# Scilab Textbook Companion for Basic Electrical Engineering by P. S. Dhogal[1]

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January 28, 2014

[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:** Basic Electrical Engineering

**Author:** P. S. Dhogal

**Publisher:** Tata McGraw-Hill Publishing, New Delhi

**Edition:** 1

**Year:** 2005

**ISBN:** 0-07-45186-1

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

**Exa** Example (Solved example)

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

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

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

# Contents

# List of Scilab Codes

# Chapter 3

# electricity and its fundamental law

**Scilab code Exa 3.1** resistance

```
//Example 3.1 // resistance
clc;
clear;
close;
//given data :
V=230; // in volts
I=10; // in A
R=V/I;
disp(R,"resistance of element ,R(ohm)= ")
```

**Scilab code Exa 3.2** voltage

```
//Example 3.2 // voltage
clc;
clear;
close;
```

```
//given data :
R1=0.5; // minimum value of resistance in ohm
R2=20; // maximum value of resistance in ohm
I=1.2; // current in A
V1=I*R1;
V2=I*R2;
disp(V1,"voltage drop in Ist case,V1(V) = ")
disp(V2,"voltage drop in IInd case,V2(V) = ")
```

**Scilab code Exa 3.3** specific resistance

```
//Example 3.3 // resistance
clc;
clear;
close;
//given data :
L=1000; // length of wire in cm
d=0.14; // diameter of wire in cm
R1=2.5*10^6; // resistance in micro-ohm
a=(%pi*d^2)/4; // cross section area
p=(R1*a)/L;
disp(p,"the specific resistance,p(micro-ohm-cm) = ")
```

**Scilab code Exa 3.4** resistance

```
//Example 3.4 // resistance
clc;
clear;
close;
//given data :
Rt1=54.3; //  resistance in ohm
alfa=0.0043; // the resistance temperature of
   coeficient in per degree celcius
```

```
t1=20; // temperature in degree celcius
t2=40; // temperature in degree celcius
Rt2=(Rt1*(1+(alfa*t2)))/(1+(alfa*t1));
disp(Rt2,"resistance at 40 degree celsius,Rt2(ohm) =
    ")
```

**Scilab code Exa 3.5.a** total resistance

```
//Example 3.5.a // resistance
clc;
clear;
close;
//given data :
r1=30; //  resistance in ohm
r2=35;  //  resistance in ohm
r3=45;  //  resistance in ohm
R=r1+r2+r3;
disp(R,"total resistance,R(ohm) = ")
```

**Scilab code Exa 3.5.b** current flowing

```
//Example 3.5.b // current
clc;
clear;
close;
//given data :
r1=30; //  resistance in ohm
r2=35;  //  resistance in ohm
r3=45;  //  resistance in ohm
R=r1+r2+r3;
V=220;
I=V/R;
disp(I,"current,I(A) = ")
```

**Scilab code Exa 3.6** voltage

```
//Example 3.6 // voltage at the generating station
clc;
clear;
close;
//given data :
I=75; // current in A
R=0.15; // resistance in ohm
v=220; // voltage in volts
V1=I*R; // voltage drop of the feeder in section AB
V2=I*R; // voltage drop of the feeder in section CD
V_total=V1+V2; // total voltage drop in the lead and
    return feeder
V=v+V_total;
disp(V,"voltage at the generating station,V(v) = ")
```

**Scilab code Exa 3.7** total resistance

```
//Example 3.7 // total resistance
clc;
clear;
close;
//given data :
r1=6; //  resistance in ohm
r2=10; //  resistance in ohm
r3=15; //  resistance in ohm
r=(1/r1)+(1/r2)+(1/r3);
R=1/r;
disp(R,"equivalent resistance,R(ohm) = ")
```

**Scilab code Exa 3.8** voltage

```
//Example 3.8 // voltage
clc;
clear;
close;
//given data :
I=5; // current in A
n=2; // number of resistance in parallel of section
    BC
r1=15; // resistance in ohm
r2=20; // resistance in ohm
r3=60; // resistance in ohm
r4=64; // resistance in ohm
r5=64; // resistance in ohm
r6=2.5; // resistance in ohm
R1=r4/n; // equivalent resistance of section BC
R2=(r1*r2*r3)/((r1*r2)+(r2*r3)+(r3*r1)); //
    equivalent resistance of section CD
R=R1+R2+r6; // equivalent resistance of section AD
V=I*R;
disp(V,"voltage ,V(v) = ")
```

**Scilab code Exa 3.9** effective resistance and current

```
//Example 3.9 // resistance and current
clc;
clear;
close;
//given data :
V=240; // voltage in volts
r1=2; // resistance in ohm
```

```
r2=3; // resistance in ohm
r3=8.8;  // resistance in ohm
r4=10;  // resistance in ohm
r5=3;  // resistance in ohm
R1=(r1*r2)/(r1+r2); // equivalent resistance of
    parallel branch
R2=R1+r3; // equivalent resistance of section ABC
R3=(R2*r4)/(R2+r4);
R=R3+r5; // total resistance of section AD
I=V/R;
V1=I*r5; // voltage drop across r5
V2=V-V1; // voltage drop across section ABC
I1=V2/r4; // current flowing through r4 resistance
I2=I-I1; // current in r3 resistance
V3=I2*r3; // voltage drop across r3 resistance ,
    section ABC
V4=V2-V3; // voltage drop between section AB
I3=V4/r1; // current flowing through r1 resistance
I4=V4/r2; //  current flowing through r2 resistance
disp(I3,"current flowing through r1 (2 ohms)
    resistance ,I3(A) = ")
disp(I4,"current flowing through r2 (3 ohms)
    resistance ,I4(A) = ")
disp(R,"total resistance ,R(ohm) = ")
disp(V1,"voltage drop across r5(3 ohms) resistance ,
    V1(V) = ")
disp(V2,"voltage drop across section ABC,V2(V) = ")
disp(V3,"voltage drop across r3 resistance(8.8 ohms)
    ,V3(V) = ")
disp(V4," voltage drop between section AB,V4(V) = ")
```

**Scilab code Exa 3.10** current

```
//Example 3.10 // current
clc;
```

```
clear;
close;
//given data :
I=44; // current in A
r1=6; // resistance in ohm
r2=12;  // resistance in ohm
r3=18; // resistance in ohmr1
a=(1/r1)+(1/r2)+(1/r3);
R=1/a;
V=I*R;
i1=V/r1;
i2=V/r2;
i3=V/r3;
disp(i1,"current in 6 ohm resistance ,i1(A) = ")
disp(i2,"current in 12 ohm resistance ,i2(A) = ")
disp(i3,"current in 18 ohm resistance ,i3(A) = ")
```

**Scilab code Exa 3.11.a** unknow resistance

```
//Example 3.11.A // RESISTANCE
clc;
clear;
close;
t=15;//TOTAL CURRENT IN AMPERES
i1=2;//CURRENT THROUGH UNKNOWN RESISTANCE
R1=15;//in ohms
R2=50/2;//in ohms
x=(t-i1)*((R1*R2)/(R1+2*R2));//unknown resistance in
    ohms)
disp(x,"unknown resistance in ohms")
```

**Scilab code Exa 3.11.b** potential drop

```
//Example 3.11.B // potential drop across the
    circuit
clc;
clear;
close;
t=15;//TOTAL CURRENT IN AMPERES
i1=2;//CURRENT THROUGH UNKNOWN RESISTANCE
R1=15;//in ohms
R2=50/2;//in ohms
x=(t-i1)*((R1*R2)/(R1+2*R2));//unknown resistance in
    ohms
PD=i1*x;//in volts
disp(PD,"potential drop across the circuit in volts
    is")
```

**Scilab code Exa 3.11.c** current

```
//Example 3.11.C // CURRENT IN EACH RESISTANCE
clc;
clear;
close;
t=15;//TOTAL CURRENT IN AMPERES
i1=2;//CURRENT THROUGH UNKNOWN RESISTANCE
R1=15;//in ohms
R2=50/2;//in ohms
x=(t-i1)*((R1*R2)/(R1+2*R2));//unknown resistance in
    ohms
PD=i1*x;//in volts
i5= PD/(2*R2);//current in 5 ohms resistance
i15=PD/R1;//current in 15 ohms resistance
disp(i5,"current in 5 ohms resistance in ampere")
disp(i15,"current in 15 ohms resistance in ampere")
```

**Scilab code Exa 3.11.d** total resistance

```
//Example 3.11.d // total resistance
clc;
clear;
close;
t=15;//TOTAL CURRENT IN AMPERES
i1=2;//CURRENT THROUGH UNKNOWN RESISTANCE
R1=15;//in ohms
R2=50/2;//in ohms
x=(t-i1)*((R1*R2)/(R1+2*R2));//unknown resistance in
    ohms
PD=i1*x;//in volts
RX=((1/R1)+(1/(2*R2))+(1/x));//
R=1/RX;//
disp(R,"total resistance of the circuit in ohms")
```

# Chapter 4

# Work power and energy

**Scilab code Exa 4.1.b** power lost

```
//Example 4.1.b // power lost
clc;
clear;
close;
//given data :
I=11; // current in A
V1=55;  // voltage in V
V2=220; // voltage in V
V=V2-V1;
R=V/I;
P=I^2*R;
disp(P,"power lost ,P(W) = ")
```

**Scilab code Exa 4.1** resistance

```
//Example 4.1.a // resistance
clc;
clear;
```

```
close;
//given data :
I=11; // current in A
V1=55;  // voltage in V
V2=220; // voltage in V
V=V2-V1;
R=V/I;
disp(R,"resistance ,R(ohm) = ")
```

**Scilab code Exa 4.2** resistance

```
//Example 4.2 : resistance of each coil
clc;
clear;
close;
//given data :
V=300; // voltage in volts
W=360; // power lost in one coil in watt
I=6; // current in A
R1=V/I;
R=V^2/W;
a=(1/R1)-(1/R);
r2=1/a;
disp(R,"resistance of 360W coil1 ,R(ohm) = ")
disp(r2,"resistance of second coil2 ,r2(ohm) = ")
```

**Scilab code Exa 4.3** resistance

```
//Example 4.3 : resistance
clc;
clear;
close;
//given data :
```

```
W1=100;// in watt
E=110;// in volts
W2=60;// in watt
I1=W1/E;// current taken by 100 w lamp
I2=W2/E;// current taken by 60W lamp
I=I1-I2;
R=E/I;
disp(R,"resistance ,R(ohm) = ")
```

**Scilab code Exa 4.4.a** power taken in parallel case

```
//Example 4.4.a: power in case of parallel
clc;
clear;
close;
//given data :
w=100; // in watt
V=220; // voltage in volts
R1=V^2/w;
R=R1/2; // total resistance of the circuit
I=V/R;
W=I^2*R;
disp(W,"power in case of parallel ,W(watt) = ")
```

**Scilab code Exa 4.4.b** power taken in series case

```
//Example 4.4.b: power in case of series
clc;
clear;
close;
//given data :
w=100; // in watt
V=220; // voltage in volts
```

```
R1=V^2/w;
R2=V^2/w;
R=R1+R2; // total resistance of the circuit
I=V/R;
W=I^2*R;
disp(W,"power in case of series,W(watt) = ")
```

