

Scilab Textbook Companion for
Introduction to Electric Drives
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Book Description

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

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

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

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

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Chapter 1

Thyristors Principles and Characteristics

Scilab code Exa 1.1 Anode Current

```
1 //Example 1_1
2 clc;
3 clear;close;
4
5 //Given data
6 alfa1=0.35;
7 alfa2=0.4;
8 IG=40*10^-3;//A
9
10 //Solution :
11 IA=alfa2*IG/(1-(alfa1+alfa2));//A
12 disp(IA,"Anode current in A : ");
```

Scilab code Exa 1.2 Equivalent capacitance

```
1 //Example 1_2
```



```

2  clc;
3  clear;close;
4
5  //Given data
6  dv_dt=190; //V/ s
7  IC=8*10^-3; //A
8
9  //Solution :
10 C=IC/(dv_dt/10^-6); //F
11 disp(C,"Capacitance of depletion layer in F : ");

```

Scilab code Exa 1.3 Find various voltages

```

1  //Example 1_3
2  clc;
3  clear;close;
4
5  //Given data
6  RG=2000; //ohm
7  VCC=20; //V
8  VT=0.75; //V
9  Vthy=0.7; //V(Voltage across thyristor)
10 R=200; //ohm
11 IT=7*10^-3; //A
12 Ih=5*10^-3; //A
13
14
15 //Solution :
16 //part (a)
17 Vo=VCC; //V////thyristor not conducting
18 disp(Vo,"(a) When thyristor is in off state , Output
    voltage in V")
19 //part (b)
20 Vs=VT+IT*RG; //V
21 disp(Vs,"(b) Voltage necessary to turn on the

```

```

        thyristor in V")
22 //part (c)
23 VR1=Ih*R; //V
24 disp("(c) Current through thyristor should be less
        than holding current. Voltage should be reduced
        to less than "+string(VR1)+" V")
25 //part (d)
26 VR2=VR1+Vthy; //V
27 disp("(d) VCC should be reduced to less than "+
        string(VR2)+" V")

```

Scilab code Exa 1.4 Find VG IG and RG

```

1 //Example 1-4
2 clc;
3 clear; close;
4
5 //Given data
6 IG=poly(0, 'IG'); //A
7 VG=1+9*IG; //V
8 Vgate=25; //V
9 t=%pi; //radian (duration)
10 Pavg=0.6; //W
11
12 //Solution :
13 Ploss=Pavg*2*%pi/t; //W
14 //Ploss=VG*IG
15 X=VG*IG-Ploss;
16 IG=roots(X); //A
17 IG=IG(2); //A(taking +ve value only)
18 VG=1+9*IG; //V
19 //Vgate=RG*IG+VG
20 RG=(Vgate-VG)/IG; //ohm
21 disp(VG, "VG in V");
22 disp(IG, "IG in A");

```

```
23 disp(RG,"RG in ohm");
```

Scilab code Exa 1.5 Minimum width of gate pulse

```
1 //Example 1_5
2 clc;
3 clear;close;
4
5 //Given data
6 Vdc=100;//V
7 L=10;//H
8 i=80*10^-3;//A
9
10 //Solution :
11 t=i*L/Vdc;//s
12 disp("Width of pulse should be more than "+string(t
    *1000)+" milli-seconds.");
```

Scilab code Exa 1.6 Minimum width of gate pulse

```
1 //Example 1_6
2 clc;
3 clear;close;
4
5 //Given data
6 Vdc=100;//V
7 R=10;//ohm
8 L=5;//H
9 i=50*10^-3;//A
10
11 //Solution :
12 // i=Vdc/R*(1-exp(-R*t/L))
13 t=-log(1-i/Vdc*R)/R*L;//s
```

```
14 disp("Minimum width of gate pulse is "+string(t
    *1000)+" milli-seconds.");
```

Scilab code Exa 1.7 Maximum value of R

```
1 //Example 1_7
2 clc;
3 clear; close;
4
5 //Given data
6 i_latch=40*10^-3; //A
7 t=40*10^-6; //s
8 Vdc=90; //V
9 R=25; //ohm
10 L=0.5; //H
11
12 //Solution :
13 i=Vdc/R*(1-exp(-R*t/L)); //A
14 disp("Current in the circuit is "+string(i)+" A, it
    is less than latchig current, the thyristor will
    not turn on.");
15 R=Vdc/(i_latch-i); //ohm
16 disp("Maximum value of R is "+string(R)+" ohm.");
```

Scilab code Exa 1.8 Maximum value of R

```
1 //Example 1_8
2 clc;
3 clear; close;
4
5 //Given data
6 i_h=50*10^-3; //A
7 t=50*10^-6; //s
```

```

8 Vdc=100; //V
9 R=20; //ohm
10 L=0.5; //H
11
12 //Solution :
13 i=Vdc/R*(1-exp(-R*t/L)); //A
14 //i<i_h;;;so thyristor will return to off state
15 iR=i_h-i; //A//current through R
16 R=Vdc/iR; //ohm
17 disp("Maximum value of R is "+string(R)+" ohm.");

```

Scilab code Exa 1.9 Find Triggering angle

```

1 //Example 1_9
2 clc;
3 clear; close;
4
5 //Given data:
6 V=240; //Volt
7 f=50; //Hz
8 R=5; //ohm
9 L=0.05; //H
10 theta=atand(2*%pi*f*L/R); //degree
11 Vm=V*sqrt(2); //Volt
12 //sind(fi-theta)=0; //for no current transient
13 fi=theta+asind(0); //degree
14 disp(fi,"For no current transient , triggering angle
    in degree");
15 //sind(fi-theta)=1; //for worst current transient
16 fi=theta+asind(1); //degree
17 disp(fi,"For worst current transient , triggering
    angle in degree");

```

Scilab code Exa 1.12 RMS current and form factor

```
1 //Example 1_12
2 clc;
3 clear; close;
4
5 //Given data:
6 I=120; //A
7 Gamma=180; //degree
8 RMS_current=I*sqrt(Gamma/360); //A
9 AVG_current=I*(Gamma/360); //A
10 FormFactor=RMS_current/AVG_current; //no unit
11 disp(RMS_current, "rms current (in A) : ");
12 disp(FormFactor, "Form Factor : ");
```

Scilab code Exa 1.13 Power supplied

```
1 //Example 1_13
2 clc;
3 clear; close;
4
5 //Given data:
6 V=130; //V
7 R=100; //ohm
8 theta1=60; //degree
9 theta2=45; //degree
10 v=sqrt(2)*V; //
11 Irms=sqrt(1/2/%pi*integrate('(3.25*sin(omega_t))^2',
    'omega_t', theta1*%pi/180, %pi)); //A
12 P=Irms^2*R; //W
13 disp(P, "(a) Power supplied to load (in W) : ");
14 Irms=sqrt(1/2/%pi*integrate('(3.25*sin(omega_t))^2',
    'omega_t', theta2*%pi/180, %pi)); //A
15 P=Irms^2*R; //W
16 disp(P, "(a) Power supplied to load (in W) : ");
```

Scilab code Exa 1.14 Average power loss

```
1 //Example 1_14
2 clc;
3 clear;close;
4
5 //Given data:
6 Iavg=200;//A
7 period1=2*%pi;
8 period2=%pi;
9 Vth1=1.8;//V
10 I1=200;//A
11 Vth2=1.9;//V
12 I2=400;//A
13 //part (a)
14 Ploss1=I1*Vth1*period1/2/%pi;//W
15 disp(Ploss1,"(a) Average power loss (in W) : ");
16 Ploss2=I2*Vth2*period2/2/%pi;//W
17 disp(Ploss2,"(b) Average power loss (in W) : ");
```

Scilab code Exa 1.15 Average on state current

```
1 //Example 1_15
2 clc;
3 clear;close;
4
5 //Given data:
6 Irms=40;//A
7 f=50;//Hz
8 period1=170;//degree
9 period2=100;//degree
```

```

10 period3=40; //degree
11 //part (a)
12 alfa1=%pi-period1*%pi/180; //degree
13 Irms_by_Im=sqrt(1/2/%pi*((%pi-alfa1)/2+sin(2*alfa1)
    /4));
14 Im=Irms/Irms_by_Im; //A
15 Iav1=Im/2/%pi*(1+cos(alfa1)); //A
16 disp(Iav1,"(a) Average current (in A) : ");
17 //part (b)
18 alfa2=%pi-period2*%pi/180; //degree
19 Irms_by_Im=sqrt(1/2/%pi*((%pi-alfa2)/2+sin(2*alfa2)
    /4));
20 Im=Irms/Irms_by_Im; //A
21 Iav2=Im/2/%pi*(1+cos(alfa2)); //A
22 disp(Iav2,"(b) Average current (in A) : ");
23 //part (c)
24 alfa3=%pi-period3*%pi/180; //radian
25 Irms_by_Im=sqrt(1/2/%pi*((%pi-alfa3)/2+sin(2*alfa3)
    /4));
26 Im=Irms/Irms_by_Im; //A
27 Iav3=Im/2/%pi*(1+cos(alfa3)); //A
28 disp(Iav3,"(c) Average current (in A) : ");

```

Scilab code Exa 1.16 Mean power dissipation

```

1 //Example 1_16
2 clc;
3 clear; close;
4
5 //Given data:
6 //VT=0.9+0.02*IT; //V
7 //part (a)
8 IT=20; //A
9 VT=0.9+0.02*IT; //V
10 Pdis=VT*IT; //W

```



```

11 disp(Pdiss,"(a) Mean power dissipation (in W) : ");
12 //part (b)
13 IT_mean=20;//A
14 IT_peak=20*%pi;//A
15 Pdiss=1/2/%pi*integrate('(0.9+0.02*IT_peak*sin(theta
    ))*(IT_peak*sin(theta))','theta',0,%pi);//W
16 disp(Pdiss,"(b) Mean power dissipation (in W) : ");
17 //part (c)
18 IT=20;//A//for half cycle
19 VT=0.9+0.02*IT;//V
20 Pdiss=VT*IT/2;//W
21 disp(Pdiss,"(c) Power dissipation occur only during
    half cycle. Mean power dissipation (W)");
22 //part (d)
23 IT=20;//A//for half cycle
24 VT=0.9+0.02*IT;//V
25 Pdiss=VT*IT/3;//W
26 disp(Pdiss,"(d) Power dissipation occur only during
    1/3rd period in a cycle. Mean power dissipation (
    W)");

