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

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# Book Description

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Scilab numbering policy used in this document and the relation to the above book.

**Exa** Example (Solved example)

**Eqn** Equation (Particular equation of the above book)

**AP** Appendix to Example(Scilab Code that is an Appednix to a particular Example of the above book)

For example, Exa 3.51 means solved example 3.51 of this book. Sec 2.3 means a scilab code whose theory is explained in Section 2.3 of the book.

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# Chapter 1

# Basic Concepts

**Scilab code Exa 1.1** Line current and Power Consumed

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

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

```
1 //Exa 1.2
2 clc;
3 clear;
4 close;
5 //Given data :
6 format('v',6);
7 VL=440;//in volt
8 IL=10;//in Ampere
9 //In star connected :
10 disp("In star connected :");
11 Iph=IL;//in Ampere
12 Vph=VL/sqrt(3);//in volt
13 Rph=Vph/Iph;//in ohm
14 disp(Rph,"Value of each resistor(in ohm) :");
15 //In delta connected :
16 disp("In delta connected :");
17 Iph=IL/sqrt(3);//in Ampere
18 Vph=Iph*Rph;//in volt
19 disp(Vph,"Voltage in delta connection(in volt) :");
20 disp("Voltage needed is 1/3rd, the voltage in star
      connection.")
```

**Scilab code Exa 1.3** Line current power factor and power consumed

```
1 //Exa 1.3
2 clc;
3 clear;
4 close;
5 //Given Data :
6 format('v',6);
```

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

**Scilab code Exa 1.4** Phase current and line current

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

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

# Chapter 2

# Layout of Transmission Systems

**Scilab code Exa 2.1** Most Economical cross section

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

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

**Scilab code Exa 2.2** `Weight of copper`

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

```
16  IL=Pt/(sqrt(3)*V*cosfi);//in Ampere
17  LineLosses=(Loss/100)*Pt;//in watts
18  rho=R*10^-4/(1*10^3);//in ohm−meter
19  a=3*IL^2*rho*l/(LineLosses);//in m^2
20  Volume=3*a*l;//in m^3
21  Cu_weight=Volume*density;//in Tones
22  disp(Cu_weight,"Weight of copper(in Tones) : ");
23  disp("Single phase 2 wire :");
24  IL=Pt/(V*cosfi);//in Ampere
25  a=2*IL^2*rho*l/(LineLosses);//in m^2
26  Volume=2*a*l;//in m^3
27  Cu_weight=Volume*density;//in Tones
28  disp(Cu_weight,"Weight of copper(in Tones) : ");
29  //Note : answer is not accurate in the book.
```

**Scilab code Exa 2.3** Most Economical cross section

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

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

**Scilab code Exa 2.4** Most Economical cross section

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

```scilab
17  cosfi1=0.8//unitless
18  I1=P1/(sqrt(3)*VL*10^3*cosfi1);//in Ampere
19  P2=1.5*10^6;//in watt
20  h2=6;//in hours
21  cosfi2=0.9//unitless
22  I2=P2/(sqrt(3)*VL*10^3*cosfi2);//in Ampere\
23  P3=0.5*10^6;//in watt
24  h3=8;//in hours
25  cosfi3=0.9;//unitless
26  I3=P3/(sqrt(3)*VL*10^3*cosfi3);//in Ampere
27  //Etot=3*(I1^2*h1+I2^2*h2+I3^2*h3)*R*365/1000;//in
         kwh
28  //Ccost_line=40000*a*4;//in Rs.
29  //AnnualCharges=Ccost_line*i/100;//in Rs.
30  disp("Annual chrges on account of interest and
         depriciation(in Rs.) : "+string(40000*4*i/100)+"a
         ");
31  //AnnualCost2=(E_cost/100)*Etot ;//in Rs.
32  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");
33  disp("For most ecpnomic cross section :");
34  a=sqrt(1783/12800);
35  disp(a,"Most economical cross section(in cm^2) :");
```

**Scilab code Exa 2.5** Most Economical size

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

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

**Scilab code Exa 2.6** Volume and weight of conducting mterial

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

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

**Scilab code Exa 2.7** Three phase Load

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

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

**Scilab code Exa 2.8** Percentage saving of copper

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

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

**Scilab code Exa 2.9** Volume of conducting material

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

**Scilab code Exa 2.10** Volume and weight of conducting material

```scilab
1  //Exa 2.10
2  clc;
3  clear;
4  close;
5  //Given Data :
6  format('v',6);
7  P=20*10^6;//in VA
8  cosfi=0.75;//power factor
9  P=20*10^6*cosfi;//in watts
10 V=33*10^3;//in Volt
11 l=20*10^3;//in meter
12 Eta=85;//in %
13 rho=3*10^-8;//in ohm-meter
14 W=P*(100-Eta)/100;//in watts
15 //For single phase system :
16 I=P/(V*cosfi);//in Ampere
17 a1=2*I^2*rho*l/W;//in m^2
18 V1=2*a1*l;//in m^3
19 disp(V1,"For single phase system :Volume of the
       conductor material(in m^3) :");
20 //For 3 phase 3 wire system :
21 I=P/(sqrt(3)*V*cosfi);//in Ampere
22 a2=3*I^2*rho*l/W;//in m^2
23 V2=3*a2*l;//in m^3
24 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

```scilab
1  //Exa 2.11
2  clc;
3  clear;
4  close;
5  //Given Data :
6  format('v',8);
```

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

**Scilab code Exa 2.12** Three phase Load

```
 1  //Exa 2.12
 2  clc;
 3  clear;
 4  close;
 5  //Given Data :
 6  format('v',8);
 7  //Vcon=V;//in volt
 8  //pf=cosfi;//unitless
 9  //Rcon=R;//in ohm
10  //Part (i) : single phase system
11  disp("Single phase system :");
```

