Scilab Textbook Companion for Electrical Power-1 Transmission And Distribution Of Electrical Power by M. L. Anand[1]

Created by
Ashish Kumar
B.Tech
Mechanical Engineering
Uttarakhand Tech. University
College Teacher
Arshad Khan
Cross-Checked by
Mukul Kulkarni

December 12, 2013

[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: Electrical Power-1 Transmission And Distribution Of Electrical Power

Author: M. L. Anand

Publisher: Satya Prakashan, New Delhi

Edition: 1

Year: 2006

ISBN: 81-7684-317-2

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 Line current and Power Consumed

```
//Exa 1.1
clc;
clear;
close;
//Given data :
format('v',6);
R=4;//in ohm
XL=3;//in ohm
VL=400;//in volt
Vph=VL/sqrt(3);//in volt
Zph=sqrt(R^2+XL^2);//in ohm
Iph=Vph/Zph;//in Ampere
//In star connected IL=Iph
IL=Iph;//in Ampere
disp(IL,"Line Current (in A) :");
cosfi=R/Zph;//unitless
PowerConsumed=sqrt(3)*VL*IL*cosfi;//in watts
disp(PowerConsumed,"Total power consumed by the load
    (in Watts)");
```

Scilab code Exa 1.2 Value of resistor and chane in line Voltage

```
//Exa 1.2
clc;
clear;
close;
//Given data :
format('v',6);
VL=440;//in volt
IL=10;//in Ampere
//In star connected :
disp("In star connected :");
Iph=IL;//in Ampere
Vph=VL/sqrt(3);//in volt
Rph=Vph/Iph;//in ohm
disp(Rph,"Value of each resistor(in ohm) :");
//In delta connected :
disp("In delta connected :");
Iph=IL/sqrt(3);//in Ampere
Vph=Iph*Rph;//in volt
disp(Vph,"Voltage in delta connection(in volt) :");
disp("Voltage needed is 1/3rd, the voltage in star
    connection.")
```

Scilab code Exa 1.3 Line current power factor and power consumed

```
//Exa 1.3
clc;
clear;
close;
//Given Data :
format('v',6);
```

```
R=16;//in ohm
L=38.2;//in mH
L=38.2*10^-3;//in H
VL=400;//in volt
f=50;//in Hz
XL=2*%pi*f*L;//in ohm
Zph=sqrt(R^2+XL^2);//in ohm
//In star connected :
Vph=VL/sqrt(3);//in volt
Iph=Vph/Zph;//in Ampere
IL=Iph;//in Ampere
disp(IL,"Line Current (in A) :");
cosfi=R/Zph;//unitless
disp(cosfi,"Power factor : ");
P=sqrt(3)*VL*IL*cosfi;//in watts
disp(P/10^3,"Total power consumed by the load (in kW
    )");
```

Scilab code Exa 1.4 Phase current and line current

```
//Exa 1.4
clc;
clear;
close;
//Given Data :
format('v',6);
R=15;//in ohm
X=40;//in ohm
VL=440;//in volt
//In delta connection :
Vph=VL;//in volt
Zph=sqrt(R^2+X^2);//in ohm
Iph=Vph/Zph;//in Ampere
disp(Iph,"Phase Current(in A) :");
IL=Iph*sqrt(3);//in Ampere
```

```
disp(IL,"Linee Current(in A) :");
```

Chapter 2

Layout of Transmission Systems

Scilab code Exa 2.1 Most Economical cross section

```
//Exa 2.1
clc;
clear;
close;
//Given Data :
format('v',7);
//CableCost=20+400*a;//in Rs./meter (a=cross section
    in cm^2)
//Cable_cost=(20+400*a)*1000;//in Rs./meter
l=1;//in Km
P=1;//in MW
V=11;//in KV
cosfi=0.8;//powerfactor
h=3000;//hours
i=10;//in %
E_cost=15;//in paisa/kwh
rho=1.75*10^-6;//sp. resistance in ohm-cm
//C1=CableCost*1000;//in Rs./km
disp("Cost of 1km cable=Rs"+string(20*1000)+"+"+
    string(400*1000)+"a");
//R=rho*l*10^3/(a*10^-2);//in ohm
```

```
disp("Resistance of 1km cable(in ohm) = "+string(rho*l*10^3/(10^-2))+"/a");
Ifl=(P*10^6)/(V*10^3*cosfi);//in Ampere
disp(Ifl,"Full load current(in Ampere) :");
//Ploss=2*I^2*R;//in Watts
disp("Power loss in the cable(in watts) : "+string(2*Ifl^2*rho*l*10^3/(10^-2))+"/a");
//Annual_cost=Ploss*10^-3*h*E_cost/100;//in Rs.
disp("Annual cost of energy(in Rs.) : "+string(2*Ifl^2*rho*l*h*E_cost/(10^-2))+"/a");
//AnnualCost2=400*10^3*a*i/100;//in Rs.
disp("AnnualCost of interest and depriciation(in Rs.)="+string(400*10^3*i/100)+"a");
disp("Using Kelvin law for most ecpnomical cross sectional area :");
a=2032.5/40000;
disp(a,"Most economical cross section(in cm^2) :");
```

Scilab code Exa 2.2 Weight of copper

```
//Exa 2.2
clc;
clear;
close;
//Given Data :
format('v',9);
Pt=30*10^6;//in watt
V=220*10^3;//in volt
l=275*10^3;//in meter
R=0.173;//in ohm/km
Eta=90;//in %
density=8.9;//copper density
Loss=100-Eta;//in %
cosfi=0.8;//powerfactor
disp("3-phase 3 wire :");
```

```
IL=Pt/(sqrt(3)*V*cosfi);//in Ampere
LineLosses=(Loss/100)*Pt;//in watts
rho=R*10^-4/(1*10^3);//in ohm-meter
a=3*IL^2*rho*l/(LineLosses);//in m^2
Volume=3*a*l;//in m^3
Cu_weight=Volume*density;//in Tones
disp(Cu_weight,"Weight of copper(in Tones) : ");
disp("Single phase 2 wire :");
IL=Pt/(V*cosfi);//in Ampere
a=2*IL^2*rho*l/(LineLosses);//in m^2
Volume=2*a*l;//in m^3
Cu_weight=Volume*density;//in Tones
disp(Cu_weight,"Weight of copper(in Tones) : ");
//Note : answer is not accurate in the book.
```

Scilab code Exa 2.3 Most Economical cross section

```
//Exa 2.3
clc;
clear;
close;
//Given Data :
format('v',9);
l=1;//in Km
l=l*10^5;//in cm
I=200;//in Ampere
//CableCost=50*a;//in Rs./meter (a=cross section in
   cm^2)
E_cost=5;//in paisa/kwh
i=10;//in %
rho=1.72*10^-6;//resistivity in ohm-cm
//R=rho*l/a;//in ohm
disp("Resistance of cable(in ohm) = "+string(rho*l)+
   "/a");
//Eloss=2*I^2*R*24*365/1000;//in kwh
```

```
disp("Power loss in the cable(in kwh) : "+string(2*I^2*rho*l*24*365/1000)+"/a");
//AnnualCost2=(E_cost/100)*2*I^2*rho*l*24*365/1000a;//in Rs.
disp("AnnualCost of Energy Lost(in Rs.)="+string((E_cost/100)*2*I^2*rho*l*24*365/1000)+"/a");
//C1=CableCost*1000;//in Rs./km
disp("Cost of 1km cable=Rs"+string(50*1000)+"/a");
//AnnualCharges=C1*i/100;//in Rs.
disp("Annual chrges on account of interest and depriciation(in Rs.) : "+string(50*1000*i/100)+"a");
disp("For most ecpnomic cross section :");
a=sqrt(6026.88/5000);
disp(a,"Most economical cross section(in cm^2) :");
```

Scilab code Exa 2.4 Most Economical cross section

```
//Exa 2.4
clc;
clear;
close;
//Given Data :
format('v',9);
l=4*10^5;//in cm
VL=30;//in KV
//LineCost=40000*a+7500;//in Rs/km
i=8;//in %
E_cost=4;//in paisa/kwh
rho=1.72*10^-6;//in ohm-cm
//R=rho*l/a;//in ohm
disp("Resistance of cable(in ohm) = "+string(rho*l)+"/a");
P1=3*10^6;//in watt
h1=10;//in hours
```

```
cosfi1=0.8//unitless
I1=P1/(sqrt(3)*VL*10^3*cosfi1);//in Ampere
P2=1.5*10^6;//in watt
h2=6;//in hours
cosfi2=0.9//unitless
I2=P2/(sqrt(3)*VL*10^3*cosfi2);//in Ampere\
P3=0.5*10^6;//in watt
h3=8;//in hours
cosfi3=0.9;//unitless
I3=P3/(sqrt(3)*VL*10^3*cosfi3);//in Ampere
//Etot=3*(I1^2*h1+I2^2*h2+I3^2*h3)*R*365/1000;//in kwh
//Ccost_line=40000*a*4;//in Rs.
//AnnualCharges=Ccost_line*i/100;//in Rs.
disp("Annual chrges on account of interest and depriciation(in Rs.) : "+string(40000*4*i/100)+"a ");
//AnnualCost2=(E_cost/100)*Etot ;//in Rs.
disp("AnnualCost of Energy Lost(in Rs.)="+string((E_cost/100)*3*(I1^2*h1+I2^2*h2+I3^2*h3)*rho*l*365/1000)+"/a");
disp("For most ecpnomic cross section :");
a=sqrt(1783/12800);
disp(a,"Most economical cross section(in cm^2) :");
```

Scilab code Exa 2.5 Most Economical size

```
//Exa 2.5
clc;
clear;
close;
//Given Data :
format('v',7);
P=5*10^6;//in watt
VL=33*10^3;//in volt
```

```
cosfi=0.8//unitless
//LineCost=31250*a+4000;//in Rs/km
rho=10^-6;//in ohm-cm
i=8;//in %
E_cost=4;//in paisa/kwh
IL=P/(sqrt(3)*VL*cosfi);//in Ampere
//Line_length=l*10^5;//in cm
//R=rho*l*10^5/a;//in ohm
disp("Resistance of cable(in ohm) = "+string(rho*10^5)+"(l/a)");
//E_lost=3*IL^2*R*365/1000;//in kwh
disp("Total Energy Lost per annum in 3 conductor(in kwh)="+string(3*IL^2*rho*10^5*365/1000)+"(l/a)");
//Ccost_line=31250*a*l;//in Rs.
//AnnualCharges=Ccost_line*i/100;//in Rs.
disp("Annual chrges on account of interest and depriciation(in Rs.) : "+string(31250*i/100)+"(a*l)");
disp("For most ecpnomic cross section :");
a=sqrt(1309.33/2500);
disp(a,"Most economical cross section(in cm^2) :");
```

Scilab code Exa 2.6 Volume and weight of conducting mterial

```
//Exa 2.6
clc;
clear;
close;
//Given Data :
format('v',8);
P=50*10^6;//in watt
VL=220*10^3;//in volt
cosfi=0.8//unitless
Eta=90;//in %
l=200*10^3;//in meter
```

```
rho=1.75*10^-8;//in ohm-cm
W=P*(100-Eta)/100;//in Wats(Line losses)
//Part (i) : 3 phase 3 wire with Cu condutor
gravity=8.9;//specific gravity
IL=P/(sqrt(3)*VL*cosfi);//in Ampere
a=3*IL^2*rho*l/W;//in m^2
Vol3=3*a*l;//volume of 3 lines(in m^3)
CuWeight=Vol3*gravity;//in Tones
disp(CuWeight,"Weight of copper(in Tones) :");
//Part (ii) : When Al conductor is used.
gravity=2.7;//specific gravity
rho=3*10^-8;//in ohm-meter
a=3*IL^2*rho*(l/W);//in m^2
Vol=3*a*l;//volume of 3 lines(in m^3)
AlWeight=Vol*gravity;//in Tones
disp(AlWeight,"Weight of Alluminium(in Tones) :");
```