**Scilab code Exa 4.5.a** total load

```
//Example 4.5.a: total load
clc;
clear;
close;
//given data :
l=300; // number of lamps
w1=60; // in watt
W1=w1*l; // wattage required for 300 lamps, 60 watt each
w2=40; // in watt
f=100; // number of fan
W2=w2*f;// wattage required for 100 fans, 40 watt each
W=(W1+W2)*10^-3;
disp(W,"total load,W(kilo-watt) = ")
```

**Scilab code Exa 4.5.b** current taken

```
//Example 4.5.b: current taken by load
clc;
clear;
close;
//given data :
V=220; // voltage in volts
```

```
l=300; // number of lamps
w1=60; // in watt
W1=w1*l;
w2=40; // in watt
f=100; // number of fan
W2=w2*f;
W=(W1+W2)*10^-3;
I=(W*1000)/V;
disp(I,"current,I(A) = ")
```

**Scilab code Exa 4.6** total cots of electric energy and total charges of bill

```
//Example 4.6 // total cost of elecric charge
clc;
clear;
close;
nl=12;//no. of lamps
wl=100;//wattage of lamps
hl=6;//each lamps work 6 hours a days
w12=wl*nl*hl;//wattage of 12 lamps in Wh
nf=6;//no. of fans
wf=60;//wattage of fans
hf=5;//each fans work 5 hours a days
w6=wf*nf*hf;//wattage of 12 fans in Wh
nc=2;//no. of electric cookers
wc=1500;//wattage of electric cookers
hc=4;//each electric cookers work 4 hours a days
w2=wc*nc*hc;//wattage of 2 electric cookers in Wh
ng=2;//no. of gysers
wg=1000;//wattage of each gyser
hg=3;//each gyser works 3 hours a day
w21=wg*hg*ng;//total wattage of gysers in Wh
tcg=(w12+w6)*10^-3;//TOTAL WATTAGE OF LAMPS AND FANS
Ccg=40;//IN PAISA
Ecg= (tcg*Ccg*30)/100;//TOTAL ENERGY CHARGES @40
```

```
PAISA PER UNIT
tcg1=(w2+w21)*10^-3;//TOTAL WATTAGE OF COOKERS AND
    GYSERS
Ccg1=35;//IN PAISA
Ecg1= (tcg1*Ccg1*30)/100;//TOTAL ENERGY CHARGES @35
    PAISA PER UNIT
tc=Ecg+Ecg1;// IN RUPPES
disp(Ecg,"total cost of electric charge @40 paisa
    per unit in rupees")
disp(Ecg1,"total cost of electric charge @35 paisa
    per unit in rupees")
disp(tc,"total charge for ligh and power in rupees")
```

**Scilab code Exa 4.7** voltage current power and bill amount

```
//Example 4.7 // total consumption of factory in
    killo watts
clc;
clear;
close;
nl=400;//no. of lamps
wl=100;//wattage of lamps
w400=wl*nl;//wattage of 400 lamps in W
nf=100;//no. of fans
wf=40;//wattage of fans
w6=wf*nf;//wattage of 100 fans in W
nc=200;//no. of wall scokets
wc=60;//wattage of wall scckets
w2=wc*nc;//wattage of 200 wall sockets in Wh
tc= w400+w6+w2;//total consumption in kW
tc= w400+w6+w2;//total consumption in kW
h=5;// hours
ll=tc*10^-3*h;//lightning load in kWh
V=250;//in volts
I=20;//in amperes
```

```
Ml=V*I*10^-3;//miscellaneous loads in kW
Ml=V*I*10^-3;//miscellaneous loads in kW
hm=2;//hours
hl=50;//heating load in kW
Mhp=40;//BNHP
Mo= ((50*80*746)/(100*1000));//MOTOR AT 80% LOAD IN
    Kw
tl=tc*10^-3+Ml+hl+Mo;//total load in kW
disp(tl,"total load is ,(kW)=")
It= (tl*10^3)/V;//total current taken buy the
    factory in amperes
disp(It,"total current taken by the factory is ,(A)="
    )
r=0.03;//IN OHMS
Vc=It*r;//voltage drop in the cable
Vs=Vc+V;//voltage at the sending end of the feeder
    in volts
disp(Vs,"voltage at the sending end of the feeder is
    ,(V)")
r=0.03;//IN OHMS
Vc=It*r;//voltage drop in the cable
Pw=It^2*r;//power wasted in kW
disp(Pw*10^-3,"power wasted is ,(kW)")
Mlh=Ml*hm;//miscellaneous load in kWh
te=Mlh+ll;//TOTAL ENERGY COSNUMED PER DAY
Nu=te*6;//NO. OF UNITS
Ec=(Nu*30)/100;// ENERGY CHARGE @30 PAISA PER UNIT
eCM=Ec+2+34.80;//TOTAL CHARGE AFTER TAX AND RENT IN
    RUPEES
hl=50;//heating load in kW
hlh=50*4;//heating load in kWh
Moh=Mo*8;//MOTOR LOAD IN kWh
TEP=hlh+Moh;//total energy per day
tepl=TEP*6;//total energy in 6 days
tepc=(tepl*35)/100;// energy charges @35 paisa per
    unit in rupees
tepcl=tepc+50+78.96;//total charges in rupess
disp(eCM,"total lightning charges including meter
```

```
    rent and electricy tax is ,(Rs)=")
disp(tepcl,"total power charges including meter rent
     and electricy tax is ,(Rs)=")
gt=tepcl+eCM;//
disp(gt,"grand total of bills is ,(Rs)=")
```

**Scilab code Exa 4.8** current taken

```
//Example 4.8: current taken by load
clc;
clear;
close;
//given data :
V=250; // voltage in volts
L=5*746; // 1 hp=746 watt
eta=80;// eficiency of motor in %
Input=(L*100)/80;
I=Input/V;
disp(I,"cureent ,I(A) = ")
```

**Scilab code Exa 4.9** amount of bills

```
//Example 4.9 //total of bills
clc;
clear;
close;
p=30;//horse power of motor
r=24;// rupees per kWh
ec=35;//paisa per unit
n=80;//percentage of load
t=8;// in hours
d=25;// total days
ne=96;//efficiency of motor in percentage
```

```
mo=(n*p)/100;//output of motor at 80% of load
mi=(mo*100*746)/(ne);//input of motor in watts
ecm=mi*10^-3*t*d;//energy consumed in a month
ecu=(ecm*35)/100;//energy charges
mid=(30*100*746)/(ne*1000);//input of motor in kW at
    demanded
ecud=(mid*24);// demanded connection in rupees
ta=ecu+ecud;//total bill in rupees
disp(ta,"total bill in rupees is")
```

**Scilab code Exa 4.10.a** total load of light and fans

```

//Example 4.10.a//total load of lights and fans
clc;
clear;
close;
lp=50;//no. of light points
lw=60;//wattage of light points
fp=20;//no. of fan points
fw=100;//wattage of fan points
wpp=10;//no. of wall plug points
wppw=60;//wattage of wall plug points
bp=5;//no. of bell points
bpw=40;//wattage of bell points
ppp=8;//power plug points
pppw=5000;//wattage of power plug points
lpw=lp*lw;//wattage of 50 lamps
fpw=fp*fw;//wattage of 20 fans
wpppw=wpp*wppw;//wattage of wall plug points
bpww=bp*bpw;//wattage of bell points
tl=lpw+fpw+wpppw+bpww;//total wattage
disp(tl,"total wattage of lightning load is in watts
    ")
```

**Scilab code Exa 4.10.b** total load current

```
//Example 4.10.b//total load of power connection
clc;
clear;
close;
V=400;//three phase voltage
lp=50;//no. of light points
lw=60;//wattage of light points
fp=20;//no. of fan points
fw=100;//wattage of fan points
wpp=10;//no. of wall plug points
wppw=60;//wattage of wall plug points
bp=5;//no. of bell points
bpw=40;//wattage of bell points
ppp=8;//power plug points
pppw=500;//wattage of power plug points
lpw=lp*lw;//wattage of 50 lamps
fpw=fp*fw;//wattage of 20 fans
wpppw=wpp*wppw;//wattage of wall plug points
bpww=bp*bpw;//wattage of bell points
tl=lpw+fpw+wpppw+bpww;//total wattage
ppppw=ppp*pppw;//wattage of power plug points
tw=tl+ppppw;//total wattage
Il=(tl/V);// CURRENT THROUGH LIGHTNING LOAD
Ip=ppppw/V;// current through power load
ttl=Il+Ip;//total load curent
disp(ttl,"total load current in amperes")
```

**Scilab code Exa 4.11** horsepower of the motor

```
//Example 4.11: horse power
```

```
clc;
clear;
close;
//given data :
h=30; // in m
Fl=10;// friction loss in %
Hl=(Fl/100)*h;
total_H=h+Hl;
eta=90; // eficiency of pump
w=1000; // water weight in kg
flow_rate=243; // in per hour
W_done=(flow_rate*w*total_H)/60; // in kg-m/min
output=W_done/4500; //output of pump in hp
in=(output*100)/eta;
O=in;
disp(O,"output of the motor,O(hp) = ")
```

**Scilab code Exa 4.12.a** Bhp of the motor

```

//Example 4.12.a: BHP of the motor
clc;
clear;
close;n=80;//efficiency
l=7.5;//load in tonnes
h=135;//height in meters
c=0.5;//cge weight in tonnes
b=3;//balance weight in tonnes
td=90;//time in seconds
onet=1000;// in kg
onehp=746;//watt
wl=l+c-b;//weight lifted during upward journey in
    tonnes
wld=b-c;//weight lifted during downward journey in
    tonnes
```

```
wdu=(wl*10^3*h*60)/td;//work done by the lift per
    minute during upward journey
wdd=(wld*10^3*h*60)/td;//work done by the lift per
    minute during downward journey
mou=wdu/4500;// in hp
miu=(mou*100*746)/(n*1000);// input of motor in kW
mod=wdd/4500;// in hp
mid=(mod*100*746)/(n*1000);// input of motor in kW
disp(mou,"BHP of the motor in upward journey in hp")
disp(mod,"BHP of the motor in downward journey in hp
    ")
```

**Scilab code Exa 4.12.b** cost of the energy

```
//Example 4.12.b: cost of the energy
clc;
clear;
close;n=80;//efficiency
l=7.5;//load in tonnes
h=135;//height in meters
c=0.5;//cge weight in tonnes
b=3;//balance weight in tonnes
td=90;//time in seconds
onet=1000;// in kg
onehp=746;//watt
wl=l+c-b;//weight lifted during upward journey in
    tonnes
wld=b-c;//weight lifted during downward journey in
    tonnes
wdu=(wl*10^3*h*60)/td;//work done by the lift per
    minute during upward journey
wdd=(wld*10^3*h*60)/td;//work done by the lift per
    minute during downward journey
mou=wdu/4500;// in hp
miu=(mou*100*746)/(n*1000);// input of motor in kW
```

```
mod=wdd/4500;// in hp
mid=(mod*100*746)/(n*1000);// input of motor in kW
tc=miu+mid;//total energy consumption in kW
Eh=tc*10;//total energy consuption per hour
rate=40;//rate in paisa
ce=Eh*(rate/100);//cost of energy in rupees
disp(ce,"cost of energy in rupees is")
```