```scilab
12  P1 =5*10^6; // in  watt
13  // I1=P1/(V* c o s f i ); // in  Ampere
14  disp (" Line  current , I1=" + string (P1) +"/V* c o s f i ");
15  //W1=2* I1 ^2*R; // in  Wats( Line  l o s s e s )
16  disp (" Line  Losses ,W1=" + string (2* P1 ^2) +"R/(V* c o s f i )^2
        ");
17  // Lloss_percent=W1*P1/100; // in  %          eqn ( 1 )
18  disp ("% Line  Losses=" + string (2* P1 ^2*100/ P1) +"R/(V*
        c o s f i )^2");
19  // Part ( i i )  :  3  phase  3  wire  system
20  disp ("3  phase  3  wire  system  :");
21  // I2=P2/(V* c o s s f i * s q r t ( 3 ) ); // in  Ampere
22  disp (" Line  current , I2=" + string (10^6/ sqrt (3) ) +"P2/V*
        c o s f i ");
23  //W1=2* I2 ^2*R; // in  Wats( Line  l o s s e s )
24  disp (" Line  Losses ,W2=" + string (2*(10^6/ sqrt (3) ) ^2) +"R
        *P2^2/(V* c o s f i )^2");
25  // Lloss_percent=W2*P2/100; // in  %          eqn ( 2 )
26  disp ("% Line  Losses=" + string (3*(10^6/ sqrt (3) ) ^2) +"R*
        P2^2/(V* c o s f i )^2");
27  P2 =2* P1; // in  watts
28  disp ("3  phase  load  in  MW :" + string (P2/10^6) );
```

**Scilab code Exa 2.13** Percentage saving of copper

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

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

# Chapter 3

# Costructional mechanial feature of line

**Scilab code Exa 3.1** Voltage across disc and string efficiency

```
1  //Exa 3.1
2  clc ;
3  clear ;
4  close ;
5  //Given Data :
6  format ( 'v ' ,6) ;
7  m =1/10; // unitless
8  EL =66; // in KV
9  E = EL / sqrt (3) ; // in KV
10 // Formula : E=E1+(11/10)*E1+(131/100)*E1+(1651/1000)
       *E1=(5061/1000)*E1
11 E1 = E *(1000/5061) ; // in KV
12 disp ( E1 , " E1 ( in KV) : " ) ;
13 E2 = E1 *(11/10) ; // in KV
14 disp ( E2 , " E1 ( in KV) : " ) ;
15 E3 = E1 *(131/100) ; // in KV
16 disp ( E3 , " E2 ( in KV) : " ) ;
17 E4 = E1 *(1651/1000) ; // in KV
18 disp ( E4 , " E4 ( in KV) : " ) ;
```

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

**Scilab code Exa 3.2** Horizontal and vertical sag

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

**Scilab code Exa 3.3** sag

```
1 //Exa 3.3
2 clc;
3 clear;
4 close;
5 //Given Data :
6 format('v',5);
7 L=150;//in meter
```

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

**Scilab code Exa 3.4** Find sag

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

**Scilab code Exa 3.5** `Clearance between conductors`

```
1  //Exa 3.5
2  clc ;
3  clear ;
4  close ;
5  //Given Data :
6  format ('v' ,7);
7  m=75-45;//in meter
8  L=300;//in meter
9  T=2500;//in Kg
10 w=0.9;//in kg/meter
11 x=L/2-T*m/(w*L);//in meters
12 disp(x,"x=");
13 disp("The negative sign of x shows that point A is
       on the side of O.");
14 x=L/2-x;//in meter
15 disp("Centre point P from O is "+string(L/2-x)+"
       meters .");
16 y=w*x^2/(2*T);//in meter
17 disp("Height of point P, y= "+string(y))
18 x=L/2-T*m/(w*L);//in meters
19 z=w*(L-x)^2/(2*T);//in meters
20 disp("Height of B above O is , z="+string(z)+" meters
       .");
21 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`

28

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

**Scilab code Exa 3.7** Maximum sag

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

**Scilab code Exa 3.8** Height above the ground

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

**Scilab code Exa 3.9** Voltge distribution and string efficiency

```
1  //Exa 3.9
2  clc;
3  clear;
4  close;
5  //Given Data :
6  format('v',5);
7  m=1/9;//unitless
8  EL=33;//in KV
9  EbyE1=1+(1+m)+(1+3*m+m^2);//assumed
10 E=EL/sqrt(3);//in KV
11 E1=E/EbyE1;//in KV
12 disp(E1,"E1(in KV) :");
13 E2=(1+m)*E1;//in KV
14 disp(E2,"E2(in KV) :");
15 E3=(1+3*m+m^2)*E1;//in KV
16 disp(E3,"E3(in KV) :");
17 E=E1+E2+E3;//in KV
```

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

**Scilab code Exa 3.10** `String Efficiency`

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

**Scilab code Exa 3.11** `sag in the line`

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

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

**Scilab code Exa 3.12** Clculate vertical sag

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

# Chapter 4

# Electrical Features of Lines 1

**Scilab code Exa 4.1** Inductance per Km

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

**Scilab code Exa 4.2** Inductance per phase per Km

33

```
1  //Exa 4.2
2  clc;
3  clear;
4  close;
5  //Given Data :
6  format('v',7);
7  d=2.8*100;//in cm(spacing)
8  r=0.5*1.5;//in cm
9  ds=0.77888*r;//in cm
10 L=0.2*log(d/ds);//in H/m/phase
11 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

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

**Scilab code Exa 4.4** Find the capacitance

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

**Scilab code Exa 4.5** Inductance and capacitance

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

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

**Scilab code Exa 4.6** `Inductance per phase per Km`

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

**Scilab code Exa 4.7** `Capacitance of single phase line`

```
1  //Exa 4.7
2  clc;
3  clear;
4  close;
5  //Given Data :
6  format('v',9);
7  dia=5;//in mm
8  d=1.5;//in meter(spacing)
```

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

**Scilab code Exa 4.8** Loop inductance per Km

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

**Scilab code Exa 4.9** Inductance per Km

```
1  //Exa 4.9
```

```
 2  clc;
 3  clear;
 4  close;
 5  //Given Data :
 6  format('v',9);
 7  d1=100;//in cm(spacing)
 8  d2=100;//in cm(spacing)
 9  d3=100;//in cm
10  r=1;//in cm
11  L=10^-7*[0.5+2*log((d1*d2*d3)^(1/3)/r)];//in H/m
12  L=L*1000*1000;//in mH/km
13  disp(L,"Inductance per km(in mH) :");
14  //Note : Answer in the book is wrong due to
        calculation mistake.
15  //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

