(e1)*sqrt(1-pf^2))+
```

```
    imag(e1)))^2));//
disp(e11,"emf  when the armature current is full
    load unit pf is,(V)=")
disp(e12,"emf  when the armature current is full
    load 0.8 pf (lag) is,(V)=")
disp(e13,"emf  when the armature current is full
    load 0.8 pf (lead) is,(V)=")
```

Chapter 7

ELECTROTHERMAL ENERGY CONVERSION

Scilab code Exa 7.1 length and width

```
//Example  7.1// width and length
clc;
clear;
close;
format('v',6)
vph=400;//phase voltage in volts
n=3;//number of phase
kw=36;//power in kW
r=((vph^2)/(n*((kw*10^3)/n)));//resistance in ohms
p=1.016*10^-6;//resitivity
t=0.3;//thickness in mm
x=(((r*t*10^-3)/(p)));//variable
t1=1000;//initial temperature in degree celsius
t1k=273+t1;//initial temperature in kelvin
t2=650;//final temperature in degree celsius
t2k=273+t2;//final temperature in kelvin
h=((3*10^4)*((t1k/1000)^4-(t2k/1000)^4));//W/m^2
y=((kw*10^3)/(3*2*h));//variable
l=sqrt(x*y);//length in meter
```

```
w=y/l;//width in meter
disp(l,"length is ,(m)=")
disp(w*10^3,"width is ,(mm)=")
```

Scilab code Exa 7.2 power required

```
//Example  7.2// power required
clc;
clear;
close;
format('v',6)
l=0.2;//length in meter
w=0.1;//width in meter
th=25;//thickness in mm
vw=l*w*th*10^-3;//volume in m^3
ww=600;//weight of wood in kg/m^3
ww1=vw*ww;//weight of wood kg
shw=1500;//specific heat of wood in J/kg/degree
    celsius
t=200;//temperature in degree celsius
rg=t*shw*ww1;//energy in joules
h=(rg/(3.6*10^3));//Wh
t=15;//time in minutes
pr=h*(60/t);//power required in Watt
disp(pr,"power required is ,(W)=")
```

Scilab code Exa 7.3 voltage and current

```
//Example  7.3// voltage and current
clc;
clear;
close;
l=0.2;//length meter
```

```
w=0.1;//width in meter
th=25;//thickness in mm
vw=l*w*th*10^-3;//volume of wood in m^3
ww=600;//weight of wood in kg/m^3
ww1=vw*ww;//weight of wood kg
shw=1500;//specific heat of wood  in J/kg/degree celsius
t=200;//temperature in degree celsius
rg=t*shw*ww1;//energy in joules
h=(rg/(3.6*10^3));//Wh
t=15;//time in minutes
pr=h*(60/t);//power required in Watt
eo=8.854*10^-12;//permittivity constant
er=5;//permittivity of wood
c=((eo*er*l*w)/(th*10^-3));//capacitance in Farads
f=50;//frequency in MHz
pf=0.5;//power factor
ph=acosd(pf);//phase angle degree
v=sqrt((pr)/(c*2*%pi*f*10^6*0.05));//voltage in volts
disp(round(v),"voltage is ,(V)=")
ic=v*2*%pi*f*10^6*c;//current in amperes
disp(ic,"current is ,(A)=")
```