Scilab code Exa 2.7 Three phase Load

```
//Exa 2.7
clc;
clear;
close;
//Given Data :
format('v',8);
//Vcon=V;//in volt
//pf=cosfi;//unitless
//Rcon=R;//in ohm
//Part (i) : single phase system
disp("Single phase system :");
P1=15*10^6;//in watt
//I1=P1/(V*cosfi);//in Ampere
disp("Line current,I1="+string(P1)+"/V*cosfi");
//W1=2*I1^2*R;//in Wats(Line losses)
disp("Line Losses,W1="+string(2*P1^2)+"R/(V*cosfi)^2
```

```
");
//Lloss_percent=W1*P1/100;//in %          eqn(1)
disp("% Line Losses="+string(2*P1^2*100/P1)+"R/(V*cosfi)^2");
//Part (ii) : 3 phase 3 wire system
disp("3 phase 3 wire system :");
//I2=P2/(V*cossfi*sqrt(3));//in Ampere
disp("Line current,I2="+string(10^6/sqrt(3))+"P2/V*cosfi");
//W1=2*I2^2*R;//in Wats(Line losses)
disp("Line Losses,W2="+string(2*(10^6/sqrt(3))^2)+"R*P2^2/(V*cosfi)^2");
//Lloss_percent=W2*P2/100;//in %          eqn(2)
disp("% Line Losses="+string(3*(10^6/sqrt(3))^2)+"R*P2^2/(V*cosfi)^2");
P2=2*P1;//in watts
disp(P2/10^6,"3 phase load in MW :");
```

Scilab code Exa 2.8 Percentage saving of copper

```
//Exa 2.8
clc;
clear;
close;
//Given Data :
format('v',8);
disp("Assumptions : ");
disp("Power to be transmitted is the same(say, P watts)");
disp("Length of the line is the same(say, l meters)");
disp("Losses in the line are the same(say, W watts)");
//I=P/V;//in Ampere
//a=2*I^2*R=2*(P/V)^2*rho*l/W;//in m^2
```

```
//volume=2*a*l;//
disp("Volume of copper required for 2 wires=K/V^2")
//(i) When V=220 volts
V1=220;//in volts
disp("Vol1=K*"+string(1/V1^2));
//(ii) When V=500 volts
V2=500;//in volts
disp("Vol2=K*"+string(1/V2^2));
saving=((1/V1^2)-(1/V2^2))*100/(1/V1^2);//in
disp(saving,"% saving in copper : ");
```

Scilab code Exa 2.9 Volume of conducting material

```
//Exa 2.9
clc;
clear;
close;
//Given Data :
format('v',6);
P=30*10^6;//in watts
V=220*10^3;//in Volt
l=250*10^3;//in meter
Eta=85;//in %
rho=3*10^-8;//in ohm-meter
cosfi=0.8;//power factor
W=P*(100-Eta)/100;//in watts
I=P/(sqrt(3)*V*cosfi);//in Ampere
a=3*I^2*rho*l/W;//in m^2
Volume=3*a*l;//in m^3
disp(Volume,"Volume of the conductor material(in m
    ^3) :");
```

Scilab code Exa 2.10 Volume and weight of conducting material

```
//Exa 2.10
clc;
clear;
close;
//Given Data :
format('v',6);
P=20*10^6;//in VA
cosfi=0.75;//power factor
P=20*10^6*cosfi;//in watts
V=33*10^3;//in Volt
l=20*10^3;//in meter
Eta=85;//in %
rho=3*10^-8;//in ohm-meter
W=P*(100-Eta)/100;//in watts
//For single phase system :
I=P/(V*cosfi);//in Ampere
a1=2*I^2*rho*l/W;//in m^2
V1=2*a1*l;//in m^3
disp(V1,"For single phase system :Volume of the
    conductor material(in m^3) :");
//For 3 phase 3 wire system :
I=P/(sqrt(3)*V*cosfi);//in Ampere
a2=3*I^2*rho*l/W;//in m^2
V2=3*a2*l;//in m^3
disp(V2,"For three phase 3-wire system :Volume of
    the conductor material(in m^3) :");
```

Scilab code Exa 2.11 Most Economical cross section

```
//Exa 2.11
clc;
clear;
close;
//Given Data :
format('v',8);
```

```
l=1*10^3;//in meter
IL=300;//in Ampere
//CableCost=100*a;//in Rs/meter : a=cross sectional area(in cm^2)
i=10;//in %
Rate=10;//in Rs/kwh
rho=1.85*10^-6;//in ohm-cm
//R=rho*l/a;//in ohm
disp("Resistance of cable(in ohm) = "+string(rho*l*100)+"/a");
//Eloss=2*I^2*R*365*24/1000;//in kwh
disp("Energy loss per annum in 2 conductors(in kwh) : "+string(2*IL^2*rho*l*100*365*24/1000)+"/a");
//AnnualCost=Eloss/Rate;//in Rs
//Ccost=100*a*l;//in Rs
disp("Annual chrges on account of interest and depriciation(in Rs.) : "+string(100*l*Rate/100)+"a");
disp("For most ecpnomic cross section :");
a=sqrt(29170.8/10000);
disp(a,"Most economical cross section(in cm^2) :");
```

Scilab code Exa 2.12 Three phase Load

```
//Exa 2.12
clc;
clear;
close;
//Given Data :
format('v',8);
//Vcon=V;//in volt
//pf=cosfi;//unitless
//Rcon=R;//in ohm
//Part (i) : single phase system
disp("Single phase system :");
```

```
P1=5*10^6;//in watt
//I1=P1/(V*cosfi);//in Ampere
disp("Line current,I1="+string(P1)+"/V*cosfi");
//W1=2*I1^2*R;//in Wats(Line losses)
disp("Line Losses,W1="+string(2*P1^2)+"R/(V*cosfi)^2");
//Lloss_percent=W1*P1/100;//in %          eqn(1)
disp("% Line Losses="+string(2*P1^2*100/P1)+"R/(V*cosfi)^2");
//Part (ii) : 3 phase 3 wire system
disp("3 phase 3 wire system :");
//I2=P2/(V*cossfi*sqrt(3));//in Ampere
disp("Line current,I2="+string(10^6/sqrt(3))+"P2/V*cosfi");
//W1=2*I2^2*R;//in Wats(Line losses)
disp("Line Losses,W2="+string(2*(10^6/sqrt(3))^2)+"R*P2^2/(V*cosfi)^2");
//Lloss_percent=W2*P2/100;//in %          eqn(2)
disp("% Line Losses="+string(3*(10^6/sqrt(3))^2)+"R*P2^2/(V*cosfi)^2");
P2=2*P1;//in watts
disp("3 phase load in MW :"+string(P2/10^6));
```

Scilab code Exa 2.13 Percentage saving of copper

```
//Exa 2.13
clc;
clear;
close;
//Given Data :
format('v',8);
disp("Assumptions : ");
disp("Power to be transmitted is the same(say, P watts)");
disp("Length of the line is the same(say, l meters)"
```

```
    );
disp("Losses in the line are the same(say, W watts)"
    );
//I=P/V;//in Ampere
//a=2*I^2*R=2*(P/V)^2*rho*l/W;//in m^2
//volume=2*a*l;//
disp("Volume of copper required for 2 wires=K/V^2")
//(i) When V=200 volts
V1=200;//in volts
disp("Vol1=K*"+string(1/V1^2));
//(ii) When V=600 volts
V2=600;//in volts
disp("Vol2=K*"+string(1/V2^2));
saving=((1/V1^2)-(1/V2^2))*100/(1/V1^2);//in
disp(saving,"% saving in copper : ");
```

Chapter 3

Costructional mechanial feature of line

Scilab code Exa 3.1 Voltage across disc and string efficiency

```
//Exa 3.1
clc;
clear;
close;
//Given Data :
format('v',6);
m=1/10;//unitless
EL=66;//in KV
E=EL/sqrt(3);//in KV
//Formula : E=E1+(11/10)*E1+(131/100)*E1+(1651/1000)
    *E1=(5061/1000)*E1
E1=E*(1000/5061);//in KV
disp(E1,"E1(in KV) :");
E2=E1*(11/10);//in KV
disp(E2,"E1(in KV) :");
E3=E1*(131/100);//in KV
disp(E3,"E2(in KV) :");
E4=E1*(1651/1000);//in KV
disp(E4,"E4(in KV) :");
```

```
Eta=(E/(4*E4))*100;//in %
disp(Eta,"String Efficiency(in %) :");
```

Scilab code Exa 3.2 Horizontal and vertical sag

```
//Exa 3.2
clc;
clear;
close;
//Given Data :
format('v',6);
W=0.85;//in Kg/meter
L=250;//in meter
Ww=1.4;//in Kg
SafetyFactor=5;//unitless
UTS=10128;//Ultimate tensile strength in Kg
T=UTS/SafetyFactor;//in Kg
Wi=0;//there is no ice
Wr=sqrt((W+Wi)^2+Ww^2);//in Kg
S=Wr*L^2/(8*T);//in meter
Sv=(W/Wr)*S;//in meter
disp(S,"Horizontal sag(in m) :");
disp(Sv,"Vertical sag(in m) :");
```

Scilab code Exa 3.3 sag

```
//Exa 3.3
clc;
clear;
close;
//Given Data :
format('v',5);
L=150;//in meter
```

```
A=2;//in cm^2(cross sectional area)
US=5000;//in Kg/cm^2(ultimate strength)
g=8.9;//specific gravity
Ww=1.5;//in Kg/m(wind pressure)
SafetyFactor=5;//unitless
B_strength=2*US;//in Kg
T=B_strength/SafetyFactor;//in Kg
Volume=A*100;//in cm^2
Wc=1.78;//in Kg/m
Wr=sqrt(Wc^2+Ww^2);//in Kg
Sag=Wr*L^2/(8*T);//in meter
disp(Sag,"Sag(in m) :");
```

Scilab code Exa 3.4 Find sag

```
//Exa 3.4
clc;
clear;
close;
//Given Data :
format('v',4);
L=160;//in meter
d=0.95;//in cm
A=%pi*d^2/4;//in cm^2(cross sectional area)
US=4250;//in Kg/cm^2(ultimate strength)
g=8.9;//specific gravity
Ww=1.5;//in Kg/m(wind pressure)
SafetyFactor=5;//unitless
B_strength=2*US;//in Kg
T=B_strength/SafetyFactor;//in Kg
Volume=A*100;//in cm^2
Wc=1.78;//in Kg/m
Wr=sqrt(Wc^2+Ww^2);//in Kg
Sag=Wr*L^2/(8*T);//in meter
disp(Sag,"Sag(in m) :");
```

```
//Note : Answer in the book is not accurate.
```

Scilab code Exa 3.5 Clearance between conductors

```
//Exa 3.5
clc;
clear;
close;
//Given Data :
format('v',7);
m=75-45;//in meter
L=300;//in meter
T=2500;//in Kg
w=0.9;//in kg/meter
x=L/2-T*m/(w*L);//in meters
disp(x,"x=");
disp("The negative sign of x shows that point A is
    on the side of O.");
x=L/2-x;//in meter
disp("Centre point P from O is "+string(L/2-x)+"
    meters.");
y=w*x^2/(2*T);//in meter
disp("Height of point P, y= "+string(y))
x=L/2-T*m/(w*L);//in meters
z=w*(L-x)^2/(2*T);//in meters
disp("Height of B above O is , z="+string(z)+" meters
    .");
disp("The mid point of the line is "+string(z-y)+"
    meter below point B, i.e., "+string(75-(z-y))+"
    meter above water level.");
```

