Scilab Textbook Companion for Fundamentals Of Electrical Engineering by R. Prasad[1]

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July 31, 2019

[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: Fundamentals Of Electrical Engineering

Author: R. Prasad

Publisher: PHI Learning Private Limited

Edition: 3

Year: 2014

ISBN: 9788120348950

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

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Chapter 1

Fundamentals of Electrical Energy

Scilab code Exa 1.1 Determination of Energy consumed and Electricity charge

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex1_1.sce.

clc;
clear;
P=200;              //power rating of lamp in watts
V=110;               //voltage rating of lamp in volts

//case1
printf("\n(a)")
I=(P/V);
printf("\nCurrent in the lamp=%f A",I)

```

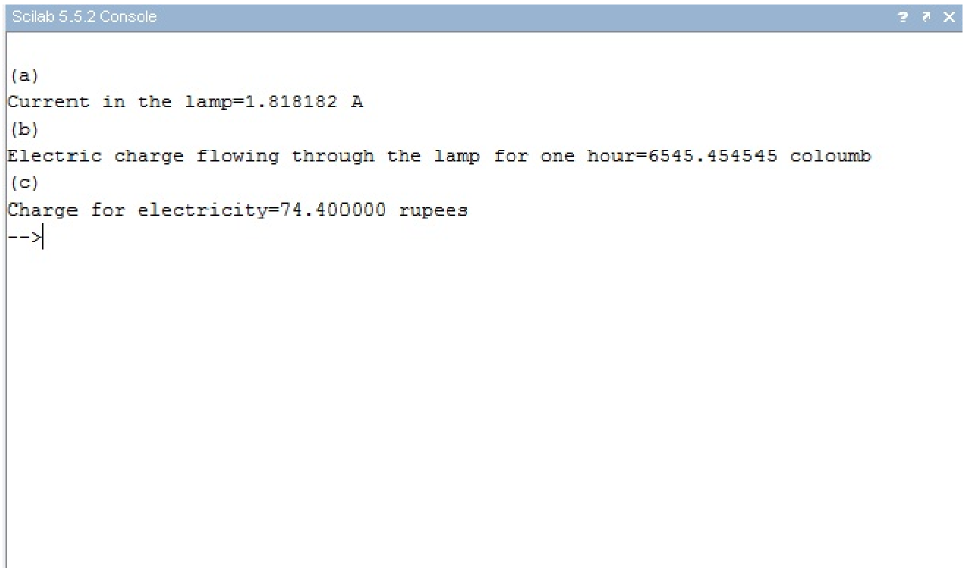


Figure 1.1: Determination of Energy consumed and Electricity charge

```
//case2
printf("\n(b)")
T=1;                    //time in hour for electric charge flow through the lamp
t=T*60*60;              //time in seconds for electric charge flow through the lamp
q=I*t;
printf("\nElectric charge flowing through the lamp for one hour=%f coloumb",q)

//case3
printf("\n(c)")
Numberofdaysinmay=31;
time=10;                          //on time of lamp in hour per day
unitcharge=1.20;                  //electricity charge in rupees (1kwhr = 1unit)
t1=time*Numberofdaysinmay;        //on time of lamp  in hour per month
Energyconsumed=P*t1;              //consumption of energy
```

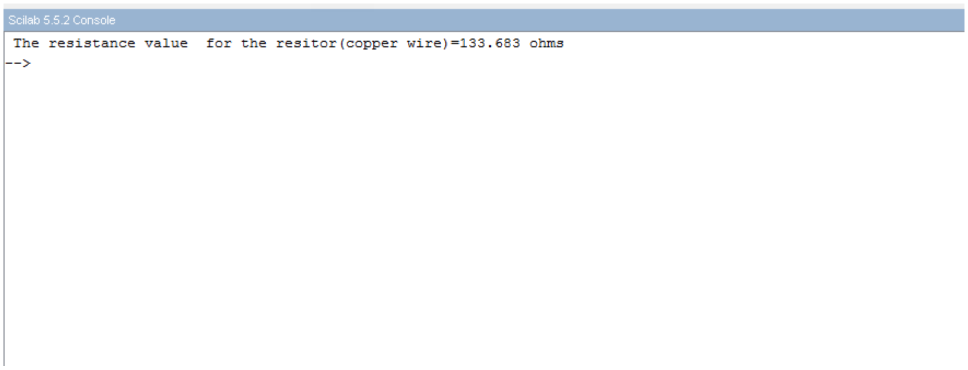


Figure 1.2: Determination of resistance value of the resistor

```
    in watt-hour
Energyconsumedinkwhr=Energyconsumed/(1e3);//
   consumption of energy in kilowatt-hour
charges=Energyconsumedinkwhr*unitcharge;
printf("\nCharge for electricity=%f rupees",charges)
```

Scilab code Exa 1.2 Determination of resistance value of the resistor

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex1_2.sce.

clc;
clear;
R25=120;             //resistance of copper wire at 25
    degree celsius
T1=25;               //temperature1 in degree celsius
T2=55;               //temperature in degree celsius
```

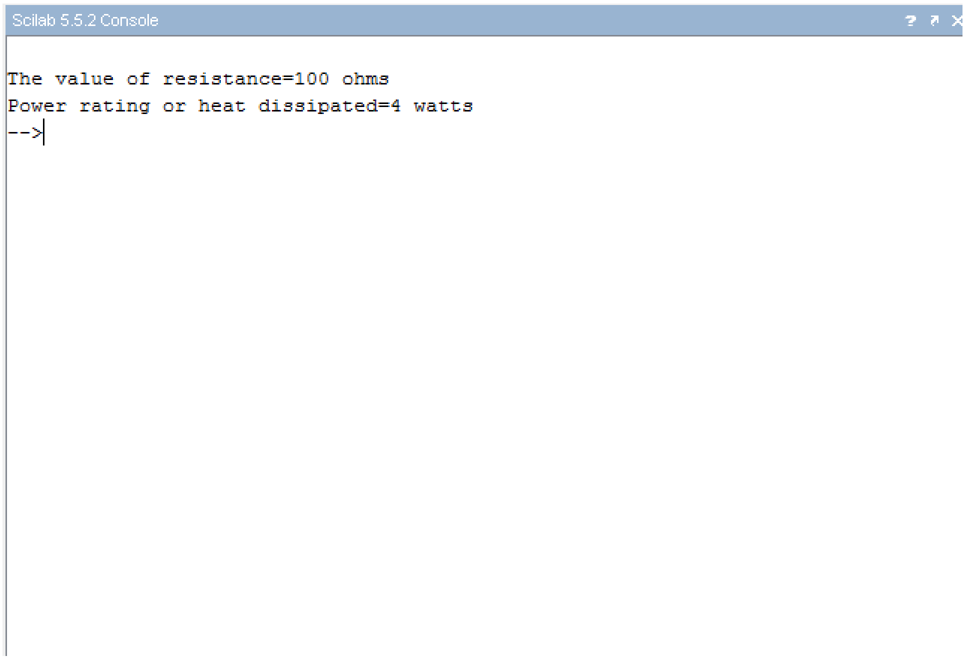


Figure 1.3: Determination of resistance value of the resistor and its power rating

```
alphazero=4.2e-3;    //temperature coefficient
R55=(R25*(1+(T2*alphazero)))/(1+(T1*alphazero));
                   //resistance of the copper wire at a
   temperature of 55 degree celsius
printf("The resistance value  for the resitor(copper
    wire)=%3.3f ohms",R55)
```

Scilab code Exa 1.3 Determination of resistance value of the resistor and its powe

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
```

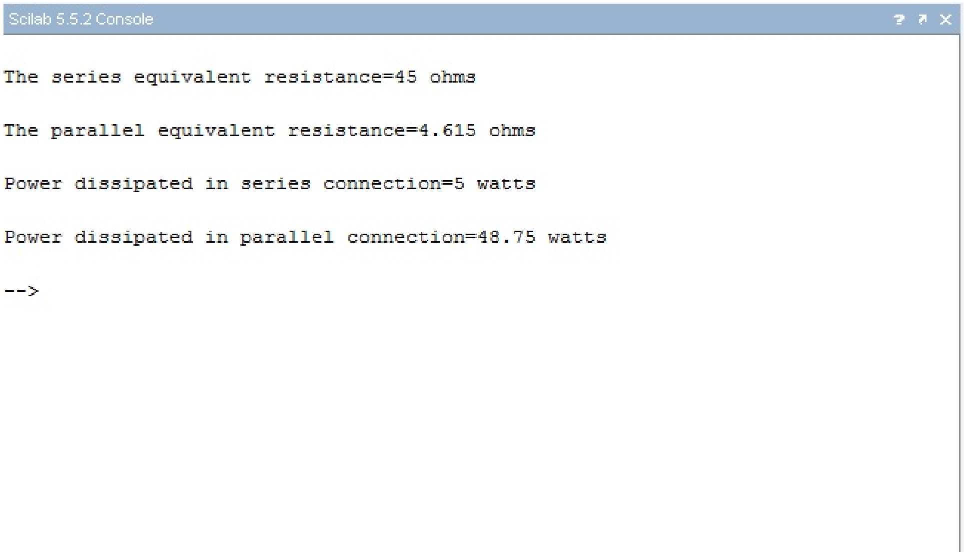


Figure 1.4: Calculation of equivalent resistances and power dissipation

```
//Edition:Third ,2014

//Ex1_3.sce.

clc;
clear;
V=20;                    //voltage rating of the battery
   in volts
I=0.2;                   //current rating of the battery
   in amphere
R=V/I;                   //from ohm's law
P=(I^2)*R;
printf("\nThe value of resistance=%d ohms",R)
printf("\nPower rating or heat dissipated=%d watts",
   P)
```

Scilab code Exa 1.4 Calculation of equivalent resistances and power dissipation

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex1_4.sce.

clc;
clear;
R1=10;            //resistance value in ohms
R2=15;            //resistance value in ohms
R3=20;           //resistance value in ohms
V=15;             //supply voltage in volts
Rs=R1+R2+R3;
Rp=(R1*R2*R3)/((R2*R3)+(R3*R1)+(R1*R2));
printf("\nThe series equivalent resistance=%2.0f
   ohms \n",Rs)
printf("\nThe parallel equivalent resistance=%1.3f
   ohms \n ",Rp)
Ps=(V^2)/Rs;
Pp=(V^2)/Rp;
printf("\nPower dissipated in series connection=%1.0
   f watts \n",Ps)
printf("\nPower dissipated in parallel connection=%2
   .2f watts \n",Pp)
```

Scilab code Exa 1.5 Sketch the capacitance current and voltage and charge and powe

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
```

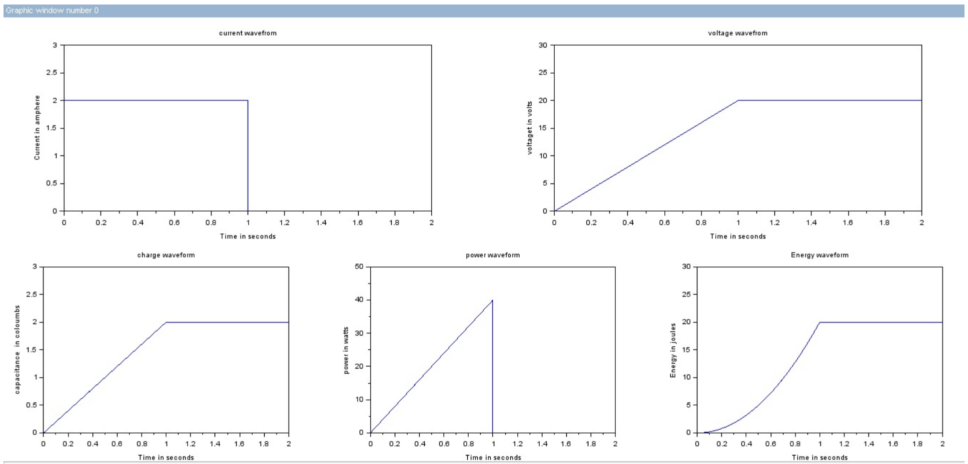


Figure 1.5: Sketch the capacitance current and voltage and charge and power and stored energy

```
//Edition:Third ,2014

//Ex1_5.sce.

clc;
clear;
subplot(2,2,1)
t=[0:0.00001:2];
x=length(t);
i=ones(1,x);
for n=1:x;
if t(n)<=1
    i(n)=2
else
    i(n)=0
end
end
xlabel("Time in seconds")
ylabel("Current in amphere")
title("current wavefrom")
plot(t,i)
```

```
subplot(2,2,2)
t=[0:0.00001:2];
x=length(t);
v=ones(1,x);
c=0.1;
for n=1:x;
    i(n)=2;
if t(n)<=1
    v(n)=i(n)*t(n)/c;
else
    v(n)=i(n)/c;
end
end
xlabel("Time in seconds")
ylabel("voltaget in volts")
title("voltage wavefrom")
plot(t,v)
subplot(2,3,4)
t=[0:0.00001:2];
x=length(t);
q=ones(1,x);
c=0.1;
for n=1:x;
    v(n)=20;
if t(n)<=1
    q(n)=v(n)*t(n)*c;
else
    q(n)=v(n)*c;
end
end
xlabel("Time in seconds")
ylabel("capacitance  in coloumbs")
title("charge waveform")
plot(t,q)
subplot(2,3,5)
t=[0:0.00001:2];
x=length(t);
p=ones(1,x);
```

```
for n=1:x;
    v(n)=20;
if t(n)<=1
    i(n)=2;
    p(n)=v(n)*t(n)*i(n);
else
    i(n)=0;
    p(n)=v(n)*i(n);
end
end
xlabel("Time in seconds")
ylabel("power in watts")
title("power waveform")
plot(t,p)
subplot(2,3,6)
t=[0:0.00001:2];
x=length(t);
e=ones(1,x);
c=0.1;
for n=1:x;
    v(n)=20;
if t(n)<=1
  e(n)=((v(n)*t(n))^2*c)/2;
else
    e(n)=((v(n)^2)*c)/2;
end
end
xlabel("Time in seconds")
ylabel("Energy in joules")
title("Energy waveform")
plot(t,e)
```

Scilab code Exa 1.6 Plotting power waveform and calculate dissipated power

```
//Book Name:Fundamentals of Electrical Engineering
```

```
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex1_6.sce.

clc;
clear;
t=[0:0.0001:4];
x=length(t);
p=ones(1,x);
for n=1:x;
    if t(n)<=2
        v(n)=3;
        i(n)=10;
        p(n)=v(n)*t(n)*i(n);
    else if t(n)>2
            v(n)=12;
            i(n)=-5;
            p(n)=(v(n)-(3*t(n)))*i(n);
        else
            p(n)=0;
        end
    end
    end
xlabel("Time in seconds")
ylabel("Power in watts")
title("Power waveform")
plot(t,p)


//Case(b)
printf("\n (b)")
area_OAB=(1/2)*max(p)*max(t)/2;
area_BCD=(1/2)*abs(min(p))*max(t)/2;
energy=area_OAB-area_BCD;
avg_power=energy/max(t);
printf("\n The average power=%1.1f W \n",avg_power)
```

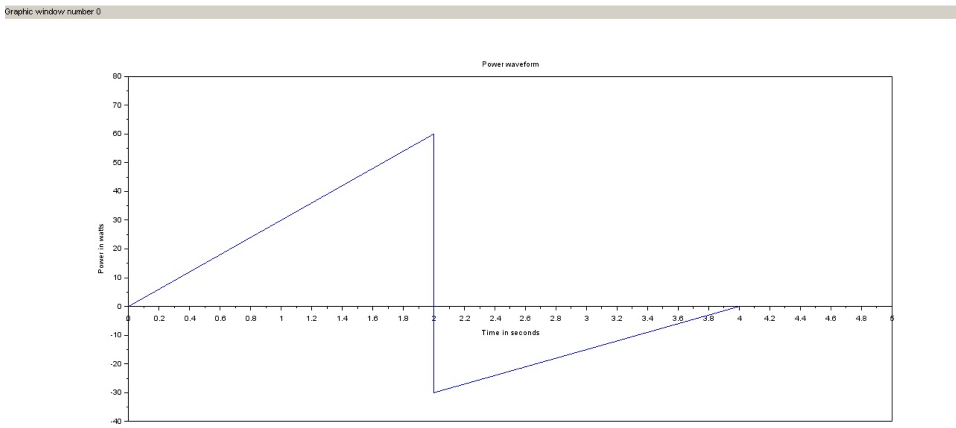


Figure 1.6: Plotting power waveform and calculate dissipated power

---

Scilab code Exa 1.7 `Identification of electric device from the given plot`

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex1_7.sce

clc;
clear;
printf("\n  From the given plots the waveform of
   voltage is the time integral of the current wave.
```

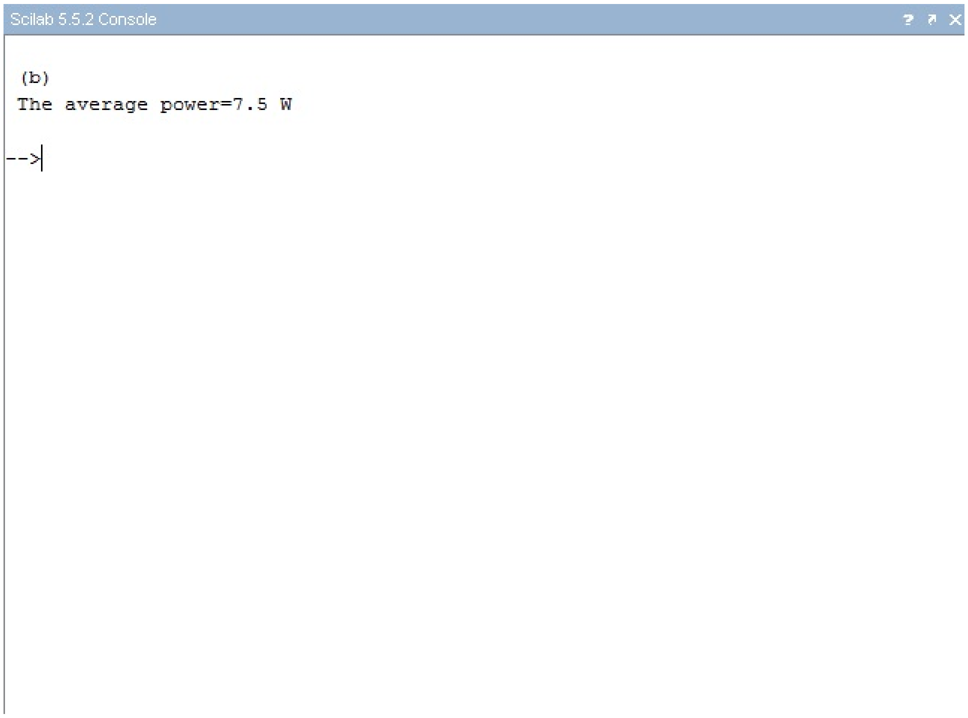


Figure 1.7: Plotting power waveform and calculate dissipated power

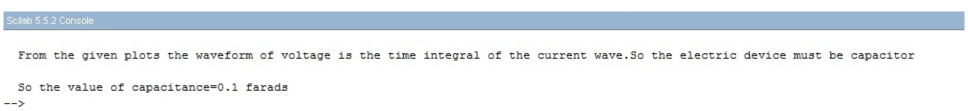


Figure 1.8: Identification of electric device from the given plot

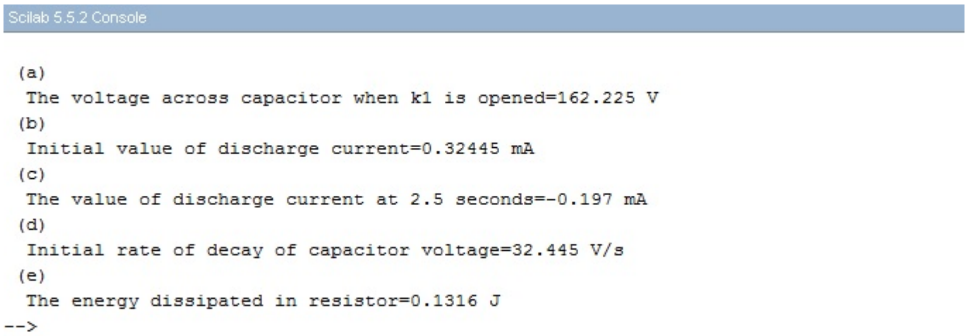


Figure 1.9: Calculation of capacitor voltage and current and energy dissipated

```
So the electric device must be capacitor\n")

t=2;            //time in seconds
V=100;          //voltage of elecric device(capacitor) in volts
I=5;            //capacitance (electric devce) current in amphere
C=(I*t)/V;
printf("\n  So the value of capacitance=%1.1f farads ",C)
```

Scilab code Exa 1.8 Calculation of capacitor voltage and current and energy dissip

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex1_8.sce.

clc;
clear;
V=200;          //suply voltage in volts
R1=0.3e6;       //resistance value in ohms
R2=0.5e6;       //resistance value in ohms
C=10e-6;        //capacitance value in farad
t1=5;           //time seconds
t2=2.5;         //time in seconds

//case1
printf("\n (a)")
v=V*(1-exp(-(t1/(R1*C))));
printf("\n  The voltage across capacitor when k1 is
   opened=%3.3f V",v)
//case2
printf("\n (b)")
Im=(v/R2);
printf("\n  Initial value of discharge current=%1.5f
    mA",Im*1e3)
//case3
printf("\n (c)")
i=-Im*exp(-(t2/(R2*C)));
printf("\n  The value of discharge current at 2.5
   seconds=%1.3f mA",i*1e3)
//case4
printf("\n (d)")
Vc=v/(R2*C);
printf("\n  Initial rate of decay of capacitor
   voltage=%2.3f V/s",Vc)
```

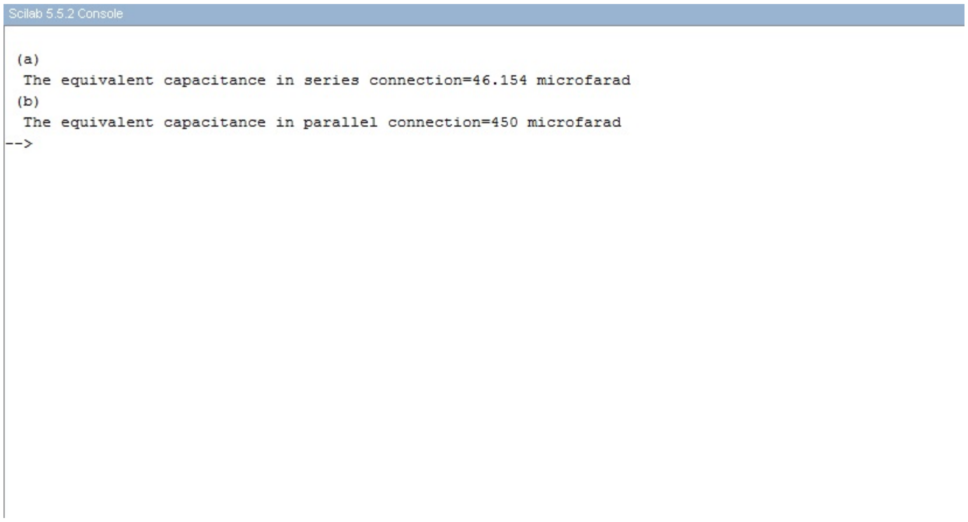


Figure 1.10: Determination of equivalent capacitance value

```
//case5
printf("\n (e)")
E=(1/2)*(C*v^2);
printf("\n  The energy dissipated in resistor=%1.4f
   J",E)
```

Scilab code Exa 1.9 Determination of equivalent capacitance value

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex1_9.sce.

clc;
clear;
```

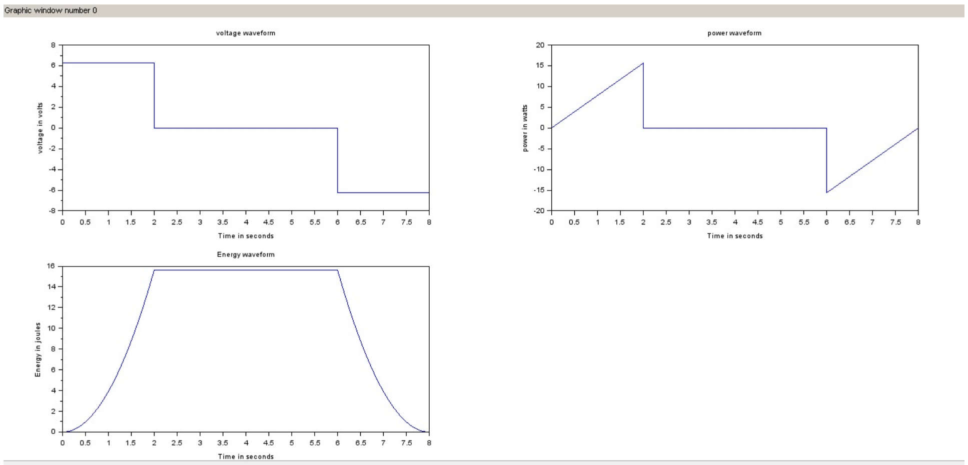


Figure 1.11: Plotting voltage and power and energy waveform

```
C1=100;        //capacitance value in microfarad
C2=150;         //capacitance value in microfarad
C3=200;        //capacitance value in microfarad

//CASE1
printf("\n (a)")
Cs=(C1*C2*C3)/((C2*C3)+(C1*C2)+(C3*C1));
printf("\n The equivalent capacitance in series
   connection=%2.3f microfarad",Cs)

//CASE2
printf("\n (b)")
Cp=C1+C2+C3;
printf("\n The equivalent capacitance in parallel
   connection=%3.0f microfarad",Cp)
```

Scilab code Exa 1.10 `Plotting voltage and power and energy waveform`

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex1_10.sce.

clc;
clear;
subplot(2,2,1)
t=[0:0.001:8];
x=length(t);
v=ones(1,x);
for n=1:x;
    L=5;
    if t(n)<=2
       v(n)=6.25;
    else if t(n)>=6 & t(n)<8
           v(n)=-6.25;
        else
            v(n)=0;
            end
    end
    end
xlabel("Time in seconds")
ylabel("voltage in volts")
title("voltage waveform")
plot(t,v)
subplot(2,2,2)
t=[0:0.001:8];
x=length(t);
p=ones(1,x);
for n=1:x;
    if t(n)<=2
       v(n)=6.25;
       i(n)=1.25;
       p(n)=v(n)*t(n)*i(n);
    else if t(n)>=6 & t(n)<8
```

```
            v(n)=-6.25;
            i(n)=10;
            p(n)=(i(n)-(1.25*t(n)))*v(n);
         else
             v(n)=0;
             i(n)=2.5;
             p(n)=v(n)*t(n)*i(n);
             end
    end
    end
xlabel("Time in seconds")
ylabel("power in watts")
title("power waveform")
plot(t,p)
subplot(2,2,3)
t=[0:0.001:8];
x=length(t);
e=ones(1,x);
L=5;
for n=1:x;
    if t(n)<=2
       i(n)=1.25;
       e(n)=(1/2)*L*(t(n)*i(n))^2;
    else if t(n)>=6 & t(n)<8
            i(n)=10;
            e(n)=(1/2)*L*(i(n)-(1.25*t(n)))^2;
        else
            i(n)=2.5;
            e(n)=(1/2)*L*(i(n))^2;
            end
    end
    end
xlabel("Time in seconds")
ylabel("Energy in joules")
title("Energy waveform")
plot(t,e)
```

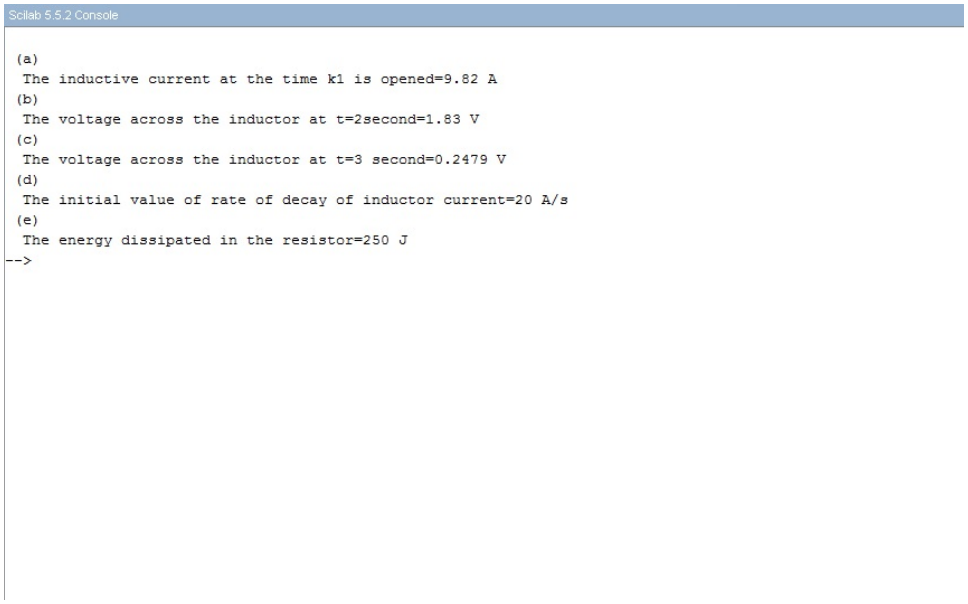


Figure 1.12: Determination of current and voltage and dissipated energy

Scilab code Exa 1.11 Determination of current and voltage and dissipated energy

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex1_11.sce.
clc;
clear;
R=10;          //resistance in ohms
L=5;           //inductance in henry
V=100;         //supply voltage in volts
t1=2;         //time at which k1 switch opened in
```

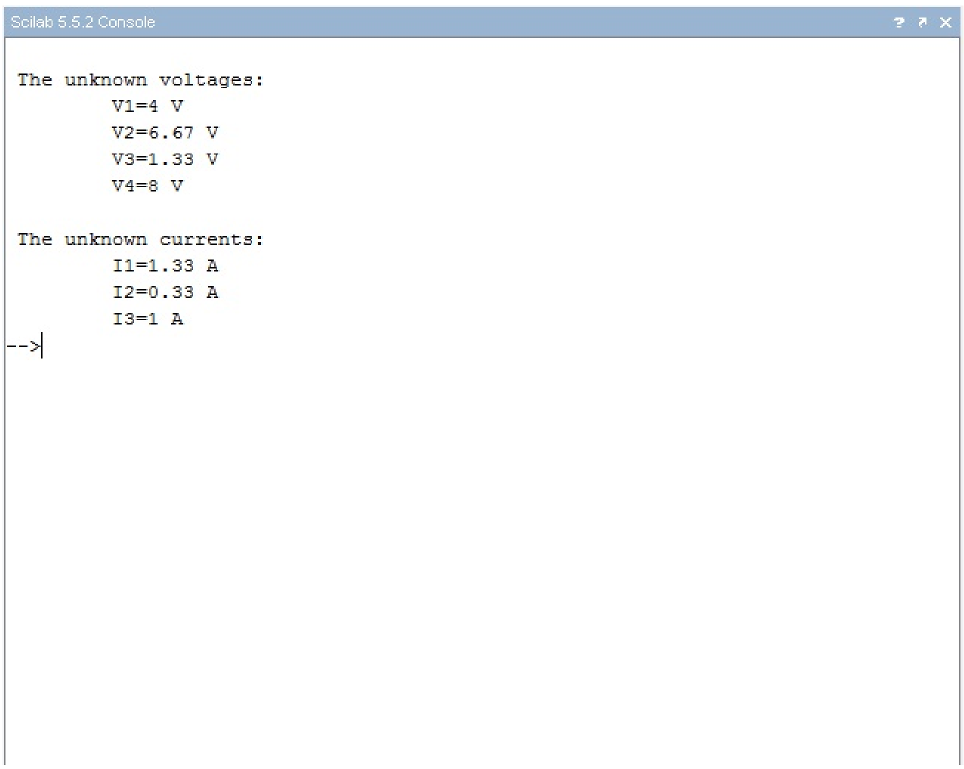
```
seconds
//CASE1
printf("\n (a)")
i=(V*(1-exp(-((R*t1)/L))))/R;
printf("\n  The inductive current at the time k1 is opened=%1.2f A",i)

//CASE2
printf("\n (b)")
v1=V*exp(-((R*t1))/L);
printf("\n  The voltage across the inductor at t=2 second=%1.2f V",v1)

//CASE3
printf("\n (c)")
t2=3;      //time in seconds
Imax=(V/R);
v2=Imax*R*(exp(-((R*t2))/L));
printf("\n  The voltage across the inductor at t=3 second=%1.4f V",v2)
//For v2 calculation ,the answer in the book is wrong

//CASE4
printf("\n (d)")
t3=0;    //initial time in seconds
it=(-R*(-Imax)*exp(-(R*t3)/L))/L;     //rate of decay of inductor current in amphere per seconds
printf("\n  The initial value of rate of decay of inductor current=%d A/s",it)

//CASE5
printf("\n (e)")
Energy=(1/2)*L*Imax^2;
printf("\n  The energy dissipated in the resistor=%d J",Energy)
```

Chapter 2

Circuit Analysis Resistive Network

Scilab code Exa 2.1 Determination of unknown currents and voltages

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex2_1.sce.

clc;
clear;
R1=3;     //Resistance in ohm
R2=5;     //Resistance in ohm
R3=4;     //Resistance in ohm
R4=8;     //Resistance in ohm

I2=1/3;
I1=4*I2;
I3=I1-I2;;
```



```
The unknown voltages:
        V1=4 V
        V2=6.67 V
        V3=1.33 V
        V4=8 V

The unknown currents:
        I1=1.33 A
        I2=0.33 A
        I3=1 A
-->
```

Figure 2.1: Determination of unknown currents and voltages

```
V1=R1*I1;                            //Applying ohm's law(V=IR)
V2=R2*I1;
V3=R3*I2;
V4=R4*I3;
printf("\n The unknown voltages:")
printf("\n\t V1=%d V",V1)
printf("\n\t V2=%1.2f V",V2)
printf("\n\t V3=%1.2f V",V3)
printf("\n\t V4=%d V \n",V4)
printf("\n The unknown currents:")
printf("\n\t I1=%1.2f A",I1)
printf("\n\t I2=%1.2f A",I2)
printf("\n\t I3=%d A",I3)
```

Scilab code Exa 2.2 Determination of currents in the given network

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex2_2.sce.

clc;
clear;
a1=2;b1=1;c1=5;d1=1;                         //these are the coefficient values of I1,I2,I3 and source obtained from loop ABDA in the given circuit
a2=4;b2=-5;c2=-3;d2=0;                       //these are the coefficient values of I1,I2,I3 and source obtained from loop ABCA in the given circuit
a3=4;b3=1;c3=-9;d3=0;                        //these
```

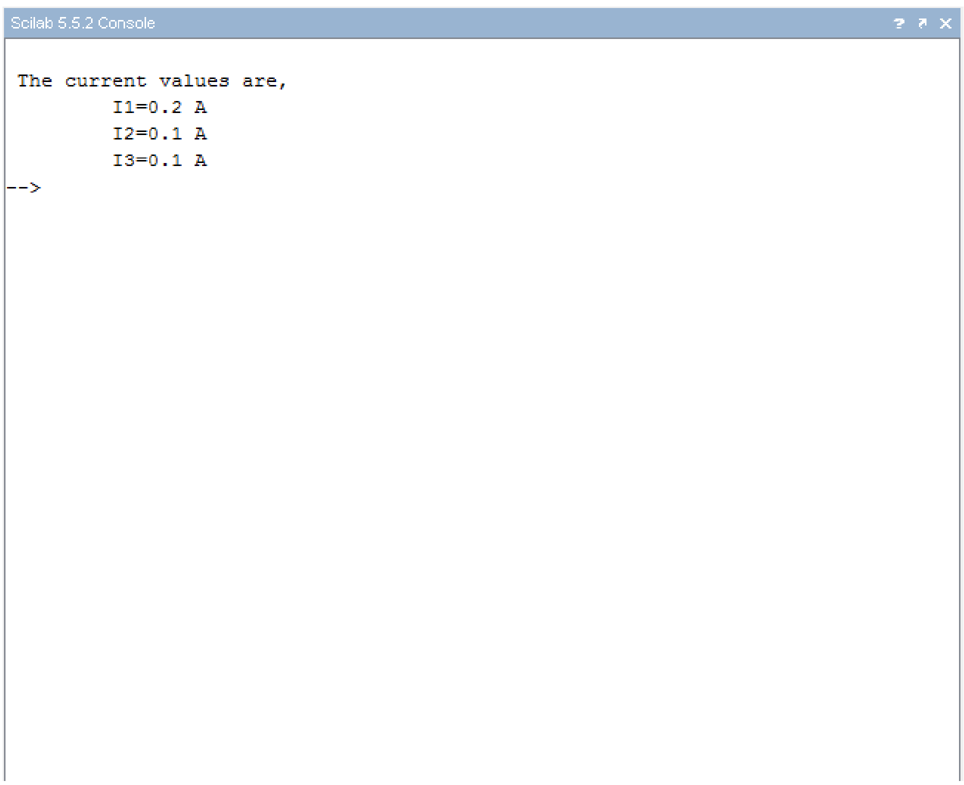


Figure 2.2: Determination of currents in the given network

```
are the coefficient values of I1,I2,I3 and source obtained from loop BCDB in the given circuit

del=det([a1 b1 c1;a2 b2 c2;a3 b3 c3]);
del1=det([d1 b1 c1;d2 b2 c2;d3 b3 c3]);
del2=det([a1 d1 c1;a2 d2 c2;a3 d3 c3]);
del3=det([a1 b1 d1;a2 b2 d2;a3 b3 d3]);

I1=del1/del;                                  //Using Cramer's rule
I2=del2/del;                                  //Using Cramer's rule
I3=del3/del;                                  //Using Cramer's rule

printf("\n The current values are,")
printf("\n\t I1=%1.1f A",I1)
printf("\n\t I2=%1.1f A",I2)
printf("\n\t I3=%1.1f A",I3)
```

Scilab code Exa 2.3 Conversion of current source into a voltage source and voltage

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex2_3.sce.

clc;
clear;
//case1
//voltage source series with the resistance
```

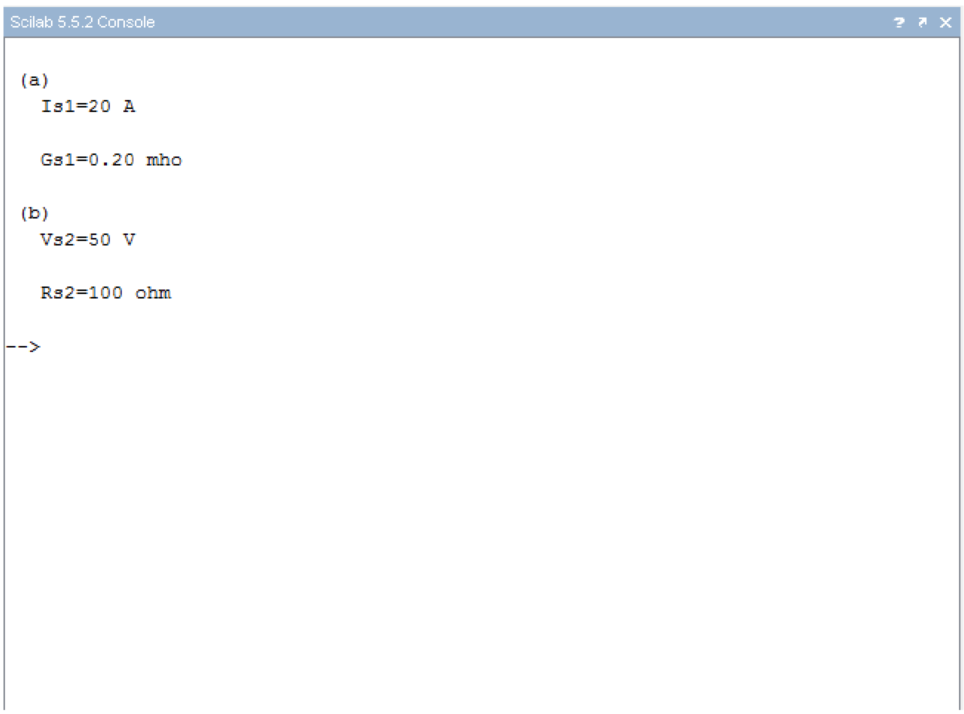


Figure 2.3: Conversion of current source into a voltage source and voltage source into a current source

```
converted into current source parallel to the conductance
printf("\n (a)")
Rs1=5;
Vs1=100;
Is1=Vs1/Rs1;
Gs1=1/Rs1;
printf("\n    Is1=%d A \n",Is1)
printf("\n    Gs1=%1.2f mho \n",Gs1)

//case2
//current source parallel to the conductance converted into voltage source series with the resistance
printf("\n (b)")
Gs2=10e-3;
Is2=500e-3;
Vs2=Is2/Gs2;
Rs2=1/Gs2;
printf("\n    Vs2=%d V \n",Vs2)
printf("\n    Rs2=%d ohm \n",Rs2)
```

Scilab code Exa 2.4 Determination of voltage and current using nodal analysis meth

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex2_4.sce.

clc;
clear;
```

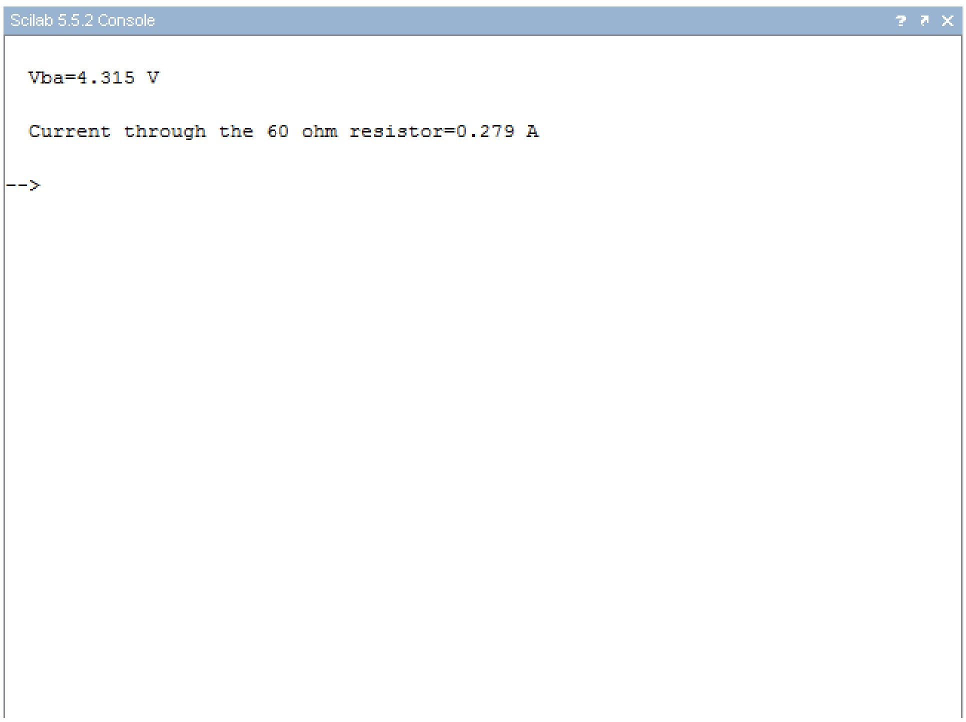


Figure 2.4: Determination of voltage and current using nodal analysis method

```
R5=60;
a1=9;b1=-5;c1=0;d1=80;                //these are the coefficient values of VA,VB,VC and the source obtained from node A in the given circuit
a2=-1;b2=7;c2=-2;d2=24;               //these are the coefficient values of VA,VB,VC and the source obtained from node B in the given circuit
a3=0;b3=-3;c3=4;d3=36;               //these are the coefficient values of VA,VB,VC and the source obtained from node C in the given circuit

del=det([a1 b1 c1;a2 b2 c2;a3 b3 c3]);
del1=det([d1 b1 c1;d2 b2 c2;d3 b3 c3]);
del2=det([a1 d1 c1;a2 d2 c2;a3 d3 c3]);
del3=det([a1 b1 d1;a2 b2 d2;a3 b3 d3]);

VA=del1/del;                          //Using Cramer's rule
VB=del2/del;                          //Using Cramer's rule
VC=del3/del;                          //Using Cramer's rule
Vba=VA-VB;
I5=VC/R5;                            // from Ohm's law
printf("\n  Vba=%1.3f V \n",Vba)
//Answer vary dueto round off error
printf("\n  Current through the 60 ohm resistor=%1.3f A \n",I5)
```

