Scilab Textbook Companion for Introduction To Power Electronics by V. Jagannathan[1]

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April 14, 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 Power Electronics

Author: V. Jagannathan

Publisher: Prentice-Hall of India Pvt.Ltd

Edition: 1

Year: 2009

ISBN: 9788120323995

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 2

Power Switching Devices and their Characteristics

Scilab code Exa 2.1 Value of VA

```
//Ex 2.1 page 67

clc;
clear;
close;

V1=1;//V across SCR
IG=0;//A
Ih=2;//mA holding current
R=50;//ohm

// Applying kirchoff law
//VA-(IAK*R)-V1=0
VA=(Ih*10**-3*R)+V1;//V (let IAK=Ih)
printf('VA = %.2f V',VA)
```

Scilab code Exa 2.2 min duration of gating pulse

```
//Ex 2.2 page 67

clc;
clear;
close;

diBYdt=1000;//A/s (rate of rise of current)
il=10;//mA (latching current = diBYdt * tp)
tp=il*10**-3/diBYdt;//s
printf('Minimum duration of gating pulse = %.f micro
    s',tp*10**6)
```

Scilab code Exa 2.3 gate power dissipation

```
//Ex 2.3 page 68

clc;
clear;
close;

m=16;// V/A (gradient)
t_on=4;// us
IG=500;// mA
VS=15;// V

VG=m*IG/1000;// V
//Load line equation
//VG=VS-IG*RS
RS=(VS-VG)/(IG/1000) ;// ohm
Pg=VS*(IG/1000)**2 ; // W
printf('Gate power dissipation = %.f W',Pg)
printf('\n Resistance to be connected = %.f ohm',RS)
```

Scilab code Exa 2.4 resistance in series

```
//Ex 2.4 page 68

clc;
clear;
close;

// VG=0.5+8*IG -- eqn(1)
f=400; // Hz
delta=0.1 ; // (Duty Cycle)
P=0.5;//W
VS=12;// V

Tp=1/f*10**6;// us
// P= VG*IG -- eqn(2)
// solving eqn  1 and 2
//8*IG*IG**2+0.5*IG-P=0
p=[8, 0.5, -P] // polynomial for IG
IG=roots(p) ;// A
IG=IG(2) ;// A (discarding -ve value)
VG=0.5+8*IG;// V
// VS=VG+IG*RS
RS=(VS-VG)/IG
printf('Value of resistance to be added in series =
    %.2f ohm',RS)
```

Scilab code Exa 2.5 duty cycle of triggering pulse

```
//Ex 2.5 page 69

clc;
```

```
clear;
close;

// VG=10*IG -- eqn(1)
PGM=5;// W
PGav=.5;// W
VS=12;// V
Tp=20;// us

// PGM = VG*IG where VG=10*IG
IG=sqrt(PGM/10);// A
VG=10*IG;// V
// During the application of pulse VS = VG+(IG*RS)
RS=(VS-VG)/IG ;// ohm
f=PGav/(PGM*Tp*10**-6)/1000;// kHz
delta=f*1000*Tp*10**-6;// Duty Cycle
printf('Value of resistance to be connected in
    series = %.2f ohm',RS)
printf('\n Triggering frequency = %.2f kHz',f)
printf('\n Duty Cycle = %.1f ',delta)
// Note : ans in the textbook is not accurate.
```

Scilab code Exa 2.6 `value of R and C`

```
//Ex 2.6 page 70

clc;
clear;
close;

VS=3;// kV
IS=750;// A

VD=800;// V
ID=175;// A
```

```
dr=30/100;// de-rating factor
IB=8;//mA
delQ=30;// u Coulomb
// dr = 1-IS/np*ID
np = round(IS/(1-dr)/(ID)) ; // no. of parallel
   string
ns = round(VS*1000/(1-dr)/(VD)) ; // no. of series
   string
R=(ns*VD-VS*1000)/(ns-1)/(IB/1000)/1000;//kohm
C=(ns-1)*delQ*10**-6/(ns*VD-VS*1000)
printf('Value of R = %.2f kohm',R)
printf('\n Value of C = %.2e F',C)
```

