Scilab Textbook Companion for Introduction to Electric Drives by J. S. Katre[1]

Created by
Lalit Kumar Saini
B.TECH
Electronics Engineering
Uttrakhand Technical Univeristy
College Teacher
Arshad Khan
Cross-Checked by
KVP Pradeep

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: Introduction to Electric Drives

Author: J. S. Katre

Publisher: Tech-max Publications, Pune

Edition: 2

Year: 2012

ISBN: 978-81-8492-024-6

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

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

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

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

Contents

List of Scilab Codes

Chapter 1

Thyristors

Scilab code Exa 1.11.1 `peak reverse recovery current`

```
//Example 1.11.1: peak reverse recovery current
clc;
clear;
close;
//given data :
itt=10;// time in micro seconds
qtt=150;//charge in micro colums
prrc=((2*qtt)/itt);//peak reverse recovery current
   in amperes
disp(prrc,"peak reverse recovery current in amperes"
   )
```

Scilab code Exa 1.18.1 `voltage`

```
//Example 1.18.1: voltage of the capacitor
clc;
clear;
close;
```

```
format('v',7)
r=10;//in ohms
l=10;///inductance in mH
c=10;//capacitance in micro farads
v=100;//in volts
t=((%pi)/(sqrt((1/(l*10^-3*c*10^-6))-(r^2/(4*(l
   *10^-3)^2)))));// time in seconds
vc= v*(1-cosd(t/(sqrt(l*10^-3*c*10^-6))));//in volts
disp(vc,"the capacitor voltage in volts is")
//answer is wrong in the textbook
```

Scilab code Exa 1.18.2 voltage of the capacitor

```
//Example 1.18.2: voltage of the capacitor
clc;
clear;
close;
format('v',7)
r=15;//in ohms
l=12;///inductance in mH
c=8;//capacitance in micro farads
v=100;//in volts
t=((%pi)/(sqrt((1/(l*10^-3*c*10^-6))-(r^2/(4*(l
   *10^-3)^2)))));// time in seconds
vc= v*(1-cosd(t/(sqrt(l*10^-3*c*10^-6))));//in volts
disp(vc,"the capacitor voltage in volts is")
//this question is not solved in the textbook
```

Scilab code Exa 1.20.1 turn off time

```
//Example 1.20.1: Turn Off Time
clc;
clear;
```

```
close;
//given data :
format('v',6)
Vs=200;//in volts
R1=10;// in ohm
R2=R1;
C=5;// in micro-farad
Tc=(R1*C)/1.44;
disp(Tc,"The Circuit Turn Off Time,Tc(micro-sec) = "
    )
```

Scilab code Exa 1.20.2 state thyristor current and circuit turn off time

```
//Example 1.20.2: Peak Current and turn off time
clc;
clear;
close;
format('v',6)
//given data :
Vs=200;//in volts
R1=10;// in ohm
R2=R1;
Vc=200;//in volts
C=10;// in micro-farad
I1=Vs/R1;
I2=(Vs+Vc)/R2;
It1=I1+I2;
disp(It1,"Peak Current,It1(A) = ")
Tc=(R1*C)/1.44;
disp(Tc,"The Circuit Turn Off Time,Tc(micro-sec) = "
    )
```

Scilab code Exa 1.21.1 inductance and capacitance

```
//Example 1.21.1: L and C
clc;
clear;
close;
//given data :
V=100;// in volts
Irm=40;// in A
tq=40;// in micro-sec
Del_t=(50/100)*tq;// in micro-sec
C=(Irm*(tq+Del_t))/V;
disp(C,"capacitance,C(micro-farad) = ")
L_min=(V/Irm)^2*C;
disp(L_min,"minimum inductance,L_min(micro-Henry) = ")
T=2.5;// assume one cycle period in ms
L_max=((0.01*(T*10^-3)^2)/(%pi^2*C*10^-6))*10^6;
disp(L_max,"Maximum inductance,L_max(micro-Henry) = ")
```

Chapter 2

Gate triggering Circuits

Scilab code Exa 2.6.1 design the triggering circuit

```
//Example 2.6.1;// design
clc;
clear;
close;
//given data :
format('v',7)
c1=0.1;//in micro farads
vbb=30;//in volts
n=0.51;//
ip=10;//in micro amperes
vv=3.5;//in volts
iv=10;//in mA
f=50;//in Hz
w=50;//eifth in micro seconds
vd=0.7;//in volts
vp=n*vbb+vd;//in volts
vc=vp;//in volts
x=log(vv/(vp-vd));//
r1=-(w*10^-6/(c1*10^-6*x));//
T=(1/(f))*10^3;//in ms
t1=T-(w*10^-3);// in ms
```

```
r=((t1*10^-3)/(c1*10^-6*log(1/(1-n))));//
r2=(10^4/(n*vbb));//in ohms
disp(round(r1),"resistance R1 in ohm is")
disp(r*10^-3,"resistance R in kilo ohm is")
disp(r2,"resistance R2 in ohm is")
```

Scilab code Exa 2.7.1 load current

```
//Example 2.7.1;//current
clc;
clear;
close;
//given data :
format('v',3)
v=100;//in volts
r=20;//in ohms
t=50;//in micro seconds
l=0.5;//in henry
il=(v/r)*(1-exp(-t*10^-6*(r/l)));//
disp("load current in (mA) "+string(il*10^3)+"")
```

Scilab code Exa 2.7.2 minimum width of gate pulse

```
//Example 2.7.2;//MINIMUM WIDTH
clc;
clear;
close;
//given data :
format('v',7)
v=100;//in volts
r=20;//in ohms
l=0.5;//in henry
il=50;//in mA
```

```
t1=log(1-((il*10^-3)/(v/r)))/(-(r/l));//
disp(t1*10^6,"minimum pulse width in micro seconds
    is")
```

Scilab code Exa 2.7.3 minimum width of gate pulse

```
//Example 2.7.3;//MINIMUM WIDTH
clc;
clear;
close;
//given data :
format('v',7)
v=207;//in volts
r=10;//in ohms
l=1;//in henry
il=100;//in mA
t1=log(1-((il*10^-3)/(v/r)))/(-(r/l));//
disp(t1*10^6,"minimum pulse width in micro seconds
    is")
```

Scilab code Exa 2.7.4 resistance and duty cycle

```
//Example 2.7.4;// resistance and duty cycle
clc;
clear;
close;
//given data :
format('v',7)
vr=15;//in volts
t=20;//in micro seconds
pd=0.3;//power dissipation in watts
Ig=poly(0,"Ig");
p=-5+Ig+10*Ig^2;//
```

```
x=roots(p);//
rg=(vr-(1+10*x(2,1)))/(x(2,1));//resistance in ohms
disp("part (a)")
disp(rg,"resistance Rg in ohm is")
pgm=5;//peak power in watts
d=(pd/pgm)*100;//duty cycle
disp("part (b)")
disp(d,"duty cycle in percentage is")
tt=(t)/(d/100);//in micro seconds
f=(1/(tt*10^-3));//triggering frequency in kHz
disp("part (c)")
disp(f,"triggering frequency in kHz is")
```

Scilab code Exa 2.7.5 gate source resistance

```
//Example 2.7.5;// resistance
clc;
clear;
close;
//given data :
format('v',4)
vg=15;//in volys
vgk=0.7;//in volts
pg=0.5;// in watts
ig=pg/vgk;//in amperes
rg=(vg-vgk)/ig;//in ohms
disp(rg,"gate source resistance in ohm ")
```

Scilab code Exa 2.7.6 resistance and frequency

```
//Example 2.7.6;// resistance ,frequency
clc;
clear;
```

```
close;
//given data :
format('v',6)
li=3.7;//leakage current in mA
c1=0.1;//in micro farads
vp=16;//in volts
vv=1;//in volts
n=0.7;//
ip=0.7;//in milli amperes
iv=6;//in mA
f=1000;//in Hz
rb1=5.5;//in killo ohms
t=(1/f)*10^3;//in ms
tg=50;//in micro seconds
r2=((tg*10^-6/(c1*10^-6)));// in ohms
r1=500 ;//in ohms assume
vs=(r1+(rb1*10^3)+r2)*(li*10^-3);//in volts
r=((t*10^-3)/(c1*10^-6*log(1/(1-n))))*10^-3;//in
   killo ohms
rmin=(vs-vv)/iv;//minimum resistance in killo ohms
rmax=(vs-vp)/ip;//maxium resistance in killo ohms
fmin=(1/(rmax*10^3*c1*10^-6*log(1/(1-n))));//minimum
    frequency in Hz
fmax=(1/(rmin*10^3*c1*10^-6*log(1/(1-n))))*10^-3;//
   minimum frequency in Hz
disp(vs,"Voltage is ,(V)=")
disp(r,"charging resistance in kilo ohm is")
disp(rmin,"minimum resistance in kilo ohm is")
disp(rmax,"maximum resistance in kilo ohm is")
disp(fmin,"minimum frequency is Hz is")
disp(fmax,"maximum frequency in kHz is")
//mimimum frequency is calculated wrong in the
   textbook
```