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

**Scilab code Exa 4.11** `Loop inductance per Km`

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

**Scilab code Exa 4.12** `Inductance of 1 Km line`

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

**Scilab code Exa 4.13** Capacitance of single phase overhead line

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

**Scilab code Exa 4.14** Capacitance of 10 km long line

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

**Scilab code Exa 4.15** capacitance of line and charging current

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

# Chapter 5

# Electrical Features of Lines 2

**Scilab code Exa 5.1** Estimate of weight of copper

```
1  //Exa 5.1
2  clc;
3  clear;
4  close;
5  //Given Data :
6  format('v',6);
7  Load=100;//in MW
8  V=380;//in KV
9  d=100;//in km
10 rho=0.045;//in ohm/cm^2/km
11 w=0.01;//in kg/cm^3
12 Eff=90;//in %
13 IL=Load*10^6/(sqrt(3)*V*10^3);//in Ampere
14 P_loss=Load*(100-Eff)/100;//in MW
15 P_loss=P_loss*10^6;//in Watt
16 P_loss=P_loss/3;//in watt/conductor
17 R_con=P_loss/IL^2;//in ohm/conductor
18 //R_con=R_con/d;//in ohm/conductor/km
19 a=rho*d/R_con;//in cm^2
20 vol=a*d;//in cm^3
21 W_cu=vol*w;//in Kg
```

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

**Scilab code Exa 5.2** Voltage between phase to neutral

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

**Scilab code Exa 5.3** Sending end voltage regulation and efficiency

```
1 //Exa 5.3
2 clc ;
3 clear ;
4 close ;
5 //Given Data :
6 format ('v',7);
```

```
7   l=10*10^3; //in meter
8   P_del=4000; //in KVA
9   cos_fir=0.9; //unitless
10  VL=11*10^3; //in volt
11  R=0.2*10; //in ohm/phase/10km
12  X=0.3*10; //in ohm/phase/10km
13  I=P_del*10^3/(sqrt(3)*VL); //in Ampere
14  VR_phase=VL/sqrt(3); //in volt
15  Vs=sqrt((VR_phase*cos_fir+I*R)^2+(VR_phase*sqrt(1-
        cos_fir^2)+I*X)^2);
16  disp(Vs*sqrt(3)/1000,"Sending end voltage Vs(line in
        KV) :");
17  disp(((Vs-VR_phase)/VR_phase)*100,"% Regulation : ")
        ;
18  Losses3line=3*I^2*R; //in watt
19  P_rec=P_del*cos_fir; //in KW
20  Pin=P_rec+Losses3line/1000; //in KW
21  ETA=P_rec/Pin; //unitless
22  disp(ETA*100,"Transmission Efficiency(in %) :")
23  cos_fis=(VR_phase*cos_fir+I*R)/Vs; //unitless
24  disp(cos_fis,"Sending end PF(lag) :");
```

**Scilab code Exa 5.4** Sending end voltage PF and regulation

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

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

**Scilab code Exa 5.5** Line voltage Regulation and efficieny

```
1  //Exa 5.5
2  clc;
3  clear;
4  close;
5  //Given Data :
6  format('v',9);
7  Vs_line=33*10^3;//in volt
8  cos_fir=0.8;//unitless
9  P_KVA=6000;//in KVA
10  P_KW=P_KVA*cos_fir;//in KW
11  cos_fir=0.8;//unitless
12  impedence=2+%i*6;//in ohm
13  R=real(impedence);//in ohm
14  X=imag(impedence);//in ohm
15  Vs_phase=Vs_line/sqrt(3);//in volt
16  disp("Sending end Voltage, Vs(in Volt) = VR+I*R*
       cos_fir+I*X*sin_fir ");
17  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)].")
18  sin_fir=sqrt(1-cos_fir^2);
```

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

**Scilab code Exa 5.6** Estimate distance

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

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

**Scilab code Exa 5.7** Sending end voltage

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

**Scilab code Exa 5.8** Efficiency and regulation of line

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

```scilab
 8  dia=1;//in cm
 9  r=dia/2;//in cm
10  Length=20;//in km
11  V=33;//in KV
12  P=10;//in MW
13  cosfi=0.8;//unitless
14  f=50;//in Hz
15  R=0.19;//in ohm/km/phase
16  //Part (i) :
17  L=2*10^-7*log(d/r);//in H/m
18  L20=L*Length*10^3;//in H
19  XL=2*%pi*f*L20;//in ohm
20  R20=R*Length;//in ohm
21  Z=sqrt(R20^2+XL^2);//in ohm
22  IR=P*10^3/(sqrt(3)*V*cosfi)
23  Losses=3*IR^2*R20;//in watt
24  ETA=P/(P+Losses/10^6);//unitless
25  disp(ETA*100,"Efficiency of line(in %) :");
26  //Part (ii) :
27  VR=V*1000/sqrt(3);//in volt
28  Vs=((VR*cosfi+IR*R20)+(VR*sqrt(1-cosfi^2)+IR*XL));
29  disp(((Vs-VR)/VR)*100,"% Regulation : ");
30  //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

```scilab
1  //Exa 5.9
2  clc;
3  clear;
4  close;
5  //Given Data :
6  format('v',8);
7  R=2.5;//in ohm
```

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

**Scilab code Exa 5.10** Sending end voltage regulation and efficiency

```
 1  //Exa 5.10
 2  clc;
 3  clear;
 4  close;
 5  //Given Data :
 6  format('v',8);
 7  Pt =4000*10^3; //in watt(power to be transmitted)
 8  VR =11000; //in volt
 9  cos_fir =0.9; //unitless
10  R =1; //in ohm
11  X =2.5; //in ohm
12  I=Pt/VR; //in Ampere
13  Vs=VR+I*R*cos_fir+I*X*sqrt(1-cos_fir^2); //in volt
14  disp(Vs,"Sending end voltage(in volts) : ");
15  Reg=(Vs-VR)*100/VR; //in %
16  disp(Reg,"% Regulation : ");
17  cos_fis=(VR*cos_fir+I*R)/Vs; //unitless
18  disp(cos_fis,"Sending end pf(lag) : ");
19  losses=I^2*R; //in watts
20  Pr=Pt*cos_fir; //in wats(Receiving end power)
21  Psend=Pr+losses; //in watts
22  Eff=Pr*100/Psend; //unitless
23  disp(Eff,"Transmission efficiency (in %) :");
```

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**Scilab code Exa 5.11** Sending end voltage regulation and efficiency

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

**Scilab code Exa 5.12** Voltage regultion and efficiency

```
1  //Exa 5.12
2  clc;
3  clear;
4  close;
5  //Given Data :
6  format('v',8);
```

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```
 7  R=2;//in ohm
 8  X=3;//in ohm
 9  VR=10*1000;//in volt
10  P=1000*10^3;//in watt(power delivered)
11  cos_fir=0.8;//unitless
12  I=P/(VR*cos_fir);//in Ampere
13  Vs=sqrt((VR*cos_fir+I*R)^2+(VR*sqrt(1-cos_fir^2)+I*X
       )^2);//in volt
14  Reg=(Vs-VR)*100/VR;//in %
15  disp(Reg,"% Regulation : ");
16  losses=I^2*R;//in watts
17  Pr=P*cos_fir;//in wats(Receiving end power)
18  Psend=Pr+losses;//in watts
19  Eff=Pr*100/Psend;//unitless
20  disp(Eff,"Transmission efficiency (in %) :");
```