Scilab code Exa 2.7 no of scr to be connected

```
//Ex 2.7 page 71

clc;
clear;
close;

VS=4;// kV
IS=800;// A

VD=800;// V
ID=200;// A
dr=20/100;// de-rating factor
// for series connection
ns = ceil(VS*1000/(1-dr)/(VD)) ; // no. of series
   string
// for parallel connection
np = round(IS/(1-dr)/(ID)) ; // no. of parallel
   string
printf('\n no. of series connection = %d',ns)
printf('\n no. of parallel connection = %d',np)
```

Scilab code Exa 2.8 value of series resistance

```
//Ex 2.8 page 72

clc;
clear;
close;

IS1=100;// A
IS2=150;// A
vd1=2.1;// V
vd2=1.75;// V
I=250;// A

rf1=vd1/IS1;// ohm
rf2=vd2/IS2;// ohm
// Equating voltage drops
// vd1+IS1*re = vd2+IS2*re
re=(vd1-vd2)/(IS2-IS1)
printf(' Series resistance = %.3f ohm',re)
```

Scilab code Exa 2.9 average power loss

```
//Ex 2.9 page 72

clc;
clear;
close;

Vf1=1;// V
If1=0;//A
```

```
Vf2=1.9;// V
If2=60;//A
IT=20*%pi;// A
// PAV = 1/T*integrate(VT*IT,0,T)*dt = ITAV+0.015*
    IRMS**2
ITAV=IT/%pi;//A
ITRMS=IT/2;// A
dt=ITAV+0.015*ITRMS**2;// W
printf('Average power loss = %.1f W',dt)
```

Scilab code Exa 2.10 minimum gate pulse width

```
//Ex 2.10 page 73

clc;
clear;
close;

R=10;// ohm
L=0.1;// H
delta_i=20/1000;// A
Vs=230;// V4
f=50;// Hz
theta=45;//degree

delta_t = L*delta_i/Vs; // s
delta_t = delta_t*10**6;// micro s
printf('Minimum gate pulse width = %.1f micro s',
    delta_t)
```

Scilab code Exa 2.11 gate source resistance

```
//Ex 2.11 page 73
```

```

clc;
clear;
close;

m=3*10**3;// gradient (VG/IG)
VS=10;// V
PG=0.012;// W
// IG = VG/m & PG=VG*IG
VG=sqrt(PG*m)
IG=VG/m ; // A
RS=(VS-VG)/IG/1000;// kohm
printf('gate source resistance = %.1f kohm',RS)
```

Scilab code Exa 2.12 value of resistance

```
//Ex 2.12 page 74

clc;
clear;
close;

VS=300;// V
delta_i = 50/1000;// A
R=60;// ohm
L=2;// H
TP=40*10**-6;// s

I1=VS/L*TP;// A (at the end of pulse)
// as I1 << delta_i
I2=delta_i;// A (anode current with RL load)

Rdash = VS/(I2-I1)/1000;// kohm
printf('Value of resistance = %.2f kohm',Rdash)
```

Scilab code Exa 2.13 average on state current

```
//Ex 2.13 page 74

clc;
clear;
close;

Im=50;// A

printf('For half sine wave current : \n')
// theta=180;// degree
theta=180;// degree
Iav=Im/%pi;// A
Irms=Im/2;// A
FF=Irms/Iav;// form factor
ITav=Im/FF ; // A
printf('(i) Average ON State current  = %.2f A\n',
    ITav)

// theta=90;// degree
theta=90;// degree
Iav=Im/2/%pi;// A
Irms=Im/2/sqrt(2);// A
FF=Irms/Iav;// form factor
ITav=Im/FF ; // A
printf('(ii) Average ON State current  = %.2f A\n',
    ITav)

// theta=180;// degree
theta=180;// degree
Iav=Im*0.0213;// A
Irms=Im*0.0849;// A
FF=Irms/Iav;// form factor
```

```
ITav=Im/FF ; // A
printf('(iii) Average ON State current  = %.2f A\n',ITav)

printf('\n For rectangular wave current : \n')
// theta=180;// degree
theta=180;// degree
Iav=Im/2;// A
Irms=Im/sqrt(2);// A
FF=Irms/Iav;// form factor
ITav=Im/FF ; // A
printf('(i) Average ON State current  = %.2f A\n',ITav)

// theta=90;// degree
theta=90;// degree
Iav=Im/4;// A
Irms=Im/2;// A
FF=Irms/Iav;// form factor
ITav=Im/FF ; // A
printf('(ii) Average ON State current  = %.2f A\n',ITav)

// theta=180;// degree
theta=180;// degree
Iav=Im/12;// A
Irms=Im/2/sqrt(3);// A
FF=Irms/Iav;// form factor
ITav=Im/FF ; // A
printf('(i) Average ON State current  = %.2f A\n',ITav)
```