Scilab code Exa 3.6 Factor of safety

```
//Exa 3.6
clc;
clear;
close;
//Given Data :
format('v',5);
L=60;//in meter
S=25*10^-2;//in meter
A=61.36;//in mm^2(cross sectional area)
W=0.5445;//in Kg/m
UTS=42.20;//in Kg/mm^2
T=W*L^2/(8*S);//in Kg
B_strength=UTS*A;//in Kg
SafetyFactor=B_strength/T;//unitless
disp(SafetyFactor,"Factor of safety : ");
```

Scilab code Exa 3.7 Maximum sag

```
//Exa 3.7
clc;
clear;
close;
//Given Data :
format('v',5);
L=220;//in meter
W=0.604;//in Kg/m
T_strength=5758;//in Kg
SafetyFactor=2;//unitless
T=T_strength/SafetyFactor;//in Kg
S=W*L^2/(8*T);//in meter
disp(S,"Sag(in meter) : ");
```

Scilab code Exa 3.8 Height above the ground

```
//Exa 3.8
clc;
clear;
close;
//Given Data :
format('v',6);
W=850/1000;//in Kg/m
US=7950;//in kg
L=275;//in meter
h=8;//in meter(ground clearance)
SafetyFactor=2;//unitless
T=US/SafetyFactor;//in Kg
S=W*L^2/(8*T);//in meter
H=h+S;//in meter
disp(H,"Height above the ground(in meter): ");
```

Scilab code Exa 3.9 Voltge distribution and string efficiency

```
//Exa 3.9
clc;
clear;
close;
//Given Data :
format('v',5);
m=1/9;//unitless
EL=33;//in KV
EbyE1=1+(1+m)+(1+3*m+m^2);//assumed
E=EL/sqrt(3);//in KV
E1=E/EbyE1;//in KV
disp(E1,"E1(in KV) :");
E2=(1+m)*E1;//in KV
disp(E2,"E2(in KV) :");
E3=(1+3*m+m^2)*E1;//in KV
disp(E3,"E3(in KV) :");
E=E1+E2+E3;//in KV
```

```
disp(E);
Eff=E/(3*E3);
disp(Eff*100,"String Efficiency(in %) : ");
```

Scilab code Exa 3.10 String Efficiency

```
//Exa 3.10
clc;
clear;
close;
//Given Data :
format('v',4);
//Applying KCL we get I1+i1=I2+ix and I2+i2=I3+iy
//On solving we get : 1*2*E1=1*1*E2+0*1*E3 and 0*2*
   E1=-1*2*E2+1*3*E3
E1byE=1/(1+(154/155)+(166/155));//assumed
E2byE=(154/155)*E1byE;//assumed
E3byE=(166/155)*E1byE;//assumed
Eff=1/((3*(166/155)*E1byE));
disp(Eff*100,"String Efficiency(in %) : ");
```

Scilab code Exa 3.11 sag in the line

```
//Exa 3.11
clc;
clear;
close;
//Given Data :
format('v',5);
L=200;//in meter
W=684/1000;//in Kg/m
T=1450;//in Kg
S=W*L^2/(8*T);//in meter
```

```
disp(S,"Sag(in meter) : ");
```

Scilab code Exa 3.12 Clculate vertical sag

```
//Exa 3.12
clc;
clear;
close;
//Given Data :
format('v',6);
L=220;//in meter
T=586;//in Kg
Wc=0.62;//in Kg
Ww=39.2*0.94/100;//in Kg
Wr=sqrt(Wc^2+Ww^2);//in Kg
cos_theta=Wc/Wr;//unitless
Sv=Wr*L^2*cos_theta/(8*T);//in meter
disp(Sv,"Sag(in meter) : ");
```

Chapter 4

Electrical Features of Lines 1

Scilab code Exa 4.1 Inductance per Km

```
//Exa 4.1
clc;
clear;
close;
//Given Data :
format('v',9);
r=1.213/2;//in cm
f=60;//in Hz
ds=0.77888*r;//in cm
spacing=1.25;//in meter
L=4*10^-7*log(spacing*100/ds);//in H/m
disp(L*1000,"Inductance(in H/km) :");
XL=2*%pi*f*L;//in ohm/m
disp(XL*1000*60,"Inductive reactance for 60 km line(
    in ohm) :");
```

Scilab code Exa 4.2 Inductance per phase per Km

```
//Exa 4.2
clc;
clear;
close;
//Given Data :
format('v',7);
d=2.8*100;//in cm(spacing)
r=0.5*1.5;//in cm
ds=0.77888*r;//in cm
L=0.2*log(d/ds);//in H/m/phase
disp(L*20,"Inductance per phase for a 20 km line (in
    mH) :");
```

Scilab code Exa 4.3 Resistance and Inducance of 1 km Line

```
//Exa 4.3
clc;
clear;
close;
//Given Data :
format('v',7);
a=1.5;//in cm^2
d=8;//in meter(spacing)
r=39.8/2;//in mm
l=1*10^5;//in cm
rho=1.73*10^-6;//in ohm-cm
R=rho*l/a;//in ohm/km
disp(R,"Resistance of line(in ohm/km) :");
ds=0.77888*r;//in cm
L=0.2*log(d/(ds*10^-3));//in mH/km/phase
disp(L,"Inductance per phase for a 1 km line (in mH/
    km) :");
```

Scilab code Exa 4.4 Find the capacitance

```
//Exa 4.4
clc;
clear;
close;
//Given Data :
format('v',6);
Cs=1/3;//in uF
Cc=(0.6-Cs)/2;//in uF
//Part (a) :
C1=(3/2)*Cc+(1/2)*Cs;//in uF(between any two
   conductor)
disp(C1,"Capacitance between any two conductor(in uF
   ) :");
//Part (b) :
C2=2*Cc+2*Cs/3
disp(C2,"Capacitance between any shorted onductors(
   in uF) :");
```

Scilab code Exa 4.5 Inductance and capacitance

```
//Exa 4.5
clc;
clear;
close;
//Given Data :
format('v',7);
d1=3;//in meter
d2=3;//in meter
d3=d1+d2;//in meter
d=378;//in cm
dia=2.5;//in cm
r=dia/2;//in cm
epsilon_o=8.854*10^-12;//constnt
```

```
L=(0.5+2*log10(d/r))*10^-7;//in H/m
disp(L*60*1000*1000,"Inductance for 60 km line(in mH
    ) :");
C=2*%pi*epsilon_o/log(d/r);//in F/m
disp(C*60*10^3*10^6,"Capacitnce for 60 km line(in uF
    ) :");
```

Scilab code Exa 4.6 Inductance per phase per Km

```
//Exa 4.6
clc;
clear;
close;
//Given Data :
format('v',5);
dinner=6;//in meter
douter=12;//in meter
d=(dinner^2*douter)^(1/3);//in meter
r=2.8;//in meter
ds=0.7788*r;//in cm
L=2*log10(d*100/ds);//in mH/phase/km
disp(L*100,"Inductance for 100 km line(in mH) :");
```

Scilab code Exa 4.7 Capacitance of single phase line

```
//Exa 4.7
clc;
clear;
close;
//Given Data :
format('v',9);
dia=5;//in mm
d=1.5;//in meter(spacing)
```

```
r=dia/2;//in mm
r=r*10^-3;//in meter
epsilon_o=8.854*10^-12;//constnt
C=%pi*epsilon_o/log(d/r);//in Farad per meter
disp(C*50*1000,"Capacitance for 50 km line(in Fardas
    ) :");
//Note : answer is not accurate in the book.
```

Scilab code Exa 4.8 Loop inductance per Km

```
//Exa 4.8
clc;
clear;
close;
//Given Data :
format('v',9);
d=300;//in cm(spacing)
r=1;//in cm
//Formula : L=10^-7*[mu_r+4*log10(d/r)];// in H/m
//Part (i) : mu_r=1
mu_r=1;//constant
L=10^-4*[mu_r+4*log(d/r)];//in H/m
disp(L*1000,"Loop inductance per km for copper(in mH
    ) :");
//Part (ii) : mu_r=100
mu_r=100;//constant
L=10^-4*[mu_r+4*log(d/r)];//in H/m
disp(L*1000,"Loop inductance per km for steel(in mH)
     :");
```

Scilab code Exa 4.9 Inductance per Km

```
//Exa 4.9
```

```
clc;
clear;
close;
//Given Data :
format('v',9);
d1=100;//in cm(spacing)
d2=100;//in cm(spacing)
d3=100;//in cm
r=1;//in cm
L=10^-7*[0.5+2*log((d1*d2*d3)^(1/3)/r)];//in H/m
L=L*1000*1000;//in mH/km
disp(L,"Inductance per km(in mH) :");
//Note : Answer in the book is wrong due to
    calculation mistake.
//Note : In the last line it should be multiply by
    10^6 to convert from H/m to mH/km instead of
    10^8.
```

Scilab code Exa 4.10 Inductance per Km

```
//Exa 4.10
clc;
clear;
close;
//Given Data :
format('v',9);
d1=2;//in cm
d2=2.5;//in cm
d3=4.5;//in cm
r=1.24/2;//in cm
L=10^-7*[0.5+2*log((d1*d2*d3)^(1/3)/r)];//in H/m
L=L*1000*1000;//in mH/km
disp(L,"Inductance per km(in mH) :");
//Note : Answer in the book is wrong(calculation
    mistake).
```

Scilab code Exa 4.11 Loop inductance per Km

```
//Exa 4.11
clc;
clear;
close;
//Given Data :
format('v',5);
r=0.75*10;//in mm
d=1.5*10^3;//in mm
ds=0.7788*r;//in mm
L=4*10^-7*log(d/ds);//in H/m
L=L*10^6;//in mH/km
disp(L,"Inductance of line(in mH/km) :");
```

Scilab code Exa 4.12 Inductance of 1 Km line

```
//Exa 4.12
clc;
clear;
close;
//Given Data :
format('v',5);
d1=4*100;//in cm
d2=5*100;//in cm
d3=6*100;//in cm
r=1;//in cm
ds=0.7788*r;//in cm
L=[0.2*log((d1*d2*d3)^(1/3)/ds)];//in mH
disp(L*10^3,"Inductance per km(in uH) :");
//Note : answer in the book is wrong.
```

Scilab code Exa 4.13 Capacitance of single phase overhead line

```
//Exa 4.13
clc;
clear;
close;
//Given Data :
format('v',5);
d=300;//in cm(spacing)
r=1;//in cm
epsilon_o=8.854*10^-12;//constnt
C=%pi*epsilon_o/log(d/r);//in Farad per meter
disp(C*30*1000*10^6,"Capacitance for 30 km line(in
    uF) :");
```

Scilab code Exa 4.14 Capacitance of 10 km long line

```
//Exa 4.14
clc;
clear;
close;
//Given Data :
format('v',5);
d=2.5*100;//in cm(spacing)
r=2/2;//in cm
epsilon_o=8.854*10^-12;//constnt
C=2*%pi*epsilon_o/log(d/r);//in Farad per meter
disp(C*10*1000*10^6,"Capacitance for 10 km line(in
    uF) :");
//Note : answer given in the book is wrong but
    calculated is right.
```

Scilab code Exa 4.15 capacitance of line and charging current

```
//Exa 4.15
clc;
clear;
close;
//Given Data :
format('v',6);
VL=33;//in KV
f=50;//in hz
d1=4;//in meter
d2=4;//in meter
d3=8;//in meter
d=(d1*d2*d3)^(1/3);//in meter
epsilon_o=8.854*10^-12;//constnt
d=d*100;//in cm
r=0.62;//in cm
C=2*%pi*epsilon_o/log(d/r);//in Farad per meter
disp(C*50*1000*10^6,"Capacitance for 50 km line(in
    uF) :");
Vp=VL/sqrt(3);//in KV
Vp=Vp*10^3;//in volt
Ic=2*%pi*f*(C*50*1000*10^6)*10^-6*Vp;//in Ampere
disp(Ic,"The charging current(in Ampere) :");
```