**Scilab code Exa 5.13** Voltage regultion and efficiency

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

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

# Chapter 7

# Distribution Systems

**Scilab code Exa 7.1** Voltage drop along the distributor

```
1  //Exa 7.1
2  clc;
3  clear;
4  close;
5  //Given data :
6  format('v',5);
7  l=1;//in km
8  I=100;//in Ampere
9  cosfi=0.8;//Power factor(lag) unitless
10 VC=200;//in volt
11 IL=60;//in Ampere
12 cosfi_load=0.9;//Power factor(lag) unitless
13 R=0.6;//in ohm
14 XL=0.08;//in ohm
15 IC=I*(0.8-%i*0.6);//in Ampere
16 z=(0.06+%i*0.08)/2;//in ohm
17 VD_BC=z*IC;//in volt
18 VB=VC+VD_BC;//in volt
19 IB=IL*(0.9-%i*0.4357)+IC;//in Ampere
20 VD_AB=z*IB;//in volt
21 disp(VD_AB,"V.D. from sending end to mid point(in
```

```
       volt ) : " ) ;
22  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

```
 1  //Exa 7.2
 2  clc ;
 3  clear ;
 4  close ;
 5  //Given data :
 6  format ('v',6);
 7  l=500;//in meter
 8  i=1;//in Ampere/meter
 9  IL1=200; IL2=150; IL3=50; IL4=100;//in Ampere
10  l1=100; l2=200; l3=300; l4=400;//in meter
11  r=0.1;//in ohm/km
12  Vd=250;//in volt
13  //Drop_AC=100*(r/10^3)*(I-i*l1/2);
14  //Drop_CD=I;
15  //Drop_DE=100*r*(I-550)-I*100/2;
16  //Drop_EF=100*r*(I-700-I*100/2);
17  //Drop_FB=100*r*(I-900-I*100/2);
18  //VD_tot=0.05*I-27;//in volts
19  disp ("As the both ends are fed with same voltage, VD
        should be equal to zero.");
20  I=27/0.05;//in Ampere
21  disp (I,"Curent (in Ampere) :");
22  Drop_AD=(0.01*I-0.5)+(0.01*I-3.5);
23  disp (Vd-Drop_AD ,"Value at minimum potential at D(in
       V) :");
24  //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`

```
1  //Exa 7.3
2  clc;
3  clear;
4  close;
5  //Given data :
6  format('v',6);
7  l=250;//in meter
8  VA=230;//in volt
9  VB=232;//in volt
10 r=0.5;//in ohm/km
11 r=0.5/10^3;//in ohm/m
12 RAC=r*50*2;//in ohm
13 RCD=RAC;RDE=RAC;REF=RAC;RFB=RAC;//in ohm
14 //VA-VB=VAC+VCD+VDE+VEF+VFB;//in volt
15 Ia=(VA-VB+15)/(5*RAC);//in Ampere
16 IAC=Ia;ICD=IAC-20;IDE=IAC-60;IED=-IDE;IEF=IAC-100;
       IFE=-IEF;IFB=IAC-120;IBF=-IFB;//in Ampere
17 disp(IAC,"IAC(in A):");
18 disp(ICD,"ICD(in A):");
19 disp(IDE,"IDE(in A):");
20 disp(IED,"IED(in A):");
21 disp(IEF,"IEF(in A):");
22 disp(IFE,"IFE(in A):");
23 disp(IFB,"IFB(in A):");
24 disp(IBF,"IBF(in A):");
25 VAC=IAC*RAC;//in volt
26 VCD=ICD*RCD;//in volt
27 VD=VA-VAC-VCD;//in volt
28 disp(VD,"The minimum potential(in Volt) :");
```

**Scilab code Exa 7.4** `Current in various sections`

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

**Scilab code Exa 7.5** `Voltages at B and C`

```
1  //Exa 7.5
```

```scilab
 2 clc;
 3 clear;
 4 close;
 5 //Given data :
 6 format('v',6);
 7 VA=400;//in volt
 8 r=0.03;//in ohm/km
 9 r=0.03/1000;//in ohm/m
10 RAB=r*500*2;//in ohm
11 RBC=r*300*2;//in ohm
12 RAB=r*700*2;//in ohm
13 RAB=r*500*2;//in ohm
14 //VA-VB=VAC+VCD+VDE+VEF+VFB;//in volt
15 IA=(17.4)/(0.09);//in Ampere
16 VAB=(RAB)*IA;//in volt
17 VB=VA-VAB;//in volt
18 disp(VB,"Voltage at B(in volts) :");
19 VBC=(RBC)*(IA-150);//in volt
20 VC=VB-VBC;//in volt
21 disp(VC,"Voltage at C(in volts) :");
22 IBC=IA-150;//in A
23 disp(IBC,"Current in section BC(in A) :");
24 //Note : answer of VB is wrong in the book.
```

**Scilab code Exa 7.6** Cross setional area of conductor

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

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

**Scilab code Exa 7.7** Total voltage drop in the cable

```
1   //Exa 7.7
2   clc;
3   clear;
4   close;
5   //Given data :
6   format('v',6);
7   R=0.2;//in ohm/km
8   X=0.1;//in ohm/km
9   ZAM=((R+%i*X)/1000)*200;//in ohm
10  ZMB=((R+%i*X)/1000)*100;//in ohm
11  I1=100*(0.707-0.707*%i);//in A
12  I2=200*(0.8-0.6*%i);//in A
13  IAM=I1+I2;//in Ampere
14  VAM=ZAM*IAM;//in volts
15  VMB=ZMB*I2;//in volts
16  VAB=VAM+VMB;//in volts
17  magVAB=sqrt(real(VAB)^2+imag(VAB)^2);
18  disp(magVAB,"Total voltage drop(in volts) :");
```