Scilab code Exa 2.7.7 `resistance`

```
//Example 2.7.7;// resistance
clc;
clear;
close;
//given data :
format('v',4)
il=50;//in mA
pw=50;//pulse width in micro seconds
i=10;//in mA
v=100;//in volts
if1=50;//in mA
rmax=(v/(if1-i));//maximum resistance in killo ohms
disp(rmax,"maximum resistance in kilo ohm is")
```

Scilab code Exa 2.7.8 resistance and gate power dissipation and frequency

```
//Example 2.7.8;// resistance and gate power
   dissipation and frequency
clc;
clear;
close;
//given data :
format('v',7)
g=16;//in volts/ampere
vr=15;//in volts
t=4;//in micro seconds
ig=500;//in mA
rg=(vr/(ig*10^-3))-g;//resistance in ohms
disp("part (a)")
disp(rg,"resistance in series with SCR gate in ohm
   is")
ig=500;//in mA
rg=(vr/(ig*10^-3))-g;//resistance in ohms
pg=(ig*10^-3)^2*(g);//
disp("part (b)")
```

```
disp(pg,"gate power dissipation in Watt is")
ogv=0.3;//in watts
d=(ogv/pg)*100;//
t1=(t)/(d/100);//in micro seconds
f1=(1/(t1*10^-3));//frequency in kHz
disp("part (c)")
disp(f1,"triggering frequency in kHz is")
```

Scilab code Exa 2.7.9 series resistance

```
//Example 2.7.9;// series resistance and power
   dissipation
clc;
clear;
close;
//given data :
format('v',7)
vr=12;//in volts
t=50;//in micro seconds
d=0.2;//duty cycle
pd=5;//power dissipation in watts
Ig=poly(0,"Ig");
p=-5+1.5*Ig+8*Ig^2;//
x=roots(p);//
rg=(vr-(1.5+8*x(2,1)))/(x(2,1));//resistance in ohms
pg=d*pd;//average power loss in watts
disp(round(rg),"resistance Rg in ohm is")
disp(pg,"average power loss in Watt is")
```

Scilab code Exa 2.7.10 design

```
//Example 2.7.10;// design
clc;
```

```
clear;
close;
//given data :
format('v',6)
vs=20;//in volts
c1=0.1;//in micro farads
vv=2.5;//in volts
n=0.66;//
ip=10;//in micro amperes
iv=10;//in mA
f=1;//in KHz
tg=40;//in micro seconds
vd=0.8;//in volts
vp=(n*vs+vd);//in volts
r1=((tg*10^-6/(c1*10^-6)));// in ohms
r=((1)/(f*10^3*c1*10^-6*log(1/(1-n))))*10^-3;//in killo ohms
rmin=(vs-vv)/iv;//minimum resistance in killo ohms
rmax=(vs-vp)/ip;//maxium resistance in killo ohms
r2=10^4/(n*vs);//in ohms
disp(vp,"Vp in volts is")
disp(r1,"R1 in ohm is")
disp(r,"R in kilo ohm is")
disp(rmin,"minimum resistance in kilo ohm is")
disp(rmax*10^3,"maximum resistance in kilo ohm is")
disp(round(r2),"R2 in ohm is")
```

Scilab code Exa 2.7.11 trigger angle

```
//Example 2.7.11;//trigger angle
clc;
clear;
close;
//given data :
format('v',5)
```

```
vm=120*sqrt(2);//in volts
vrb=0.7;//in volts
rb=500;//in ohms
rl=1000;//in ohms
rmin=1000;//in ohms
r=4000;//in ohms
alpha=asind((0.7*(rl+rmin+r+rb))/(rb*vm));//in
    degree
disp(alpha,"triggering angle in degree is")
```

Scilab code Exa 2.7.12 `pulse width`

```
//Example 2.7.12;// pulse width
clc;
clear;
close;
//given data :
format('v',5)
v=200;//in volts
il=100;//latch current in mA
l=0.2;//inductance in henry
dit=v/l;//in amp/sec
dt=(il*10^-3)/dit;//in seconds
disp("part (a)")
disp(dt*10^6,"minimum pulse width required to turn
    on the SCR is in micro seconds")
r=20;//in ohms
x=(il*10^-3*r)/v;//
t=(log(1-x))*(-l/r);//
disp("part (b)")
disp(round(t*10^6),"minimum pulse width in micro
    seconds is")
//part b answer is calculated wrong in the textbook
```

Scilab code Exa 2.7.13 design the triggering circuit

```
//Example 2.7.13;// design
clc;
clear;
close;
format('v',6)
vs=30;//in volts
n=0.51;//
vd=0.7;//in volts
vp=(n*vs+vd);//in volts
c=0.1;//in micro farads
vv=3.5;//in volts
x=log(vv/(vp-vd));//
t2=50;//in micro seconds
r3=-((t2*10^-6)/(x*c*10^-6));//in ohms
f=50;//in Hz
t=(1/f)*10^3;//in ms
t1=(t-(t2*10^-6));//inms
x1=log(1-((vp-vv)/(vs)));//
y1=(-t1*10^-3)/(c*10^-6);//
r1=y1/x1;//in ohms
r2=(10^4)/(n*vs);//in ohms
disp(r1*10^-3,"R1 in ohm is")
disp(r2,"R2 in ohm is")
disp(round(r3),"R3 in ohm is")
disp(c,"capaictance in micro Farad is")
//R3 is wrong in the textbook
```

Chapter 3

Single phase controlled rectifiers

Scilab code Exa 3.3.1 form factor ripple factor transformation utilization factor a

```
// Example 3.3.1: form factor,ripple factor , transformation utilization factor and peak inverse voltage
clc;
clear;
close;
Vm=1;//assume
R=1;//assume
t=%pi/3:%pi;
Vldc= ((Vm/(2*%pi))*intsplin(t,sin(t)));//
Vlms=sqrt((Vm^2/(2*%pi))*intsplin(t,(sin(t))^2));//
ff=Vlms/Vldc;
disp("part (a)")
disp("form factor is "+string(ff)+" or "+string(ff*100)+" percentage")
//form factor is calculated wrong in the textbook
disp("part (b)")
rf=sqrt(ff^2-1);//
disp("ripple factor is "+string(rf)+ " or "+string(
```

```
    rf*100)+" percentage")
//ripple factor is calculated wrong in the textbook
Vs=Vm/(sqrt(2));//rms secondary voltage
Is=Vlms/R;//
TUF=((Vldc^2)/R)/(Vs*Is);//
disp("part (c)")
disp("transformation utilization factor is "+string(
    TUF)+ " or "+string(TUF*100)+" percentage")
//transformation utilization factor is calculated
    wrong in the textbook
R=1;//assume
Vm=1;//assume
disp("part (d)")
disp("PIV=Vm")
```

Scilab code Exa 3.4.1 plot the variation

```
// Example 3.4.1: plot the variation
clc;
clear;
close;
vsrms=230;//volts
vm=sqrt(2)*vsrms;//volts
alpha=[0;30;60;90;120;150;180];//degree
x=[0;(30*(%pi/180));(60*(%pi/180));(90*(%pi/180))
    ;(120*(%pi/180));(150*(%pi/180));(180*(%pi/180))]
for i=1:7
    vldc(i)=(vm/%pi)*(1+cosd(alpha(i)));//
    vlms(i)=vsrms*((1/%pi)*(%pi-x(i)+(sin(2*x(i))
        /2))^(1/2);//
end
subplot(1,2,1)
xlabel("alpha");//
ylabel("Vldc");//
xtitle('(a) Variation of average load voltage')
```

```
plot(alpha,vldc);//

subplot(1,2,2)
xlabel("alpha");//
ylabel("Vlrms");//
xtitle('(b) Variation of RMS load voltage')
plot(alpha,vlms);//
```

Scilab code Exa 3.4.5 delay angle average output current average and rms thyristor

```
// Example 3.4.5: delay angle,rms , averae output current ,average and rms thyristor current
clc;
clear;
close;
format('v',5)
Vrms=120;//RMS VOLTAGE
R=10;//in ohms
Vldc= (0.25*(2*sqrt(2)*Vrms))/%pi;//in volts
csd= (Vldc*%pi)/(sqrt(2)*Vrms);//
alpha= acosd(csd-1);//
disp("part (a)")
disp(alpha,"delay angle in degree is")
Vrms=120;//RMS VOLTAGE
Vm=sqrt(2)*Vrms;//assume
t=2*%pi/3:%pi;
Vlms=((Vm/(sqrt(2)))*(((1/%pi)*((%pi-(2*%pi)/3)+sind((4*%pi)/6))))^(1/2));
Vldc= (0.25*(2*sqrt(2)*Vrms))/%pi;//in volts
Ildc=Vldc/R;//average load current in ampere
Ilms=Vlms/R;// rms load current in ampere
disp("part (b)")
disp(Ilms,"rms load current in amperes")
disp(Ildc,"average load current in amperes")
//rms load current is calculated  wrong in the
```

```
textbook
Im=Vm/R;//
Ith=((Im/(2*%pi))*intsplin(t,sin(t)));//in amperes
Ithrms=sqrt((Im^2/(2*%pi))*intsplin(t,(sin(t))^2));//in amperes
disp("part (c)")
disp(Ith,"average thyristor current in amperes is")
disp(Ithrms,"rms thyristor current in amperes is")
//average and rms thyrister current is calculated wrong in the textbook
```

