Scilab Textbook Companion for Elements of Electric Drives by J. B. Gupta, R. Manglik & R. Manglik[1]

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May 26, 2016

[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: Elements of Electric Drives

Author: J. B. Gupta, R. Manglik & R. Manglik

Publisher: S. K. Kataria & Sons, New Delhi

Edition: 1

Year: 2011

ISBN: 978-93-5014-200-4

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

Electric Drives

Scilab code Exa 1.1 Compare the annual cost of a group drive and an individual drive

```
//Exa:1.1
clc;
clear;
close;
C_g=60000;//in Rs
D=0.12*C_g;//in Rs
E_c=75000;//in kWh
C_e=4*E_c;//in Rs
C_t=D+C_e;//in Rs
C_id=18750*10;//in Rs
AD=0.15*C_id;//in Rs
E_a=60000;//in kWh
C_ea=4*E_a;//in Rs
C_total=AD+C_ea;//in Rs
disp(C_t,'Total annual cost in case of group drive (
   in Rs)=');
disp(C_total,'Total annual cost in case of
   individual drive (in Rs)=');
```

Scilab code Exa 1.2 Find the value of stable operating point

```
//Exam:1.2
clc;
clear;
close;
a=1;
b=1;
c=-30;
w_m=(-b+sqrt((b^2)-4*a*c))/(2*a);//speed of the drive
t_l=0.5*(w_m^2);//motoring torqe
disp(t_l,w_m,'stable operating point=');
```

Scilab code Exa 1.3 Find the value of moment of inertia and power developed

```
//Exam:1.2
clc;
clear;
close;
J_m=0.4;//motor inertia(in Kg-m2)
J_l=10;//load inertia(in Kg-m2)
a=0.1;//Teeth ratio of gear
i=1/a;
N=1400;
pi=22/7;
n=0.90;//efficency of motor
T_l=50;//Torque(N-m)
J=J_m+J_l/(i^2);//Total moment of inertia referred to the motor shaft
```

```
T_L=T_l/(i*n);//total equivalent torque referref to
    motor shaft
P=T_L*2*pi*N/60;//power developed by motor
disp(ceil(P),'power developed by motor(in Watt)=');
```

Scilab code Exa 1.4 Find the value of moment of inertia and power developed

```
//Exam:1.4
clc;
clear;
close;
J_m=0.4;//motor inertia(in Kg-m2)
J_l=10;//load inertia(in Kg-m2)
a=0.1;//Teeth ratio of gear
N=1500;
pi=22/7;
n_t=0.88;
m=600;//weight
g=9.81;
f_r=m*g;//force
w_m=fix(2*pi*N/60);//motor speed
w=2;//uniform speed of weight lifting
n=0.9;//efficency of motor
T_l=50;//Torque(N-m)
J=J_m+(a^2)*J_l+m*((w/w_m)^2);//Total moment of
    inertia referred to the motor shaft
T_L=(a*T_l/n)+f_r*w/(n_t*w_m) ;//total equivalent
    torque referred to motor shaft
p=T_L*w_m;//power developed by motor(in Watt)
P=p/1000;//power developed by motor(in kWatt)
disp(J,'Total torque referred to motor shaft(in kg-
    m2)=')
disp(T_L,'Total equivalent Torque referred to motor
    shaft(in N-m)=')
```

```
disp(P,'power developed by motor(in kWatt)=')
```

Scilab code Exa 1.5 Find the value of motor speed

```
//Exa:1.5
clc;
clear;
close;
V=220;//in volts
V_1=200;//in volts
N=1000;//in rpm
I=100;//in amperes
R_a=0.1;//in ohms
E_b=V-I*R_a;//in volts
I_1=I;//in amperes
E_b1=V_1-I_1*R_a;//in volts
N_1=N*E_b1/E_b;
disp(ceil(N_1),'Motor Speed (in rpm)=')
```

Scilab code Exa 1.6 Find the value of full load speed and full load torque

```
//Exa:1.6
clc;
clear;
close;
V=230;//in volts
R_sh=230;//in ohms
R_a=0.5;//in ohms
I_sh=V/R_sh;//in amperes
I_lo=3;//in amperes
I_ao=I_lo-I_sh;//in amperes
E_bo=V-I_ao*R_a;//in volts
N_o=1000;//in rpm
```

```
I_lf=23;//in amperes
I_af=I_lf-I_sh;//in amperes
E_bf=V-I_af*R_a;//in volts
Phy_ratio=0.98;
N_f=N_o*(E_bf/E_bo)/Phy_ratio;
disp(ceil(N_f),'Full Load Speed (in rpm)=');
T_f=9.55*E_bf*I_af/N_f;
disp(T_f,'Full load Torque (in Newton-meter)=');
```