**Scilab code Exa 7.8** Voltage at mid point and sending voltage

```scilab
1  //Exa 7.8
2  clc;
3  clear;
4  close;
5  //Given data :
6  format('v',6);
7  VB=200;//in volts
8  R=0.2;//in ohm/km
9  X=0.3;//in ohm/km
10 I=100;//in Ampere
11 ZAB=(R+%i*X);//in ohm
12 ZMB=ZAB/2;//in ohm
13 ZAM=ZMB;//in ohm
14 cosfi_1=0.6;//unitless
15 cosfi_2=0.8;//unitless
16 IMB=I*(cosfi_2-%i*cosfi_1);//in A
17 I2=IMB;//in Ampere
18 VMB=IMB*ZMB;//in volts
19 VM=VB+VMB;//in volts
20 disp(VM,"Voltage at M(in volt)");
21 fi=atand(imag(VM)/real(VM));//in degree
22 fi_1=acosd(cosfi_1);//in degree
23 fi_VBandI1=fi_1-fi;//in degree
24 I1=I*(cosd(fi_VBandI1)-%i*sind(fi_VBandI1));//in
        Ampere
25 IAM=I1+I2;//inA Ampere
26 VAM=ZAM*IAM;//in volts
27 VA=VM+VAM;//in volts
28 magVA=sqrt(real(VA)^2+imag(VA)^2);
29 disp(magVA,"Voltage at A, standing end voltage(in
        volts) :");
```

**Scilab code Exa 7.9** Cross setional area of conductor

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

**Scilab code Exa 7.10** Potential at P

```scilab
1  //Exa 7.10
2  clc;
3  clear;
4  close;
5  //Given data :
6  format('v',7);
7  l=300;//in meter
8  I=0.75;//in A/m
9  R=0.00018;//in ohm/m
10 x=200;//in meter
11 Vs=250;//in volt
```

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

**Scilab code Exa 7.11** Current supplied at end A and B

```
1  //Exa 7.11
2  clc;
3  clear;
4  close;
5  //Given data :
6  format('v',7);
7  l=600;//in meter
8  VA=440;//in volt
9  VB=400;//in volt
10 R=0.01;//in ohm/100m
11 RAC=(R/100)*300;//in ohm
12 RCD=(R/100)*300;//in ohm
13 RDE=(R/100)*100;//in ohm
14 REF=(R/100)*200;//in ohm
15 RFB=(R/100)*300;//in ohm
16 //VA-VB=VAC+VCD+VDE+VEF+VFB;//in volt
17 IA=(VA-VB+42.5)/(0.12);//in Ampere
18 IAC=IA;ICD=IA-100;IDE=IA-300;IFE=IA-550;IFB=IA-850;
        //in Ampere
19 disp(IAC,"Current fed at A, IA(in A):");
20 disp(-IFB,"Current fed at B, IB(in A):");
```

**Scilab code Exa 7.12** Minimum potential and Current supplied

```
1  //Exa 7.12
2  clc;
```

```
3 clear;
4 close;
5 //Given data :
6 format('v',7);
7 VA=220;//in volt
8 VB=200;//in volt
9 R=0.1;//in ohm/km
10 I=1;//in A/m
11 l=500;//in meter
12 R=2*R/1000;//in ohm/m
13 x=(VA-VB)/(I*R*l)+l/2;//in meter
14 Vmin=VA-I*R*x^2/2;//in volts
15 disp(Vmin,"Value of minimum potential(in V) :");
16 IA=I*x;//in A
17 disp(IA,"Current supplied from end A(in A) :");
18 IB=I*(l-x);//in A
19 disp(IB,"Current supplied from end B(in A) :");
```

**Scilab code Exa 7.13** Feeding end voltage

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

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

**Scilab code Exa 7.14** `Voltage at the load end`

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

**Scilab code Exa 7.15** `Potential at points`

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

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

**Scilab code Exa 7.16** Point of minimum potential

```
1   //Exa 7.16
2   clc;
3   clear;
4   close;
5   //Given data :
6   format('v',5);
7   //Applying KVL in loop AFEDA: (0.016*x)+0.09*(x-30)
        +0.14*(x-17)-0.1*y=0
8   //Applying KVL in loop ADCBA: 0.1*y-0.12*(95-x-y)
        -.01*(145-x-y)-0.008*(165-x-y)=0
9   //Equating two equtions we get
10  //3.9*x-125=97.75-0.75*x
11  x=(97.75+125)/(3.9+0.75);//in A
12  y=97.75-0.75*x;//in A
13  disp(x,"x(in A)=");
14  disp(y,"y(in A)=");
15  disp("Thus the point of minimum ppotential is E.");
```

**Scilab code Exa 7.17** Maximum voltage drop and minimum potential

```
1   //Exa 7.17
```

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

Scilab code Exa 7.18 Voltages at ands A and C

```
1  //Exa 7.18
2  clc ;
3  clear ;
4  close ;
5  //Given data :
6  format ( 'v' ,7) ;
7  VB=400; //in volt
8  ZAC=0.04+%i*0.08; //in ohm
9  ZCB=0.08+%i*0.12; //in ohm
10  I1=60*(0.8-%i*0.6) ;
11  I2=120*(0.8-%i*0.6) ;
12  VCB=I2*ZCB; //in Volt
13  VAC=(I1+I2)*ZAC; //in volt
14  VC=VB+I2*ZCB; //in Volt
15  disp (VC ,"Voltage at C(in Volt) :") ;
16  VA=VC+(I1+I2)*ZAC; //in volt
17  disp (VA ,"Voltage at A(in Volt) :") ;
```

# Chapter 8

# Underground Cables and Faults

**Scilab code Exa 8.1** Thickness of Insulation

```
1  //Exa 8.1
2  clc;
3  clear;
4  close;
5  //given data
6  R=500;//in Mohm/Km
7  R=R*10^6;//in ohm
8  r1=2.5/2;//in cm
9  r1=r1*10^-2;//in meter
10 rho=4.5*10^16;//in ohm/cm
11 rho=rho*10^-2;//in ohm/m
12 l=1;//in Km
13 l=l*1000;//in meter
14 //Formula : R=(rho/(2*%pi*l))*log(r2/r1)
15 r2=(exp(R/(rho/(2*%pi*l))))*r1;//in meter
16 thickness=r2-r1;//in meter
17 thickness=thickness*100;//in cm
18 disp(thickness,"Thickness of Insulation in cm :");
```

**Scilab code Exa 8.2** Capacitance of 1 Km

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

**Scilab code Exa 8.3** Maximum stress and minimum sttress

```
1  //Exa 8.3
2  clc;
3  clear;
4  close;
5  //given data
6  V=33;//in KV
7  d=1;//in cm
8  D=4;//in cm
9  //Part (a) :
10 gmax=2*V/(d*log(D/d));//in KV/cm
11 disp(gmax,"Maximum Stress in KV/cm");
12 //Part (b) :
13 gmin=2*V/(D*log(D/d));//in KV/cm
14 disp(round(gmin),"Minimum Stress in KV/cm");
```