```

Scilab code Exa 1.17 Current rating and I²t rating

```

1 //Example 1_17
2 clc;
3 clear;close;
4
5 //Given data
6 Isub=2000;//A
7 f=50;//Hz
8 t=10*10^-3;//s
9 T=2*t;//s//duration of half cycle
10 I=sqrt(Isub^2*t/T);//A
11 I2t=I^2*t;//A^2 seconds
12 disp(I2t,"I^2*t rating in A^2-seconds ");

```

Scilab code Exa 1.18 Series resistance and average gate power loss

```
1 //Example 1_18
2 clc;
3 clear;close;
4
5 //Given data
6 Vgate=12; //V
7 t=60*10^-6; //s
8 cycle=0.3;
9 P_peak=6; //W
10 //part (a)
11 //P_peak=Vg*Ig leads to 9*Ig^2+Ig-P_peak=0
12 X=[9 1 -6]; //polynomial
13 Ig=roots(X); //A
14 Ig=Ig(2); //A(taking +ve value)
15 Vg=1+9*Ig
16 Rg=(Vgate-Vg)/Ig; //ohm
17 disp(Rg,"Series resistance Rg in ohm");
18 PavgLoss=P_peak*cycle; //W
19 disp(PavgLoss,"Average power loss in W ");
```

Scilab code Exa 1.19 Source Resistance Trigger Current and voltage

```
1 //Example 1_19
2 clc;
3 clear;close;
4
5 //Given data
6 Vs=12; //V
7 P=0.3; //W
```

```

8 Rs=100;//ohm//as slope is -100V/A
9 //Vs=Vg+Ig*Rg leads to Rs*Ig^2-Vs*Ig+P=0
10 X=[Rs -Vs P]);//polynomial
11 Ig=roots(X);//A
12 Ig=Ig(2);//A(taking one value)
13 disp(Rs,"Source resistance , Rs in ohm ");
14 disp(Ig*1000,"Trigger current in mA ");
15 Vg=P/Ig;//V
16 disp(Vg,"Voltage Vg in V ");

```

Scilab code Exa 1.20 Find Rs R1 and R2

```

1 //Example 1_20
2 clc;
3 clear;close;
4
5 //Given data
6 V=800;//V
7 I=110;//A
8 Es=12;//V
9 Im=250;//mA
10 Ish=600;//mA
11 VG=2.4;//V
12 IG=50;//mA
13 IGm=100;//mA
14 VGm=3;//V
15 Rs=Es/(Ish*10^-3);//ohm
16 disp(Rs,"Value of Rs in ohm ");
17 R1=Es/(Im*10^-3)-Rs;//ohm(Assumed R2 is not
    connected)
18 //Rs_plus_R1>=Es/(IGm*10^-3);//ohm
19 Rs_plus_R1=Es/(IGm*10^-3);//ohm
20 R1_Lower=Rs_plus_R1-Rs;//ohm
21 //Rs_plus_R1<=(Es-VG)/(IGm*10^-3);//ohm
22 Rs_plus_R1=(Es-VG)/(IG*10^-3);//ohm

```

```

23 R1_Upper=Rs_plus_R1-Rs; //ohm
24 disp("R1 must be more than "+string(R1_Lower)+" ohm
    and less than "+string(R1_Upper)+" ohm.")
25 disp("Let R1 is 125 ohm.");
26 R1=125; //ohm
27 //R2*Es/(R1+R2+Rs)<=VGm
28 R2=(VGm*R1+VGm*Rs)/(Es-VGm); //ohm
29 disp("R2<=" +string(R2)+" ohm ")
30 disp("Let R2 is 48 ohm.");

```

Scilab code Exa 1.21 Finf thermal resistance

```

1 //Example 1_21
2 clc;
3 clear; close;
4
5 //Given data:
6 l=0.2; //m
7 w=0.01; //m
8 d=0.01; //m
9 P=3; //W
10 Tc=220; //W/m/degreeC
11 T1=30; //degreeC
12 theta=1/Tc/w/d; //degreeC/W
13 T2=P*theta+T1; //degreeC
14 disp(T2,"Temperature of the surface in degree C ");

```

Scilab code Exa 1.22 Find maximum losses

```

1 //Example 1_22
2 clc;
3 clear; close;
4

```

```

5 //Given data:
6 l=2/1000; //m
7 A=12/10000; //m^2
8 T21=4; //degreeC (T2-T1)
9 Tc=220; //W/m/degreeC
10 theta=l/Tc/A; //degreeC/W
11 Losses=T21/theta; //W
12 disp(Losses, "Maximum losses in W ");

```

Scilab code Exa 1.23 Thermal resistance of heat sink

```

1 //Example 1_23
2 clc;
3 clear; close;
4
5 //Given data:
6 P=30; //W
7 T1=125; //degreeC
8 T2=50; //degreeC
9 theta=1; //degree C/W
10 theta_mica=0.3; //degree C/W
11 Rth_total=(T1-T2)/P; //degree C/W
12 Rth_heat_sink=Rth_total-theta-theta_mica; //degree C/
   W
13 disp(Rth_heat_sink, "Thermal resistance of heat sink
   in degree C/W ");

```

Scilab code Exa 1.24 Find Junction temperature

```

1 //Example 1_25
2 clc;
3 clear; close;
4

```

```

5 //Given data:
6 T1=120;//degreeC(Junction Temperature)
7 T2=35;//degreeC(Ambient Temperature)
8 P=40;//W
9 theta_dash=0.8;//degree C/W(junction to heat sink)
10 theta=(T1-T2)/P;//degree C/W
11 disp(theta-theta_dash,"Resistance of heat sink in
    degree C/W");

```

Scilab code Exa 1.25 Maximum thermal resistance

```

1 //Example 1_25
2 clc;
3 clear;close;
4
5 //Given data:
6 T1=120;//degreeC(Junction Temperature)
7 T2=35;//degreeC(Ambient Temperature)
8 P=40;//W
9 theta_dash=0.8;//degree C/W(junction to heat sink)
10 theta=(T1-T2)/P;//degree C/W
11 disp(theta-theta_dash,"Resistance of heat sink in
    degree C/W");

```

Scilab code Exa 1.26 Average power loss and increase in rating

```

1 //Example 1_26
2 clc;
3 clear;close;
4
5 //Given data:
6 Tj=125;//degreeC
7 Ts=80;//degreeC

```

```

8 theta_jc=0.7; //degree C/W
9 theta_cs=0.4; //degree C/W
10 //part (a)
11 Pav1=(Tj-Ts)/(theta_jc+theta_cs); //W
12 disp(Pav1,"(a) Average power loss in W")
13 //part (b)
14 Ts=50; //degreeC
15 Pav2=(Tj-Ts)/(theta_jc+theta_cs); //W
16 disp(Pav2,"(b) Permissible average power loss in W")
17 rating_increase=(sqrt(Pav2)-sqrt(Pav1))/sqrt(Pav1)
    *100; // %
18 disp(rating_increase,"Percentage increase in rating"
    )

```

Scilab code Exa 1.27 Minimum and maximum firing angle

```

1 //Example 1_27
2 clc;
3 clear; close;
4
5 //Given data:
6 Vs=230; //V
7 f=50; //Hz
8 vc=25; //V
9 C=0.6*10^-6; //F
10 R=2000:20000; //ohm
11 Xc=1/(2*%pi*f*C); //ohm
12 //When R=2000 ohm
13 Z=min(R)-%i*Xc; //ohm
14 I=Vs/Z; //A
15 Vc=-%i*I*Xc; //V
16 //vc=sqrt(2)*abs(Vc)*sind(omega_t+atand(imag(Vc),
    real(Vc)))
17 omega_t=asind(vc/sqrt(2)/abs(Vc))-atand(imag(Vc),
    real(Vc)); //degree

```

```

18 alfa1=omega_t; //degree
19
20 //When R=20000 ohm
21 Z=max(R)-%i*Xc; //ohm
22 I=Vs/Z; //A
23 Vc=-%i*I*Xc; //V
24 //vc=sqrt(2)*abs(Vc)*sind(omega_t+atand(imag(Vc),
    real(Vc)))
25 omega_t=asind(vc/sqrt(2)/abs(Vc))-atand(imag(Vc),
    real(Vc)); //degree
26 alfa2=omega_t; //degree
27 disp(alfa1,"Minimum firing angle in degree")
28 disp(alfa2,"Maximum firing angle in degree")

```

Scilab code Exa 1.28 Design a UJTcircuit

```

1 //Example 1_28
2 clc;
3 clear; close;
4
5 //Given data:
6 V=32; //V
7 Eta=0.63;
8 Ip=10*10^-6; //A
9 Vv=3.5; //V
10 Iv=10*10^-3; //A
11 Vf=0.5; //V
12 f=50; //Hz
13 tau=50*10^-3; //s
14 T=1/f //s
15 Vp=Eta*V+Vf; //V
16 C=0.4*10^-6; //F//assumed
17 disp(C*10^6,"Suitable value of C in micro F ")
18 //V-Ip*R>Vp
19 R_upper=(V-Vp)/Ip; //ohm

```



```

20 //V-Iv*R<Vv
21 R_lower=(V-Vv)/Iv; //ohm
22 disp("Value of R should be lie between "+string(
    R_lower)+" ohm to "+string(R_upper)+" ohm")
23 R=T/C/log(1/(1-Eta)); //ohm
24 disp(R,"Suitale value of R in ohm ");
25 R4=tau/C; //ohm
26 disp(R4,"Suitale value of R4 in ohm ");
27 R3=10^4/Eta/V; //ohm
28 disp(R3,"Suitale value of R3 in ohm ");
29 //Answer for R4 is wrong in the book