Scilab code Exa 3.6.1 `average load voltage rms load voltage average and rms load cu`

```
// Example 3.6.1: average load voltage,rms load voltage,average and rms load currents ,form factor and ripple factor
clc;
clear;
close;
format('v',7)
R=10;//IN OHMS
r=10;//IN OHMS
Vi=230;//in volts
alpha=60;//fiirng angle in degree
Vm=Vi*sqrt(2);//in voltas
Vldc=((Vm)/%pi)*(1+cosd(alpha));//average load voltgae
disp("part (a)")
disp(Vldc,"average load voltage in volts")
disp("part (b)")
r=10;//IN OHMS
Vi=230;//in volts
alpha=60;//fiirng angle in degree
Vm=Vi*sqrt(2);//in voltas
Vlms=((Vm/(sqrt(2)))*(((%pi-%pi/3)+(sind(2*%pi/3))
```

```
/2)/%pi)^(1/2));//
disp(Vlms,"rms load voltage in volts")
//rms voltage is calculated wrong in the textbook
disp("part (c)")
Ildc=Vldc/R;// in amperes
Irms=Vlms/R;// in amperes
disp(Irms,"rms load current in ampere")
disp(Ildc,"average load current in ampere")
//rms load current is wrong in the textbook
disp("part (d)")
ff=Vlms/Vldc;
disp("form factor is "+string(ff)+" or "+string(ff*100)+" %")
rf=sqrt(ff^2-1);//
disp("ripple factor is "+string(rf)+ " or "+string(rf*100)+" %")
//form factor and ripple factor is calculated wrong in the textbook
```

Scilab code Exa 3.7.1 device rating

```
// Example 3.7.1:device ratings
clc;
clear;
close;
Io=25;//in amperes
Vsrms=120;// in colts
Vm=sqrt(2)*Vsrms;// in volts
for i= 1:5
    alpha=[0;60;90;135;180]
    Vldc(i)=((Vm)/%pi)*(1+cosd(alpha(i,1)));//
    disp(round((Vldc(i))),"mean voltage in volts is at angle "+string(alpha(i,1))+" degree")
end
PIV=Vm;//peak inverse voltage
```

```
Iascr=Io/2;//scr average currentin ampere
Iadod=Io;//average diode current in amperes
Ipscr=Iascr;//peak current rating for SCR in amperes
Ipdod=Iadod;//peak current rating for diode in
    amperes
disp(Iascr,"scr average current in amperes")
disp(Iadod,"average diode current in amperes")
disp(Ipscr,"peak current rating for SCR in amperes")
disp(Ipdod,"peak current rating for diode in amperes
    ")
```

Scilab code Exa 3.7.2 `Vldc Vn Vlrms HF DF and PF`

```
// Example 3.7.2:Vldc,Vn,Vlrms,HF,DF and PF
clc;
clear;
close;
format('v',7)
Vsrms=120;//in volts
alpha=%pi/2;//
vm=sqrt(2)*Vsrms;//
vldc=((sqrt(2)*Vsrms)/(%pi))*(1+cos(alpha));//in
    volts
vldcm=(2*vm)/(%pi);//in volts
vn=vldc/vldcm;//normalised average output voltage in
     volts
x=((1/%pi)*((%pi-alpha)+(sin((2*alpha)))/2))^(1/2);
    //
vlrms=((vm/sqrt(2))*x);//RMS load voltage in volts
Io=1;//assume
Isrms=Io*(1-(alpha/%pi))^(1/2);//in amperes
Is1rms=((2*sqrt(2))*Io*cos(alpha/2))/(%pi);//in
    amperes
HF=((Isrms/Is1rms)^2-1)^(1/2);//Harmonic Fator is
DF=cos(alpha/2);//Displacement factor
```

```
PF=(Is1rms/Isrms)*(DF);//power factor
disp(round(vldc),"average output voltage (Vldc)in
    volts is")
disp(vn,"Normalised average output voltage (Vn) in
    volts is")
disp(vlrms,"RMS load voltage (Vlrms) in volts is")
disp(HF*100,"Harmonic factor (HF) in percentage is")
disp(DF*100,"Displacement factor (DF) in percentage
    is")
disp(PF,"power factor (PF) lagging is")
```

Scilab code Exa 3.7.3 amlitude of first four harmonic components

```
// Example 3.7.3:amlitude of first four harmonic
    components
clc;
clear;
close;
format('v',7)
io=1;//assume
alpha=%pi/2;//
n=[0;0;(1/(%pi*3));0;(1/(%pi*5));0;(1/(%pi*7))
    ;0;(1/(%pi*9))];//
for i= [3;5;7;9]
    m(i)=((2*sqrt(2))*cos(((i)*alpha)/2));
end
x=[0;0;m(3)*n(3);0;m(5)*n(5);0;m(7)*n(7);0;m(9)*n(9)
    ];//
for i=[3;5;7;9]
    disp("RMS value of "+string(i)+" harmonic is I"+
        string((i))+"  = "+string(x(i))+"Io ")
end
```

Scilab code Exa 3.7.4 `Vldc FPF and PF`

```
// Example 3.7.4:Vldc,FPF and PF
clc;
clear;
close;
format('v',4)
disp("part (a)")
vm=1;//assume
alpha=[0;30;60;90;120;150;180];//in degree
for i=1:7
    vldc(i)=(vm/%pi)*(1+cosd(alpha(i)));//
    disp("average load voltage (Vldc) for angle "+string(alpha(i))+" degree is Vm*"+string(vldc(i))+" ")
end
subplot (2,2,1)
plot2d(alpha,vldc);//
xlabel("alpha(degrees)")
ylabel("average voltage (Vldc)")
xtitle("(a) Variation of Vldc Vs alpha")
disp("part (b)")
format('v',6)
vm=1;//assume
alpha=[0;30;60;90;120;150;180];//in degree
for i=1:7
     FPF(i)=cosd((alpha(i))/2)
     disp("displavefactor or fundamental power factor (FPF) for fringle angle "+string(alpha(i))+" degree is "+string(FPF(i))+" ")
end
subplot (2,2,2)
plot2d(alpha,FPF);//
xlabel("alpha(degrees)")
ylabel("FPF")
xtitle("(b) Variation of FPF Vs alpha")
disp("part (c)")
vm=1;//assume
```

```
alpha1=[0;30;60;90;120;150;180];//
alpha=[0;%pi/6;%pi/3;%pi/2;(2*%pi)/3;(5*%pi)/6;%pi]; //in degree
for i=1:6

    PF(i)=(sqrt(2)*(1+cos(alpha(i))))/sqrt((%pi)*(%pi-alpha(i))) ;
    PF(7)=0;//
    disp("displavefactor or fundamental power factor (FPF) for fringle angle "+string(alpha1(i))+" degree is "+string(PF(i))+" ")
end
subplot (2,2,3)
plot2d(alpha1,PF);//
xlabel("alpha(degrees)")
ylabel("FPF")
xtitle("(c) Variation of PF Vs alpha")
```

Scilab code Exa 3.7.5 alpha

```
// Example 3.7.5;alpha
clc;
clear;
close;
format('v',4)
disp("part (a)")
vc=135;//in volts
vs=220;//in vlts
rl=0.5;//in ohms
io=10;//in ampeeres
vm=sqrt(2)*vs;//
vldc=io*rl+vc;//
alpha=acosd((vldc*%pi)/(2*vm));//
disp("alpha is in degree "+string(alpha)+" ")
disp("part (b)")
```

```
vc=145;//in volts
vs=220;//in vlts
rl=0.5;//in ohms
io=10;//in ampeeres
vm=sqrt(2)*vs;//
vldc=io*rl-vc;//
alpha=acosd((vldc*%pi)/(2*vm));//
disp("alpha in degree "+string(alpha)+" ")
```

Scilab code Exa 3.7.6 average output voltage supply rms current supply fundamental

```
// Example 3.7.6:average output voltage,supply rms
   current ,supply fundamental current current,
   displacement factor,supply factor and supply
   harmonic factor
clc;
clear;
close;
format('v',6)
Vsrms=220;//in volts
alpha=%pi/3;//
vm=sqrt(2)*Vsrms;//
vldc=((2*vm)/(%pi))*(cos(alpha));//in volts
vldcm=(2*vm)/(%pi);//in volts
vn=vldc/vldcm;//normalised average output voltage in
    volts
x=((1/%pi)*((%pi-alpha)+(sin((2*alpha))/2))^(1/2);
   //
vlrms=((vm/sqrt(2))*x);//RMS load voltage in volts
Io=1;//assume
Isrms=Io*(1-(alpha/%pi))^(1/2);//in amperes
Is1rms=((2*sqrt(2))*Io*cos(alpha/2))/(%pi);//in
   amperes
HF=((Isrms/Is1rms)^2-1)^(1/2);//Harmonic Fator is
DF=cos(alpha/2);//Displacement factor
```

```
PF=(Is1rms/Isrms)*(DF);//power factor
disp("part (a)")
disp(round(vldc),"average output voltage (Vldc)in
   volts is")
disp("part (b)")
disp("due to exact 50% duty cycle the rms value of
   supply current Isrms=Io")
Io=1;//assume
Isrms=Io;//in amperes
Is1rms=((2*sqrt(2))*Io)/(%pi);//in amperes
disp("part (c)")
disp("supply fundamental current is "+string(Is1rms)
   +" Io ")
disp("part (d)")
DF=cos(alpha);//
disp(DF,"displacement factor is")
disp("part (a)")
SPF=Is1rms*DF;//
disp(SPF,"supply power factor is (lagging)")
disp("part (f)")
HF=(((Isrms/Is1rms)^2)-1)^(1/2);//
disp(HF*100,"supply harmonic factor in percentage is
   ")
```