Scilab code Exa 2.14 design a snubber circuit

```
//Ex 2.14 page 76
```

```
clc;
clear;
close;

VS=500;// V
IP=250;// A
diBYdt=60;// A/micro-s
dvaBYdt=200;// V/micro-s
RL=20;// ohm
r=0.65;// ohm
eps=0.65 ;// damping ratio

F=2;// saftety factor
IP=IP/2;// A
diBYdt=60/2;// A/micro-s
dvaBYdt=200/2;// V/micro-s
L=VS/diBYdt;// uH
R=L*10**6/VS*dvaBYdt/10**6;// ohm
printf('Value of L = %.2f micro H',L)
printf('\n Value of R = %.1f ohm',R)

Ip=VS/RL+VS/R;// A
if Ip > IP then
    printf('\n Value of Ip = %.1f A is greater than permissible peak current = %.1f A\n change the value of Rs',Ip,IP)
    Rs=6;//ohm
end
Ip=VS/RL+VS/Rs;// A
Cs=(2*eps/Rs)**2*L;// micro F
printf('\n Value of C = %.2f micro F',Cs)

//load combination current Cs*dv/dt = Vs/(Rs+RL)

Cs=0.4;// uF (reduced value of Cs)
Rs=6;//ohm
dvBYdt = VS/(Rs+RL)/Cs; // V/(micro-s)
```

```
printf('\n Value of dv/dt = %.1f V/(micro-s)',dvBYdt
    )
disp('This is less than the specified max. value.
    Hence the choice is correct.')

//Answer in the textbook is wrong. In last part RL+
    Rs = 18 is taken in place of 26
```

Scilab code Exa 2.15 one cycle surge current rating

```
//Ex 2.15 page 77

clc;
clear;
close;

Isb=3000;// A
f=50;// Hz
I=sqrt((Isb**2*1/2/f)*f) ;// A
I2t=I**2/2/f;// sq.A/s
printf('I sq. by t rating = %d A**2/s',ceil(I2t))
```

Chapter 3

AC to DC Converters

Scilab code Exa 3.1 average current and power

```
//Ex 3.1 page 117

clc;
clear;
close;

R=100;// ohm
Vs=230;// V
f=50;// Hz
alpha=45;// degree

Vo=Vs*sqrt(2)/2/%pi*(1+cosd(alpha));// V
Io=Vo/R;// A
printf('Average current = %.4f A',Io)
Vor=Vs/sqrt(2)*sqrt(1/180*((180-alpha)+sind(2*alpha)
    /2));// V
Ior=Vor/R;// A
P=Ior**2*R;// W
printf('\n Power delivered = %.2f W',P)

//Ans in the textbook is not accurate.
```

Scilab code Exa 3.2 average current

```
//Ex 3.2 page 118

clc;
clear;
close;

R=10;// ohm
E=165;// V
//vt=330*sin(314*t)
Vm=330;// V
f=314/2/%pi;// Hz
alpha1=asin(E/Vm);// radian
alpha2=%pi-alpha1;// radian
Io=1/2/%pi/R*(2*Vm*cos(alpha1)-E*(alpha2-alpha1));//
    A
P=E*Io;// W

printf('Power supplied to battery = %d W',P)
```