```

Scilab code Exa 1.29 Various component of circuit

```

1 //Example 1_29
2 clc;
3 clear; close;
4
5 //Given data:
6 f=2*1000; //Hz
7 Vdc=10; //V
8 Eta=0.6;
9 Ip=5*10^-3; //A
10 Vf=0.5; //V//assumed
11 Vp=Eta*Vdc+Vf; //V
12 //Vdc-Ip*R>Vp
13 R_upper=(Vdc-Vp)/Ip; //ohm
14 disp("Value of R should be less than "+string(
    R_upper)+" ohm")
15 C=0.5*10^-6; //F//assumed
16 disp(C*10^6,"Let value of C in micro F ")
17 T=1/f //s
18 R=T/C/log(1/(1-Eta)); //ohm
19 disp("For C=0.5 micro F, calculated value of R "+
    string(R)+" ohm. But it is not suitable");

```

```

20 C=1*10^-6; //F//assumed
21 disp(C*10^6,"Let value of C in micro F ")
22 R=T/C/log(1/(1-Eta)); //ohm
23 disp("For C=1 micro F, calculated value of R "+
      string(R)+" ohm. It is suitable");

```

Scilab code Exa 1.30 Range of firing angle

```

1 //Example 1_30
2 clc;
3 clear; close;
4
5 //Given data:
6 Vs=230; //V
7 R=1000:22000; //ohm
8 Vg=2; //V
9 C=0.47*10^-6; //F
10 f=50; //Hz
11 Xc=1/(2*pi*f*C); //ohm
12 //When R=1000 ohm
13 theta=atand(min(R)/Xc); //degree
14 Z=min(R)-%i*Xc; //ohm
15 I=Vs/Z; //A
16 Vc=-%i*I*Xc; //V
17 //vc=sqrt(2)*abs(Vc)*sind(omega_t+atand(imag(Vc),
      real(Vc)))
18 omega_t=asind(Vg/sqrt(2)/abs(Vc))-atand(imag(Vc),
      real(Vc)); //degree
19 alfa1=omega_t; //degree
20 //When R=22000 ohm
21 Z=max(R)-%i*Xc; //ohm
22 I=Vs/Z; //A
23 Vc=-%i*I*Xc; //V
24 //vc=sqrt(2)*abs(Vc)*sind(omega_t+atand(imag(Vc),
      real(Vc)))

```

```

25 omega_t=asind(Vg/sqrt(2)/abs(Vc))-atand(imag(Vc),
    real(Vc));//degree
26 alfa2=omega_t;//degree
27 disp(alfa1,"Minimum firing angle in degree")
28 disp(alfa2,"Maximum firing angle in degree")

```

Scilab code Exa 1.31 Time of conduction

```

1 //Example 1_31
2 clc;
3 clear;close;
4
5 //Given data:
6 R=0.8;//ohm
7 L=10*10^-6;//H
8 C=50*10^-6;//F
9 //R<sqrt(4*L/C)
10 Rupper=sqrt(4*L/C);//ohm
11 disp("Maximum value of R should be "+string(Rupper)+
    " ohm")
12 disp("Given value of R is "+string(R)+" ohm. The
    circuit is underdamped.")
13 t0=%pi/sqrt(1/L/C-R^2/4/L^2);//s
14 disp(t0,"Time of conduction of thyristor in seconds"
    )

```

Scilab code Exa 1.32 Find value of L and C

```

1 //Example 1_32
2 clc;
3 clear;close;
4
5 //Given data:

```

```

6 V=90; //V
7 Iload=8; //A
8 t_off=40*10^-6; //s
9 //Ipeak=2*Iload; // assumed
10 //V*sqrt(C/L)=2*Iload
11 C_by_L=(2*Iload/V)^2;
12 // t_off=%pi/2*sqrt(L*C)
13 L_into_C=(t_off/%pi*2)^2;
14 C=sqrt(L_into_C*C_by_L); //F
15 L=L_into_C/C; //H
16 disp(L," Value of L(H)");
17 disp(C," Value of C(F)");

```

Scilab code Exa 1.33 Find value of C

```

1 //Example 1_33
2 clc;
3 clear; close;
4
5 //Given data:
6 RL=10; //ohm
7 V=100; //V
8 t_off=50*10^-6; //s
9 C=t_off/RL/log(2); //F
10 disp(C," Value of C(F)");

```

Scilab code Exa 1.34 Find value of L and C

```

1 //Example 1_34
2 clc;
3 clear; close;
4
5 //Given data:

```

```

6 IL=40; //A
7 VC=100; //V
8 t_off=60*10^-6; //s
9 C=t_off*IL/VC; //F
10 disp(C," Value of C(F)");
11 //L>VC^2*C/IL
12 L_lower=VC^2*C/IL^2; //H
13 Ip=VC*sqrt(C/L_lower); //A
14 disp(" Value of L should be greater than "+string(
    L_lower)+" H. For this value of L, Peak capacitor
    current is "+string(Ip)+" A. But it should be
    less than maximum load current.")
15 //Let Ip=34.6 A
16 Ip=34.6; //A
17 L=C/(Ip/VC)^2; //H
18 disp(L," Value of L(H)");

```

Scilab code Exa 1.35 Current rating of thyristor

```

1 //Example 1_35
2 clc;
3 clear; close;
4
5 //Given data:
6 Vdc=100; //V
7 L=0.1*10^-3; //H
8 C=10*10^-6; //F
9 Vc=100; //V
10 t_off_thyristor=25*10^-6; //s
11 IL=10; //A
12 t_off=Vc*C/IL; //s
13 disp(" T_off is "+string(t_off)+" seconds. It is
    greater than thristor turn off time, so it is
    sufficient for communication.")
14 Ip=Vdc*sqrt(C/L); //A

```

```
15 disp(Ip," Current rating (A)");
```

Scilab code Exa 1.36 Find value of R and C

```
1 //Example 1_36
2 clc;
3 clear;close;
4
5 //Given data:
6 dv_by_dt=25/10^-6; //V/s
7 L=0.2*10^-3; //H
8 Vrms=230; //V
9 damping=0.65; //damping factor
10 Vm=sqrt(2)*Vrms; //V
11 C=1/(2*L)*[0.564*Vm/dv_by_dt]^2; //F
12 R=2*damping*sqrt(L/C); //ohm
13 disp(C," Value of C(F)");
14 disp(R," Value of R(ohm)");
```

Scilab code Exa 1.37 Value of R and C Power loss and rating

```
1 //Example 1_37
2 clc;
3 clear;close;
4
5 //Given data:
6 V=300; //V
7 RL=10; //ohm
8 L=0; //H
9 Ith=100; //A
10 f=2000; //Hz
11 dv_by_dt=100*10^6; //V/s
12 //dv/dt=(vth(tau)-vth(0))/tau
```

```

13 //dv/dt=RL*(1-0.368)*V/(R+RL)/((R+RL)*C)
14 R=V/Ith;//ohm
15 C=RL*(1-0.368)*V/(R+RL)/(R+RL)/dv_by_dt
16 disp(R,"Value of R(ohm)");
17 disp(C,"Value of C(F)");
18 Ploss=1/2*C*V^2*f;//W
19 disp(Ploss,"Power loss in snubber circuit(W)")
20 disp("Power rating of resistance is "+string(Ploss)+"
      W as all energy will be dissipated in the
      resistance.")

```

Scilab code Exa 1.38 Value of dvbydt and dibydt

```

1 //Example 1_38
2 clc;
3 clear;close;
4
5 //Given data:
6 R=4;//ohm
7 L=6*10^-6;//H
8 C=6*10^-6;//F
9 V=300;//V
10 di_by_dt_max=V/L;//A/s
11 Isc=V/R;//A
12 dvc_by_dt=R*di_by_dt_max+Isc/C;//V/s
13 disp(di_by_dt_max,"Maximum permissible value of di/
      dt(A/s)");
14 disp(dvc_by_dt,"Maximum permissible value of dv/dt(V
      /s)");

```

Scilab code Exa 1.39 Design a snubber circuit

```

1 //Example 1_39

```

```

2  clc;
3  clear; close;
4
5  //Given data:
6  RL=8; //ohm
7  V=230; //V
8  Ip=100; //A
9  SF=2; //safety factor
10 di_by_dt_max=40/10^-6/2; //A/s
11 dv_by_dt_max=150/10^-6/2; //V/s
12
13  L=sqrt(2)*V/di_by_dt_max; //H
14  disp(L, "Value of L(H)");
15  R=L/(sqrt(2)*V)*dv_by_dt_max; //ohm
16  disp(R, "Value of R(ohm)");
17  IL_peak=(sqrt(2)*V)/RL; //A
18  Ic_peak=(sqrt(2)*V)/R; //A
19  Itotal=IL_peak+Ic_peak; //A
20  disp(Itotal, "Total current through capacitor for
    these values(A)");
21  disp("Itotal>Ip, therefore value of R should be
    increased.");
22  Ic_max=Ip-IL_peak; //A
23  R=(sqrt(2)*V)/Ic_max; //ohm
24  R=ceil(R); //ohm
25  disp(R, "New Value of R(ohm)");
26  damping=0.65;
27  C=4*damping^2*L/R^2; //F
28  disp(C*10^6, "Value of C(micro F)");
29  disp(L*10^6, "Value of L(micro H)");
30  //Ic_switching=C*dv/dt
31  dv_by_dt=sqrt(2)*V/(R+RL)/C; //V/s
32  disp("Value of dv/dt is "+string(dv_by_dt)+" V/s. It
    is within the limit for the calculated value of
    R, L & C. Design is safe.")