**Scilab code Exa 8.4** Most Economical size

```
1 //Exa 8.4
2 clc;
3 clear;
4 close;
5 //given data
6 Vrms=66;//in KV
7 gmax=40;;//in KV/cm
8 V=sqrt(2)*Vrms;//in Volt
9 //Part (a) :
10 d=2*V/gmax;//in cm
11 disp(d,"The most economical diameter in cm : ");
12 //Part (b) :
13 PeakVoltage=sqrt(2)*Vrms/sqrt(3);//in Volt
14 V=PeakVoltage;//in Volt
15 d=2*V/gmax;//in cm
16 disp(d,"The most economical diameter for 3 phase
      system in cm : ");
```

**Scilab code Exa 8.5** Safe working potential in KV

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

**Scilab code Exa 8.6** Charging current on 33 KV

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

**Scilab code Exa 8.7** Calculate the KVA taken

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

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

**Scilab code Exa 8.8** `Distance of fult from testing`

```
1  //Exa  8.8
2  clc ;
3  clear ;
4  close ;
5  //given  data
6  format ('v' ,9) ;
7  P =10; //in  Ohm
8  Q =80; //in  Ohm
9  S2 =3400; //in  Ohm
10  S1 =2400; //in  Ohm
11  X=P*(S2 -S1)/(P+Q); //in  Ohm
12  LoopResistance =P* S2/Q; //in  Ohm
13  ResistancePerKm = LoopResistance /10; //in  Ohm
14  Distance =X/ ResistancePerKm ; //in  Km
15  disp ( Distance ,"Distance  of  fault  from  testing  end  in
        Km  : " ) ;
```

**Scilab code Exa 8.9** `Distance of fault from testing`

```
1  //Exa  8.9
2  clc ;
3  clear ;
4  close ;
```

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

# Chapter 9

# Substations and Earthing

**Scilab code Exa 9.1** Rating of peterson coil

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

# Chapter 10

# Power factor improvement

**Scilab code Exa 10.1** Annual saving in cost

```
1  //Exa 10.1
2  clc;
3  clear;
4  close;
5  //Given Data :
6  format('v',7);
7  Load=500;//in KW
8  cosfi_1=0.75;//powerfactor
9  x=40;//in Rs/year/KVA
10 x1=60;//cost of PF improvement equipment in Rs./KVAR
11 i=12;//in % per annum
12 y=x1*i/100;//in Rs.
13 cosfi_2=0.98;//unitless
14 KVA1=Load/cosfi_1;//in KVA(at 0.75 pf)
15 KVA2=Load/cosfi_2;//in KVA(at 0.98 pf)
16 AnnualSaving=x*(KVA1-KVA2);//in Rs.
17 fi_1=acosd(cosfi_1);//in degree
18 tanfi_1=tand(fi_1);//unitless
19 Pr1=Load*tanfi_1;//in KVAR
20 fi_2=acosd(cosfi_2);//in degree
21 tanfi_2=tand(fi_2);//unitless
```

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

**Scilab code Exa 10.2** Rating of the Heater

```
1   //Exa 10.2
2   clc;
3   clear;
4   close;
5   //Given Data :
6   format('v',7);
7   Eta=85;//in %
8   P=30;//in HP
9   P1=P*0.7355*Eta/100;//in KW
10  cosfi_1=0.8;//powerfactor
11  tanfi_1=tand(acosd(cosfi_1));//unitless
12  Pr=P1*tanfi_1;//in KVAR
13  //Let active power P2 : Total Active power = P1+P2
14  cosfi=0.9;//overall powerfactor
15  tanfi=tand(acosd(cosfi));//unitless
16  //Pr1=tanfi*(P1+P2);//in KVAR
17  //Putting Pr=Pr1
18  P2=(Pr-P1*tanfi)/tanfi;//in KW
19  disp(P2,"Rating of the heater(in KW) :");
```

**Scilab code Exa 10.3** Capacity of the condenser

```
1   //Exa 10.3
2   clc;
```

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

**Scilab code Exa 10.4** Value of shunt capacitor

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

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

**Scilab code Exa 10.5** Capacity of the condenser

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

**Scilab code Exa 10.6** Capacity of the condenser

```
1  //Exa 10.6
2  clc;
3  clear;
4  close;
5  //Given Data :
```

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

**Scilab code Exa 10.7** Determine the PF

```
1  //Exa 10.7
2  clc;
3  clear;
4  close;
5  //Given Data :
6  format('v',7);
7  //(i)
8  IMO=200;//in HP(Induction Motor output)
9  IMO=IMO*0.7355;//in KW(Induction Motor output)
10 LagEff=90;//in %
11 LagEff=90/100;//in fraction
12 MotorIn=IMO/(LagEff);//in KW
13 cosfi_1=0.75;//powerfactor
14 tanfi_1=tand(acosd(cosfi_1));//unitless
15 Pr1=MotorIn*tanfi_1;//in KVAR
16 //(ii)
17 P2=300;//in KW
18 cosfi_2=0.5;//unitless
```

```
19 tanfi_2=tand(acosd(cosfi_2));//unitless
20 Pr2=P2*tanfi_2;//in KVAR
21 //(iii)
22 P3=200;//in KW
23 cosfi_3=1;//unitless
24 tanfi_3=0;//unitless
25 Pr3=0;//in KVAR
26 //(iv)
27 PsynMotor=500;//in KW
28 Eff=93;//in %
29 Eff=93/100;//in fration
30 Input=PsynMotor/Eff;//in KW
31 Pa=MotorIn+P2+P3+PsynMotor;//in KW
32 P1=Pr1+Pr2+Pr3;//in KVAR
33 cosfi=1;//unitless
34 tanfi=0;//unitless
35 Pr=Pa*tanfi;//in KVAR
36 Prm=Pr-P1;//in KVAR
37 tanfi_m=Prm/Input
38 cosfi_m=cosd(atand(tanfi_m));//unitless
39 disp(cosfi_m,"P.F. of the motor(lead) :");
40 //Note : Answer in the book is wrong
```

**Scilab code Exa 10.8** Capacity of each condenser

```
1 //Exa 10.8
2 clc;
3 clear;
4 close;
5 //Given Data :
6 format('v',7);
7 f=50;//in Hz
8 V=400;//in volts
9 MotorOut=20;//in HP(Motor output)
10 MotorOut=MotorOut*735.5;//in Watts(Induction Motor
```