# Chapter 5

# effects of electric current

**Scilab code Exa 5.1** ECE of silver

```
//Example 5.1: E.C.E
clc;
clear;
close;
//given data :
t=200; // time in sec
M=111.83; // silver in mg
I=0.5; // current in A
Z=(M/(I*t*1000))*1000;// electro-chemical-equivalent
disp(Z,"E.C.E,Z(mg/C) = ")
```

**Scilab code Exa 5.2** thickness of coper

```
//Example 5.2: thickness
clc;
clear;
close;
//given data :
```

```
Z=0.329*10^-3;// IN g/C
I=1;// in amperes
t=90*60;// in seconds
M=Z*I*t;// in grams
A=200;//area in centimete square
S=8.9;//density in g/cc
T=(M)/(2*A*S);//thickness in cm
disp(T,"thickness of copper in cm is")
```

**Scilab code Exa 5.3** resistance

```
//Example 5.3 // resistance of the heater element
clc;
clear;
close;
w=15;// in kg
t1=15;// in degree celsius
t2=100;//in degree celsius
t=25;// time in minutes
I=10;// in ampere
n=85;//efficiency of conversion in percentage
ho=w*(t2-t1);//output heat required in kcal
R=((ho*4187*100)/(I^2*t*60*n));// resistance in ohms
disp(R,"resistance in ohms")
```

**Scilab code Exa 5.4** potential difference

```
//Example 5.4 // potential difference across the
   heater element
clc;
clear;
close;
w=20;// in kg
```

```
t1=10;// in degree celsius
t2=90;//in degree celsius
t=2*3600+19*60+34;// time in seconds
I=4;// in ampere
n=80;//efficiency of conversion in percentage
ho=w*(t2-t1);//output heat required in kcal
V=((ho*4187*100)/(I*t*n));// POTENTIAL DROP IN VOLTS
disp(V,"potential drop across heater element in
    volts is")
```

# Chapter 6

# magnetism and electromagnetism

**Scilab code Exa 6.1** field strength

```
//Example 6.1 // field strength
clc;
clear;
close;
I=1.5;// in amperes
n=50;//turns
l=0.25;//length of coil in meter
H=(I*n)/l;//field strength in ampere-turns/m
disp(H,"field strength in ampere-turns/m")
```

**Scilab code Exa 6.2** force

```
//Example 6.2 // force
clc;
clear;
close;
```

```
I=70;// in amperes
B=0.4;//flus density in Wb/m^2
n=1;//turns
F=B*n*I;// in newton
disp(F,"force in newtons is")
```

**Scilab code Exa 6.3** emf induced

```

//Example 6.3 // emf induced
clc;
clear;
close;
b=2;//in Wb/m^2
l=6;//in cm
s=0.75;//in m's
alpha=90;//
emf=b*l*s*(sind(alpha));//
disp(emf,"emf induced in volts is")
```

# Chapter 7

# DC generators

**Scilab code Exa 7.1.a** emf induced

```
//Example 7.1.a: e.m.f
clc;
clear;
close;
// given data:
p=8; // number of poles
a=p; // in lap winding
fi=15*10^-3; // in wb
N=500; // rev/min
Z=800; // number of conductors on armature
emf=(fi*Z*N*p)/(60*a);// when the armature is lap
   wound
disp(emf,"emf(V) = ")
```

**Scilab code Exa 7.1.b** emf generated

```
//Example 7.1.b: e.m.f if the armature is wave wound
clc;
```

```
clear;
close;
// given data:
p=8; // number of poles
a=2; // in wave winding
fi=15*10^-3; // in wb
N=500; // rev/min
Z=800; // number of conductors on armature
emf=(fi*Z*N*p)/(60*a);// when the armature is wave
    wound
disp(emf,"emf(V) = ")
```

**Scilab code Exa 7.2.a** total armature current

```
//Example 7.2.a: total armature current
clc;
clear;
close;
// given data:
Vt=200;// terminal voltage in volts
Rsh=100; //shunt fieldresistance  in ohm
Ra=0.1; // armature resistance in ohm
l=60; // number of lamps
w=40;// in watt
total_l=l*w;// in watt
Il=total_l/Vt;// load current
Ish=Vt/Rsh;// shunt field current
Ia=Il+Ish;
disp(Ia,"armature current,Ia(A) = ")
```

**Scilab code Exa 7.2.b** current per armature path

```
//Example 7.2.b: current per armature path
```

```
clc;
clear;
close;
// given data:
Vt=200;// terminal voltage in volts
Rsh=100; //shunt fieldresistance  in ohm
Ra=0.1; // armature resistance in ohm
l=60; // number of lamps
w=40;// in watt
total_l=l*w;// in watt
Il=total_l/Vt;// load current
Ish=Vt/Rsh;// shunt field current
Ia=Il+Ish;
N=4; // number of poles
I=Ia/N;
disp(I,"current per path in a armature,I(A) = ")
```

**Scilab code Exa 7.2.c** emf generated

```
//Example 7.2.c: emf
clc;
clear;
close;
// given data:
Vt=200;// terminal voltage in volts
Rsh=100; //shunt fieldresistance  in ohm
Ra=0.1; // armature resistance in ohm
l=60; // number of lamps
w=40;// in watt
total_l=l*w;// in watt
Il=total_l/Vt;// load current
Ish=Vt/Rsh;// shunt field current
Ia=Il+Ish;
N=4; // number of poles
I=Ia/N;
```

```
Va=Ia*Ra;//armature voltage drop
Vb=1+1; // brush contact drop for 2 pair of poles
E=Vt+Va+Vb;
disp(E,"emf,E(v) = ")
```

**Scilab code Exa 7.3.a** terminal voltage

```
//Example 7.3.a: terminal voltage
clc;
clear;
close;
// given data:
W=10;// output of the generator in k-w
V=250; // voltage in volts
R=0.07; // in ohm
Il=(W*1000)/V;// load current in A
Vf=Il*R;// voltage drop in feeder
Vt=V+Vf;
disp(Vt,"terminal voltage,Vt(V) = ")
```

**Scilab code Exa 7.3.b** emf generated

```
//Example 7.3.b: emf
clc;
clear;
close;
// given data:
W=10;// output of the generator in k-w
V=250; // voltage in volts
R=0.07; // in ohm
Il=(W*1000)/V;// load current in A
Vf=Il*R;// voltage drop in feeder
Vt=V+Vf;// terminal voltage
```

```
Rsh=63.2; // shunt resistance in ohm
Ra=0.05; // armature resistance in ohm
Vb=2; // brush contact drop
Ish=Vt/Rsh;
Ia=Il+Ish;
Vd=Ia*Ra;// voltage drop in the armature
E=Vt+Vd+Vb;
disp(E,"emf,E(V) = ")
```

**Scilab code Exa 7.4.a** terminal voltage

```
//Example 7.4.a: terminal voltage
clc;
clear;
close;
// given data:
W=20000;// in watt
V=200; // in volts
R=0.08; // in ohm
Rs=0.02; // series field resistance in ohm
I=W/V; // in A
Vf=I*R;
Vs=I*Rs;
V1=Vf+Vs; // voltage drop of feeder and series field
Vg=V+V1;
disp(Vg,"terminal voltage,Vg(V) = ")
```

**Scilab code Exa 7.4.b** emf generated

```
//Example 7.4.b: emf generated
clc;
clear;
close;
```

```
// given data:
W=20000;// in watt
V=200; // in volts
R=0.08; // in ohm
Rs=0.02; // series field resistance in ohm
I=W/V; // in A
Rsh=42; // shunt ield resistance in ohm
Ra=0.04; //  armature resistance in ohm
Vf=I*R;
Vs=I*Rs;
V1=Vf+Vs; // voltage drop of feeder and series field
Vg=V+V1;// terminal voltage
Ish=Vg/Rsh;// shunt field current
Ia=I+Ish;
Vd=Ia*Ra;
emf=Vg+Vd;
disp(emf,"emf(V) = ")
```

**Scilab code Exa 7.4.c** copper losses

```
//Example 7.4.c: copper losses
clc;
clear;
close;
// given data:
W=20000;// electrical output in watt
V=200; // in volts
R=0.08; // in ohm
Rs=0.02; // series field resistance in ohm
I=W/V; // in A
Rsh=42; // shunt ield resistance in ohm
Ra=0.04; //  armature resistance in ohm
Vf=I*R;
Vs=I*Rs;
V1=Vf+Vs; // voltage drop of feeder and series field
```

```
Vg=V+V1;// terminal voltage
Ish=Vg/Rsh;// shunt field current
Ia=I+Ish;
Vd=Ia*Ra;
emf=Vg+Vd;
Ed=emf*Ia;// in watt
copper_losses=Ed-W;
disp(copper_losses,"copper losses(Watt) = ")
```

**Scilab code Exa 7.4.d** Bhp metric of the primemover

```
//Example 7.4.d: bhp metric of the primemover
clc;
clear;
close;
// given data:
W=20000;// electrical output in watt
V=200; // in volts
R=0.08; // in ohm
Rs=0.02; // series field resistance in ohm
I=W/V; // in A
Rsh=42; // shunt ield resistance in ohm
Ra=0.04; //  armature resistance in ohm
iron_losses=309.5; // iron and friction losses
Vf=I*R;
Vs=I*Rs;
V1=Vf+Vs; // voltage drop of feeder and series field
Vg=V+V1;// terminal voltage
Ish=Vg/Rsh;// shunt field current
Ia=I+Ish;
Vd=Ia*Ra;
emf=Vg+Vd;
Ed=emf*Ia;// in watt
copper_losses=Ed-W;
mech_in=W+copper_losses+iron_losses;
```

```
Bhp=mech_in/735.5;
disp(Bhp,"bhp metric of the primemover,Bhp = ")
```

**Scilab code Exa 7.4.e** commercial efficiency

```

//Example 7.4.d: bhp metric of the primemover
clc;
clear;
close;
// given data:
W=20000;// electrical output in watt
V=200; // in volts
R=0.08; // in ohm
Rs=0.02; // series field resistance in ohm
I=W/V; // in A
Rsh=42; // shunt ield resistance in ohm
Ra=0.04; //  armature resistance in ohm
iron_losses=309.5; // iron and friction losses
Vf=I*R;
Vs=I*Rs;
V1=Vf+Vs; // voltage drop of feeder and series field
Vg=V+V1;// terminal voltage
Ish=Vg/Rsh;// shunt field current
Ia=I+Ish;
Vd=Ia*Ra;
emf=Vg+Vd;
Ed=emf*Ia;// in watt
copper_losses=Ed-W;
mech_in=W+copper_losses+iron_losses;// mechanical
    power inoput
Bhp=mech_in/735.5;
efficiency=(W/mech_in)*100;
disp(efficiency,"efficiency(%) = ")
```

**Scilab code Exa 7.5.a** total armature current

```
//Example 7.5.a: total armature current
clc;
clear;
close;
// given data:
n=3;// number of motors
i=30; //current in A
I=i*n;// current taken by three motors
Rsh=44; // shunt field resistance
V=440; // voltage in V
Ish=V/Rsh;// shunt field current
Ia=I+Ish;
disp(Ia,"total armature current,Ia(A) = ")
```

**Scilab code Exa 7.5.b** current

```
//Example 7.5.b: current in each path
clc;
clear;
close;
// given data:
n=3;// number of motors
n1=4;// number of parallel path in winding
i=30; //current in A
I=i*n;// current taken by three motors
Rsh=44; // shunt field resistance
Ra=0.08; // armature resistance in ohm
V=440; // voltage in V
Ish=V/Rsh;// shunt field current
Ia=I+Ish;
```

```
I1=Ia/n1;// current in each path
disp(I1,"current in each path,I1(A) = ")
```