Scilab code Exa 1.7 Find the value of armature voltage drop at full load

```
//Exa:1.7
clc;
clear;
close;
V=440;//in volts
N_o=2000;//in rpm
E_bo=440;//in volts
N_f=1000;//in rpm
N_h=1050;//in rpm
E_bf=E_bo*N_f/N_o//in volts
E_b=E_bo*N_h/N_o;//in volts
v=(E_b-E_bf)*2;
disp(v,'Armature voltage drop at full load (in volts
    )=')
```

Scilab code Exa 1.8 Find the value of speed

```
//Exa:1.8
clc;
clear;
close;
V=230;//in volts
```

```
N1=750;//in rpm
R=10;//in ohms
I_a=30;//in amperes
N2=N1*((V+I_a*R)/V)^-1;
disp(int(N2),'Speed (in rpm)=')
```

Scilab code Exa 1.9 Find the value of speed

```
//Exa:1.9
clc;
clear;
close;
V=200;//in volts
I_1=20//in amperes
R_a=0.5;//in ohms
E_b1=V-I_1*R_a;//in volts
N1=700;//in rpm
I_2=sqrt(1.44)*I_1;//in amperes
E_b2=V-I_2*R_a;//in volts
N2=N1*(E_b2/E_b1)*(I_1/I_2);
disp(int(N2),'(a) Speed (in rpm)=');
I_3=10;//in amperes
E_b3=V-I_3*R_a;//in volts
N3=N1*(E_b3/E_b1)*(I_1/I_3);
disp(ceil(N3),'(b) Speed (in rpm)=');
```

Scilab code Exa 1.10 Find the Value of speed and torque

```
//Exa:1.10
clc;
clear;
close;
V=230;//in volts
```

```
I_1=90;//in amperes
R_a=0.08;//in ohms
R_se=0.05;//in ohms
R_m=R_a+R_se;//in ohms
R=1.5;//in ohms
E_b1=V-I_1*(R_m+R);//in volts
E_2=180;//in volts
N2=700;//in rpm
N1=N2*(E_b1/E_2);
disp(ceil(N1),'Speed (in rpm)=');
T=9.55*E_b1*I_1/N1;
disp(T,'Torque (in Newton-meter)=')
```

Scilab code Exa 1.12 Find the Value of torque developed and terminal voltage

```
//Exa:1.12
clc;
clear;
close;
P=4;//no. of poles
f=50;//in hertz
N_s=120*f/P;//in rpm
V=400/sqrt(3);//in volts
R2=4;//in ohms
R1=1.5;//in ohms
X1=4;//in ohms
X2=4;//in ohms
N=1350;//in rpm
s=(N_s-N)/N_s;//slip
T=(3*V^2*4/s)/((((R1+(R2/s))^2)+((X1+X2)^2))*(2*%pi*
    N_s/60));//in newton-meter
N1=900;//in rpm
s1=(N_s-N1)/N_s;//slip
T1=T*(N1/N)^2;
```

```
disp(T1,' Torque developed (in Newton−meter)=');
V1=V*sqrt((N1/N)^2*(s1/s)*((((R1+(R2/s1))^2)+((X1+X2)^2)))/(((R1+(R2/s))^2)+((X1+X2)^2)));
disp(V1,'Terminal Voltage (in volts)=');
//Answer given in the textbook is worng as the torque equation is not multiplied by R2
disp('Answer given in the textbook is worng as the torque equation is not multiplied by R2')
```

Scilab code Exa 1.13 Find the Value of rms voltage

```
//Exa:1.13
clc;
clear;
close;
P=4;//no. of poles
f=50;//in hertz
N_s=120*f/P;//in rpm
s_f=0.05;//slip
N=N_s*(1-s_f);//in rpm
V=415;//in volts
s_m=0.1;//slip corresponding to maximum slip
N1=1350;//in rpm
s_fn=(N_s-N1)/N_s;//full load slip
V1=V*sqrt((N1/N)*(s_f/s_m)*(8/5));
disp(V1,' RMS Voltage (in volts)=')
```

Scilab code Exa 1.14 Find the Value of Slip Frequency

```
//Exa:1.14
clc;
clear;
close;
```

```
f1=2;//in hertz
f=50;//in hertz
s_m=0.1;
V=400;//in volts
s1=0.04;//slip
s2=(0.2095-sqrt((0.2095)^2-s1))/2;
f_n=s2*40;
disp(f_n,'Slip Frequency (in Hertz)=')
```