Scilab code Exa 3.3 PIV of thyristor

```
//Ex 3.3 page 119

clc;
clear;
close;

//v2t = 325*sin(w*t)
R=20;// ohm
```

```
alfa=45;// degree
vm=325;// V
V=230;// V
printf('part (a)\n')
Vo=vm/2/%pi*(1+cosd(alfa)) ;// V
Io=Vo/R;// A
printf(' dc voltage Vo = %.1f V',Vo)
printf('\n & Current Io = %.3f A',Io)
printf('\n\n part (b)\n')
Vor=vm/2/sqrt(%pi)*sqrt((%pi-%pi/180*alfa)+1/2*sind(2*alfa));// V
Ior=Vor/R;// A
printf(' rms voltage Vor = %.3f V',Vor)
printf('\n & Current Ior = %.3f A',Ior)
printf('\n\n part (c)')
Pdc=Vo*Io;// W
Pac=Vor*Ior;// W
eta=Pdc/Pac;// rectification efficiency
printf("\n dc Power = %.2f W", Pdc)
printf("\n ac Power = %.2f W", Pac)
printf("\n Rectification efficiency = %.4f", eta)
printf('\n\n part (d)')
FF=Vor/Vo;// form factor
RF=sqrt(FF**2-1)
printf('\n Form factor = %.3f ',FF)
printf('\n Ripple factor = %.3f ',RF)
printf('\n\n part (e)')
VA=V*Ior;// VA
TUF=Pdc/V/Ior;// Transformer Utilization factor
printf("\n VA rating = %.1f VA", VA)
printf("\n Transformer Utilization factor = %.4f", TUF)
printf('\n\n part (f)')
Vp=vm;// V
printf("\n Peak inverse voltage = %d V",Vp)
```

Scilab code Exa 3.4 Power factor of supply

```
//Ex 3.4 page 120

clc;
clear;
close;

R=10;// ohm
E=165;// V
//vt=330*sin(314*t)
Vm=330;// V
Vs=233;// V
f=314/2/%pi;// Hz
theta1=asin(E/Vm);// radian
//alpha2=%pi-alpha1;// radian
Io=1/2/%pi/R*(2*Vm*cos(theta1)-E*(%pi-2*theta1));// A
printf('(a) Average value of current = %.2f A',Io)
P=E*Io;// W
printf('\n (b) Power supplied to battery = %d W',P)
Ior=sqrt(1/2/%pi/R**2*((%pi-2*theta1)*(Vs**2+E**2)+Vm**2*sin(2*theta1)-4*Vm*E*cos(theta1)));// A
Pr=Ior**2*R;// W
printf('\n (c) Power dissipated in the resistor = %.2f W',Pr)
pf=(Pr+P)/Vs/Ior;// power factor
printf('\n (d) Power factor = %.4f',pf)
```

Scilab code Exa 3.5 average and rms current

```
//Ex 3.5 page 122
```

```
clc;
clear;
close;

R=20;// ohm
V=230;// V
f=50;// Hz
alpha=30;// degree
Vm=V*sqrt(2);//V
Vo=Vm/%pi*(1+cos(alpha*%pi/180));// V
printf('Average load voltage = %.1f V',Vo)
Io=Vo/R;// A
printf('\n Average load current = %.2f A', Io)
Vor=V/sqrt(%pi)*sqrt((%pi-alpha*%pi/180)+sin(2*alpha
    *%pi/180)/2);// V
Ior=Vor/R;// A
printf('\n rms load current = %.2f A', Ior)
Iav=Io/2;//A
printf('\n Average thyristor current = %.2f A', Iav)
Irms=Ior/sqrt(2);// A
printf('\n rms thyristor current = %.3f A', Irms)
```

Scilab code Exa 3.6 average load current

```
//Ex 3.6 page 122

clc;
clear;
close;

R=10;// ohm
L=100/1000;// H
E=100;// V
Vs=230;// V
```

```
f=50;// Hz
alpha = 45;// degree
Vm=Vs*sqrt(2);// V
Vo=2*Vm/%pi*cos(alpha*%pi/180);// V
Io=(Vo-E)/R;// A
printf('Average load current = %.3f A',Io)
```

Scilab code Exa 3.7 average load voltage

```
//Ex 3.7 page 123

clc;
clear;
close;

R=2;// ohm
L=0.3;// H
E=100;// V
Vs=230;// V
f=50;// Hz
alpha = 30;// degree
Vm=Vs*sqrt(2);// V
Vo=2*Vm/%pi*cos(alpha*%pi/180);// V
printf(' Average load voltage = %.2f V', Vo)
Io=(Vo)/R;// A
printf('\n Average load current = %.2f A', Io)
Is=Io;// A
Is1=4*Io/%pi/sqrt(2);// A
PF=Vo*Io/Vs/Is;// power factor
printf('\n Power factor = %.4f',PF)
```