Scilab code Exa 2.5 Determination of voltage and current using nodal method

```
//Book Name:Fundamentals of Electrical Engineering
```

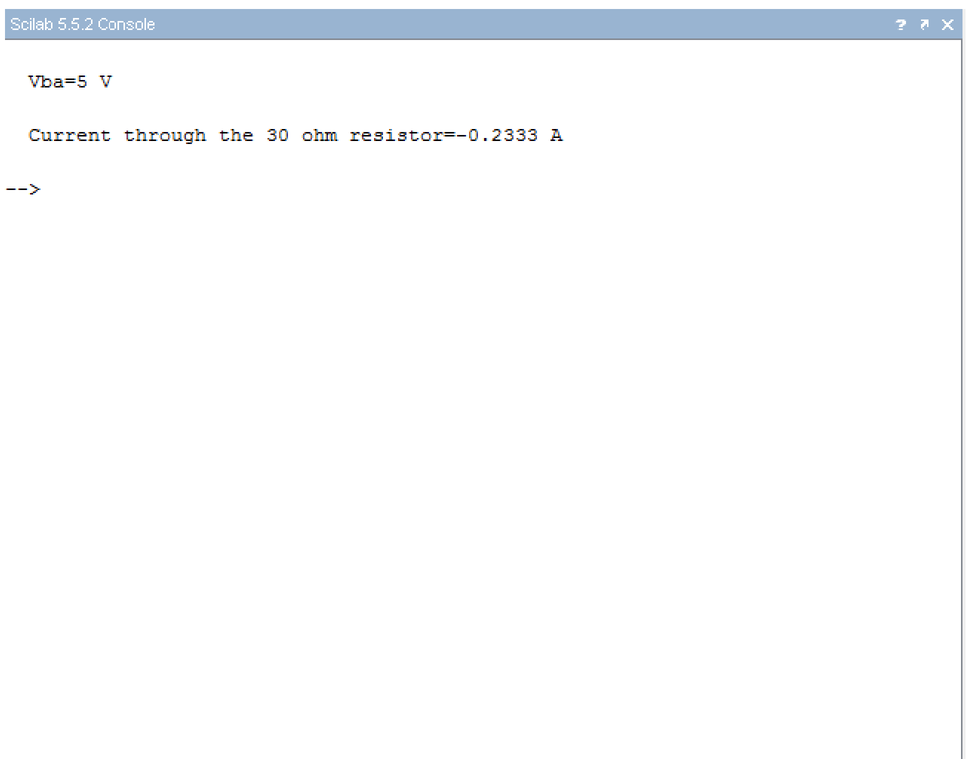


Figure 2.5: Determination of voltage and current using nodal method

```
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex2_5.sce.

clc;
clear;
R1=10;
R2=30;
R3=15;
R4=45;

a1=3;b1=-1;c1=-9;  //these are the coefficient values of VA,VB and the source obtained from node A in the given circuit
a2=-3;b2=4;c2=-27;  //these are the coefficient values of VA,VB  and the source obtained from node B in the given circuit
del=det([a1 b1;a2 b2]);
del1=det([c1 b1;c2 b2]);
del2=det([a1 c1;a2 c2]);

VA=del1/del;                                    // Using Cramer's rule
VB=del2/del;                                    //Using Cramer's rule
Vba=VA-VB;
I2=VA/R2;                                       // from Ohm's law
printf("\n  Vba=%d V \n",Vba)
printf("\n  Current through the 30 ohm resistor=%1.4f A \n",I2)
```

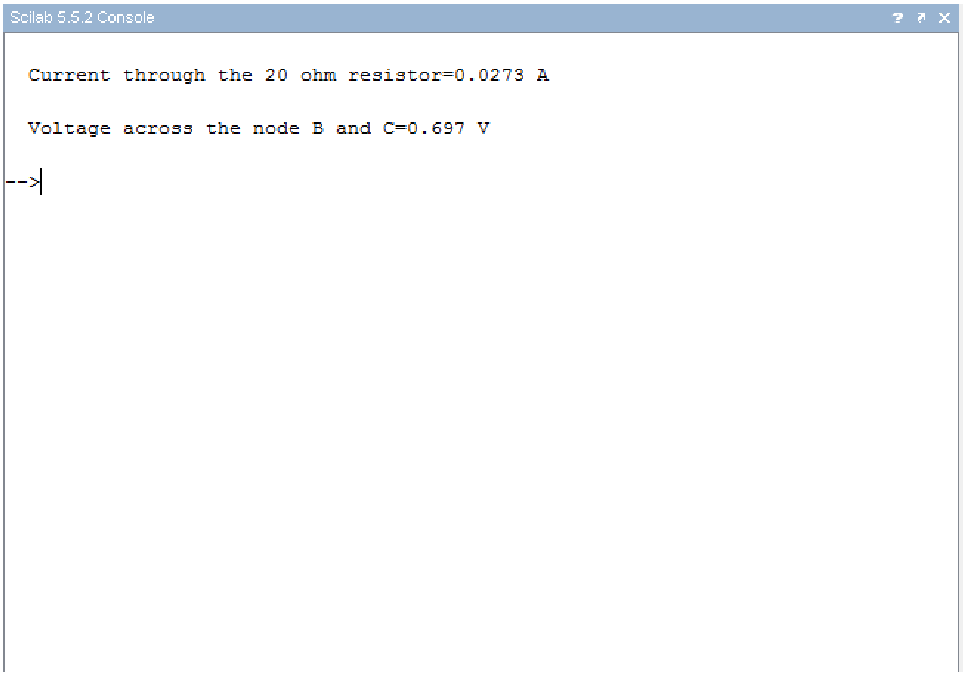


Figure 2.6: Determination of voltage and current using mesh analysis method

Scilab code Exa 2.6 `Determination of voltage and current using mesh analysis metho`

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex2_6.sce.

clc;
clear;
R1=15;
```

```
R2=20;
R3=10;
R4=5;

a1=35;b1=-20;c1=2;                                    //
   these are the coefficient values of I1,I2 and
   source obtained from loop ABDA in the given
   circuit
a2=-20;b2=35;c2=0.5;                                  //
   these are the coefficient values of I1,I2 and
   source obtained from loop BCDB in the given
   circuit
del=det([a1 b1;a2 b2]);
del1=det([c1 b1;c2 b2]);
del2=det([a1 c1;a2 c2]);

I1=del1/del;                                        //
   Using Cramer's rule
I2=del2/del;                                        //
   Using Cramer's rule
I20=I1-I2;
Vcb=R3*I2;
printf("\n  Current through the 20 ohm resistor=%1.4
   f A \n",I20)
printf("\n  Voltage across the node B and C=%1.3f V
   \n",Vcb)
```

Scilab code Exa 2.7 Determination of voltage using nodal analysis method

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014
```

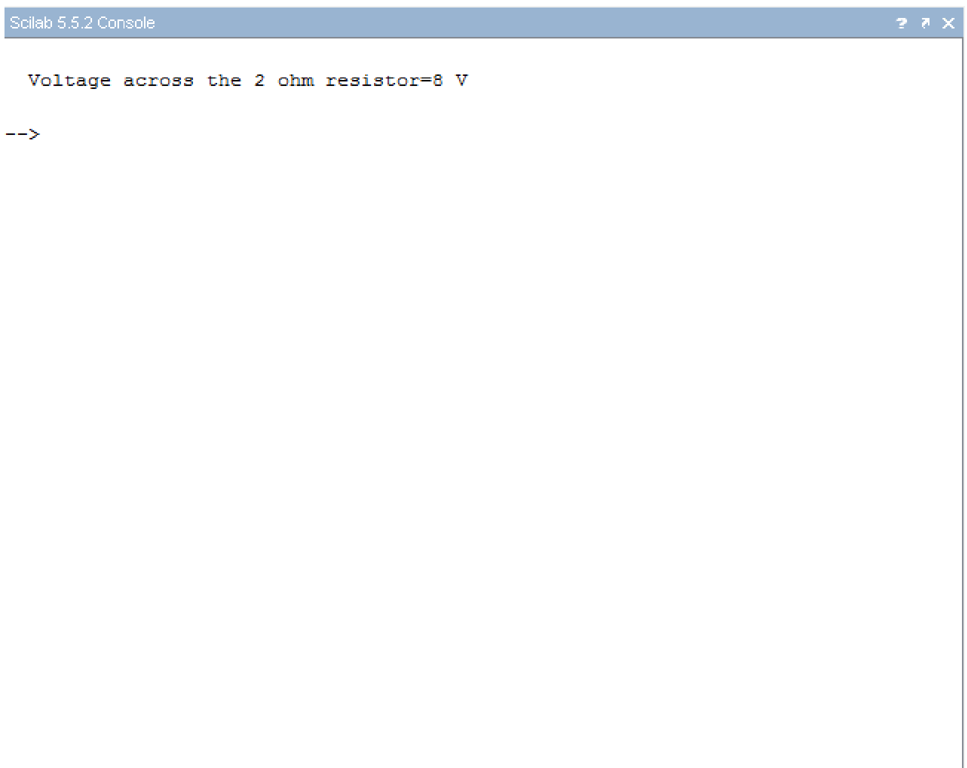


Figure 2.7: Determination of voltage using nodal analysis method

```
//Ex2_7.sce.

clc;
clear;
R1=5;              //Resistance in ohm
R2=2;             //Resistance in ohm
R3=3;            //Resistance in ohm

a1=7;b1=-5;c1=50;                         //
   these are the coefficient values of VA,VB and the
    source obtained from node A in the given circuit
a2=3;b2=5;c2=0;                          //
   these are the coefficient values of VA,VB and the
    source obtained from node B in the given circuit
del=det([a1 b1;a2 b2]);
del1=det([c1 b1;c2 b2]);
del2=det([a1 c1;a2 c2]);

VA=del1/del;                              //
   Using Cramer's rule
VB=del2/del;                             //
   Using Cramer's rule
Vba=VA-VB;
printf("\n  Voltage across the 2 ohm resistor=%d V \
   n",Vba)
```

Scilab code Exa 2.8 Determination of current using mesh voltage method

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014
```

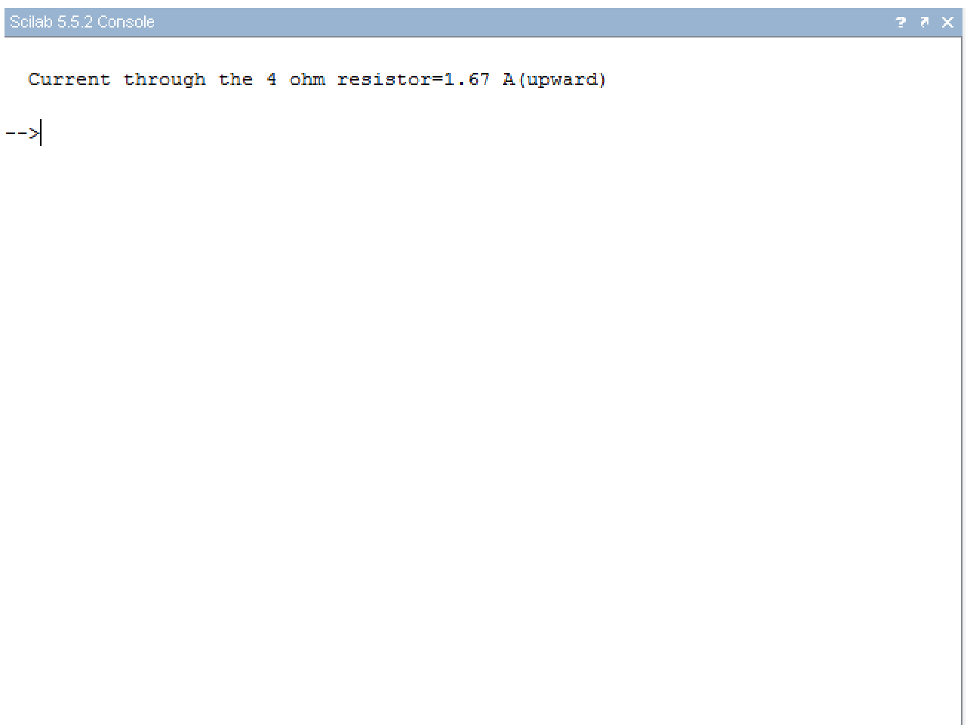


Figure 2.8: Determination of current using mesh voltage method

```
//Ex2_8.sce.

clc;
clear;
R1=3;
R2=4;
R3=2;
R4=1;

a1=7;b1=-4;c1=2;                                //these are the coefficient values of I1,I2 and source obtained from the first loop in the given circuit
a2=-10;b2=7;c2=3;                               //these are the coefficient values of I1,I2 and source obtained from the second loop  in the given circuit
del=det([a1 b1;a2 b2]);
del1=det([c1 b1;c2 b2]);
del2=det([a1 c1;a2 c2]);

I1=del1/del;                                    //Using Cramer's rule
I2=del2/del;                                      //Using Cramer's rule
I=I2-I1;
printf("\n  Current through the 4 ohm resistor=%1.2f A(upward) \n",I)
```

Scilab code Exa 2.9 Determination of current using a principle of superposition

```
//Book Name:Fundamentals of Electrical Engineering
```

Figure 2.9: Determination of current using a principle of superposition

```
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex2_9.sce.

clc;
clear;
R1=3;
R2=4;
R3=2;
R4=1;

//case (a)
a1=13;b1=-6;c1=20;    //these are the coefficient values of VA,VB and source obtained from the node A in the given circuit
a2=-5;b2=3;c2=-20;    //these are the coefficient values of VA,VB and source obtained from the node  B in the given circuit
del=det([a1 b1;a2 b2]);
del1=det([c1 b1;c2 b2]);
VA1=del1/del;
Idash=-VA1/R2;

//case (b)
Vs=3;
a1=13;b1=-6;c1=9;    //these are the coefficient values of VA,VB and source obtained from the node A in the given circuit
a2=-5;b2=3;c2=0;                                   //these are the coefficient values of VA,VB and source obtained from the node  B in the given circuit
del=det([a1 b1;a2 b2]);
```

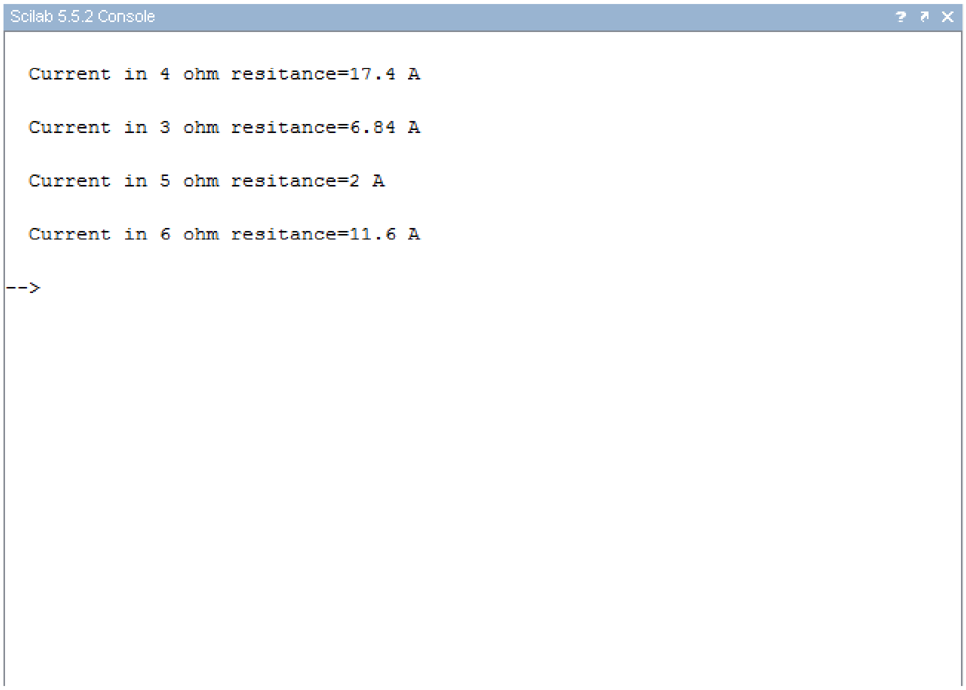


Figure 2.10: Determination of current in all resistance using superposition principle

```
del1=det([c1 b1;c2 b2]);
VA2=del1/del;
I_doubledash=(Vs-VA2)/R2;
I=Idash+I_doubledash;
printf("\n  Current through the 4 ohm resistor=%1.2f
    A \n",I)
```

Scilab code Exa 2.10 Determination of current in all resistance using superpositio

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
```

```
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex2_10.sce.

clc;
clear;
R1=4;
R2=3;
R3=5;
R4=6;

//CASE (a)
Vs1=80;
VA1=(Vs1/R3)/((1/R1)+(1/R2)+(1/R3)+(1/R4));
I1dash=VA1/R1;                  //From ohm's law(V=IR)
I2dash=VA1/R2;
I3dash=(Vs1-VA1)/R3;
I4dash=VA1/R4;

//CASE (b)
Vs2=90;
VA2=(Vs2/R2)/((1/R1)+(1/R2)+(1/R3)+(1/R4));
I1doubledash=VA2/R1;
I2doubledash=(Vs2-VA2)/R2;
I3doubledash=VA2/R3;
I4doubledash=VA2/R4;

//CASE (c)
Is=20;
VA3=Is/((1/R1)+(1/R2)+(1/R3)+(1/R4));
I1tripledash=VA3/R1;
I2tripledash=VA3/R2;
I3tripledash=VA3/R3;
I4tripledash=VA3/R4;
I1=I1dash+I1doubledash+I1tripledash;
I2=-I2dash+I2doubledash-I2tripledash;
I3=I3dash-I3doubledash-I3tripledash;
```

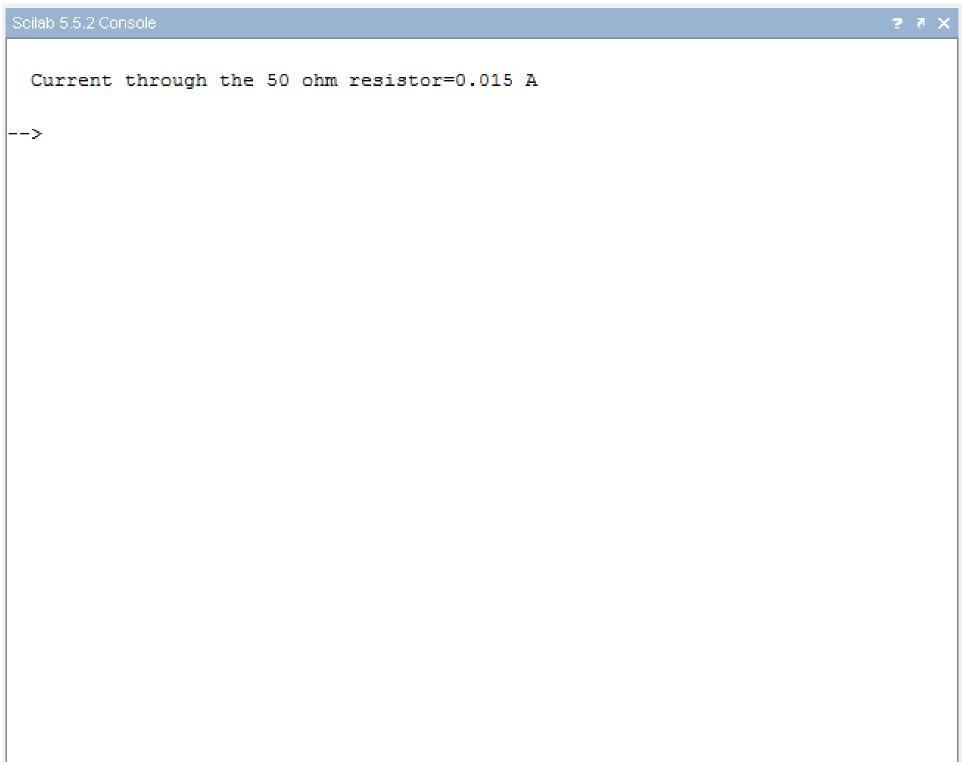


Figure 2.11: Determination of current using Thevenins theorem

```
I4=I4dash+I4doubledash+I4tripledash;
printf("\n  Current in 4 ohm resitance=%2.1f A \n",
    I1)
printf("\n  Current in 3 ohm resitance=%1.2f A \n",
    I2)
printf("\n  Current in 5 ohm resitance=%d A \n",I3)
printf("\n  Current in 6 ohm resitance=%2.1f A \n",
    I4)

//The answer vary dueto roundoff error
```

Scilab code Exa 2.11 Determination of current using Thevenins theorem

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex2_11.sce

clc;
clear;
R1=30;     //Resistance in ohm
R2=60;     //Resistance in ohm
R3=60;     //Resistance in ohm
R4=30;     //Resistance in ohm
R5=10;     //Resistance in ohm
R=50;    //Resistance in ohm
I1=5/110;            //Loop1 current in Ampere
I2=5/110;           //Loop2 current in Ampere
Voc=(I2*R2)-(I1*R1);        //Open circuit voltage in
    Volt
Isc=1/30;                    //Open circuit current in
    Ampere
Rs=Voc/Isc;                 //Series resistance in ohm
I=Voc/(Rs+R);
printf("\n  Current through the 50 ohm resistor=%1.3
   f A \n",I)
```

Scilab code Exa 2.12 Determination of current using Norton theorem

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
```

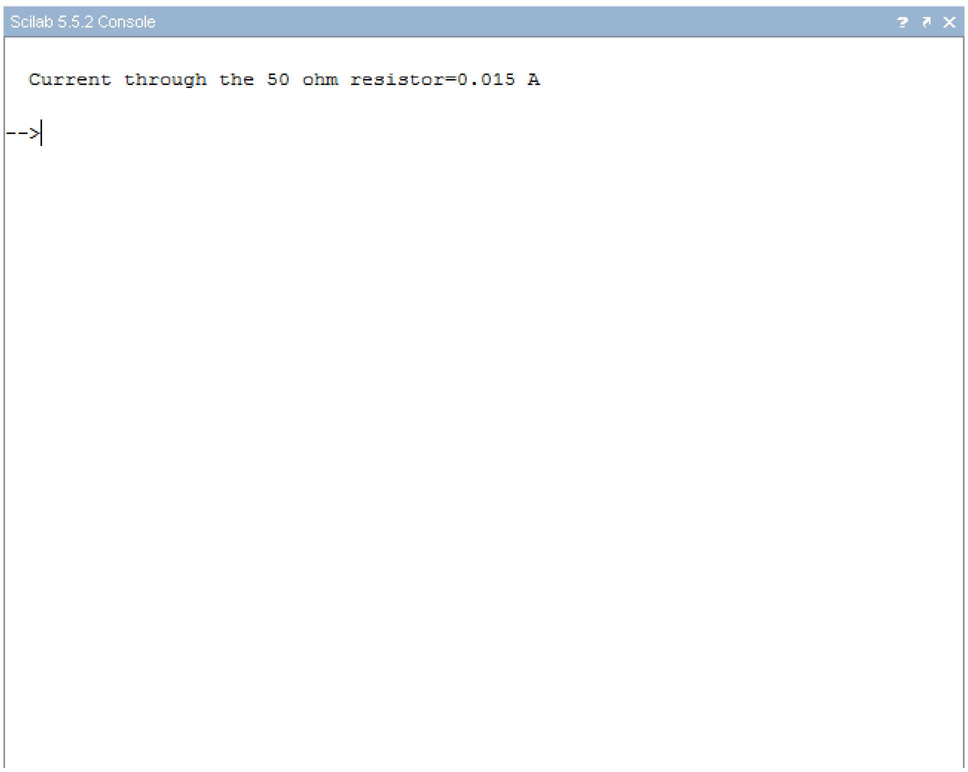


Figure 2.12: Determination of current using Norton theorem

```
//Edition:Third ,2014

//Ex2_12.sce

clc;
clear;
R=50;    //Resistance in ohm
Is=1/30;   //Source current in Ampere
Rs=40.92;   //Parallel resistance in ohm
Gs=1/Rs;    //Parallel conductance in mho
I=(Is*Rs)/(Rs+R);
printf("\n  Current through the 50 ohm resistor=%1.3
   f A \n",I)
```

Scilab code Exa 2.13 Determination of load resistance

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex2_13.sce.

clc;
clear;
R1=4;          //Resistance in ohm
R2=4;          //Resistance in ohm
R3=8;          //Resistance in ohm
R4=10;          //Resistance in ohm
R5=3;          //Resistance in ohm
R6=8;          //Resistance in ohm
R7=2;          //Resistance in ohm
R12=1/((1/R1)+(1/R2));          //R1 and R2 are in
```

Figure 2.13: Determination of load resistance

Figure 2.14: Determination of driving point resistance of the voltage source

```
    parallel
R34=1/((1/R4)+(1/(R3+R12)));    //R12 and R3 are in
    parallel with R4
R56=1/((1/R6)+(1/(R5+R34)));    //R34 and R5 are in
    parallel with R6
Rab=R7+R56;       //R56 and R7 are in series
RL=Rab;
printf("\n  Load resitance to the 10 volt source=%d
   ohm \n",RL )
```

Scilab code Exa 2.14 Determination of driving point resistance of the voltage sour

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex2_14.sce

clc;
clear;
I=5/31;     //Circuit current in ampere
Vs=5;        //Source voltage in volt
R1=3;        //Resistance in ohm
R2=4;        //Resistance in ohm
driving_point_resistance=Vs/I;
printf("\n The driving point resistance of the
   voltage source=%d ohm \n",
   driving_point_resistance)
```

Scilab code Exa 2.15 Determination of driving point resistance at the pair of term

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex2_15.sce.

clc;
```

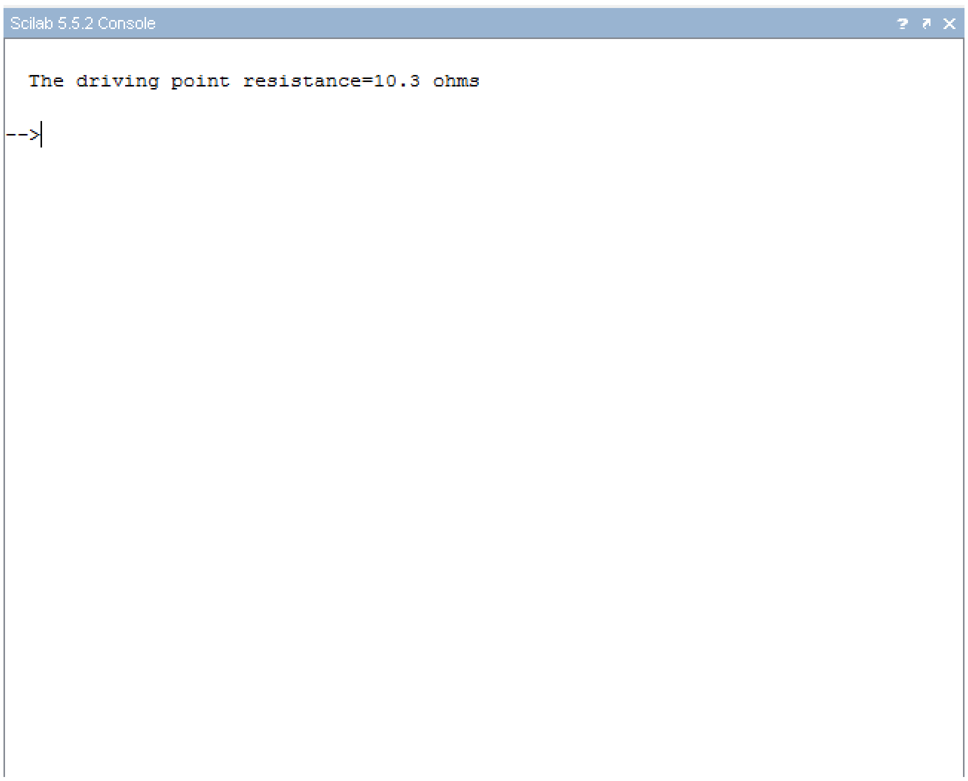


Figure 2.15: Determination of driving point resistance at the pair of terminals

```
clear;
R_aB=5;
R_AB=6;
R_BC=6;
R_CD=5;
R_AE=25;
R_ED=10;
R_DA=5;
R_EC=50;

//For triangle AED
R_OA=(R_AE*R_DA)/(R_AE+R_ED+R_DA);
R_OD=(R_ED*R_DA)/(R_AE+R_ED+R_DA);
R_OE=(R_AE*R_ED)/(R_AE+R_ED+R_DA);

//For triangle OCD
R_OC=R_OE+R_EC;
R_OdashO=(R_OC*R_OD)/(R_OC+R_OD+R_CD);
R_OdashD=(R_CD*R_OD)/(R_OC+R_OD+R_CD);
R_OdashC=(R_OC*R_CD)/(R_OC+R_OD+R_CD);

R_OB=R_OA+R_AB;
R_BOdash=((R_OB+R_OdashO)*(R_BC+(R_OdashC)))/(R_OB+
    R_OdashO+R_BC+R_OdashC);
Rab=(R_aB+(R_BOdash)+(R_OdashD));
printf("\n  The driving point resistance=%2.1f ohms
    \n",Rab)
```

Scilab code Exa 2.16 Determination of resistance value and amount of power

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
```

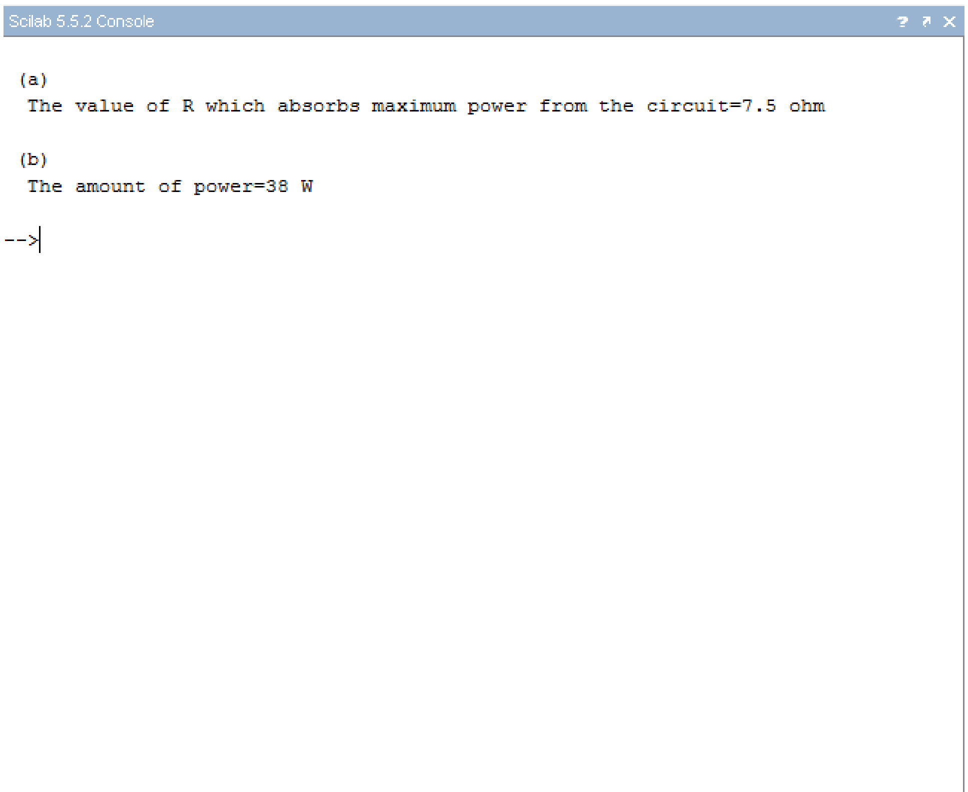


Figure 2.16: Determination of resistance value and amount of power

```
//Edition:Third ,2014

//Ex2_16.sce.

clc;
clear;
R1=10;
I1=2.5;
V2=60;
R2=30;
I2=V2/R2;                          //Ohm's law
Gs=(1/R1)+(1/R2);
Rs=1/Gs;
Isc=I1+I2;
Voc=Isc*Rs;

//case (a)
printf("\n (a)")
R=Rs;
printf("\n  The value of R which absorbs maximum power from the circuit=%1.1f ohm \n",R)

//case (b)
printf("\n (b)")
Pm=Voc^2/(4*Rs);
printf("\n  The amount of power=%2.0f W \n",Pm)
```

Chapter 3

Circuit Analysis Time Varying Excitation

Scilab code Exa 3.1 Calculation of impedence and admittance

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex3_1.sce

clc;
clear;
L=2.5;
s=-1; //complex frequency , which is taken from the
   coefficient value of time in the given
   exponential term
Z=L*s;
printf("\n Impedence=%1.1f ohm \n",Z)
Y=1/Z;
printf("\n Admittance=%0.1f mho \n",Y)
```

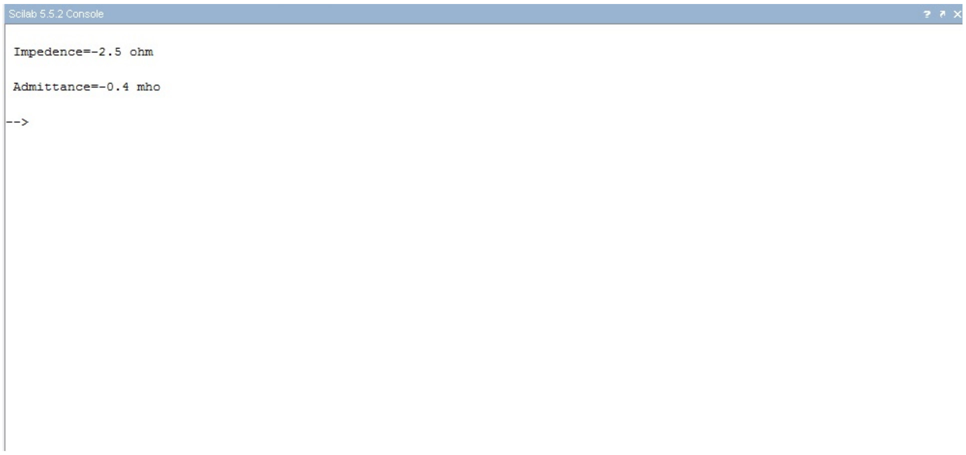


Figure 3.1: Calculation of impedence and admittance

```
//Voltage cannot be determined since it involves
   equation in the result
```

Scilab code Exa 3.3 `Determination of voltage across resistance and inductance and`

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex3_3(b).sce.

clc;
clear;
R=1;
L=1;
C=0.1;
//case (b)
```

Figure 3.2: Determination of voltage across resistance and inductance and capacitance

```
s=0;
//Z=R+(L*s)+(1/(C*s))
Z=0;   //Z=s/(s^2+s+10)
//voltage across the resistancce and inductance are
    zero

Vc=100/(s^2+s+10);//simplified form of (10s/(s^2+s
    +10))/(0.1s)
printf("\n Voltage across the capacitance=%d volt",
    Vc)
```

Scilab code Exa 3.4 Determination of current through conductance and capacitance a

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
```

Figure 3.3: Determination of current through conductance and capacitance and inductance

```
//Edition:Third ,2014

//Ex3_4(b).sce


//case(b)
clc;
clear;
R=1;
L=0.1;
C=1;
I=10;
s=0;                //complex frequency
V=(10*s)/(s^2+s+10);      //voltage across the
    parallel circuit
iG=V*R;
printf("\n Current through conductance=%d A \n",iG)
iC=V*C;
printf("\n Current through capacitance=%d A \n",iC)
iL=100/(s^2+s+10);    //simplified form of V/Ls=(10s
```

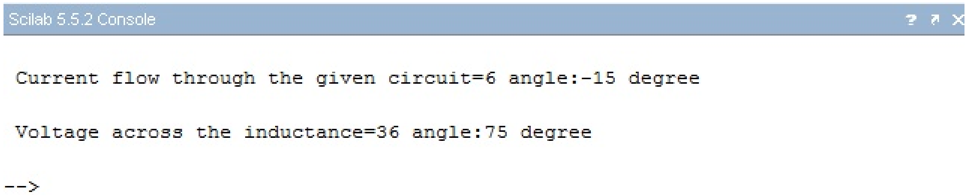


Figure 3.4: Determination of current and voltage across inductance

```
    /(s^2+s+10))/(0.1s)
printf("\n Current through inductance=%d A \n",iL)
```

Scilab code Exa 3.5 `Determination of current and voltage across inductance`

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex3_5.sce
```

```
clc;
clear;
R=2;
L=2;
C=1/12;
omega=3;
XL=omega*L;
XC=1/(omega*C);
Z=complex(R,XL-XC);
Vl=12*sqrt(2);
theta=30;
V=complex(Vl*cosd(theta),Vl*sind(theta));
I=V/Z;
I_mag=sqrt(real(I)^2+imag(I)^2);
I_angle=atand(imag(I)/real(I));
printf("\n Current flow through the given circuit=%d angle:%d degree \n",I_mag,I_angle)

XL=complex(0,6);
V_L=I*XL;
V_L_mag=sqrt(real(V_L)^2+imag(V_L)^2);
V_L_angle=atand(imag(V_L)/real(V_L));
printf("\n Voltage across the inductance=%d angle:%2.0f degree \n",V_L_mag,V_L_angle)
//result:Vl(t)=36 sin(wt+75) , i(t)=6 sin(wt-15)
```

Scilab code Exa 3.6 Determination of forced component of current

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014
```

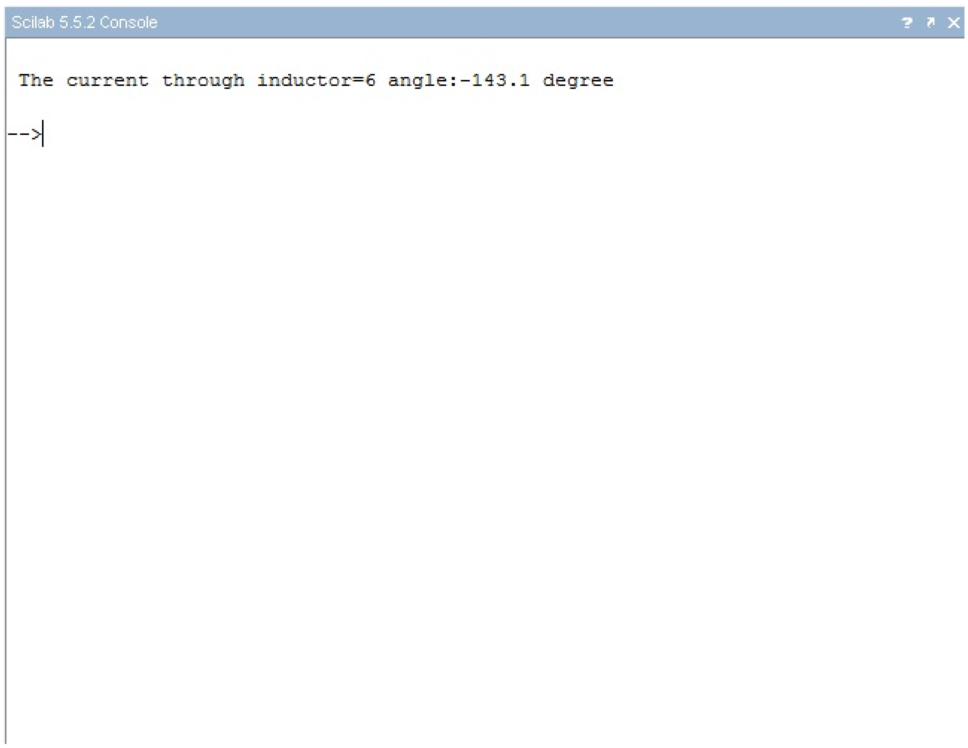


Figure 3.5: Determination of forced component of current

```
//Ex3_6.sce

clc;
clear;
G=3;     //conductance in mho
L=1/4;    //Inductor value in henry
C=3;      //capacitor value in farad
omega=2;    //taken from i(t)
XL=1/(omega*L);
XC=(omega*C);
Y=complex(G,XC-XL);
I=complex(15,0);
V=I/Y;
BL= complex(0,-2);
I_L=V*BL;
I_L_mag=sqrt(real(I_L)^2+imag(I_L)^2);
I_L_angle=atand(imag(I_L)/real(I_L))-180;
printf("\n The current through inductor=%d angle:%2
   .1f degree \n",I_L_mag,I_L_angle)
//result: iL(t)=6 cos(2t-143.1)
```

Scilab code Exa 3.7 Determination of average and RMS value of voltage

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex3_7.sce

clc;
clear;
```

Figure 3.6: Determination of average and RMS value of voltage

```

printf("\n (a)")
T=(2*%pi);    //Time value for one cycle
V=15;   //Maximum voltage in volt
t0=%pi/4;t1=%pi; //time values for particular period which is taken from the given voltage wave form
Vav=(1/T)*integrate('V*sin(t)','t',t0,t1);
printf("\n Average value=%1.3f volt \n",Vav)

printf("\n (b)")
Vrms=sqrt(((V^2)/T)*integrate('(1-cos(2*t))/2','t',t0,t1)); //sin^2(t)=(1-cos(2t))/2
printf("\n RMS value=%1.2f volt \n",Vrms)
//Answer given in the book for Vrms is wrong
```

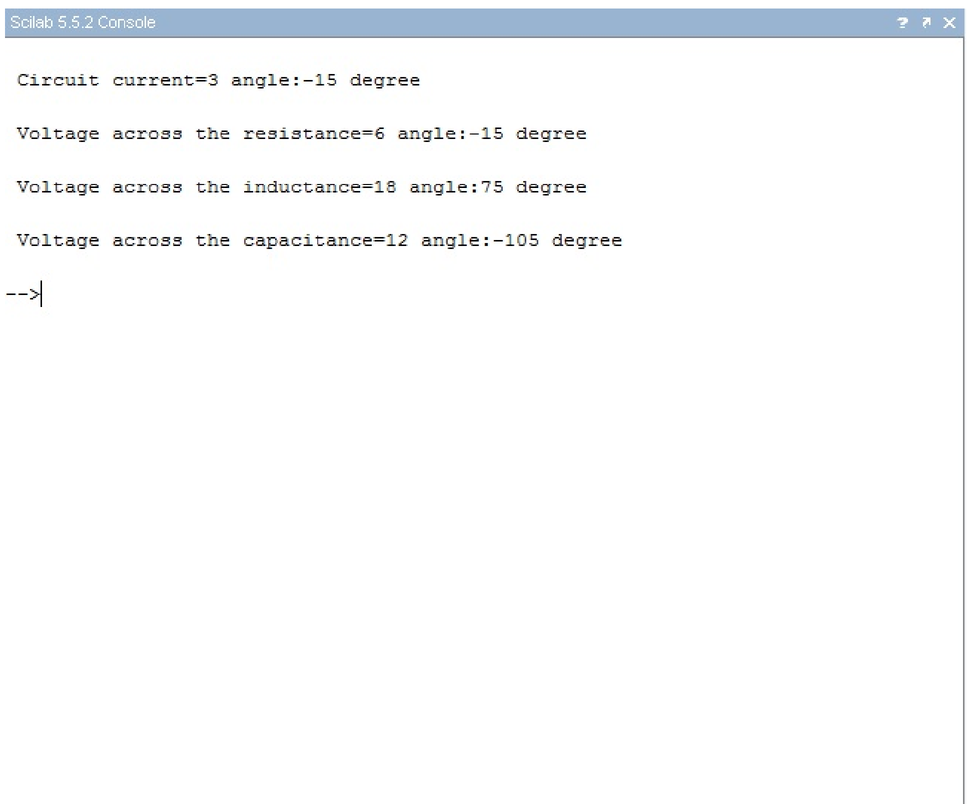


Figure 3.7: Determination of circuit current and voltage using phasor method

Scilab code Exa 3.8 Determination of circuit current and voltage using phasor meth