Scilab code Exa 1.15 Find the Value of maximum torque at one half load and 25Hz frequency

```
//Exa:1.15
clc;
clear;
close;
R1=0.02;//in ohms
X1=0.1;//in ohms
X2=X1;//in ohms
//T_ratio is defined as the ratio of maximum torque
   at one-half load and 25Hz frequency to maximum
   torque at rated voltage and frequency
T_ratio=(R1+sqrt(R1^2+(X1+X2)^2))/(2*(R1+sqrt(R1
   ^2+((X1+X2)^2)/4)));
disp(T_ratio,'   maximum torque at one-half load and
    25Hz frequency =');
disp('   times the maximum torque at rated voltage
   and frequency (T_max)');
```

Scilab code Exa 1.16 Find the value of starting torque and slip and ratio of maximum torque to full load torque

```
//Exa:1.16
```

```
clc;
clear;
close;
s_f=0.04;//full load slip
I_ratio=6;//Ratio of Starting current to full load
    current
T_ratio=I_ratio^2*s_f;//Ratio of Starting torque to
    full load torque
disp(T_ratio,'(a) Starting Torque =');
disp('   times the full load torque (T_f)');
s_max=sqrt((I_ratio^2-1)/(625-I_ratio^2));
disp(s_max,'(b) Slip at which Maximum torque occurs=
    ');
T_rm=(1/2)*((s_f/s_max)+(s_max/s_f));
disp(T_rm,'(c) Ratio of maximum torque to full load
    torque=');
```

Scilab code Exa 1.17 Find the value of starting torque

```
//Exa:1.17
clc;
clear;
close;
I_ratio=8;//Ratio of short circuit current to full
    load current
s_f=0.04;//full load slip
T_r1=I_ratio^2*s_f;
disp(T_r1,'(a) Sarting Torque when started by means
    of direct switching=');
disp('   times the full load torque');
T_r2=I_ratio^2*s_f/3;
disp(T_r2,'(b) Sarting Torque when started by star-
    delta starter=');
disp('   times the full load torque');
K=sqrt(3/8);// transformation ratio of transformer
```

```
T_st=K^2*I_ratio^2*s_f;
disp(T_st,'(C) Starting Torque =');
disp('   times the full load torque');
```

Scilab code Exa 1.18 Find the value of ratio of starting current to full load current

```
//Exa:1.18
clc;
clear;
close;
P=10*7355;//in watts
V=400;//in volts
pf=0.8//power factor
Eff=0.9;//efficiency in per unit
I_f=P/(sqrt(3)*V*pf*Eff);//in amperes
I_sc=7.2;//in amperes
I_sc1=I_sc*400/160;//in amperes
I_st=I_sc1/3;//Starting current (in amperes)
I_r=I_st/I_f;
disp(I_r,'Ratio of starting current to full load
   current=')
```

Scilab code Exa 1.19 Find the value of Tap Position of auto transformer and Ratio of Starting torque to full load torque

```
//Exa:1.19
clc;
clear;
close;
P_o=50*1000;//in VA
s_f=0.05;//slip
V=400;//in volts
```

```
I_f=P_o/(sqrt(3)*V);//in amperes
Z=0.866;//in ohms/phase
I_sc=V/(sqrt(3)*Z);//Short Circuit current (in
    amperes)
I_st=100;//Supply current at start (in amperes)
K=sqrt(I_st/I_sc);
disp(K*100,'Tap Position of auto transformer(in %)='
    );
I_ratio=I_sc/I_f;
T_r=K^2*I_ratio^2*s_f;
disp(T_r,'Ratio of Starting torque to full load
    torque =');
```

Scilab code Exa 1.20 Find the value of Starting Current of motor and Starting torque at 50 hertz and 10 hertz

```
//Exa:1.20
clc;
clear;
close;
V=440/sqrt(3);//in volts
R_s=2;//in ohms
R_r=2;//in ohms
f=50;//in hertz
X_s=3;//in ohms
P=4;//no. of poles
X_r=3;//in ohms
R_o1=R_s+R_r;//Equivalent resistance of motor as
    referred to stator (in ohms)
X_o1=X_s+X_r;////Equivalent reactance of motor as
    referred to stator (in ohms)
I_st=V/(sqrt(R_o1^2+X_o1^2));//Starting current (in
    amperes)
P_cu=3*I_st^2*R_r;//Copper loss (in watts)
P2=7446;//in watts
```

```
N_s=120*f/P;//Synchronous Speed (in rpm)
T_st=9.55*P2/N_s;//Starting Torque (in Newton-meter)
disp(I_st,'Starting Current of motor at 50 Hertz (in amperes)=');
disp(T_st,'Starting Torque of motor at 50 hertz (in Newton-meters)=');
V1=V*10/50;//in volts
X_o2=X_o1*10/50;//in ohms
I_st1=V1/(sqrt(R_o1^2+X_o2^2));//Starting current (in amperes)
P_2=3*I_st1^2*R_r;//Copper loss (in watts)
N_s1=120*10/P;//Synchronous Speed (in rpm)
T_st2=9.55*P_2/N_s1;//Starting Torque (in Newton-meter)
disp(I_st1,'Starting Current of motor at 10 Hertz (in amperes)=');
disp(T_st2,'Starting Torque of motor at 10 hertz (in Newton-meters)=');
```