Scilab code Exa 3.7.7 amplitude of the first three lower order harmonics

```
// Example 3.7.7:amlitude of first three harmonic
   components
clc;
clear;
close;
format('v',6)
io=1;//assume
n=[0;0;3*%pi;0;5*%pi;0;%pi*7]
for i= [3;5;7]
```

```
    m(i)=((2*sqrt(2))*io);
end
x=[0;0;m(3)/n(3);0;m(5)/n(5);0;m(7)/n(7);];//
for i=[3;5;7]
    disp("RMS value of "+string(i)+" harmonic is I"+
       string((i))+"  = "+string(x(i))+"Io ")
end
```

Chapter 4

Three phase controlled rectifiers

Scilab code Exa 4.8.2 current

```
//Example 4.8.2: current
clc;
clear;
close;
io=1;//assume
t0=0;//
t1=(2*%pi)/3;//
th=integrate('1','t',t0,t1);//
th1=(1/(2*%pi))*th;//
x=th1^(1/2);//
disp("Ithrms is "+string(x)+"*Io")
```

Chapter 5

Inverters

Scilab code Exa 5.3.1 `frequency`

```
//Example 5.3.1: Maximum frequency
clc;
clear;
close;
//given data :
T_off=100;// in micro-sec
L=40;// in micro-H
C=5;// in micro-farad
R=4;//in ohm
Tr=((2*%pi)/sqrt((1/(C*10^-6*L*10^-6))-(R^2/(4*(L*10^-6)^2))))*10^6;
f=(1/(Tr+T_off))*10^3;
disp(f,"maximum frequency ,f(kHz) = ")
```

Scilab code Exa 5.12.1 `rms output voltage output power average and peak currents p`

```
//Example 5.12.1: rms output voltage,output power,average and peak currents,peak reverse blocking
```

```
voltage ,THD,DF, harmonic factor and distortion factor of the lowest order harmonic
clc;
clear;
close;
disp("part (a)")
format('v',5)
v=24;//in volts
V=v;//
r=3;//in ohms
v1rms=(2*v)/(sqrt(2)*%pi);//in volts
disp(v1rms,"rms output voltage at fundamental frequency in volts is")
disp("part (b)")
po=((v/2)^2)/r;//in watts
disp(po,"output power in Watt is")
disp("part (c)")
itav=(v/(4*r));//in amperes
itp=((v/2)/r);//in amperes
disp(itav,"average transistor current in amperes is")
disp(itp,"transistor peak current in amperes is")
disp("part (d)")
vbr=2*(v/2);//in volts
disp(vbr,"peak reverse bloacking voltage in volts is")
disp("part (e)")
vo=v/2;//
THD1=((vo)^2-(v1rms)^2)^(1/2);//in volts
THD=THD1/v1rms;//
disp(THD*100,"Total Hramonic distortion in percentage is")
disp("part (f)")
n=[0;0;(1/3);0;(1/5);0;(1/7);0;(1/9);0;(1/11);0;(1/13)];//
for i=[3;5;7;9;11;13]
    v(i)=(2*V)*((n(i)))/(%pi*sqrt(2));//
end
```

```
x=sqrt((((v(3))/(3^2))^2)+(((v(5))/(5^2))^2)+(((v(7))/(7^2))^2)+(((v(9))/(9^2))^2)+(((v(11))/(11^2))^2)+(((v(13))/(13^2))^2));//
DF=x/v1rms;//
disp(DF*100,"distortion factor in percentage is")
//distortion factor is calculated wrong in the textbook
disp("part (g)")
HF3=v(3)/v1rms;//
DF3=((v(3))/(3^2))/v1rms
disp(HF3*100,"HF for the third harmonic in percentage is")
disp(DF3*100,"DF the third harmonic in percentage is")
```

Scilab code Exa 5.12.2 rms output voltage output power average and peak currents p

```
//Example 5.12.2: rms output voltage,output power,average and peak currents,peak reverse blocking voltage,THD,DF,harmonic factor and distortion factor of the lowest order harmonic
clc;
clear;
close;
format('v',5)
v=48;//in volts
V=v;//
r=2.4;//in ohms
v1rms=(4*v)/(sqrt(2)*%pi);//in volts
disp("part (a)")
disp(v1rms,"rms output voltage at fundamental frequency in volts is")
disp("part (b)")
po=((v)^2)/r;//in watts
disp(po,"output power in Watt is")
```

```
disp("part (c)")
itav=(v/(r));//in amperes
itp=((v/2)/r);//in amperes
disp(itp,"average transistor current in amperes is")
disp(itav,"transistor peak current in amperes is")
disp("part (d)")
vbr=2*(v/2);//in volts
disp(vbr,"peak reverse bloacking voltage in volts is")
disp("part (e)")
vo=v;//
THD1=((vo)^2-(v1rms)^2)^(1/2);//in volts
THD=THD1/v1rms;//
disp(THD*100,"Total Hramonic distortion in percentage is")
disp("part (f)")
n=[0;0;(1/3);0;(1/5);0;(1/7);0;(1/9);0;(1/11);0;(1/13)];//
for i=[3;5;7;9;11;13]
    v(i)=(2*V)*((n(i)))/(%pi*sqrt(2));//
end
x=sqrt((((v(3))/(3^2))^2)+(((v(5))/(5^2))^2)+(((v(7))/(7^2))^2)+(((v(9))/(9^2))^2)+(((v(11))/(11^2))^2)+(((v(13))/(13^2))^2));//
vorms=0.9
DF=x/vorms;//
disp(DF*100,"distor factor in percentage is")
//distortion factor is calculated  wrong in the textbook
disp("part (g)")
HF3=2*v(3)/v1rms;//
DF3=2*((v(3))/(3^2))/v1rms
disp(HF3*100,"HF for the third harmonic in percentage is")
disp(DF3*100,"DF the third harmonic in percentage is")
```

Scilab code Exa 5.12.3 amplitude of the first three lower order harmonics

```
//Example 5.12.3: amplitude of the first three lower
    order harmonis
clc;
clear;
close;
//given data :
v=200;//in volts
n=[(1/3);(1/5);(1/7)];//
for i=1:3
    vn(i)=((4*v*n(i))/(sqrt(2)*%pi));//
end
disp(round(vn(1)),"Rms value of third harmonic
   component of output voltage in volts is")
disp(round(vn(2)),"Rms value of fifth harmonic
   component of output voltage in volts is")
disp((vn(3)),"Rms value of seventh harmonic
   component of output voltage in volts is")
```

Scilab code Exa 5.12.4 compare performance

```
//Example 5.12.4: amplitude of the first three lower
    order harmonis
clc;
clear;
close;
//given data :
v=200;//in volts
n=[(1/3);(1/5);(1/7)];//
vo1rms=(2*v)/(sqrt(2)*%pi);//in volts
for i=1:3
```

```
    vn(i)=((2*v*n(i))/(sqrt(2)*%pi));//
end
disp(round(vo1rms),"Vo1rms for half bridge circuit in volts is")
disp(round(vn(1)),"Rms value of third harmonic component for half bridge circuit  in volts is")
disp(round(vn(2)),"Rms value of fifth harmonic component for half bridge circuit in volts is")
disp((vn(3)),"Rms value of seventh harmonic component for half bridge circuite in volts is")
disp("for bridge inverter")
vo1rms1=(4*v)/(sqrt(2)*%pi);//in volts
for i=1:3
    vn1(i)=((4*v*n(i))/(sqrt(2)*%pi));//
end
disp(round(vo1rms1),"Vo1rms for half bridge circuit in volts is")
disp(round(vn1(1)),"Rms value of third harmonic component for bridge inverter circuit  in volts is")
disp(round(vn1(2)),"Rms value of fifth harmonic component for half bridge inverter circuit in volts is")
disp((vn1(3)),"Rms value of seventh harmonic component for half bridge inverter circuite in volts is")
```

Chapter 6

Choppers

Scilab code Exa 6.5.1 average load voltage RMS load voltage Form factor and Ripple

```
//Example 6.5.1:average load voltage,RMS load voltage,Form factor and Ripple factor
clc;
clear;
close;
format('v',6)
//given data
f=1;//in kHz
t=1/f;//in ms
d=0.3;//
v=200;//
vch=2;//in volts
vldc=(v-vch)*d;//average load voltage in volts
disp("part (a)")
disp(vldc,"average load voltage in volts is")
disp("part (b)")
vlrms=(v-vch)*sqrt(d);//RMS load voltage in volts
disp(vlrms,"RMS load voltage in volts is")
disp("part (c)")
FF=vlrms/vldc;//
disp("ripple factor is "+string(FF)+" or "+string(FF
```

```
*100)+"%")
disp("part (d)")
rf=sqrt(FF^2-1);//
disp("ripple factor is "+string(rf)+" or "+string(rf
   *100)+"%")
```