Scilab code Exa 3.8 average load voltage and current

```
//Ex 3.8 page 123

clc;
clear;
close;

R=5;// ohm
L=1;// H
E=10;// V
Vs=230;// V
f=50;// Hz
alpha = 45;// degree
Vm=Vs*sqrt(2);// V
Vo=Vm/%pi*(1+cos(alpha*%pi/180));// V
printf(' Average load voltage = %.2f V', Vo)
Io=(Vo-E)/R;// A
printf('\n Average load current = %.2f A', Io)
PF=(Io**2*R+E*Io)/Vs/Io;// power factor
printf('\n Power factor = %.4f',PF)
```

Scilab code Exa 3.9 `rms value of current`

```
//Ex 3.9 page 124

clc;
clear;
close;

R=50;// ohm
Vs=230;// V
f=50;// Hz
alpha = 30;// degree
Vm=Vs*sqrt(2);// V
Vo=2*Vm/%pi*cos(alpha*%pi/180);// V
printf(' (i) Average voltage across 50 ohm resistor
```

```
    = %.2f V', Vo)
Io=(Vo)/R;// A
Ior=Io/sqrt(2);// A
printf('\n (ii) rms current = %.4f A', Ior)
```

Scilab code Exa 3.10 emf on load side

```
//Ex 3.10 page 124

clc;
clear;
close;

R=2;// ohm
Vs=230;// V
f=50;// Hz
alpha = 120;// degree
Ia=10;// A

Vo=2*sqrt(2)*Vs*cos(alpha*%pi/180)/%pi
V=Ia*R-Vo;// V
printf('emf on load side = %.2f V', V)
```

Scilab code Exa 3.11 average load voltage and current

```
//Ex 3.11 page 125

clc;
clear;
close;

Vs=230;// V
Io=5;// A
```

```
alpha = 45;// degree
printf('part(i)')
Vo=2*sqrt(2)*Vs/%pi*cos(alpha*%pi/180);// V
printf('\n dc output voltage = %.1f V',Vo)
Pi=Vo*Io;// W
printf('\n Active power = %.1f W',Pi)
Qi=2*sqrt(2)*Vs/%pi*sin(alpha*%pi/180)*Io;// VAR
printf('\n Reactive power = %.1f VAR',Qi)
printf('\n\n part(ii)')
R=Vo/Io;// ohm
Vo=sqrt(2)*Vs/%pi*(1+cos(alpha*%pi/180));// V
printf('\n dc output voltage = %.1f V',Vo)
Io=Vo/R;// A
Pi=Vo*Io;// W
printf('\n Active power = %.1f W',Pi)
Qi=sqrt(2)*Vs/%pi*sin(alpha*%pi/180)*Io;// VAR
printf('\n Reactive power = %.0f VAR',Qi)
printf('\n\n part(iii)')
Vo=sqrt(2)*Vs/%pi/2*(1+cos(alpha*%pi/180));//
printf('\n Average load voltage = %.0f V',Vo)
Io=Vo/R;// A
printf('\n Average load current = %.2f A',Io)
```

Scilab code Exa 3.12 average load voltage and current

```
//Ex 3.12 page 126

clc;
clear;
close;

R=20;// ohm
Vs=400;// V
f=50;// Hz
alpha = 30;// degree
```

```

Vm=Vs*sqrt(2);// V
Vo=3*Vm/%pi*cos(alpha*%pi/180);// V
Io=Vo/R;// A
printf('\n Average load voltage = %.3f V',Vo)
printf('\n Average load current = %.3f A',Io)
```

Scilab code Exa 3.13 output voltage and power

```
//Ex 3.13 page 126

clc;
clear;
close;

n=3;// no. of phase
Vs=400;// V
f=50;// Hz
Io=100;// A
alpha = 60;// degree

Vm=Vs*sqrt(2);// V
Vo=n*Vm/%pi*cos(alpha*%pi/180);// V
Po=Vo*Io;// W
printf(' (i)')
printf('\n Output voltage = %.0f V',Vo)
printf('\n Output power = %.0f W',Po)
printf('\n\n (ii)')
Iav=Io*2*%pi/3/2/%pi;// A
printf('\n average current through thyristor = %.2f
   A', Iav)
Ior=sqrt(Io**2*2*%pi/3/2/%pi);// A
printf('\n rms current through thyristor = %.2f A',
   Ior)
Ip=Io;//A
```

```
printf('\n peak current through thyristor = %.2f A',
    Ip)
printf('\n\n (iii)')
PIV=sqrt(2)*Vs;//V
printf('\n PIV of thyristor = %.1f V',PIV)
// Ans in the book is not accurate.
```