```

Scilab code Exa 1.40 Fault clearing time

```
1 //Example 1_40
2 clc;
3 clear; close;
4
5 //Given data:
6 V=230; //V
7 R1=2; //ohm
8 R2=5; //ohm
9 R3=1; //ohm
10 R4=6; //ohm
11 R5=5; //ohm
12 Isqr_t=30; //A2-s
13 R=R1+R2*R3/(R2+R3); //ohm(X grounded)
14 Ifault=sqrt(2)*V/R; //A
15 tc=Isqr_t/Ifault2; //s
16 disp(tc,"Fault clearing time in seconds");
```

Chapter 2

Phase Controlled Rectifiers

Scilab code Exa 2.1 Average Load and rms load voltage and current

```
1 //Example 2_1
2 clc;
3 clear;close;
4
5 //Given data:
6 Vin=400;//V
7 alfa=30;//degree
8 R=50;//ohm
9
10 //Solution :
11 Vdc=Vin/%pi/2*(1+cosd(alfa));//V
12 disp(Vdc,"Average load voltage(V) : ");
13 I=Vdc/R;//A
14 disp(I,"Average load current(A) : ");
15 Vrms=Vin*sqrt((180-alfa)/4/180+sind(2*alfa)/8/%pi);
    //V
16 disp(Vrms,"rms load voltage(V) : ");
17 Irms=Vrms/R;//A
18 disp(Irms,"rms load current(A) : ");
```

Scilab code Exa 2.2 Find average curren

```
1 //Example 2_2
2 clc;
3 clear; close;
4
5 //Given data:
6 Vo=50; //V
7 R=10; //ohm
8 //Vin=100*sin(omega*t); //V
9 Vm=100; //V
10
11 //Solution :
12 omega_t=asin(Vo/Vm); //radian
13 Iavg=1/2/%pi*integrate(' (Vm*sin(omega_t)-Vo)/R', '
    omega_t', omega_t, omega_t+2*%pi/3); //A
14 disp(Iavg, "Average current in the circuit(A) : ");
```

Scilab code Exa 2.3 Find average current

```
1 //Example 2_3
2 clc;
3 clear; close;
4
5 //Given data:
6 Eb=55.5; //V
7 R=10; //ohm
8 //Vin=110*sin(omega*t); //V
9 Vm=110*sqrt(2); //V
10
11 //Solution :
12 omega_t=asind(Eb/Vm); //degree
```

```

13 Iavg=1/2/180*integrate('(Vm*sind(omega_t)-Eb)/R','
    omega_t',omega_t,180-omega_t);//A
14 disp(Iavg,"Average current in the circuit(A) : ");

```

Scilab code Exa 2.4 Vdc Idc Vrms Irms

```

1 //Example 2_4
2 clc;
3 clear;close;
4
5 //Given data:
6 Vs=230;//V
7 R=15;//ohm
8 alfa=%pi/2;//radian
9
10 //Solution :
11 Vm=sqrt(2)*Vs;//V
12 Vdc=Vm/2/%pi*(1+cos(alfa));//V
13 disp(Vdc,"Vdc(V) : ");
14 Idc=Vdc/R;//A
15 disp(Idc,"Idc(A) : ");
16 Vrms=Vm*sqrt((%pi-alfa)/4/%pi+sin(%pi)/8/%pi);//V
17 disp(Vrms,"Vrms(V) : ");
18 Irms=Vrms/R;//A
19 disp(Irms,"Irms(A) : ");
20 Pdc=Vdc*Idc;//W
21 disp(Pdc,"Pdc(W) : ");
22 Pac=Vrms*Irms;//W
23 disp(Pac,"Pac(W) : ");
24 R_eff=Pdc/Pac;//rectification efficiency
25 disp(R_eff,"Rectification efficiency(unitless) : ");
26 Kf=Vrms/Vdc;//Form factor
27 disp(Kf,"Form factor(unitless) : ");
28 Kr=sqrt(Kf^2-1);//Ripple factor
29 disp(Kr,"Ripple factor(unitless) : ");

```

```

30 VA_rating=Vs*Irms; //VA
31 disp(VA_rating," VoltAmpere rating(VA) : ");
32 TUF=Pdc/VA_rating; //Transformer utilization factor
33 disp(TUF," Transformer utilization factor(unitless) :
    ");
34 PIV=Vm; //V
35 disp(PIV," Peak Inverse Voltage across thyristor(V) :
    ");
36 //Ans in the book is wrong for some part.

```

Scilab code Exa 2.5 Vdc Vrms Irms

```

1 //Example 2_5
2 clc;
3 clear; close;
4
5 //Given data:
6 Vo=150; //V
7 R=30; //ohm
8 alfa=45; //degree
9
10 //Solution :
11 Vdc=sqrt(2)*Vo/%pi*(1+cosd(alfa)); //V
12 disp(Vdc," Average dc Voltage(V) : ");
13 Iavg=Vdc/R; //A
14 disp(Iavg," Average load current(A) : ");
15 Vrms=sqrt(2)*Vo*sqrt((180-alfa)/2/180+sind(90)/4/%pi
    ); //V
16 disp(Vrms," rms load Voltage(V) : ");
17 Irms=Vrms/R; //A
18 disp(Irms," rms load current(A) : ");

```

Scilab code Exa 2.6 Turn ratio VA rating PIV

```

1 //Example 2_6
2 clc;
3 clear;close;
4
5 //Given data:
6 Vs=230;//V
7 f=50;//Hz
8 Vdc=100;//V
9 Ip=15;//A
10 alfa=30;//degree
11
12 //Solution :
13 Vm=Vdc*%pi/(2*cosd(alfa))+1.7;//V
14 Vrms_2nd=Vm/sqrt(2);//V
15 TurnRatio=Vs/Vrms_2nd;
16 disp(TurnRatio,"(a) Turn ratio of transformer");
17 Irms_2nd=sqrt(Ip^2/2);//A
18 Rating=2*Vrms_2nd*Irms_2nd;//VA
19 disp(Rating,"(b) Transformer rating in VA");
20 PIV=2*Vm;//V
21 disp(PIV,"(c) PIV in V");
22 disp(Irms_2nd,"(d) RMS value of thyristor current in
    A");
23 ///Answer in the book is wrong for some part.

```

Scilab code Exa 2.7 Rated voltage of thyristor

```

1 //Example 2_7
2 clc;
3 clear;close;
4
5 //Given data:
6 P=10;//kW
7 Idc=50;//A
8 SF=2;//safety factor

```

```

9
10 //Solution :
11 Vdc=P*1000/Idc;//V
12 alfa=0;//degree
13 Vm=Vdc*%pi/(2*cosd(alfa))+1.7;//V
14 PIV=2*Vm;//V
15 Vthy=SF*PIV;//V
16 disp(Vthy,"(a) Voltage rating of thristor in V");
17 PIV=Vm;//V//for bridge rectifier
18 Vthy=SF*PIV;//V
19 disp(Vthy,"(b) Voltage rating of thristor in V");
20 ///Answer in the book is wrong.

```

Scilab code Exa 2.8 Firing angle and power factor

```

1 //Example 2_8
2 clc;
3 clear;close;
4
5 //Given data:
6 Vs=230;//V
7 f=50;//Hz
8 Io=15;//A
9 R=0.5;//ohm
10 L=0.3;//H
11 E1=100;//V
12 E2=-100;//V
13
14 //Solution :
15 ///part (a)
16 Vm=sqrt(2)*Vs;//V
17 //2*Vm/%pi*cosd(alfa)=E1+Io*R
18 alfa1=acosd((E1+Io*R)/(2*Vm/%pi));//degree
19 disp(alfa1,"(a) Firing angle in degree");
20 ///part (b)

```

```

21 alfa2=acosd((E2+Io*R)/(2*Vm/%pi)); // degree
22 disp(alfa2,"(b) Firing angle in degree");
23 disp("Part(c)");
24 //Pin=Vs*Io*cosd(theta)
25 Pout=E1*Io+Io^2*R; //W
26 //Pin=Pout
27 cos_theta=(Pout/Vs/Io); //laging
28 disp(cos_theta,"When E=100, input power factor(
    lagging)");
29 Pout=-E2*Io-Io^2*R; //W
30 //Pin=Pout
31 cos_theta=(Pout/Vs/Io); //laging
32 disp(cos_theta,"When E=-100, input power factor(
    lagging)");

```

Scilab code Exa 2.9 Average load current

```

1 //Example 2_9
2 clc;
3 clear; close;
4
5 //Given data:
6 V=230; //V
7 f=50; //Hz
8 R=5; //ohm
9 L=8*10^-3; //H
10 E=50; //V
11 alfa=40; //degree
12
13 //Solution :
14 //Vdc=2*sqrt(2)*V*cosd(alfa)/%pi-E+Io*R
15 Io=(2*sqrt(2)*V*cosd(alfa)/%pi-E)/R; //A
16 disp(Io,"Average value of load current in A");

```

Scilab code Exa 2.10 Average load current

```
1 //Example 2_10
2 clc;
3 clear; close;
4
5 //Given data:
6 Vs=230; //V
7 f=50; //Hz
8 Vdc=100; //V
9 Ip=15; //A
10 alfa=30; //degree
11
12 //Solution :
13 //Vdc=2*Vm*cosd(alfa)/%pi-2*1.7//(Full converter
    bridge)
14 Vm=(Vdc+2*1.7)/2/cosd(alfa)*%pi; //V
15 Vrms=Vm/sqrt(2); //V
16 TurnRatio=Vs/Vrms;
17 disp(TurnRatio,"(a) Turn ratio of transformer");
18 Irms=sqrt(Ip^2/2); //A
19 Rating=Vrms*Ip; //VA
20 disp(Rating,"(b) Transformer rating in VA");
21 PIV=Vm; //V
22 disp(PIV,"(c) PIV in V");
23 disp(Irms,"(d) RMS value of thyristor current in A")
    ;
```

Scilab code Exa 2.11 Vrms Vdc Form factor

```
1 //Example 2_11
2 clc;
```

```

3  clear;close;
4
5  //Given data:
6  Vs=230;//V
7  f=50;//Hz
8  alfa=90;//degree
9
10 //Solution :
11 Vm=Vs*sqrt(2);//V
12 Vdc=Vm/%pi*(1+cosd(alfa))//V
13 disp(Vdc,"Vdc in V");
14 Vrms=Vm/sqrt(2)*sqrt(1/%pi*[%pi-%pi/2+sin(%pi)/2]);
    //V
15 disp(Vrms,"Vrms in V");
16 FormFactor=Vrms/Vdc;
17 disp(FormFactor,"Form factor");