Chapter 5

Electrical Features of Lines 2

Scilab code Exa 5.1 Estimate of weight of copper

```
//Exa 5.1
clc;
clear;
close;
//Given Data :
format('v',6);
Load=100;//in MW
V=380;//in KV
d=100;//in km
rho=0.045;//in ohm/cm^2/km
w=0.01;//in kg/cm^3
Eff=90;//in %
IL=Load*10^6/(sqrt(3)*V*10^3);//in Ampere
P_loss=Load*(100-Eff)/100;//in MW
P_loss=P_loss*10^6;//in Watt
P_loss=P_loss/3;//in watt/conductor
R_con=P_loss/IL^2;//in ohm/conductor
//R_con=R_con/d;//in ohm/conductor/km
a=rho*d/R_con;//in cm^2
vol=a*d;//in cm^3
W_cu=vol*w;//in Kg
```

```
disp(W_cu*100*10^3*3,"Weight of Cu for 3 onductors
    of 100 km length(in Kg) :");
//Note : answer in the book is not accurate.
```

Scilab code Exa 5.2 Voltage between phase to neutral

```
//Exa 5.2
clc;
clear;
close;
//Given Data :
format('v',7);
R=2;//in ohm
X=6;//in ohm
P=10000*10^3;//in watts
cos_fir=0.8;//unitless
VR=22*10^3;//in volt
I=P/(sqrt(3)*VR*cos_fir);//in Ampere
VR_phase=VR/sqrt(3);//in volt
Vs=sqrt((VR_phase*cos_fir+I*R)^2+(VR_phase*sqrt(1-
    cos_fir^2)+I*X)^2);
disp(Vs,"Sending end voltage Vs(phase) :");
disp(((Vs-VR_phase)/VR_phase)*100,"% Regulation : ")
    ;
```

Scilab code Exa 5.3 Sending end voltage regulation and efficiency

```
//Exa 5.3
clc;
clear;
close;
//Given Data :
format('v',7);
```

```
l=10*10^3;//in meter
P_del=4000;//in KVA
cos_fir=0.9;//unitless
VL=11*10^3;//in volt
R=0.2*10;//in ohm/phase/10km
X=0.3*10;//in ohm/phase/10km
I=P_del*10^3/(sqrt(3)*VL);//in Ampere
VR_phase=VL/sqrt(3);//in volt
Vs=sqrt((VR_phase*cos_fir+I*R)^2+(VR_phase*sqrt(1-
    cos_fir^2)+I*X)^2);
disp(Vs*sqrt(3)/1000,"Sending end voltage Vs(line in
     KV) :");
disp(((Vs-VR_phase)/VR_phase)*100,"% Regulation : ")
    ;
Losses3line=3*I^2*R;//in watt
P_rec=P_del*cos_fir;//in KW
Pin=P_rec+Losses3line/1000;//in KW
ETA=P_rec/Pin;//unitless
disp(ETA*100,"Transmission Efficiency(in %) :")
cos_fis=(VR_phase*cos_fir+I*R)/Vs;//unitless
disp(cos_fis,"Sending end PF(lag) :");
```

Scilab code Exa 5.4 Sending end voltage PF and regulation

```
//Exa 5.4
clc;
clear;
close;
//Given Data :
format('v',7);
l=15*10^3;//in meter
Pt=10000;//in KW
cos_fir=0.8;//unitless
VL=33*10^3;//in volt
R=0.2*15;//in ohm/phase/15km
```

```
X=0.4*15;//in ohm/phase/15km
I=Pt*10^3/(sqrt(3)*VL*cos_fir);//in Ampere
VR_phase=VL/sqrt(3);//in volt
Vs=sqrt((VR_phase*cos_fir+I*R)^2+(VR_phase*sqrt(1-
    cos_fir^2)-I*X)^2);
disp(Vs*sqrt(3)/1000,"Sending end voltage Vs(line)
    in KV :");
cos_fis=(VR_phase*cos_fir+I*R)/Vs;//unitless
disp(cos_fis,"Sending end PF(leading) :");
disp(((Vs-VR_phase)/VR_phase)*100,"% Regulation : ")
    ;
```

Scilab code Exa 5.5 Line voltage Regulation and efficieny

```
//Exa 5.5
clc;
clear;
close;
//Given Data :
format('v',9);
Vs_line=33*10^3;//in volt
cos_fir=0.8;//unitless
P_KVA=6000;//in KVA
P_KW=P_KVA*cos_fir;//in KW
cos_fir=0.8;//unitless
impedence=2+%i*6;//in ohm
R=real(impedence);//in ohm
X=imag(impedence);//in ohm
Vs_phase=Vs_line/sqrt(3);//in volt
disp("Sending end Voltage, Vs(in Volt) = VR+I*R*
    cos_fir+I*X*sin_fir ");
disp("It gives polynomial p = [1 -Vs_phase P_KVA
    *10^3*R*cos_fir/sqrt(3)+P_KVA*10^3*X*sin_fir/sqrt
    (3)].")
sin_fir=sqrt(1-cos_fir^2);
```

```
p=[1 -Vs_phase P_KVA*10^3*R*cos_fir/sqrt(3)+P_KVA
    *10^3*X*sin_fir/sqrt(3)];
VR=roots(p);
VR=VR(1);//(root calculated using -ve sign is
    discarded in shreedharacharya method)
VR_line=VR*sqrt(3);//in volt
disp(VR_line/1000,"Line voltage at receiving end(in
    KV) :");
Regulation=((Vs_line-VR_line)/VR_line)*100;//
    unitless
disp(Regulation,"% Regulation : ");
I=P_KVA*10^3/(sqrt(3)*VR_line)
//I=P*10^3/(sqrt(3)*VR_line);//in Ampere
TotalLoss=3*I^2*R;//in watt
Pout=P_KVA*cos_fir;//in KW
Pin=Pout+TotalLoss/1000;//in KW
ETA=Pout/Pin;//unitless
disp(ETA*100,"Transmission Efficiency(in %) :");
```

Scilab code Exa 5.6 Estimate distance

```
//Exa 5.6
clc;
clear;
close;
//Given Data :
format('v',6);
P_del=10000*10^3;//in Watts
cos_fir=0.8;//unitless
R=0.95;//in ohm/km
VR=132*10^3;//in volt
IL=P_del/(sqrt(3)*VR*cos_fir);//in Ampere
//TotalLosses=3*I^2*R and should be equal to
    (7.5/100)*P_del;//in watt
l=(7.5/100)*P_del/(3*IL^2*R);//in km
```

```
disp(l,"Distance (in km) :");
```

Scilab code Exa 5.7 Sending end voltage

```
//Exa 5.7
clc;
clear;
close;
//Given Data :
format('v',7);
I=180;//in Ampere
cos_fir=0.8;//unitless
R=0.7;//in ohm/phase
X=1.2;//in ohm/phase
ETA=90;//in %
Pdev_BY_VR=3*I*cos_fir;//in KW
Psending_BY_VR=Pdev_BY_VR/(ETA/100);//in kW
Losses=3*I^2*R;//in watt
VR=Losses/(Psending_BY_VR-Pdev_BY_VR);//in volt
Vs=sqrt((VR*cos_fir+I*R)^2+(VR*sqrt(1-cos_fir^2)+I*X
    )^2);
disp(Vs*sqrt(3),"Sending end voltage Vs(line) in
    volts :");
```

Scilab code Exa 5.8 Efficiency and regulation of line

```
//Exa 5.8
clc;
clear;
close;
//Given Data :
format('v',7);
d=1*100;//in cm
```

```
dia=1;//in cm
r=dia/2;//in cm
Length=20;//in km
V=33;//in KV
P=10;//in MW
cosfi=0.8;//unitless
f=50;//in Hz
R=0.19;//in ohm/km/phase
//Part (i) :
L=2*10^-7*log(d/r);//in H/m
L20=L*Length*10^3;//in H
XL=2*%pi*f*L20;//in ohm
R20=R*Length;//in ohm
Z=sqrt(R20^2+XL^2);//in ohm
IR=P*10^3/(sqrt(3)*V*cosfi)
Losses=3*IR^2*R20;//in watt
ETA=P/(P+Losses/10^6);//unitless
disp(ETA*100,"Efficiency of line(in %) :");
//Part (ii) :
VR=V*1000/sqrt(3);//in volt
Vs=((VR*cosfi+IR*R20)+(VR*sqrt(1-cosfi^2)+IR*XL));
disp(((Vs-VR)/VR)*100,"% Regulation : ");
//Note : Answer in the book is wrong. In second last
    line of the solution in the book 16079+12885 is
   taken as 20605 instead of 28964.
```

Scilab code Exa 5.9 Sending end voltage

```
//Exa 5.9
clc;
clear;
close;
//Given Data :
format('v',8);
R=2.5;//in ohm
```

```
X=4.33;//in ohm
I=120;//in Ampere
Vr=3300;//in volt
cos_fir=0.8;//unitless
Vs=Vr+I*R*cos_fir+I*X*sqrt(1-cos_fir^2);//in volt
disp(Vs,"Sending end voltage(in volts) : ");
```

Scilab code Exa 5.10 Sending end voltage regulation and efficiency

```
//Exa 5.10
clc;
clear;
close;
//Given Data :
format('v',8);
Pt=4000*10^3;//in watt(power to be transmitted)
VR=11000;//in volt
cos_fir=0.9;//unitless
R=1;//in ohm
X=2.5;//in ohm
I=Pt/VR;//in Ampere
Vs=VR+I*R*cos_fir+I*X*sqrt(1-cos_fir^2);//in volt
disp(Vs,"Sending end voltage(in volts) : ");
Reg=(Vs-VR)*100/VR;//in %
disp(Reg,"% Regulation : ");
cos_fis=(VR*cos_fir+I*R)/Vs;//unitless
disp(cos_fis,"Sending end pf(lag) : ");
losses=I^2*R;//in watts
Pr=Pt*cos_fir;//in wats(Receiving end power)
Psend=Pr+losses;//in watts
Eff=Pr*100/Psend;//unitless
disp(Eff,"Transmission efficiency (in %) :");
```

Scilab code Exa 5.11 Sending end voltage regulation and efficiency

```
//Exa 5.11
clc;
clear;
close;
//Given Data :
format('v',8);
L=20;//in Km(length of the line)
Pdev=3000*10^3;//in watt(power delivered)
cos_fir=0.8;//unitless
VR=11*1000;//in volt
R=0.15*L;//in ohm
X=0.4*L;//in ohm
I=Pdev/VR;//in Ampere
Vs=VR+I*R*cos_fir-I*X*sqrt(1-cos_fir^2);//in volt
disp(Vs,"Sending end voltage(in volts) : ");
Reg=(VR-Vs)*100/VR;//in %
disp(Reg,"% Regulation : ");
cos_fis=(VR*cos_fir+I*R)/Vs;//unitless
disp(cos_fis,"Sending end pf(lag) : ");
losses=I^2*R;//in watts
Pr=Pdev*cos_fir;//in wats(Receiving end power)
Psend=Pr+losses;//in watts
Eff=Pr*100/Psend;//unitless
disp(Eff,"Transmission efficiency (in %) :");
```

Scilab code Exa 5.12 Voltage regultion and efficiency

```
//Exa 5.12
clc;
clear;
close;
//Given Data :
format('v',8);
```

```
R=2;//in ohm
X=3;//in ohm
VR=10*1000;//in volt
P=1000*10^3;//in watt(power delivered)
cos_fir=0.8;//unitless
I=P/(VR*cos_fir);//in Ampere
Vs=sqrt((VR*cos_fir+I*R)^2+(VR*sqrt(1-cos_fir^2)+I*X
    )^2);//in volt
Reg=(Vs-VR)*100/VR;//in %
disp(Reg,"% Regulation : ");
losses=I^2*R;//in watts
Pr=P*cos_fir;//in wats(Receiving end power)
Psend=Pr+losses;//in watts
Eff=Pr*100/Psend;//unitless
disp(Eff,"Transmission efficiency (in %) :");
```