Scilab code Exa 3.14 average load voltage and current

```
//Ex 3.14 page 127

clc;
clear;
close;

n=3;// no. of phase
R=60;// ohm
Vs=400;// V
alpha = 30;// degree

Vm=Vs*sqrt(2);// V
Vo=3*Vm/%pi*cos(alpha*%pi/180);// V
Io=Vo/R;// A
Is=Io*sqrt(2/3);// A
P=Io**2*R;// W
pf=P/sqrt(3)/Vs/Is;// power factor

printf('\n Average load voltage = %.3f V',Vo)
printf('\n Average load current = %.1f A',Io)
printf('\n input power factor(lag) = %.4f',pf)
// Note : Ans in the textbook is wrong as in
    calculation for pf Io is used in place of Is
```

Scilab code Exa 3.15 `average load voltage and current`

```
//Ex 3.15 page 127

clc;
clear;
close;

n=3;// no. of phase
R=50;// ohm
Vs=400;// V
f=50;// Hz
alpha = 45;// degree

Vm=Vs*sqrt(2);// V
Vo=3*Vm/2/%pi*(1+cos(alpha*%pi/180));// V
Io=Vo/R;// A
printf('\n Average load voltage = %.2f V',Vo)
printf('\n Average load current = %.2f A',Io)
```

Scilab code Exa 3.16 `firing angle and overlap angle`

```
//Ex 3.16 page 128

clc;
clear;
close;

n=3;// no. of phase
Vs=400;// V
f=50;// Hz
Ls=5/1000;// H
Io=20;// A
Ri=1;// ohm
Vdc=400;// V
```

```
Vo=Vdc+Io*Ri;// V
// Vo=3*Vm/%pi*cos(alpha*%pi/180)-3*2*%pi*f*Ls/%pi*Io
Vm=sqrt(2)*Vs;// V
alpha=acos((Vo+3*2*%pi*f*Ls/%pi*Io)/(3*Vm/%pi))*180/%pi;// degree

// Vo=3*Vm/%pi*cos((alpha+mu)*%pi/180)-3*2*%pi*f*Ls/%pi*Io
mu=acos((Vo-3*2*%pi*f*Ls/%pi*Io)/(3*Vm/%pi))*180/%pi-alpha;// degree
printf('\n Firing angle = %.2f degree',alpha)
printf('\n Overlap angle = %.2f degree',mu)
// ans in the textbook is not accurate.
```

Scilab code Exa 3.17 `load resistance and source inductance`

```
//Ex 3.17 page 128

clc;
clear;
close;


n=3;// no. of phase
Vs=400;// V
f=50;// Hz
alpha = %pi/4;// radian
Io=10;// A
Vo=360;// V

// Vo=n*Vs*sqrt(2)/%pi/sqrt(2)-3*2*%pi*f*Ls*Io/%pi
Ls=(n*Vs*sqrt(2)/%pi/sqrt(2)-Vo)/(3*2*%pi*f)/(Io/%pi)*1000;// mH
```

```
R=Vo/Io;// ohm
printf(' Load resistance = %.f ohm',R)
printf('\n Source inductance = %.1f mH',Ls)
// Vo = n*Vs*sqrt(2)/%pi*cos(alpha+mu)+3*2*%pi*f*Ls*
    Io/%pi
mu=acos((Vo-3*2*%pi*f*Ls/1000*Io/%pi)/(n*Vs*sqrt(2)/
    %pi))-alpha;// radian
mu=mu*180/%pi;// degree
printf('\n Overlap angle = %.d degree',mu)
```

Chapter 4

AC to AC Converters

Scilab code Exa 4.1 load voltage and rms current

```
//Ex 4.1 page 158

clc;
clear;
close;


R=5;// ohm
Vs=230;// V
f=50;// Hz
alpha = 120;// degree

Vor=Vs*sqrt(1/%pi*(%pi-alpha*%pi/180+sin(2*alpha*%pi
   /180)/2));// V
printf('\n rms load voltage = %.2f V', Vor)
Ior=Vor/R;// A
printf('\n rms load current = %.2f A', Ior)
Irms=Ior/sqrt(2);//A
printf('\n rms thyristor current = %.2f A', Irms)
pf=sqrt(1/%pi*((%pi-alpha*%pi/180)+sin(2*alpha*%pi
   /180)/2));// power factor
```

```
printf('\n input power factor = %.3f ',pf)
```