**Scilab code Exa 7.5.c** emf generated

```
//Example 7.5.c: e.m.f
clc;
clear;
close;
// given data:
n=3;// number of motors
n1=4;// number of parallel path in winding
i=30; //current in A
I=i*n;// current taken by three motors
Rsh=44; // shunt field resistance
Ra=0.08; // armature resistance in ohm
V=440; // voltage in V
Ish=V/Rsh;// shunt field current
Ia=I+Ish;
I1=Ia/n1;// current in each path
Va=Ia*Ra; // armature drop
Vb=2;// we know , brush contact drops
E=V+Va+Vb;
disp(E,"emf,E(V) = ")
// answer is wrong in a book
```

**Scilab code Exa 7.5.d** power developed

```
//Example 7.5.d: electrical power developed in the
    armature
clc;
clear;
close;
```

```
// given data:
n=3;// number of motors
n1=4;// number of parallel path in winding
i=30; //current in A
Bhp=65;// in hp
I=i*n;// current taken by three motors
Rsh=44; // shunt field resistance
Ra=0.08; // armature resistance in ohm
V=440; // voltage in V
Ish=V/Rsh;// shunt field current
Ia=I+Ish;
I1=Ia/n1;// current in each path
Va=Ia*Ra; // armature drop
Vb=2;// we know , brush contact drops
E=V+Va+Vb;
E_power=E*Ia;
W=V*I;// in watt
M_power=Bhp*746;// assume Bhp=746 W
disp(E_power,"electrical power developed in watt = "
    )
// answer is wrong in a book
```

**Scilab code Exa 7.5.e** copper losses

```
//Example 7.5.e: copper losses
clc;
clear;
close;
// given data:
n=3;// number of motors
n1=4;// number of parallel path in winding
i=30; //current in A
Bhp=65;// in hp
I=i*n;// current taken by three motors
Rsh=44; // shunt field resistance
```

```
Ra=0.08; // armature resistance in ohm
V=440; // voltage in V
Ish=V/Rsh;// shunt field current
Ia=I+Ish;
I1=Ia/n1;// current in each path
Va=Ia*Ra; // armature drop
Vb=2;// we know , brush contact drops
E=V+Va+Vb;
E_power=E*Ia;
W=V*I;// in watt
M_power=Bhp*746;// assume Bhp=746 W
Copper_losses=E_power-W;
disp(Copper_losses,"copper losses (W) = ")
```

**Scilab code Exa 7.5.f** stray losses

```
//Example 7.5.f: stray losses
clc;
clear;
close;
// given data:
n=3;// number of motors
n1=4;// number of parallel path in winding
i=30; //current in A
Bhp=65;// in hp
I=i*n;// current taken by three motors
Rsh=44; // shunt field resistance
Ra=0.08; // armature resistance in ohm
V=440; // voltage in V
Ish=V/Rsh;// shunt field current
Ia=I+Ish;
I1=Ia/n1;// current in each path
Va=Ia*Ra; // armature drop
Vb=2;// we know , brush contact drops
E=V+Va+Vb;
```

```
E_power=E*Ia;
W=V*I;// in watt
M_power=Bhp*746;// assume Bhp=746 W
Copper_losses=E_power-W;
S_loses=M_power-E_power;
disp(S_loses,"stray losses(W) = ")
```

**Scilab code Exa 7.5.g.1** electrical efficiency

```
//Example 7.5.g.i: electrical efficiency
clc;
clear;
close;
// given data:
n=3;// number of motors
n1=4;// number of parallel path in winding
i=30; //current in A
Bhp=65;// in hp
I=i*n;// current taken by three motors
Rsh=44; // shunt field resistance
Ra=0.08; // armature resistance in ohm
V=440; // voltage in V
Ish=V/Rsh;// shunt field current
Ia=I+Ish;
I1=Ia/n1;// current in each path
Va=Ia*Ra; // armature drop
Vb=2;// we know , brush contact drops
E=V+Va+Vb;
E_power=E*Ia;
W=V*I;// in watt
M_power=Bhp*746;// assume Bhp=746 W
Copper_losses=E_power-W;
S_loses=M_power-E_power;
eta_e=(W/E_power)*100;
disp(eta_e,"electrical efficiency,eta_e(%) = ")
```

**Scilab code Exa 7.5.g.2** commercial efficiency

```
//Example 7.5.g.i: commercial efficiency
clc;
clear;
close;
// given data:
n=3;// number of motors
n1=4;// number of parallel path in winding
i=30; //current in A
Bhp=65;// in hp
I=i*n;// current taken by three motors
Rsh=44; // shunt field resistance
Ra=0.08; // armature resistance in ohm
V=440; // voltage in V
Ish=V/Rsh;// shunt field current
Ia=I+Ish;
I1=Ia/n1;// current in each path
Va=Ia*Ra; // armature drop
Vb=2;// we know , brush contact drops
E=V+Va+Vb;
E_power=E*Ia;
W=V*I;// in watt
M_power=Bhp*746;// assume Bhp=746 W
Copper_losses=E_power-W;
S_loses=M_power-E_power;
eta_c=(W/M_power)*100;
disp(eta_c,"commercial efficiency ,eta_c(%) = ")
```

**Scilab code Exa 7.5.g.3** mechanical efficiency

```
//Example 7.5.g.i: electrical efficiency
clc;
clear;
close;
// given data:
n=3;// number of motors
n1=4;// number of parallel path in winding
i=30; //current in A
Bhp=65;// in hp
I=i*n;// current taken by three motors
Rsh=44; // shunt field resistance
Ra=0.08; // armature resistance in ohm
V=440; // voltage in V
Ish=V/Rsh;// shunt field current
Ia=I+Ish;
I1=Ia/n1;// current in each path
Va=Ia*Ra; // armature drop
Vb=2;// we know , brush contact drops
E=V+Va+Vb;
E_power=E*Ia;
W=V*I;// in watt
M_power=Bhp*746;// assume Bhp=746 W
Copper_losses=E_power-W;
S_loses=M_power-E_power;
eta_m=(E_power/M_power)*100;
disp(eta_m,"mechanical efficiency ,eta_m(%) = ")
```

# Chapter 8

# DC motors

**Scilab code Exa 8.1** speed

```
//Example 8.1 // speed
clc;
clear;
close;
//given data :
pi=22/7;
s=22; // shaft of the motor in hp
Tsh=210; // torue in hp
N=(s*60*746)/(2*pi*Tsh);
disp(N,"speed ,N(rpm) = ")
```

**Scilab code Exa 8.2.a** Bhp

```
//Example 8.2.a: bhp
clc;
clear;
close;
//given data :
```

```
V=230; // voltage in volts
I=72; // current in A
W=V*I;
s=968; // stray losses
Rsh=115; // shunt field resistance in ohm
Ra=0.5;// armature resistance in ohm
Ish=V/Rsh;// shunt field resistance
Ia=I-Ish;
Eb=V-(Ia*Ra);// back emf in volts
Dpd=Eb*Ia;// driving power developed
Mpo=Dpd-s;
bhp=Mpo/746;
disp(bhp,"bhp = ")
```

**Scilab code Exa 8.2.b** copper losses

```
//Example 8.2.b: copper losses
clc;
clear;
close;
//given data :
V=230; // voltage in volts
I=72; // current in A
W=V*I;
s=968; // stray losses
Rsh=115; // shunt field resistance in ohm
Ra=0.5;// armature resistance in ohm
Ish=V/Rsh;// shunt field resistance
Ia=I-Ish;
Eb=V-(Ia*Ra);// back emf in volts
Dpd=Eb*Ia;// driving power developed
Mpo=Dpd-s;
bhp=Mpo/746;
c_losses=W-Dpd;
disp(c_losses,"copper losses(W) = ")
```

**Scilab code Exa 8.2.c** armature torque

```
//Example 8.2.c: armature torque
clc;
clear;
close;
//given data :
N=955; // in r.p.m
V=230; // voltage in volts
I=72; // current in A
W=V*I;
s=968; // stray losses
Rsh=115; // shunt field resistance in ohm
Ra=0.5;// armature resistance in ohm
Ish=V/Rsh;// shunt field resistance
Ia=I-Ish;
Eb=V-(Ia*Ra);// back emf in volts
Dpd=Eb*Ia;// driving power developed
Mpo=Dpd-s;
bhp=Mpo/746;
c_losses=W-Dpd;
Ta=(9.55*Eb*Ia)/N;
disp(Ta,"torque armature,Ta(N-m) = ")
```

**Scilab code Exa 8.2.d** shaft torque

```
//Example 8.2.d: shaft torque
clc;
clear;
close;
//given data :
```

```
pi=22/7;
N=955; // in r.p.m
V=230; // voltage in volts
I=72; // current in A
W=V*I;
s=968; // stray losses
Rsh=115; // shunt field resistance in ohm
Ra=0.5;// armature resistance in ohm
Ish=V/Rsh;// shunt field resistance
Ia=I-Ish;
Eb=V-(Ia*Ra);// back emf in volts
Dpd=Eb*Ia;// driving power developed
Mpo=Dpd-s;
bhp=Mpo/746;
c_losses=W-Dpd;
Ta=(9.55*Eb*Ia)/N;
Tsh=(bhp*60*746)/(2*pi*N);
disp(Tsh,"shaft torque,Tsh(N-m) = ")
```

**Scilab code Exa 8.2.e** lost torque

```
//Example 8.2.e: lost torque
clc;
clear;
close;
//given data :
pi=22/7;
N=955; // in r.p.m
V=230; // voltage in volts
I=72; // current in A
W=V*I;
s=968; // stray losses
Rsh=115; // shunt field resistance in ohm
Ra=0.5;// armature resistance in ohm
Ish=V/Rsh;// shunt field resistance
```

```
Ia=I-Ish;
Eb=V-(Ia*Ra);// back emf in volts
Dpd=Eb*Ia;// driving power developed
Mpo=Dpd-s;
bhp=Mpo/746;
c_losses=W-Dpd;
Ta=(9.55*Eb*Ia)/N;
Tsh=(bhp*60*746)/(2*pi*N);
Tl=Ta-Tsh;
disp(Tl,"lost torque,Tl(N-m) = ")
```

**Scilab code Exa 8.2.f** commercial efficiency

```
//Example 8.2.f: commercial efficiency
clc;
clear;
close;
//given data :
pi=22/7;
N=955; // in r.p.m
V=230; // voltage in volts
I=72; // current in A
W=V*I;
s=968; // stray losses
Rsh=115; // shunt field resistance in ohm
Ra=0.5;// armature resistance in ohm
Ish=V/Rsh;// shunt field resistance
Ia=I-Ish;
Eb=V-(Ia*Ra);// back emf in volts
Dpd=Eb*Ia;// driving power developed
Mpo=Dpd-s;
bhp=Mpo/746;
c_losses=W-Dpd;
Ta=(9.55*Eb*Ia)/N;
Tsh=(bhp*60*746)/(2*pi*N);
```

```
Tl=Ta-Tsh;
eta=(Mpo/W)*100;
disp(eta,"commercial efficioency ,eta(%) = ")
```