```

Scilab code Exa 2.12 Vrms Vdc form factor power factor

```

1  //Example 2_12
2  clc;
3  clear;close;
4
5  //Given data:
6  Vs=230;//V
7  f=50;//Hz
8  alfa=90;//degree
9
10 //Solution :
11 Vm=Vs*sqrt(2);//V
12 Vdc=Vm/%pi*(1+cosd(alfa))//V
13 disp(Vdc,"Vdc in V");
14 Vrms=Vm/sqrt(2)*sqrt(1/%pi*[%pi-%pi/2+sin(%pi)/2]);
    //V
15 disp(Vrms,"Vrms in V");

```

```

16 Is_by_I=sqrt(1-%pi/2/%pi);
17 Is1_by_I=2*sqrt(2)/%pi*cos(%pi/4);
18 HF=sqrt((Is_by_I/Is1_by_I)^2-1); // unitless
19 disp(HF," Harmonic factor");
20 theta1=-alfa/2*%pi/180; //radian
21 DF=cos(theta1); // unitless
22 disp(DF," Displacement factor");
23 PF=(Is1_by_I/Is_by_I)*DF; //lagging
24 disp(PF," Power factor (lagging)");

```

Scilab code Exa 2.13 Vrms Vdc form factor power factor

```

1 //Example 2_13
2 clc;
3 clear; close;
4
5 //Given data:
6 Vs=230; //V
7 f=50; //Hz
8 alfa=%pi/3; //radian
9
10 //Solution :
11 Vm=Vs*sqrt(2); //V
12 Vdc=2*Vm/%pi*cos(alfa) //V
13 disp(Vdc," Vdc in V");
14 Vrms=Vs; //V
15 disp(Vrms," Vrms in V");
16 Is_by_I=sqrt(1-%pi/2/%pi);
17 Is1_by_I=2*sqrt(2)/%pi*cos(%pi/4);
18 HF=sqrt((Is_by_I/Is1_by_I)^2-1); // unitless
19 disp(HF," Harmonic factor");
20 fi1=-alfa; //radian
21 DF=cos(fi1); // unitless
22 disp(DF," Displacement factor");
23 PF=(Is1_by_I/Is_by_I)*DF; //lagging

```

```
24 disp(PF,"Power factor (lagging)");
```

Scilab code Exa 2.14 Find output volage and current

```
1 //Example 2_14
2 clc;
3 clear;close;
4
5 //Given data:
6 Vs=230;//V
7 f=50;//Hz
8 alfa=30*%pi/180;//radian
9 I=4;//A
10
11 //Solution :
12 disp(" part (a)");
13 Vm=Vs*sqrt(2);//V
14 Vdc=2*Vm/%pi*cos(alfa)//V
15 RL=Vdc/I;//ohm
16 IL=I*2*sqrt(2)/%pi;//A
17 Pin_active=Vs*IL*cos(alfa);//W
18 Pin_reactive=Vs*IL*sin(alfa);//vars
19 Pin_appearent=Vs*IL;//VA
20 disp(Vdc,"dc output voltage(V)");
21 disp(Pin_active,"Active power input(W)");
22 disp(Pin_reactive,"Reactive power input(vars)");
23 disp(Pin_appearent,"Appearent power input(VA)");
24 disp(" part (b)");
25 Vdc=Vm/%pi*(1+cos(alfa))//V
26 IL=Vdc/RL;//A
27 I_fund=2*sqrt(2)/%pi*IL*cos(alfa/2);//A
28 Pin_active=Vs*I_fund*cos(alfa/2);//W
29 Pin_reactive=Vs*I_fund*sin(alfa/2);//vars
30 Pin_appearent=Vs*I_fund;//VA
31 disp(Vdc,"dc output voltage(V)");
```

```

32 disp(Pin_active," Active power input (W)");
33 disp(Pin_reactive," Reactive power input (vars)");
34 disp(Pin_apparent," Apparent power input (VA)");
35 disp(" part (c)");
36 Vdc=Vs/sqrt(2)/%pi*(1+cos(alfa))//V
37 Idc=Vdc/RL;//A
38 disp(Vdc," dc output voltage (V)");
39 disp(Idc," dc output current (A)");

```

Scilab code Exa 2.15 Voltage current and various factors

```

1 //Example 2_15
2 clc;
3 clear;close;
4
5 //Given data:
6 Vs=230;//V
7 f=50;//Hz
8 alfa=30;//degree
9 IL=10;//A
10
11 //Solution :
12 Vm=Vs*sqrt(2);//V
13 Vdc=2*Vm/%pi*cosd(alfa)//V
14 disp(Vdc," (a) dc output voltage (V)");
15 Irms=IL;//A
16 disp(Irms," (b) Irms in A");
17 Is1=2*sqrt(2)/%pi*IL;//A
18 disp(Is1," (c) Fundamental component of input current
    in A");
19 DF=cosd(-alfa);// unitless
20 disp(DF," (d) Displacement fator");
21 pf_in=Is1/IL*DF;//lagging
22 disp(pf_in," (e) Input power fator (lagging)");
23 HF=sqrt((IL/Is1)^2-1);// unitless

```

```

24 disp(HF,"(f) Harmonic factor");
25 Vrms=Vs;//V
26 FF=Vrms/Vdc;//form fator
27 RF=sqrt(FF^2-1);//ripple fator
28 disp(RF,"(g) Ripple factor");

```

Scilab code Exa 2.16 Voltage current power factor and power disipated

```

1 //Example 2_16
2 clc;
3 clear;close;
4
5 //Given data:
6 Vs=240;//V
7 f=50;//Hz
8 alfa=60;//degree
9 RL=10;//ohm
10
11 //Solution :
12 Vm=Vs*sqrt(2);//V
13 Vdc=Vm/%pi*(1+cosd(alfa))//V
14 disp(Vdc,"(a) average load voltage(V)");
15 I=Vdc/RL;//A
16 Is=I*sqrt(1-alfa/180);//A
17 Irms=Is;//A
18 disp(Irms,"(b) rms input current(A)");
19 Is1=2*sqrt(2)/%pi*I*cosd(alfa/2);//A
20 fi1=-alfa/2;//degree
21 DF=cosd(fi1);//unitless
22 pf_in=Is1/Is*DF;//lagging
23 disp(pf_in,"(c) Input power fator(lagging)");
24 Pavg=I^2*RL;//W
25 disp(Pavg,"(d) Average power dissipated(W)");

```

Scilab code Exa 2.17 Firing angle Power and variation in firing angle

```
1 //Example 2_17
2 clc;
3 clear; close;
4
5 //Given data:
6 IL=200; //A
7 VL=400; //V
8 Vdc=360; //V
9 variation=10; // %
10
11 //Solution :
12 Vm=VL*sqrt(2)/sqrt(3); //V
13 //Vdc=3*sqrt(3)/%pi*Vm*cosd(alfa) //V
14 alfa=acosd(Vdc/(3*sqrt(3)/%pi*Vm)) //degree
15 disp(alfa,"Firing angle in degree");
16 S=sqrt(3)*VL*IL; //VA
17 disp(S,"Apparent power (VA)");
18 P=S*cosd(alfa); //W
19 disp(P,"Active power (W)");
20 Q=sqrt(S^2-P^2); //vars
21 disp(Q,"Rective power (vars)");
22 Vac1=(1+variation/100)*VL; //V
23 alfa1=acosd(Vdc/(3*Vac1*sqrt(2)/%pi)); //degree
24 Vac2=(1-variation/100)*VL; //V
25 alfa2=acosd(Vdc/(3*Vac2*sqrt(2)/%pi)); //degree
26 disp(alfa1,"When variation is +10%, firing angle(
    degree)");
27 disp(alfa2,"When variation is -10%, firing angle(
    degree)");
28 //Answer in the book is wrong for some part.
```

Scilab code Exa 2.18 Pdc Current and PIV

```
1 //Example 2_18
2 clc;
3 clear;close;
4
5 //Given data:
6 Vs=400;//V
7 f=50;//Hz
8 Idc=150;//A
9 alfa=60;//degree
10
11 //Solution :
12 Vm=Vs*sqrt(2)/sqrt(3);//V
13 Vdc=3*sqrt(3)/%pi*Vm*cosd(alfa)//V
14 Pdc=Vdc*Idc;//W
15 disp(Pdc,"Output power , Pdc(W)");
16 Iavg=Idc/3;//A
17 disp(Iavg,"Average thyristor current(A)");
18 Irms=Idc/sqrt(3);//A
19 disp(Irms,"RMS value of thyristor current(A)");
20 Ipeak=Idc;//A
21 disp(Ipeak,"Peak current through thyristor(A)");
22 PIV=sqrt(2)*Vs;//V
23 disp(PIV,"Peak inverse voltage(V)");
24 //Answer of first part in the book is wrong.
```

Scilab code Exa 2.19 Firing angle Power and current

```
1 //Example 2_19
2 clc;
3 clear;close;
```



```

4
5 //Given data:
6 V=415; //V
7 Vdc=460; //V
8 I=200; //A
9 f=50; //Hz
10
11 //Solution :
12 Vm=V*sqrt(2)/sqrt(3); //V
13 alfa=acosd(Vdc/(3*sqrt(3)/%pi*Vm)); //degree
14 disp(alfa," Converter firing angle(degree)");
15 Pdc=Vdc*I; //W
16 disp(Pdc/1000," dc power (kW)");
17 IL=I*sqrt(120/180); //A
18 disp(IL,"AC line current(A)");
19 Ipeak=I; //A
20 Irms=Ipeak*sqrt(120/360); //A
21 disp(Irms,"RMS value of thyristor current(A)");
22 Iavg=Ipeak/3; //A
23 disp(Iavg,"Average thyristor current(A)");

```

Scilab code Exa 2.20 Firing angle and power factor

```

1 //Example 2_20
2 clc;
3 clear; close;
4
5 //Given data:
6 Vs=230; //V
7 f=50; //Hz
8 emf=200; //V
9 Rint=0.5; //ohm
10 I=20; //A
11
12 //Solution :