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//EX3_8.sce

clc;
clear;
R=2;   //Resistance in ohm
L=2;    //Inductor value in henry
C=1/12;    //capacitor value in farad
omega=3; //Taken from v(t) value
//given v(t)=12 sin(3t+30);
Vm=12;
Vrms=Vm/sqrt(2);
theta=30;

Z=complex(R,(omega*L)-(1/(omega*C)));
V=complex(Vrms*cosd(theta),Vrms*sind(theta));
I=V/Z;
I_mag=sqrt(real(I)^2+imag(I)^2);
I_ang=atand(imag(I)/real(I));
printf("\n Circuit current=%1.0f angle:%d degree \n",I_mag,I_ang)

Vr=I*R;
Vr_mag=sqrt(real(Vr)^2+imag(Vr)^2);
Vr_ang=atand(imag(Vr)/real(Vr));
printf("\n Voltage across the resistance=%1.0f angle:%d degree \n",Vr_mag,Vr_ang)

theta1=90;
Xl=complex(omega*L*cosd(theta1),omega*L*sind(theta1));
Vl=I*Xl;
```

```
Vl_mag=sqrt(real(Vl)^2+imag(Vl)^2);
Vl_ang=atand(imag(Vl)/real(Vl));
printf("\n Voltage across the inductance=%1.0f angle :%1.0f degree \n",Vl_mag,Vl_ang)

theta2=-90;
Xc=complex(cosd(theta2)/(omega*C),sind(theta2)/(omega*C));
Vc=I*Xc;
Vc_mag=sqrt(real(Vc)^2+imag(Vc)^2);
Vc_ang=atand(imag(Vc)/real(Vc))-180;
printf("\n Voltage across the capacitance=%1.0f angle:%d degree \n",Vc_mag,Vc_ang)
```

Scilab code Exa 3.9 Determination of current through different elements and voltag

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex3_9.sce

clc;
clear;
G=3;   //Conductance in mho
L=1/4;   //Inductor value in henry
C=3;    //capacitor value in farad
//Given i(t)=15 cos 2t;
Im=15;
Irms=Im/sqrt(2);
omega=2;
theta=0;
```

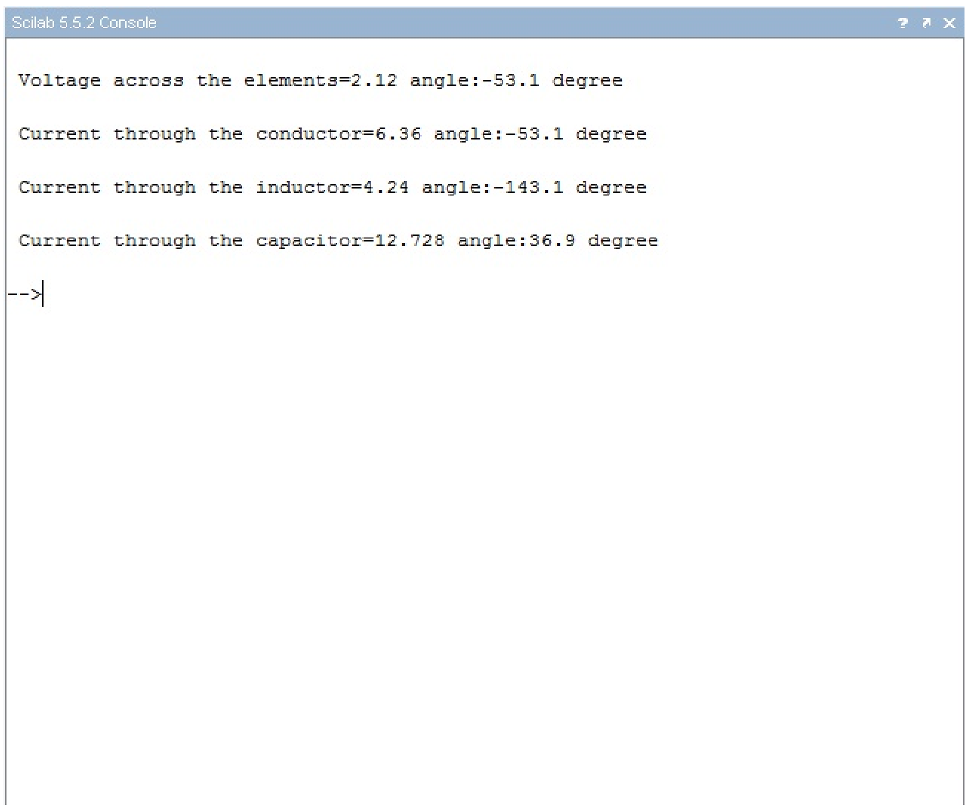


Figure 3.8: Determination of current through different elements and voltage

```
Y=complex(G,(omega*C)-(1/(omega*L)));
I=complex(Irms*cosd(theta),Irms*sind(theta));
V=I/Y;
V_mag=sqrt(real(V)^2+imag(V)^2);
V_ang=atand(imag(V)/real(V));
printf("\n Voltage across the elements=%1.2f angle:%2.1f degree \n",V_mag,V_ang)

Ig=V*G;
Ig_mag=sqrt(real(Ig)^2+imag(Ig)^2);
Ig_ang=atand(imag(Ig)/real(Ig));
printf("\n Current through the conductor=%1.2f angle:%2.1f degree \n",Ig_mag,Ig_ang)

theta1=-90;
Bl=complex(cosd(theta1)/(omega*L),sind(theta1)/(omega*L));
Il=V*Bl;
Il_mag=sqrt(real(Il)^2+imag(Il)^2);
Il_ang=atand(imag(Il)/real(Il))-180;
printf("\n Current through the inductor=%1.2f angle:%3.1f degree \n",Il_mag,Il_ang)

theta2=90;
Bc=complex(cosd(theta1)*omega*C,sind(theta1)*omega*C);
Ic=V*Bc;
Ic_mag=sqrt(real(Ic)^2+imag(Ic)^2);
Ic_ang=atand(imag(Ic)/real(Ic));
printf("\n Current through the capacitor=%2.3f angle:%2.1f degree \n",Ic_mag,Ic_ang)
```

```
Scilab 5.5.2 Console

 circuit current is

   2.8977775 - 0.7764571i

Voltage across the resistance is

   5.795555 - 1.5529143i

Voltage across the inductance is

   4.6587428 + 17.386665i

Voltage across the capacitance is

 - 3.1058285 - 11.59111i

The sum of three element voltages is

   7.3484692 + 4.2426407i

-->
```

Figure 3.9: Determination of voltage and current using complex method

Scilab code Exa 3.10 Determination of voltage and current using complex method

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex3_10.sce

clc;
clear;
//datas are taken from example 3.8
R=2;    //Resistance in ohm
L=2;     //Inductor value in henry
C=1/12;    //capacitor value in farad
omega=3; //Taken from v(t) value
//given v(t)=12 sin(3t+30);
Vm=12;
Vrms=Vm/sqrt(2);
theta=30;

Z=complex(R,(omega*L)-(1/(omega*C)));
V=complex(Vrms*cosd(theta),Vrms*sind(theta));
I=V/Z; //from Ohm's law
disp(I,' circuit current is')

Vr=I*R;
disp(Vr,'Voltage across the resistance is')

theta1=90;
Xl=complex(omega*L*cosd(theta1),omega*L*sind(theta1)
   );
Vl=I*Xl;
disp(Vl,'Voltage across the inductance is')

theta2=-90;
Xc=complex(cosd(theta2)/(omega*C),sind(theta2)/(
   omega*C));
```

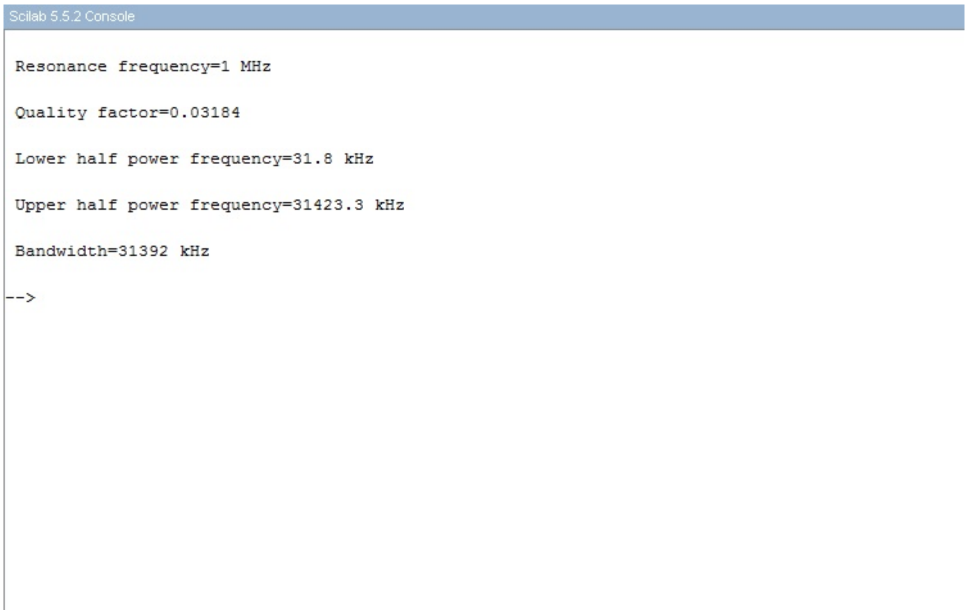


Figure 3.10: Calculation of resonance frequency and quality factor and bandwidth

```
Vc=I*Xc;
disp(Vc,'Voltage across the capacitance is')

Vsum=Vr+Vl+Vc;
disp(Vsum,'The sum of three element voltages is')

//Answers are displayed in a complex mode(real and imaginary) because it is solved in  complex method
```

Scilab code Exa 3.11 Calculation of resonance frequency and quality factor and ban

```
//Book Name:Fundamentals of Electrical Engineering
```

```
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex3_11.sce

clc;
clear;
R=10e3;   //Resistance in ohm
L=50.7e-6;   //Inductor value in henry
C=500e-12;   //capacitor value  in farad

fr=1/(2*%pi*sqrt(L*C));
printf("\n Resonance frequency=%1.0f MHz \n",fr*1e-6)

Q=(1/R)*sqrt(L/C);
printf("\n Quality factor=%1.5f \n",Q)

f1=(-fr/(2*Q))+(fr*sqrt((1/(2*Q))^2+1));
printf("\n Lower half power frequency=%2.1f kHz \n",f1*1e-3)

f2=(fr/(2*Q))+(fr*sqrt((1/(2*Q))^2+1));
printf("\n Upper half power frequency=%5.1f kHz \n",f2*1e-3)

BW=f2-f1;
printf("\n Bandwidth=%5.0f kHz \n",BW*1e-3)

//Answer vary dueto round off error in fr , Q Calculation
```

```
Scilab 5.5.2 Console

 Resonance frequency=1 MHz

 Quality factor=31.4

 Lower half power frequency=984 kHz

 Upper half power frequency=1016 kHz

 Bandwidth=32 kHz

-->
```

Figure 3.11: Calculation of resonance frequency and quality factor and bandwidth

Scilab code Exa 3.12 Calculation of resonance frequency and quality factor and ban

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex3_12.sce

clc;
clear;
R=10e3;   //Resistance in ohm
L=50.7e-6;   //Inductor value  in henry
C=500e-12;   //capacitor value in farad

fr=1/(2*%pi*sqrt(L*C));
printf("\n Resonance frequency=%1.0f MHz \n",fr*1e-6)

Q=(R)*sqrt(C/L);
printf("\n Quality factor=%2.1f \n",Q)

f1=(-fr/(2*Q))+(fr*sqrt((1/(2*Q))^2+1));
printf("\n Lower half power frequency=%3.0f kHz \n",f1*1e-3)

f2=(fr/(2*Q))+(fr*sqrt((1/(2*Q))^2+1));
printf("\n Upper half power frequency=%4.0f kHz \n",f2*1e-3)

BW=f2-f1;
printf("\n Bandwidth=%2.0f kHz \n",BW*1e-3)
```

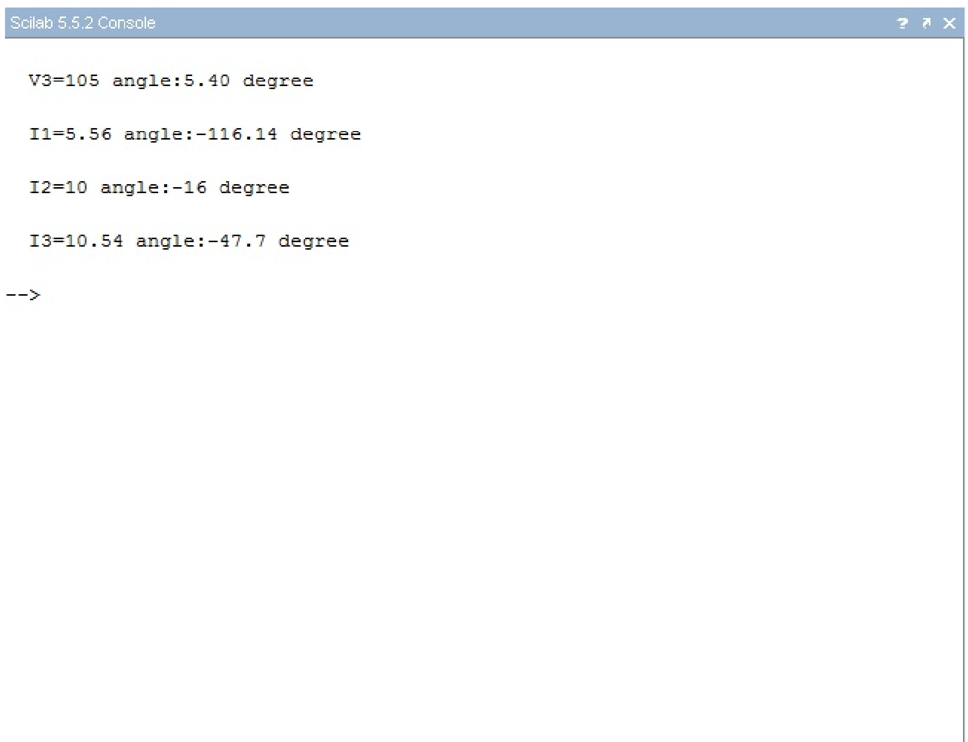


Figure 3.12: Determination of current using nodal method

Scilab code Exa 3.13 Determination of current using nodal method

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex3_13.sce

clc;
clear;

//from the figure 3.25 the below values are taken
Z1=complex(1.2,1.6);
Z2=complex(1.0,-1.75);
Z12=complex(6,8);

V1=complex(110,0);
V2=complex(110*cosd(-5),110*sind(-5));

//VA is calculated from the nodal equation of node A
VA=((V1/Z1)+(V2/Z2))/(1/Z1 + 1/Z2 + 1/Z12);
VA_mag=sqrt(real(VA)^2+imag(VA)^2);
VA_ang=atand(imag(VA)/real(VA));
printf("\n  V3=%3.0f angle:%1.2f degree \n",VA_mag,VA_ang)

I1=(V1-VA)/Z1;
I1_mag=sqrt(real(I1)^2+imag(I1)^2);
I1_ang=atand(imag(I1)/real(I1))-180;
printf("\n  I1=%1.2f angle:%3.2f degree \n",I1_mag,I1_ang)

I2=(V2-VA)/Z2;
I2_mag=sqrt(real(I2)^2+imag(I2)^2);
I2_ang=atand(imag(I2)/real(I2));
printf("\n  I2=%2.0f angle:%2.0f degree \n",I2_mag,I2_ang)
```

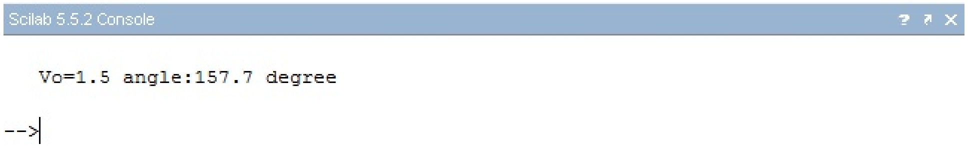


Figure 3.13: Determination of voltage using nodal method

```

I3=(VA)/Z12;
I3_mag=sqrt(real(I3)^2+imag(I3)^2);
I3_ang=atand(imag(I3)/real(I3));
printf("\n  I3=%2.2f angle:%2.1f degree \n",I3_mag,
   I3_ang)

//Answer vary dueto round off error
```

Scilab code Exa 3.14 Determination of voltage using nodal method

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
```

```
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex3_14.sce

clc;
clear;

//i(t)=sqrt(2)*1e-4*cos(4*10^7*t);
a1=complex(5,4.04);b1=complex(0,-0.04);c1=1/10;    //these are the coefficient values of VA,VB and source obtained from the node A in the given circuit
a2=complex(200,-0.04);b2=complex(1.2,-1.56);c2=0;    //these are the coefficient values of VA,VB and source obtained from the node  B in the given circuit
del=det([a1 b1;a2 b2]);
delB=det([a1 c1;a2 c2]);
VB=delB/del;

VB_mag=sqrt(real(VB)^2+imag(VB)^2);
VB_ang=atand(imag(VB)/real(VB))+180;
printf("\n   Vo=%1.1f angle:%3.1f degree \n",VB_mag,VB_ang)

//Answer vary due to  roundoff error
//Result:Vo(t)=sqrt(2)*1.5*cos(4*10^7*t+157.7)
```

Scilab code Exa 3.15 Determination of current using mesh analysis

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
```

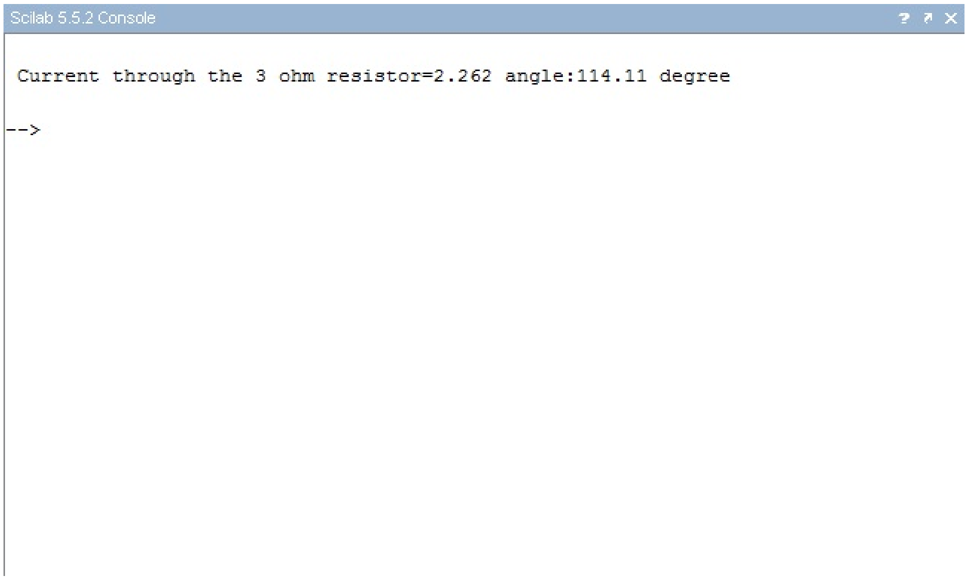


Figure 3.14: Determination of current using mesh analysis

```
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex3_15.sce

clc;
clear;
V1=complex(12,0);
//current source and its parallel impedance gives the voltage source
V2=complex(5*cosd(-30),5*sind(-30))*complex(6,-3);
//for loop1 , the coefficient of I1 ,I2 and source is given below
a1=complex(10+6,15);
b1=-complex(10,15);
c1=V1;
//for loop2 , the coefficient of I1 ,I2 and source is given below
a2=-complex(10,15);
```

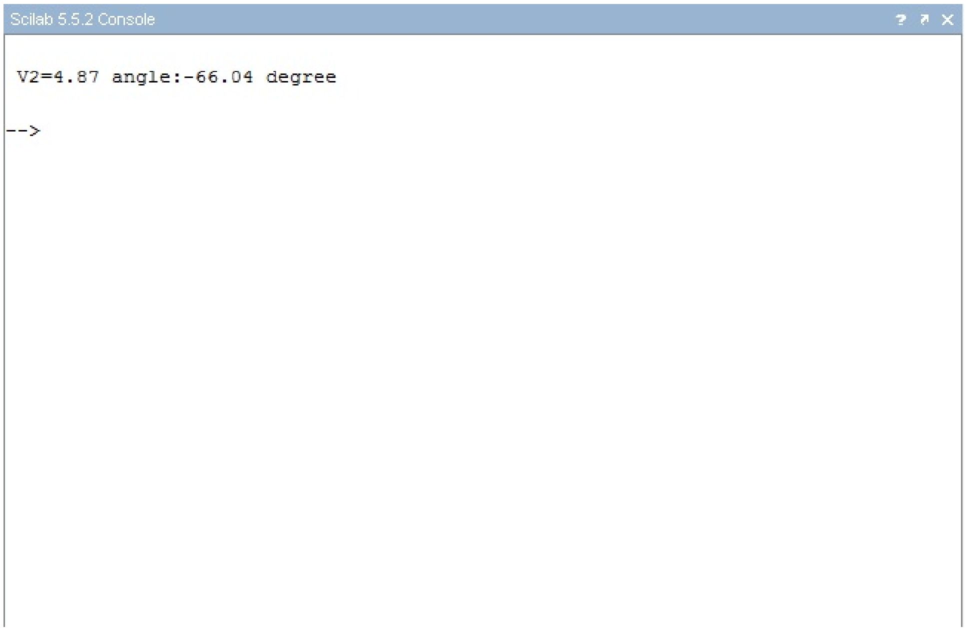


Figure 3.15: Determination of voltage using mesh analysis

```
b2=complex(19,12);
c2=-V2;
del2=det([a1 c1;a2 c2]);
del=det([a1 b1;a2 b2]);
I2=del2/del;
I2_mag=sqrt(real(I2)^2+imag(I2)^2);
I2_ang=atand(imag(I2)/real(I2))+180;
printf("\n Current through the 3 ohm resistor=%1.3f
    angle:%3.2f degree \n",I2_mag,I2_ang)
```

Scilab code Exa 3.16 Determination of voltage using mesh analysis

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
```

```
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//EX3_16.sce

clc;
clear;
//from the mesh equations coefficient of I1,I2,and source is given below
a1=complex(4,-2);
b1=-complex(3,-2);
c1=complex(12,0);
a2=-complex(3,4);
b2=complex(5,3);
c2=complex(0);

del1=det([c1 b1;c2 b2]);
del2=det([a1 c1;a2 c2]);
del=det([a1 b1;a2 b2]);
I2=del2/del;
I1=del1/del;

V2=(2*I2)+((3*(-2*%i))*(I1-I2));
V2_mag=sqrt(real(V2)^2+imag(V2)^2);
V2_ang=atand(imag(V2)/real(V2));
printf("\n V2=%1.2f angle:%2.2f degree \n",V2_mag,V2_ang)
//Anawer vary dueto round off error
//Result:v2(t)=4.87*sqrt(2) sin(2t-66.04)
```

Scilab code Exa 3.17 Determination of voltage using Thevenins theorem

```
//Book Name:Fundamentals of Electrical Engineering
```

Figure 3.16: Determination of voltage using Thevenins theorem

```
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex3_17.sce

clc;
clear;
//Below values are taken from the given circuit (fig
    .3.29)
Z1=complex(5,-5);
Z2=complex(5,-5);
Z3=complex(10,10);
V=complex(100,0);

I=V/(Z1+Z2);
Vab=I*Z2;
Zs=(Z1*Z2)/(Z1+Z2)+Z3;
```

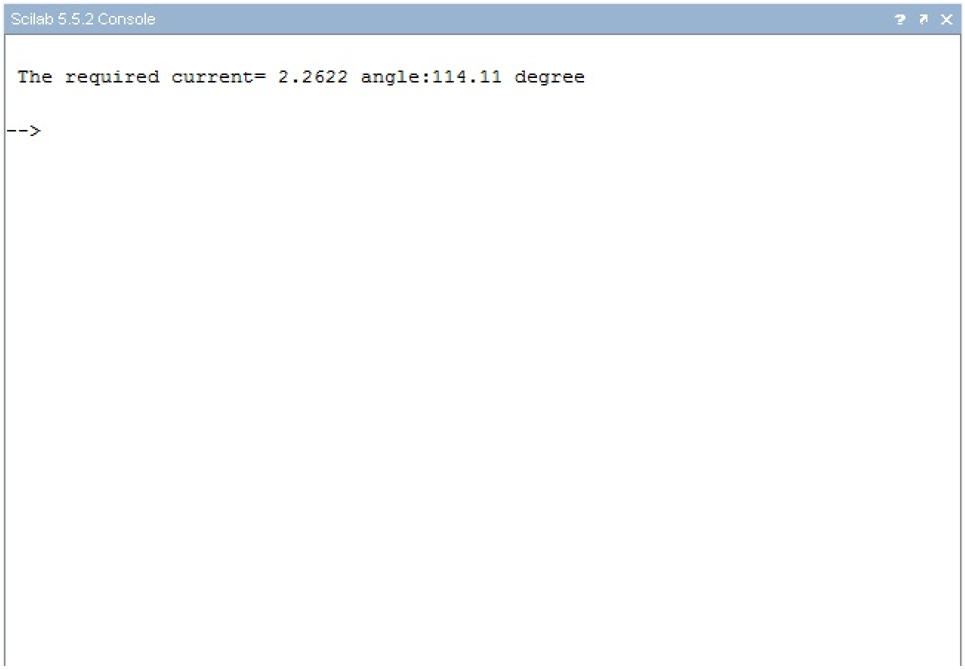


Figure 3.17: Determination of current using Thevenins theorem

```
V_AB=(Vab*real(Z3))/Zs;
V_AB_mag=sqrt(real(V_AB)^2+imag(V_AB)^2);
V_AB_ang=atand(imag(V_AB)/real(V_AB));
printf("\n V_AB=%2.2f angle:%2.2f degree \n",
   V_AB_mag,V_AB_ang)
```

Scilab code Exa 3.18 Determination of current using Thevenins theorem

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

```

```
//Ex3_18.sce

clc;
clear;
//Below values are taken from the given circuit (fig.3.27)
Z1=complex(6,0);
Z2=complex(10,15);
Z3=complex(6,-3);

Zs=(Z1*Z2)/(Z1+Z2)+Z3;
V=12;
Va=V-(V/(Z1+Z2))*real(Z3);
Is=complex(5*cosd(-30),5*sind(-30));
Vb=Is*Z3;
Voc=Va-Vb;
I=Voc/(Zs+3);
I_mag=sqrt(real(I)^2+imag(I)^2);
I_ang=atand(imag(I)/real(I))+180;
printf("\n The required current= %1.4f angle:%3.2f degree \n",I_mag,I_ang)
```

Scilab code Exa 3.19 Determination of current using Norton theorem

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex3_19.sce

clc;
clear;
```

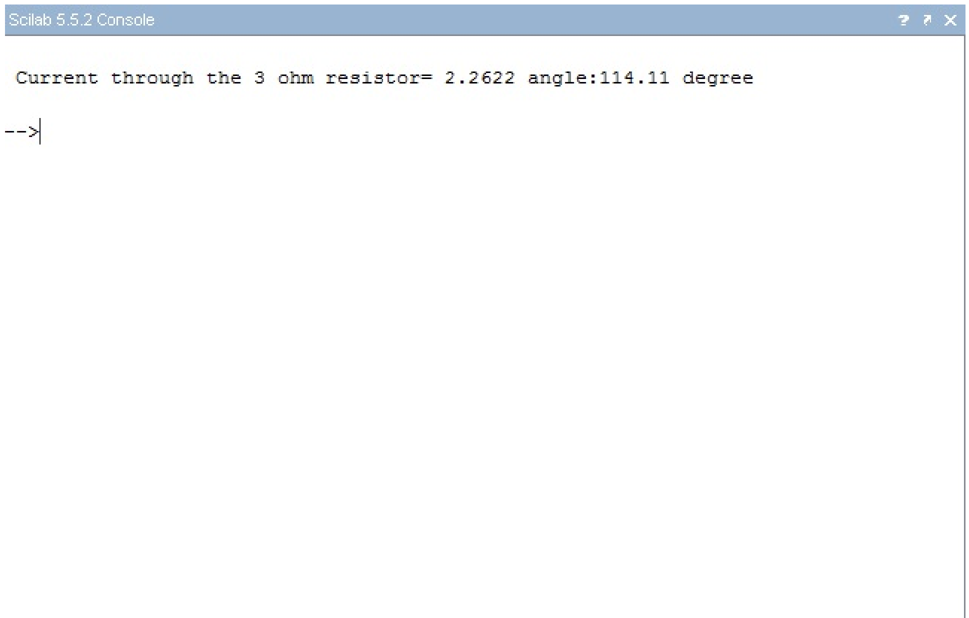


Figure 3.18: Determination of current using Norton theorem

```
//Below values are taken from the given circuit (fig.3.27)
Z1=complex(6,0);
Z2=complex(10,15);
Z3=complex(6,-3);
Zs=(Z1*Z2)/(Z1+Z2)+Z3;
Vs=complex(12,0);
Is=complex(5*cosd(-30),5*sind(-30));

//for loop1 , the coefficient of I2 ,Isc and source is given below
a1=Z1+Z2;
b1=Z1;
c1=Vs;
//for loop2 , the coefficient of I1 ,I2 and source is given below
a2=Z2;
b2=-Z3;
```

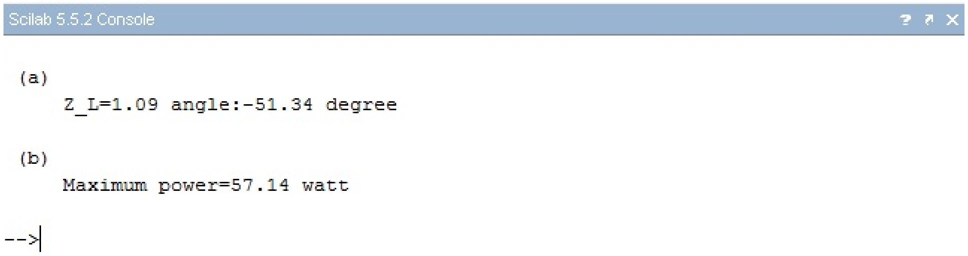


Figure 3.19: Calculation of impedence and maximum power

```
c2=Is*Z3;
del2=det([a1 c1;a2 c2]);
del=det([a1 b1;a2 b2]);

Isc=del2/del;
Ys=1/Zs;
I=(Isc/Ys)/((1/Ys)+3);
I_mag=sqrt(real(I)^2+imag(I)^2);
I_ang=atand(imag(I)/real(I))+180;
printf("\n Current through the 3 ohm resistor= %1.4f
    angle:%3.2f degree \n",I_mag,I_ang)
```

Scilab code Exa 3.20 Calculation of impedence and maximum power

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex3_20.sce.

clc;
clear;

Vm=16*sqrt(2);    //Maximum voltage value in volt
Vrms=Vm/sqrt(2);    //RMS voltage in volt
R=1;     //resistance in ohm
C=-%i;   //capacitance in ohm
R1=2;     //resistance in ohm
R2=3;     //resistance in ohm
C1=-%i;   //capacitance in ohm
//After simplication of the network by star-delta
    transformation
Za=complex(2,-10)/26;
Zb=complex(3,-15)/26;
Zc=complex(30,6)/26;
Voc=(Vrms*(Zc+C))/(R+Za+Zc+C);
Zs=(1/((1/(Za+R))+(1/(Zc+C))))+Zb;

printf("\n (a)")
Zl=Zs;
Zl_mag=sqrt(real(Zl)^2+imag(Zl)^2);
Zl_ang=atand(imag(Zl)/real(Zl));
printf("\n      Z_L=%1.2f angle:%2.2f degree \n",
    Zl_mag,Zl_ang)

```

Figure 3.20: Determination of voltage and power and reactive power

```
printf("\n (b)")
Voc_mag=sqrt(real(Voc)^2+imag(Voc)^2);
Pmax=Voc_mag^2/(2*real(Zl));
printf("\n      Maximum power=%2.2f watt \n",Pmax)
//There is a mistake in Zs calculation .Zs=0.7555-0.8539i is wrong  .the correct value of Zs=0.6829-0.8536i
//So the answer vary
```

Scilab code Exa 3.21 `Determination of voltage and power and reactive power`

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
```

```
//Edition:Third ,2014

//Ex3_21.sce

clc;
clear;
P1=7e3;    //supplied power in watt
pf1=0.8;   //lagging power factor
//below values are taken from the given circuit (fig.3.39)
Z1=complex(0.8,1);
Z2=complex(1.4,1.6);
V1=440;     //terminal voltage in volt
PL=10e3;     //power required by the load in watt
pf2=0.8;     //lagging power factor

I1=P1/(V1*pf1);
Pr1=P1-(I1^2*real(Z1));
Q1=P1*tand(acosd(pf1));
Qr1=Q1-(I1^2*imag(Z1));
VA=sqrt(Pr1^2+Qr1^2);
VL=VA/I1;
printf("\n V_L=%3.1f V \n",VL)

QL=PL*tand(acosd(pf2));
Pr2=PL-Pr1;
Qr2=QL-Qr1;
VA_load=sqrt(Pr2^2+Qr2^2);
I2=VA_load/VL;

P2=Pr2+(I2^2*real(Z2));
Q2=Qr2+(I2^2*imag(Z2));
V2=sqrt(P2^2+Q2^2)/I2;
printf("\n V2=%3.1f V \n",V2)
printf("\n Reactive power:P2=%4.1f W \t Q2=%4.1f Var \n",P2,Q2)
```

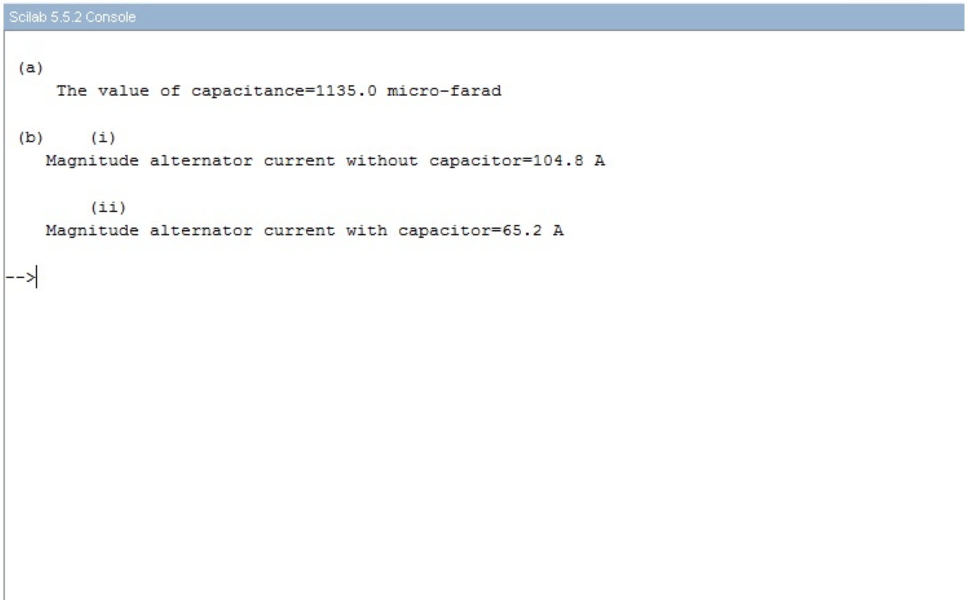


Figure 3.21: Determination of capacitance and current of alternator

Scilab code Exa 3.22 `Determination of capacitance and current of alternator`

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex3_22.sce.

clc;
clear;
V=230;    //Supply voltage in volt
PL1=10E3;  //supply power to loaad 1 in watt
pf1=0.7;// lagging power factor value of load 1
```

```
P2=10E3;    //supply power  to load 2 in watt
pf2=0.5;  //lagging power factor value of load 2

printf("\n (a)")
PL2=P2*pf2;
QL1=PL1*tand(acosd(pf1));
QL2=PL2*tand(acosd(pf2));
PL=PL1+PL2;
QL=QL1+QL2;
QC=-QL;
IC=QC/V;
XC=QC/IC^2;
f=50;
C=1/(2*%pi*f*-XC);
printf("\n      The value of capacitance=%4.1f micro-
   farad \n",C*1e6)

printf("\n (b)\t(i)")
kVA=sqrt(PL^2+QL^2);
Ig=kVA/V;
printf("\n     Magnitude alternator current without
   capacitor=%3.1f A \n",Ig)
printf("\n\t(ii)")
kVA=PL;
Ig=kVA/V;
printf("\n     Magnitude alternator current with
   capacitor=%2.1f A \n",Ig)
//Answer vary dueto roundoff error
```

Scilab code Exa 3.27 Plotting the four components from the given circuit

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
```

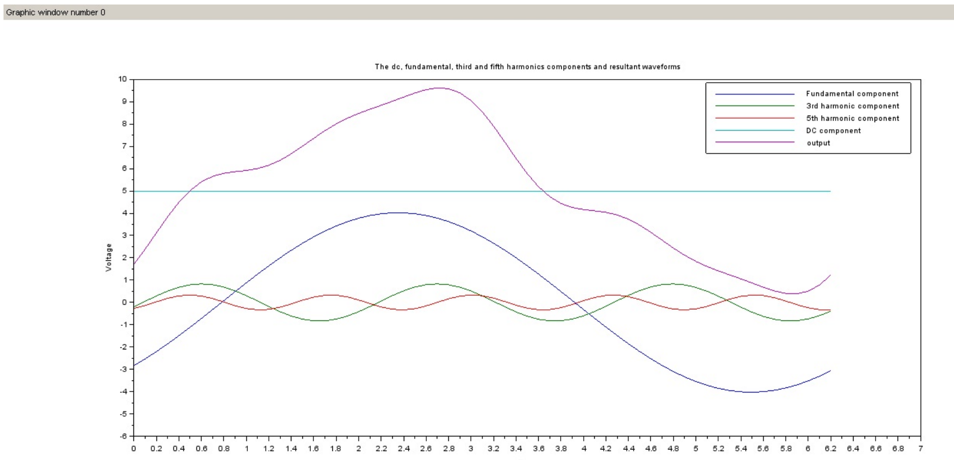


Figure 3.22: Plotting the four components from the given circuit

```
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex3_27(b).sce

clc;
clear;
//case(b)
//from case(a) result v(t)=5+6.36 sin(t)+2.12 sin(3t
    )+1.27 sin(5t)
V0=5
V1=6.36/sqrt(2);
V3=2.12/sqrt(2);
V5=1.27/sqrt(2);

omega0=0;
omega1=1;
omega3=3;
omega5=5;

Vdc=(2*V0)/(2+%i*omega0);
V1=(2*V1)/(2+%i*omega1)
```

```
V3=(2*V3)/(2+%i*omega3)
V5=(2*V5)/(2+%i*omega5)

Vdc_mag=sqrt(real(Vdc)^2+imag(Vdc)^2);
Vdc_ang=atand(imag(Vdc)/real(Vdc));
V1_mag=sqrt(real(V1)^2+imag(V1)^2);
V1_ang=atand(imag(V1)/real(V1))-180;
V3_mag=sqrt(real(V3)^2+imag(V3)^2);
V3_ang=atand(imag(V3)/real(V3));
V5_mag=sqrt(real(V5)^2+imag(V5)^2);
V5_ang=atand(imag(V5)/real(V5));


t=[0:0.1:2*%pi];

Vc1=V1_mag*sin(t-V1_ang);
Vc3=V3_mag*sin((3*t)-V3_ang);
Vc5=V5_mag*sin((5*t)-V5_ang);
for tt=1:length(t)
 V(tt)=Vdc_mag*sin(%pi/2);
end
V=V';
Vc=V+Vc1+Vc3+Vc5;

plot(t,[Vc1; Vc3; Vc5; V ;Vc])

title('The dc, fundamental, third and fifth
   harmonics components and resultant waveforms')
xlabel('Time')
ylabel('Voltage')
legend('Fundamental component','3rd harmonic
   component','5th harmonic component','DC component
   ','output')
```

Chapter 4

Electrostatics

Scilab code Exa 4.1 Determination of force between two spheres

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex4_1.sce.

clc;
clear;
Q1=2e-9;   //Sphere 1 charges in coulomb
Q2=-0.5e-9; //Sphere 2 charges in coulomb
r=4e-2;    //Distance between the two spheres in m
epsilon_not=1/(36e9*%pi);
printf("\n(a)")
F=-(Q1*Q2)/(4*%pi*epsilon_not*r^2);
                         //Coulomb's law
printf("\n Force between two spheres when they are
    displaced 4cm apart=%1.4f*10^-5 N Attractive\n",F
    *1e5)
```

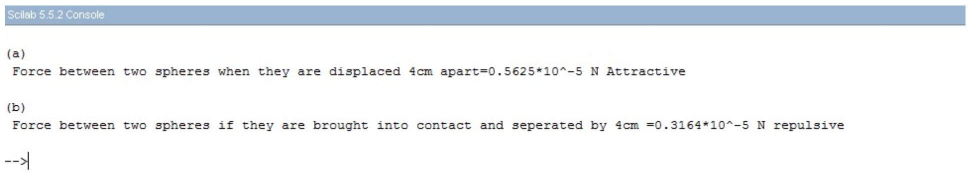


Figure 4.1: Determination of force between two spheres

```

printf("\n(b)")
q=(Q1+Q2)/2;
F=(q^2)/(4*%pi*epsilon_not*r^2)
printf("\n Force between two spheres if they are
    brought into contact and separated by 4cm =%1.4f
    *10^-5 N repulsive\n",F*1e5)
```

Scilab code Exa 4.3 Calculation of force

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex4_3.sce

clc;
clear;
```

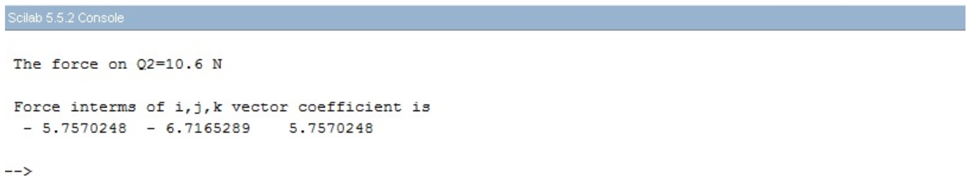


Figure 4.2: Calculation of force

```
r=[-0.03 0.01 0.04];
r_dash=[0.03 0.08 -0.02];
Q1=129e-9;
Q2=110e-6;
epsilon_not=1/(36*%pi*1e9);

a=r-r_dash;  //r and r_dash are the position of two charges
b=a.^2;
c=b(1,1)+b(1,2)+b(1,3);
d=sqrt(c);      //b,c,d are assumed alphabets for calculating magnitude of difference of r and r'

F=(Q1*Q2)/(4*%pi*epsilon_not*d^2);
printf("\n The force on Q2=%2.1f N \n",F)
Ir=a/d;
F1=Ir*F;
printf("\n Force interms of i,j,k vector coefficient is")
disp(F1)

//There is a error in the book for calculating F
```