**Scilab code Exa 8.3** speed

```
//Example 8.3 // speed
clc;
clear;
close;
V=230;// in volts
 I=5;// in amperes
 rpm=914;//turns
 ra=0.5;//resistance of armature in ihms
 rsh=115;//shunt field in ohms
 Il=30;// in amperes
 ar=10;// in percent
 Ish=V/rsh;// in amperes
 anl=I-Ish;//armature current in amperes at no load
 al=Il-Ish;//armature currentin amperes at load
 Eb1=(V-anl*ra);//back emf at no load
 Eb2=(V-al*ra);//back emf at load
 ph1=100;//
 ph2=90;//
 Ns=(rpm*Eb2*ph1)/(Eb1*ph2);//speed when loaded in
    rpm
 disp(Ns,"speed when loaded in rpm")
```

**Scilab code Exa 8.4.a** stray losses

```
//Example 8.4.a // stray losses
clc;
clear;
```

```
close;
Il=83;// WHEN LOADED IN AMPERES
V=110;// in volts
I=5;// in amperes without load
ra=0.5;//armature resistance in ohms
rsh=110;//shunt field in ohms
Ish=V/rsh;// in ampere
 anl=I-Ish;//armature current in amperes at no load
 al=Il-Ish;//armature currentin amperes at load
 Eb1=(V-anl*ra);//back emf at no load
 Eb2=(V-al*ra);//back emf at load
 Dp=Eb1*anl;//driving power at no load in watt
 Dpl=Eb2*al;//driving power at load in watt
 mo=Dpl-Dp;//out of motor in watt
disp(Dp,"stray losses in watt")
```

**Scilab code Exa 8.4.b** horsepower of the motor

```
//Example 8.4.b // horse power
clc;
clear;
close;
Il=83;// WHEN LOADED IN AMPERES
V=110;// in volts
I=5;// in amperes without load
ra=0.5;//armature resistance in ohms
rsh=110;//shunt field in ohms
Ish=V/rsh;// in ampere
 anl=I-Ish;//armature current in amperes at no load
 al=Il-Ish;//armature currentin amperes at load
 Eb1=(V-anl*ra);//back emf at no load
 Eb2=(V-al*ra);//back emf at load
 Dp=Eb1*anl;//driving power at no load in watt
 Dpl=Eb2*al;//driving power at load in watt
 mo=Dpl-Dp;//out of motor in watt
```

```
bhp=mo/746;//horse power
disp(bhp,"horse power in ampere is")
```

**Scilab code Exa 8.4.c** efficiency

```
//Example 8.4.c // efficiency
clc;
clear;
close;
Il=83;// WHEN LOADED IN AMPERES
V=110;// in volts
I=5;// in amperes without load
ra=0.5;//armature resistance in ohms
rsh=110;//shunt field in ohms
Ish=V/rsh;// in ampere
 anl=I-Ish;//armature current in amperes at no load
 al=Il-Ish;//armature currentin amperes at load
 Eb1=(V-anl*ra);//back emf at no load
 Eb2=(V-al*ra);//back emf at load
 Dp=Eb1*anl;//driving power at no load in watt
 Dpl=Eb2*al;//driving power at load in watt
 mo=Dpl-Dp;//out of motor in watt
 bhp=mo/746;//horse power
 mi=V*al;//input power in watt
 n=(mo/mi)*100;//efficiency in percentage
disp(n,"efficiency of motor when it is work on full
   ,load in percentage is")
//answer is wrong in the textbook
```

**Scilab code Exa 8.5.a** back emf

```
//Example 8.5.a // back emf
clc;
```

```
clear;
close;
V=230;// in volts
 I=60;// in amperes
 rpm=955;//turns
 ra=0.2;//resistance of armature in ihms
 rsh=0.15;//shunt field in ohms
 sl=604;//stray losses in watts
 Rm=ra+rsh;// in ohms
 Eb=(V-I*Rm);// back emf in volts
 disp(Eb,"back emf in volts")
```

**Scilab code Exa 8.5.b** copper losses

```
//Example 8.5.b // copper losses
clc;
clear;
close;
V=230;// in volts
 I=60;// in amperes
 rpm=955;//turns
 ra=0.2;//resistance of armature in ihms
 rsh=0.15;//shunt field in ohms
 sl=604;//stray losses in watts
 Rm=ra+rsh;// in ohms
 Eb=(V-I*Rm);// back emf in volts
 Dp=Eb*I;//driving power in watts
 mi=V*I;//input power in watts
 Cl=mi-Dp;// copper losses in watts
 disp(Cl,"copper losses in watts")
```

**Scilab code Exa 8.5.c** Bhp

```
//Example 8.5.c //horse power
clc;
clear;
close;
V=230;// in volts
 I=60;// in amperes
 rpm=955;//turns
 ra=0.2;//resistance of armature in ihms
 rsh=0.15;//shunt field in ohms
 sl=604;//stray losses in watts
 Rm=ra+rsh;// in ohms
 Eb=(V-I*Rm);// back emf in volts
 Dp=Eb*I;//driving power in watts
 mi=V*I;//input power in watts
 Cl=mi-Dp;// copper losses in watts
 mo=Dp-sl;//output of motor
 bhp=mo/746;// horse power in bhp
disp(bhp,"horse power  is")
```

**Scilab code Exa 8.5.d** total torque

```
//Example 8.5.d //total torque
clc;
clear;
close;
V=230;// in volts
 I=60;// in amperes
 rpm=955;//turns
 ra=0.2;//resistance of armature in ihms
 rsh=0.15;//shunt field in ohms
 sl=604;//stray losses in watts
 Rm=ra+rsh;// in ohms
 Eb=(V-I*Rm);// back emf in volts
 Dp=Eb*I;//driving power in watts
 mi=V*I;//input power in watts
```

```
Cl=mi-Dp;// copper losses in watts
mo=Dp-sl;//output of motor
bhp=mo/746;// horse power in bhp
Ta=(9.55*Eb*I)/rpm;//total torque in N-m
disp(Ta,"total torque in N-m")
```

**Scilab code Exa 8.5.e** shaft torque

```
//Example 8.5.e //shaft torque
clc;
clear;
close;
V=230;// in volts
 I=60;// in amperes
 rpm=955;//turns
 ra=0.2;//resistance of armature in ihms
 rsh=0.15;//shunt field in ohms
 sl=604;//stray losses in watts
 Rm=ra+rsh;// in ohms
 Eb=(V-I*Rm);// back emf in volts
 Dp=Eb*I;//driving power in watts
 mi=V*I;//input power in watts
 Cl=mi-Dp;// copper losses in watts
 mo=Dp-sl;//output of motor
 bhp=mo/746;// horse power in bhp
  Ta=(9.55*Eb*I)/rpm;//total torque in N-m
 Ts=(bhp*60*746)/(2*%pi*rpm);//shaft torque in N-m
disp(Ts,"shaft torque in N-m")
```

**Scilab code Exa 8.5.f** lost torque

```
//Example 8.5.f //lost torque
clc;
```

```
clear;
close;
V=230;// in volts
 I=60;// in amperes
 rpm=955;//turns
 ra=0.2;//resistance of armature in ihms
 rsh=0.15;//shunt field in ohms
 sl=604;//stray losses in watts
 Rm=ra+rsh;// in ohms
 Eb=(V-I*Rm);// back emf in volts
 Dp=Eb*I;//driving power in watts
 mi=V*I;//input power in watts
 Cl=mi-Dp;// copper losses in watts
 mo=Dp-sl;//output of motor
 bhp=mo/746;// horse power in bhp
  Ta=(9.55*Eb*I)/rpm;//total torque in N-m
 Ts=(bhp*60*746)/(2*%pi*rpm);//shaft torque in N-m
 Tl=Ta-Ts;//lost torque in N-m
disp(Tl,"lost torque in N-m")
```

**Scilab code Exa 8.5.g** commercial efficiency

```
//Example 8.5.g //commercial efficiency
clc;
clear;
close;
V=230;// in volts
 I=60;// in amperes
 rpm=955;//turns
 ra=0.2;//resistance of armature in ihms
 rsh=0.15;//shunt field in ohms
 sl=604;//stray losses in watts
 Rm=ra+rsh;// in ohms
 Eb=(V-I*Rm);// back emf in volts
 Dp=Eb*I;//driving power in watts
```

```
mi=V*I;//input power in watts
Cl=mi-Dp;// copper losses in watts
mo=Dp-sl;//output of motor
bhp=mo/746;// horse power in bhp
 Ta=(9.55*Eb*I)/rpm;//total torque in N-m
Ts=(bhp*60*746)/(2*%pi*rpm);//shaft torque in N-m
Tl=Ta-Ts;//lost torque in N-m
nc=(mo/mi)*100;//commercial efficiency in percentge
disp(nc,"commercial efficiency in percentge")
```

**Scilab code Exa 8.6** current taken

```
//Example 8.6 //current
clc;
clear;
close;
V=220;// in volts
 I=60;// in amperes
 rpm=728;//turns
 Ts=150;//shaft torque in N-m
 nc=80;//commercial efficiency in percentge
 I=((Ts*2*%pi*rpm*746)/(60*746*(nc/100)*V));//
    CURRENT TAKEN IN AMPERES
disp(round(I),"current taken in amperes is")
```

**Scilab code Exa 8.7** speed

```
//Example 8.7 //SPEED
clc;
clear;
close;
V=220;// in volts
 rpm=2100;//turns
```

```
 ra=0.5;//resistance of armature in ihms
 rsh=220;//shunt field in ohms
 Il=21;// in amperes
 R1=220;// in ohms
 Ish=V/rsh;// in amperes
 Ifs=V/(rsh+R1);//shunt field current in second case
     in ampere
ph1=50;//
ph2=100;//
n2=(rpm*ph2)/ph1;//speed in rpm
disp(n2,"speed in rpm is")
```

# Chapter 9

# cells and batteries

**Scilab code Exa 9.1** value of current flowing

```
//Example 9.1 // current
clc;
clear;
close;
//given data :
n=20; // dry cells of emf
E=1.5; // emf in volts
R=5; // external resistance in ohm
r=0.5; // internal resistance in ohm
I=(n*E)/(R+(n*r));
disp(I,"current flowing,I(A) = ")
```

**Scilab code Exa 9.2** value of current flowing

```
//Example 9.2 // current
clc;
clear;
close;
```

```
//given data :
n=10; // dry cells of emf
E=1.5; // emf in volts
R=4.9; // resistance in ohm
r=1; // internal resistance in ohm
I=(n*E)/((n*R)+(r));
disp(I,"current flowing,I(A) = ")
```

**Scilab code Exa 9.3** value of current flowing

```
//Example 9.3 // current
clc;
clear;
close;
//given data :
m=3;
n=10; // dry cells of emf
E=1.5; // emf in volts
R=2.5; // resistance in ohm
r=0.5; // internal resistance in ohm
I=(m*n*E)/((m*R)+(n*r));
disp(I,"current flowing,I(A) = ")
```

**Scilab code Exa 9.4.a** internal resistance

```
//Example 9.4.a // internal resistance of each cell
clc;
clear;
close;
n=10;// no. of cells
Rl=4;// LOAD RESISTANCE
V=12;// in volts
Va=18;// IN VOLTS
```

```
r=((Va-V)*Rl)/(n*V);// internal resistance in ohms
disp(r,"internal resistance in ohms is")
```