Scilab code Exa 6.5.2 chooper efficiency input resistance and average load curren

```
//Example 6.5.2: chooper efficiency ,input resistance
    and average load current
clc;
clear;
close;
format('v',6)
//given data
r=10;//in ohms
f=1;//in kHz
t=1/f;//in ms
d=0.3;//
v=200;//
vch=2;//in volts
Po=((v-vch)^2)*(d/r);//in watts
Pi=((d*v*(v-vch))/r);//in watts
cn=Po/Pi;//chopper efficiency
disp("part (a)")
disp("chopper efficiency is "+string(cn)+" or "+
   string(cn*100)+"%")
disp("part (b)")
R1=r/d;//
disp(R1,"input resistance in ohm is")
disp("part (c)")
vldc=59.4;//V
r=10;//ohm
Ildc=vldc/r;//amp
disp(Ildc,"average load current is ,(A)=")
```

Scilab code Exa 6.5.3 Duty Cycle Average Load voltage and RMS Load Voltage

```
//Example 6.5.3: Duty Cycle,Average Load voltage and
    RMS Load Voltage
clc;
clear;
close;
format('v',6)
//given data
V=200;// in volts
T_on=500*10^-6;
f=1*10^3;// in Hz
D=T_on*f;
disp("part (a)")
disp("duty cycle is "+string(D)+" or "+string(D*100)
    +"%")
disp("part (b)")
VL_dc=D*V;
disp(VL_dc,"Average Load Voltage,(volts) = ")
disp("part (c)")
VL_rms=sqrt(D)*V;
disp(VL_rms,"RMS Load Voltage,VL_rms(volts) = ")
//part c answer is calculated wrong in book
```

Scilab code Exa 6.5.4 plot the variation

```
//Example 6.5.4:average load voltage and rms load
    voltage
clc;
clear;
close;
```

```
//given data
for i=1:10
    sr(i)=i;//
    d(1)=0;
    d(i+1)=d(i)+0.1;//
end
for i=1:11
    v=1;//
    vldc(i)=d(i)*v;//
    vlrms(i)=sqrt(d(i))*v;//
end
X = [sr];
Y = [d];
Z  = [vldc];
U= [vlrms];
disp(Z,"Vldc different values of average load
   voltage are in volts")
disp(U,"Vlrms diffent values of RMS load voltage are
    in volts")
plot(d,[vlrms vldc]);
xlabel("DUTY CYCLE D")
ylabel("Vldc & Vlrms Volts")
xtitle("Variation of Vldc and Vlrms with duty cycle
   D")
```

Scilab code Exa 6.5.5 `plot the variation`

```
//Example 6.5.5:average load voltage and rms load
   voltage
clc;
clear;
close;
//given data
d=[0.1;0.2;0.3;0.4;0.5;0.6;0.7;0.8;0.9;1.0]
for i=1:10
```

```
    FF(i)=(1/sqrt(d(i)))*100;//
     RF(i)=(((((FF(i))/100)^2)-1)^(1/2))*100;//
end

disp(FF,"FF different values of form factor in
   percentage is")
disp(RF,"RF diffent values of ripple factor in
   percentage is")
plot(d,[FF RF]);
xlabel("DUTY CYCLE D")
ylabel("FF & RF (%)")
xtitle("Variation of FF and RF with duty cycle D")
hl=legend(['FF %';'RF %']);
```

Scilab code Exa 6.5.6 Average output voltage RMS output voltage chopper efficiency

```
//Example 6.5.6: Average output voltage,RMS output
   voltage,chopper efficiency and Effective input
   resistance
clc;
clear;
close;
//given data :
format('v',6)
r=10;//in ohms
d=0.3;//
v=230;//
vch=1.5;//in volts
D=80/100;// duty cycle
V=220;// in volts
Vch=1.5;//in volts
VL_dc=D*(V-Vch);
disp("part (a)")
disp(VL_dc,"Average output voltage,VL_dc(V) = ")
disp("part (b)")
```

```
VL_rms=sqrt(D)*(V-Vch);
disp(VL_rms,"RMS output voltage,VL_rms(V) = ")
disp("part (c)")
Po=((v-vch)^2)*(d/r);//in watts
Pi=((d*v*(v-vch))/r);//in watts
cn=Po/Pi;//chopper efficiency
disp("chopper efficiency is "+string(cn)+" or "+
    string(cn*100)+"%")
disp("part (d)")
D=80/100;// duty cycle
R=20;//in ohm
Ri=R/D;
disp(Ri,"Effective input resistance,Ri(ohm) = ")
```

Scilab code Exa 6.5.7 average output voltage and average load current

```
//Example 6.5.7.a;average output voltage and current
clc;
clear;
close;
//given data :
vs=120;//in volts
vb=1;//in volts
d=0.33;//
rl=10;//in ohms
f=200;//in Hz
Vldc=d*vs;//
Ildc=round(Vldc)/rl;//in amperes
disp(round(Vldc),"average/DC output voltage in volts
    is")
disp(Ildc,"average load current in amperes is")
```

Scilab code Exa 6.6.5 average armature current

```
//Example 6.6.5 : Average armature current
clc;
clear;
close;
//given data :
V=200;// in volts
D=50/100;// duty cycle
VL_dc=V*D;
Eb=75;// in volts
Ra=1;// in ohm
Ia=(VL_dc-Eb)/Ra;
disp(Ia,"Average armature current,Ia(A) = ")
```

Scilab code Exa 6.6.6 minimum instantaneous load current peak instantaneous curren

```
//Example 6.6.6 :minimum instantaneous load current, peak instantaneous current and maximum peak to peak ripple
clc;
clear;
close;
format('v',6)
v=220;//volts
r=10;//in ohms
l=15.5;//in mH
f=5;//in kHz
Eb=20;//in volts
d=0.5;//
x=exp((-(1-d)*r)/(f*10^3*l*10^-3));//
y=(1-x)*(Eb/r);//
y1=(1-x)*((v-Eb)/r);//
A=[0.94 -0.94*0.94;0.94 -1];
B=[-0.94*0.125;-1.25];
X=A\B;//
disp("part (a)")
```

```
disp(X(1,1),"minimum instantaneous current in amperes is")
disp("part (b)")
disp(X(2,1),"peak instantaneous current in amperes is")
disp("part (c)")
PP=X(2,1)-X(1,1);//
disp(PP,"maximum peak to peak ripple in the load current in amperes is")
```

Scilab code Exa 6.6.7 `load inductance`

```
//Example 6.6.7;inductance
clc;
clear;
close;
v=220;//in volts
r=0.2;//in ohms
ia=200;//in amperes
f=200;//in hz
di=0.05*ia;//in amperes
e=0;//in volts
d=0.5;//
l=((1-d)*v*d*(1/f))/di;//
disp(l*10^3,"inductance in mH is")
```

Scilab code Exa 6.6.9 `load current is continuous or not Average output current max`

```
//Example 6.6.9: load current is continuous or not, Average output current , maximum and minimum steady state output current and RMS values of first and second harmonics of the load current
clc;
```

```
clear;
close;
//given data :
format('v',6)
V=220;//in volts
La=5;// in mH
Eb=24;//in volts
Ra=1;// in ohm
T=2;//in m-sec
D=0.6/2;
D_dash=(La/(T*Ra))*log(1-((Eb/V)*(1-exp((T*Ra)/La))));
disp("part (c)")
disp("As D = "+string(D)+"% is greater then D_dash = "+string(D_dash)+"% so load current is continous")
disp("part (d)")
Io=((D*V)-Eb)/Ra;
disp(Io,"Average output current,Io(A) = ")
I_max=(V/Ra)*((1-exp(-(D*T*Ra)/La))/(1-exp(-(T*Ra)/La)))-(Eb/Ra);
disp(I_max,"Maximum steady state putput current, I_max(A) = ")
I_min=(V/Ra)*((1-exp((D*T*Ra)/La))/(1-exp((T*Ra)/La)))-(Eb/Ra);
disp(round(I_min),"Minimum steady state output current,I_min(A) = ")
disp("part (e)")
C1_rms=((2*V)/(%pi*sqrt(2)))*sin(%pi*D);// in volts
C2_rms=((2*V)/(2*%pi*sqrt(2)))*sin(2*%pi*D);// in volts
Z1=((Ra^2+(2*%pi*La*10^-3*(1/(T*10^-3)))^2)^(1/2));//
Z2=((Ra^2+(2*2*%pi*La*10^-3*(1/(T*10^-3)))^2)^(1/2));//
Ifl=C1_rms/Z1;//in amperes
Ifl1=C2_rms/Z2;//in amperes
disp(Ifl,"fundamental component of load current in
```

```
amperes is")
disp(Ifl1,"second harmonic component of load current in amperes is")
```