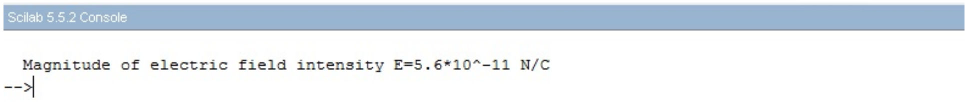


Figure 4.3: Determination electric field intensity

```
   value
//So answer given in the book is wrong
```

Scilab code Exa 4.4 `Determination electric field intensity`

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex4_4.sce.

clc;
clear;
q=1.6e-19;
m=9.1e-31;
g=9.8;
```

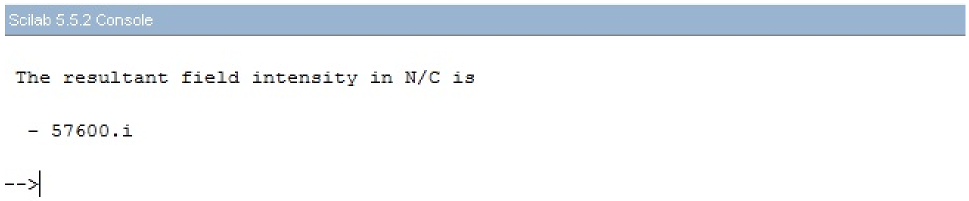


Figure 4.4: Calculation of electric field intensity

```
F=m*g;
E=F/q;
printf("\n  Magnitude of electric field intensity E=
   %1.1f*10^-11 N/C",E*1e11)
```

Scilab code Exa 4.5 `Calculation of electric field intensity`

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex4_5.sce.
```

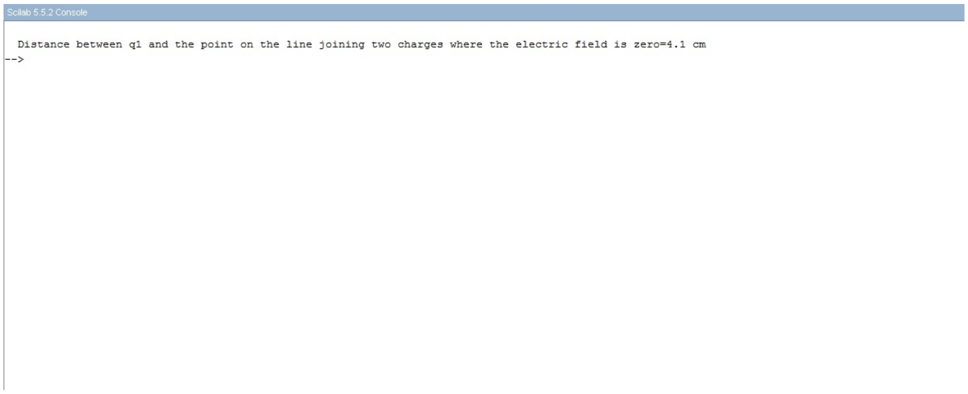


Figure 4.5: Determination of distance between two charges at which electric field strength is zero

```

clc;
clear;
//from the given figure
q=1e-8;
OB=sqrt(5^2-4^2); //Distance between point O and B
cos_theta=3/5;
sin_theta=4/5;
r=5e-2;

epsilon_not=1/(36e9*%pi);
modulus_E=q/(4*%pi*epsilon_not*r^2);
E1=((modulus_E*cos_theta)-(modulus_E*sin_theta*%i));
E2=((-modulus_E*cos_theta)-(modulus_E*sin_theta*%i))
    ;
E=E1+E2;
disp(E,'The resultant field intensity in N/C is')
```

Scilab code Exa 4.7 Determination of distance between two charges at which electri

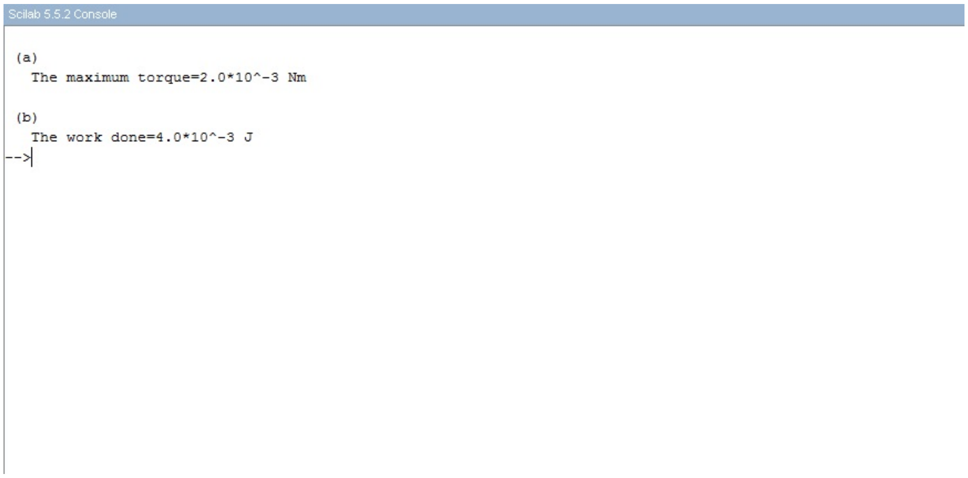


Figure 4.6: Determination of maximum torque and work done

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex4_7.sce.

clc;
clear;
q1=1e-4;
q2=2e-4;
l=10e-2;
x=l*1e2/(1+sqrt(q2/q1));
printf("\n  Distance between q1 and the point on the line joining two charges where the electric field is zero=%1.1f cm",x)
```

Scilab code Exa 4.11 Determination of maximum torque and work done

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex4_11.sce.

clc;
clear;
q=1e-6;
l=2e-2;
E=1e5;

printf("\n (a)")
theta=90;
p=l*q;
T_max=p*E*sind(theta);
printf("\n   The maximum torque=%1.1f*10^-3 Nm\n",
   T_max*1e3)

printf("\n (b)")
U_180=-p*E*cosd(180);                          //U is
    the potential energy for theta=180 degree and 0
   degree
U_0=-p*E*cosd(0);
W=(U_180)-(U_0);
printf("\n   The work done=%1.1f*10^-3 J",W*1e3)
```

Scilab code Exa 4.14 Determination of charge

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
```

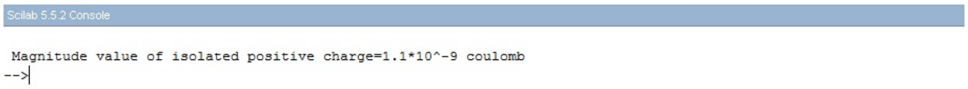


Figure 4.7: Determination of charge

```
//Edition:Third ,2014

//Ex4_14.sce.

clc;
clear;
V=100;
epsilon_not=8.854e-12;
r=10e-2;
q=4*%pi*epsilon_not*r*V;
printf("\n Magnitude value of isolated positive
    charge=%1.2g*10^-9 coulomb",q*1e9)
```

Scilab code Exa 4.15 Calculation of potential difference between two points

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014
```

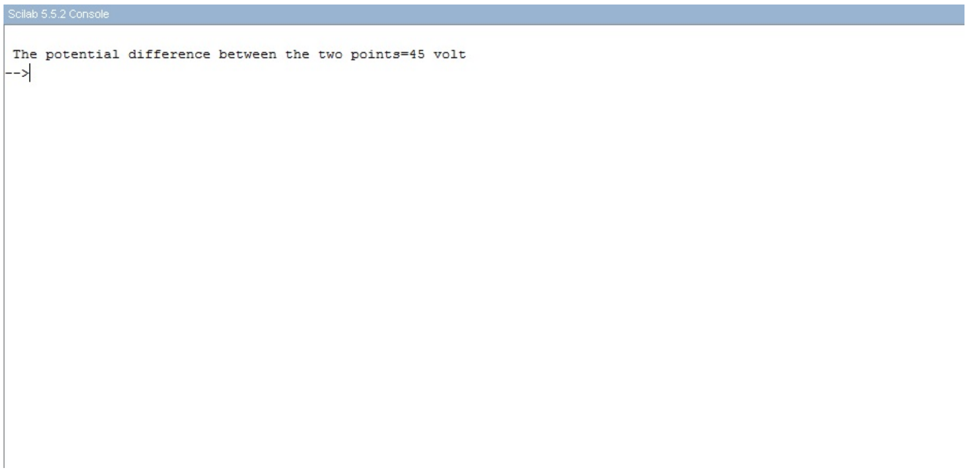


Figure 4.8: Calculation of potential difference between two points

```

//Ex4_15.sce.

clc;
clear;
q=1e-9;
r_p=10e-2;
r_q=20e-2;
epsilon_not=8.854e-12;
V=(q/(4*%pi*epsilon_not))*((1/r_p)-(1/r_q));
printf("\n The potential difference between the two
   points=%2.0f volt",V)
```

Scilab code Exa 4.16 `Calculation of net potential`

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
```

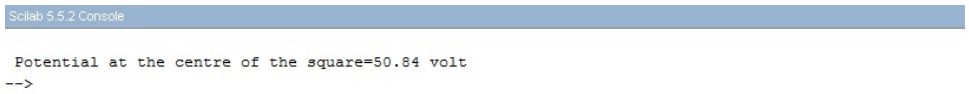


Figure 4.9: Calculation of net potential

```
//Edition:Third ,2014

//Ex4_16.sce.

clc;
clear;
q1=-2e-9;
q2=3e-9;
q3=2e-9;
q4=1e-9;
AB=1;                    //Given square side as 1 metre
BC=1;
epsilon_not=8.854e-12;
AP=sqrt(AB^2+BC^2)/2;                  //formula derived from the figure
Vp=(1/(4*%pi*epsilon_not*AP))*(q1+q2+q3+q4);
printf("\n Potential at the centre of the square=%2.2f volt",Vp)

//Answer vary due to roundoff error
```

Figure 4.10: Calculation of electric field

Scilab code Exa 4.18 `Calculation of electric field`

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex4_18.sce.
clc;
clear;
Q1=3e-6;
Q2=2e-6;
a=9e9;                  //a=(1/(4*%pi*epsilon_not))

x=1;y=2;z=3;

//V=-a*((Q1/(sqrt((x-1)^2+(y-1)^2+(z-1)^2)))+(Q2/(
```

```
sqrt((x-1)^2+(y-3)^2+(z-2)^2))));

dV_dx=-a*((Q1*(x-1)/((x-1)^2+(y-1)^2+(z-1)^2)^(3/2))+(Q2*(x-1)/((x-1)^2+(y-3)^2+(z-2)^2)^(3/2)));    //differentietion of potential with respect to x

dV_dy=-a*((Q1*(y-1)/((x-1)^2+(y-1)^2+(z-1)^2)^(3/2))+(Q2*(y-3)/((x-1)^2+(y-3)^2+(z-2)^2)^(3/2)));    //differentietion of potential with respect to y

dV_dz=-a*((Q1*(z-1)/((x-1)^2+(y-1)^2+(z-1)^2)^(3/2))+(Q2*(z-2)/((x-1)^2+(y-3)^2+(z-2)^2)^(3/2)));        //differentietion of potential with respect to z

//E=-(del_V)
printf("\n E=(%gi)+(%4.0fj)+(%5.0fk) V/m",-dV_dx,-dV_dy,-dV_dz)
```

Scilab code Exa 4.19 Calculation of potential and field strength

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex4_19.sce.

clc;
clear;
r1=3e-2;
r2=6e-2;
r3=9e-2;
```

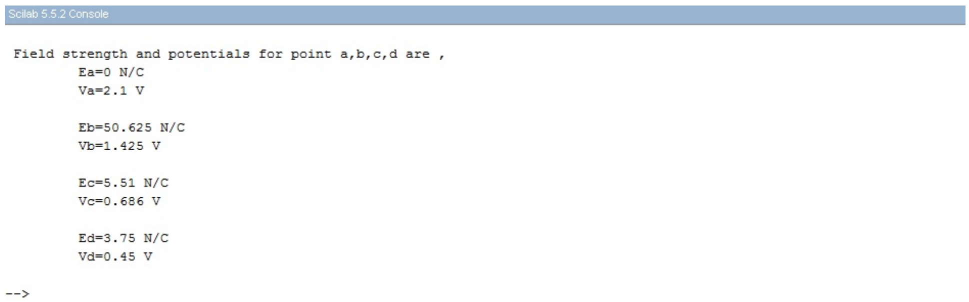


Figure 4.11: Calculation of potential and field strength

```
q1=9e-12;
q2=-6e-12;
q3=3e-12;
d1=2e-2;
d2=4e-2;
d3=7e-2;
d4=12e-2;
epsilon_not=8.854e-12;
a=9e9;                    //a=1/(4*%pi*epsilon_not);

printf("\n Field strength and potentials for point a
    ,b,c,d are ,")
Ea=0;
printf("\n\t Ea=%g N/C",Ea)
Va=a*((q1/r1)+(q2/r2)+(q3/r3));
printf("\n\t Va=%g V \n",Va)

Eb=a*(q1/d2^2);
printf("\n\t Eb=%g N/C",Eb)
Vb=a*((q1/d2)+(q2/r2)+(q3/r3));
printf("\n\t Vb=%g V \n",Vb)
```

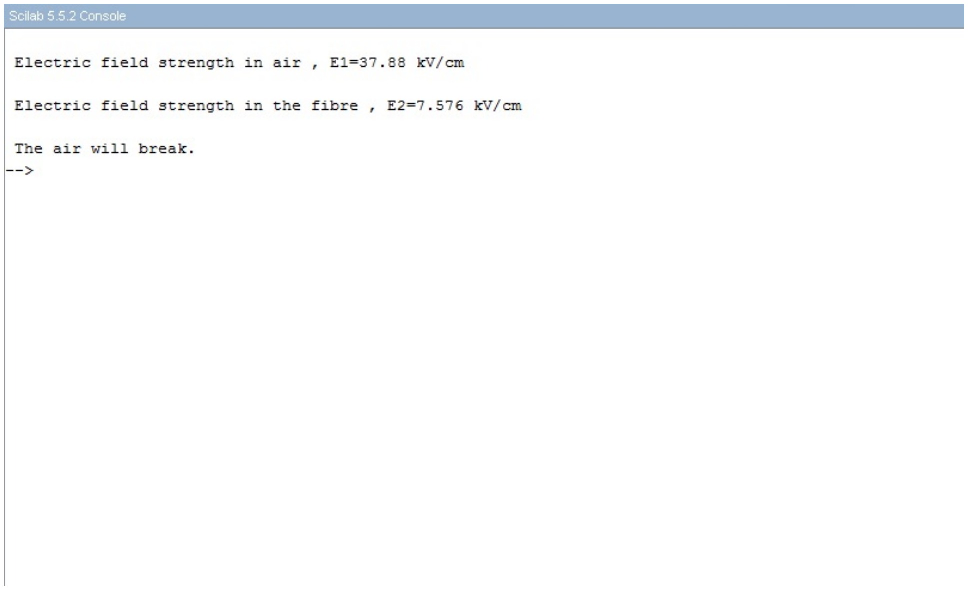


Figure 4.12: Determination of electric field strength

```

Ec=a*((q1/d3^2)+(q2/d3^2));
printf("\n\t Ec=%1.2f N/C",Ec)
Vc=a*((q1/d3)+(q2/d3)+(q3/r3));
printf("\n\t Vc=%1.3f V \n",Vc)

Ed=(a/d4^2)*(q1+q2+q3);
printf("\n\t Ed=%g N/C",Ed)
Vd=(a/d4)*(q1+q2+q3);
printf("\n\t Vd=%g V \n",Vd)
//There is a error in book calculation on Vc. In the
    book Vc=0.762 volt instead of 0.6857 volt
```

Scilab code Exa 4.22 Determination of electric field strength

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex4_22.sce.

clc;
clear;
V=2.5;                  //potential difference of the plates in kv
x=0.25;                 //distance between two parallel plates in cm
x1=0.02;                //airgap in between the parallel plates in cm
x2=0.23;               //thickness of fibre sheet in the gap in cm
epsilon_r=5;

//As the eletric displacement is perpendicular to the boundary
//D=D1=D2;   ,   D1=epsilon_not*E1;          ,    D2=epsilon_not*epsilon_r*E2;
//from this E1=5*E2;

//V=V1+V2;        V1=x1*E1;          V2=x2*E2;
//from this we can find the equation of E2

E2=V/((x1*epsilon_r)+(x2));
E1=5*E2;

printf("\n Electric field strength in air , E1=%2.2f kV/cm \n",E1)
printf("\n Electric field strength in the fibre , E2=%1.3f kV/cm \n",E2)

E=30;           //Dielectric strength of air in kV/cm
if (E1>E)
```

```
Scilab 5.5.2 Console

 Capacitance=13.281 pF

 Potential difference=56.5 volt

 New capacitance=53.124 pF

 New potential difference=14.118 volt

-->
```

Figure 4.13: Determination of capacitance of the capacitor and potential difference across the capacitor

```
     printf("\n The air will break.")
else
    printf("\n The air will not break.")
end
```

Scilab code Exa 4.24 Determination of capacitance of the capacitor and potential d

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex4_24.sce.

clc;
clear;
```

```
d=1e-2;
l=15e-2;
h=10e-2;
Q=750e-12;
epsilon_not=8.854e-12;

A=l*h;
C=(epsilon_not*A)/d;
printf("\n  Capacitance=%2.3f pF \n",C*1e12)
V=Q/C;
printf("\n  Potential difference=%2.1f volt \n",V)

epsilon_r=4;
C=(epsilon_not*epsilon_r*A)/d;
printf("\n  New capacitance=%2.3f pF \n",C*1e12)
V=Q/C;
printf("\n  New potential difference=%2.3f volt \n",
   V)

//There is a error in the book calculation for
   finding new potential difference(V) ,the answer
   is given V=14.125 volt insteadof 14.118 volt
```

Scilab code Exa 4.26 `Calculation of electric field intensity and electric flux den`

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex4_26.sce.

clc;
```

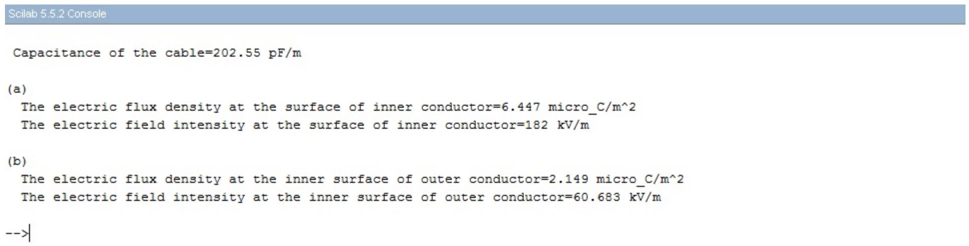


Figure 4.14: Calculation of electric field intensity and electric flux density

```
clear;
d_i=5e-3;                    //Diameter of inner cylinder in metre
d_o=15e-3;                   //Diameter of outer cylinder in metre
epsilon_r=4;
V=500;
epsilon_not=8.854e-12;
epsilon=epsilon_r*epsilon_not;
a=d_i/2;
b=d_o/2;
C=(2*%pi*epsilon)/(log(b/a));
printf("\n Capacitance of the cable=%3.2f pF/m \n",C*1e12)

printf("\n(a)")
p_l=C*V;                       //Electric displacement through a cylindrical area of unit length in C/m
D=p_l/(2*%pi*a);
E=D/epsilon;
printf("\n  The electric flux density at the surface
```

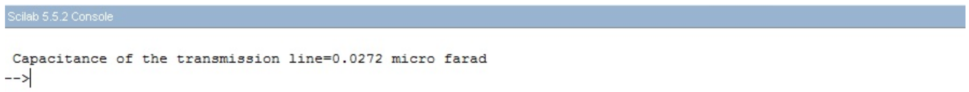


Figure 4.15: Calculation of capacitance of the line

```
    of inner conductor=%1.3f micro_C/m^2",D*1e6)
printf("\n  The electric field intensity at the surface of inner conductor=%3.0f kV/m \n",E*1e-3)

printf("\n(b)")
D=p_l/(2*%pi*b);
E=D/epsilon;
printf("\n  The electric flux density at the inner surface of outer conductor=%1.3f micro_C/m^2",D*1e6)
printf("\n  The electric field intensity at the inner surface of outer conductor=%2.3f kV/m \n",E*1e-3)
//Answer vary dueto round off error
```

Scilab code Exa 4.27 Calculation of capacitance of the line

```
//Book Name:Fundamentals of Electrical Engineering
```

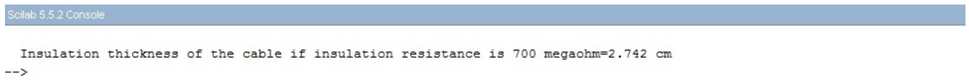


Figure 4.16: Calculation of thickness of the dielectric

```
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex4_27.sce.

clc;
clear;
l=4e3;
b=2*75e-2;
a=2.5e-2;
epsilon_not=8.854e-12;
C=(%pi*epsilon_not*l)/log(b/a);
printf("\n Capacitance of the transmission line=%1.4
   f micro farad",C*1e6)
```

Scilab code Exa 4.28 Calculation of thickness of the dielectric

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex4_28.sce.

clc;
clear;
t1=1.5;                //Insulation thickness of
   conductor in cm
d_c=1.5;               //Diameter of conductor in cm
a1=d_c/2;
b1=a1+t1;
R1=500;               //Insulation resistance in
   megaohm for a given thickness
R2=700;               //Insulation resistance in
   megaohm for a unknown thickness

//R=(p/(2*%pi*l))*log(b/a)          R1=(p/(2*%pi*l))*
   log(b1/a1)                  R2=(p/(2*%pi*l))*log(b2/
   a2)

a2=d_c/2;
b2=a2;                //b2 is the sum of a2 and unknown
    thickness

t2=a2*(b1/a1)^(R2/R1)-b2;          //thickness of 700
    megaohm resistance insulation in cm
printf("\n  Insulation thickness of the cable if
   insulation resistance is 700 megaohm=%1.3f cm",t2
   )
```

Figure 4.17: Determination of loss energy

Scilab code Exa 4.29 `Determination of loss energy`

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex4_29.sce.

clc;
clear;
Q1=60e-6;    //Capacitor charges in coulomb
V1=180;      //Volatge in volt

C1=Q1/V1;
C2=4*C1;
Q2=0;
E1=(1/2)*C1*V1^2;                    //Before two
```

```
capacitance are joined the energy stored in C1
E2=0;                           //Energy stored in C2
Ea=E1+E2;                       //Total energy before two capacitors are joined
V=(Q1+Q2)/(C1+C2);              //Potential in volt

E1=(1/2)*C1*V^2;        //Energy stored in C1 in joule
E2=(1/2)*C2*V^2;        //Energy stored in C2 in joule
Eb=E1+E2;                    //Total energy after two capacitors are joined

E_loss=Ea-Eb;
printf("\n Loss of energy=%2.1f*10^-4 joule",E_loss*1e4)
```

Chapter 5

Electromagnetism and Electromechanical Energy Conversion

Scilab code Exa 5.5 Determination of mmf and total flux and flux density

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex5_5.sce.

clc;
clear;
N=200;
A=5e-4;
I=4;
l=60e-2;

printf("\n\t (a)")
```

Figure 5.1: Determination of mmf and total flux and flux density

```
F=N*I;
printf("\n Magnetomotive force=%d AT \n",F)

printf("\n\t (b)")
mew_r=1;
mew_not=4e-7*%pi;
mew=mew_r*mew_not;
R=l/(mew*A);
phi=(F)/R;
printf("\n Total flux=%1.5f microWb \n",phi*1e6)

printf("\n\t (c)")
B=phi/A;
printf("\n Flux density=%1.4f mWb/m^2",B*1e3)
//Answer vary dueto round off error
//The unit for B(flux density) is Wbm/m^2
```

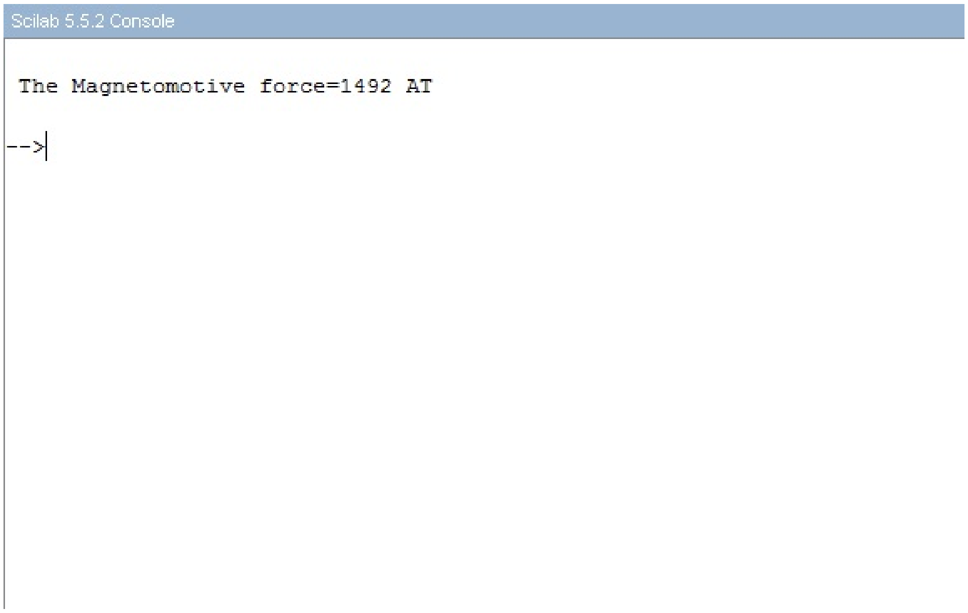


Figure 5.2: Determination of mmf

Scilab code Exa 5.6 `Determination of mmf`

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex5_6.sce.

clc;
clear;
l=2.5e-3;
A=200e-4;
```

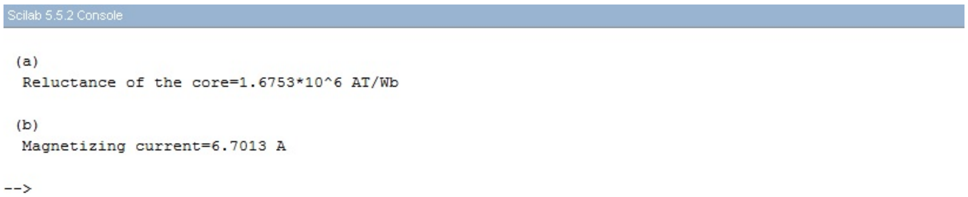


Figure 5.3: Calculation of reluctance and current

```
phi=0.015;                //flux in weber
mew_r=1;
mew_not=4e-7*%pi;
mew=mew_r*mew_not;
R=l/(mew*A);
F=phi*R;
printf("\n The Magnetomotive force=%d AT \n",F)
```

Scilab code Exa 5.7 Calculation of reluctance and current

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex5_7.sce.

```

```
clc;
clear;
A=5e-4;
l=0.4;
N=200;
mew_r=380;
mew_not=4e-7*%pi;
mew=mew_r*mew_not;

printf("\n (a)")
R=(l*1e-6)/(mew*A);
printf("\n  Reluctance of the core=%1.4f*10^6 AT/Wb \n",R)

printf("\n (b)")
phi=800e-6;      //flux in weber
F=phi*1e6*R;
I=F/N;
printf("\n  Magnetizing current=%1.4f A \n",I)
//Answer vary dueto round off error
```

Scilab code Exa 5.8 Calculation of reluctance and current

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex5_8.sce.

clc;
clear;
mew_rA=250;
```

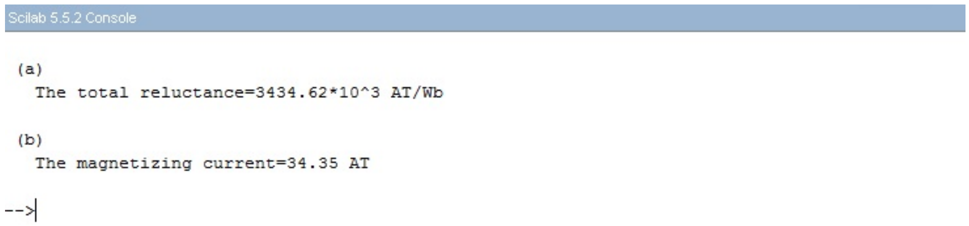


Figure 5.4: Calculation of reluctance and current

```
mew_rB=320;
lA=40e-2;
lB=25e-2;
aA=5e-4;
aB=7e-4;
N=250;
printf("\n (a)")
mew_not=4e-7*%pi;
mew_A=mew_rA*mew_not;
mew_B=mew_rB*mew_not;
R=((lA/(mew_A*aA))+(lB/(mew_B*aB)));
printf("\n   The total reluctance=%g*10^3 AT/Wb \n",
   R*1e-3)

printf("\n (b)")
phi=2.5e-3;
F=phi*R;
I=F/N;
printf("\n   The magnetizing current=%2.2f AT \n",I)
```

Figure 5.5: Calculation of mmf

```
//Answer vary dueto round_off error
```

Scilab code Exa 5.9 Calculation of mmf

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex5_9.sce.

clc;
clear;
//from the given figure
l_not=350e-3;
lc=150e-3;
la=1e-3;
A_not=400e-6;
```

Figure 5.6: Calculation of magnetizing current

```
Ac=800e-6;
pi=1e-3;              //flux in weber
mew_r=340;
mew_not=4e-7*%pi;

R_not=l_not/(mew_r*mew_not*A_not);
Rc=lc/(mew_r*mew_not*Ac);
Ra=la/(mew_not*Ac);
F=pi*(R_not/2+Rc+Ra);
printf("\n Total mmf=%4.2f AT",F)
//Answer vary dueto round_off error
```

Scilab code Exa 5.10 `Calculation of magnetizing current`

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex5_10.sce.

clc;
clear;
N=800;
Hi=50e-3;
Wi=40e-3;
l_not=2e-3;
A_not=2500e-6;
leakage_factor=1.2;
mew_not=4e-7*%pi;
mew_r=322;
pi_not=2.5e-3;
lc=600e-3;                    //from the figure

B_not=pi_not/A_not;
H_not=B_not/mew_not;
F_not=H_not*l_not;
pi_T=pi_not*leakage_factor;
Ac=Wi*Hi*0.92;                    //given 8 percent is
    taken for insulation . so (1-0.08=0.92)
Bc=pi_T/Ac;
Hc=Bc/(mew_r*mew_not);
Fc=Hc*lc;
F=Fc+F_not;
Im=F/N;
printf("\n Magnetizing current=%d A \n",Im)
```

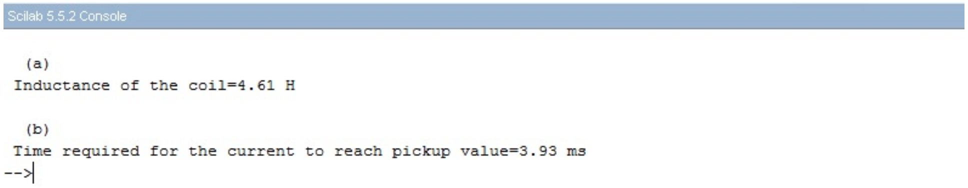


Figure 5.7: Calculation of inductance and time at pickup value of current

Scilab code Exa 5.12 Calculation of inductance and time at pickup value of current

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex5_12.sce.

clc;
clear;
N=20000;
R=5e2;
V=250;
mmf=3471;
pi=0.04e-3;

printf("\n  (a)")
I=mmf/N;
```

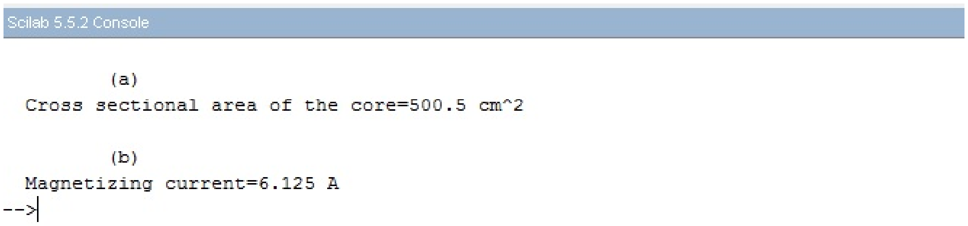


Figure 5.8: Calculation of cross sectional area of the core and magnetizing current

```
L=(N*pi)/I;
printf("\n Inductance of the coil=%1.2f H \n",L)

printf("\n  (b)")
t=log(1/(1-((I*R)/V)))*(L/R);
printf("\n Time required for the current to reach pickup value=%1.2f ms",t*1E3)
//The book answer for t (=3.93 ms) is obtained only if R=500 ohm.Otherwise (R=5000) we cannot get the answer
//So there is a mistake in R value given
```

Scilab code Exa 5.13 Calculation of cross sectional area of the core and magnetizi

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex5_13.sce.

clc;
clear;
Bm=1.1;
V=2.2e3;
f=50;
N=200;

printf("\n\t (a)")
stack_factor=0.9;
pi_m=V/(4.44*f*N);
A=pi_m/(Bm*stack_factor);
printf("\n  Cross sectional area of the core=%3.1f cm^2 \n",A*1e4)
//There is a small (printing) mistake in the final answer of A in the book

printf("\n\t (b)")
l=250e-2;
H=490;              //from the graph 5.21 H value is taken which is corresponding to B=1.1 wb/m^2
mmf=H*l;
Im=mmf/N;
printf("\n  Magnetizing current=%1.3f A",Im)
```

Scilab code Exa 5.14 Determination of steady state value of current and resistance

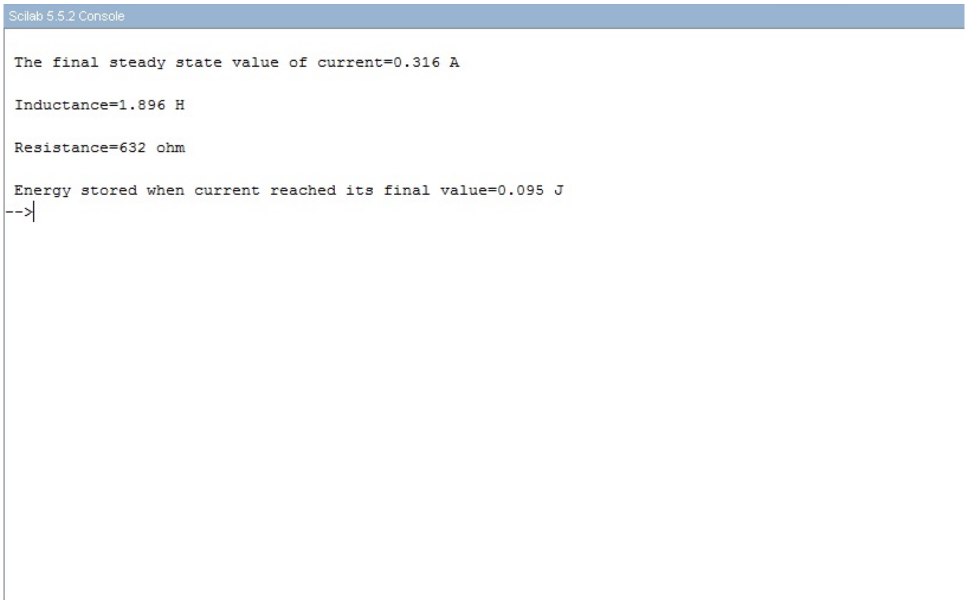


Figure 5.9: Determination of steady state value of current and resistance and inductance of the coil and stored energy

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex5_14.sce.

clc;
clear;
V=200;
i=0.2;
T=3e-3;
t=3e-3;

R=(V/i)*(1-exp(-t/T));
I=V/R;
printf("\n The final steady state value of current=
   %1.3f A \n",I)
```

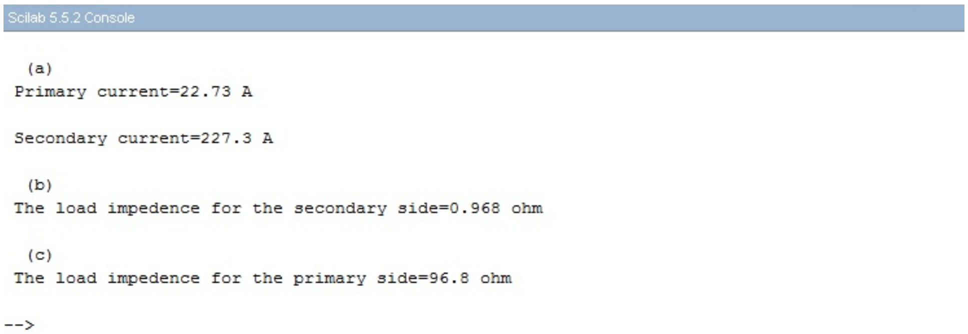


Figure 5.10: Calculation of load current and impedence referred to primary and secondary side

```

L=R*T;
printf("\n Inductance=%1.3f H \n",L)
printf("\n Resistance=%3.0f ohm \n",R)

E=(L*I^2)/2;
printf("\n Energy stored when current reached its
    final value=%1.3f J",E)
```

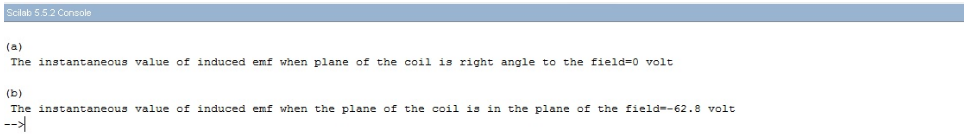
Scilab code Exa 5.15 Calculation of load current and impedence referred to primary

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
```

```
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex5_15.sce.

clc;
clear;
P=50e3;
V1=2.2e3;
V2=220;

printf("\n  (a)")
I1=P/V1;
I2=P/V2;
printf("\n Primary current=%2.2f A \n",I1)
printf("\n Secondary current=%3.1f A \n",I2)

printf("\n  (b)")
Zl2=V2/I2;
printf("\n The load impedence for the secondary side
   =%1.3f ohm \n",Zl2)

printf("\n  (c)")
Zl1=V1/I1;
printf("\n The load impedence for the primary side=
   %2.1f ohm \n",Zl1)
```

Scilab code Exa 5.16 Calculation of instantaneous values of induced emf

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014
```


Scilab 5.5.2 Console

(a)
The instantaneous value of induced emf when plane of the coil is right angle to the field=0 volt

(b)
The instantaneous value of induced emf when the plane of the coil is in the plane of the field=-62.8 volt
-->

Figure 5.11: Calculation of instantaneous values of induced emf

```

//Ex5_16.sce.

clc;
clear;
N=100;
a=10e-2;
n=20;
B=0.5;

omega=2*%pi*n;
A=a^2;
v=A*N*omega*B;

printf("\n(a)")
//theta=40*180*t=n*180 where n=0,1,2,3.....
//if we take n=2
V=v*sind(180*2);
printf("\n The instantaneous value of induced emf when plane of the coil is right angle to the field=%d volt \n",V)

printf("\n(b)")
//theta=n*180/2  where n=1,3,5,7.........
```

Figure 5.12: Determination of torque exerted on the coil

```
//if we take n=3
V=v*sind(180*3/2);
printf("\n The instantaneous value of induced emf
   when the plane of the coil is in the plane of the
    field=%2.1f volt",V)
```

Scilab code Exa 5.17 Determination of torque exerted on the coil

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex5_17.sce.
```

```
clc;
clear;
l=7.5e-2;
b=5e-2;
N=100;
B=1.1;
i=5;
T=N*B*l*b*i;
printf("\n Torque exerted on the coil=%1.4f Nm",T)
```

Chapter 7

Transformer

Scilab code Exa 7.1 Calculation of current and number of turns and maximum flux va

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex7_1.sce.

clc;
clear;
p=175e3;                              //power rating of transformer in KVA
Ep=6600;                              //primary voltage in volts
Es=440;                              //secondary voltage in volts
f=50;
Ns=100;                             //Number of secondary turns

```

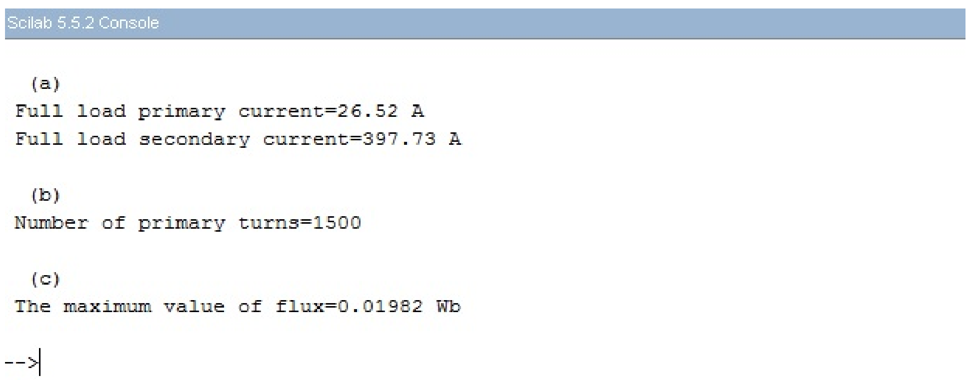


Figure 7.1: Calculation of current and number of turns and maximum flux value

```
//(a)
printf("\n  (a)")
Ip=p/Ep;
Is=p/Es;
printf("\n Full load primary current=%2.2f A ",Ip)
printf("\n Full load secondary current=%3.2f A \n",
   Is)

//(b)
printf("\n  (b)")
Np=Ns*Ep/Es;
printf("\n Number of primary turns=%d \n",Np)

//(c)
printf("\n  (c)")
max_flux=Es/(4.44*f*Ns);
printf("\n The maximum value of flux=%1.5f Wb \n",
   max_flux)
```

Scilab code Exa 7.2 Calculation of primary current and power factor

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex7_2.sce.

clc;
clear;
Np=1000;                              //number of
   Primary turns
Ns=200;                               //number of
```

Figure 7.2: Calculation of primary current and power factor

```
   secondary turns
Io=3;                              //No load current
   in A
cos_phi_not=0.2;                    //lagging
Is=250;                             //secondary
   current in A
cos_phi_s=0.8;                         //lagging

Is_dash=Ns*Is/Np;
phi_s=(acosd(0.8));
phi_not=(acosd(0.2));
Ip_cos_phi_p=(Is_dash*cos_phi_s)+(Io*cos_phi_not);
Ip_sin_phi_p=(Is_dash*(sind(phi_s)))+(Io*(sind(
   phi_not)));
Ip=sqrt((Ip_cos_phi_p)^2+(Ip_sin_phi_p)^2);
printf("\n Primary current=%2.2f A\n",Ip)

phi_p=atand((Ip_sin_phi_p)/(Ip_cos_phi_p));
printf("\n Power factor=%1.3f lagging",cosd(phi_p))
```

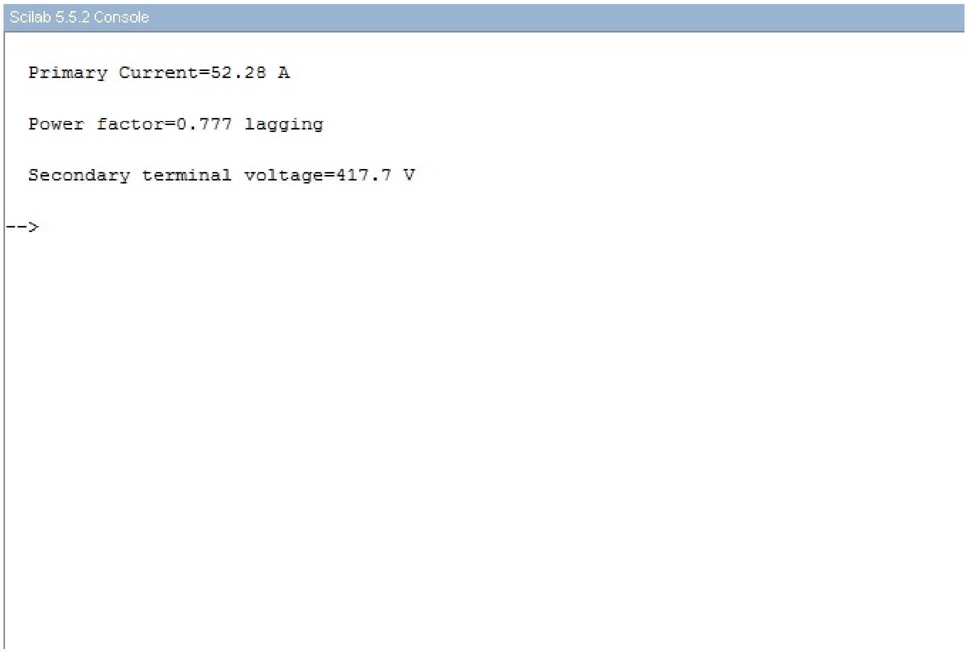


Figure 7.3: Determination of primary current and power factor and secondary terminal voltage