**Scilab code Exa 9.4.b** value of current flowing

```
//Example 9.4.b // current
clc;
clear;
close;
n=10;// no. of cells
Rl=4;// LOAD RESISTANCE
V=12;// in volts
Va=18;// IN VOLTS
r=((Va-V)*Rl)/(n*V);// internal resistance in ohms
Il=V/Rl;// IN AMPERES
disp(Il,"load current in amperes is")
```

**Scilab code Exa 9.5** emf of each cell and its internal resistance

```
//Example 9.5 // emf and internal resistance of each
    cell
clc;
clear;
close;
n=6;// no. of cells
Rl=3;// LOAD RESISTANCE
I=2.5;// IN AMPERES
r1=9;// in ohms
I2=1.25;// om amperes
r=((r1*I2)-(Rl*I))/(n*(I-I2));// internal resistance
    in ohms
E=((I*(Rl+n*r))/n);// emf of each cell in volts
disp(E,"emf of each cell in volts is")
```

```
disp(r,"internal resistance of each cell in ohms")
```

**Scilab code Exa 9.6** ampere hour capacity

```
//Example 9.6 //find ampere-hour capacity of a
    batery
clc;
clear;
close;
I=20;// in amperes
t=15;// in hours
Ah=I*t;// ampere hour capacity of the battery
disp(Ah,"ampere hour capacity of the battery in A-h"
    )
```

**Scilab code Exa 9.7.a** ampere hour efficiency

```
//Example 9.7.a //find ampere-hour efficiency
clc;
clear;
close;
I=30;// in amperes
t=6;// in hours
Vt=2;// terminal voltage
Ic=40;// in amperes
tc=5;// in hours
Vc=2.5;// in volts
Aho=I*t;// ampere hour output of the battery
Ahi=Ic*tc;// ampere hour input of the battery
nAh=(Aho/Ahi)*100;// ampere hour efficiency
disp(nAh,"ampere hour efficiency of the battery in
    percentage is")
```

**Scilab code Exa 9.7.b** watt hour efficiency

```
//Example 9.7.b //find watt-hour efficiency
clc;
clear;
close;
I=30;// in amperes
t=6;// in hours
Vt=2;// terminal voltage
Ic=40;// in amperes
tc=5;// in hours
Vc=2.5;// in volts
Who=I*t*Vt;// watt hour output of the battery
Whi=Ic*tc*Vc;// watt hour input of the battery
nWh=(Who/Whi)*100;// ampere hour efficiency
disp(nWh,"watt hour efficiency of the battery in
    percentage is")
```

**Scilab code Exa 9.8.a** initial charging current

```
//Example 9.8.a //initial charging current
clc;
clear;
close
n=50;// no. of cells
Vc=250;// in volts
Vd=1.8;//in volts
Vcs=2.2;//in volts
r=0.01;//internal resistance of each cell in ohms
rl=0.1;//lead resistance in ohms
Re=19.4;//external resitance in ohms
Ib=n*r;// internal resistnce of battery
```

```
Tb=rl+Ib;//total resistance of battery
Eb=Vd*n;//total rmf of battery
I=(Vc-Eb)/(Re+Tb);// initial charging current in
    amperes
disp(I,"initial charging current in amperes is")
```

**Scilab code Exa 9.8.b** final charging current

```
//Example 9.8.b //final charging current
clc;
clear;
close
n=50;// no. of cells
Vc=250;// in volts
Vd=1.8;//in volts
Vcs=2.2;//in volts
r=0.01;//internal resistance of each cell in ohms
rl=0.1;//lead resistance in ohms
Re=19.4;//external resitance in ohms
Ib=n*r;// internal resistnce of battery
Tb=rl+Ib;//total resistance of battery
Eb=Vd*n;//total rmf of battery
Ebf=Vcs*n;//emf of the battery at the end of
    charging
I=(Vc-Ebf)/(Re+Tb);// initial charging current in
    amperes
disp(I,"final charging current in amperes is")
```

**Scilab code Exa 9.9.a** value and direction of current

```
//Example 9.9.a //value and direction of the current
clc;
clear;
```

```
close
V=230;// in volts
emf1=122;//in volts
r=0.4;//internal resistance in ohms
emf2=130;//in volts
r1=0.5;//in ohms
//apllying kirchoff's low
// x ampere is the total current taken by battery
// x1 ampere is the total current taken by battery A
// x-x1 ampere is the total current taken by battery
    B
// 5*x+0.4*y=180 is the equation in mesh ABEF
// 5.5*x+0.5*y=100 equation in the mesh CDEF
// equation 1 is 25*x+2*y=540 and equation 2 is 22*x
   -2*y=400
A=[25 2 ;22 -2];// EQUATIONS
B=[540;400];// VALUES
X=A\B;// UNKNOW VALUES
x=X(1,1);//TOTAL CURRENT IN AMPERES
x1=X(2,1);//current taken by battery A
x2=20-20;//
disp(x1,"current in battery A in amperes (
   discharging)")
disp(x2,"current in bettery B in amperes")
```

**Scilab code Exa 9.9.b** total current

```
//Example 9.9.b //total current
clc;
clear;
close
V=230;// in volts
emf1=122;//in volts
r=0.4;//internal resistance in ohms
emf2=130;//in volts
```

```
r1=0.5;//in ohms
//apllying kirchoff's low
// x ampere is the total current taken by battery
// x1 ampere is the total current taken by battery A
// x−x1 ampere is the total current taken by battery
   B
// 5∗x+0.4∗y=180 is the equation in mesh ABEF
// 5.5∗x+0.5∗y=100 equation in the mesh CDEF
// equation 1 is 25∗x+2∗y=540 and equation 2 is 22∗x
   −2∗y=400
A=[25 2 ;22 -2];// EQUATIONS
B=[540;400];// VALUES
X=A\B;// UNKNOW VALUES
x=X(1,1);//TOTAL CURRENT IN AMPERES
x1=X(2,1);//current taken by battery A
x2=20-20;//
disp(x,"total current in battery A and B in amperes
   (charging)")
```

**Scilab code Exa 9.9.c** power dissipated

```
//Example 9.9.c //tpower dissipated
clc;
clear;
close
R=5;// in ohms
V=230;// in volts
emf1=122;//in volts
r=0.4;//internal resistance in ohms
emf2=130;//in volts
r1=0.5;//in ohms
//apllying kirchoff's low
// x ampere is the total current taken by battery
// x1 ampere is the total current taken by battery A
// x−x1 ampere is the total current taken by battery
```

```
    B
// 5*x+0.4*y=180 is the equation in mesh ABEF
// 5.5*x+0.5*y=100 equation in the mesh CDEF
// equation 1 is 25*x+2*y=540 and equation 2 is 22*x
    -2*y=400
A=[25 2 ;22 -2];// EQUATIONS
B=[540;400];// VALUES
X=A\B;// UNKNOW VALUES
x=X(1,1);//TOTAL CURRENT IN AMPERES
x1=X(2,1);//current taken by battery A
x2=20-20;//
p=x^2*R;// in watt
disp(p,"power dissipated in watts is")
```

**Scilab code Exa 9.10** direction of current and total resistance

```
//Example 9.10 //value and direction of the current
clc;
clear;
close
V=34;// in volts
emf1=2;//in volts
r1=6;//in ohms
r2=1;//in ohms
r3=2;//in ohms
r4=4;// in ohms
//apllying kirchoff's low
// x ampere is the current in branch AB
// x1 ampere is the current in branch AC
//x2 ampere is the current in the Branch BD
// x-x2 ampere is the current in the branch BC
// x1+x2 ampere is the current in the branch DC
// x-6*x1+8*x2=2 in mesh ABD
// 2*x-4*x1-14*x2=-2 in mesh BCD
// 10*x1+4*x2=34;//in mesh ADCEF
```

```
A=[1 -6 8;2 -4 -14;0 10 4];// EQUATIONS
B=[2;-2;34];// VALUES
X=A\B;// UNKNOW VALUES
x=X(1,1);//TOTAL CURRENT IN AMPERES
x1=X(2,1);//current taken by battery A
x2=X(3,1);//
b1=x-x2;// in amperes
b2=x1+x2;//in amperes
R=((r1*x1+r4*(x2+x1))/(x+x1));//total resistance in
    ohms
disp(x," current in 1 ohms resistance from A to B in
     amperes ")
disp(x1," current in 6 ohms resistance from A to D
    in amperes ")
disp(x2," current in 8 ohms resistance from B to D
    in amperes ")
disp(b1,"current in 2 ohm resistance from B to C in
    amperes")
disp(b2,"current in 4 ohm resistance from D to C in
    amperes")
disp(R,"total reistance in ohms is")
```

# Chapter 11

# single phase AC circuits

**Scilab code Exa 11.1** instantaneous emf

```
//Example 11.1 // instantaneous value
clc;
clear;
close;
//given data :
E_max=500; // emf in volts
thita=30; // in degree
e=E_max*sind(thita);
disp(e,"instantaneous value,e(v) = ")
```

**Scilab code Exa 11.2** rms value of alternating current

```
//Example 11.2 // rms value
clc;
clear;
close;
//given data :
I_max=1.414; // maximum value of current in A
```

```
I_rms=I_max*0.707;
disp(round(I_rms),"rms value of current,I_rms(A) ")
```

**Scilab code Exa 11.3** current drawn

```
//Example 11.3 // current drawn
clc;
clear;
close;
//given data :
f=50; // frequency in Hz
L=0.2; // inductance in H
V=220; // voltage in volts
pi=22/7;
XL=2*pi*f*L;// in ohm
Z=XL;
I=V/Z;
disp(I,"current drawn,I(A) = ")
```

**Scilab code Exa 11.4** current

```
//Example 11.4 // current flowing
clc;
clear;
close;
//given data :
f=50; // frequency in Hz
C=100*10^-6;// capacitor in Farad
V=210; // voltage in volts
pi=22/7;
XC=(1/(2*pi*f*C));
Z=XC;
I=V/Z;
```

```
disp(I,"current flowing,I(A) = ")
```

**Scilab code Exa 11.5.a** value of current flowing

```

//Example 11.5.a // current
clc;
clear;
close;
//given data :
f=50; // frequency in Hz
L=0.4; // inductance in H
V=220; // voltage in volts
pi=22/7;
XL=2*pi*f*L;
I=V/XL;
f1=25; // when frequency is halved
pi=22/7;
XL1=2*pi*f1*L;
I1=V/XL1;

disp(I,"current flowing,I(A) = ")
disp(I1,"current when frequency is halved,I(A) = ")
```

**Scilab code Exa 11.5.b** value of current flowing

```
//Example 11.5.b // current if frequency is halved
clc;
clear;
close;
//given data :
//given data :
f=50; // frequency in Hz
```

```
L=0.4; // inductance in H
V=220; // voltage in volts
f2=100; // when frequency is doubled
pi=22/7;
XL=2*pi*f2*L;
I=V/XL;
disp(I,"current when frequency is halved,I(A) = ")
```