```

```

13 Vm=Vs*sqrt(2)/sqrt(3); //V
14 Vdc=emf+Rint*I; //V
15 alfa=acosd(Vdc/(3*sqrt(3)/%pi*Vm)); // degree
16 disp(alfa," Firing angle(degree)");
17 Pout=emf*I+I^2*Rint; //W
18 Is=sqrt(I^2*120/180); //A
19 cos_theta=Pout/(sqrt(3)*Vs*Is); //power factor
20 disp(cos_theta," Input power factor(lagging)");

```

Scilab code Exa 2.21 Firing angle current and power factor

```

1 //Example 2_21
2 clc;
3 clear; close;
4
5 //Given data:
6 Vs=400; //V
7 R=10; //ohm
8 f=50; //Hz
9
10 //Solution :
11 Vm=Vs*sqrt(2)/sqrt(3); //V
12 Vdc_max=3*sqrt(3)*Vm/2/%pi*(1+cosd(0)); //V
13 //Vdc should be Vdc_max/2
14 Vdc=Vdc_max*50/100; //V
15 alfa=acosd(1-Vdc/(3*sqrt(3)*Vm/2/%pi)); // degree
16 disp(alfa," Firing angle(degree)");
17 Idc=Vdc/R; //A
18 disp(Idc," Average output current(A)");
19 Vrms=sqrt(3)*Vm*sqrt(3/4/%pi*(%pi-%pi/2+sin(%pi)/2))
    ; //V
20 Irms=Vrms/R; //A
21 disp(Vrms,"RMS output voltage(V)");
22 disp(Irms,"RMS output current(A)");
23 Iavg_thy=Idc/3; //A

```

```

24 disp(Iavg_thy,"Average thyristor current(A)");
25 Irms_thy=Irms/sqrt(3);//A
26 disp(Irms_thy,"RMS thyristor current(A)");
27 Eff=Vdc*Idc/(Vrms*Irms)*100;//%
28 disp(Eff,"Rectification Efficiency(%)");
29 Iline_rms=Irms*sqrt(120/180);//A
30 VA_in=3*Vs*Iline_rms/sqrt(3);//VA
31 TUF=Vdc*Idc/VA_in;
32 disp(TUF,"Transformer utilisation factor");
33 Pin_active=Irms^2*R;//W
34 pf_in=Pin_active/VA_in;//lagging
35 disp(pf_in,"Input power factor(lagging)");
36 //Answer in the book is wrong for some part.

```

Scilab code Exa 2.22 Firing angle current and power factor

```

1 //Example 2_22
2 clc;
3 clear;close;
4
5 //Given data:
6 Vs=400;//V
7 R=10;//ohm
8 f=50;//Hz
9
10 //Solution :
11 Vm=Vs*sqrt(2)/sqrt(3);//V
12 alfa=60;//degree(For 50% output voltage)
13 Vdc=3*sqrt(3)*Vm/%pi*cosd(alfa);//V
14 alfa=acosd(Vdc/3/sqrt(3)/Vm*%pi);//V
15 disp(alfa,"Firing angle in degree");
16 Idc=Vdc/R;//A
17 disp(Idc,"Average output current(A)");
18 Vrms=sqrt(3)*Vm*sqrt(0.5+3*sqrt(3)/4/%pi*cosd(2*alfa
    ));//V

```

```

19 Irms=Vrms/R; //A
20 disp(Vrms,"RMS output voltage(V)");
21 disp(Irms,"RMS output current(A)");
22 Iavg_thy=Idc/3; //A
23 disp(Iavg_thy,"Average thyristor current(A)");
24 Irms_thy=Irms/sqrt(3); //A
25 disp(Irms_thy,"RMS thyristor current(A)");
26 Eff=Vdc*Idc/(Vrms*Irms)*100; //%
27 disp(Eff,"Rectification Efficiency(%)");
28 Iline_rms=Irms*sqrt(120/180); //A
29 VA_in=3*Vs*Iline_rms/sqrt(3); //VA
30 TUF=Vdc*Idc/VA_in;
31 disp(TUF,"Transformer utilisation factor");
32 Pin_active=Irms^2*R; //W
33 pf_in=Pin_active/VA_in; //lagging
34 disp(pf_in,"Input power factor(lagging)");
35 //Answer in the book is wrong for some part.

```

Scilab code Exa 2.25 Firing angle of converter

```

1 //Example 2_25
2 clc;
3 clear; close;
4
5 //Given data:
6 Vs=400; //V
7 f=50; //Hz
8 Eb=300; //V
9
10 //Solution :
11 Vdc=Eb; //V
12 Vm=Vs*sqrt(2); //V
13 //Vdc=3*sqrt(3)/2/%pi*Vm*cosd( alfa ); //V
14 alfa=acosd(Vdc/(3*sqrt(3)/2/%pi*Vm)); //degree
15 disp(alfa,"Firing angle(degree)");

```


Chapter 3

Inverters

Scilab code Exa 3.1 Maximum output frequency

```
1 //Example 3_1
2 clc;
3 clear;close;
4
5 //Given data:
6 R=80;//ohm
7 L=8;//mH
8 C=1.2;// micro F
9
10 //Solution :
11 if R^2<4*(L*10^-3)/(C*10^-6) then
12     disp("As R^2<4*L/C, Circuit will work as a
13         series inverter.");
14 else
15     disp("As R^2>4*L/C, Circuit will not work as a
16         series inverter.");
17 end
18 omega_m=sqrt(1/(L*10^-3*C*10^-6)-R^2/4/(L*10^-3)^2);
19 //rad/s
20 fm=omega_m/2/%pi;//Hz
21 disp(fm,"Maximum frequency in Hz : ");
```

Scilab code Exa 3.2 Frequency of output

```
1 //Example 3_2
2 clc;
3 clear;close;
4
5 //Given data:
6 R=80;//ohm
7 L=8;//mH
8 C=1.2;// micro F
9 Toff=14;//micro sec
10
11 //Solution :
12 omega_m=sqrt(1/(L*10^-3*C*10^-6)-R^2/4/(L*10^-3)^2);
13 //rad/s
14 fm=omega_m/2/%pi;//Hz
15 T=1/fm;//sec
16 f=1/(T+2*Toff*10^-6);//Hz
17 disp(f,"Frequency of output in Hz : ");
```

Scilab code Exa 3.3 Voltage power and current

```
1 //Example 3_3
2 clc;
3 clear;close;
4
5 //Given data:
6 RL=3;//in ohm
7 V=30;//in V
8
9 //Solution :
```

```

10 Vpeak=2*V/%pi; //V
11 Vrms=Vpeak/sqrt(2); //V
12 disp(Vrms,"(a) RMS value of output voltage(V) : ");
13 //VL=sqrt(2/T*integrate('(V/2)^2','t',0,T/2)); //V
14 VL=V/2; //V
15 Pout=VL^2/RL; //W
16 disp(Pout,"(b) Output power(W) : ");
17 Ipeak=VL/RL; //A
18 disp(Ipeak,"(c) Peak current in thyristor(A) : ");
19 Iavg=Ipeak*50/100; //A
20 disp(Iavg,"(d) Average current of each thyristor(A)
    : ");
21 Vprb=2*VL; //V
22 disp(Vprb,"(e) Peak reverse braking voltage(V) : ");

```

Scilab code Exa 3.4 Voltage power and current

```

1 //Example 3_4
2 clc;
3 clear; close;
4
5 //Given data:
6 RL=3; //in ohm
7 V=30; //in V
8
9 //Solution :
10 Vpeak=4*V/%pi; //V
11 Vrms=Vpeak/sqrt(2); //V
12 disp(Vrms,"(a) RMS value of output voltage in volt :
    ");
13 //VL=sqrt(2/T*integrate('V^2','t',0,T/2)); //V
14 VL=V; //V
15 Pout=VL^2/RL; //W
16 disp(Pout,"(b) Output power(W) : ");
17 Ipeak=VL/RL; //A

```



```

18 disp(Ipeak,"(c) Peak current in thyristor(A) : ");
19 Iavg=Ipeak*50/100; //A
20 disp(Iavg,"(d) Average current of each thyristor(A)
    : ");
21 Vprb=VL; //V
22 disp(Vprb,"(e) Peak reverse braking voltage(V) : ");

```

Scilab code Exa 3.5 Current Distortion and power

```

1 //Example 3_5
2 clc;
3 clear; close;
4
5 //Given data:
6 V=200; //V
7 R=10; //in ohm
8 L=20; //mH
9 C=100; //pF
10 f=50; //Hz
11
12 //Solution :
13 Z1=R+%i*(2*%pi*f*L*10^-3-1/(2*%pi*f*C*10^-6)); //ohm
14 Z3=R+%i*(3*2*%pi*f*L*10^-3-1/(3*2*%pi*f*C*10^-6)); //
    ohm
15 Z5=R+%i*(5*2*%pi*f*L*10^-3-1/(5*2*%pi*f*C*10^-6)); //
    ohm
16 Z7=R+%i*(7*2*%pi*f*L*10^-3-1/(7*2*%pi*f*C*10^-6)); //
    ohm
17 Z9=R+%i*(9*2*%pi*f*L*10^-3-1/(9*2*%pi*f*C*10^-6)); //
    ohm
18 I=4*V/%pi/abs(Z1); //A
19 Irms=I/sqrt(2); //A
20 disp(Irms,"RMS load current (A)");
21 Ip=sqrt((4*V/%pi/abs(Z1))^2+(4*V/3/%pi/abs(Z3))
    ^2+(4*V/5/%pi/abs(Z5))^2+(4*V/7/%pi/abs(Z7))

```

```

    ^2+(4*V/9/%pi/abs(Z9))^2); //A
22 disp(Ip,"Peak value of load current(A)");
23 Ih=sqrt(Ip^2-I^2)/sqrt(2); //A
24 disp(Ih,"RMS harmonic current(A)");
25 hd=sqrt(Ip^2-I^2)/I; //harmonic distortion
26 disp(hd*100,"Harmonic distortion(%)");
27 Irms_load=Ip/sqrt(2); //A
28 Pout=Irms_load^2*R; //W
29 disp(Pout,"Total output power(W)");
30 Pout_com=Irms^2*R; //W(fundamental component)
31 disp(Pout_com,"Fundamental component of power(W)");
32 Iavg_in=Pout/V; //A
33 disp(Iavg_in,"Average input current(A)");
34 Ip_thy=Ip; //A
35 disp(Ip_thy,"Peak thyristor current(A)");