Scilab code Exa 7.3 `Determination of primary current and power factor and secondar`

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex7_3.sce.

clc;
clear;
```

```
T1=1000;                                          //number of Primary turns
T2=200;                                           //number of secondary turns
Is=250;                                           //secodary load current in A
I0=3;                                             //No load current in A
rp=0.72;                                          //primary winding resistance in ohms
rs=0.025;                                         //secondary  winding resistance in ohms
xp=0.92;                                          //primary winding leakage reactance in ohms
xs=0.036;                                         //secondary winding leakage reactance in ohms
Vs=2.2e3;                                         //supply voltage in volts

N=T1/T2;                                          //turns ratio of transformer
Is_dash=Is/N;
rs_dash=N^2*rs;
xs_dash=N^2*xs;
cos_pi_s=0.8;
cos_pi_0=0.2;
sin_pi_s=sind(acosd(0.8));
sin_pi_0=sind(acosd(0.2));
Isdash=(Is_dash*cos_pi_s)-%i*(Is_dash*sin_pi_s);
Io=(I0*cos_pi_0)-%i*(I0*sin_pi_0);
Ip=Isdash+Io;
a=real(Ip);
b=imag(Ip);
Ip_mag=sqrt(a^2+b^2);
printf("\n  Primary Current=%2.2f A \n",Ip_mag)

pi_p=atand(b/a);
printf("\n  Power factor=%1.3f lagging \n",cosd(pi_p
```

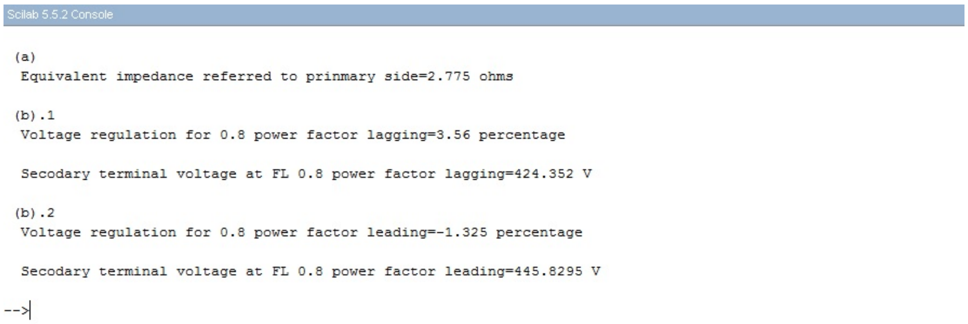


Figure 7.4: Calculation of impedence and voltage regulation

```
    ))

VL_dash=Vs-(Ip*(rp+%i*xp))-(Isdash*(rs_dash+%i*
    xs_dash));                    //secondary terminal
    voltage referred to primary
VL_dash_mag=real(VL_dash);
VL=VL_dash_mag/N;
printf("\n  Secondary terminal voltage=%3.1f V \n",
    VL)
```

Scilab code Exa 7.4 Calculation of impedence and voltage regulation

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014
```

```

//Ex7_4.sce.

clc;
clear;
P=75e3;                                    //power rating of transformer in KVA
Np=500;                                    //number of Primary turns
Ns=100;                                    //number of secondary turns
rp=0.4;                                    //primary winding resistance in ohms
rs=0.02;                                   //secondary winding resistance in ohms
xp=1.5;                                    //primary winding leakage reactance in ohms
xs=0.045;                                  //secondary winding leakage reactance in ohms
Vs=2200;                                   //supply voltage in volts

//case1
printf("\n (a)")
Re=rp+(Np/Ns)^2*rs;                        //Equivalent resistance in ohms
Xe=xp+(Np/Ns)^2*xs;                        //Equivalent leakage reactance in ohms
Ze=sqrt(Re^2+Xe^2);
printf("\n  Equivalent impedance referred to prinmary side=%1.3f ohms\n",Ze)

//case2
printf("\n (b).1")
I1=P/Vs;                                   //full load primary current in A
cos_pi2=0.8;
sin_pi2=sind(acosd(0.8));
```

```
percentage_voltage_reg=((I1*((Re*cos_pi2)+(Xe*
    sin_pi2)))/Vs)*100;
printf("\n  Voltage regulation for 0.8 power factor
    lagging=%1.2f percentage \n",
    percentage_voltage_reg)
NL_secondary_voltage=(Ns/Np)*Vs;

    //NL means "no load"
del_V=(NL_secondary_voltage*percentage_voltage_reg)
    /100;
FL_secondary_voltage=(NL_secondary_voltage)-(del_V);
printf("\n  Secodary terminal voltage at FL 0.8
    power factor lagging=%3.3f V \n",
    FL_secondary_voltage)

//case3
printf("\n (b).2")
percentage_voltage_reg=((I1*((Re*cos_pi2)-(Xe*
    sin_pi2)))/Vs)*100;
printf("\n  Voltage regulation for 0.8 power factor
    leading=%1.3f percentage \n",
    percentage_voltage_reg)
del_V=(NL_secondary_voltage*percentage_voltage_reg)
    /100;
FL_secondary_voltage=(NL_secondary_voltage)-(del_V);
printf("\n  Secodary terminal voltage at FL 0.8
    power factor leading=%4.4f V \n",
    FL_secondary_voltage)
//The anwser vary dueto roundoff error
```

Scilab code Exa 7.5 Calculation of efficiency

```
//Book Name:Fundamentals of Electrical Engineering
```

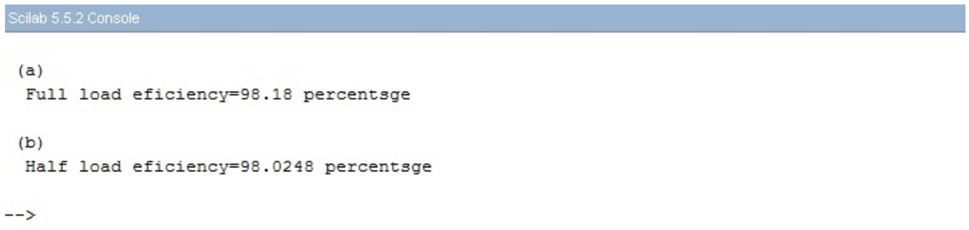


Figure 7.5: Calculation of efficiency

```
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex7_5.sce.

clc;
clear;
P=500e3;                              //KVA rating of the transformer
Vp=6600;                              //primary voltage in V
Vs=440;                               //secondary voltage in V
rp=0.45;                              //primary winding resistance in ohms
rs=0.0015;                            //secondary winding resistance in ohms
iron_loss=2.9e3;
```

```
pf=0.8;                              //power factor lagging

//case1
printf("\n (a)")
Ip=P/Vp;                             //primary current in A
Is=P/Vs;                             //secondary current in A
Ip_square_rp=Ip^(2)*rp;              //primary copper loss
Is_square_rs=Is^(2)*rs;              //secondary copper loss
FL_copper_loss=Ip_square_rp+Is_square_rs;    //FL means "full load"
FL_total_loss=iron_loss+FL_copper_loss;
FL_output_power=P*pf;
FL_input_power=FL_output_power+FL_total_loss;
FL_efficiency=(FL_output_power/FL_input_power)*100;
printf("\n  Full load efficiency=%2.2f percentage \n",FL_efficiency)

//case2
printf("\n (b)")
HL_copper_loss=FL_copper_loss*(0.5^2);       //HL means "half load"
HL_total_loss=iron_loss+HL_copper_loss;
HL_output_power=FL_output_power/2;
HL_input_power=HL_output_power+HL_total_loss;
HL_efficiency=(HL_output_power/HL_input_power)*100;
printf("\n  Half load efficiency=%2.4f percentage \n",HL_efficiency)
```

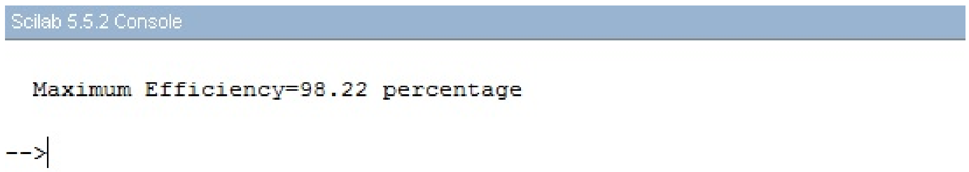


Figure 7.6: Calculation of maximum efficiency

Scilab code Exa 7.6 `Calculation of maximum efficiency`

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex7_6.sce.

clc;
```

```
clear;
//the given data are taken from previous example(Ex7_5)

Vp=6600;                                   //primary voltage in V
Vs=440;                                    //secondary voltage in V
rp=0.45;                                   //primary winding resistance in ohms
rs=0.0015;                                 //secondary winding resistance in ohms
Wi=2.9e3;                                  //iron loss in watt
pf=0.8;                                    //power factor lagging

Re=rp+(Vp/Vs)^2*rs;                        //equivalent resistance referred to primary
Ip=sqrt(Wi/Re);
P_max=Vp*Ip*pf;
total_loss=2*Wi;
Max_efficiency=(P_max/(P_max+total_loss))*100;
printf("\n  Maximum Efficiency=%2.2f percentage \n",Max_efficiency)
```

Scilab code Exa 7.7 Calculation of efficiency and voltage regulation and secondary

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

```

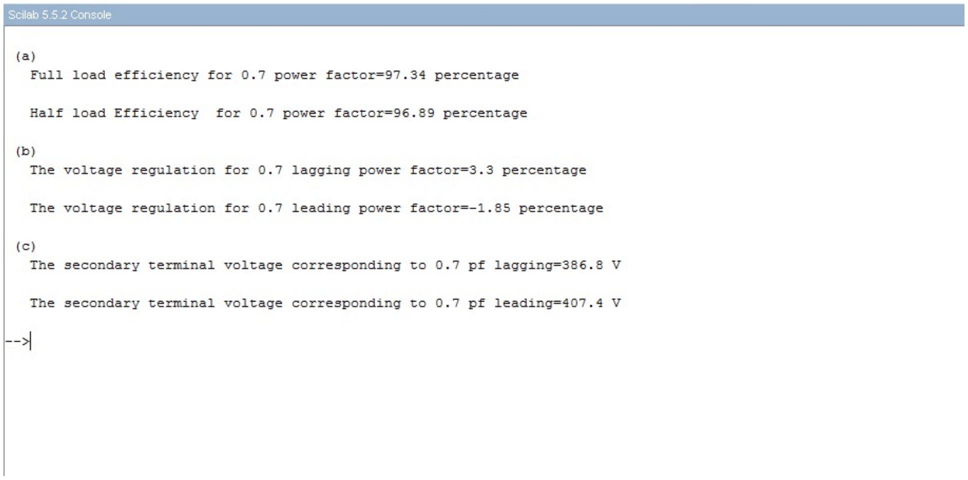


Figure 7.7: Calculation of efficiency and voltage regulation and secondary terminal voltage

```
//Ex7_7.sce
clc;
clear;
KVA=50e3;

printf("\n (a)")
PF=0.7;
iron_loss=430;                //primary power of transformer on open circuit test in watt is called iron loss
copper_loss_FL=525;                //primary power of transformer on short circuit test in watt is called copper loss
total_loss_FL=iron_loss+copper_loss_FL;
eta_FL=(KVA*PF)/((KVA*PF)+total_loss_FL)*100;                //full load efficiency
printf("\n   Full load efficiency for 0.7 power factor=%2.2f percentage \n",eta_FL)
copper_loss_HL=(0.5^2)*copper_loss_FL;
total_loss_HL=iron_loss+copper_loss_HL;
eta_HL=(KVA*PF*0.5)/((KVA*0.5*PF)+total_loss_HL)
```

```
*100;
printf("\n   Half load Efficiency  for 0.7 power factor=%2.2f percentage \n",eta_HL)

printf("\n (b)")
Vsc=124;                              //primary voltage on short circuit test in volts
Isc=15.3;                             //primary current on short circuit test in amphere
Psc=525;                             //primary power of transformer on open circuit test in watt
pi_e=acosd(Psc/(Vsc*Isc));
pi_2=acosd(PF);
Voc=3300;
voltage_regulation1=Vsc*cosd(pi_e-pi_2)/(Voc)*100;
printf("\n   The voltage regulation for 0.7 lagging power factor=%1.1f percentage \n",voltage_regulation1)
pi_2=-acosd(PF);
voltage_regulation2=Vsc*cosd(pi_e-pi_2)/(Voc)*100;
printf("\n   The voltage regulation for 0.7 leading power factor=%1.2f percentage \n",voltage_regulation2)

printf("\n (c)")
Voc=400;
decrease_in_voltage=voltage_regulation1*Voc/100;
Vs1=Voc-decrease_in_voltage;
increase_in_voltage=voltage_regulation2*Voc/100;
Vs2=Voc-increase_in_voltage;
printf("\n   The secondary terminal voltage corresponding to 0.7 pf lagging=%3.1f V \n",Vs1)
printf("\n   The secondary terminal voltage corresponding to 0.7 pf leading=%3.1f V \n",Vs2)
```

```
Scilab 5.5.2 Console

 (a)
 Delta star connection:

  Primary line current=27.3 A
  Primary line voltage=2540 V
  Transformation ratio =5.8

(b)
 star delta connection:

  Primary line current=9.1 A
  Primary line voltage=7621 V
  Transformation ratio =17.32
-->
```

Figure 7.8: Calculation of primary line current and voltage and line to line transformation ratio

Scilab code Exa 7.8 Calculation of primary line current and voltage and line to li

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex7_8.sce.

clc;
clear;
Np=1000;                                    //number of Primary turns
Ns=100;                                     //number of secondary turns
KVA=120e3;                                  //KVA rating of the transformer
V_SL=440;                                   //supply voltage in V

K=Np/Ns;                                    //transformer turns ratio
I_SL=KVA/(sqrt(3)*V_SL);

printf("\n (a)")
V_PL=(V_SL*K)/sqrt(3);
I_PL=(sqrt(3)*I_SL)/K;
transformation_ratio=V_PL/V_SL;
printf("\n Delta star connection:\n")
printf("\n  Primary line current=%2.1f A ",I_PL)
printf("\n  Primary line voltage=%d V ",V_PL)
printf("\n  Transformation ratio =%2.1f \n",transformation_ratio)

```

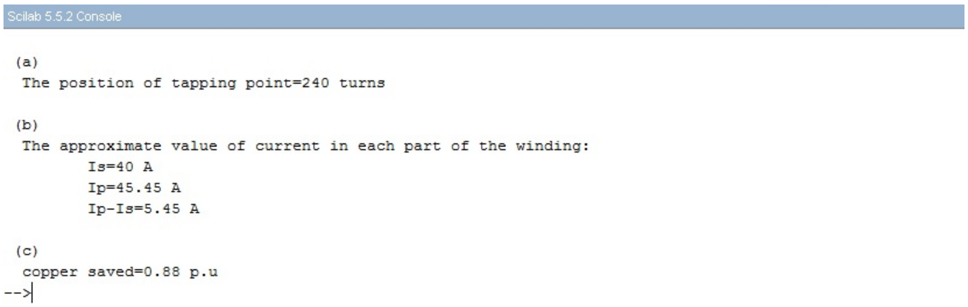


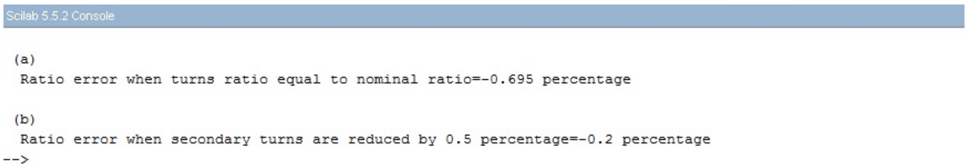
Figure 7.9: Determination of position of tapping point and current in each part of winding and copper saved

```
printf("\n(b)")
V_PL=V_SL*K*sqrt(3);
I_PL=I_SL/(sqrt(3)*K);
transformation_ratio=V_PL/V_SL;
printf("\n star delta connection:\n")
printf("\n  Primary line current=%1.1f A ",I_PL)
printf("\n  Primary line voltage=%d V ",V_PL)
printf("\n  Transformation ratio =%2.2f ",
    transformation_ratio)
```

Scilab code Exa 7.9 Determination of position of tapping point and current in each

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

```

```
//Ex7_9.sce.

clc;
clear;
Vp=220;                                         //primary voltage in V
Vs=250;                                         //secondary voltage in V
Ns=2000;                                        //number of secondary turns

printf("\n (a)")
Np=(Vp/Vs)*Ns;                                  //number of Primary turns
tapping_point=Ns-Np;                            //number of turns from C to A in figure
printf("\n  The position of tapping point=%d turns \n",tapping_point)

printf("\n (b)")
Po=10e3;                                        //output power in KVA
Is=Po/Vs;                                       //secodary current in A
Ip=(Vs/Vp)*Is;                                  //primary current in A
approximate_current=Ip-Is;
printf("\n  The approximate value of current in each part of the winding:\n")
printf("\t Is=%d A\n",Is)
printf("\t Ip=%2.2f A\n",Ip)
printf("\t Ip-Is=%1.2f A\n",approximate_current)

printf("\n (c)")
copper_saved=Vp/Vs;
printf("\n  copper saved=%1.2f p.u",copper_saved)
```


Scilab 5.5.2 Console

(a)
Ratio error when turns ratio equal to nominal ratio=-0.695 percentage

(b)
Ratio error when secondary turns are reduced by 0.5 percentage=-0.2 percentage
-->

Figure 7.10: Determination of ratio error

Scilab code Exa 7.10 `Determination of ratio error`

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex7_10.sce.

clc;
clear;
Ip=1000;                                    //primary current in A
Is=5;                                       //secodary current in A
Tp=1;                                        //number of Primary turns

printf("\n (a)")
```

```
nominal_ratio=Ip/Is;
Ie=7;                              //loss component of current in A
actual_ratio=nominal_ratio+(Ie/Is);
epsilon_r=((nominal_ratio-actual_ratio)/actual_ratio)*100;
printf("\n  Ratio error when turns ratio equal to nominal ratio=%1.3f percentage \n",epsilon_r)

printf("\n (b)")
reducing_value=0.5/100;
Ts=nominal_ratio-(reducing_value*nominal_ratio);
n=Ts/Tp;                                        //transformer turns ratio
actual_ratio=n+(Ie/Is);
epsilon_r=((nominal_ratio-actual_ratio)/actual_ratio)*100;
printf("\n  Ratio error when secondary turns are reduced by 0.5 percentage=%1.1f percentage",epsilon_r)
```

Chapter 8

Direct Current Machines

Scilab code Exa 8.1 Calculation of design parameters for a dc machine

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex8_1.sce

clc;
clear;
p=4;
s=24;
com_seg=24;
//winding detail calculation
pole_pitch=s/p;
c=com_seg;
printf("\n Number of coils=%d \n",c)
Cs=2*c;
printf("\n Number of coil sides=%d \n",Cs)
Yb1=Cs/p+1;
```

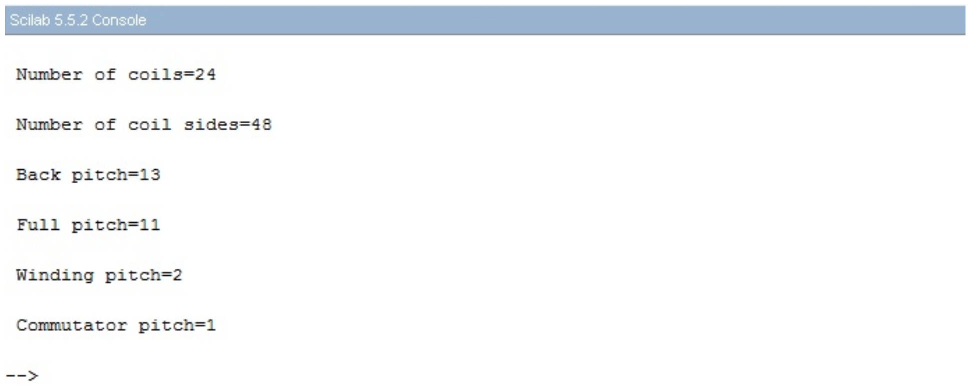


Figure 8.1: Calculation of design parameters for a dc machine

```
Yb2=Cs/p-1;
Yb=Yb1;    //choosing full pitch coil
printf("\n Back pitch=%d \n",Yb)
Yf1=Yb-2; //For progressive winding
Yf2=Yb+2; //For retrogressive winding
Yf=Yf1;
printf("\n Full pitch=%d \n",Yf)
//for progressive winding
Y=2;
Yc=1;
printf("\n Winding pitch=%d \n",Y)
printf("\n Commutator pitch=%d \n",Yc)
```

Scilab code Exa 8.2 Calculation of design parameters for a dc machine

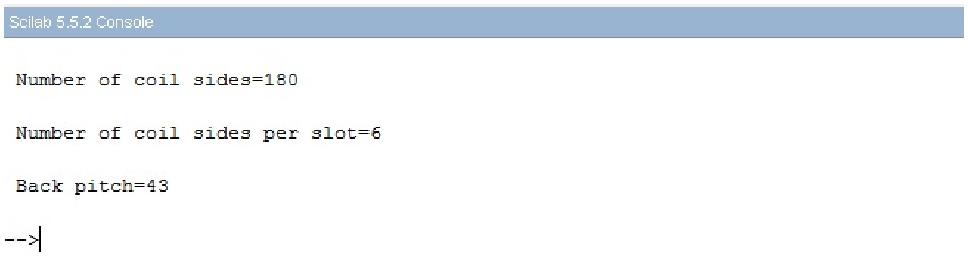


Figure 8.2: Calculation of design parameters for a dc machine

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex8_2.sce

clc;
clear;
p=4;
s=30;
c=90;
Cs=2*c;
printf("\n Number of coil sides=%d \n",Cs)
Cs_per_slot=Cs/s;
printf("\n Number of coil sides per slot=%d \n",
    Cs_per_slot)
Yb1=Cs/p+2;          //Winding is not split
Yb2=Cs/p-2;          //Winding is split
```

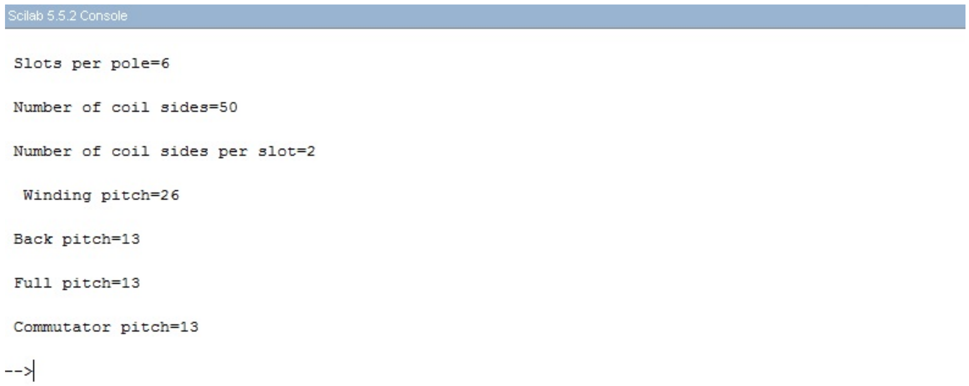


Figure 8.3: Calculation of design parameters for a dc machine

```
Yb=Yb2;
printf("\n Back pitch=%d \n",Yb)
Cs1=1+Yb;
Cs3=3+Yb;
Cs5=5+Yb;
//Top coil sides 1,3,5 are in in slot,while all the
    corresponding bottom coil sides 44,46,48 are in
    slot 8.
```

Scilab code Exa 8.3 `Calculation of design parameters for a dc machine`

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex8_3.sce

```

```
clc;
clear;
s=25;
c=25;
com_seg=25;
p=4;
Sp=s/p; //slot per pole
printf("\n Slots per pole=%d \n",Sp)
Cs=2*c;
printf("\n Number of coil sides=%d \n",Cs)
Cs_per_slot=Cs/s;
printf("\n Number of coil sides per slot=%d \n",
   Cs_per_slot)
Y1=((2*c)+2)/(p/2);
Y2=((2*c)-2)/(p/2);
Y=Y1; //For progressive winding
printf("\n  Winding pitch=%d \n",Y)
Yb=Y/2;
printf("\n Back pitch=%d \n",Yb)
Yf=Yb;
printf("\n Full pitch=%d \n",Yf)
Yc=(c+1)/(p/2);
printf("\n Commutator pitch=%d \n",Yc)
```

Scilab code Exa 8.4 Calculation of design parameters for a dc machine

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex8_4.sce

```

Figure 8.4: Calculation of design parameters for a dc machine

```
clc;
clear;
p=4;
s=21;
Cs_per_slot=4;
Cs=Cs_per_slot*s;
printf("\n Number of coil sides=%d \n",Cs)
C=Cs/2;
printf("\n Number of coils=%d \n",C)
Yc1=(C+1)/(p/2);
Yc2=(C-1)/(p/2);
C=41; //Simplex wave winding is not possible with 42
    coils.Therefore active coils are 42
Yc=(C+1)/(p/2);
printf("\n Commutator pitch=%d \n",Yc)
Y=((2*C)+2)/(p/2);
printf("\n Winding pitch=%d \n",Y)
Yb=Y/2;
printf("\n Back pitch=%d \n",Yb)
Yf=Yb;
printf("\n Full pitch=%d \n",Yf)
//This value of Yb also satisfies the condition to
```

Figure 8.5: Calculation of generated emf

```
avoid split winding
```

Scilab code Exa 8.5 `Calculation of generated emf`

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex8_5.sce.

clc;
clear;
s=50;
c=8;
N=900;
```

Figure 8.6: Calculation of number of conductors per slot

```
phi=25e-3;
Z=s*c;
a=2;
p=2;
n=N/60;
E=(2*Z*phi*p*n)/a;
printf("\n  Emf generated=%d volt",E)
```

Scilab code Exa 8.6 Calculation of number of conductors per slot

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex8_6.sce.

clc;
clear;
N=360;
phi=45e-3;
s=120;
```

Figure 8.7: Calculation of number of demagnetizing and cross ampere turns per pole

```
E=260;
p=4;
n=N/60;
a=8;
Z=(E*a)/(2*phi*p*n);
coductors_per_slot=Z/s;
total_no_of_conductors=coductors_per_slot*s;
printf("\n Number of conductors per slot=%d \n",
   coductors_per_slot)

phi=(E*a)/(2*960*n*p)
printf("\n Flux=%1.5f Wb/pole",phi)
```

Scilab code Exa 8.7 Calculation of number of demagnetizing and cross ampere turns

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
```

```
//Edition:Third ,2014

//Ex8_7.sce.

clc;
clear;
P=300e3;
V=500;
a=8;
p=4;
Z=786;
theta=5;

I=P/V;
armature_AT=(1/2)*(I/a)*(Z/(2*p));                    //
   Total AT per pole
demagnetizing_AT=armature_AT*(4*theta/360);          //
   demagnetizing AT per pole
distorting_AT=armature_AT-demagnetizing_AT;
             //distorting AT per pole
printf("\n    Demagnetizing AT per pole=%d AT/pole \n
   ",demagnetizing_AT)
printf("\n    Cross AT per pole=%4.0f AT/pole \n",
   distorting_AT)

//There is a error in the substitution of number of
   conductors (Z) in the book
//In the question Z=786 but problem is solved by
   substituting Z=768
//But I make the codes with the given data that is Z
   =786
//So the book answer vary
```

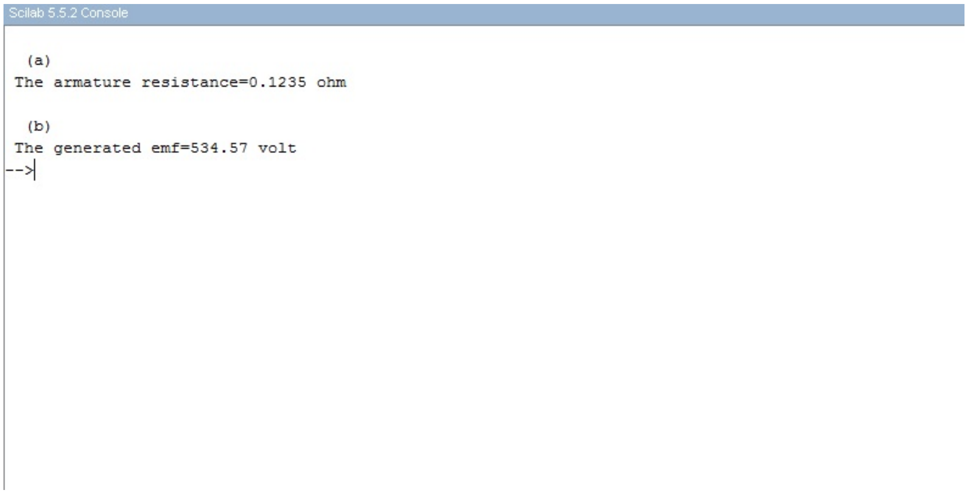


Figure 8.8: Calculation of armature resistance and generated emf

Scilab code Exa 8.8 `Calculation of armature resistance and generated emf`

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex8_8.sce.

clc;
clear;
R=200;
P=100e3;
V=500;
E=525;

printf("\n  (a)")
Il=P/V;
If=V/R;
Ia=Il+If;
Ra=(E-V)/Ia;
printf("\n The armature resistance=%1.4f ohm \n",Ra)
```

Figure 8.9: Calculation of armature generated voltage

```

printf("\n  (b)")
P=60e3;
V=520;
Il=P/V;
If=V/R;
Ia=Il+If;
E=V+(Ia*Ra);
printf("\n The generated emf=%3.2f volt",E)
```

Scilab code Exa 8.9 Calculation of armature generated voltage

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

```

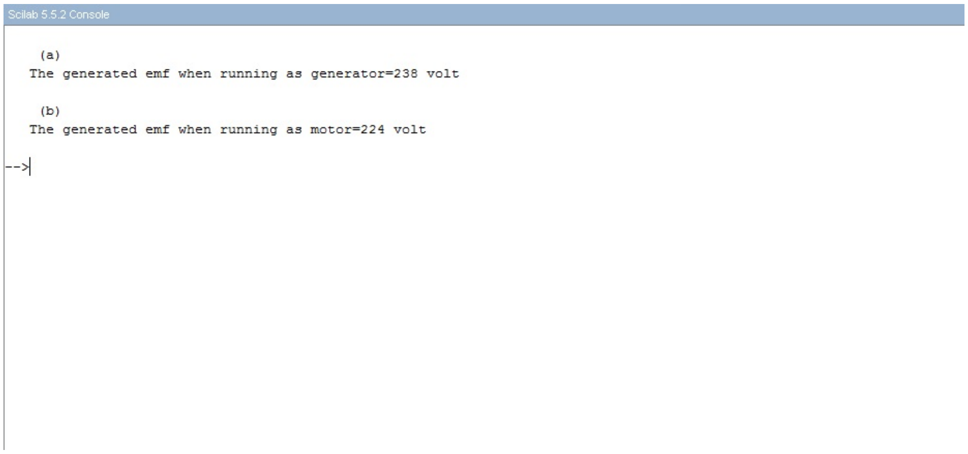


Figure 8.10: Calculation of generated emf

```
//Ex8_9.sce.

clc;
clear;
Ra=0.8;
Rsh=45;
Rse=0.6;
P=5e3;
V=250;
Il=P/V;
If=(V+(Rse*Il))/Rsh;
Ia=Il+If;
E=V+(Il*Rse)+(Ia*Ra);
printf("\n    Armature generated voltage=%3.2f volt \n",E)
```

Scilab code Exa 8.10 `Calculation of generated emf`

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex8_10.sce.

clc;
clear;
Ra=0.1;

printf("\n    (a)")
Ia=80;
V=230;
E=V+(Ia*Ra);
printf("\n   The generated emf when running as
    generator=%3.0f volt \n",E)

printf("\n    (b)")
Ia=60;
V=230;
E=V-(Ia*Ra);
printf("\n   The generated emf when running as motor
    =%3.0f volt \n",E)
```

Scilab code Exa 8.11 `Calculation of motor speed`

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex8_11.sce.
```

Figure 8.11: Calculation of motor speed

```

clc;
clear;
V1=440;
V2=220;
Ia=50;
Ra=0.3;
a=2;
p=2;
Z=850;
phi_1=0.025;
phi_2=0.02;

E=V1-(Ia*Ra);
n1=(E*a)/(2*Z*p*phi_1);
N1=n1*60;
n1_by_n2=(V1*phi_2)/(V2*phi_1);
n2=n1/(n1_by_n2);
N2=n2*60;
printf("\n    Motor Speed: \t N1=%d r.p.m \t N2=%d r.
```

Figure 8.12: Calculation of motor speed and gross torque developed

```
p.m \n",N1,N2)
```

Scilab code Exa 8.12 Calculation of motor speed and gross torque developed

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex8_12.sce.

clc;
clear;
V=480;
Ia=110;
Ra=0.2;
Z=864;
phi=0.05;
```

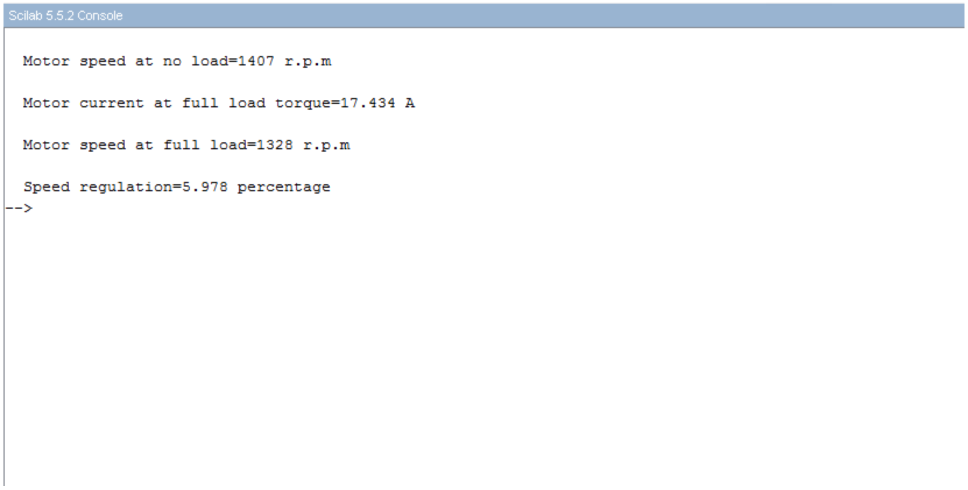


Figure 8.13: Calculation of motor speed and current and speed regulation

```
a=6;
p=3;

printf("\n (a)")
E=V-(Ia*Ra);
n=(E*a)/(2*Z*p*phi);
N=(n*60);
printf("\n  Speed=%d r.p.m \n",N)

printf("\n (b)")
Pm=E*Ia;
T=Pm/(2*%pi*n);
printf("\n  Gross torque developed in the armature=
   %d Nm \n",T)
```

Scilab code Exa 8.13 Calculation of motor speed and current and speed regulation

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex8_13.sce.

clc;
clear;
Il=2;
Z=864;
If=0.6;
V=220;
Ra=0.8;
a=2;
p=2;
phi=5.4e-3;
T=25;

Ia=Il-If;
E1=V-(Ia*Ra);
n1=(E1*a)/(2*Z*phi*p);
N1=n1*60;
printf("\n  Motor speed at no load=%4.0f r.p.m \n",
   N1)

Ia=(T*a*%pi)/(p*phi*Z);
Il=Ia+If;
printf("\n  Motor current at full load torque=%2.3f
   A \n",Il)
E2=V-(Ia*Ra);
n2=(E2*a)/(2*Z*phi*p);
N2=n2*60;
printf("\n  Motor speed at full load=%4.0f r.p.m \n"
   ,N2)

speed_reg=((N1-N2)/N2)*100;
printf("\n  Speed regulation=%1.3f percentage",
```

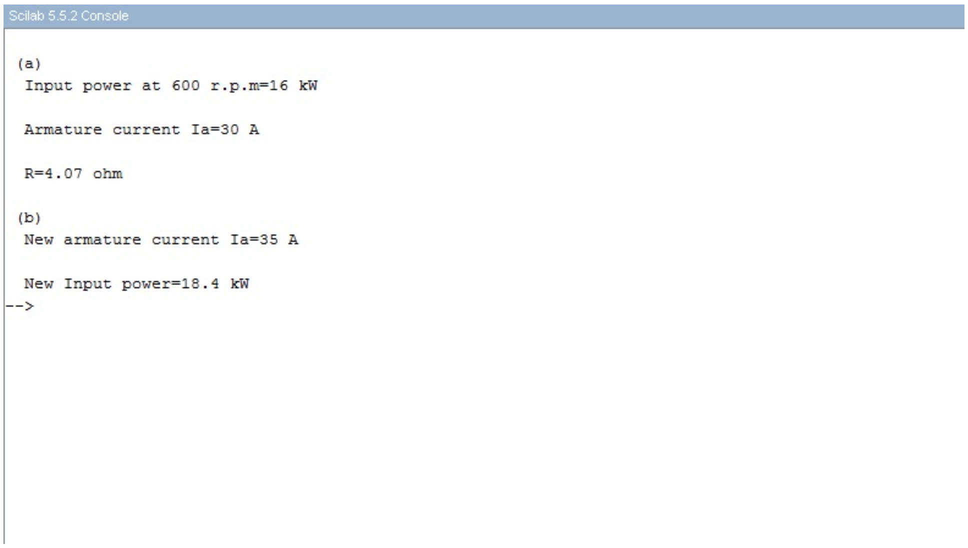


Figure 8.14: Calculation of current and kW input of the motor

```
   speed_reg)
//There is a error in the regulation calculation in
   the book
//The book answer 9.95% is wrong
```

Scilab code Exa 8.14 `Calculation of current and kW input of the motor`

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex8_14.sce.

clc;
clear;
```

```
N=600;
V=500;
Il=32;
Ra=0.4;
Rf=250;

printf("\n (a)")
P=(V*Il)/1e3;
N1=450;
Ia=Il-(V/Rf);
k_phi=(V-(Ia*Ra))/N;
R=(V-(k_phi*N1))/Ia-Ra;
printf("\n  Input power at 600 r.p.m=%d kW \n",P)
printf("\n  Armature current Ia=%d A \n",Ia)
printf("\n  R=%1.2f ohm \n",R)

printf("\n (b)")
//To increase the speed the field control is used.
If1_by_If=0.856;
If=Il-Ia;
If1=If1_by_If*If;
Rf1=V/If1;
R=Rf1-Rf;
Ia1=Ia/If1_by_If;
Il=Ia1+If1;
Pi=(V*Il)/1e3;
printf("\n  New armature current Ia=%d A \n",Ia1)
printf("\n  New Input power=%2.1f kW",Pi)
```

Scilab code Exa 8.15 Calculation of external resistance and electric braking torqu

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
```

Figure 8.15: Calculation of external resistance and electric braking torque

```
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex8_15.sce.

clc;
clear;
P_in_HP=37.5;
V=220;
N=535;
Ra=0.086;
Ia1=140;
I=200;

E=V-(Ia1*Ra);
R=(V+E)/I;
R_ext=R-Ra;
P=(P_in_HP)*736;
omega=(2*%pi*N)/60;
FL_T=P/omega;
initial_braking_T=FL_T*(I/Ia1);
Ia2=(V+(E/2))/R;
halfspeed_braking_T=FL_T*(Ia2/Ia1);
```

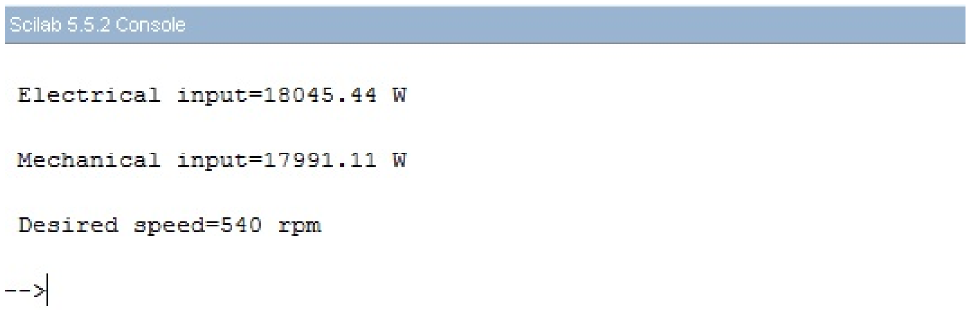


Figure 8.16: Calculation of speed at full load torque

```
printf("\n  Armature circuit resistance=%1.2f ohm \n
   ",R)
printf("\n  The external resistance=%1.3f ohm \n",
   R_ext)
printf("\n  Initial braking torque=%3.1f Nm \n",
   initial_braking_T)
printf("\n  Braking torque at half speed=%3.1f Nm \n
   ",halfspeed_braking_T)
//Answer vary due to roundoff error
```

Scilab code Exa 8.16 `Calculation of speed at full load torque`

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex8_16.sce.

clc;
clear;
P_in_HP=20;
P=(P_in_HP)*736;
N=450;
Ra=0.18;
Rf=0.12;
R=8.7+Ra+Rf;
omega=(2*%pi*N)/60;
Tf=P/omega;

//The voltage developed for 450 rpm is 289 volt
    which is taken from the curve
E=289;
P_not=(E*E)/R;
Pi=(2*%pi*N*Tf)/60;

//The mechanical input is greater than electrical
    output , so the motor speed increases
//The voltage developed for 550 rpm is 403 volt
    which is taken from the curve
N=550;
E=403;
P_not=(E*E)/R;
Pi=(2*%pi*N*Tf)/60;

printf("\n Electrical input=%5.2f W \n",P_not)
printf("\n Mechanical input=%5.2f W \n",Pi)
if Pi<P_not then
    N1=540;
else
```

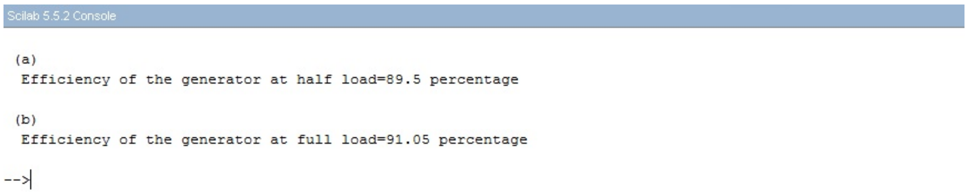


Figure 8.17: Calculation of efficiency of generator at full load and half load