Scilab code Exa 6.6.11 `value of current limiting resistor maximum and minimum duty`

```
//Example 6.6.11: value of current limiting resistor ,maximum and minimum duty cycle
clc;
clear;
close;
format('v',6)
//given data :
v=325;//in volts
eb=120;//in volts
r=0.2;//in ohms
ra=0.3;//in ohms
e=120;//in volts
rb=0.2;//in ohms
rl=0.3;//in ohms
d=60;//in percentage
i=20;//in amperes
vo=(d/100)*v;//
R=((i*rl)-(v-eb)+(i*rb))/(-i);//
disp("part (a)")
disp(R,"value of current limiting resistor in ohm is")
//value of current limiting resistor is calculated wrong in the textbook
disp("part (b)")
p=15;//
R=9.45;//
vmax=v+(v*(p/100));//
vmin=v-(v*(p/100));//
Dmax=((i*R)/vmin)*100;//
```

```
Dmin=((i*R)/vmax)*100;//
disp(Dmax,"maximum duty cycle in percentage is")
disp(Dmin,"minimum duty cycle in percentage is")
```

Scilab code Exa 6.9.1 output voltage

```
//Example 6.9.1 : pulse width and output voltage
clc;
clear;
close;
//given data :
v=220;//in volts
vo=660;//in volts
toff=100;//in micro seconds
ton=((vo*toff)/v)-toff;//in micro secondsT=ton+toff
    ;//in micro seconds
T=ton+toff;
f=(1/T);//in Hz
Vo=((v)/(1-(f*(ton/2))));//in volts
disp(ton,"pulse width (ton) in micro seconds is")
disp(Vo,"new output voltage in volts is")
```

Scilab code Exa 6.9.2 chopping frequency and output voltage

```
//Example 6.9.2 :chopping frequency and new output
    voltage
clc;
clear;
close;
format('v',8)
//given data :
v=200;//in volts
vo=600;//in volts
```

```
ton=200;//in micro seconds
x=-((v/vo)-1);//
f=x/(ton*10^-6);//
ton1=ton/2;//
Vo=((v)/(1-(f*ton1*10^-6)));//in volts
disp(f,"chopping frequency in Hz is")
disp(Vo,"new output voltage in volts is")
```

Chapter 8

Control of DC drivers

Scilab code Exa 8.12.1 `back emf Required armature voltage and Rated armatuer curre`

```
//Example 8.12.1: back emf ,Required armature voltage and Rated armatuer current
clc;
clear;
close;
//given data :
format('v',7)
TL=45;// in N-M
N=1200;//in rpm
Rf=147;//in ohm
Ra=25;// in ohm
Kv=0.7032;
w=(2*%pi*N)/60;
Vf=220;//in volts
Kt=Kv;
If=Vf/Rf;
T=TL;
Ia=T/(Kt*If);
Eg=Kv*w*If;
disp("part (a)")
disp(Eg,"Back emf,Eg(Volts) = ")
```

```
disp("part (b)")
Ea=(Ia*(Ra/100))+Eg;
disp(Ea,"Required armature voltage,Ea(volts) = ")
disp("part (c)")
rac=11191.4/Vf;//
disp(rac,"rated armature current in amperes is")
```

Scilab code Exa 8.12.2 the field current Evaluation of alfa Evaluation of power fa

```
//Example 8.12.2: the field current,Evaluation of
   alfa,Evaluation of power factor
clc;
clear;
close;
//given data :
format('v',7)
TL=50;// in N-M
N=1000;//in rpm
Rf=150;//in ohm
Ra=.25;// in ohm
Kv=0.7032;
alfa=0;
Vm=230;// in volts
Ef=((Vm*sqrt(2))/%pi)*(1+cosd(alfa));
If=Ef/Rf;
disp("part (a)")
disp(If,"Field current,If(A) = ")
disp("part (b)")
w=(2*%pi*N)/60;
Ia=TL/(Kv*If);
Eg=Kv*w*If;
Ea=Eg+(Ra*Ia);
alfa_a=acosd(((Ea*%pi)/(Vm*sqrt(2)))-1);
disp(alfa_a,"angle in degree")
disp("part (c)")
```

```
Ismax=Ia*((180-alfa_a)/180)^(1/2);//in amperes
PF=((Ea*Ia)/(Vm*Ismax));//lagging
disp(PF,"power factor (lagging) is")
```

Scilab code Exa 8.12.3 torque

```
//Example 8.12.3: torque
clc;
clear;
close;
format('v',7)
//given data :
Ia=50;// in A
Rf=150;//in ohm
Ra=.25;// in ohm
Kv=1.4;// in V/A-rad/sec
alfa_f=0;
alfa_a=45;// in degree
Vm=230*sqrt(2);// in volts
Vs=230;// in volts
Ef=((2*Vm)/%pi)*(cosd(alfa_f));
If=Ef/Rf;
T=Kv*Ia*If;
disp("part (a)")
disp(T,"Torque developed by the motor,T(N/m) = ")
Ea=((2*Vm)/%pi)*(cosd(alfa_a));
Eg=Ea-(Ia*Ra);
w=Eg/(Kv*If);
N=(w/(2*%pi))*60;
disp("part (b)")
disp(N,"Speed,N(rpm) = ")
disp("part (c)")
Ea=Eg+(Ra*Ia);
alfa_a=acosd(((Ea*%pi)/(Vm*sqrt(2)))-1);
Ismax=Ia*((180-alfa_a)/180)^(1/2);//in amperes
```

```
PF=((Ea*Ia)/(Vm*Ismax));//lagging
disp(PF,"power factor (lagging) is")
//supply power factor is calculated wrong in the
   textbook
```

Scilab code Exa 8.12.4 Motor torque

```
//Example 8.12.4: Motor torque
clc;
clear;
close;
format('v',7)
//given data :
Vs_rms=230;// in volts
N=1200;// in rpm
Ia=40;// in A
Ra=0.25;//in ohm
Ka_fi1=0.182;// in V/rpm
Ka_fi=(0.182*60)/(2*%pi);
alfa_a=30;
T=Ka_fi*Ia;
disp("part (a)")
disp(T,"Motor torque,T(N-m) = ")
disp("part (b)")
Ea=((2*sqrt(2)*Vs_rms)/%pi)*(cosd(alfa_a));
N=(Ea-(Ra*Ia))/Ka_fi1;
disp(N,"Speed of the motor,N(rpm) = ")
disp("part (c)")
Is_rms=Ia;
PF=(Ea*Ia)/(Vs_rms*Is_rms);
disp(PF,"Power factor,PF(lagging) = ")
```

Scilab code Exa 8.12.6 draw characterstics

```
//Example 8.12.6;Torque speed charaterstics
clc;
clear;
close;
format('v',7)
//given data :
v=230;//in volts
vm=sqrt(2)*v;//in clts
Ka=1;
QR=1;//
ra=0.05;//
alpha=30;//in degree
y=(60/(2*%pi));//
z=((vm/%pi)*(1+cosd(alpha)));//
x=(ra/(0.5)^2)
for i=1:8
    wm(i)= (z-(i)*x)*y;//
end
wm=[(y*z);wm(1);wm(2);wm(3);wm(4);wm(5);wm(6);wm(7);
   wm(8)]
disp(wm,"varoius values of speed in RPM is")
T=[0;1;2;3;4;5;6;7;8];
plot2d(T,wm)
xlabel("Torque ,N-m")
ylabel("Speed (rpm)  for alpha=30 degree")
```

Scilab code Exa 8.18.1 `No load speed firing angle Power Factor and speed regulatio`

```
//Example 8.18.1: No load speed ,firing angle ,Power
    Factor and speed regulation
clc;
clear;
close;
format('v',6)
//given data :
```

```
Ra=0.075;//in ohm
alfa1=0;// in degree
alfa2=30;// in degree
VL_rms=480;// in volts
Ka_fi=0.3;// in V/rms
Vs_rms=round(VL_rms/sqrt(3));
Vm=sqrt(2)*Vs_rms;
Ea=round((3*sqrt(3)*Vm*cosd (alfa1))/%pi);
Ea1=((3*sqrt(3)*Vm*cosd(alfa2))/%pi);
Ia=(10/100)*160;// in A
N_0=(Ea-Ia*Ra)/Ka_fi;
N_30=(Ea1-Ia*Ra)/Ka_fi;
disp("part (a)")
disp(N_0,"No load speed at alfa=0 degree,(rpm) = ")
disp(N_30,"No load speed at alfa=30 degree,(rpm) = ")
disp("part (b)")
Ia=160;// in A
N=1800;// in rpm
Eg=540;// in volts
Ea=(Eg+(Ia*Ra));
alfa=(acosd((Ea*%pi)/(3*sqrt(3)*Vm)));
disp(alfa,"the firng angel,alfa(degree) = ")
disp("part (c)")
Is_rms=sqrt(2/3)*Ia;
Sva=3*Vs_rms*Is_rms;
PF=(Ea*Ia)/(Sva);
disp(PF,"Power Factor,PF(lagging) = ")
disp("part (d)")
Ra=0.075;//in ohm
Ia=160;// in A
Ia1=16;// in A
Eg=540;// in volts
Ka_fi=0.3;// in V/rms
N=1800;// in rpm
Ea=(Eg+(Ia*Ra));
Eg1=Ea-(Ia1*Ra);
N_0=Eg1/Ka_fi;
```

```
SR=((N_0-N)/N)*100;
disp(SR,"Speed Regulation ,SR(%) = ")
```