Scilab code Exa 5.13 Voltage regultion and efficiency

```
//Exa 5.12
clc;
clear;
close;
//Given Data :
format('v',8);
R=1.5;//in ohm
X=4;//in ohm
VR=11*1000;//in volt
VRphase=VR/sqrt(3);//in volt/phase
P=6000;//in KVA(power delivered)
cos_fir=0.8;//unitless
I=P*1000/(3*VRphase);//in Ampere
Vs=VRphase+cos_fir*I*R+sqrt(1-cos_fir^2)*I*X;//in
    volt
Vs=Vs*sqrt(3);//in volt(not phase)
Reg=(Vs-VR)*100/VR;//in %
```

```
disp(Reg,"% Regulation : ");
losses=3*I^2*R/1000;//in Kw
Pr=P*cos_fir;//in wats(Receiving end power)
Psend=Pr+losses;//in watts
Eff=Pr*100/Psend;//unitless
disp(Eff,"Transmission efficiency (in %) :");
```

Chapter 7

Distribution Systems

Scilab code Exa 7.1 Voltage drop along the distributor

```
//Exa 7.1
clc;
clear;
close;
//Given data :
format('v',5);
l=1;//in km
I=100;//in Ampere
cosfi=0.8;//Power factor(lag) unitless
VC=200;//in volt
IL=60;//in Ampere
cosfi_load=0.9;//Power factor(lag) unitless
R=0.6;//in ohm
XL=0.08;//in ohm
IC=I*(0.8-%i*0.6);//in Ampere
z=(0.06+%i*0.08)/2;//in ohm
VD_BC=z*IC;//in volt
VB=VC+VD_BC;//in volt
IB=IL*(0.9-%i*0.4357)+IC;//in Ampere
VD_AB=z*IB;//in volt
disp(VD_AB,"V.D. from sending end to mid point(in
```

```
    volt) : ");
disp(VD_BC,"V.D. from mid point to the far end(in
    volt) : ");
```

Scilab code Exa 7.2 Position and value of minimum potential point

```
//Exa 7.2
clc;
clear;
close;
//Given data :
format('v',6);
l=500;//in meter
i=1;//in Ampere/meter
IL1=200; IL2=150; IL3=50; IL4=100;//in Ampere
l1=100; l2=200; l3=300; l4=400;//in meter
r=0.1;//in ohm/km
Vd=250;//in volt
//Drop_AC=100*(r/10^3)*(I-i*l1/2);
//Drop_CD=I;
//Drop_DE=100*r*(I-550)-I*100/2;
//Drop_EF=100*r*(I-700-I*100/2);
//Drop_FB=100*r*(I-900-I*100/2);
//VD_tot=0.05*I-27;//in volts
disp("As the both ends are fed with same voltage, VD
     should be equal to zero.");
I=27/0.05;//in Ampere
disp(I,"Curent(in Ampere) :");
Drop_AD=(0.01*I-0.5)+(0.01*I-3.5);
disp(Vd-Drop_AD,"Value at minimum potential at D(in
    V) :");
//Note : Ans in the book is wrong as 27/0.05 gives
    540 instead of 54.
```

Scilab code Exa 7.3 Current in various sections

```
//Exa 7.3
clc;
clear;
close;
//Given data :
format('v',6);
l=250;//in meter
VA=230;//in volt
VB=232;//in volt
r=0.5;//in ohm/km
r=0.5/10^3;//in ohm/m
RAC=r*50*2;//in ohm
RCD=RAC;RDE=RAC;REF=RAC;RFB=RAC;//in ohm
//VA-VB=VAC+VCD+VDE+VEF+VFB;//in volt
Ia=(VA-VB+15)/(5*RAC);//in Ampere
IAC=Ia;ICD=IAC-20;IDE=IAC-60;IED=-IDE;IEF=IAC-100;
    IFE=-IEF;IFB=IAC-120;IBF=-IFB;//in Ampere
disp(IAC,"IAC(in A):");
disp(ICD,"ICD(in A):");
disp(IDE,"IDE(in A):");
disp(IED,"IED(in A):");
disp(IEF,"IEF(in A):");
disp(IFE,"IFE(in A):");
disp(IFB,"IFB(in A):");
disp(IBF,"IBF(in A):");
VAC=IAC*RAC;//in volt
VCD=ICD*RCD;//in volt
VD=VA-VAC-VCD;//in volt
disp(VD,"The minimum potential(in Volt) :");
```

Scilab code Exa 7.4 Current in various sections

```
//Exa 7.4
clc;
clear;
close;
//Given data :
format('v',6);
VA=235;//in volt
VB=236;//in volt
l=200;//in meter
IL1=20; IL2=40; IL3=25; IL4=30;//in Ampere
l1=50; l2=75; l3=100; l4=50;//in meter
r=0.4;//in ohm/km
r=0.4/10^3;//in ohm/m
RAC=r*l1*2;//in ohm
RCD=r*(l2-l1)*2*RAC;RDE=r*(l2-l1)*2*RAC;REF=r*l1*2*RAC;RFB=r*l1*2*RAC;//in ohm
//VA-VB=VAC+VCD+VDE+VEF+VFB;//in volt
IA=(VA-VB+9.6)/(0.16);//in Ampere
IAC=IA;ICD=IA-IL1;IDE=IA-IL1-IL2;IEF=IA-IL1-IL2-IL3;IFB=IA-IL1-IL2-IL3-IL4;//in Ampere
disp(IAC,"IAC(in A):");
disp(ICD,"ICD(in A):");
disp(-IDE,"IED(in A):");
disp(-IEF,"IFE(in A):");
disp(-IFB,"IBF(in A):");
VAC=IAC*RAC;//in volt
VCD=ICD*RCD;//in volt
VD=VA-VAC-VCD;//in volt
disp(VD,"The minimum potential(in Volt) :");
```

Scilab code Exa 7.5 Voltages at B and C

```
//Exa 7.5
```

```
clc;
clear;
close;
//Given data :
format('v',6);
VA=400;//in volt
r=0.03;//in ohm/km
r=0.03/1000;//in ohm/m
RAB=r*500*2;//in ohm
RBC=r*300*2;//in ohm
RAB=r*700*2;//in ohm
RAB=r*500*2;//in ohm
//VA-VB=VAC+VCD+VDE+VEF+VFB;//in volt
IA=(17.4)/(0.09);//in Ampere
VAB=(RAB)*IA;//in volt
VB=VA-VAB;//in volt
disp(VB,"Voltage at B(in volts) :");
VBC=(RBC)*(IA-150);//in volt
VC=VB-VBC;//in volt
disp(VC,"Voltage at C(in volts) :");
IBC=IA-150;//in A
disp(IBC,"Current in section BC(in A) :");
//Note : answer of VB is wrong in the book.
```

Scilab code Exa 7.6 Cross setional area of conductor

```
//Exa 7.6
clc;
clear;
close;
//Given data :
format('v',5);
VA=240;//in volt
MAxVDrop=VA*5/100;//in volt
rho=2.87*10^-6;//in ohm-cm
```

```
//VAB+VBC+VCA=0;//in volt
IA=(3200)/(26);//in Ampere
IAB=IA;//in Ampere
IBC=IA-100;//in Ampere
//Allowed voltage drop: IAB*RAB+IBC*RBC=12
R=12/(1015.26);//in ohm
RAB=R*300*2/100;//in ohm
RBC=R*600*2/100;//in ohm
RCA=R*400*2/100;//in ohm
//formula : R=rho*l/a
a=rho*(100*100)/R;//in cm^2
disp(a,"Cross section area(in cm^2) :");
```

Scilab code Exa 7.7 Total voltage drop in the cable

```
//Exa 7.7
clc;
clear;
close;
//Given data :
format('v',6);
R=0.2;//in ohm/km
X=0.1;//in ohm/km
ZAM=((R+%i*X)/1000)*200;//in ohm
ZMB=((R+%i*X)/1000)*100;//in ohm
I1=100*(0.707-0.707*%i);//in A
I2=200*(0.8-0.6*%i);//in A
IAM=I1+I2;//in Ampere
VAM=ZAM*IAM;//in volts
VMB=ZMB*I2;//in volts
VAB=VAM+VMB;//in volts
magVAB=sqrt(real(VAB)^2+imag(VAB)^2);
disp(magVAB,"Total voltage drop(in volts) :");
```

Scilab code Exa 7.8 Voltage at mid point and sending voltage

```
//Exa 7.8
clc;
clear;
close;
//Given data :
format('v',6);
VB=200;//in volts
R=0.2;//in ohm/km
X=0.3;//in ohm/km
I=100;//in Ampere
ZAB=(R+%i*X);//in ohm
ZMB=ZAB/2;//in ohm
ZAM=ZMB;//in ohm
cosfi_1=0.6;//unitless
cosfi_2=0.8;//unitless
IMB=I*(cosfi_2-%i*cosfi_1);//in A
I2=IMB;//in Ampere
VMB=IMB*ZMB;//in volts
VM=VB+VMB;//in volts
disp(VM,"Voltage at M(in volt)");
fi=atand(imag(VM)/real(VM));//in degree
fi_1=acosd(cosfi_1);//in degree
fi_VBandI1=fi_1-fi;//in degree
I1=I*(cosd(fi_VBandI1)-%i*sind(fi_VBandI1));//in
    Ampere
IAM=I1+I2;//inA Ampere
VAM=ZAM*IAM;//in volts
VA=VM+VAM;//in volts
magVA=sqrt(real(VA)^2+imag(VA)^2);
disp(magVA,"Voltage at A, standing end voltage(in
    volts) :");
```

Scilab code Exa 7.9 Cross setional area of conductor

```
//Exa 7.9
clc;
clear;
close;
//Given data :
format('v',7);
l=500;//in meter
VA=200;//in volt
MAxVDrop=6;//in % of declared voltage
rho=0.014;//in ohm/m
//VD in the distributor=53*10^3*r
AllowedVD=VA*(6/100);//in volts
r=AllowedVD*10^6/(53*10^3);//in ohm/meter
//formula : R=rho*l/a
a=rho*(2*l)/r;//in m^2
disp(a,"Cross section area(in m^2) :");
```

Scilab code Exa 7.10 Potential at P

```
//Exa 7.10
clc;
clear;
close;
//Given data :
format('v',7);
l=300;//in meter
I=0.75;//in A/m
R=0.00018;//in ohm/m
x=200;//in meter
Vs=250;//in volt
```

```
VD=I*R*(l*x-x^2/2);//in volt
V_A=Vs-VD;//in volt(Voltage at 200m from end A)
disp(V_A,"Voltage as 200m from supply end A(in volts
   ) :");
```

Scilab code Exa 7.11 Current supplied at end A and B

```
//Exa 7.11
clc;
clear;
close;
//Given data :
format('v',7);
l=600;//in meter
VA=440;//in volt
VB=400;//in volt
R=0.01;//in ohm/100m
RAC=(R/100)*300;//in ohm
RCD=(R/100)*300;//in ohm
RDE=(R/100)*100;//in ohm
REF=(R/100)*200;//in ohm
RFB=(R/100)*300;//in ohm
//VA-VB=VAC+VCD+VDE+VEF+VFB;//in volt
IA=(VA-VB+42.5)/(0.12);//in Ampere
IAC=IA;ICD=IA-100;IDE=IA-300;IFE=IA-550;IFB=IA-850;
   //in Ampere
disp(IAC,"Current fed at A, IA(in A):");
disp(-IFB,"Current fed at B, IB(in A):");
```