```

Scilab code Exa 3.6 Find value of C

```

1 //Example 3_6
2 clc;
3 clear;close;
4
5 //Given data:
6 R=2; //in ohm
7 XL=10; //ohm
8 f=4; //kHz
9 Toff=12; //micro sec
10
11 //Solution :
12 Toff_time=Toff*1.5; //micro sec
13 theta=2*%pi*f*10^3*Toff_time*10^-6; //radians
14 Xc=tan(theta)*R+XL; //ohm
15 C=1/(2*%pi*f*1000*Xc); //F
16 disp(C,"Value of Capacitance in F : ");

```

Scilab code Exa 3.7 Current and power

```
1 //Example 3_7
2 clc;
3 clear;close;
4
5 //Given data:
6 V=400;//V
7 R=10;//in ohm/phase
8
9 //Solution :
10 Ipeak=V/2/R;//A
11 Irms=sqrt(Ipeak^2*2/3);//A
12 disp(Irms,"RMS load current in A : ");
13 Pout=Irms^2*R*3;//W
14 disp(Pout,"Power output(W) : ");
15 Iavg=Ipeak/3;//A
16 disp(Iavg,"Average thyristor current(A) : ");
17 Irms_thyristor=sqrt(Ipeak^2/3);//A
18 disp(Irms_thyristor,"RMS value of thyristor current(
    A) : ");
```

Scilab code Exa 3.8 Current and power

```
1 //Example 3_8
2 clc;
3 clear;close;
4
5 //Given data:
6 V=400;//V
7 R=10;//in ohm/phase
8
```

```

 9 //Solution :
10 RL=R+R/2; //ohm
11 i1=V/RL; //A
12 i2=V/RL; //A
13 i3=V/RL; //A
14 Irms_load=sqrt(1/2/%pi*(integrate('i1^2','theta',
    ,0,2*%pi/3)+integrate('(i1/2)^2','theta',2*%pi
    /3,2*%pi))); //A
15 disp(Irms_load,"RMS load current in A : ");
16 Pout=Irms_load^2*R*3; //W
17 disp(Pout,"Power output (W) : ");
18 Ipeak=i1; //A
19 Iavg=1/2/%pi*[Ipeak*%pi/3+Ipeak/2*2*%pi/3]; //A
20 disp(Iavg,"Average thyristor current (A) : ");
21 Irms_thyristor=sqrt(1/2/%pi*[Ipeak^2*%pi/3+(Ipeak/2)
    ^2*2*%pi/3]); //A
22 disp(Irms_thyristor,"RMS value of thyristor current(
    A) : ");

```

Chapter 4

Choppers

Scilab code Exa 4.1 Period of conduction and blocking

```
1 //Example 4_1
2 clc;
3 clear;close;
4
5 //Given data:
6 V=230;//V
7 Vav=150;//V
8 f=1*1000;//Hz
9
10 //Solution :
11 T=1/f;//s
12 Ton=Vav*T/V;//s
13 Toff=T-Ton;//s
14 disp(Toff,Ton,"Periods of conduction & blocking(
    seconds)");
```

Scilab code Exa 4.2 Periods of conduction and blocking

```

1 //Example 4_2
2 clc;
3 clear;close;
4
5 //Given data:
6 Ra=0.06; //ohm
7 Rf=0.03; //ohm
8 Iav=15; //A
9 f=500; //Hz
10 Eb=100; //V
11 V=200; //V
12
13 //Solution :
14 Vav=Iav*(Ra+Rf)+Eb; //V
15 T=1/f; //s
16 Ton=Vav*T/V; //s
17 Toff=T-Ton; //s
18 disp(Toff,Ton,"Periods of conduction & blocking(
    seconds)");

```

Scilab code Exa 4.3 Find duty cycle

```

1 //Example 4_3
2 clc;
3 clear;close;
4
5 //Given data:
6 N=800; //rpm
7 I=20; //A
8 Ra=0.5; //ohm
9 Vs=240; //V
10 Ndash=600; //rpm
11
12 //Solution :
13 Eb_800=Vs-I*Ra; //V

```

```

14 Eb_600=Eb_800*Ndash/N; //V
15 Vav=I*Ra+Eb_600; //V
16 alfa=Vav/Vs; //duty cycle
17 disp(alfa,"(a) Duty cycle");
18 //Torque reduced to half will reduce I to half
19 I=I/2; //A
20 Vav=I*Ra+Eb_600; //V
21 alfa=Vav/Vs; //duty cycle
22 disp(alfa,"(b) Duty cycle");

```

Scilab code Exa 4.4 Voltage Efficiency and resistance

```

1 //Example 4_4
2 clc;
3 clear;close;
4
5 //Given data:
6 V=200; //V
7 RL=8; //ohm
8 Vthy=2; //V
9 f=800; //Hz
10 alfa=0.4; //duty cycle
11
12 //Solution :
13 Vav=alfa*(V-Vthy); //V
14 disp(Vav,"(a) Average output voltage(V)");
15 VL=sqrt(alfa)*(V-Vthy); //V
16 disp(VL,"(b) RMS output voltage(V)");
17 Pout=VL^2/RL; //W
18 Pin=alfa*V*(V-Vthy)/RL; //W
19 Eff=Pout/Pin*100; //%
20 disp(Eff,"(c) Chopper efficiency(%)");
21 Rin=RL/alfa; //ohm
22 disp(Rin,"(d) Input resistance(ohm)");
23 V1=(V-Vthy)*sqrt(2)/%pi; //V

```

```
24 disp(V1,"(e) RMS value of fundamental component(V)")  
    ;
```

Scilab code Exa 4.5 Chopping frequency

```
1 //Example 4_5  
2 clc;  
3 clear;close;  
4  
5 //Given data:  
6 V=400;//V  
7 R=0;//ohm  
8 L=0.05;//H  
9 alfa=0.25;//duty cycle  
10 delta_i=10;//A  
11  
12 //Solution :  
13 Vav=alfa*V;//V  
14 delta_T=L*delta_i/(V-Vav);//s  
15 Ton=delta_T;//s  
16 T=Ton/alfa;//s  
17 f=1/T;//pulses/s  
18 disp(f,"Chopping frequency (pulses/s)");
```

Scilab code Exa 4.6 Find the current

```
1 //Example 4_6  
2 clc;  
3 clear;close;  
4  
5 //Given data:  
6 R=4;//ohm  
7 L=6/1000;//H
```



```

8 V=200; //V
9 alfa=0.5; //duty cycle
10 f=1000; //Hz
11
12 //Solution :
13 T=1/f; //s
14 E=0; //V
15 Imax=V/R*[(1-exp(-alfa*T*R/L))/(1-exp(-T*R/L))]-E/R;
    //A
16 Imin=V/R*[(exp(alfa*T*R/L)-1)/(exp(T*R/L)-1)]-E/R; //
    A
17 disp(Imax, "Maximum current (A)");
18 disp(Imin, "Minimum current (A)");
19 Iavg=(Imax+Imin)/2; //A
20 disp(Iavg, "Average load current (A)");
21 IL=sqrt(1/alfa/T*integrate(' (Imin+(Imax-Imin)*t/ alfa
    /T)^2 ', 't', 0, alfa*T)); //A
22 disp(IL, "RMS load current (A)");
23 Iavg_in=alfa*Iavg; //A
24 disp(Iavg_in, "Average input current (A)");
25 Irms_in=sqrt(1/T*integrate(' (Imin+(Imax-Imin)*t/ alfa
    /T)^2 ', 't', 0, alfa*T)); //A
26 disp(Irms_in, "RMS input current (A)");

```

Scilab code Exa 4.7 Find load inductance

```

1 //Example 4_7
2 clc;
3 clear; close;
4
5 //Given data:
6 V=300; //V
7 R=4; //ohm
8 f=250; //Hz
9 ripple=20; //%
```

```

10 Iavg=30; //A
11
12 //Solution :
13 T=1/f; //s
14 E=0; //V
15 Imax_sub_Imin=ripple/100*Iavg; //A
16 L=V/Imax_sub_Imin/R/f; //H
17 disp(L,"Load Inductance(H)");

```

Scilab code Exa 4.8 Find the current

```

1 //Example 4_8
2 clc;
3 clear; close;
4
5 //Given data:
6 Ra=0.5; //ohm
7 L=16/1000; //H
8 V=200; //V
9 E=100; //V
10 Imin=10; //A
11 toff=2/1000; //s
12
13 //Solution :
14 i=(V-E)/Ra*[1-exp(-Ra*toff/L)]+Imin*exp(-Ra*toff/L
    ); //A
15 disp(i,"Current at instant of turn off(A)");
16 t=5/1000; //s
17 i_dash=i*exp(-Ra*t/L); //A
18 disp(i_dash,"Current 5 ms after turn off(A)");
19 //Answer is wrong in the book.