**Scilab code Exa 11.6.a** value of current flowing

```
//Example 11.6.a // current
clc;
clear;
close;
//given data :
f=50; // frequency in Hz
C=28*10^-6;// capacitor in Farad
V=250; // voltage in volts
pi=22/7;
XC=1/(2*pi*f*C);
I1=V/XC;
f=50; // frequency in Hz
C=28*10^-6;// capacitor in Farad
V=250; // voltage in volts
pi=22/7;
f1=25;// when frequency is halved
XC=1/(2*pi*f1*C);
I2=V/XC;
disp(I1,"current flowing,I(A) = ")
disp(I2,"current flowing when frequency is halved,I(
    A) = ")
```

**Scilab code Exa 11.6.b** value of current flowing

```
//Example 11.6.b // current if frequency is halved
clc;
clear;
close;
//given data :
f=50; // frequency in Hz
C=28*10^-6;// capacitor in Farad
V=250; // voltage in volts
pi=22/7;
f2=100;// when frequency is doubled
XC=1/(2*pi*f2*C);
I=V/XC;
disp(I,"current flowing when frequency is doubled ,I
    (A) = ")
```

**Scilab code Exa 11.7.a** inductive reactance

```
//Example 11.7.a // inductive reactance
clc;
clear;
close;
R=40;//in ohms
L=0.07;//IN HENRY
v=223;//IN VOLTS
F=50;// IN HERTS
Xl=2*%pi*F*L;// inductive reactance in ohms
disp(round(Xl),"inductive reactance in ohms is")
```

**Scilab code Exa 11.7.b** impedance

```
//Example 11.7.b // impedence
clc;
clear;
```

```
close;
R=40;//in ohms
L=0.07;//IN HENRY
v=223;//IN VOLTS
F=50;// IN HERTS
Xl=2*%pi*F*L;// inductive reactance in ohms
Z=sqrt(R^2+Xl^2);//IMPEDENCE IN OHMS
disp(Z,"impedence in ohms is")
```

**Scilab code Exa 11.7.c** current

```
//Example 11.7.c // current
clc;
clear;
close;
R=40;//in ohms
L=0.07;//IN HENRY
V=223;//IN VOLTS
F=50;// IN HERTS
Xl=2*%pi*F*L;// inductive reactance in ohms
Z=sqrt(R^2+Xl^2);//IMPEDENCE IN OHMS
I=V/Z;//in amperes
disp(I,"current in amperes is")
```

**Scilab code Exa 11.7.d** angle of phase difference

```
//Example 11.7.d // angle of phase differnce
clc;
clear;
close;
R=40;//in ohms
L=0.07;//IN HENRY
V=223;//IN VOLTS
```

```
F=50;// IN HERTS
Xl=2*%pi*F*L;// inductive reactance in ohms
Z=sqrt(R^2+Xl^2);//IMPEDENCE IN OHMS
I=V/Z;//in amperes
csp=R/Z;//pf
phi=acosd(csp);//angle of phase differnce in degree
x=floor(phi);//
y=phi-x;//
disp("angle of phase difference is "+string(x)+"
   degree and "+string(y*60)+" minutes ")
```

**Scilab code Exa 11.8** inductance and phase angle

```
//Example 11.8 // inductance and phase angle between
    voltage and current
clc;
clear;
close;
V=200;//in volts
I=2.5;// in amperes
Vo=250;// in volts
f=50;// in hertz
R=V/I;// in ohms
Z=Vo/I;// in ohms
Xl=sqrt(Z^2-R^2);//inductive reactance in ohms
L=(Xl/(2*%pi*f));//inductance in henry
pf=R/Z;//power factor
phi=acosd(pf);//angle of phase differnce in degree
x=floor(phi);//
y=phi-x;//
disp(L,"inductance in henry is")
disp("angle of phase difference is "+string(x)+"
   degree and "+string(round(y*60))+" minutes ")
```

**Scilab code Exa 11.9** capacitance

```
//Example 11.9 // capacitance
clc;
clear;
close;
W=100;//in watts
V=110;//in volts
Vc=220;//in volts
f=50;//in hertz
I=W/V;// in amperes
R=V/I;//in ohms
Z=Vc/I;// in ohms
Xc=sqrt(Z^2-R^2);// IN OHMS
C=(1/(2*%pi*f*Xc));// in farads
disp(C*10^6,"capacitance in micro farads is")
```

**Scilab code Exa 11.10.a** impedance

```
//Example 11.10.a // impedence
clc;
clear;
close;
R=5.94;//in ohms
L=0.35;//IN HENRY
C=35;// in micro farads
V=220;//IN VOLTS
F=50;// IN HERTS
Xc=(1/(2*%pi*F*C*10^-6));// capacitive reactance in
    ohms
Xl=2*%pi*F*L;// inductive reactance in ohms
Z=sqrt(R^2+(Xl-Xc)^2);// impedence in ohms
```

```
disp(round(Z),"impedence in ohms is")
```

**Scilab code Exa 11.10.b** current

```
//Example 11.10.B // CURRENT
clc;
clear;
close;
R=5.94;//in ohms
L=0.35;//IN HENRY
C=35;// in micro farads
V=200;//IN VOLTS it is given wrong in the book
F=50;// IN HERTS
Xc=(1/(2*%pi*F*C*10^-6));// capacitive reactance in
    ohms
Xl=2*%pi*F*L;// inductive reactance in ohms
Z=sqrt(R^2+(Xl-Xc)^2);// impedence in ohms
I=V/round(Z);// in amperes
disp(I,"current in amperes is")
```

**Scilab code Exa 11.10.c** phase angles

```
//Example 11.10.c // angle of phase diffenrce
clc;
clear;
close;
R=5.94;//in ohms
L=0.35;//IN HENRY
C=35;// in micro farads
V=200;//IN VOLTS it is given wrong in the book
F=50;// IN HERTS
Xc=(1/(2*%pi*F*C*10^-6));// capacitive reactance in
    ohms
```

```
Xl=2*%pi*F*L;// inductive reactance in ohms
Z=sqrt(R^2+(Xl-Xc)^2);// impedence in ohms
I=V/round(Z);// in amperes
pf=R/round(Z);// power factor
disp(pf,"angle of phase diffence between voltage and
    current is")
```

**Scilab code Exa 11.10.d** voltage

```
//Example 11.10.d // voltage across te coil
clc;
clear;
close;
R=5.94;//in ohms
L=0.35;//IN HENRY
C=35;// in micro farads
V=200;//IN VOLTS it is given wrong in the book
F=50;// IN HERTS
Xc=(1/(2*%pi*F*C*10^-6));// capacitive reactance in
   ohms
Xl=2*%pi*F*L;// inductive reactance in ohms
Z=sqrt(R^2+(Xl-Xc)^2);// impedence in ohms
I=V/round(Z);// in amperes
pf=R/round(Z);// power factor
Zc=sqrt(R^2+Xl^2);//impedence of the coil
Vl=I*Zc;//voltage drop across the coil
disp(Vl,"voltage across the coil in volts is")
```

**Scilab code Exa 11.10.e** voltage across the coil

```
//Example 11.10.e // voltage across the capacitor
clear;
close;
```

```
clc;
R=5.94;//in ohms
L=0.35;//IN HENRY
C=35;// in micro farads
V=200;//IN VOLTS it is given wrong in the book
F=50;// IN HERTS
Xc=(1/(2*%pi*F*C*10^-6));// capacitive reactance in
    ohms
Xl=2*%pi*F*L;// inductive reactance in ohms
Z=sqrt(R^2+(Xl-Xc)^2);// impedence in ohms
I=V/round(Z);// in amperes
pf=R/round(Z);// power factor
Vc=I*Xc;//voltage drop across the capacitor
disp(Vc,"voltage across capacitor in volts is")
```

**Scilab code Exa 11.10.f** total power taken

```

//Example 11.10.f // total power taken
clear;
close;
clc;
R=5.94;//in ohms
L=0.35;//IN HENRY
C=35;// in micro farads
V=200;//IN VOLTS it is given wrong in the book
F=50;// IN HERTS
Xc=(1/(2*%pi*F*C*10^-6));// capacitive reactance in
    ohms
Xl=2*%pi*F*L;// inductive reactance in ohms
Z=sqrt(R^2+(Xl-Xc)^2);// impedence in ohms
I=V/round(Z);// in amperes
W=I^2*R;//total power taken in watts
disp(W,"total power taken in watts is")
```

**Scilab code Exa 11.11.a** total impedance

```
//Example 11.11.a // impedence
clc;
clear;
close;
r1=6;//in ohms
r2=3.95;//in ohms
R=r1+r2;//in ohms
L1=0.21;//IN HENRY
L2=0.14;//in henry
C1=30;// in micro farads
C2=60;//in micro farads
V=220;//IN VOLTS
F=50;// IN HERTS
Xc1=(1/(2*%pi*F*C1*10^-6));// capacitive reactance
    in ohms
Xc2=(1/(2*%pi*F*C2*10^-6));// capacitive reactance
    in ohms
Xc=Xc1+Xc2;//IN OHMS
Xl1=2*%pi*F*L1;// inductive reactance in ohms
Xl2=2*%pi*F*L2;// inductive reactance in ohms
Xl=Xl1+Xl2;//in ohms
Z=sqrt(R^2+(Xl-Xc)^2);// impedence in ohms
disp(round(Z),"impedence in ohms is")
```

**Scilab code Exa 11.11.b** current taken

```
//Example 11.11.b // current taken
clc;
clear;
close;
```

```
r1=6;//in ohms
r2=3.95;//in ohms
R=r1+r2;//in ohms
L1=0.21;//IN HENRY
L2=0.14;//in henry
C1=30;// in micro farads
C2=60;//in micro farads
V=200;//IN VOLTS
F=50;// IN HERTS
Xc1=(1/(2*%pi*F*C1*10^-6));// capacitive reactance
    in ohms
Xc2=(1/(2*%pi*F*C2*10^-6));// capacitive reactance
    in ohms
Xc=Xc1+Xc2;//IN OHMS
Xl1=2*%pi*F*L1;// inductive reactance in ohms
Xl2=2*%pi*F*L2;// inductive reactance in ohms
Xl=Xl1+Xl2;//in ohms
Z=sqrt(R^2+(Xl-Xc)^2);// impedence in ohms
I=V/Z;//
disp(round(I),"current in amperes is")
```

**Scilab code Exa 11.11.c** power factor

```
//Example 11.11.c // power factor
clc;
clear;
close;
r1=6;//in ohms
r2=3.95;//in ohms
R=r1+r2;//in ohms
L1=0.21;//IN HENRY
L2=0.14;//in henry
C1=30;// in micro farads
C2=60;//in micro farads
V=200;//IN VOLTS
```

```
F=50;// IN HERTS
Xc1=(1/(2*%pi*F*C1*10^-6));// capacitive reactance
   in ohms
Xc2=(1/(2*%pi*F*C2*10^-6));// capacitive reactance
   in ohms
Xc=Xc1+Xc2;//IN OHMS
Xl1=2*%pi*F*L1;// inductive reactance in ohms
Xl2=2*%pi*F*L2;// inductive reactance in ohms
Xl=Xl1+Xl2;//in ohms
Z=sqrt(R^2+(Xl-Xc)^2);// impedence in ohms
I=V/Z;//
pf=R/Z;// leading power factor
disp(pf,"power factor (leading) is")
```