```
    N1>N
end
printf("\n Desired speed=%d rpm \n",N1)
//Answer vary dueto roundoff error
//since mechanical input is less than electrical
   output the motor cannot attain a speed as 550 rpm
//So the speed is 540 rpm which is obtained using
   trial and error method
```

Scilab code Exa 8.17 `Calculation of efficiency of generator at full load and half`

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex8_17.sce.

clc;
```

```
clear;
P=100e3;
V=460;
It=9.8;
If=2.7;
R=0.11;

printf("\n (a)")
I=(P/2)/V;
Ia=I+If;
Wa=Ia^2*R;
Wsh=V*If;
Ian=It-If;
W_not=V*Ian;
NL_armature_loss=Ian^2*R;
other_loss=W_not-NL_armature_loss;            //other losses include iron,friction,windage losses
T_loss_HL=Wa+Wsh+other_loss;
Pi_HL=(P/2)+T_loss_HL;
efficiency=((P/2)/Pi_HL)*100;
printf("\n  Efficiency of the generator at half load =%2.1f percentage \n",efficiency)

printf("\n (b)")
I=P/V;
Ia=I+If;
Wa=Ia^2*R;
Wsh=V*If;
Ian=It-If;
W_not=V*Ian;
NL_armature_loss=Ian^2*R;
other_loss=W_not-NL_armature_loss;            //other losses include iron,friction,windage losses
T_loss_FL=Wa+Wsh+other_loss;
Pi_FL=P+T_loss_FL;
efficiency=(P/Pi_FL)*100;
printf("\n  Efficiency of the generator at full load =%2.2f percentage \n",efficiency)
```

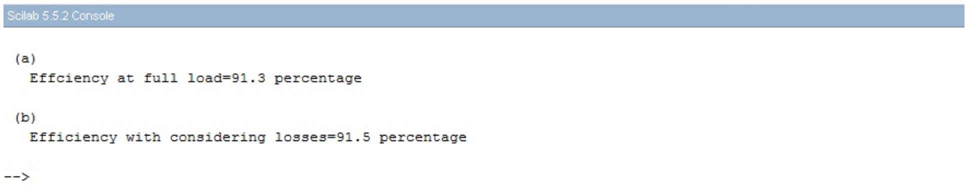


Figure 8.18: Calculation of efficiency of the generator

Scilab code Exa 8.18 `Calculation of efficiency of the generator`

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex8_18.sce.

clc;
clear;
P=1000e3;
V=500;
I1=2000;
I2=400;
Ig=21;                  //shunt field current of generator
Im=17;                    //shunt field current of motor
```

```
R=0.01;
I=P/V;

printf("\n (a)")
efficiency=sqrt(I1/(I1+I2))*100;
printf("\n   Effciency at full load=%2.1f percentage
    \n",efficiency)

printf("\n (b)")
Ia_G=I1+Ig;
copper_loss_G=Ia_G^2*R;
loss_G=V*Ig;

Ia_M=I1+I2-Im;
copper_loss_M=Ia_M^2*R;
loss_M=V*Im;

total_loss=V*I2;
other_loss=total_loss-(copper_loss_G+loss_G+
   copper_loss_M+loss_M);                    //other
   losses include iron,friction,windage losses
other_loss_each=other_loss/2;
total_loss_G=copper_loss_G+loss_G+other_loss_each;
Pi_G=P+total_loss_G;
efficiency=(P/Pi_G)*100;
printf("\n   Efficiency with considering losses=%2.1
   f percentage \n",efficiency)
//There is a mistake in the (a) part calculation in
   the book.
//The efficiency is 91.3% not 89.1%
```

Scilab code Exa 8.20 Determination of time

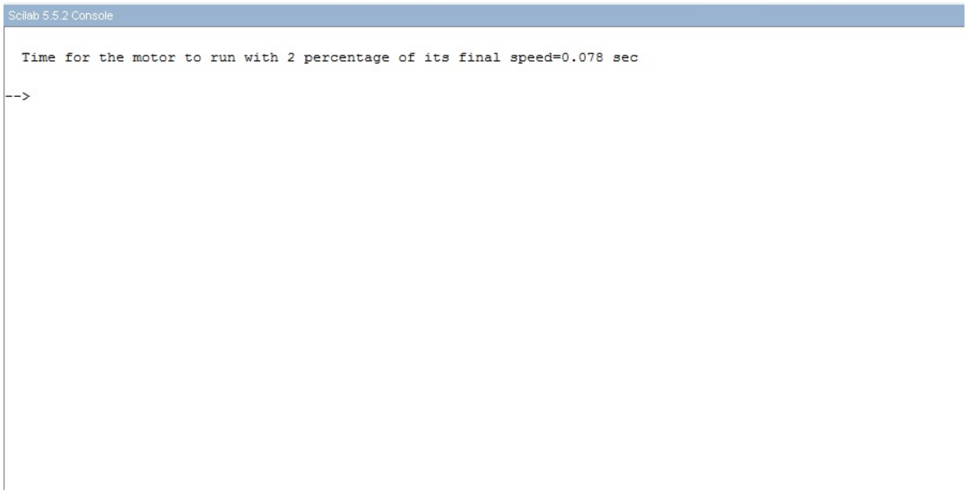


Figure 8.19: Determination of time

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex8_20(c).sce.

clc;
clear;
Ra=35;
J=6e-5;
K=0.325;

T=(J*Ra)/K^2;
t=-T*log(1-0.98);                //(1-0.98)=0.02
printf("\n  Time for the motor to run with 2 percentage of its final speed=%1.3f sec \n",t)
```

Chapter 9

Synchronous Machines

Scilab code Exa 9.1 Calculation of distribution factor

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex9_1.sce.

clc;
clear;
slots=24;
pole=4;

printf("\n   (a)")
//when all slots are wound
m=slots/pole;
alpha=180/m;
Kd=sind(m*alpha/2)/(m*sind(alpha/2));
printf("\n  Distribution factor when all slots are
    wound=%1.3f",Kd)
```

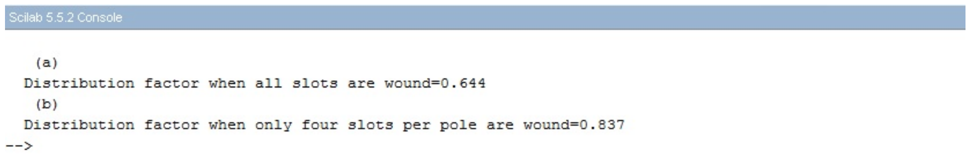


Figure 9.1: Calculation of distribution factor

```

printf("\n    (b)")
//only 4 adjacent slots are wound
m=4;
Kd=sind(m*alpha/2)/(m*sind(alpha/2));
printf("\n  Distribution factor when only four slots
    per pole are wound=%1.3f",Kd)
```

Scilab code Exa 9.2 Calculation of number of poles and flux per pole

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex9_2.sce

```

Figure 9.2: Calculation of number of poles and flux per pole

```
clc;
clear;
V=3.6e3;
phase=3
f=50;
N=500;
m=3;
c=10;

printf("\n (a)")
p=(120*f)/N;
printf("\n    The number of poles=%d",p)

printf("\n (b)")
slots_per_phase=m*p;
conductor_per_phase=(slots_per_phase)*c;
turns_per_phase=conductor_per_phase/2;
emf_per_phase=V/sqrt(3);
solts_per_pole=m*phase;
alpha=180/solts_per_pole;

Kd=sind(m*alpha/2)/(m*sind(alpha/2));
betta=alpha;
```

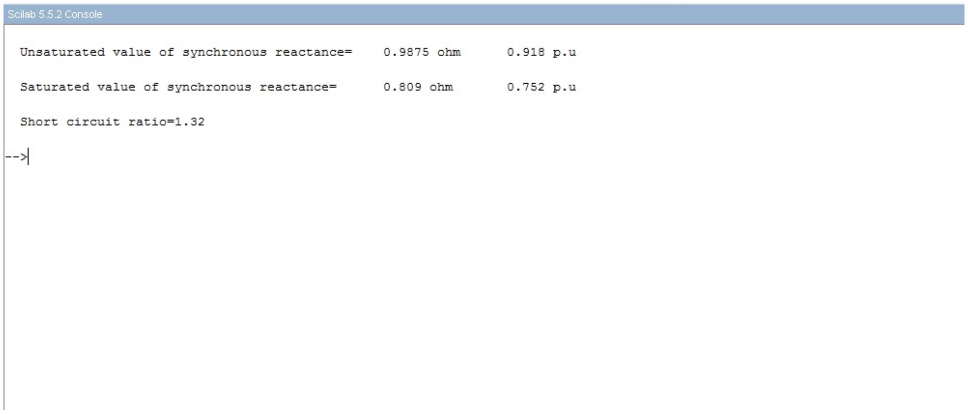


Figure 9.3: Determination of short circuit ratio and synchronous reactance

```
Kp=cosd(betta/2);
phi=emf_per_phase/(4.44*f*Kd*Kp*turns_per_phase);
printf("\n    The useful flux per pole=%1.3f Wb",phi)
```

Scilab code Exa 9.3 Determination of short circuit ratio and synchronous reactance

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex9_3.sce

clc;
clear;
P=45e3;
E=220;
phase=3;
p=6;
```

```
f=50;

I=P/(E*sqrt(3));
//From SCC ,the excitation current is ,
Isc1=118.1;
If=2.2;
//For this If, the corresponding line voltage from the air gap line is,
V1=202;
I1=1.0;
Vph=V1/sqrt(3);
Xs_unsat=Vph/Isc1;            //Unsaturated reactance in ohm
V=V1/E;
Xs_unsat_pu=V/I1;             //Unsaturated reactance in per unit
printf("\n Unsaturated value of synchronous reactance=\t %1.4f ohm \t %1.3f p.u \n",Xs_unsat,Xs_unsat_pu)

//For 220 volt from figure ,
If=2.9;
Isc2=157;
Vph=E/sqrt(3);
Xs_sat=Vph/Isc2;
Xs_sat_pu=I1/(Isc2/Isc1);
printf("\n Saturated value of synchronous reactance=\t %1.3f ohm \t %1.3f p.u \n",Xs_sat,Xs_sat_pu)

Ie2=2.9;
Ie1=2.2;
SCR=Ie2/Ie1;
printf("\n Short circuit ratio=%1.2f \n",SCR)
```

Figure 9.4: Calculation of leakage reactance and field current

Scilab code Exa 9.4 Calculation of leakage reactance and field current

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex9_4.sce.

clc;
clear;
//From figure 9.26
EG=25;
P=45e3;
E=220;
I=P/(E*sqrt(3));
Xl=EG/(sqrt(3)*I);
printf("\n Leakage reactance=%1.4f ohm \n",Xl)

//From fig 9.26 armature reaction amphere is equal
   to the field current
```

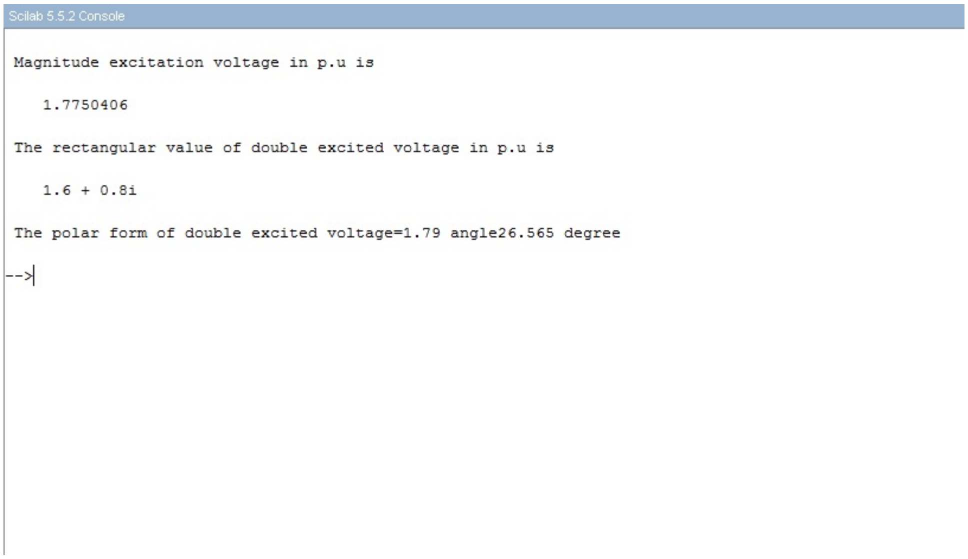


Figure 9.5: Determination of excitation voltage

```
If=1.925;
printf("\n Field amphere current=%1.3f A \n",If)
```

Scilab code Exa 9.5 Determination of excitation voltage

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex9_5.sce

clc;
clear;
V=1+%i*0;
Xd=1.0;
```

```
Xq=0.6;
pf=0.8;
theta=acosd(pf);
Ia1=pf-%i*sind(acosd(pf));
Ia=1.0;                //phase magnitude of Ia

tan_del=(Ia*Xq*cosd(theta))/(V+(Ia*Xq*sind(theta)));
del=atand(real(tan_del));
Ef_dash=((V+(Ia*Xq*sind(theta)))^2+(Ia*Xq*cosd(theta))^2)^(1/2);

Ef=real(Ef_dash)+(Ia*sind(theta+del)*(Xd-Xq));
disp(Ef,'Magnitude excitation voltage in p.u is')

Ef_double_dash=V*(1+%i*0)+%i*((cosd(theta)-%i*sind(theta))*Xd);
disp(Ef_double_dash,'The rectangular value of double excited voltage in p.u is')

Ef_double_dash_mag=sqrt(real(Ef_double_dash)^2+imag(Ef_double_dash)^2);
Ef_double_dash_ang=atand(imag(Ef_double_dash)/real(Ef_double_dash));
printf("\n The polar form of double excited voltage=%1.2f angle%2.3f degree \n",Ef_double_dash_mag,Ef_double_dash_ang)
```

Scilab code Exa 9.6 Calculation of voltage regulation

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014
```

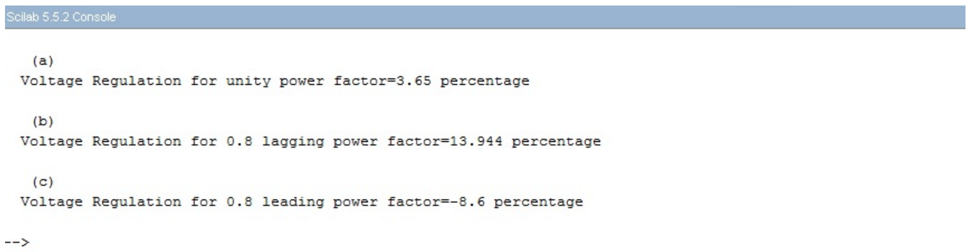


Figure 9.6: Calculation of voltage regulation

```

//Ex9_6.sce.

clc;
clear;
P=500e3;
Vl=3.3e3
Il=P/(sqrt(3)*Vl);
Vph=Vl/sqrt(3);
Iph=Il;
Rph=0.4;
Xsyn=4.2;

printf("\n    (a)")
pf=1;                   //unity
Ef=((Vph+(Iph*Rph))^2+(Iph*Xsyn)^2)^(1/2);
reg=((Ef/Vph)-1)*100;
printf("\n  Voltage Regulation for unity power
    factor=%1.2f percentage \n",reg)

printf("\n    (b)")
```

```
pf=0.8;                    //lagging
theta=acosd(pf);
Ef=((Vph+(Iph*Rph*cosd(theta))+(Iph*Xsyn*sind(theta)
   ))^2+((Iph*Xsyn*cosd(theta))-(Iph*Rph*sind(theta)
   ))^2)^(1/2);
reg=((Ef/Vph)-1)*100;
printf("\n  Voltage Regulation for 0.8 lagging power
    factor=%2.3f percentage \n",reg)

printf("\n   (c)")
pf=0.8;                     //leading
theta=acosd(pf);
Ef=((Vph+(Iph*Rph*cosd(theta))-(Iph*Xsyn*sind(theta)
   ))^2+((Iph*Xsyn*cosd(theta))+(Iph*Rph*sind(theta)
   ))^2)^(1/2);
reg=((Ef/Vph)-1)*100;
printf("\n  Voltage Regulation for 0.8 leading power
    factor=%1.1f percentage \n",reg)
```

Scilab code Exa 9.7 Calculation of voltage regulation

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex9_7.sce.

clc;
clear;
//input data are taken from example 9.5
V=1+%i*0;
Xd=1.0;
```

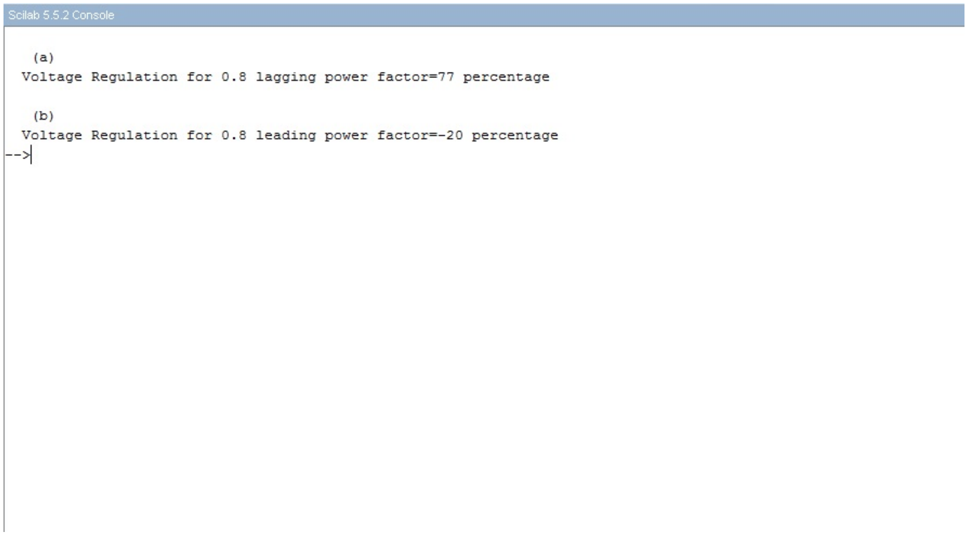


Figure 9.7: Calculation of voltage regulation

```
Xq=0.6;
pf=0.8;
theta=acosd(pf);
Ia1=pf-%i*sind(acosd(pf));
Ia=1.0;                    //phase magnitude of Ia

printf("\n   (a)")
//lagging power factor
tan_del=(Ia*Xq*cosd(theta))/(V+(Ia*Xq*sind(theta)));
del=atand(real(tan_del));
Ef_dash=((V+(Ia*Xq*sind(theta)))^2+(Ia*Xq*cosd(theta))^2)^(1/2);
Ef=real(Ef_dash)+(Ia*sind(theta+del)*(Xd-Xq));
reg=((Ef-V)/1.0)*100;
printf("\n  Voltage Regulation for 0.8 lagging power factor=%d percentage \n",reg)

printf("\n   (b)")
tan_del=(Ia*Xq*cosd(theta))/(V-(Ia*Xq*sind(theta)));
del=atand(real(tan_del));
Ef=((V-(Ia*Xq*sind(theta)))^2+(Ia*Xq*cosd(theta))^2)
```

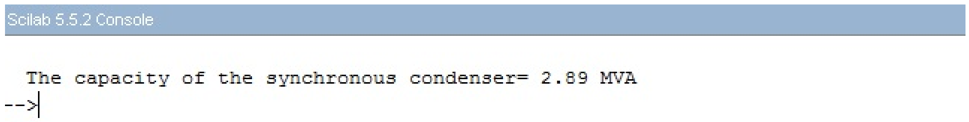


Figure 9.8: Determination of capacity of the condenser

```
    ^(1/2);
reg=((Ef-V)/1.0)*100;
printf("\n  Voltage Regulation for 0.8 leading power
    factor=%2.0f percentage",reg)
```

Scilab code Exa 9.8 `Determination of capacity of the condenser`

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex9_8.sce.

```

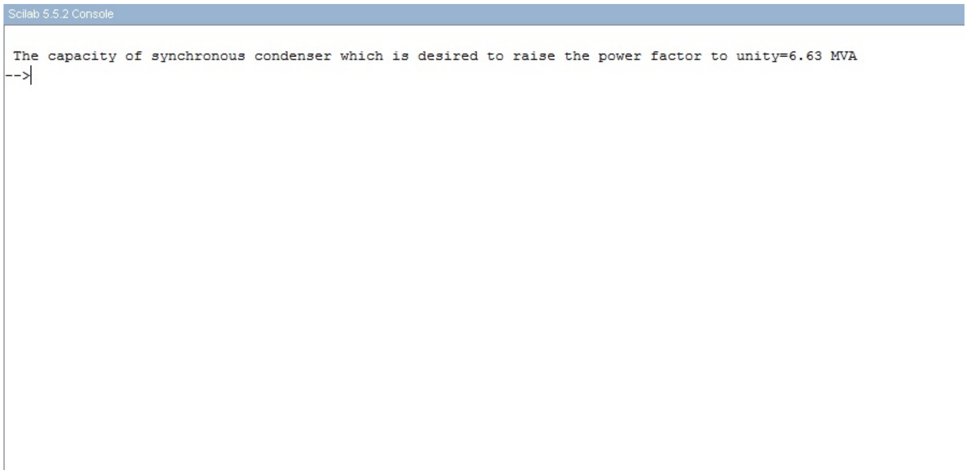


Figure 9.9: Determination of capacity of the synchronous condenser

```
clc;
clear;
VI1=10e6;
phi1=acosd(0.75);
phip=acosd(0.9);
phic=90-asind(7/100);                    //given loss is 7%
      of KVA output
KVAc=VI1*(((sind(phi1)*cosd(phip))-(cosd(phi1)*sind(
    phip)))/((sind(phic)*cosd(phip))+(cosd(phic)*sind
    (phip))))*1e-3;
MVAc=KVAc*1e-3;
printf("\n  The capacity of the synchronous
    condenser= %1.2f MVA",MVAc)
```

Scilab code Exa 9.9 Determination of capacity of the synchronous condenser

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
```

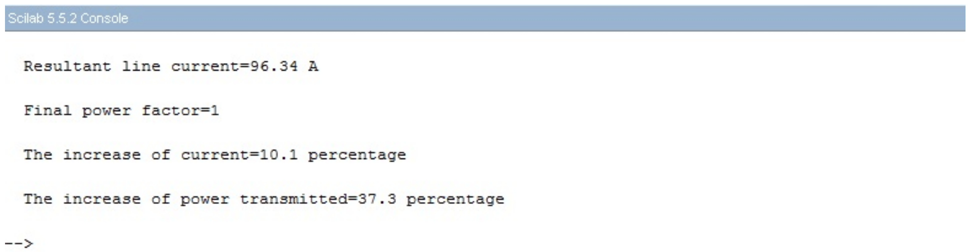


Figure 9.10: Determination of line current and power factor

```
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex9_9.sce.

//input data are taken from example 9.8
clc;
clear;
VI1=10e6;
pf1=0.75;
pfc=cosd(90-asind(7/100));
KVAc=VI1*((sqrt(1-pf1^2))/(sqrt(1-pfc^2)))*1e-3;
MVAc=KVAc*1e-3;
printf("\n The capacity of synchronous condenser
    which is desired to raise the power factor to
    unity=%1.2f MVA",MVAc);
```

Scilab code Exa 9.10 Determination of line current and power factor

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex9_10.sce.

clc;
clear;
Pl=1e6;
Pd=360;    //developing power
Pi=600e3;
Vl=6600;
pf=0.8;
Pin=800e3;
theta=acosd(pf);
Il=Pl/(Vl*sqrt(3));
Ps=(Pd*746)/0.9;           // 1HP=746 watt       and efficiency is assumed 90% (i.e 0.9)
phi_s=acosd(Ps/Pi);
Is=Pi/(Vl*sqrt(3));
lag_reactive_crt_load=Il*sind(theta);
lead_reacitve_crt_motor=lag_reactive_crt_load*sind(phi_s);
lag_reactive_crt_result=lag_reactive_crt_load-lead_reacitve_crt_motor;
resultant_active_crt=(Il*pf)+(lag_reactive_crt_load*cosd(phi_s));

resultant_line_crt=sqrt(resultant_active_crt^2+lag_reactive_crt_result^2);
printf("\n  Resultant line current=%2.2f A \n",
```

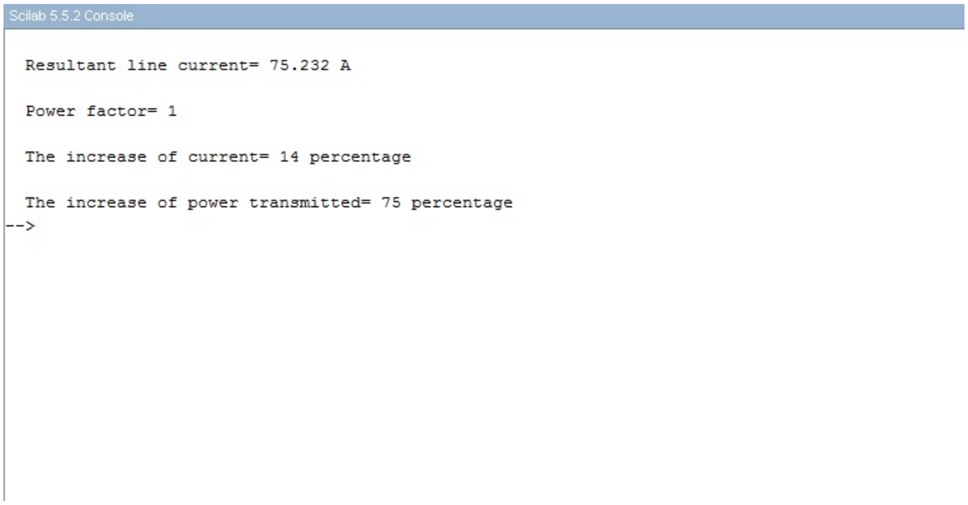


Figure 9.11: Determination of increase in additional loss and decrease in line current and final line current

```
    resultant_line_crt);

final_power_factor=resultant_active_crt/
    resultant_line_crt;
printf("\n  Final power factor=%1.0f \n",
    final_power_factor);

increase_of_crt=(resultant_line_crt-Il)*100/Il;
printf("\n  The increase of current=%2.1f percentage
     \n",increase_of_crt)

increase_power_trans=((Pin+Ps)-Pin)*100/Pin;
printf("\n  The increase of power transmitted=%2.1f
    percentage \n",increase_power_trans)
```

Scilab code Exa 9.11 Determination of increase in additional loss and decrease in

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex9_11.sce

clc;
clear;
//The input data are taken from the previous example 9.10

Pl=1e6;
Pd=360;    //developing power
Pi=600e3;
Vl=6600;
pf=0.1;
pf1=0.8;
Pin=800e3;
theta=acosd(pf);
Il=Pl/(Vl*sqrt(3));
Ps=(Pd*746)/0.9;            // 1HP=746 watt       and efficiency is assumed 90% (i.e 0.9)
phi_s=acosd(Ps/Pi);
Is=Pi/(Vl*sqrt(3));
lag_reactive_crt_motor=52.5;
lead_reacitve_crt_motor=lag_reactive_crt_motor*sind(acosd(pf));
active_crt=lag_reactive_crt_motor*pf;
lag_reactive_crt_result=lag_reactive_crt_motor-lead_reacitve_crt_motor;
resultant_active_crt=(Il*pf1)+(active_crt);

resultant_line_crt=sqrt(resultant_active_crt^2+lag_reactive_crt_result^2);
printf("\n  Resultant line current= %2.3f A \n",resultant_line_crt);

```

```
pf=resultant_active_crt/resultant_line_crt;
printf("\n  Power factor= %1.0f \n",pf)

increase_of_crt=(Il-resultant_active_crt)*100/Il;
printf("\n  The increase of current= %2.0f
   percentage \n",increase_of_crt)

increase_power_trans=(Pi*pf)*100/Pin;
printf("\n  The increase of power transmitted= %2.0f
    percentage",increase_power_trans)
```

Chapter 10

Three Phase Induction Motor

Scilab code Exa 10.1 Calculation of synchronous speed and rotor speed and rotor fr

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex10_1.sce

clc;
clear;
f=50;
p=4;

printf("\n    (a)")
Ns=(120*f)/p;
printf("\n  Synchronous speed=%d r.p.m \n",Ns)

printf("\n    (b)")
s=0.04;
N=Ns-(s*Ns);
```

Figure 10.1: Calculation of synchronous speed and rotor speed and rotor frequency

```
printf("\n  The rotor speed=%d r.p.m \n",N)

printf("\n   (c)")
N=600;
s=(Ns-N)/Ns;
fs=s*f;
printf("\n  The rotor frequency=%d Hz",fs)
```

Scilab code Exa 10.2 Calculation of flux per pole and rotor emf and phase angle

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex10_2.sce
```

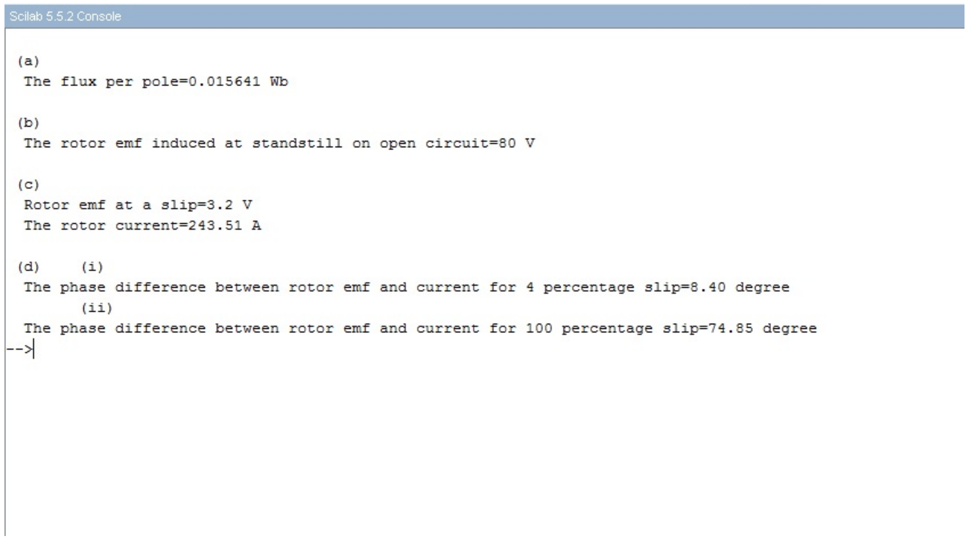


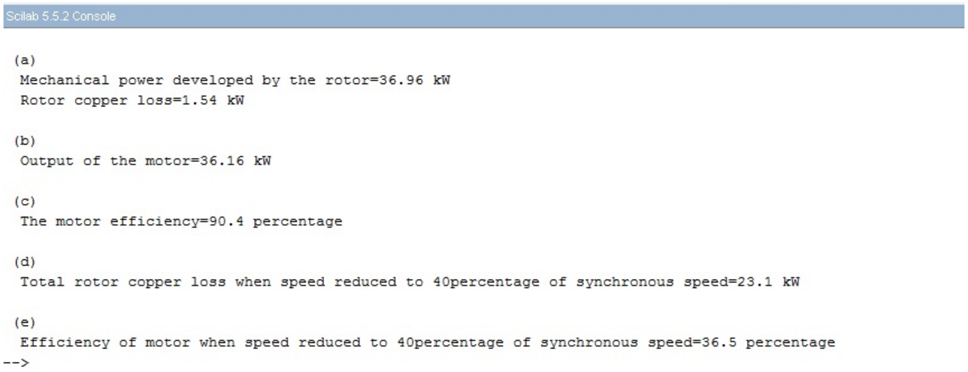
Figure 10.2: Calculation of flux per pole and rotor emf and phase angle

```

clc;
clear;
T1=120;
T2=24;
R2=0.013;
X2=0.048;
V=400;
kd=0.96;
kp=1.0;
f=50;

printf("\n (a)")
phi=V/(4.44*kd*kp*f*T1);
printf("\n  The flux per pole=%1.6f Wb \n",phi)

printf("\n (b)")
E2=4.44*kd*kp*phi*f*T2;
printf("\n  The rotor emf induced at standstill on
   open circuit=%d V \n",E2)
```

```
printf("\n (c)")
s=0.04;
Er=s*E2;
printf("\n  Rotor emf at a slip=%1.1f V",Er)
Ir=Er/sqrt(R2^2+(s*X2)^2);
printf("\n  The rotor current=%3.2f A \n",Ir)

printf("\n (d)\t(i)")
s=0.04;
phir=atand(s*(X2/R2));
printf("\n  The phase difference between rotor emf and current for 4 percentage slip=%2.2f degree",phir)
printf("\n\t(ii)")
s=1;
phir=atand(s*(X2/R2));
printf("\n  The phase difference between rotor emf and current for 100 percentage slip=%2.2f degree",phir)
```

Scilab code Exa 10.3 Calculation of output power and mechanical power developed an

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex10_3.sce

clc;
clear;
Pin=40;  // power in kW
```


Scilab 5.5.2 Console

(a)
Mechanical power developed by the rotor=36.96 kW
Rotor copper loss=1.54 kW

(b)
Output of the motor=36.16 kW

(c)
The motor efficiency=90.4 percentage

(d)
Total rotor copper loss when speed reduced to 40percentage of synchronous speed=23.1 kW

(e)
Efficiency of motor when speed reduced to 40percentage of synchronous speed=36.5 percentage
-->

Figure 10.3: Calculation of output power and mechanical power developed and rotor copper loss and efficiency

```
Ps=1.5;    // power in kW
Ns=100;                //speed percentage value
N=40;                  //speed percentage value
power_loss=0.8;          // power in kW

printf("\n (a)")
rotor_input_power=Pin-Ps;
s=0.04;
rotor_copper_loss=s*rotor_input_power;
mec_power_developed=rotor_input_power-
   rotor_copper_loss;
printf("\n  Mechanical power developed by the rotor=
   %2.2f kW",mec_power_developed)
printf("\n  Rotor copper loss=%2.2f kW \n",
   rotor_copper_loss)

printf("\n (b)")
motor_output_power=mec_power_developed-power_loss;
printf("\n  Output of the motor=%2.2f kW \n",
   motor_output_power)
```

```
printf("\n (c)")
motor_efficiency=(motor_output_power/Pin)*100;
printf("\n  The motor efficiency=%2.1f percentage \n
   ",motor_efficiency)

printf("\n (d)")
new_slip=(Ns-N)/Ns;
total_rotor_copper_loss=new_slip*rotor_input_power;
printf("\n  Total rotor copper loss when speed
   reduced to 40percentage of synchronous speed=%2.1
   f kW \n",total_rotor_copper_loss)

printf("\n (e)")
total_rotor_loss=total_rotor_copper_loss+power_loss;
motor_output_power=rotor_input_power-
   total_rotor_loss;
motor_efficiency=(motor_output_power/Pin)*100;
printf("\n  Efficiency of motor when speed reduced
   to 40percentage of synchronous speed=%2.1f
   percentage",motor_efficiency)
```

Scilab code Exa 10.4 Determination of synchronous speed and slip and maximum torqu

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex10_4.sce

clc;
clear;
```

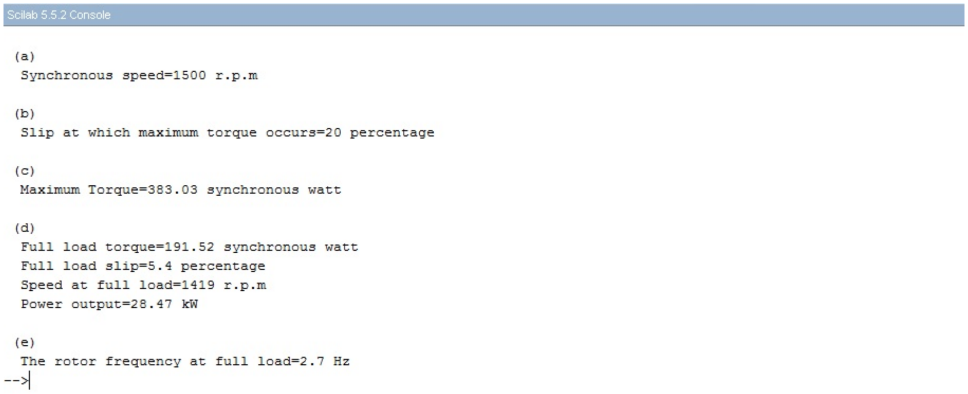


Figure 10.4: Determination of synchronous speed and slip and maximum torque and rotor frequency

```

f=50;
p=4;
V=400;
E2=190;
R1=0.5;
X1=2.5;
R2=0.06;
X2=0.3;

printf("\n (a)")
Ns=(120*f)/p;
printf("\n  Synchronous speed=%d r.p.m \n",Ns)

printf("\n (b)")
s=(R2/X2)*100;
printf("\n  Slip at which maximum torque occurs=%d
    percentage \n",s)

printf("\n (c)")
E=E2/sqrt(3);
```

```
Ir=(s*E)/(sqrt(2)*R2*100);
pf=1/sqrt(2);
Pi=sqrt(3)*E2*Ir*pf;
P0=(1-s/100)*Pi;
Tm=Pi/(2*%pi*Ns/60);
printf("\n  Maximum Torque=%3.2f synchronous watt \n",Tm)

printf("\n (d)")
Tfl=(1/2)*Tm;
//(2/1)=(R2^2+sf^2*X2^2)/(2*X2*R2*sf)
//From this equation we get sf^2-0.8*sf+0.04=0;
a=1;
b=-0.8;//a,b,c are coefficient values taken from the above second order equation
c=0.04;
sf=(-b-sqrt(b^2-(4*a*c)))/(2*a);
sf_percentage=sf*100;
Nf=Ns*(1-sf);
Pf=2*%pi*(Nf/60)*Tfl;
printf("\n  Full load torque=%3.2f synchronous watt",Tfl)
printf("\n  Full load slip=%1.1f percentage",sf_percentage)
printf("\n  Speed at full load=%d r.p.m",Nf)
printf("\n  Power output=%2.2f kW \n",Pf/1000)
//Answer vary dueto round off error

printf("\n (e)")
f_at_fullload=sf*f;
printf("\n  The rotor frequency at full load=%1.1f Hz",f_at_fullload)
```

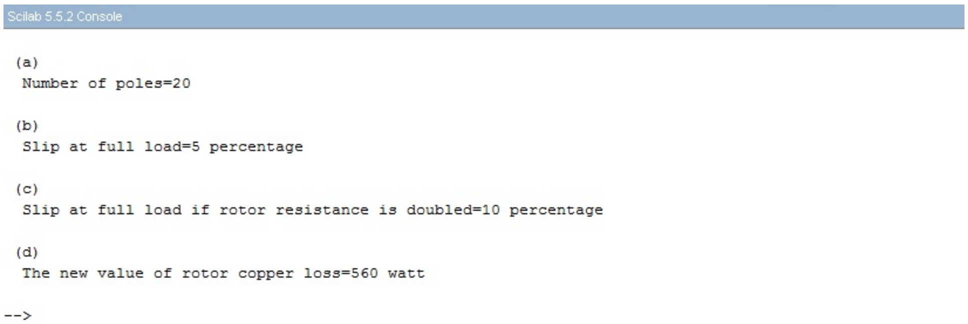


Figure 10.5: Calculation of number of poles and slip and rotor copper loss

Scilab code Exa 10.5 `Calculation of number of poles and slip and rotor copper loss`

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex10_5.sce

clc;
clear;
f=50;
N=285;
Ns=300;   //which is near the value of N as slip lies
    b/w 0.03 to 0.05

printf("\n (a)")
p=(120*f)/Ns;
printf("\n  Number of poles=%d \n",p)

printf("\n (b)")
```

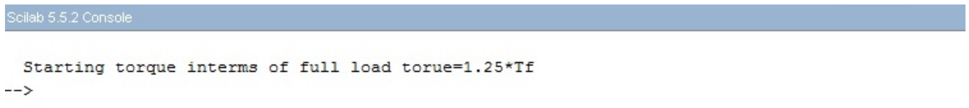


Figure 10.6: Determination of starting torque

```
s=(Ns-N)/Ns;
s_percentage=s*100;
printf("\n Slip at full load=%d percentage \n",
    s_percentage)

printf("\n (c)")
//slip is proportional to rotor resistance
s=2*s_percentage;
printf("\n Slip at full load if rotor resistance is
     doubled=%d percentage \n",s)

printf("\n (d)")
//copper loss=I^2*R; so copper loss doubles if rotor
     resistance doubles
Pcu=280;
Pcu_new=2*Pcu;
printf("\n The new value of rotor copper loss=%d
    watt \n",Pcu_new)
```

Scilab code Exa 10.6 `Determination of starting torque`

Figure 10.7: Calculation motor parameters and slip and pullout torque

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex10_6.sce

clc;
clear;
s=0.05;     //Full load slip of 5 percentage
Iss_by_Isf=5;    //Taken from question statement
Ts_by_Tf=s*(Iss_by_Isf)^2;
printf("\n  Starting torque interms of full load
    torque=%1.2f*Tf",Ts_by_Tf)
```

Scilab code Exa 10.7 Calculation motor parameters and slip and pullout torque

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex10_7.sce

clc;
clear;
Vl_not=400;  //No load voltage in volt
Vl_sc=50;    //Blocked rotor voltage in volt
I_not=20;      //No load current in Ampere
Isc=60;       //Blocked rotor currnet in Ampere
W1_not=5e3;        //watt meter readings for no load test in watt
W2_not=-3.2e3;     //watt meter readings for no load test in watt
Wsc1=2.3e3;        //watt meter readings for blocked rotor test in watt
Wsc2=0.75e3;       //watt meter readings for blocked rotor test in watt
Vdc=18; //dc voltage in volt
Idc=60;  //dc line current in Ampere

printf("\n (a)")
R1=(Vdc/Idc)/2;
printf("\n  R1=%1.2f ohm",R1)
P_not=W1_not+W2_not;
V_not=Vl_not/sqrt(3);
cos_phi_not=P_not/(3*V_not*I_not);
R_not=V_not/(I_not*cos_phi_not);
printf("\n  R0=%2.3f ohm",R_not)
//R_not answer vary dueto round off error in v_not and cos_phi_not
X_not=V_not/(I_not*sqrt(1-cos_phi_not^2));
printf("\n  X0=%2.3f ohm",X_not)
Psc=Wsc1+Wsc2;
Vsc=Vl_sc/sqrt(3);
```

```
cos_phi_sc=Psc/(3*Vsc*Isc);
R2_dash=((Vsc/Isc)*cos_phi_sc)-R1;
printf("\n  R2dash=%1.3f ohm",R2_dash)
X1=((Vsc/Isc)*sqrt(1-cos_phi_sc^2))/2;
printf("\n  X1=%1.3f ohm",X1)
X2_dash=X1;
printf("\n  X2dash=%1.3f ohm \n",X2_dash)

printf("\n (b)")
ns=25;
s=R2_dash/X2_dash;  //Slip for maximum torque
pf_max=1/sqrt(2);
Ps=(3*V_not^2)/sqrt((R1+R2_dash/s)^2+(2*X1)^2);
Pc=(3*V_not^2*(R1+R2_dash))/((R1+R2_dash/s)^2+(2*X1)^2);   //Stator copper loss in  kw
Pin=Ps-Pc;
T=Pin/(2*%pi*ns);
printf("\n  Slip for pullout torque=%g",s)
printf("\n  Magnitude of pullout torque=%3.2f Nm",T)
//There is a mistake in the book solution in part (b)
//The calculated Ps  value is wrong
//Hence T answer vary
```

Scilab code Exa 10.9 `Determination ratio of starting current to full load current`

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex10_9.sce

```

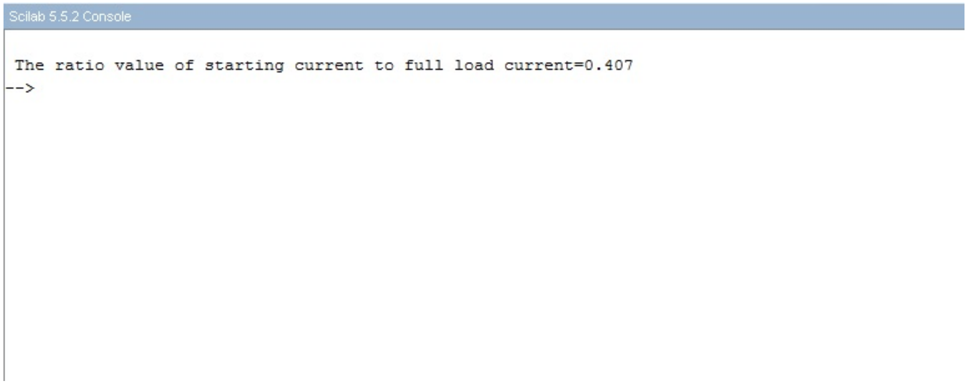


Figure 10.8: Determination ratio of starting current to full load current