Scilab code Exa 7.12 Minimum potential and Current supplied

```
//Exa 7.12
clc;
```

```
clear;
close;
//Given data :
format('v',7);
VA=220;//in volt
VB=200;//in volt
R=0.1;//in ohm/km
I=1;//in A/m
l=500;//in meter
R=2*R/1000;//in ohm/m
x=(VA-VB)/(I*R*l)+l/2;//in meter
Vmin=VA-I*R*x^2/2;//in volts
disp(Vmin,"Value of minimum potential(in V) :");
IA=I*x;//in A
disp(IA,"Current supplied from end A(in A) :");
IB=I*(l-x);//in A
disp(IB,"Current supplied from end B(in A) :");
```

Scilab code Exa 7.13 Feeding end voltage

```
//Exa 7.13
clc;
clear;
close;
//Given data :
format('v',7);
VL=240;//in volt
Router=0.2;//in ohm
I1=VL/5;//in Ampere
I2=VL/6;//in Ampere
Ineutral=I1-I2;//in Ampere
//Applying KVL on +ve side
V1=VL+I1*0.2+8*0.4;//in volt
disp(V1,"Voltage at +ve side(in V): ");
//Applying KVL on +ve side
```

```
V2=VL-(8*0.4)+I2*0.2;//in volt
disp(V2,"Voltage at -ve side(in V): ");
```

Scilab code Exa 7.14 Voltage at the load end

```
//Exa 7.14
clc;
clear;
close;
//Given data :
format('v',7);
//Applying KVL on +ve side
V1=200-(600*0.015)-(100)*0.03;//in volt
disp(V1,"Voltage at +ve side(in V): ");
//Applying KVL on -ve side
V2=200-(-100*0.03)-500*0.0015;//in volt
disp(V2,"Voltage at -ve side(in V): ");
//Note : answer of 2nd part is wrong in the book.
```

Scilab code Exa 7.15 Potential at points

```
//Exa 7.15
clc;
clear;
close;
//Given data :
format('v',7);
//VD in section AC from RHS: VD1=(40+x)*0.02+0.17*x
//VD in section AC from LHS: VD2=(350-x)*0.015+(150-x)*0.03
//Equating two VDs we get
//x*0.02+0.17*x+0.015*x+x*0.03=350*0.015+150*0.03-40*0.02
```

```
x=(350*0.015+150*0.03-40*0.02)/0.082;//in A
VB=500-(x+40)*0.02;//in volts
disp(VB,"Potential at point B(in V) :");
VC=VB-(x*0.017);//in volts
disp(VC,"Potential at point C(in V) :");
VD=500-(350-x)*0.015;//in volts
disp(VD,"Potential at point D(in V) :");
//Note : Answer of 3rd part is given wrong in the
    book.
```

Scilab code Exa 7.16 Point of minimum potential

```
//Exa 7.16
clc;
clear;
close;
//Given data :
format('v',5);
//Applying KVL in loop AFEDA: (0.016*x)+0.09*(x-30)
    +0.14*(x-17)-0.1*y=0
//Applying KVL in loop ADCBA: 0.1*y-0.12*(95-x-y)
    -.01*(145-x-y)-0.008*(165-x-y)=0
//Equating two equtions we get
//3.9*x-125=97.75-0.75*x
x=(97.75+125)/(3.9+0.75);//in A
y=97.75-0.75*x;//in A
disp(x,"x(in A)=");
disp(y,"y(in A)=");
disp("Thus the point of minimum ppotential is E.");
```

Scilab code Exa 7.17 Maximum voltage drop and minimum potential

```
//Exa 7.17
```

```
clc;
clear;
close;
//Given data :
format('v',7);
V=200;//in volt
I=1;//in A/m
R=2*0.05/1000;//in ohm/m
l=1*1000;//in meter
IT=I*l;//in Ampere
RT=R*l;//in ohm
VD=IT*RT/8;//in volt
Vmin=V-VD;//in volt
disp(Vmin,"Minimum potential occurs at the mid point
    & is(in V) : ");
```

Scilab code Exa 7.18 Voltages at ands A and C

```
//Exa 7.18
clc;
clear;
close;
//Given data :
format('v',7);
VB=400;//in volt
ZAC=0.04+%i*0.08;//in ohm
ZCB=0.08+%i*0.12;//in ohm
I1=60*(0.8-%i*0.6);
I2=120*(0.8-%i*0.6);
VCB=I2*ZCB;//in Volt
VAC=(I1+I2)*ZAC;//in volt
VC=VB+I2*ZCB;//in Volt
disp(VC,"Voltage at C(in Volt) :");
VA=VC+(I1+I2)*ZAC;//in volt
disp(VA,"Voltage at A(in Volt) :");
```

Chapter 8

Underground Cables and Faults

Scilab code Exa 8.1 Thickness of Insulation

```
//Exa 8.1
clc;
clear;
close;
//given data
R=500;//in Mohm/Km
R=R*10^6;//in ohm
r1=2.5/2;//in cm
r1=r1*10^-2;//in meter
rho=4.5*10^16;//in ohm/cm
rho=rho*10^-2;//in ohm/m
l=1;//in Km
l=l*1000;//in meter
//Formula : R=(rho/(2*%pi*l))*log(r2/r1)
r2=(exp(R/(rho/(2*%pi*l))))*r1;//in meter
thickness=r2-r1;//in meter
thickness=thickness*100;//in cm
disp(thickness,"Thickness of Insulation in cm :");
```

Scilab code Exa 8.2 Capacitance of 1 Km

```
//Exa 8.2
clc;
clear;
close;
//given data
d=1;//in cm
d=d*10^-2;//in meter
D=1.8;//in cm
D=D*10^-2;//in meter
epsilon_r=4;//permittivity of insulation
C=0.024*epsilon_r/log10(D/d);//in uF/Km
disp(C,"Capacitance/km of the fibre in uF :  ");
```

Scilab code Exa 8.3 Maximum stress and minimum sttress

```
//Exa 8.3
clc;
clear;
close;
//given data
V=33;//in KV
d=1;//in cm
D=4;//in cm
//Part (a) :
gmax=2*V/(d*log(D/d));//in KV/cm
disp(gmax,"Maximum Stress in KV/cm");
//Part (b) :
gmin=2*V/(D*log(D/d));//in KV/cm
disp(round(gmin),"Minimum Stress in KV/cm");
```

Scilab code Exa 8.4 Most Economical size

```
//Exa 8.4
clc;
clear;
close;
//given data
Vrms=66;//in KV
gmax=40;;//in KV/cm
V=sqrt(2)*Vrms;//in Volt
//Part (a) :
d=2*V/gmax;//in cm
disp(d,"The most economical diameter in cm : ");
//Part (b) :
PeakVoltage=sqrt(2)*Vrms/sqrt(3);//in Volt
V=PeakVoltage;//in Volt
d=2*V/gmax;//in cm
disp(d,"The most economical diameter for 3 phase
    system in cm : ");
```

Scilab code Exa 8.5 Safe working potential in KV

```
//Exa 8.5
clc;
clear;
close;
//given data
d=2;//in cm
D=2.5*2;//in cm
d1=(5/4)*d;//in cm
d2=(5/3)*d;//in cm
gmax=40;//in KV/cm
PeakVoltage=(gmax/2)*[d*log(d1/d)+d1*log(d2/d1)+d2*
    log(D/d2)];//in KV
disp(PeakVoltage/sqrt(2),"The safe Working Potential
     in KV : ");
```

Scilab code Exa 8.6 Charging current on 33 KV

```
//Exa 8.6
clc;
clear;
close;
//given data
CN=0.4;//in uF
V=33;//in KV
VP=V/sqrt(3);//in KV
f=25;//in Hz
//Capacitance between 2 cores for 15 Km length
CN_1=15*CN;//in uF
//Capacitance of each core to neutral
CN=2*CN_1;//in uF
//Charging current per phase
I=2*%pi*f*VP*1000*CN*10^-6;//in Ampere
disp(round(I),"Charging current per phase in Ampere
    : ");
```

Scilab code Exa 8.7 Calculate the KVA taken

```
 //Exa 8.7
clc;
clear;
close;
//given data
format('v',9);
l=10;//in Km
C=0.3;//in uF
V=22;//in KV
VP=V/sqrt(3);//in KV
```

```
VP=VP*1000;//in Volt
f=50;//in Hz
Capacitance=C*l;//in uF
CN=2*Capacitance;//in uF
KVA_Taken=3*VP*2*%pi*f*VP*CN*10/1000;//in KVA
disp(KVA_Taken,"KVA taken by the 10 Km cable(KVA) :
    ");
```

Scilab code Exa 8.8 Distance of fult from testing

```
//Exa 8.8
clc;
clear;
close;
//given data
format('v',9);
P=10;//in Ohm
Q=80;//in Ohm
S2=3400;//in Ohm
S1=2400;//in Ohm
X=P*(S2-S1)/(P+Q);//in Ohm
LoopResistance=P*S2/Q;//in Ohm
ResistancePerKm=LoopResistance/10;//in Ohm
Distance=X/ResistancePerKm;//in Km
disp(Distance,"Distance of fault from testing end in
    Km : ");
```

Scilab code Exa 8.9 Distance of fault from testing

```
//Exa 8.9
clc;
clear;
close;
```

```
//given data
format('v',9);
Resistance=1.6;//in ohm/Km
l=1000;//in meter
PbyQ=3;//unitless
PplusQbyQ=4;//unitless
LoopResistance=(Resistance/1000)*2*l;//in Ohm
X=(1/PplusQbyQ)*LoopResistance;//in Ohm
Distance=X/(Resistance/1000);//in meter
disp(Distance,"Distance of Fault from testing end in
    meters : ");
```

Chapter 9

Substations and Earthing

Scilab code Exa 9.1 Rating of peterson coil

```
//Exa 9.1
clc;
clear;
close;
//Given Data :
format('v',5);
V=250;//in volt
f=50;//in Hz
l=300;//in km
C_earth=0.03;//in uF
C=l*C_earth*10^-6;//in F
XL=1/(3*2*%pi*f*C);//in ohm
disp(XL,"Reactance required for the Peterson coil(in
    ohm) :");
```

Chapter 10

Power factor improvement

Scilab code Exa 10.1 Annual saving in cost

```
//Exa 10.1
clc;
clear;
close;
//Given Data :
format('v',7);
Load=500;//in KW
cosfi_1=0.75;//powerfactor
x=40;//in Rs/year/KVA
x1=60;//cost of PF improvement equipment in Rs./KVAR
i=12;//in % per annum
y=x1*i/100;//in Rs.
cosfi_2=0.98;//unitless
KVA1=Load/cosfi_1;//in KVA(at 0.75 pf)
KVA2=Load/cosfi_2;//in KVA(at 0.98 pf)
AnnualSaving=x*(KVA1-KVA2);//in Rs.
fi_1=acosd(cosfi_1);//in degree
tanfi_1=tand(fi_1);//unitless
Pr1=Load*tanfi_1;//in KVAR
fi_2=acosd(cosfi_2);//in degree
tanfi_2=tand(fi_2);//unitless
```

```
Pr2=Load*tanfi_2;//in KVAR
Rating=Pr1-Pr2;//in KVAR
AnnualExpenditure=y*Rating;//in Rs.
NetSaving=AnnualSaving-AnnualExpenditure;//in Rs./
    year
disp(NetSaving,"Net saving per year(in Rs.) :");
```

Scilab code Exa 10.2 Rating of the Heater

```
//Exa 10.2
clc;
clear;
close;
//Given Data :
format('v',7);
Eta=85;//in %
P=30;//in HP
P1=P*0.7355*Eta/100;//in KW
cosfi_1=0.8;//powerfactor
tanfi_1=tand(acosd(cosfi_1));//unitless
Pr=P1*tanfi_1;//in KVAR
//Let active power P2 : Total Active power = P1+P2
cosfi=0.9;//overall powerfactor
tanfi=tand(acosd(cosfi));//unitless
//Pr1=tanfi*(P1+P2);//in KVAR
//Putting Pr=Pr1
P2=(Pr-P1*tanfi)/tanfi;//in KW
disp(P2,"Rating of the heater(in KW) :");
```