Scilab code Exa 8.18.2 Delay Angel of Armature No load speed and speed regulation

```
//Example 8.18.2: Delay Angel of Armature ,No load speed and speed regulation
clc;
clear;
close;
//given data :
format('v',5)
VL_rms=208;// in volts
Kv=1.2;// in V/A-rad/sec
Vs_rms=round(VL_rms/sqrt(3));
Vm=sqrt(2)*Vs_rms;
Rf=240; // in ohm
Ra=0.25;// in ohm
alfa_f=0;// in degree
V=280;// in volts
Twenty_HP=20*746;//in watt
Ia=Twenty_HP/V
Ef=round((3*sqrt(3)*Vm*cosd (alfa_f))/%pi);
N=1800;
w=(N*2*%pi)/60;
If=Ef/Rf;
Eg=Kv*w*If;
Ea=round(Eg+(Ia*Ra));
alfa_a=(acosd((Ea*%pi)/(3*sqrt(3)*Vm)));
disp("part (a)")
disp(alfa_a,"Delay Angel Of Armature, alfa_a(degree) = ")
disp("part (b)")
Ia1=(Ia*10)/100
Eg_noL=Ea-(Ia1*Ra);
```

```
w_0=(Eg_noL/(1.2*1.17));// rad/sec
N_0=(w_0*60)/(2*%pi);
disp(N_0,"NO load speed at alfa|_a,(rpm) = ")
// no load speed is calculated wrong in textbook
disp("part (c)")
SR=((N_0-N)/N)*100;
disp(SR,"Speed Regulation,SR(%) = ")
// speed regulation is calculated wrong in the
   textbook
```

Scilab code Exa 8.18.3 alphas speed and delay angle

```
//Example 8.18.3: alphas,speed and delay angle
clc;
clear;
close;
//given data :
format('v',7)
v1=208;//
vsrms=v1/sqrt(3);//
n=1000;//rpm
w=n*(%pi/30);//in rad/s
ang=0;//
ef=((3*sqrt(3)*sqrt(2)*vsrms*cosd(ang))/%pi);//in
   volts
rf=140;//in ohms
If=ef/rf;//in amperes
t=120;//N-m
 kv=1.2;//
ia=(t)/(kv*If);//in amperes
eg=kv*If*w;//in volts
ra=0.25;//in ohms
ea=eg+(ia*ra);//
alpha=acosd((ea*%pi)/(3*sqrt(3)*sqrt(2)*vsrms))
disp("part (a)")
```

```
disp(round(alpha),"alpha in degree is")
disp("part (b)")
rf=140;//in ohms
If=ea/rf;//in amperes
t=120;//N-m
 kv=1.2;//
ia=(t)/(kv*If);//in amperes
ra=0.25;//in ohms
eg=ea-(ia*ra);//
w=(eg/(kv*If));//in rad/s
N=w*(30/%pi);//rpm
disp(N,"speed in rpm is")
//speed is calculated wrong in the textbook
disp("part (c)")
n1=1000;//rpm
w=n1*(%pi/30);//in rad/s
v1=208;//
vsrms=v1/sqrt(3);//
w1=(1800*(%pi/30));//
n=1800;//rpm
ang=0;//
T=120;//n-m
alphas=0;//
ang=0;//
ea=((3*sqrt(3)*sqrt(2)*vsrms*cosd(ang))/%pi);//in
    volts
rf=140;//in ohms
If=ea/rf;//in amperes
t=120;//N-m
 kv=1.2;//
ia=(t)/(kv*If);//in amperes
ra=0.25;//in ohms
eg=ea-(ia*ra);//
if1=eg/(kv*w1);//in amperese
ef1=if1*rf;//in volts
alphaf=acosd((ef1*%pi)/(3*sqrt(3)*120*sqrt(2)));
disp(alphaf,"delay angle in degree is")
```

Scilab code Exa 8.19.1 Firing angle to keep the motor current and Power fed back

```
//Example 8.19.1: Firing angle to keep the motor
    current and Power fed back
clc;
clear;
close;
//given data :
format('v',7)
Vs_rms=260;// in volts
Ia=40;// in A
Eg=192;//in volts
kv=0.182;// in V/rpm
Ra=0.3;// in ohm
Ea=Eg+(Ia*Ra);
alfa_a=acosd((Ea*%pi)/(2*Vs_rms*sqrt(2)));
disp("part (a)")
disp(alfa_a,"Firing angle to keep motor current,
    alfa_a(degree) = ")
Ea1=-Eg+(Ia*Ra);
alfa_b=acosd((Ea1*%pi)/(2*Vs_rms*sqrt(2)));
disp(alfa_b,"Firing angle ,alfa_a(degree) =")
disp("part (b)")
Ia=40;// in A
Eg=192;//in volts
Ra=0.3;// in ohm
Ea=-Eg+(Ia*Ra);
P=abs(Ea)*Ia;
disp(P,"Power fed back,P(Watt) = ")
```

Scilab code Exa 8.19.2 Average armature voltage back emf speed of the motor motor

```
//Example 8.19.2 Average armature voltage ,back emf
   ,speed of the motor , motor torque and supply
   power factor
clc;
clear;
close;
format('v',5)
//given data :
Vm=230;// in volts
Ia=40;// in A
Ra=0.5;// in ohm
Ka_fi=0.2;// in V/rpm
alfa=30;
Ea=(Vm*sqrt(2)*(1+cosd(alfa)))/%pi;
disp("part (a)")
disp(Ea,"Average armature current,Ea(volts) = ")
disp("part (b)")
Eb=Ea-(Ia*Ra);
disp(Eb,"Back emf,Eb(volts) = ")
disp("part (c)")
N=Eb/Ka_fi;
disp(round(N),"Speed of the motor,N(rpm) = ")
disp("part (d)")
Ka_fi1=(Ka_fi*60)/(2*%pi);
T=Ka_fi1*Ia;
disp(T,"Torque,T(N/m) = ")
disp("part (e)")
alfa=%pi/6;
PF=(2*sqrt(2)*cos(alfa/2)^2)/(sqrt(%pi*(%pi-alfa)));
disp(PF,"power factor (lagging) is")
```

Scilab code Exa 8.19.3 torque developed speed and input power factor

```
//Example 8.19.3: torque developed,speed and input
   power factor
```

```
clc;
clear;
close;
//given data :
format('v',7)
v=208;//in volts
f=50;//in Hz
ra=0.5;//in ohms
rf=345;//in ohms
kv=0.71;//in V/A-rad/sec
alpha=45;//in degree
ia=55;//in amperes
If=((2*sqrt(2)*v*cosd(0))/(%pi*rf));//in amperes
t=kv*If*ia;//in  N/m
disp("part (a)")
disp(t,"torque in N/m is")
disp("part (b)")
eb=((2*sqrt(2)*v*cosd(alpha))/%pi)-(ia*ra);//in volts
w=eb/(kv*If);//in rad/sec
N=w/(2*%pi);//rps
disp(N*60,"speed in rpm")
//speed is calculated wrong in the textbook
disp("part (c)")
ea=132.4;//in volts
ef=187.3;//in volts
pi=(ea*ia)+(ef*If);//in watts
Isrms=sqrt((ia)^2+(If)^2);//in amperes
va1=Isrms*v;//in VA
Pf=pi/va1;//
disp(Pf,"power factor (lagging) is")
```

Scilab code Exa 8.19.4 develepoed back emf required armature voltage and firing an

```
//Example 8.19.4:develepoed back emf,required
```

```
armature voltage and firing angle and rated
armature current
clc;
clear;
close;
//given data :
format('v',6)
hp=20;//
v=230;//volts
n=1000;//rpm
lt=50;//load torque in N-m
s=1000;//speed in rpm
ra=0.2;//in ohms
rf=150;//in ohms
la=10;//in mH
kv=0.7;//
vf=(2*sqrt(2)*v)/(%pi);//
If=vf/rf;//in amperes
ia=(lt/(kv*If));//in amperes
eg=((kv*2*%pi*n*If))/(60);//in volts
disp("part (a)")
disp(eg,"back emf in volts is")
disp("part (b)")
ea=eg+(ia*ra);//in volts
alpha=acosd((ea*%pi)/(2*sqrt(2)*v));//
disp(ea,"armature voltage in volts is")
disp(alpha,"firing angle in degree is")
disp("part (c)")
ea1=220;//in volts
ha20=746*20;//
iar=(ha20/ea1);//in amperes
disp(iar,"rated armature current in amperes is")
```

Scilab code Exa 8.21.1 average armature current

```
//Example 8.21.1 : Average armature current
clc;
clear;
close;
//given data :
V=200;// in volts
D=50/100;// duty cycle
VL_dc=V*D;
Eb=75;// in volts
Ra=1;// in ohm
Ia=(VL_dc-Eb)/Ra;
disp(Ia,"Average armature current,Ia(A) = ")
```

Chapter 9

Power factor improvement

Scilab code Exa 9.4.3 plot the variation

```
//Example 9.4.3:plot the varaition of average load
   voltage with firing angle
clc;
clear;
close;
alpha=[0;30;60;90];//firing angle in degree
for i=1:4
    ea(i)=(2/%pi)*cosd(alpha(i));//V
end
plot2d(alpha,ea);//
ylabel("Average load voltage(in terms of Vm)")
xlabel("Firing angle (alpha)")
xtitle("Variation of Ea Vs alpha for SAC")
```