Scilab code Exa 4.2 average and rms value of scr current

```
//Ex 4.2 page 158

clc;
clear;
close;


R=10;// ohm
Vs=230;// V
f=50;// Hz
nc=18;// conducting cycles
noff=32;// off cycles

k=nc/(nc+noff);// duty ratio
Vor=Vs*sqrt(k);// V
Po=Vor**2/R;// W
Pi=Po;// W (losses are negligble)
Ior=Vor/R;//A
pf=Po/Vs/Ior;//W
Im=Vs*sqrt(2)/R;//A
Irms=Im*sqrt(k)/2;//A
Iav=k*Im/%pi;//A
printf('\n (a) rms output voltage = %.0f V', Vor)
printf('\n (b) Power output to load = %.1f W', Po)
printf('\n (c) Power input to regulator = %.1f W',
   Pi)
printf('\n (d) input power factor = %.1f ',pf)
printf('\n (e) average scr current = %.3f A', Iav)
printf('\n     rms scr current = %.3f A', Irms)
```

Scilab code Exa 4.3 `load voltage and rms current`

```
//Ex 4.3 page 159

clc;
clear;
close;


R=10;// ohm
Vs=230;// V
f=50;// Hz
alpha = 90;// degree

Vor=Vs*sqrt(1/%pi*(%pi-alpha*%pi/180+sin(2*alpha*%pi
    /180)/2));// V
Ior=Vor/R;// A
P=Ior**2*R;// W
pf=Vor/Vs;// power factor
printf('\n rms load voltage = %.2f V', Vor)
printf('\n rms load current = %.2f A', Ior)
printf('\n power input = %.2f W', P)
printf('\n load power factor = %.1f ',pf)
```

Scilab code Exa 4.4 `rms load voltage and rms current`

```
//Ex 4.4 page 160

clc;
clear;
close;

```

```
R=30;// ohm
Vs=230;// V
f=50;// Hz
alpha = 45;// degree

Vor=Vs*sqrt(1/%pi*(%pi-alpha*%pi/180+sin(2*alpha*%pi
    /180)/2));// V
Ior=Vor/R;// A
printf('\n rms load voltage = %.2f V', Vor)
printf('\n rms load current = %.2f A', Ior)
```

Scilab code Exa 4.5 max voltage and current

```
//Ex 4.5 page 160

clc;
clear;
close;


R=10;// ohm
Vs=230;// V
f=50;// Hz
fi = 45;// degree

Vmax=Vs;// V(max supply voltage)
XL=R*tan(fi*%pi/180);// ohm
Z=XL*sqrt(2);// ohm
Imax=Vs/Z;//A

printf('\n max load voltage = %.2f V', Vmax)
printf('\n max load current = %.3f A', Imax)
printf('\n range of delay angle = %d to %d',0,fi)
```

Scilab code Exa 4.7 control range of firing angle

```
//Ex 4.7 page 161

clc;
clear;
close;


R=3;// ohm
wL=4;//ohm
Vs=230;// V
f=50;// Hz

fi=atan(wL/R)*180/%pi;//degree
printf('\n (i) control range of firing angle = %.2f
    to pi',fi)
Imax=Vs/sqrt(R**2+wL**2);// A
printf('\n (ii) max rms load current = %.f A', Imax)
Pmax=Imax**2*R;//W
printf('\n (iii) max power input to load = %.f W',
    Pmax)
pf_max=Pmax/Vs/Imax;// power factor
printf('\n (iv) max power factor = %.1f ', pf_max)
Ithrms=Imax/sqrt(2);// A
Ithav=Ithrms/1.57;// A
printf('\n (v) max rms thyristor current = %.3f A',
    Ithrms)
printf('\n     max average thyristor current = %.3f
    A', Ithav)
```