Scilab code Exa 10.3 Capacity of the condenser

```
//Exa 10.3
clc;
```

```
clear;
close;
//Given Data :
format('v',6);
Im=50;//in Ampere
f=50;//in Hz
V=400;//in volts
cosfi_1=0.6;//powerfactor
tanfi_1=tand(acosd(cosfi_1));//unitless
Ia=Im*cosfi_1;//in Ampere
Ir1=Ia*tanfi_1;//in Ampere
//Let the capaitor of C farads be connected to
   improve pf i.e., 0.9(lag)
cosfi_2=0.9;//powerfactor
tanfi_2=tand(acosd(cosfi_2));//unitless
Ir2=Ia*tanfi_2;//in Ampere
Ic=Ir1-Ir2;//in Ampere
C=Ic/(2*%pi*f*V);//in farads
disp(C*10^6,"Capacity of condenser(in uF) :");
```

Scilab code Exa 10.4 Value of shunt capacitor

```
//Exa 10.4
clc;
clear;
close;
//Given Data :
format('v',7);
Im=10;//in Ampere
f=50;//in Hz
V=240;//in volts
cosfi_1=0.707;//powerfactor
sinfi_1=sind(acosd(cosfi_1));//unitless
Ir1=Im*sinfi_1;//in Ampere
cosfi_2=1;//powerfactor
```

```
Ir2=0;//in A(as cosfi_2=1)
Ic=Ir1-Ir2;//in Ampere
C=Ic/(2*%pi*f*V);//in farads
disp(C*10^6,"Capacity of condenser(in uF) :");
```

Scilab code Exa 10.5 Capacity of the condenser

```
//Exa 10.5
clc;
clear;
close;
//Given Data :
format('v',6);
Im=30;//in Ampere
f=50;//in Hz
V=200;//in volts
cosfi_1=0.8;//powerfactor
Ia=Im*cosfi_1;//in Ampere
cosfi_2=1;//powerfactor
Ir2=0;//in A(as cosfi_2=1)
tanfi_1=tand(acosd(cosfi_1));//unitless
Ir1=Ia*tanfi_1;//in Ampere
Ic=Ir1-Ir2;//in Ampere
C=Ic/(2*%pi*f*V);//in farads
disp(C*10^6,"Capacity of condenser(in uF) :");
```

Scilab code Exa 10.6 Capacity of the condenser

```
//Exa 10.6
clc;
clear;
close;
//Given Data :
```

```
format('v',7);
Im=30;//in Ampere
f=50;//in Hz
V=200;//in volts
cosfi_1=0.7;//powerfactor
Ia=Im*cosfi_1;//in Ampere
tanfi_1=tand(acosd(cosfi_1));//unitless
Ir1=Ia*tanfi_1;//in Ampere
cosfi_2=0.85;//powerfactor
tanfi_2=tand(acosd(cosfi_2));//unitless
Ir2=Ia*tanfi_2;//in Ampere
Ic=Ir1-Ir2;//in Ampere
C=Ic/(2*%pi*f*V);//in farads
disp(C*10^6,"Capacity of condenser(in uF) :");
```

Scilab code Exa 10.7 Determine the PF

```
//Exa 10.7
clc;
clear;
close;
//Given Data :
format('v',7);
//(i)
IMO=200;//in HP(Induction Motor output)
IMO=IMO*0.7355;//in KW(Induction Motor output)
LagEff=90;//in %
LagEff=90/100;//in fraction
MotorIn=IMO/(LagEff);//in KW
cosfi_1=0.75;//powerfactor
tanfi_1=tand(acosd(cosfi_1));//unitless
Pr1=MotorIn*tanfi_1;//in KVAR
//(ii)
P2=300;//in KW
cosfi_2=0.5;//unitless
```

```
tanfi_2=tand(acosd(cosfi_2));//unitless
Pr2=P2*tanfi_2;//in KVAR
//(iii)
P3=200;//in KW
cosfi_3=1;//unitless
tanfi_3=0;//unitless
Pr3=0;//in KVAR
//(iv)
PsynMotor=500;//in KW
Eff=93;//in %
Eff=93/100;//in fration
Input=PsynMotor/Eff;//in KW
Pa=MotorIn+P2+P3+PsynMotor;//in KW
P1=Pr1+Pr2+Pr3;//in KVAR
cosfi=1;//unitless
tanfi=0;//unitless
Pr=Pa*tanfi;//in KVAR
Prm=Pr-P1;//in KVAR
tanfi_m=Prm/Input
cosfi_m=cosd(atand(tanfi_m));//unitless
disp(cosfi_m,"P.F. of the motor(lead) :");
//Note : Answer in the book is wrong
```

Scilab code Exa 10.8 Capacity of each condenser

```
//Exa 10.8
clc;
clear;
close;
//Given Data :
format('v',7);
f=50;//in Hz
V=400;//in volts
MotorOut=20;//in HP(Motor output)
MotorOut=MotorOut*735.5;//in Watts(Induction Motor
```

```
    output)
CorrectPF=0.85;//in fraction
MotorIn=MotorOut/(CorrectPF*1000);//in KW
cosfi_1=0.7071;//powerfactor
tanfi_1=tand(acosd(cosfi_1));//unitless
Pr1=MotorIn*tanfi_1;//in KVAR
cosfi_2=0.85;//unitless
tanfi_2=tand(acosd(cosfi_2));//unitless
Pr2=Pr1*tanfi_2;//in KVAR
Prc=Pr1-Pr2;//in KVAR
Prc_ph=Prc/3;//in KVAR
C=Prc_ph*10^3/(2*%pi*f*V^2)
disp(C*10^6,"Rating of each capacitor per phase(in
    uF)");
```

Scilab code Exa 10.9 Find power factor

```
//Exa 10.9
clc;
clear;
close;
//Given Data :
format('v',7);
Pa=500;//in KW
cosfi_1=0.7071;//powerfactor
tanfi_1=tand(acosd(cosfi_1));//unitless
Pr1=Pa*tanfi_1;//in KVAR
Pm=100;//in KW
P=Pa+Pm;//in KW
cosfi_2=0.95;//unitless
tanfi_2=tand(acosd(cosfi_2));//unitless
Pr=P*tanfi_2;//in KVAR
Prm=Pr-Pr1;//in KVAR
Pam=sqrt(Pm^2+Prm^2)
PFsynMotor=Pm/Pam;//leading PF
```

```
disp(PFsynMotor,"P.F. of synchronous motor(leading)
    :");
```

Scilab code Exa 10.10 Input of synchronous motor

```
//Exa 10.10
clc;
clear;
close;
//Given Data :
format('v',7);
P=1500;//in KW
cosfi_1=0.75;//powerfactor
tanfi_1=tand(acosd(cosfi_1));//unitless
Pr1=P*tanfi_1;//in KVAR
Pm=150;//in KW
P=P+Pm;//in KW
cosfi_2=0.9;//unitless
tanfi_2=tand(acosd(cosfi_2));//unitless
Pr=P*tanfi_2;//in KVAR
Prm=Pr-Pr1;//in KVAR
Pam=sqrt(Pm^2+Prm^2)
cosfi=Pm/Pam;//leading PF
disp(cosfi,"P.F. of synchronous motor(leading) :");
```

Scilab code Exa 10.11 Determine the saving

```
//Exa 10.11
clc;
clear;
close;
//Given Data :
format('v',7);
```

```
Load=100;//in KW
LoadPF=0.75;//powerfactor
x=100;//in Rs/KVA
y=600*(10/100);//in Rs.
cosfi_2=sqrt(1-(y/x)^2)
disp(cosfi_2,"P.F.(lag) is :");
MaxDemand1=Load/LoadPF;//in KW(at 0.75 load power factor)
MaxDemand2=Load/cosfi_2;//in KW(at cosfi_2 power factor)
AnnSaving=(MaxDemand1-MaxDemand2)*x;//in Rs.
cosfi_1=0.75;//powerfactor
tanfi_1=tand(acosd(cosfi_1));//unitless
tanfi_2=tand(acosd(cosfi_2));//unitless
KVAR1=Load*tanfi_1;//in KVAR
KVAR2=Load*cosfi_2;//in KVAR
Rating=KVAR1-KVAR2;//in KVAR
AnnualExpenditure=y*Rating;//in Rs.
AnnualSaving=AnnSaving-AnnualExpenditure;//in Rs.
disp(AnnualSaving,"Annual Savings(in Rs.) :");
```

Scilab code Exa 10.12 PF of synchronous motor

```
//Exa 10.12
clc;
clear;
close;
//Given Data :
format('v',9);
//(i)
PHeater=50;//in KW
cosfi_1=1;//unitless
tanfi_1=tand(acosd(cosfi_1));//unitless
Pr1=PHeater*tanfi_1;//in KVAR
//(ii)
```

```
cosfi_2=0.7;//unitless
P2=200*735.5/(1000*0.8);//in KW
tanfi_2=tand(acosd(cosfi_2));//unitless
Pr2=P2*tanfi_2;//in KVAR
//(iii)
cosfi=0.9;//unitless New PF
P3=200*735.5/(1000*cosfi);//in KW
TotalActivePower=PHeater+P2+P3;//in KW
TotalReactivePower=Pr1+Pr2;//in KW
tanfi=tand(acosd(cosfi));//unitless
TotalPr=TotalActivePower*tanfi;//in KVAR
Pnn=TotalPr-TotalReactivePower;//in KVAR(
    ReactivePower of motor)
tanfi_mu=Pnn/P3;//unitless
cosfi_mu=cosd(atand(tanfi_mu));
disp(cosfi_mu,"PF of the synchronous motor :");
//Note : Answer in the book is wrong
```

Scilab code Exa 10.13 Limit of power factor

```
//Exa 10.13
clc;
clear;
close;
//Given Data :
format('v',6);
x=60;//in Rs./KVA
x1=100;//in Rs/KVAR(cost of phase advancing
    equipment)
InterestCepriciation=x1*10/100;//in Rs.
y=10;//in Rs./KVAR
cosfi_2=sqrt(1-(y/x)^2);//unitless
disp(cosfi_2,"Most Ecomnomical PF(lag) :");
```

Scilab code Exa 10.14 Value of Capacitor

```
//Exa 10.14
clc;
clear;
close;
//Given Data :
format('v',9);
f=50;//in Hz
V=240;//in Volts
//(i)
Imoter=20;//in Ampere
cosfi_1=0.75;//unitless
ReacComponent1=Imoter*sqrt(1-cosfi_1^2);//in Ampere
//(ii)
cosfi_2=0.9;//unitless
P2=200*735.5/(1000*0.8);//in KW
ReacComponent2=Imoter*sqrt(1-cosfi_2^2);//in Ampere
Ic=ReacComponent1-ReacComponent2;//in Ampere(Leading reactive component)
C=Ic/(2*%pi*f*V);//in Farads
disp(round(C*10^6),"Capacitance of the capacitor(in uF) :");
//Power of the motor=5 KW
P=5;//in KW
tanfi_1=tand(acosd(cosfi_1));
tanfi_2=tand(acosd(cosfi_2));
LeadingKVAR=P*(tanfi_1-tanfi_2);//in KVAR
disp(round(LeadingKVAR),"Leading KVAR supplied by the capactor(in KVAR) :");
disp(LeadingKVAR/3,"KVAR supplied per phase : ");
//Note : Answer in the book is wrong
```