Scilab code Exa 9.5.1 ISrms I1rms FPF PF and HF

```
//Example 9.5.1; IS_rms, I1_rms, FPF, PF and HF
clc;
```

```
clear;
close;
format('v',7)
//given data :
Vm=230;// in volts
Ia=12;// in A
pi=180;
Av=200;// average load voltage in volts
alfa=acosd(((Av*%pi)/(Vm*sqrt(2)))-1);
Is_rms=Ia*sqrt((pi-alfa)/pi);
disp( "(a)for PAC")
disp(Is_rms,"(1) Is_rms(A) = ")
I1_rms=((2*sqrt(2))/%pi)*Ia*cosd(alfa/2);
disp(I1_rms,"(2) I1_rms(A) = ")
fi=alfa/2;
FPF=cosd(fi);
disp(FPF,"(3) FPF(lag) = ")
CDF=I1_rms/Is_rms;
disp(CDF,"(4) CDF = ")
PF=CDF*FPF;
disp(PF,"(4) PF (lag)= ")
HF=sqrt((1/CDF^2)-1);
disp(HF,"(5) HF = ")
Vm=230;// in volts
Ia=12;// in A
pi=180;
Av=200;// average load voltage in volts
alfa=acosd(((Av*%pi)/(2*Vm*sqrt(2))));
Is_rms=Ia*sqrt((pi-(2*alfa))/pi);
disp( "(b)for SAC")
disp(Is_rms,"(1) Is_rms(A) = ")
I1_rms=((2*sqrt(2))/%pi)*Ia*cosd(alfa);
disp(I1_rms,"(2) I1_rms(A) = ")
fi=0;
FPF=cosd(fi);
disp(FPF,"(3) FPF = ")
CDF=I1_rms/Is_rms;
disp(CDF,"(4) CDF = ")
```

```
//in book CDF is mentioned as DF which is wrongly
    mentioned
PF=CDF*FPF;
disp(PF,"(4) PF (lagging)= ")
HF=(sqrt((1/CDF^2)-1))*100;
disp(HF,"(5) HF (%) = ")
```

Scilab code Exa 9.5.2 parameters amd average voltage

```
//Example 9.5.2;average voltage
clc;
clear;
close;
format('v',7)
a1=30;//in degree
a2=75;//in degree
b1=60;//in degree
ia=10;//in amperes
vsrms=230;//in volts
b3=180-a1;//
a3=180-b1;//
b2=180-a2;//
alfa=0;//
vldc=((vsrms*sqrt(2))/%pi)*(cosd(a1)-cosd(b1)+cosd(
    a2)-cosd(b2)+cosd(a3)-cosd(b3));//
disp(vldc,"average voltage in volts is")
Is_rms=ia*((1/180)*(b1-a1+b2-a2+b3-a3))^(1/2);//
disp(Is_rms," Is_rms(A) = ")
I1_rms=((sqrt(2)*ia)/(%pi))*(cosd(a1)-cosd(b1)+cosd(
    a2)-cosd(b2)+cosd(a3)-cosd(b3));//
disp(I1_rms," I1_rms(A) = ")
fi=alfa;
FPF=cosd(fi);
disp(FPF,"FPF = ")
DF=I1_rms/Is_rms;
```

```
disp(DF," DF = ")
PF=DF*FPF;
disp(PF," PF(lag)= ")
HF=sqrt((1/DF^2)-1);
disp(HF*100," HF(%) = ")
```

Scilab code Exa 9.5.3 parameters

```
//Example 9.5.3: IS_rms, I1_rms, PF and HF
clc;
clear;
close;
//given data :
Vm=230;// in volts
Ia=10;// in A
alpha=%pi/6;//degree
ea=((2*Vm*sqrt(2))/%pi)*cos(alpha);//
disp(ea,"average output voltage is,(V)=")
isrms=Ia*(1-(2*alpha)/%pi)^(1/2);//
disp(isrms,"rms value of supply current is,(A)=")
I1rms=((2*sqrt(2)*Ia*cos(alpha))/%pi);//
disp(I1rms,"rms value of fundamental component of
    supply current is,(A)=")
hf=((isrms/I1rms)^2-1)^(1/2);//
disp(hf*100,"HF of supply current is,(%)=")
PF=((sqrt(2))*(1+cos(alpha)))/((%pi*(%pi-alpha))
    ^(1/2));//
disp(PF,"PF (lagging)of supply current is,(%)=")
```

Chapter 10

Control of AC drivers

Scilab code Exa 10.15.1 slip the air gap power and efficiency

```
//Example 10.15.1: slip ,the air gap power and efficiency
clc;
clear;
close;
format('v',6)
//given data :
w=100;// in rad/sec
F1=50;//in Hz
P=4;
Ns=(120*F1)/P;
ws=2*%pi*(Ns/60);
s=((ws-w)/ws);
disp("part (1)")
disp("slip is "+string(s)+" or "+string(s*100)+" % ")
disp("part (2)")
T=100;// in N-M
w=100;// in rad/sec
Pag=ws*T;
P_slip=s*Pag;
```

```
P_mech=(1-s)*Pag;
disp(Pag,"(a)the air gap power,pag(W) = ")
disp(P_slip,"(b)slip power(W) =")
disp(P_mech,"(c)Mech o/p power,P_mech(W) = ")
//air gap power is calculated wrong in the textbook
disp("part (3)")
eta=(P_mech/Pag);
disp("efficiency of the rotor circuit is "+string(
    eta)+" or "+string(eta*100)+" % ")
```

Scilab code Exa 10.15.2 Supply voltage per phase slip slip frequency slip and roto

```
//Example 10.15.2 :Supply voltage per phase,slip,
    slip frequency ,slip and rotor loss
clc;
clear;
close;
//given data :
format('v',6)
V_rms=240;// in volts
F1=50;//in Hz
Vs_rms=240/2;
disp("part (1)")
disp(Vs_rms,"supply voltage (V) = ")
disp("part (2)")
N=1440;// in rpm
P=4;// pole
Ns=(120*F1)/4;
S=((Ns-N)/Ns);
disp("slip is "+string(S)+" or "+string(S*100)+" % "
    )
disp("part (3)")
S_frequency=S*F1;
disp(S_frequency,"slip frequency(Hz) = ")
disp("part (4)")
```

```
f=2;//Hz
f1=25;//Hz
s=(f/f1);//
disp("slip is "+string(s)+" or "+string(s*100)+" % ")
disp("part (5)")
F2=25;//in Hz
S1=(S_frequency/F2);
rotor_loss=S1/(1-S1);
disp(rotor_loss ,"Rotor loss(%) = ")
```

Scilab code Exa 10.15.6 supply voltage slip slip frequency and percentage rotor lo

```
//Example 10.15.6: supply voltage per phase , slip , slip frequency and percentage rotor loss
clc;
clear;
close;
Ns1=750;//
V_rms=240;// in volts
f2=25;//Hz
F1=50;//in Hz
Vs_rms=240/2;
N=1440;// in rpm
P=4;// pole
Ns=(120*F1)/4;
S=((Ns-N)/Ns);
S_frequency=S*F1;
fs12=S_frequency/4;//
S1=fs12/f2;
rotor_loss=S1/(1-S1);
n=Ns1-((S1*Ns1));//
disp(Vs_rms,"supply voltage (V) = ")
disp(S1*100,"slip ,S(%) = ")
disp(S_frequency,"slip frequency at 50Hz (Hz) = ")
```

```
disp(fs12,"slip frequency at 25Hz (Hz) = ")
disp(rotor_loss ,"Rotor loss(%) = ")
disp(n,"speed in rpm is")
```

Chapter 11

Appendix B

Scilab code Exa 2.b power absorbed

```
// Example 2(b): power absorbed
clc;
clear;
close;
vsrms=230;//volts
vm=(sqrt(2)*vsrms)/2;//volts
alpha=[45:90];//degree
x=[(45*(%pi/180));(90*(%pi/180))]
for i=1:2
    vldc(i)=(vm/%pi)*(1+cosd(alpha(i)));//
    vlms(i)=vm*((1/%pi)*(%pi-x(i)+(sin(2*x(i))/2))
       ^(1/2);//
    r1=100;//ohm
end
r1=100;//OHM
pl1=((vlms(1))^2)/r1//W
pl2=((vlms(2))^2)/r1;//W
disp(pl1,"power aborbed is,(W)=")
disp(pl2,"power aborbed is,(W)=")
```

Scilab code Exa 5.b speed slip and torque

```
// Example 5(b): power absorbed
clc;
clear;
close;
v=400;//V
po=15;//kW
nfx=1440;//rpm
f=50;//Hz
z2=0.4+%i*1.6;//ohm
p=4;//
x=120;//Hz
ns=((x*f)/p);//rpm
s=((ns-nfx)/ns);//slip
ns1=(x*x)/p;//rpm
nfl1=(1-s)*ns1;//rpm
disp(nfl1,"full load speed is ,(rpm)=")
sm=real(z2)/imag(z2);//slip
disp(sm,"slip is,=")
tfy=((po*10^3)/(2*%pi*(nfl1/60)));//N-m
a=sm;//
tm=((a^2+s^2)/(2*a*s))*tfy;//N-m
disp(tm,"maximum torque is,(N-m)=")
```