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

**Scilab code Exa 10.9** Find power factor

```
 1  //Exa 10.9
 2  clc;
 3  clear;
 4  close;
 5  //Given Data :
 6  format('v',7);
 7  Pa=500;//in KW
 8  cosfi_1=0.7071;//powerfactor
 9  tanfi_1=tand(acosd(cosfi_1));//unitless
10  Pr1=Pa*tanfi_1;//in KVAR
11  Pm=100;//in KW
12  P=Pa+Pm;//in KW
13  cosfi_2=0.95;//unitless
14  tanfi_2=tand(acosd(cosfi_2));//unitless
15  Pr=P*tanfi_2;//in KVAR
16  Prm=Pr-Pr1;//in KVAR
17  Pam=sqrt(Pm^2+Prm^2)
18  PFsynMotor=Pm/Pam;//leading PF
```

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

**Scilab code Exa 10.10** Input of synchronous motor

```
1  //Exa 10.10
2  clc;
3  clear;
4  close;
5  //Given Data :
6  format('v',7);
7  P=1500;//in KW
8  cosfi_1=0.75;//powerfactor
9  tanfi_1=tand(acosd(cosfi_1));//unitless
10  Pr1=P*tanfi_1;//in KVAR
11  Pm=150;//in KW
12  P=P+Pm;//in KW
13  cosfi_2=0.9;//unitless
14  tanfi_2=tand(acosd(cosfi_2));//unitless
15  Pr=P*tanfi_2;//in KVAR
16  Prm=Pr-Pr1;//in KVAR
17  Pam=sqrt(Pm^2+Prm^2)
18  cosfi=Pm/Pam;//leading PF
19  disp(cosfi,"P.F.  of  synchronous  motor(leading)  :");
```

**Scilab code Exa 10.11** Determine the saving

```
1  //Exa 10.11
2  clc;
3  clear;
4  close;
5  //Given Data :
6  format('v',7);
```

```
7 Load =100; //in KW
8 LoadPF =0.75; // powerfactor
9 x =100; //in Rs/KVA
10 y =600*(10/100) ; //in Rs.
11 cosfi_2=sqrt(1-(y/x)^2)
12 disp(cosfi_2,"P.F.(lag) is :");
13 MaxDemand1=Load/LoadPF; //in KW(at 0.75 load power
      factor)
14 MaxDemand2=Load/cosfi_2; //in KW(at cosfi_2 power
      factor)
15 AnnSaving =(MaxDemand1 -MaxDemand2)*x; //in Rs.
16 cosfi_1=0.75; // powerfactor
17 tanfi_1=tand(acosd(cosfi_1)); // unitless
18 tanfi_2=tand(acosd(cosfi_2)); // unitless
19 KVAR1=Load*tanfi_1; //in KVAR
20 KVAR2=Load*cosfi_2; //in KVAR
21 Rating =KVAR1-KVAR2; //in KVAR
22 AnnualExpenditure=y*Rating; //in Rs.
23 AnnualSaving =AnnSaving -AnnualExpenditure; //in Rs.
24 disp(AnnualSaving ,"Annual Savings(in Rs.) :");
```

**Scilab code Exa 10.12** PF of synchronous motor

```
1 //Exa 10.12
2 clc;
3 clear;
4 close;
5 //Given Data :
6 format('v',9);
7 //(i)
8 PHeater =50; //in KW
9 cosfi_1=1; // unitless
10 tanfi_1=tand(acosd(cosfi_1)); // unitless
11 Pr1=PHeater*tanfi_1; //in KVAR
12 //(ii)
```

```
13  cosfi_2 =0.7; // unitless
14  P2 =200*735.5/(1000*0.8) ; // in KW
15  tanfi_2=tand ( acosd ( cosfi_2 ) ) ; // unitless
16  Pr2 =P2 * tanfi_2 ; // in KVAR
17  // ( i i i )
18  cosfi =0.9; // unitless New PF
19  P3 =200*735.5/(1000* cosfi ) ; // in KW
20  TotalActivePower=PHeater +P2 +P3 ; // in KW
21  TotalReactivePower=Pr1 +Pr2 ; // in KW
22  tanfi=tand ( acosd ( cosfi ) ) ; // unitless
23  TotalPr=TotalActivePower * tanfi ; // in KVAR
24  Pnn=TotalPr - TotalReactivePower ; // in KVAR(
        ReactivePower of motor )
25  tanfi_mu=Pnn/P3 ; // unitless
26  cosfi_mu=cosd ( atand ( tanfi_mu ) ) ;
27  disp ( cosfi_mu ,"PF of the synchronous motor :") ;
28  // Note : Answer in the book is wrong
```

**Scilab code Exa 10.13** `Limit of power factor`

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

**Scilab code Exa 10.14** Value of Capacitor

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

**Scilab code Exa 10.15** Find the supplied KVAR

```scilab
1  //Exa 10.15
2  clc;
3  clear;
4  close;
5  //Given Data :
6  format('v',9);
7  f=50;//in Hz
8  V=240;//in Volts
9  TotalLoad=200+80;//in KW
10 cosfi_1=0.8;//unitless
11 tanfi_1=tand(acosd(cosfi_1));
12 cosfi_2=0.9;//unitless
13 tanfi_2=tand(acosd(cosfi_2));
14 //(i)
15 OA=200;//in KW
16 OD=280;//in KW
17 CM=OA*tanfi_1-OD*tanfi_2;//in KVAR
18 disp(CM,"Leading KVAR supplied by the motor(in KVAR)
       :");
19 //(ii)
20 BM=80;//in KW
21 CM=15.6;//in KW
22 KVA_Rating=sqrt(BM^2+CM^2);//in KVA
23 disp(KVA_Rating,"KVA rating(in KVA) :");
24 //(iii)
25 BC=KVA_Rating;//in KW
26 cosfi_m=BM/BC;//unitless
27 disp(cosfi_m,"P.F. Of the motor  : ");
28 //Note : Answer of (i) part is wrong in the book is
       wrong
```

**Scilab code Exa 10.16** Most economical PF

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

**Scilab code Exa 10.17** Most economical PF and annual saving

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

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

# Chapter 11

# Various types of Tariffs

**Scilab code Exa 11.1** Calculate cost per unit

```
1  //Exa 11.1
2  clc;
3  clear;
4  close;
5  //Given Data :
6  format('v',6);
7  E=438000;//in kWh(Energy consumed per year)
8  pf=0.8;//unitless
9  cosfi=pf;//unitless
10 LoadFactor=40;//in %
11 //tarrif=Rs. 75/year/kw of max demand plus 3 paise
         per unit per reactive KVA
12 h=8760;//no. of years in a year
13 AvgLoad=E/h;//kw
14 MaxLoad=AvgLoad/(LoadFactor/100);//in kw
15 MaxLoad_KVA=MaxLoad/pf;//in KVA
16 tanfi=tand(acosd(cosfi));//unitless
17 ReactiveKVAR=h*tanfi*AvgLoad;//in KVA
18 AnnualBill=75*MaxLoad+(3/100)*E+(1.5/100)*
         ReactiveKVAR;//in Rs.
19 CostPerUnit=AnnualBill/E;//in Rs.
```