Chapter 5

DC to DC Converters

Scilab code Exa 5.1 `average load current`

```
//Ex 5.1 page 184

clc;
clear;
close;

R=10;// ohm
Vs=230;// V
f=1*1000;// Hz
Ton=0.4;// ms
k=0.4 ;// duty cycle

Vo=Vs*k;//V
Ioav=Vo/R;// A
Vor=Vs*sqrt(k);// V
Po=Vor**2/R;// W
printf('\n Average load current = %.1f A', Ioav)
printf('\n Power delivered = %.2f W',Po)
```

Scilab code Exa 5.2 duty ratio and chopping frequency

```
//Ex 5.2 page 185

clc;
clear;
close;

R=5;// ohm
Vs=300;// V
f=1*1000;// Hz
Ton=20;// ms
Toff=10;// ms

k= Ton/(Ton+Toff);// duty ratio
f=1000/(Ton+Toff);//Hz
Voav=Vs*k;// V
Ioav=Voav/R;// A
printf('\n duty ratio = %.3f',k)
printf('\n chopping frequency = %.2f Hz',f)
printf('\n Average load voltage = %.2f V', Voav)
printf('\n Average load current = %.2f A', Ioav)
```

Scilab code Exa 5.3 chopping frequency

```
//Ex 5.3 page 185

clc;
clear;
close;

Vs=400;//V
alfa=0.25;// duty cycle
delta_I=10;// A
L=0.5;// H
```

```
R=0;// ohm

Vo=alfa*Vs;//V
//Vo+L*di/dt=Vs -- putting dt=Ton & di=delta_I
Ton=delta_I/((Vs-Vo)/L)*1000;// ms
T=Ton/alfa;// ms
f=1/T*1000;//Hz
printf('\n chopping frequency = %d Hz',f)
```

Scilab code Exa 5.5 new output voltage

```
//Ex 5.5 page 186

clc;
clear;
close;

Vs=220;//V
Vo=660;// V
Toff=100;// micro s

//Vo=Vs/(1-alfa)
alfa=1-Vs/Vo;// duty cycle
//alfa=Ton/(Ton+Toff)
Ton=alfa*Toff/(1-alfa);// micro s
T=Ton+Toff;//micro s
printf('Pulse width of output voltage, Ton = %d
    micro s & T = %d micro s',Ton,T)
//(ii) reduce pulse width by 50%
Ton=Ton/2;// micro s
Toff=T-Ton;// micro s
alfa=Ton/(Ton+Toff);// duty cycle
Vo=Vs/(1-alfa);// V
printf('\n New output voltage = %d V',Vo)
```

Chapter 7

Power Controllers their Applications

Scilab code Exa 7.1 speed of motor

```
//Ex 7.1 page 260

clc;
clear;
close;

N1=1000;// rpm
Va1=200;// V
alfa=60;// degree
Va2=230;// V

N2=2*Va2*sqrt(2)*cos(alfa*%pi/180)*N1/Va1/%pi
printf('\n Speed of motor = %d rpm',N2)
// ans in the textbook is not accurate.
```

Scilab code Exa 7.2 duty ratio

```
//Ex 7.2 page 260

clc;
clear;
close;

N1=1100;// rpm
Va1=220;// V
N2=900;// rpm

Va2=Va1*N2/N1;// V
delta=Va2/Va1;// duty ratio
printf('\n duty ratio = %.2f',delta)
```

Scilab code Exa 7.3 `triggering angle`

```
//Ex 7.3 page 261

clc;
clear;
close;

N1=900;// rpm
Va1=198;// V
N2=500;// rpm
Vs=230;// V

Va2=Va1*N2/N1;// V
// 2*sqrt(2)*Vs*cos(alfa)/%pi=Va2
alfa=acos(Va2/(2*sqrt(2)*Vs)*%pi)*180/%pi;// degree

printf('\n triggering angle = %.1f degree',alfa)
```

Scilab code Exa 7.4 average armature current

```
//Ex 7.4 page 261

clc;
clear;
close;

Vs=230;// V
Ton=10;// ms
Toff=25;// ms
Ra=2;//ohm
N=1400;// rpm
k=0.5;// V/rad/s (back emf constant)
kt=0.5;// NM-A**-1 (torque constant)

Eb=N*2*%pi*k/60;// V
Va=Vs*Ton/(Toff);// V
Ia=(Va-Eb)/Ra;// A
T=kt*Ia;// Nm
printf('\n average armature current = %.2f A', Ia)
printf('\n torque = %.3f Nm', T)
```