Scilab code Exa 10.15 Find the supplied KVAR

```
//Exa 10.15
clc;
clear;
close;
//Given Data :
format('v',9);
f=50;//in Hz
V=240;//in Volts
TotalLoad=200+80;//in KW
cosfi_1=0.8;//unitless
tanfi_1=tand(acosd(cosfi_1));
cosfi_2=0.9;//unitless
tanfi_2=tand(acosd(cosfi_2));
//(i)
OA=200;//in KW
OD=280;//in KW
CM=OA*tanfi_1-OD*tanfi_2;//in KVAR
disp(CM,"Leading KVAR supplied by the motor(in KVAR)
    :");
//(ii)
BM=80;//in KW
CM=15.6;//in KW
KVA_Rating=sqrt(BM^2+CM^2);//in KVA
disp(KVA_Rating,"KVA rating(in KVA) :");
//(iii)
BC=KVA_Rating;//in KW
cosfi_m=BM/BC;//unitless
disp(cosfi_m,"P.F. Of the motor  : ");
//Note : Answer of (i) part is wrong in the book is
   wrong
```

Scilab code Exa 10.16 Most economical PF

```
//Exa 10.16
clc;
clear;
close;
//Given Data :
format('v',5);
x=80;//in Rs./KVA
x1=100;//in Rs/KVAR(cost of phase advancing
    equipment)
i=12;//in %
y=(i/100)*150;//in Rs./KVAR
cosfi_2=sqrt(1-(y/x)^2);//unitless
disp(cosfi_2,"Most Ecomnomical PF(lag) :");
```

Scilab code Exa 10.17 Most economical PF and annual saving

```
//Exa 10.17
clc;
clear;
close;
//Given Data :
format('v',6);
P=300;//in KW
cosfi_1=0.7;//unitless
tanfi_1=tand(acosd(cosfi_1));
y=13;//in Rs./KVAR
x=130;//in Rs./KVA
cosfi_2=sqrt(1-(y/x)^2);//unitless
disp(cosfi_2,"Most Ecomnomical PF :");
tanfi_2=tand(acosd(cosfi_2));
```

```
//(ii)
LeadingKVAR=P*(tanfi_1-tanfi_2);//in KVAR
AnnSavingMD=x*[P/cosfi_1-P/cosfi_2];//in Rs.
AnnExpenditure=y*LeadingKVAR;//in Rs.
NetSaving=AnnSavingMD-AnnExpenditure;//in Rs.
disp(NetSaving,"Net Saving in Rs. :");
//Note : Answer in the book is not accurate.
```

Chapter 11

Various types of Tariffs

Scilab code Exa 11.1 Calculate cost per unit

```
//Exa 11.1
clc;
clear;
close;
//Given Data :
format('v',6);
E=438000;//in kWh(Energy consumed per year)
pf=0.8;//unitless
cosfi=pf;//unitless
LoadFactor=40;//in %
//tarrif=Rs. 75/year/kw of max demand plus 3 paise
   per unit per reactive KVA
h=8760;//no. of years in a year
AvgLoad=E/h;//kw
MaxLoad=AvgLoad/(LoadFactor/100);//in kw
MaxLoad_KVA=MaxLoad/pf;//in KVA
tanfi=tand(acosd(cosfi));//unitless
ReactiveKVAR=h*tanfi*AvgLoad;//in KVA
AnnualBill=75*MaxLoad+(3/100)*E+(1.5/100)*
   ReactiveKVAR;//in Rs.
CostPerUnit=AnnualBill/E;//in Rs.
```

```
CostPerUnit=CostPerUnit*100;//in Paisa
disp(CostPerUnit,"Cost per unit(in Paisa) :");
```

Scilab code Exa 11.2 Calculate cost per unit

```
//Exa 11.2
clc;
clear;
close;
//Given Data :
format('v',6);
//tarrif=Rs. 275/year/KVA of max demand plus 35
   paise per unit
C1=275;//in Rs.year/KVA
C2=35;//in paisa/unit
LoadFactor=30;//in %/year
LoadFactor=30/100;//in fraction
//Let MaxDemand = x KW
//Case (i) PF=1
cosfi=1;//unitless
AnnualBillBYx=C1/cosfi+(C2/100)*LoadFactor*24*365;//
   in Rs.(Here 24*365 is for No. of hours in a year)
AnnualBill=AnnualBillBYx*100/(LoadFactor*24*365);//
   in paisa/unit
disp(AnnualBill,"Cost per unit(at unity power factor
    in paisa/unit) :");
//Case (i) PF=0.8
cosfi=0.8;//unitless
AnnualBillBYx=C1/cosfi+(C2/100)*LoadFactor*24*365;//
   in Rs.(Here 24*365 is for No. of hours in a year)
AnnualBill=AnnualBillBYx*100/(LoadFactor*24*365);//
   in paisa/unit
disp(AnnualBill,"Cost per unit(at 0.8 power factor
   in paisa/unit) :");
```

Scilab code Exa 11.3 Estimate annual payment

```
//Exa 11.3
clc;
clear;
close;
//Given Data :
format('v',9);
FixedLoad=200;//in kW
PF=0.8;//unitless
cosfi=PF;//unitless
h=10;//in hours/day
d=300;//in days
Time=h*d;//in hours
Energy=FixedLoad*Time;//in kwh/year
// (i) tarrif=Rs. 100/KVA/Annum plus 20 paise per
    kwh
C1=100;//in Rs.year/KVA
C2=20;//in paisa/kwh
KVA=FixedLoad/cosfi;//in KVA
AnnualBill=KVA*C1+(C2/100)*Energy;//in Rs.
disp(AnnualBill," Case (i) Annual Payment(in Rs.) :"
    );
// (ii) tarrif=Rs. 100/KW/Annum plus 20 paise per
    kwh plus 2 paise/KVARH
C1=100;//in Rs./year/KW
C2=20;//in paisa/kwh
C3=2;//in paisa/KVARH
tanfi=tand(acosd(cosfi));//unitless
ReactiveKVARH=FixedLoad*tanfi*Time;//in KVARH
AnnualBill=C1*FixedLoad+(C2/100)*Energy+(C3/100)*
    ReactiveKVARH;//in Rs.
disp(AnnualBill," Case (ii) Annual Payment(in Rs.) :
    ");
```

Scilab code Exa 11.4 Total Annual Electricity Charges

```
//Exa 11.4
clc;
clear;
close;
//Given Data :
format('v',9);
Energy=180000;//in kwh
LoadFactor=45;//in %/year
LoadFactor=45/100;//in fraction
//Charges=Rs. 50/KW/Annum plus 8 paise per unit
C1=50;//in Rs.year/KW
C2=8;//in paisa/unit
h=365*24;//no. of hours per year
AvgLoad=Energy/h;//in KW
MaxLoad=AvgLoad/LoadFactor;//in KW
FixCharges=MaxLoad*C1;//in Rs.
PlusCharges=(C2/100)*Energy;//in rs.
TotalTarrif=FixCharges+PlusCharges;//in Rs.
disp(TotalTarrif,"Total Annual electricity charges(
   in Rs.) :");
```

Scilab code Exa 11.5 Annual cost of Energy

```
//Exa 11.5
clc;
clear;
close;
//Given Data :
format('v',9);
Energy=25*10^6;//in kwh
```

```
MaxDemand=1600;//in KW
//(i) Rs. 70/KW max demand plus 2 paise per kwh
C1=70;//in Rs.year/KW
C2=2;//in paisa/unit
AnnualCost=MaxDemand*C1+(C2/100)*Energy;//in Rs.
disp(AnnualCost,"Case (i) Annual cost of energy(in
   Rs.) :");
//(ii) Annual cost at a flat rate of 5p/kwh
C=5;//in paisa/kwh
AnnualCost=(C/100)*Energy;//in Rs.
disp(AnnualCost,"Case (ii) Annual cost of energy(in
   Rs.) :");
```

Scilab code Exa 11.6 No of units to be onsumed

```
//Exa 11.6
clc;
clear;
close;
//Given Data :
format('v',9);
MaxDemand=20;//in KW
//(i) Rs. 180/KW/annum max demand plus 15 paise per
   unit
//(ii) Flat rate tarrif 40 paise/unit
C1=180;//in Rs.year/KW
C2=15;//in paisa/unit
//AnnualBill1=C1*MaxDemand+(C2/100)*x ;x is the
   energy consumed
C=40;//in paisa/unit
//AnnualBill2=(C/100)*x ;x is the energy consumed
//Puting two bills equal gives :
x=C1*MaxDemand/((C/100)-(C2/100));//in kwh
disp(x,"No. of units to be consumed(or in kwh) :");
```

Scilab code Exa 11.7 Annual Bill of a consumer

```
//Exa 11.7
clc;
clear;
close;
//Given Data :
format('v',9);
MaxDemand=500;//in KW
LoadFactor=70;//in %/year
LoadFactor=70/100;//in fraction
cosfi=0.8;//unitless
//(i) Rs. 80/KVA of max demand
//(ii) Running chargeare  5 paise/kwh
C1=80;//in Rs./KVA
C2=5;//in paisa/kwh
AvgLoad=MaxDemand*LoadFactor;//in KW
h=365*24;//no. of hours per year
Energy=AvgLoad*h;//in kwh
MaxDemandKVA=MaxDemand/cosfi;//in KVA
AnnualBill=MaxDemandKVA*C1+(C2/100)*Energy;//in RS
disp(AnnualBill,"Annual bill of consumer(in Rs.) :")
    ;
```

Scilab code Exa 11.8 Overall Annual charges

```
//Exa 11.8
clc;
clear;
close;
//Given Data :
format('v',9);
```

```
MD=100;//in KW
LF=60;//in %/year
LF=60/100;//in fraction
//Tarrif Rs. 100/KW of max demand and Rs. 1/kwh
C1=100;//in Rs./KW
C2=1;//in Rs./kwh
h=365*24*12;//no. of hours
UnitsConsumed=MD*LF*h;//in kwh/year
AnnualCharges=C1*MD+C2*UnitsConsumed;//in RS
disp(AnnualCharges,"Overall Annual chrges(in Rs.) :"
    );
```

Scilab code Exa 11.9 Annual Bill of Industry

```
//Exa 11.9
clc;
clear;
close;
//Given Data :
format('v',9);
MD=250;//in KW
PF=0.8;//power factor
cosfi=PF;//unitless
Energy=50000;//in units/annum
//Tarrif Rs. 50/KVA of max demand and 0.25paisa/unit
C1=50;//in Rs./KW
C2=0.25;//in Paise/kwh
MDKVA=MD/cosfi;//in KVA
AnnualBill1=C1*MDKVA+C2*Energy;//in RS
disp(AnnualBill1,"Annuall bill of industry(in Rs.) :
    ");
//Note : If consumer raised the PF to unity.
PF=1;//power factor
cosfi=PF;//unitless
MDKVA=MD/cosfi;//in KVA
```

```
AnnualBill2=C1*MDKVA+C2*Energy;//in RS
disp(AnnualBill1-AnnualBill2,"Saving by consumer in the bill(in Rs.) :");
```

Scilab code Exa 11.10 Which tariff to be choose

```
//Exa 11.10
clc;
clear;
close;
//Given Data :
format('v',9);
MD=10;//in KW
Energy=50000;//in kwh/year(Annual consumption)
//(i) Rs. 100/KW/year max demand plus Rs. 0.20 paise per unit
//(ii) Simple tarrif 0.30 Rs./unit
C1=100;//in Rs.year/KW
C2=0.20;//in Rs. /unit
//Case (i)
AnnualBill1=C1*MD+C2*Energy;//in Rs.
disp(AnnualBill1,"Case(i) Annual Bill of tarrif 1 (in Rs.) :");
C=0.30;//in Rs. /unit
AnnualBill2=C*Energy;//in Rs.
disp(AnnualBill2,"Case(ii) Annual Bill of tarrif 2 (in Rs.) :");
disp("Naturally he will hoose the first tarrif.");
```