**Scilab code Exa 11.12.a** current taken

```

//Example 11.12.a // current
clc;
clear;
close;
V=200;// in volts
L=0.04;// in henry
C=100;//in micro fards
f=50;// hertz
Xl=2*%pi*f*L;//inductive reactance in ohms
Xc=(1/(2*%pi*f*C*10^-6));//CAPACITIVE REACTANCE IN
   OHMS
Z1=10;//ohms
R1=10;// in ohms
X1=0;// in ohms
R2=5;// in ohms
Z2=sqrt(R2^2+Xl^2);//in ohms
X2=Xl;//
R3=15;// in ohms
```

```
Z3=sqrt(R3^2+Xc^2);// IN OHMS
X3=Xc;//
g1=R1/(Z1)^2;// conductance of  branch 1 in mho
b1=X1/(Z1)^2;//susceptance in mho in branch 1
g2=R2/(Z2)^2;// conductance of  branch 2 in mho
b2=X2/(Z2)^2;//susceptance in mho in branch 2
g3=R3/(Z3)^2;// conductance of  branch 3 in mho
b3=X3/(Z3)^2;//susceptance in mho in branch 3
G=g1+g2+g3;// total conductance in mho
B=b1+b2-b3;// total susceptance in mho
Y=sqrt(G^2+B^2);//in ohms
I=V*Y;//curent in ampere
disp(I,"current in amperes is")
```

**Scilab code Exa 11.12.b** phase angle

```

//Example 11.12.b // PHASE ANGLE OF CURRENT AND
    VOLTAGE
clc;
clear;
close;
V=200;// in volts
L=0.04;// in henry
C=100;//in micro fards
f=50;// hertz
Xl=2*%pi*f*L;//inductive reactance in ohms
Xc=(1/(2*%pi*f*C*10^-6));//CAPACITIVE REACTANCE IN
    OHMS
Z1=10;//ohms
R1=10;// in ohms
X1=0;// in ohms
R2=5;// in ohms
Z2=sqrt(R2^2+Xl^2);//in ohms
X2=Xl;//
```

```
R3=15;// in ohms
Z3=sqrt(R3^2+Xc^2);// IN OHMS
X3=Xc;//
g1=R1/(Z1)^2;// conductance of  branch 1 in mho
b1=X1/(Z1)^2;//susceptance in mho in branch 1
g2=R2/(Z2)^2;// conductance of  branch 2 in mho
b2=X2/(Z2)^2;//susceptance in mho in branch 2
g3=R3/(Z3)^2;// conductance of  branch 3 in mho
b3=X3/(Z3)^2;//susceptance in mho in branch 3
G=g1+g2+g3;// total conductance in mho
B=b1+b2-b3;// total susceptance in mho
Y=sqrt(G^2+B^2);//in ohms
I=V*Y;//curent in ampere
theta=acosd(G/Y);//
x=round(theta);//
y=theta-x;//
disp("phase angle is "+string(x)+" degree and "+
   string(60*y)+" munutes ")
//answer is wrong in the textbook
```

---

**Scilab code Exa 11.12.c** series equivalent arrangement of resistance and reactance

```
//Example 11.12.c // series equivalent arrangement
   of resistance and reactance
clc;
clear;
close;
V=200;// in volts
L=0.04;// in henry
C=100;//in micro fards
f=50;// hertz
Xl=2*%pi*f*L;//inductive reactance in ohms
Xc=(1/(2*%pi*f*C*10^-6));//CAPACITIVE REACTANCE IN
   OHMS
```

```
Z1=10;//ohms
R1=10;// in ohms
X1=0;// in ohms
R2=5;// in ohms
Z2=sqrt(R2^2+Xl^2);//in ohms
X2=Xl;//
R3=15;// in ohms
Z3=sqrt(R3^2+Xc^2);// IN OHMS
X3=Xc;//
g1=R1/(Z1)^2;// conductance of  branch 1 in mho
b1=X1/(Z1)^2;//susceptance in mho in branch 1
g2=R2/(Z2)^2;// conductance of  branch 2 in mho
b2=X2/(Z2)^2;//susceptance in mho in branch 2
g3=R3/(Z3)^2;// conductance of  branch 3 in mho
b3=X3/(Z3)^2;//susceptance in mho in branch 3
G=g1+g2+g3;// total conductance in mho
B=b1+b2-b3;// total susceptance in mho
I=V/Z3;//curent in amperes
pf3=R3/Z3;//power factor
phi=acosd(pf3);//angle of phase differnce in degree
x=floor(phi);//
y=phi-x;//
tc3=pf3;//
ts3=sind(phi)
pf1=R1/R1;//
tc1=pf1;//
ts1=sind(acosd(pf1));//
I1=V/Z1;//
E1=I1*tc1;// energy component in branch 1
EL1=I1*ts1;// idel current component in branch 1
I2=V/Z2;//
pf2=R2/Z2;//
tc2=pf2;//
ts2=sind(acosd(pf2));//
E2=I2*tc2;//ENERGY COMPONENT IN BRANCH2
EL2=I2*ts2;//idele current component in branch 2
E3=I*tc3;//energy component in branch3
EL3=I*ts3;//idle component of current in branch 3
```

```
E=E1+E2+E3;//sum of energy component of current
EL=EL1+EL2-EL3;//sum of idel component of current
It=sqrt(E^2+EL^2);// total current
pft=E/It;//power factor of the complete circuit
phi=acosd(0.95);//angle of phase differnce in degree
x=round(phi);//
y=phi-x;//
Zt=V/It;//in ohms
R=Zt*pft;//equivalent series resistance
X=Zt*(sind(phi));//equivalent series reactance
disp(R,"equivalent series resistance in ohms is")
disp(X,"euivalent series reactance in ohms is")
```

# Chapter 12

# polyphase system

**Scilab code Exa 12.1.a** line current and phase current

```
//Example 12.1.a // line current
clc;
clear;
close;
L=30;//load in kW
pf=0.8;//power factor
Vl=250;//line voltage in volts
I=((L*10^3)/(Vl*pf*sqrt(3)));//line current in
    ampers
Ip=I;// in star connection
disp(I,"line current (star connection) in ampere is"
    )
disp(Ip,"pahse current (start connection) in ampere
    is")
```

---

**Scilab code Exa 12.1.b** line current and phase current

```
//Example 12.1.b // phase current
```

```
clc;
clear;
close;
L=30;//load in kW
pf=0.8;//power factor
Vl=250;//line voltage in volts
I=((L*10^3)/(Vl*pf*sqrt(3)));//line current in
   ampers
Ip=I/(sqrt(3));//phase current
Il=sqrt(3)*Ip;//line current in amperes
disp(Ip,"phase current in ampere is")
disp(Il,"line current (delta connection ) in amperes
    is")
```

**Scilab code Exa 12.2.a** line current and total power

```
//Example 12.2.a // line current and power abosrbed
clc;
clear;
close;
R=11.88;//coil resistance in ohms
L=0.07;//inductance in henry
f=50;// in hertz
pf=0.48;//power factor
Vl=433;//line voltage in volts
Vp= Vl/(sqrt(3));//phase voltage
Xl=(2*%pi*f*L);//in ohms
Zb=sqrt(R^2+Xl^2);// in ohms
Ie=Vp/Zb;//current in each winding in amperes
Il=Ie;//line current in amperes
W=sqrt(3)*Vl*Il*pf;//power in watts
disp(Il,"line current in ampere is")
disp(W*10^-3,"power taken in connection in kW")
```

**Scilab code Exa 12.2.b** line current and total power

```
//Example 12.2.b // line current and power abosrbed
clc;
clear;
close;
R=11.88;//coil resistance in ohms
L=0.07;//inductance in henry
f=50;// in hertz
pf=0.48;//power factor
Vl=433;//line voltage in volts
Vp= Vl;//phase voltage
Xl=(2*%pi*f*L);//in ohms
Zb=sqrt(R^2+Xl^2);// in ohms
Ie=Vp/Zb;//current in each winding in amperes
Il=sqrt(3)*Ie;//line current in amperes
W=sqrt(3)*Vl*Il*pf;//power in watts
disp(Il,"line current in ampere is")
disp(W*10^-3,"power taken in connection in kW")
```

**Scilab code Exa 12.3.a** current in each phase of the motor

```

//Example 12.3.a // motor current in each phase
clc;
clear;
close;
Vl=1100;//line voltage in volts
n=99;//motor efficiency in percentage
Mo=n*735.5;//output of the motor
Mi=(Mo*100)/75;// INPUT OF THE MOTOR IN WATTS
pf= 0.8;//power factor
```

```
Il=(Mi)/(sqrt(3)*Vl*pf);//line current in amperes
Ip=Il/(sqrt(3));//phase current in amperes
Ipm=Il;//phase curent of the motor
Ac=Ip*pf;//active component of phase current in the motor
Rc=Ip*(sqrt(1-pf^2));//reactive component of phase current of motor
disp(Ip,"phae current of motor in amperes is")
disp(Ac,"active component of phase current in the motor in amperes")
disp(Rc,"reactive component of phase current in the motor in amperes")
```

**Scilab code Exa 12.3.b** current in each phase of the generator

```

//Example 12.3.b // motor generator in each phase
clc;
clear;
close;
Vl=1100;//line voltage in volts
n=99;//motor efficiency in percentage
Mo=n*735.5;//output of the motor
Mi=(Mo*100)/75;// INPUT OF THE MOTOR IN WATTS
pf= 0.8;//power factor
Il=(Mi)/(sqrt(3)*Vl*pf);//line current in amperes
Ip=Il/(sqrt(3));//phase current in amperes
Ipm=Il;//phase curent of the motor
Ac=Ipm*pf;//active component of phase current in the generator
Rc=Ipm*(sqrt(1-pf^2));//reactive component of phase current of generator
disp(Ipm,"phase current of the genertor in ampere is")
disp(Ac,"active component of phase current in the
```

```
generator in amperes")
disp(Rc,"reactive component of phase current in the
    generator in amperes")
```

**Scilab code Exa 12.4** reading

```
//Example 12.4 // reading
clc;
clear;
close;
ni=74.6;//efficiency
Mo=40;//HP OF MOTOR
mo=Mo*ni;//output of motor in watts
mi=(mo*100)/(ni*1000);//input of motor in kW
tw=40;//total in kW
pf=0.8;//power factor
theta=acosd(pf);//in degree
v=tand(theta);//
dw=(v*tw)/(sqrt(3));//
w1=(tw+dw)/2;//FIRST READING IN kW
w2=tw-w1;//second reading in kW
disp(w1,"first reading in kW")
disp(w2,"second reading in kW")
```

**Scilab code Exa 12.5.a** power factor when both readings are positive

```
//Example 12.5.a // power factor
clc;
clear;
close;
w1=4.5;//first reading in kW
w2=3;//second reading in kW , this value is given
    wrong in question
```

```
tw=w1+w2;//in kW
dw=w1-w2;//in kW
pfa=atand(sqrt(3)*(dw/tw));
pf=cosd(pfa);////power factor when both the eadings are positive
disp(pf,"power factor when both the readings are positive")
```

**Scilab code Exa 12.5.b** power factor

```
//Example 12.5.b // power factor
clc;
clear;
close;
w1=4.5;//first reading in kW
w2=-3;//second reading in kW , this value is given wrong in question
tw=w1+w2;//in kW
dw=w1-w2;//in kW
pfa=atand(sqrt(3)*(dw/tw));
pf=cosd(pfa);////power factor when second reading is obtained by reversing the connection
disp(pf,"power factor when second reading is obtained by reversing the connections ")
```