```
clc;
clear;
P_in_HP=10;
eta=0.9;
pf=0.8;
Vl=400;
Vsc=160;
Isc=7.2;
P_in_watt=P_in_HP*735.5;
If=P_in_watt/(sqrt(3)*Vl*pf*eta);
Isc_400=Isc*Vl/Vsc;
Ist=Isc_400/3;
Ist_by_If=Ist/If;
printf("\n The ratio value of starting current to
    full load current=%1.3f",Ist_by_If)
```

Scilab code Exa 10.10 `Calculation of starting torque and starting current`

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
```

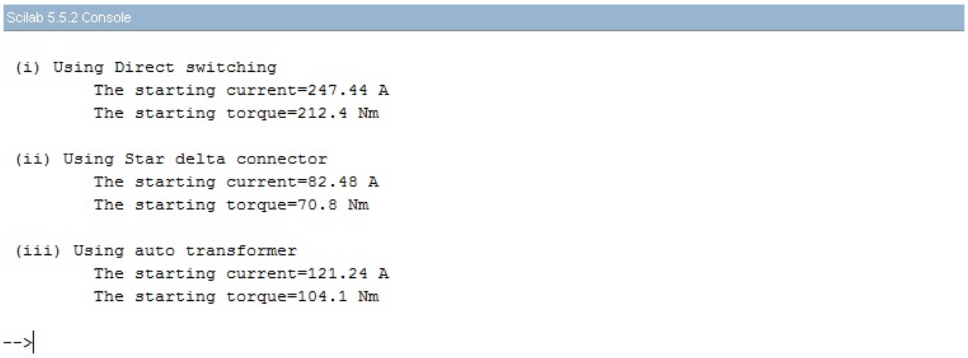


Figure 10.9: Calculation of starting torque and starting current

```
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//EX10_10.sce.
clc;
clear;
sf=0.04;
If=37.5;
f=50;
p=4;
V=400;
P_in_HP=25;
z=2.8;
P_in_watt=P_in_HP*735.5;
Nf=((120*f)/p)*(1-sf);
nf=Nf/60;
Tf=P_in_watt/(2*%pi*nf);
Isc_phase=V/z;
Isc=sqrt(3)*Isc_phase;
```

```
printf("\n (i) Using Direct switching")
Ist=Isc;
printf("\n \t The starting current=%3.2f A",Ist)
Tst=(Isc/If)^2*sf*Tf;
printf("\n \t The starting torque=%3.1f Nm \n",Tst)

printf("\n (ii) Using Star delta connector")
Ist=(1/3)*Isc;
printf("\n \t The starting current=%3.2f A",Ist)
Tst=(1/3)*(Isc/If)^2*sf*Tf;
printf("\n \t The starting torque=%3.1f Nm \n",Tst)

printf("\n (iii) Using auto transformer")
k=0.7;
Ist=k^2*Isc;
printf("\n \t The starting current=%3.2f A",Ist)
Tst=k^2*(Isc/If)^2*sf*Tf;
printf("\n \t The starting torque=%3.1f Nm \n",Tst)
```

Scilab code Exa 10.11 Calculation of plugging torque

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex10_11.sce

clc;
clear;


```

Figure 10.10: Calculation of plugging torque

```
P_in_HP=25;
s=0.04;
p=4;
f=50;
Ns=(120*f)/p;
ns=Ns/60;
nf=(1-s)*ns;
P_in_watt=P_in_HP*735.5;
Tf=P_in_watt/(2*%pi*nf);
sf=s;
sp=2-s;          //At the time of plugging the slip is 200%
a=4;
X2_by_R2=a;
Tp=(sp/sf)*((1+(sf^2*X2_by_R2^2))/(1+(sp^2*X2_by_R2^2)))*Tf;
printf("\n Plugging torque at full load=%2.1f Nm",Tp)
```

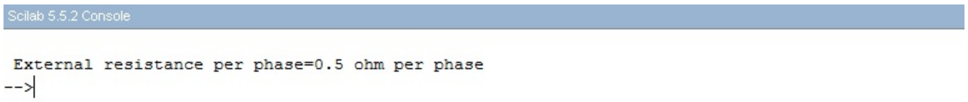
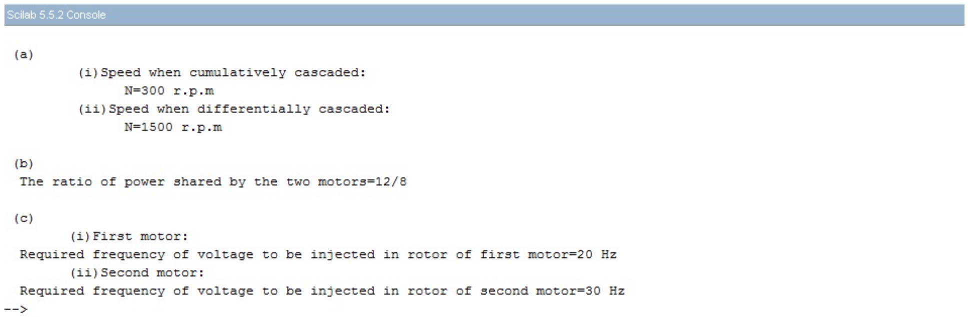


Figure 10.11: Calculation of external resistance

Scilab code Exa 10.12 Calculation of external resistance

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex10_12.sce

clc;
clear;
p=4;
f=50;
R2=0.25;
N1=1425;
N2=1275;

Ns=(120*f)/p;
s1=(Ns-N1)/Ns;
```



```
Scilab 5.5.2 Console

 (a)
        (i)Speed when cumulatively cascaded:
              N=300 r.p.m
        (ii)Speed when differentially cascaded:
              N=1500 r.p.m

 (b)
 The ratio of power shared by the two motors=12/8

 (c)
       (i)First motor:
 Required frequency of voltage to be injected in rotor of first motor=20 Hz
       (ii)Second motor:
 Required frequency of voltage to be injected in rotor of second motor=30 Hz
-->
```

Figure 10.12: Calculation of speed and power ratio and frequency

```
s2=(Ns-N2)/Ns;
R=(R2*(s2/s1))-R2;
printf("\n External resistance per phase=%1.1f ohm
    per phase",R)
```

Scilab code Exa 10.13 Calculation of speed and power ratio and frequency

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex10_13.sce

clc;
clear;
p1=12;
p2=8;
```

```
f=50;
printf("\n (a)")
printf("\n \t (i)Speed when cumulatively cascaded:")
N1=(120*f)/(p1+p2);
printf("\n \t       N=%d r.p.m",N1)
printf("\n \t (ii)Speed when differentially cascaded:")
N2=(120*f)/(p1-p2);
printf("\n \t       N=%d r.p.m \n",N2)

printf("\n (b)")
printf("\n  The ratio of power shared by the two motors=%d/%d \n",p1,p2)

printf("\n (c)")
printf("\n \t(i)First motor:")
Ns1=(120*f)/p1;
s1=(Ns1-N1)/Ns1;
sf1=s1*f;
printf("\n  Required frequency of voltage to be injected in rotor of first motor=%d Hz",sf1)
printf("\n \t(ii)Second motor:")
Ns2=(120*f)/p2;
s2=(Ns2-N1)/Ns2;
sf2=s2*f;
printf("\n  Required frequency of voltage to be injected in rotor of second motor=%d Hz",sf2)
```

Chapter 11

Special Purpose Electrical Machines

Scilab code Exa 11.1 Determination of motor parameters and stator current and powe

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex11_1.sce

clc;
clear;
V_not=220;
I_not=4;
W_not=100;
Vsc=110;
Isc=10;
Wsc=400;
p=6;
V=220;
```

Figure 11.1: Determination of motor parameters and stator current and power factor and speed and torque

```
f=50;

printf("\n (a)")
r1=(Wsc/Isc^2)/2;
x1=sqrt((Vsc/Isc)^2-(2*r1)^2)/2;
r2_dash=r1;
x2_dash=x1;
phi_not=acosd(W_not/(V_not*I_not));
V_not_dash=V_not-((I_not*(cosd(phi_not)-%i*sind(
    phi_not)))*((r1+r2_dash/4)+%i*(x1+x2_dash/2)));
Wi=W_not-(I_not^2*(r1+r2_dash/4));
R_not_by_2=(V_not_dash^2)/Wi;
Y_not=(I_not)/(V_not_dash*2);
B_not=sqrt((2*Y_not)^2-(1/R_not_by_2)^2)/2;
X_not_by_2=1/(2*B_not);
printf("\n  Parameters of the motor:")
printf("\n \t r1=r2dash=%d ohm",r1)
printf("\n \t x1=x2dash=%1.3f ohm",x1)
```

```
printf("\n \t R0/2=%3.2f ohm",sqrt(real(R_not_by_2)^2+imag(R_not_by_2)^2))
printf("\n \t X0/2=%2.2f ohm",sqrt(real(X_not_by_2)^2+imag(X_not_by_2)^2))

printf("\n (b)")
//From the applied parameters of equivalent circuit of the motor stator current is simplified
I1=complex(1.096,-0.526)*complex(6.36,-1.92);
I1_mag=sqrt(real(I1)^2+imag(I1)^2);
I1_angle=atand(imag(I1)/real(I1));
pf=cosd(I1_angle);
P_input=1075;
P_loss=102.87;
P_not=P_input-P_loss;
Ns=1000;
s=0.04;
Nfl=(1-s)*Ns;
T_net=P_not/(2*%pi*Nfl/60);
motor_input=V*I1_mag*pf;
efficiency=(P_not/motor_input)*100;
printf("\n Stator current: \n\t magnitude=%1.2f V,\n\t angle=%2.2f degree",I1_mag,I1_angle)
printf("\n Power factor=%0.3f lagging",pf)
printf("\n Power output=%3.2f watt",P_not)
printf("\n Speed=%d r.p.m",Nfl)
printf("\n Torque=%1.2f Nm",T_net)
printf("\n Efficiency=%d percentage",efficiency)
//Answer vary dueto roundoff error
```

Scilab code Exa 11.2 Calculation of developed power and copper loss

```
//Book Name:Fundamentals of Electrical Engineering
```

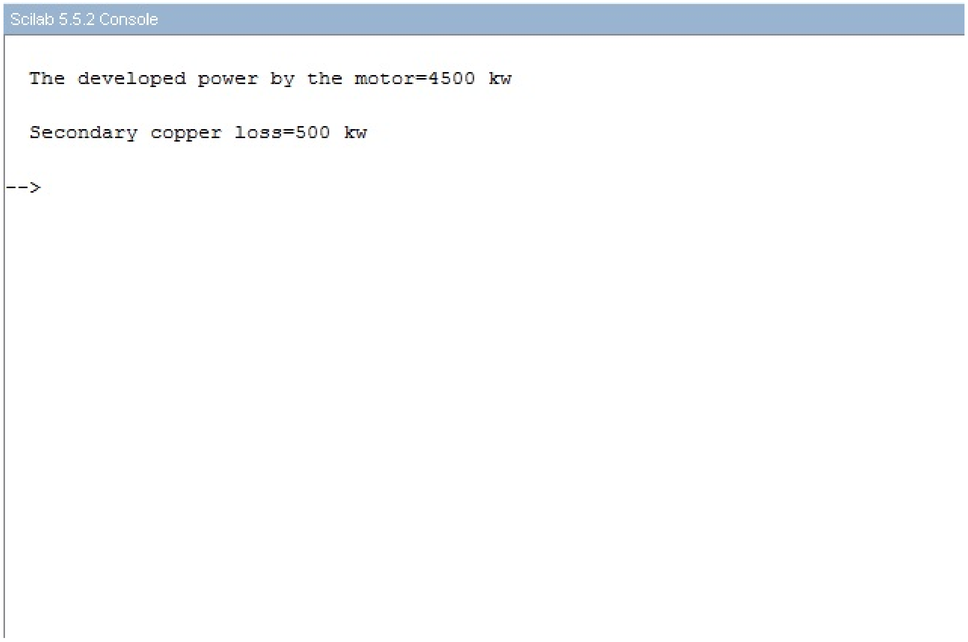


Figure 11.2: Calculation of developed power and copper loss

```
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex11_2.sce

clc;
clear;
t=0.5;          //pole pitch
f=50;
vmp=162;
fd=100e3;
vm=vmp*1e3/(60*60);
pd=fd*vm;
vs=2*t*f;
s=(vs-vm)/vs;
pcu=s*fd*vs;
printf("\n The developed power by the motor=%d kw \
```

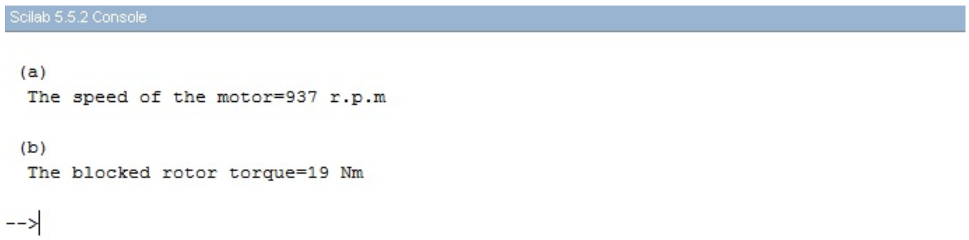


Figure 11.3: Calculation of motor speed and torque

```
    n",pd/1000)
printf("\n  Secondary copper loss=%d kw \n",pcu
    /1000)
```

Scilab code Exa 11.3 Calculation of motor speed and torque

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex11_3.sce

clc;
```

Figure 11.4: Calculation of magnetic flux

```
clear;
Ra=0.8;
Va=40;
Td=1.2;
Ka=600;
phi_p=0.004;

printf("\n (a)")
n=(Va/(Ka*phi_p))-(2*%pi*Ra*Td/(Ka*phi_p)^2);
N=n*60;
printf("\n  The speed of the motor=%d r.p.m \n",N)
//The book answer for part(a) is wrong value

printf("\n (b)")
n=0;
Td=(Va*Ka*phi_p)/(2*%pi*Ra);
printf("\n  The blocked rotor torque=%d Nm \n",Td)
```

Scilab code Exa 11.4 Calculation of magnetic flux

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex11_4.sce

clc;
clear;
P=200;
V=100;
N=1500;
Ka=525;
Ra=2;
Pl=15;

Pd=P+Pl;
n=N/60;
Td=Pd/(2*%pi*n);
//n=(Va/(Ka*phi_p))-(2*%pi*Ra*Td/(Ka*phi_p)^2);
//from this equation we get phi^2-o-0.0076*phi+2.5e-6=0;
a=1;
b=-0.0076;//a,b,c are coefficient values taken from the above second order equation
c=2.5e-6;
phi_p=(-b+sqrt(b^2-(4*a*c)))/(2*a);
printf("\n The magnetic flux=%1.3f mWb \n",phi_p*1000)
```

Chapter 12

Analysis of Three Phase Circuits

Scilab code Exa 12.1 Calculation of line current of load and alternator

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex12_1.sce

clc;
clear;
z=complex(3,4);
Vl=120;
printf("\n  Line current of load:  Magnitude \t Angle(deg) \n")
I_R=complex(Vl*cosd(0),Vl*sind(0))/(sqrt(3)*z);
I_Y=complex(Vl*cosd(-120),Vl*sind(-120))/(sqrt(3)*z);
I_B=complex(Vl*cosd(120),Vl*sind(120))/(sqrt(3)*z);
```

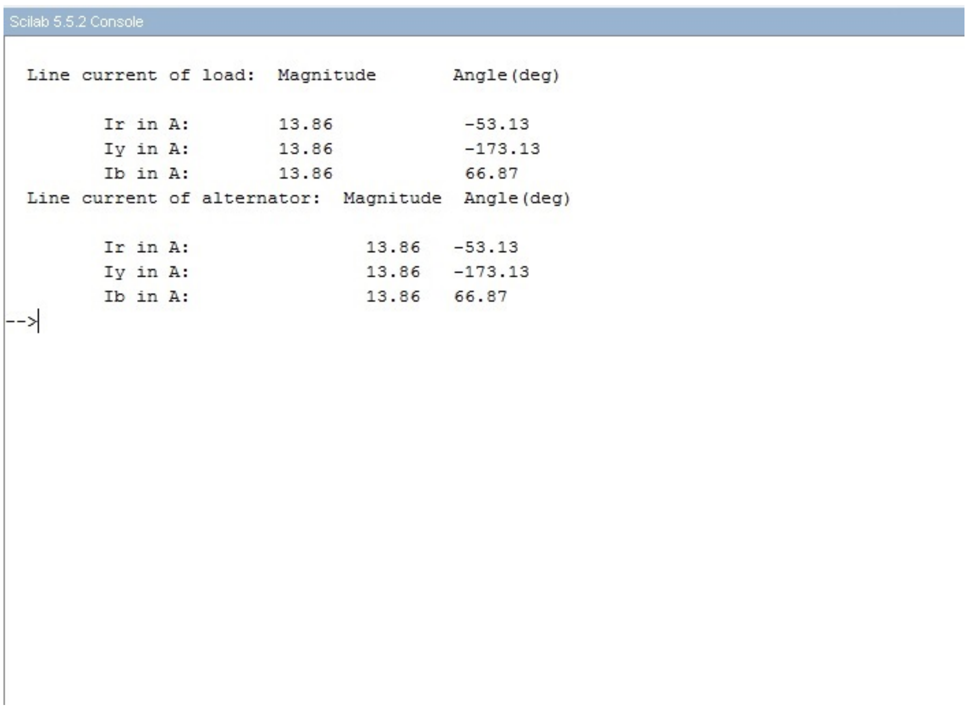


Figure 12.1: Calculation of line current of load and alternator

```
I_R_mag=sqrt(real(I_R)^2+imag(I_R)^2);
I_Y_mag=sqrt(real(I_Y)^2+imag(I_Y)^2);
I_B_mag=sqrt(real(I_B)^2+imag(I_B)^2);
I_R_angle=atand(imag(I_R)/real(I_R));
I_Y_angle=atand(imag(I_Y)/real(I_Y))-180;
I_B_angle=atand(imag(I_B)/real(I_B));
printf("\n\t Ir in A:\t %2.2f  \t  %2.2f",I_R_mag,I_R_angle)
printf("\n\t Iy in A:\t %2.2f  \t  %2.2f",I_Y_mag,I_Y_angle)
printf("\n\t Ib in A:\t %2.2f  \t  %2.2f",I_B_mag,I_B_angle)
//The line current of alternator  is same as the line or phase current of load

printf("\n  Line current of alternator:  Magnitude Angle(deg) \n")
I_R=complex(Vl*cosd(0),Vl*sind(0))/(sqrt(3)*z);
I_Y=complex(Vl*cosd(-120),Vl*sind(-120))/(sqrt(3)*z);
I_B=complex(Vl*cosd(120),Vl*sind(120))/(sqrt(3)*z);
I_R_mag=sqrt(real(I_R)^2+imag(I_R)^2);
I_Y_mag=sqrt(real(I_Y)^2+imag(I_Y)^2);
I_B_mag=sqrt(real(I_B)^2+imag(I_B)^2);
I_R_angle=atand(imag(I_R)/real(I_R));
I_Y_angle=atand(imag(I_Y)/real(I_Y))-180;
I_B_angle=atand(imag(I_B)/real(I_B));
printf("\n\t Ir in A:        \t %2.2f \t %2.2f",I_R_mag,I_R_angle)
printf("\n\t Iy in A:        \t %2.2f \t %2.2f",I_Y_mag,I_Y_angle)
printf("\n\t Ib in A:       \t %2.2f \t %2.2f",I_B_mag,I_B_angle)
```

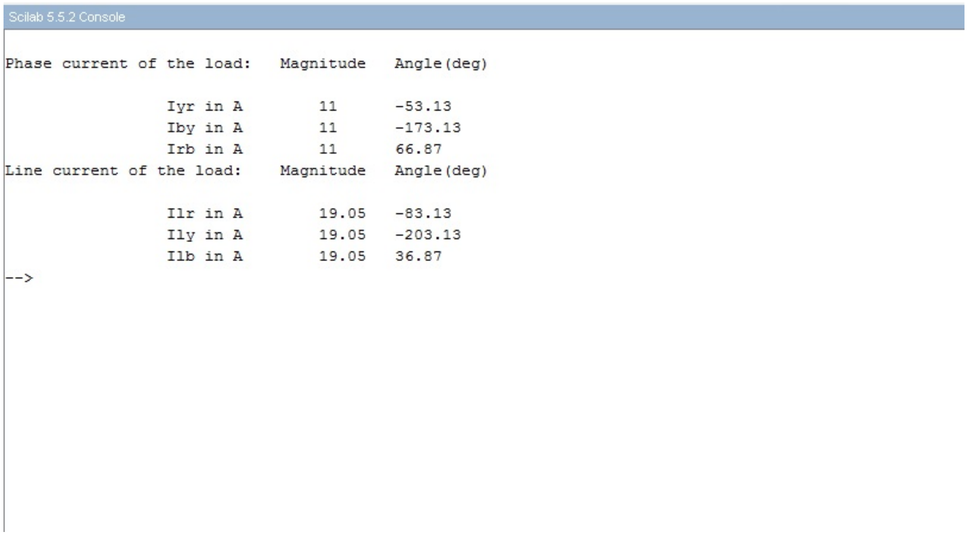


Figure 12.2: Determination of phase and line current of the load

Scilab code Exa 12.2 Determination of phase and line current of the load

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex12_2.sce

clc;
clear;
z=complex(6,8);
Vl=110;
printf("\nPhase current of the load:   Magnitude \t
    Angle(deg) \n")
I_YR=complex(Vl*cosd(0),Vl*sind(0))/(z);
I_BY=complex(Vl*cosd(-120),Vl*sind(-120))/(z);
I_RB=complex(Vl*cosd(120),Vl*sind(120))/(z);
I_YR_mag=sqrt(real(I_YR)^2+imag(I_YR)^2);
I_BY_mag=sqrt(real(I_BY)^2+imag(I_BY)^2);
I_RB_mag=sqrt(real(I_RB)^2+imag(I_RB)^2);
```

```
I_YR_angle=atand(imag(I_YR)/real(I_YR));
I_BY_angle=atand(imag(I_BY)/real(I_BY))-180;
I_RB_angle=atand(imag(I_RB)/real(I_RB));
printf("\n\t\t Iyr in A \t %d \t %2.2f",I_YR_mag,I_YR_angle)
printf("\n\t\t Iby in A \t %d \t %2.2f",I_BY_mag,I_BY_angle)
printf("\n\t\t Irb in A \t %d \t %2.2f",I_RB_mag,I_RB_angle)

printf("\nLine current of the load:    Magnitude \t Angle(deg) \n")
I_LR_mag=sqrt(3)*I_YR_mag;
I_LY_mag=sqrt(3)*I_BY_mag;
I_LB_mag=sqrt(3)*I_RB_mag;
I_LR_angle=I_YR_angle-30;
I_LY_angle=I_BY_angle-30;
I_LB_angle=I_RB_angle-30;
printf("\n\t\t Ilr in A \t %2.2f \t %2.2f",I_LR_mag,I_LR_angle)
printf("\n\t\t Ily in A \t %2.2f \t %2.2f",I_LY_mag,I_LY_angle)
printf("\n\t\t Ilb in A \t %2.2f \t %2.2f",I_LB_mag,I_LB_angle)
```

Scilab code Exa 12.3 Calculation of total KVA of capacitors and capacitance value

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex12_3.sce
```

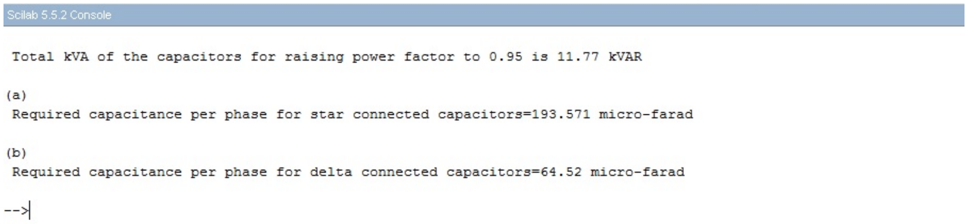


Figure 12.3: Calculation of total KVA of capacitors and capacitance value

```

clc;
clear;
P=36;    //power in kilowatt
Vl=440;
f=50;
efficiency=0.89;
pf1=0.85;
pf2=0.95;
P_not=P/3;
P_input=P_not/efficiency;
Q1=P_input*tand(acosd(pf1));
Q2=P_input*tand(acosd(pf2));
Qc=Q1-Q2;
kVA=3*Qc;
printf("\n Total kVA of the capacitors for raising
   power factor to 0.95 is %2.2f kVAR \n",kVA)
V=Vl/sqrt(3);
Xc=V^2/(Qc*1e3);

printf("\n(a)")
C_star=1/(2*%pi*f*Xc);
```

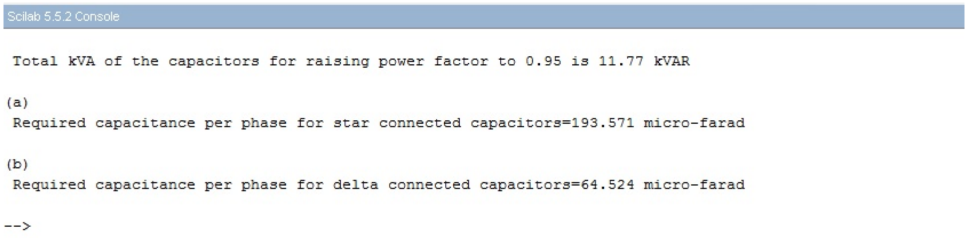


Figure 12.4: Calculation of total KVA of capacitors and capacitance value

```
printf("\n Required capacitance per phase for star
    connected capacitors=%3.3f micro-farad \n",C_star
    /1e-6)

printf("\n(b)")
C_delta=C_star/3;
printf("\n Required capacitance per phase for delta
    connected capacitors=%2.2f micro-farad \n",
    C_delta/1e-6)
//Answer vary dueto round off error
```

Scilab code Exa 12.4 Calculation of total KVA of capacitors and capacitance value

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
```

```
//Edition:Third ,2014

//Ex12_4.sce


//The input data taken from Example:12.3
clc;
clear;
P=36;
Vl=440;
f=50;
efficiency=0.89;
pf1=0.85;
pf2=0.95;
Pm=P/efficiency;
Qm=Pm*tand(acosd(pf1));
Qs=Pm*tand(acosd(pf2));
Qc=Qm-Qs;
Qc_phase=Qc/3;
kVA=Qc_phase;
printf("\n Total kVA of the capacitors for raising
    power factor to 0.95 is %2.2f kVAR \n",Qc)

printf("\n(a)")
Vph=Vl/sqrt(3);
Iph=kVA*1e3/Vph;
C=Iph/(2*%pi*f*Vph);
printf("\n Required capacitance per phase for star
    connected capacitors=%3.3f micro-farad \n",C/1e
    -6)

printf("\n(b)")
Vph=Vl;
Iph=kVA*1e3/Vph;
C=Iph/(2*%pi*f*Vph);
printf("\n Required capacitance per phase for delta
    connected capacitors=%3.3f micro-farad \n",C/1e
    -6)
```

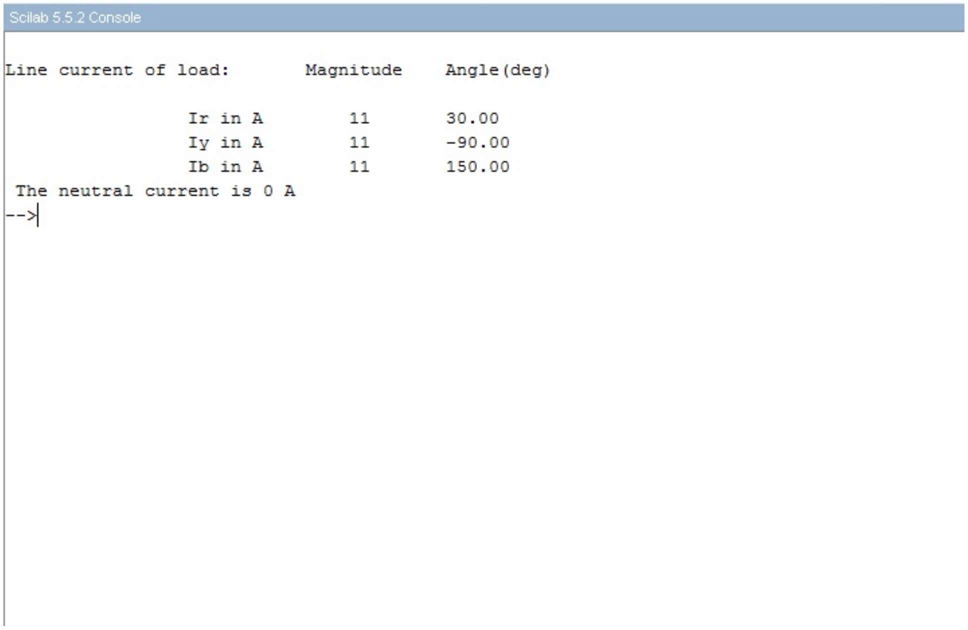


Figure 12.5: Calculation of line current and neutral current

```
//Answer vary dueto round off error
```

Scilab code Exa 12.5 `Calculation of line current and neutral current`

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex12_5.sce

clc;
clear;
Vl=440;
```

```
z_mag=40;
z_angle=-30;
z=complex(z_mag*cosd(z_angle),z_mag*sind(z_angle));
Iph=Vl/z;
Iph_mag=sqrt(real(Iph)^2+imag(Iph)^2);
Iph_angle=atand(imag(Iph)/real(Iph));

printf("\nLine current of load:\t    Magnitude \t
    Angle(deg) \n")
I_R_mag=Iph_mag;
I_Y_mag=Iph_mag;
I_B_mag=Iph_mag;
I_R_angle=Iph_angle-0;
I_Y_angle=Iph_angle-120;
I_B_angle=Iph_angle+120;
printf("\n\t\t Ir in A \t%d \t %2.2f",I_R_mag,
    I_R_angle)
printf("\n\t\t Iy in A \t%d \t %2.2f",I_Y_mag,
    I_Y_angle)
printf("\n\t\t Ib in A \t%d \t %2.2f",I_B_mag,
    I_B_angle)

I_R=complex(I_R_mag*cosd(I_R_angle),I_R_mag*sind(
    I_R_angle))
I_Y=complex(I_Y_mag*cosd(I_Y_angle),I_Y_mag*sind(
    I_Y_angle))
I_B=complex(I_B_mag*cosd(I_B_angle),I_B_mag*sind(
    I_B_angle))
I_N=I_R+I_Y+I_B;
printf("\n The neutral current is %d A",I_N)
```

Scilab code Exa 12.6 Determination of complex power and line current

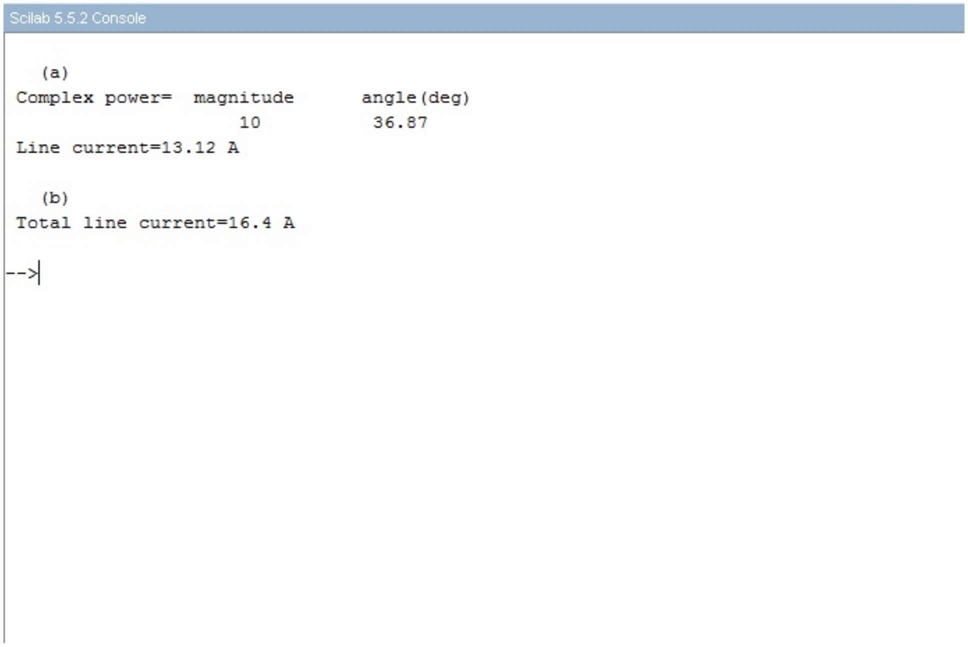


Figure 12.6: Determination of complex power and line current

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex12_6.sce

clc;
clear;
printf("\n    (a)")
Pi=8; //power in kilowatt
pf=0.8;
Vl=440;
Qi=Pi*tand(acosd(pf));
P=complex(Pi,Qi);
P_mag=sqrt(real(P)^2+imag(P)^2);
P_angle=atand(imag(P)/real(P));
Il=(P_mag*1e3)/(sqrt(3)*Vl);
```

```
printf("\n Complex power=  magnitude\tangle(deg) \n\
   t\t      %1.0f \t %2.2f",P_mag,P_angle)
printf("\n Line current=%2.2f A \n",Il)

printf("\n    (b)")
Pl=7.5;
pf=0.6;
P=Pi+(Pl*pf);
Q=Qi-(P*sind(acosd(pf)));
kVA=P;
Il=(kVA*1e3)/(sqrt(3)*Vl);
printf("\n Total line current=%2.1f A \n",Il)
```

Scilab code Exa 12.7 Calculation of line current and phase current and total power

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex12_7.sce

clc;
clear;
z1=complex(8,6);
z2=complex(6,8);
z3=complex(4,-3);
R_YR=z1;
R_BY=z2;
R_RB=z3;
Vl=440;

printf("\n(a)Delta connected load of phase sequence
```

```
Scilab 5.5.2 Console

(a)Delta connected load of phase sequence RYB:
Phase current=          Magnitude       Angle(deg)

        Iyr in A        44          -36.87
        Iby in A        44          -173.13
        Irb in A        88          156.87
Line current=           Magnitude       Angle(deg)
        Ir in A         131.16      -27.70
        Iy in A         81.67       165.00
        Ib in A         54.53       133.08
 Toatal power dissipated:

        W_YR=15488 W
        W_BY=11616 W
        W_RB=30976 W

(b)Delta connected load of phase sequence RBY:
Phase current=          Magnitude       Angle(deg)

        Iyr in A        44          -36.87
        Iby in A        44          66.87
        Irb in A        88          -83.13
Line current=           Magnitude       Angle(deg)
        Ir in A         65.77       67.97
        Iy in A         69.22       105.00
        Ib in A         128.01     -93.03
 Toatal power dissipated:

        W_YR=15488 W
        W_BY=11616 W
        W_RB=30976 W
-->
```

Figure 12.7: Calculation of line current and phase current and total power dissipated

```
RYB:")
theta1=0;
theta2=-120;
theta3=120;
V_YR=complex(Vl*cosd(theta1),Vl*sind(theta1));
V_BY=complex(Vl*cosd(theta2),Vl*sind(theta2));
V_RB=complex(Vl*cosd(theta3),Vl*sind(theta3));
I_YR=V_YR/z1;
I_BY=V_BY/z2;
I_RB=V_RB/z3;
I_YR_mag=sqrt(real(I_YR)^2+imag(I_YR)^2);
I_BY_mag=sqrt(real(I_BY)^2+imag(I_BY)^2);
I_RB_mag=sqrt(real(I_RB)^2+imag(I_RB)^2);
I_YR_angle=atand(imag(I_YR)/real(I_YR));
I_BY_angle=atand(imag(I_BY)/real(I_BY))-180;
I_RB_angle=atand(imag(I_RB)/real(I_RB))+180;
printf("\nPhase current=     \tMagnitude\tAngle(deg)\n")
printf("\n\t Iyr in A \t %d \t      %2.2f",I_YR_mag,I_YR_angle)
printf("\n\t Iby in A \t %d \t      %2.2f",I_BY_mag,I_BY_angle)
printf("\n\t Irb in A \t %d \t      %2.2f",I_RB_mag,I_RB_angle)

I_R=I_YR-I_RB;
I_Y=I_BY-I_YR;
I_B=I_RB-I_BY;
I_R_mag=sqrt(real(I_R)^2+imag(I_R)^2);
I_Y_mag=sqrt(real(I_Y)^2+imag(I_Y)^2);
I_B_mag=sqrt(real(I_B)^2+imag(I_B)^2);
I_R_angle=atand(imag(I_R)/real(I_R));
I_Y_angle=atand(imag(I_Y)/real(I_Y))+180;
I_B_angle=atand(imag(I_B)/real(I_B))+180;
printf("\nLine current=      \tMagnitude\tAngle(deg)")
printf("\n\t Ir in A \t %2.2f      %2.2f",I_R_mag,I_R_angle)
```

```
printf("\n\t Iy in A \t %2.2f \t     %2.2f",I_Y_mag,
    I_Y_angle)
printf("\n\t Ib in A \t %2.2f \t     %2.2f",I_B_mag,
    I_B_angle)

W_YR=(I_YR_mag)^2*real(z1);
W_BY=(I_BY_mag)^2*real(z2);
W_RB=(I_RB_mag)^2*real(z3);
printf("\n Toatal power dissipated:\n")
printf("\n\t W_YR=%d W",W_YR)
printf("\n\t W_BY=%d W",W_BY)
printf("\n\t W_RB=%d W",W_RB)


printf("\n\n(b)Delta connected load of phase
    sequence RBY:")
theta1=0;
theta2=120;
theta3=-120;
V_YR=complex(Vl*cosd(theta1),Vl*sind(theta1));
V_BY=complex(Vl*cosd(theta2),Vl*sind(theta2));
V_RB=complex(Vl*cosd(theta3),Vl*sind(theta3));
I_YR=V_YR/z1;
I_BY=V_BY/z2;
I_RB=V_RB/z3;
I_YR_mag=sqrt(real(I_YR)^2+imag(I_YR)^2);
I_BY_mag=sqrt(real(I_BY)^2+imag(I_BY)^2);
I_RB_mag=sqrt(real(I_RB)^2+imag(I_RB)^2);
I_YR_angle=atand(imag(I_YR)/real(I_YR));
I_BY_angle=atand(imag(I_BY)/real(I_BY));
I_RB_angle=atand(imag(I_RB)/real(I_RB));
printf("\nPhase current=     \tMagnitude\tAngle(deg)
    \n")
printf("\n\t Iyr in A \t %d \t      %2.2f",I_YR_mag,
    I_YR_angle)
printf("\n\t Iby in A \t %d \t      %2.2f",I_BY_mag,
    I_BY_angle)
printf("\n\t Irb in A \t %d \t      %2.2f",I_RB_mag,
```

```
I_RB_angle)

I_R=I_YR-I_RB;
I_Y=I_BY-I_YR;
I_B=I_RB-I_BY;
I_R_mag=sqrt(real(I_R)^2+imag(I_R)^2);
I_Y_mag=sqrt(real(I_Y)^2+imag(I_Y)^2);
I_B_mag=sqrt(real(I_B)^2+imag(I_B)^2);
I_R_angle=atand(imag(I_R)/real(I_R));
I_Y_angle=atand(imag(I_Y)/real(I_Y))+180;
I_B_angle=atand(imag(I_B)/real(I_B))-180;
printf("\nLine current=     \tMagnitude\tAngle(deg)")
printf("\n\t Ir in A \t %2.2f      %2.2f",I_R_mag,I_R_angle)
printf("\n\t Iy in A \t %2.2f \t    %2.2f",I_Y_mag,I_Y_angle)
printf("\n\t Ib in A \t %2.2f    %2.2f",I_B_mag,I_B_angle)

W_YR=(I_YR_mag)^2*real(z1);
W_BY=(I_BY_mag)^2*real(z2);
W_RB=(I_RB_mag)^2*real(z3);
printf("\n Toatal power dissipated:\n")
printf("\n\t W_YR=%d W",W_YR)
printf("\n\t W_BY=%d W",W_BY)
printf("\n\t W_RB=%d W",W_RB)
```

Scilab code Exa 12.8 Calculation of total power and reactive power

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
```

```
Scilab 5.5.2 Console

 (a)
  Phase power=181.5 W

 (b)
  Reactive  power=127.37 VAR
-->
```

Figure 12.8: Calculation of total power and reactive power

```
//Edition:Third ,2014

//Ex12_8.sce

clc;
clear;
Vl=110;
f=50;

printf("\n (a)")
R_YR=0;
R_BY=100;
R_RB=200;
W_YR=0; //since R_YR value is zero
W_BY=Vl^2/R_BY;
W_RB=Vl^2/R_RB;
printf("\n  Phase power=%3.1f W \n",W_YR+W_BY+W_RB)


printf("\n (b)")
X_YR=95;
X_BY=0;
X_RB=0;
W_YR=Vl^2/X_YR;
W_BY=0; //since X_BY value is zero
W_RB=0; //since X_RB value is zero
printf("\n  Reactive  power=%3.2f VAR",W_YR+W_BY+
   W_RB)
```

Scilab code Exa 12.9 Calculation of neutral current and power taken by each phase

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
```

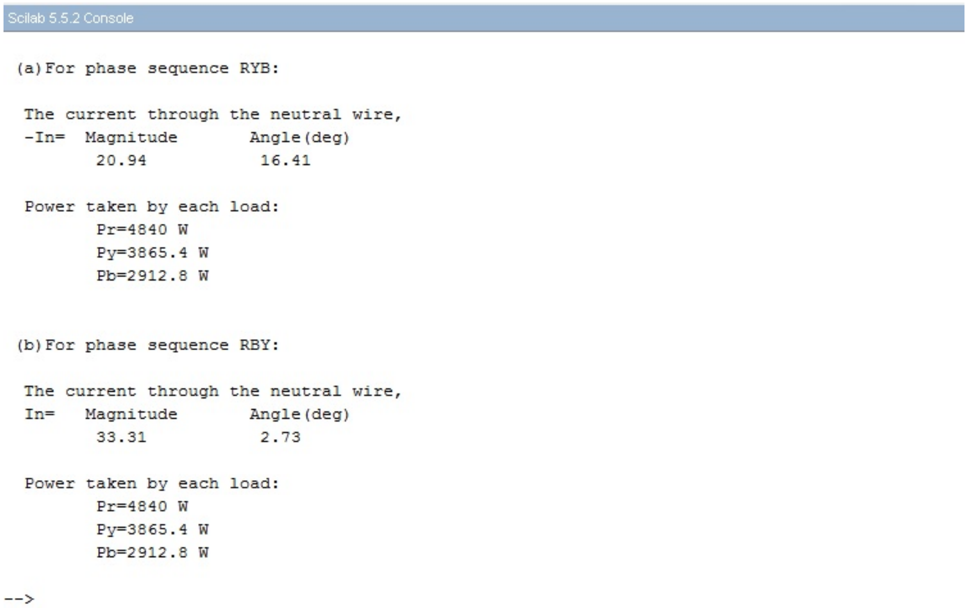


Figure 12.9: Calculation of neutral current and power taken by each phase

```
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex12_9.sce

clc;
clear;
z=10;
ang1=0;
ang2=37;
ang3=-53;
Zr=complex(z*cosd(ang1),z*sind(ang1));
Zy=complex(z*cosd(ang2),z*sind(ang2));
Zb=complex(z*cosd(ang3),z*sind(ang3));

printf("\n (a)For phase sequence RYB:\n")
V=220;
theta1=0;
```

```
theta2=-120;
theta3=120;
Vr=complex(V*cosd(theta1),V*sind(theta1));
Vy=complex(V*cosd(theta2),V*sind(theta2));
Vb=complex(V*cosd(theta3),V*sind(theta3));