```

Scilab code Exa 4.9 Speed of motor

```

1 //Example 4_9
2 clc;
3 clear;close;
4
5 //Given data:
6 V=220;//V
7 N_NoLoad=1000;//rpm
8 alfa=0.6;//duty cycle
9 I=20;//A
10 Ra=1;//ohm
11
12 //Solution :
13 Eb1=V;//V////at no load
14 Vin=alfa*V;//V
15 Eb2=Vin-I*Ra;//V
16 N=N_NoLoad*Eb2/Eb1;//rpm
17 disp(N,"Speed of the motor(rpm)");

```

Scilab code Exa 4.10 Average load voltage

```

1 //Example 4_10
2 clc;
3 clear;close;
4
5 //Given data:
6 V=230;//V
7 Ton=25/1000;//s
8 Toff=10/1000;//s
9
10 //Solution :
11 Vavg=V*Ton/(Ton+Toff);//V
12 disp(Vavg,"Average load voltage(V)");

```

Scilab code Exa 4.11 Find current and voltage

```
1 //Example 4_11
2 clc;
3 clear; close;
4
5 //Given data:
6 V=100; //V
7 R=0.5; //ohm
8 L=1/1000; //H
9 Ton=1/1000; //s
10 T=3/1000; //s
11
12 //Solution :
13 Toff=T-Ton; //s
14 alfa=Ton/T; //duty cycle
15 E=0; //V
16 Imax=V/R*[(1-exp(-alfa*T*R/L))/(1-exp(-T*R/L))]-E/R;
    //A
17 Imin=V/R*[(exp(alfa*T*R/L)-1)/(exp(T*R/L)-1)]-E/R; //
    A
18 disp(Imax,"Maximum current (A)");
19 disp(Imin,"Minimum current (A)");
20 Iavg=(Imax+Imin)/2; //A
21 disp(Iavg,"Average load current (A)");
22 Vavg=alfa*V; //V
23 disp(Vavg,"Average load voltage (V)");
```

Scilab code Exa 4.12 Output current and voltage

```
1 //Example 4_12
2 clc;
3 clear; close;
4
5 //Given data:
```

```

6 V=100; //V
7 E=12; //V
8 L=0.8/1000; //H
9 R=0.2; //ohm
10 T=2.4/1000; //s
11 Ton=1/1000; //s
12
13 //Solution :
14 alfa=Ton/T; //duty cycle
15 Imax=V/R*[(1-exp(-alfa*T*R/L))/(1-exp(-T*R/L))]; //A
16 Imin=V/R*[(exp(alfa*T*R/L)-1)/(exp(T*R/L)-1)]; //A
17 disp(Imax, "Maximum current (A)");
18 disp(Imin, "Minimum current (A)");
19 Vavg=alfa*V; //V
20 disp(Vavg, "Average load voltage (V)");

```

Scilab code Exa 4.13 Find series inductance

```

1 //Example 4_13
2 clc;
3 clear; close;
4
5 //Given data:
6 V=500; //V
7 I=10; //A
8 f=400; //Hz
9
10 //Solution :
11 alfa=0.5; //for maximum swing
12 //I=V/(4*f*L); //A
13 L=V/(4*f*I); //H
14 disp(L, "Series inductance (H)");

```

Scilab code Exa 4.14 Motor speed and current swing

```
1  ////Example 4_14
2  clc;
3  clear;close;
4
5  //Given data:
6  V=800; //V
7  P=300; //HP
8  Eff=0.9; //Efficiency
9  R=0.1; //ohm
10 L=100/1000; //H
11 alfa=0.2; //duty cycle
12 N=900; //rpm
13 f=400; //Hz
14
15 //Solution :
16 Pout=P*735.5/1000; //kW
17 Pin=Pout/Eff; //kW
18 I=Pin*1000/V; //A
19 E=V-I*R; //V(at rated voltage)
20 Edash=V*alfa-I*R; //V(at 0.2 duty cycle)
21 Ndash=N*Edash/E; //rpm
22 disp(Ndash,"Motor speed(rpm)");
23 T=1/f; //s
24 d_ia=(V-alfa*V)/L*alfa*T; //A
25 disp(d_ia,"Current swing(A)");
```

Scilab code Exa 4.17 Find the current

```
1  ////Example 4_17
2  clc;
3  clear;close;
4
5  //Given data:
```

```

6 V=200; //V
7 R=2; //ohm
8 L=10/1000; //H
9 E=20; //V
10 T=1000/10^6; //s
11 Ton=300/10^6; //s
12
13 //Solution :
14 f=1/T; //Hz
15 alfa_min=1/(R*T/L)*log(1+E/V*(exp(R*T/L)-1)); //duty
    cycle
16 alfa=Ton/T; //duty cycle
17 disp(alfa_min,"Minimum value required of alfa");
18 disp(alfa,"Actual value of alfa");
19 disp("Load current is continuous as alfa_actual>
    alfa_min")
20 Imax=V/R*[(1-exp(-alfa*T*R/L))/(1-exp(-T*R/L))]-E/R;
    //A
21 Imin=V/R*[(exp(alfa*T*R/L)-1)/(exp(T*R/L)-1)]-E/R; //
    A
22 disp(Imax,"Maximum current(A)");
23 disp(Imin,"Minimum current(A)");
24 Iavg=(alfa*V-E)/R; //A
25 disp(Iavg,"Average load current(A)");
26 Iavg_in=alfa*(V-E)/R-L/R/T*(Imax-Imin); //A
27 disp(Iavg_in,"Average input current(A)");

```

Scilab code Exa 4.18 RMS value of load current

```

1 ///Example 4_18
2 clc;
3 clear; close;
4
5 //Given data:
6 V=200; //V

```

```

7 T=1000/10^6; //s
8 Ton=300/10^6; //s
9 R=4; //ohm
10 L=10/1000; //H
11
12 //Solution :
13 f=1/T; //Hz
14 Vrms1=sqrt((200/%pi*sin(2*%pi*0.3))^2+(200/%pi*((1-
      cos(2*%pi*0.3))))^2)/sqrt(2); //V
15 Vrms2=sqrt((200/2/%pi*sin(2*%pi*2*0.3))^2+(200/2/%pi
      *((1-cos(2*%pi*2*0.3))))^2)/sqrt(2); //V
16 Vrms3=sqrt((200/3/%pi*sin(2*%pi*3*0.3))^2+(200/3/%pi
      *((1-cos(2*%pi*3*0.3))))^2)/sqrt(2); //V
17 Z1=R+%i*(2*%pi*f*L); //ohm
18 I1=Vrms1/abs(Z1); //A
19 disp(I1,"RMS value of 1st harmonic of load current(A
      )");
20 Z2=R+%i*(2*2*%pi*f*L); //ohm
21 I2=Vrms2/abs(Z2); //A
22 disp(I2,"RMS value of 2nd harmonic of load current(A
      )");
23 Z3=R+%i*(3*2*%pi*f*L); //ohm
24 I3=Vrms3/abs(Z3); //A
25 disp(I3,"RMS value of 3rd harmonic of load current(A
      )");
26 Iavg=V/R*Ton/T; //A
27 Irms=sqrt(Iavg^2+I1^2+I2^2+I3^2); //A
28 disp(Irms,"RMS value of load current(A)");

```

Scilab code Exa 4.19 Period of conduction

```

1 //Example 4_19
2 clc;
3 clear; close;
4

```



```

5 //Given data:
6 V=200; //V
7 Vav=250; //V
8 Toff=0.6*10^-3; //s
9
10 //Solution :
11 T=Vav/V*Toff; //s
12 Ton=T-Toff; //s
13 disp(Ton,"Period of conduction(seconds)");

```

Scilab code Exa 4.20 Period of conduction

```

1 //Example 4_20
2 clc;
3 clear; close;
4
5 //Given data:
6 V=150; //V
7 Vav=250; //V
8 Toff=1*10^-3; //s
9
10 //Solution :
11 T=Vav/V*Toff; //s
12 Ton=T-Toff; //s
13 disp(Ton,"Period of conduction(seconds)");

```

Chapter 6

Control of DC drives

Scilab code Exa 6.1 Proper size of motor

```
1 //Example 6_1
2 clc;
3 clear;close;
4
5 //Given data:
6 hp=[50 100 150 120 0];//hp
7 t=[20 20 10 20 15];//seconds
8
9 //Solution :
10 hp_rms_t=0;//initializing
11 for i=1:5
12     hp_rms_t=hp_rms_t+(hp(i)^2*t(i));//hp
13 end
14 hp_rms=sqrt(hp_rms_t/sum(t));//hp
15 disp(hp_rms,"Required hp(rms)");
16 disp("Motor size should be 100 hp");
```

Scilab code Exa 6.2 Thermal time constant and temperature rise

```

1 //Example 6_2
2 clc;
3 clear;close;
4
5 //Given data:
6 P=30; //kW
7 theta1=30; //degree C
8 t1=40; //minutes
9 theta2=45; //degree C
10 t2=80; //minutes
11 t2=2*t1; //minutes
12 Loss_fl=2; //kW
13 Loss_Cu=2.5; //kW
14
15 //Solution :
16 //theta1=theta_f*(1-exp(-t1/T));
17 //let exp(-t1/T)=a
18 a=poly(0, 'a');
19 polynomial=(1-a^2)*(theta1/theta2)-1+a;
20 a=roots(polynomial)
21 a=a(2);
22 T=-t1/log(a); //s
23 disp(T,"Thermal time constant(minutes)");
24 theta_f=theta1/(1-exp(-t1/T));
25 disp(theta_f,"Final temperature rise(degree C)");
26 alfa=Loss_fl/Loss_Cu;
27 t=20; //minutes
28 rating=P*sqrt((1+alfa)/(1-exp(-t/T))-alfa); //kW
29 disp(rating,"20 minute rating of motor(kW)");

```

Scilab code Exa 6.3 Field current

```

1 //Example 6_3
2 clc;
3 clear;close;

```

```

4
5 //Given data:
6 V=230; //V
7 f=50; //Hz
8 alfa=0; //degree
9 Rf=200; //ohm
10 Ra=0.3; //ohm
11 T=50; //N-m
12 N=900; //rpm
13 Kv=0.8; //V/A-rad/s
14 Kt=0.8; //N-m/A^2
15
16 //Solution :
17 Vm=V*sqrt(2); //V
18 Vf=2*Vm/%pi; //V
19 If=Vf/Rf; //A
20 disp(If,"Field current (A)");
21 Ia=T/(Kt*If); //A
22 omega=(2*%pi/60)*N; //radian/s
23 Eb=Kv*omega*If; //V
24 Va=Eb+Ia*Ra; //V
25 alfa_a=acosd(Va/(Vm/%pi)-1); //degree
26 disp(alfa_a,"Firing angle of armature circuit (degree)
    ");
27 Pout=Va*Ia; //W
28 I_in=sqrt(2/(2*%pi)*integrate('Ia^2','t',alfa_a*%pi
    /180,%pi)); //A
29 VA_in=V*I_in; //VA
30 pf_in=Pout/VA_in; //lagging
31 disp(pf_in,"Input power factor (lagging)");

```