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

**Scilab code Exa 11.2** Calculate cost per unit

```
1 //Exa 11.2
2 clc;
3 clear;
4 close;
5 //Given Data :
6 format('v',6);
7 //tarrif=Rs. 275/year/KVA of max demand plus 35
      paise per unit
8 C1=275;//in Rs.year/KVA
9 C2=35;//in paisa/unit
10 LoadFactor=30;//in %/year
11 LoadFactor=30/100;//in fraction
12 //Let MaxDemand = x KW
13 //Case (i) PF=1
14 cosfi=1;//unitless
15 AnnualBillBYx=C1/cosfi+(C2/100)*LoadFactor*24*365;//
      in Rs.(Here 24*365 is for No. of hours in a year)
16 AnnualBill=AnnualBillBYx*100/(LoadFactor*24*365);//
      in paisa/unit
17 disp(AnnualBill,"Cost per unit(at unity power factor
       in paisa/unit) :");
18 //Case (i) PF=0.8
19 cosfi=0.8;//unitless
20 AnnualBillBYx=C1/cosfi+(C2/100)*LoadFactor*24*365;//
      in Rs.(Here 24*365 is for No. of hours in a year)
21 AnnualBill=AnnualBillBYx*100/(LoadFactor*24*365);//
      in paisa/unit
22 disp(AnnualBill,"Cost per unit(at 0.8 power factor
      in paisa/unit) :");
```

**Scilab code Exa 11.3** Estimate annual payment

```
1  //Exa 11.3
2  clc;
3  clear;
4  close;
5  //Given Data :
6  format('v',9);
7  FixedLoad=200;//in kW
8  PF=0.8;//unitless
9  cosfi=PF;//unitless
10 h=10;//in hours/day
11 d=300;//in days
12 Time=h*d;//in hours
13 Energy=FixedLoad*Time;//in kwh/year
14 // (i) tarrif=Rs. 100/KVA/Annum plus 20 paise per
       kwh
15 C1=100;//in Rs.year/KVA
16 C2=20;//in paisa/kwh
17 KVA=FixedLoad/cosfi;//in KVA
18 AnnualBill=KVA*C1+(C2/100)*Energy;//in Rs.
19 disp(AnnualBill," Case (i) Annual Payment(in Rs.) :"
       );
20 // (ii) tarrif=Rs. 100/KW/Annum plus 20 paise per
       kwh plus 2 paise/KVARH
21 C1=100;//in Rs./year/KW
22 C2=20;//in paisa/kwh
23 C3=2;//in paisa/KVARH
24 tanfi=tand(acosd(cosfi));//unitless
25 ReactiveKVARH=FixedLoad*tanfi*Time;//in KVARH
26 AnnualBill=C1*FixedLoad+(C2/100)*Energy+(C3/100)*
       ReactiveKVARH;//in Rs.
27 disp(AnnualBill," Case (ii) Annual Payment(in Rs.) :
       ");
```

**Scilab code Exa 11.4** Total Annual Electricity Charges

```
1  //Exa 11.4
2  clc;
3  clear;
4  close;
5  //Given Data :
6  format('v',9);
7  Energy=180000;//in kwh
8  LoadFactor=45;//in %/year
9  LoadFactor=45/100;//in fraction
10 //Charges=Rs. 50/KW/Annum plus 8 paise per unit
11 C1=50;//in Rs.year/KW
12 C2=8;//in paisa/unit
13 h=365*24;//no. of hours per year
14 AvgLoad=Energy/h;//in KW
15 MaxLoad=AvgLoad/LoadFactor;//in KW
16 FixCharges=MaxLoad*C1;//in Rs.
17 PlusCharges=(C2/100)*Energy;//in rs.
18 TotalTarrif=FixCharges+PlusCharges;//in Rs.
19 disp(TotalTarrif,"Total Annual electricity charges(
       in Rs.) :");
```

**Scilab code Exa 11.5** Annual cost of Energy

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

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

**Scilab code Exa 11.6** No of units to be onsumed

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

**Scilab code Exa 11.7** Annual Bill of a consumer

```
1  //Exa 11.7
2  clc;
3  clear;
4  close;
5  //Given Data :
6  format('v',9);
7  MaxDemand=500;//in KW
8  LoadFactor=70;//in %/year
9  LoadFactor=70/100;//in fraction
10 cosfi=0.8;//unitless
11 //(i) Rs. 80/KVA of max demand
12 //(ii) Running chargeare  5 paise/kwh
13 C1=80;//in Rs./KVA
14 C2=5;//in paisa/kwh
15 AvgLoad=MaxDemand*LoadFactor;//in KW
16 h=365*24;//no. of hours per year
17 Energy=AvgLoad*h;//in kwh
18 MaxDemandKVA=MaxDemand/cosfi;//in KVA
19 AnnualBill=MaxDemandKVA*C1+(C2/100)*Energy;//in RS
20 disp(AnnualBill,"Annual bill of consumer(in Rs.) :")
     ;
```

**Scilab code Exa 11.8** Overall Annual charges

```
1  //Exa 11.8
2  clc;
3  clear;
4  close;
5  //Given Data :
6  format('v',9);
```

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

**Scilab code Exa 11.9** Annual Bill of Industry

```
1  //Exa 11.9
2  clc;
3  clear;
4  close;
5  //Given Data :
6  format('v',9);
7  MD=250;//in KW
8  PF=0.8;//power factor
9  cosfi=PF;//unitless
10 Energy=50000;//in units/annum
11 //Tarrif Rs. 50/KVA of max demand and 0.25 paisa/unit
12 C1=50;//in Rs./KW
13 C2=0.25;//in Paise/kwh
14 MDKVA=MD/cosfi;//in KVA
15 AnnualBill1=C1*MDKVA+C2*Energy;//in RS
16 disp(AnnualBill1,"Annuall bill of industry(in Rs.) :
      ");
17 //Note : If consumer raised the PF to unity.
18 PF=1;//power factor
19 cosfi=PF;//unitless
20 MDKVA=MD/cosfi;//in KVA
```

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

**Scilab code Exa 11.10** Which tariff to be choose

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