Ir=Vr/Zr;
Iy=Vy/Zy;
Ib=Vb/Zb;
In=Ir+Iy+Ib;
In_mag=sqrt(real(In)^2+imag(In)^2);
In_angle=atand(imag(In)/real(In));
printf("\n  The current through the neutral wire,\n -In=\tMagnitude\tAngle(deg) \n\t %2.2f  \t %2.2f \n",In_mag,In_angle)

Ir_mag=sqrt(real(Ir)^2+imag(Ir)^2);
Iy_mag=sqrt(real(Iy)^2+imag(Iy)^2);
Ib_mag=sqrt(real(Ib)^2+imag(Ib)^2);
Pr=(Ir_mag)^2*real(Zr);
Py=(Iy_mag)^2*real(Zy);
Pb=(Ib_mag)^2*real(Zb);
printf("\n  Power taken by each load:\n\t Pr=%d W \n\t Py=%4.1f W \n\t Pb=%4.1f W \n", Pr, Py, Pb)



printf("\n\n (b)For phase sequence RBY:\n")
V=220;
theta1=0;
theta2=120;
theta3=-120;
Vr=complex(V*cosd(theta1),V*sind(theta1));
Vy=complex(V*cosd(theta2),V*sind(theta2));
Vb=complex(V*cosd(theta3),V*sind(theta3));

Ir=Vr/Zr;
Iy=Vy/Zy;
```

```
Ib=Vb/Zb;
In=Ir+Iy+Ib;
In_mag=sqrt(real(In)^2+imag(In)^2);
In_angle=atand(imag(In)/real(In));
printf("\n  The current through the neutral wire,\n
    In=\tMagnitude\tAngle(deg) \n\t %2.2f  \t %2.2f
   \n",In_mag,In_angle)

Ir_mag=sqrt(real(Ir)^2+imag(Ir)^2);
Iy_mag=sqrt(real(Iy)^2+imag(Iy)^2);
Ib_mag=sqrt(real(Ib)^2+imag(Ib)^2);
Pr=(Ir_mag)^2*real(Zr);
Py=(Iy_mag)^2*real(Zy);
Pb=(Ib_mag)^2*real(Zb);
printf("\n  Power taken by each load:\n\t Pr=%d W \n
   \t Py=%4.1f W \n\t Pb=%4.1f W \n", Pr, Py, Pb)
```

Scilab code Exa 12.10 Determination of phase voltage and current

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex12_10.sce

clc;
clear;
Z_R=complex(8,6);
Z_Y=complex(8,-6);
Z_B=complex(5,0);
Z_N=complex(0.5,1);
Y_R=1/Z_R;
```

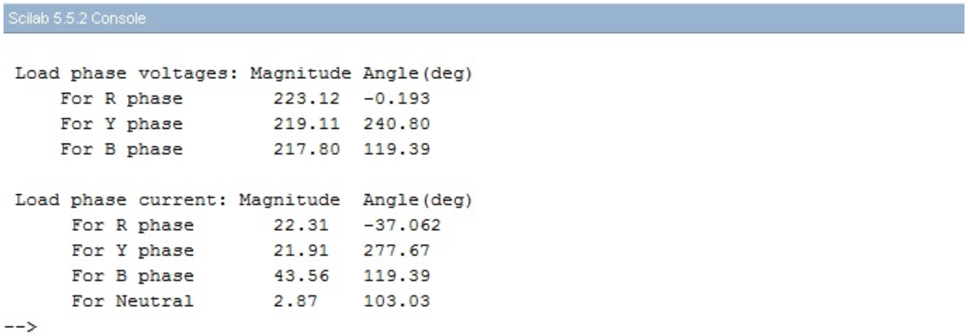


Figure 12.10: Determination of phase voltage and current

```
Y_Y=1/Z_Y;
Y_B=1/Z_B;
Y_N=1/Z_N;
E_R=220;
E_Y=220;
E_B=220;
theta1=0;
theta2=-120;
theta3=120;
V_R=complex(E_R*cosd(theta1),E_R*sind(theta1));
V_Y=complex(E_Y*cosd(theta2),E_Y*sind(theta2));
V_B=complex(E_B*cosd(theta3),E_B*sind(theta3));
V_NN_dash=((V_R*Y_R)+(V_Y*Y_Y)+(V_B*Y_B))/(Y_R+Y_Y+
    Y_B+Y_N);

V_R_dash=V_R-V_NN_dash;
V_Y_dash=V_Y-V_NN_dash;
V_B_dash=V_B-V_NN_dash;
```

```
V_R_dash_mag=sqrt(real(V_R_dash)^2+imag(V_R_dash)^2);
V_Y_dash_mag=sqrt(real(V_Y_dash)^2+imag(V_Y_dash)^2);
V_B_dash_mag=sqrt(real(V_B_dash)^2+imag(V_B_dash)^2);
V_R_dash_angle=atand(imag(V_R_dash)/real(V_R_dash));
V_Y_dash_angle=atand(imag(V_Y_dash)/real(V_Y_dash))+180;
V_B_dash_angle=atand(imag(V_B_dash)/real(V_B_dash))+180;
printf("\n Load phase voltages: Magnitude\tAngle(deg)")
printf("\n     For R phase\t%3.2f\t%0.3f",V_R_dash_mag,V_R_dash_angle)
printf("\n     For Y phase\t%3.2f\t%3.2f",V_Y_dash_mag,V_Y_dash_angle)
printf("\n     For B phase\t%3.2f\t%3.2f",V_B_dash_mag,V_B_dash_angle)
//For V_NN_dash value , the answer given in the book is wrong.So load phase voltage vary from the book answer.
//Also V_R_dash angle is not 0.168. It is negative angle that is -0.193
I_R=V_R_dash*Y_R;
I_Y=V_Y_dash*Y_Y;
I_B=V_B_dash*Y_B;
I_N=V_NN_dash*Y_N;
I_R_mag=sqrt(real(I_R)^2+imag(I_R)^2);
I_Y_mag=sqrt(real(I_Y)^2+imag(I_Y)^2);
I_B_mag=sqrt(real(I_B)^2+imag(I_B)^2);
I_N_mag=sqrt(real(I_N)^2+imag(I_N)^2);
I_R_angle=atand(imag(I_R)/real(I_R));
I_Y_angle=atand(imag(I_Y)/real(I_Y))+360;
I_B_angle=atand(imag(I_B)/real(I_B))+180;
I_N_angle=atand(imag(I_N)/real(I_N))+180;
printf("\n\n Load phase current: Magnitude\tAngle(deg)")
```

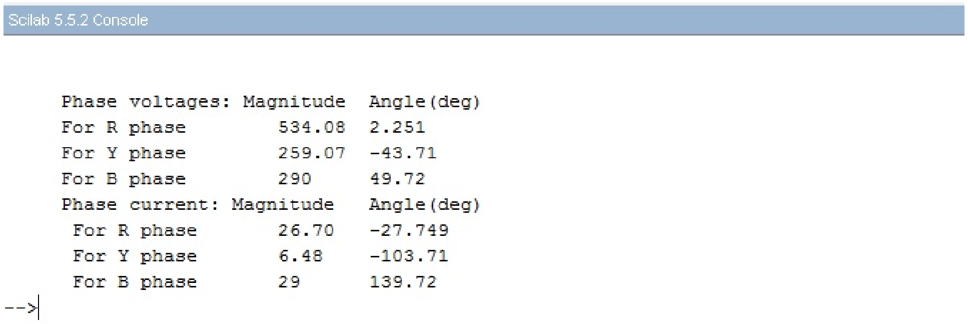


Figure 12.11: Calculation of each branch voltage and current

```
printf("\n          For R phase\t%3.2f\t%0.3f",I_R_mag,
    I_R_angle)
printf("\n          For Y phase\t%3.2f\t%3.2f",I_Y_mag,
    I_Y_angle)
printf("\n          For B phase\t%3.2f\t%3.2f",I_B_mag,
    I_B_angle)
printf("\n          For Neutral\t%3.2f\t%3.2f",I_N_mag,
    I_N_angle)
```

Scilab code Exa 12.11 Calculation of each branch voltage and current

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
```

```
//Edition:Third ,2014

//Ex12_11.sce

clc;
clear;
Vl=400;
V=Vl/sqrt(3);
Z_R=complex(20*cosd(30),20*sind(30));
Z_Y=complex(40*cosd(60),40*sind(60));
Z_B=complex(10*cosd(-90),10*sind(-90));
Y_R=1/Z_R;
Y_Y=1/Z_Y;
Y_B=1/Z_B;
theta1=0;
theta2=-120;
theta3=120;
V_R=complex(V*cosd(theta1),V*sind(theta1));
V_Y=complex(V*cosd(theta2),V*sind(theta2));
V_B=complex(V*cosd(theta3),V*sind(theta3));
V_NN_dash=((V_R*Y_R)+(V_Y*Y_Y)+(V_B*Y_B))/(Y_R+Y_Y+
    Y_B);
V_R_dash=V_R-V_NN_dash;
V_Y_dash=V_Y-V_NN_dash;
V_B_dash=V_B-V_NN_dash;
V_R_dash_mag=sqrt(real(V_R_dash)^2+imag(V_R_dash)^2)
    ;
V_Y_dash_mag=sqrt(real(V_Y_dash)^2+imag(V_Y_dash)^2)
    ;
V_B_dash_mag=sqrt(real(V_B_dash)^2+imag(V_B_dash)^2)
    ;
V_R_dash_angle=atand(imag(V_R_dash)/real(V_R_dash));
V_Y_dash_angle=atand(imag(V_Y_dash)/real(V_Y_dash));
V_B_dash_angle=atand(imag(V_B_dash)/real(V_B_dash));
printf("\n\n       Phase voltages: Magnitude\tAngle(
    deg)")
printf("\n       For R phase\t%3.2f\t%0.3f",
    V_R_dash_mag,V_R_dash_angle)
```

```
printf("\n      For Y phase\t%3.2f\t%3.2f",
    V_Y_dash_mag,V_Y_dash_angle)
printf("\n      For B phase\t%3.0f\t%3.2f",
    V_B_dash_mag,V_B_dash_angle)

I_R=V_R_dash*Y_R;
I_Y=V_Y_dash*Y_Y;
I_B=V_B_dash*Y_B;
I_R_mag=sqrt(real(I_R)^2+imag(I_R)^2);
I_Y_mag=sqrt(real(I_Y)^2+imag(I_Y)^2);
I_B_mag=sqrt(real(I_B)^2+imag(I_B)^2);
I_R_angle=atand(imag(I_R)/real(I_R));
I_Y_angle=atand(imag(I_Y)/real(I_Y))-180;
I_B_angle=atand(imag(I_B)/real(I_B))+180;
printf("\n      Phase current: Magnitude\tAngle(deg)"
    )
printf("\n       For R phase\t%2.2f\t%0.3f",I_R_mag,
    I_R_angle)
printf("\n       For Y phase\t%1.2f\t%3.2f",I_Y_mag,
    I_Y_angle)
printf("\n       For B phase\t%2.0f\t%3.2f",I_B_mag,
    I_B_angle)

//Answer vary due to roundoff error
```

Scilab code Exa 12.12 Calculation of line current or star phase current

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex12_12.sce
```

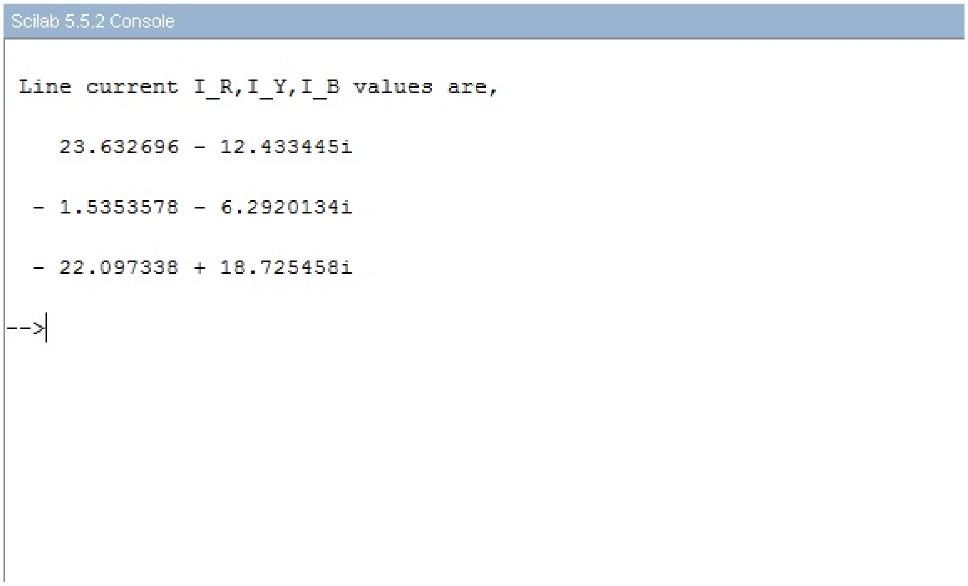


Figure 12.12: Calculation of line current or star phase current

```

//The input data taken from Example:12.11
clc;
clear;
Vl=400;
V=Vl/sqrt(3);
Z_R=complex(20*cosd(30),20*sind(30));
Z_Y=complex(40*cosd(60),40*sind(60));
Z_B=complex(10*cosd(-90),10*sind(-90));
Z_YR=((Z_R*Z_Y)+(Z_Y*Z_B)+(Z_B*Z_R))/Z_B;
Z_BY=((Z_R*Z_Y)+(Z_Y*Z_B)+(Z_B*Z_R))/Z_R;
Z_RB=((Z_R*Z_Y)+(Z_Y*Z_B)+(Z_B*Z_R))/Z_Y;
theta1=30;
theta2=-90;
theta3=150;
V_YR=complex(Vl*cosd(theta1),Vl*sind(theta1));
V_BY=complex(Vl*cosd(theta2),Vl*sind(theta2));
V_RB=complex(Vl*cosd(theta3),Vl*sind(theta3));
I_YR=V_YR/Z_YR;
```

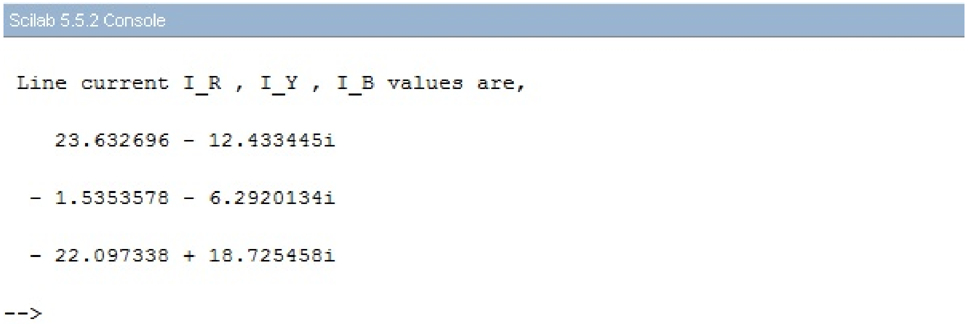


Figure 12.13: Calculation of line current

```
I_BY=V_BY/Z_BY;
I_RB=V_RB/Z_RB;
I_R=I_YR-I_RB;
I_Y=I_BY-I_YR;
I_B=I_RB-I_BY;
printf("\n Line current I_R,I_Y,I_B values are,\n")
disp(I_R)
disp(I_Y)
disp(I_B)
```

Scilab code Exa 12.13 `Calculation of line current`

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex12_13.sce

//The input data taken from Example:12.11
clc;
clear;
Vl=400;
V=Vl/sqrt(3);
Z_R=complex(20*cosd(30),20*sind(30));
Z_Y=complex(40*cosd(60),40*sind(60));
Z_B=complex(10*cosd(-90),10*sind(-90));
theta1=30;
theta2=-90;
theta3=150;
V_YR=complex(Vl*cosd(theta1),Vl*sind(theta1));
V_BY=complex(Vl*cosd(theta2),Vl*sind(theta2));
V_RB=complex(Vl*cosd(theta3),Vl*sind(theta3));

I_R=((V_YR*Z_B)-(V_RB*Z_Y))/((Z_R*Z_Y)+(Z_Y*Z_B)+(
    Z_B*Z_R));
I_Y=((V_BY*Z_R)-(V_YR*Z_B))/((Z_R*Z_Y)+(Z_Y*Z_B)+(
    Z_B*Z_R));
I_B=((V_RB*Z_Y)-(V_BY*Z_R))/((Z_R*Z_Y)+(Z_Y*Z_B)+(
    Z_B*Z_R));
printf("\n Line current I_R , I_Y , I_B values are,\
    n")
disp(I_R)
disp(I_Y)
disp(I_B)
```

Chapter 13

Dynamic Response of Network

Scilab code Exa 13.1 Calculation of resistance

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex13_1.sce.

clc;
clear;
Vc=60;
V_not=120;
t=20;
C=10e-6;
R=-t/(C*log(Vc/V_not));
printf("\n The value of resistance=%1.3f mega_ohm",
   R*1e-6)
```

Figure 13.1: Calculation of resistance

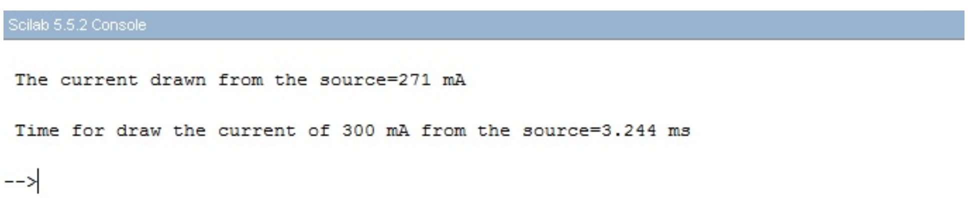


Figure 13.2: Determination of current and time

Scilab code Exa 13.2 Determination of current and time

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex13_2.sce

clc;
clear;
R1=60;
R2=80;
C=100e-6;
V=12;
t1=6e-3;
i_S=300e-3;
i_R=V/R1;
i_C=(V/R2)*exp(-t1/(R2*C));
i=i_R+i_C;
printf("\n The current drawn from the source=%3.0f
   mA \n",i*1e3)
I_C=i_S-i_R;
t2=(R2*C)*log(V/(R2*I_C));
printf("\n Time for draw the current of 300 mA from
   the source=%1.3f ms \n",t2*1e3)
```

Scilab code Exa 13.5 Determination of time constant and damping ratio and current

```
//Book Name:Fundamentals of Electrical Engineering
```

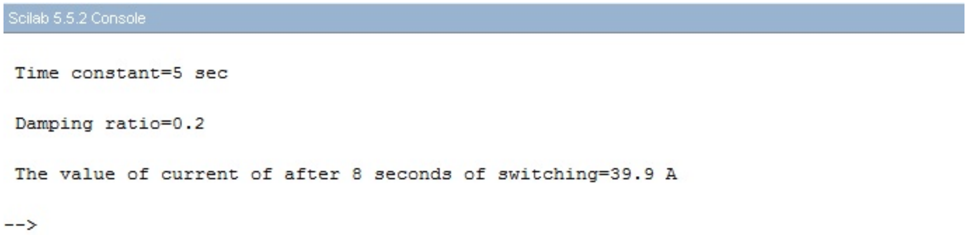


Figure 13.3: Determination of time constant and damping ratio and current

```
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex13_5.sce

clc;
clear;
V=100;
R=2;
L=10;
t=8;
T=L/R;
printf("\n Time constant=%d sec \n",T)
del=R/L;
printf("\n Damping ratio=%1.1f \n",del)
I=(V/R)*(1-exp(-t/T));
printf("\n The value of current of after 8 seconds
    of switching=%2.1f A \n",I)
```

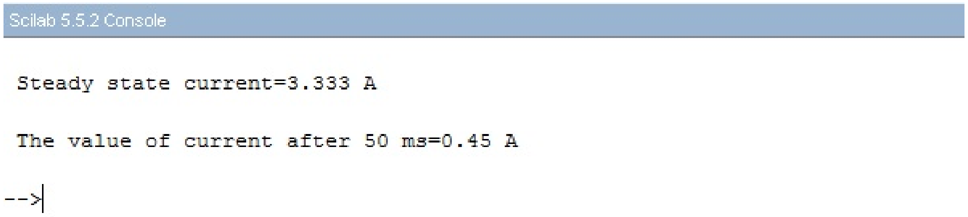


Figure 13.4: Determination of current values

Scilab code Exa 13.6 `Determination of current values`

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex13_6.sce

clc;
clear;
R=20;
```

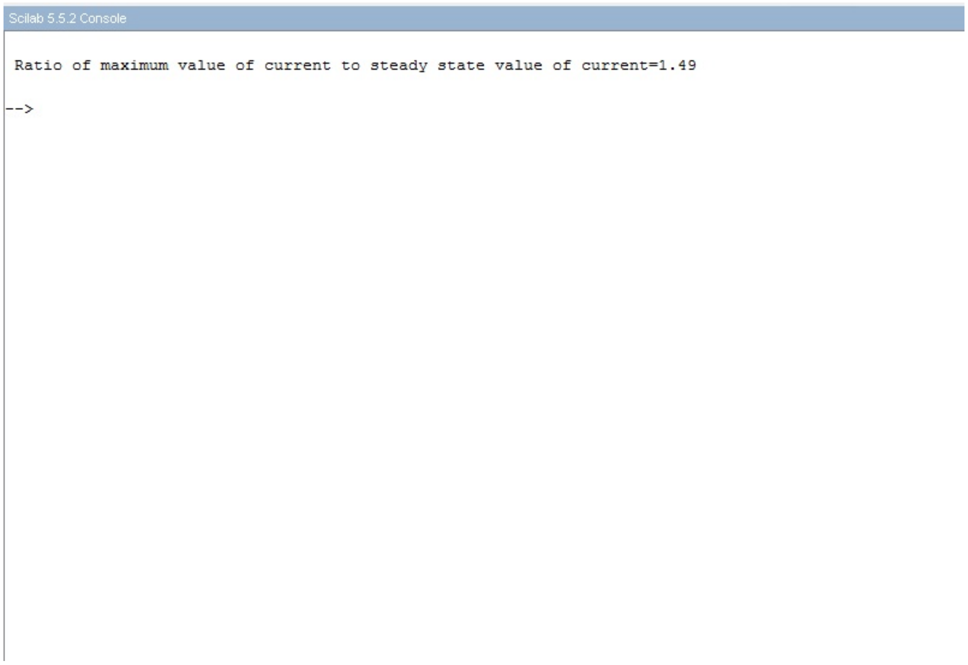


Figure 13.5: Calculation of current ratio

```
L=0.5;
V=100;
R_S=10;
t1=0;
t2=50e-3;
Req=R+R_S;
T1=L/Req;//Time constant1
T2=L/R;//Time constant2
I=V/Req;
printf("\n Steady state current=%1.3f A \n",I)
i=I*exp(-t2/T2);
printf("\n The value of current after 50 ms=%0.2f A
   \n",i)
```

Scilab code Exa 13.7 Calculation of current ratio

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex13_7.sce

clc;
clear;
R=10;
L=0.1;
t1=0.01;
omega=100*%pi;
phi=omega*t1;
t=(asin(1)+atan((omega*L)/R))/omega;
Imax=((-omega*L*exp(-R*t/L))/(R^2+(omega*L)^2))-(sin
   ((100*%pi*t)-(atan(omega*L/R)))/sqrt(R^2+(omega*L
   )^2));
t=0;
Iss=((-omega*L*exp(-R*t/L))/(R^2+(omega*L)^2))-(sind
   ((100*%pi*t)-(atan(omega*L/R)))/sqrt(R^2+(omega*L
   )^2));
a=Imax/Iss;
printf("\n Ratio of maximum value of current to
   steady state value of current=%1.2f \n",a)
//Answer vary dueto round off error in 't'
   calculation
```

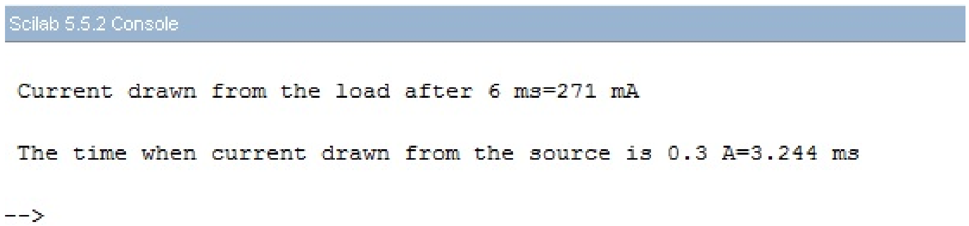


Figure 13.6: Determination of current

Scilab code Exa 13.14 `Determination of current`

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex13_14.sce

clc;
clear;
//From Ex_13.2
Id=300e-3;
t=6e-3;
V=12;
R=60;
Ir=V/R;
```

```
Ic1=0.15*exp(-125*t); // it Obtain, after the
    simplification of loop equation
I=Ir+Ic1;
printf("\n Current drawn from the load after 6 ms=%3
    .0f mA \n",I*1e3)
Ic2=Id-Ir;
t=log(Ic2/0.15)/-125;
printf("\n The time when current drawn from the
    source is 0.3 A=%1.3f ms \n",t*1e3)
```

Chapter 14

Electrical Power System

Scilab code Exa 14.1 Calculation of average load and energy consumption and load f

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex14_1.sce.

clc;
clear;
maximum_demand=1.5e3;
total_lamps=10;
lamps_on=7;
lamp_ontime=5;
lamp_power=100;
heater_on=2;
heater_ontime=3;
heater_power=1e3;
printf("\n (a)")
actual_energy_consumed=(lamps_on*lamp_power*
```

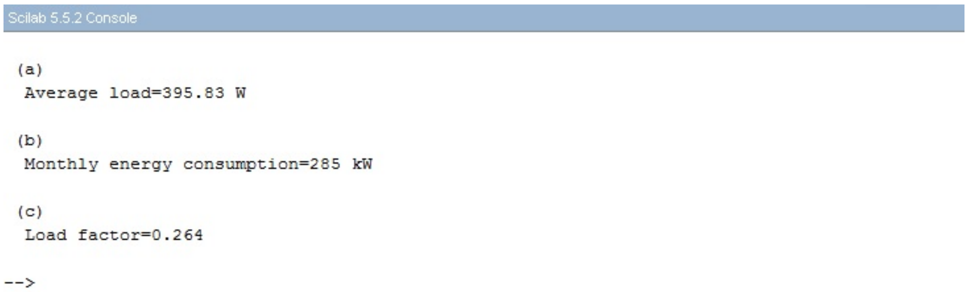
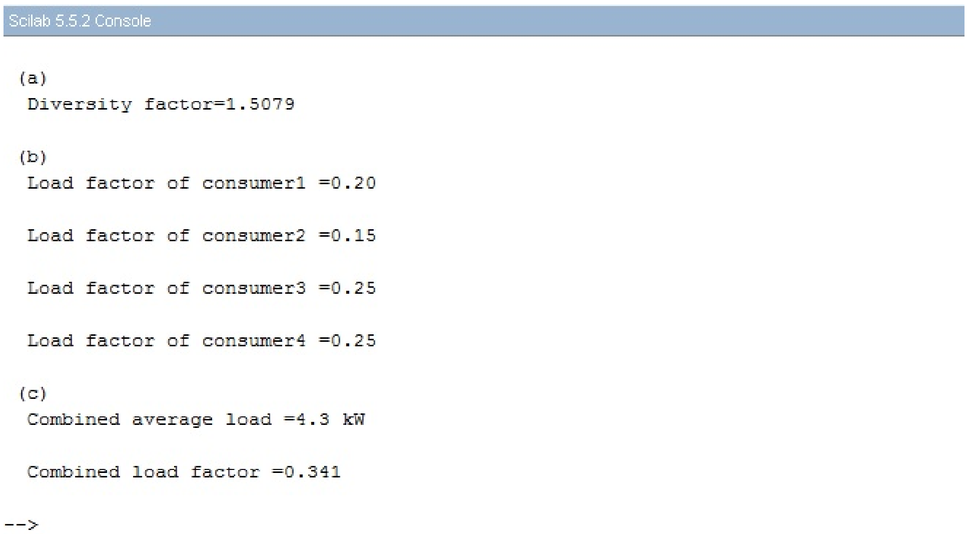


Figure 14.1: Calculation of average load and energy consumption and load factor

```
   lamp_ontime)+(heater_on*heater_power*
   heater_ontime);
time_duration=24;
average_load=(actual_energy_consumed)/(time_duration
   );
printf("\n  Average load=%3.2f W \n",average_load)

printf("\n (b)")
monthly_energy_consump=actual_energy_consumed*30*1e
   -3;
printf("\n  Monthly energy consumption=%3.0f kW \n",
   monthly_energy_consump)

printf("\n (c)")
load_factor=average_load/maximum_demand;
printf("\n  Load factor=%1.3f \n",load_factor)
```


Scilab 5.5.2 Console

```
 (a)
  Diversity factor=1.5079

 (b)
  Load factor of consumer1 =0.20

  Load factor of consumer2 =0.15

  Load factor of consumer3 =0.25

  Load factor of consumer4 =0.25

 (c)
  Combined average load =4.3 kW

  Combined load factor =0.341

-->
```

Figure 14.2: Determination of diversity factor and load factor and combined average load

Scilab code Exa 14.2 `Determination of diversity factor and load factor and combine`

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex14_2.sce.

clc;
```

```
clear;
//Loads are in kilowatt
avg_load1=1;
avg_load2=0.3;
avg_load3=0.5;
avg_load4=2.5;
max_load1=5;
max_load2=2;
max_load3=2;
max_load4=10;
max_demand1=5;
max_demand2=1.6;
max_demand3=1;
max_demand4=5;

printf("\n (a)")
sumof_individualmax_dem=max_load1+max_load2+
    max_load3+max_load4;
max_demandof_wholegroup=max_demand1+max_demand2+
    max_demand3+max_demand4;
diversity_factor=sumof_individualmax_dem/
    max_demandof_wholegroup;
printf("\n  Diversity factor=%1.4f \n",
    diversity_factor)


printf("\n (b)")
LF_of_consumer1=avg_load1/max_load1;
printf("\n  Load factor of consumer1 =%1.2f \n",
    LF_of_consumer1)
LF_of_consumer2=avg_load2/max_load2;
printf("\n  Load factor of consumer2 =%1.2f \n",
    LF_of_consumer2)
LF_of_consumer3=avg_load3/max_load3;
printf("\n  Load factor of consumer3 =%1.2f \n",
    LF_of_consumer3)
LF_of_consumer4=avg_load4/max_load4;
printf("\n  Load factor of consumer4 =%1.2f \n",
```

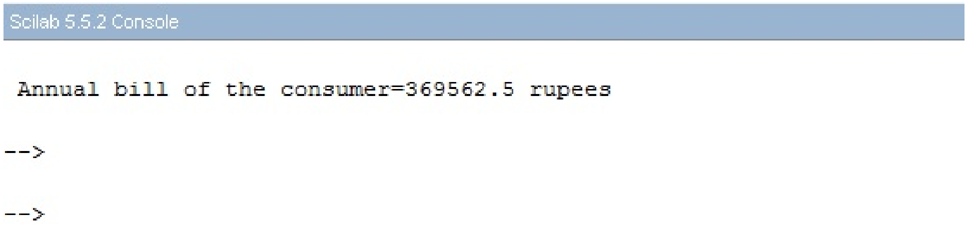


Figure 14.3: Calculation of annual bill of the consumer

```
    LF_of_consumer4)

printf("\n (c)")
combined_avg_load=(avg_load1+avg_load2+avg_load3+
    avg_load4);
printf("\n  Combined average load =%1.1f kW \n",
    combined_avg_load)
combined_load_factor=combined_avg_load/
    max_demandof_wholegroup;
printf("\n  Combined load factor =%1.3f \n",
    combined_load_factor)
```

Scilab code Exa 14.3 Calculation of annual bill of the consumer

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex14_3.sce.

clc;
clear;
average_demand=33.75;                          //in
   kilowatt
time_duration=24*365;                          // in hours
tariff=1.25;                                   //in rupees
   per kilowatthour
annualenergy_consumption=average_demand*
   time_duration;
C=annualenergy_consumption*tariff;
printf(" \n Annual bill of the consumer=%6.1f rupees
    \n",C)
```

Scilab code Exa 14.4 Calculation of overall cost per kWh

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex14_4.sce.

clc;
clear;
max_demand=75;                          //in kilowatt
time_duration=24*365;                      //in hour
```

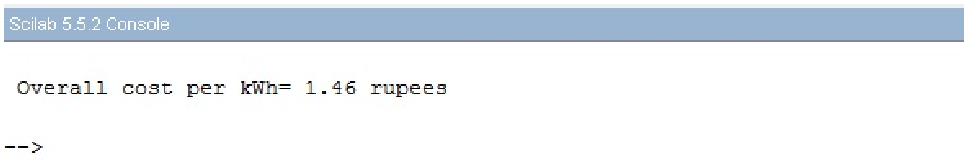


Figure 14.4: Calculation of overall cost per kWh

```
load_factor=0.45;
tariff1=650;
tariff2=1.30;
annual_energy_consump=max_demand*time_duration*
    load_factor;
Ce=tariff2*annual_energy_consump;
Cf=tariff1*max_demand;
total_annualcharge=Ce+Cf;
overall_costperkwhr=total_annualcharge/
    annual_energy_consump;
printf(" \n Overall cost per kWh= %1.2f rupees \n",
    overall_costperkwhr)
```

Scilab code Exa 14.5 `Calculation of monthly bill of the consumer`

Figure 14.5: Calculation of monthly bill of the consumer

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex14_5.sce

clc;
clear;
tariff1=3.50;                  //tariff in rupees per
    kilowatthour for first 500kilowatthour
tariff2=3.00;                   //tariff in rupees per
    kilowatthour for next 500kilowatthour
tariff3=2.50;                   //tariff in rupees per
    kilowatthour for usage exceeding 1000kilowatthour
days_in_a_month=31;
time_duration=24*days_in_a_month;
average_demand=2.5;                                   //
    in kilowatt
monthly_consumption=time_duration*average_demand;
a1=500;                //kWh for tariff1
a2=500;                 //kWh for tariff2
a3=monthly_consumption-a1-a2;           //kWh for
    tariff3
monthly_charge=(a1*tariff1)+(a2*tariff2)+(a3*tariff3
    );
printf("\n Monthly Charge=%d rupees.",monthly_charge
    )
```

Scilab code Exa 14.6 Calculation of annual bill of the consumer

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
```

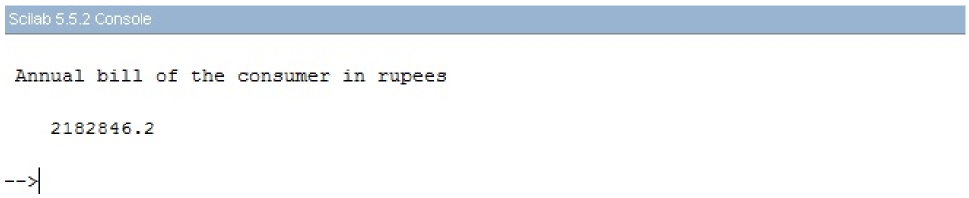


Figure 14.6: Calculation of annual bill of the consumer

```
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex14_6.sce.

clc;
clear;
average_demand=450;
load_factor=0.65;
power_factor=0.8;
tariff1=75;          //in ruees per month per kVA
tariff2=1.30;             //in rupees per kilowatthour
working_time=8*300;
maximum_kw_demand=average_demand/load_factor;
maximum_kVA_demand=maximum_kw_demand/power_factor;
annual_energy_charge=tariff2*average_demand*
   working_time;
annual_max_demand_charge=tariff1*12*
```

```
    maximum_kVA_demand;
annual_charge=annual_energy_charge+
    annual_max_demand_charge;
disp(annual_charge,'Annual bill of the consumer in
    rupees')
//The answer vary dueto roundoff error.
```

Chapter 15

Domestic Lighting

Scilab code Exa 15.1 Calculation of lamp efficiency and luminous intensity and MSC

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex15_1.sce

clc;
clear;
W=100;
V=250;
light_flux=3000;
printf("\n(a)")
mew=light_flux/W;
printf("\n Lamp efficiency=%d Lumens/watt \n",mew)

printf("\n(b)")
total_solid_angle=(4*%pi);
I=light_flux/total_solid_angle;
```

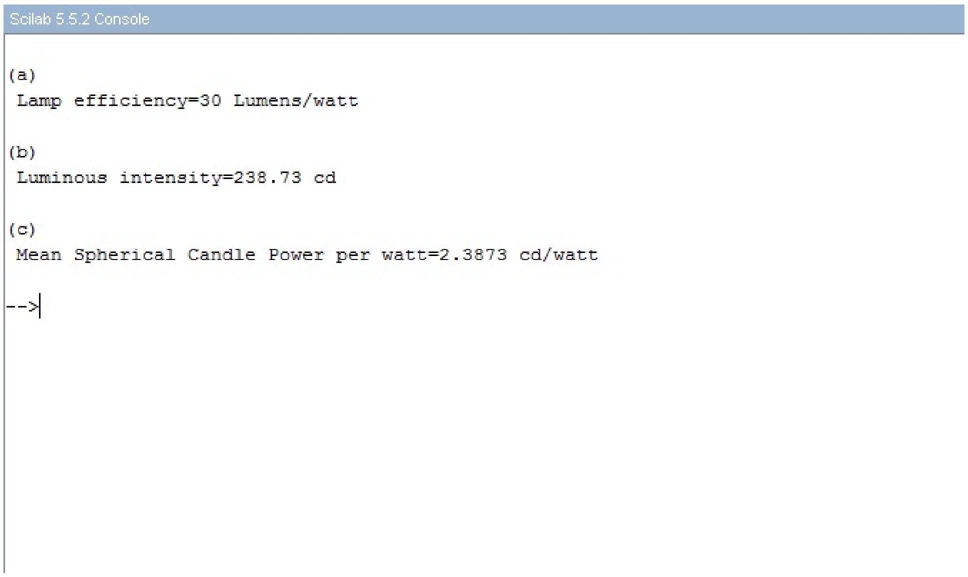


Figure 15.1: Calculation of lamp efficiency and luminous intensity and MSCP

```
printf("\n Luminous intensity=%3.2f cd \n",I)

printf("\n(c)")
M.S.C.P=I/W;
printf("\n Mean Spherical Candle Power per watt=%1.4
    f cd/watt \n",M.S.C.P)
```

Scilab code Exa 15.2 `Calculation of average luminance of the sphere`

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex15_2.sce
```

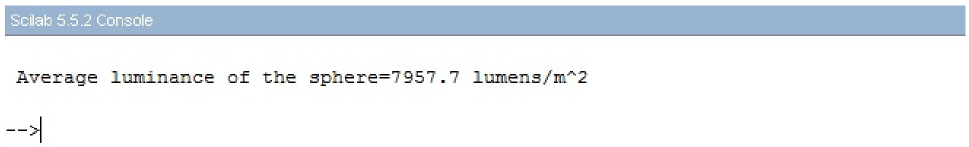


Figure 15.2: Calculation of average luminance of the sphere

```

clc;
clear;
d=40e-2;
light_flux=5000;
absorption_factor=0.2;
transmission_factor=0.8;
F=light_flux*transmission_factor;
A=%pi*d^2;
L=F/A;
printf("\n Average luminance of the sphere=%4.1f
    lumens/m^2 \n",L)
//Answer vary due to roundoff error in surface area
    (A) calculation
```

Figure 15.3: Determination of illumination

Scilab code Exa 15.3 `Determination of illumination`

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex15_3.sce

clc;
clear;
M.S.C.P=1000;
h=2.8;
x=2.5;
```

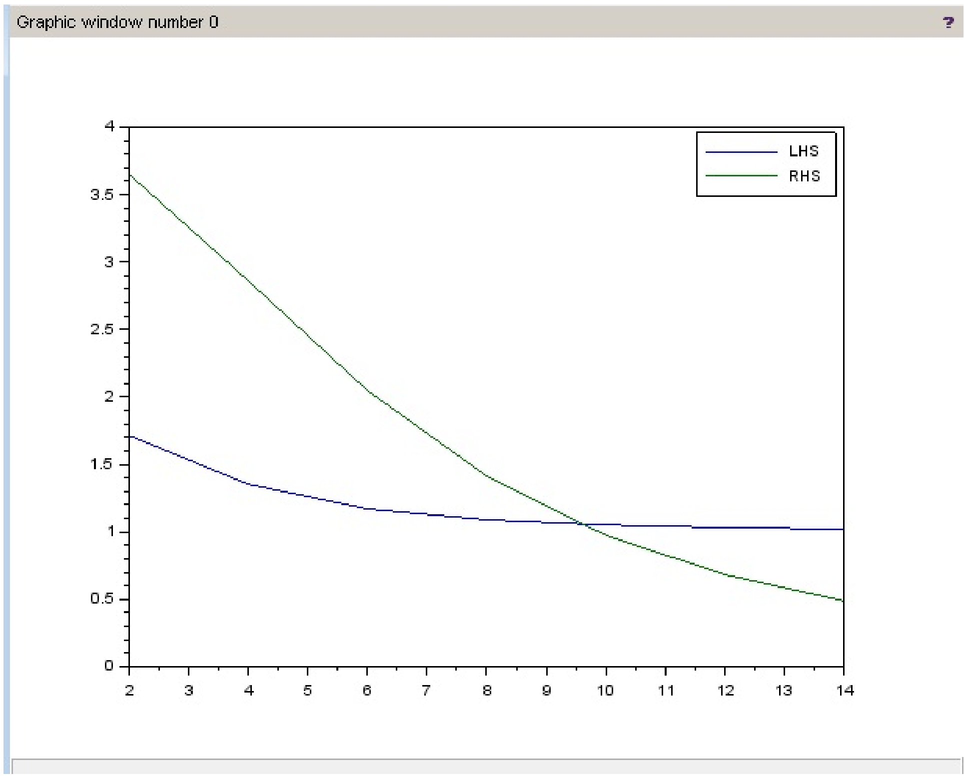


Figure 15.4: Calculation of distance between two lamps

```
E=(M.S.C.P*h)/(h^2+x^2)^(3/2);
printf("\n Illumination=%2.2f lux \n",E)
```

Scilab code Exa 15.4 Calculation of distance between two lamps

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

```

```
//Ex15_4.sce.

clc;
clear;
//There is a mistake in the question , given height
   is 5 instead of 4
h=4;
x=[2:2:14];
for i=1:length(x)

Ed(i)=(64/(4^2+x(i)^2)^(3/2))+1;
Eb(i)=(256/(4^2+(x(i)/2)^2)^(3/2));

end
xlabel("x-axis")
ylabel("y-axis")
title("Curves of L.H.S and R.H.S for different
   values of x")
plot(x,[Ed Eb])

legend('LHS','RHS')
```

Scilab code Exa 15.5 Determination of size of the conductor

```
//Book Name:Fundamentals of Electrical Engineering
//Author:Rajendra Prasad
//Publisher: PHI Learning Private Limited
//Edition:Third ,2014

//Ex15_5.sce

clc;
clear;
```

Figure 15.5: Determination of size of the conductor

```
I=25;
V=230;
l=45;
d=(0.02*V)+1; //Permissible voltage drop
//Referring table 15.10,
d1=(l/3.4)*(I/27);      //voltage for selected values from the table
if (d<d1) then
    I_refer=43;
    l_refer=5.4;
    A=16;
    d2=(l/l_refer)*(I/I_refer);
else
    d1=d2
end

printf("\n Voltage drop=%1.3f V \n",d2)
```

```
printf("\n Size of the conductor=%d mm^2 \n",A)
```