Scilab code Exa 1.21 Find the value of moment of inertia of drive

```
//Exa:1.21
clc;
clear;
close;
T_m=100;//Motor Torque (in Newton-meter)
T_l=30;//Load Torque (in Newton-meter)
alpha=2*%pi*10;//in angular acceleration (in rad/sec^2)
J=(T_m-T_l)/alpha;
disp(J,'Moment of inertia of drive (in Kg-m^2)')
```

Scilab code Exa 1.22 Find the value of Time in attaining full load speed

```
//Exa:1.22
clc;
clear;
close;
P_o=37.5*1000;//in watts
N=500;//in rpm
T_l=P_o*60/(2*%pi*N);//Full load  torque (in Newton-meter)
T_st=(1.1+1.4)*T_l/2;// Average Starting Torque (in Newton-meters)
T_a=T_st-T_l;//total available torque for acceleration
J=20;//Moment of Inertia (in Kg-m^2)
t1=J*2*%pi*N/(60*T_a);
disp(t1,'Time in attaining full load speed (in seconds)=')
```

Scilab code Exa 1.23 Find the value of starting period

```
//Exa:1.23
clc;
clear;
close;
P_o=37.5*1000;//in watts
N=500;//in rpm
T_l=P_o*60/(2*%pi*N);//Full load  torque (in Newton-meter)
T_m=2*T_l;// Torque developed by motor during starting
T_a=T_m-T_l;//total available torque for acceleration
E=37.5*660*9.81;//Stored energy of machine
J=E*2/(2*%pi*N/60)^2;//Moment of inertia (in Kg-m^2)
alpha=T_a/J;//angular acceleration (in rad/sec^2)
t=(2*%pi*N/60)/alpha;
```

```
disp(t,'Starting Period (in seconds)=')
```

Scilab code Exa 1.24 Find the value of energy dissipated

```
//Exa:1.24
clc;
clear;
close;
V=220;//in volts
I=20;//in ampers
R=1;//in ohms
P_o=V*I-I^2*R;//Motor Output (in watts)
w=200;//in radians/second
T_l=P_o/w;//Load Torque (in N-m)
J=5;//kg-m^2
t_st=2.5;//in seconds
alpha=w/t_st;//angular acceleration (in rad/second
    ^2)
K=(J*alpha+T_l)/I^2;
W_st=(J*R*w/K)+(T_l*R*t_st/K);
disp(W_st,'Energy Dissipated (in watts)=')
```

Scilab code Exa 1.25 Find the value of additional resistance

```
//Exa:1.25
clc;
clear;
close;
I_l1=22;//in amperes
V=220;//in volts
R_sh=100;//in ohms
R_a=0.1;//in ohms
I_sh=V/R_sh;//in amperes
```

```
I_a1=I_l1-I_sh;//armatur current (in amperes)
E_b1=V-I_a1*R_a;//Back Emf (in volts)
N1=1000;//in rpm
I_a2=0.8*19.8;//in amperes
R=(218.416-(800*218.02/1000))/I_a2;
disp(R,'Value of additional resistance (in ohms)=');
I_a3=0.64*I_a1;//in amperes
R3=(218.7328-(800*218.02/1000))/I_a3;
disp(R3,'Value of additional resistance (in ohms)=')
    ;
```

Scilab code Exa 1.26 Find the value of additional resistance

```
//Exa:1.26
clc;
clear;
close;
I_1=50;//in amperes
V=500;//in volts
N_ratio=0.5;//Speed Ratio
E_b1=V;//Back Emf (in volts)
T_ratio=N_ratio^3;//Torque ratio
I_2=I_1*sqrt(T_ratio);//in amperes
R=(E_b1-(I_2*N_ratio*E_b1/I_1))/I_2;
disp(R,'Value of additional resistance (in ohms)=');
```

Scilab code Exa 1.27 Find the value of diverter resistance

```
//Exa:1.27
clc;
clear;
close;
N_ratio=1.2;//Speed Ratio
```

```
//From Saturation Curve
I_ratio=0.65;//feild current ratio corresponding to
    83.3% of full load value of flux to 65% of full
    load value of flux
I_a_ratio=N_ratio;//Armature current ratio
    corresponding to 83.3% of full load value of flux
     to 65% of full load value of flux
R_ratio=I_ratio/(I_a_ratio-I_ratio);
disp(R_ratio,'Value of Diverter resistance (in ohms)
    =');
disp('   times the Series Feild Resistance (R_se)')
```

Scilab code Exa 1.28 Find the value of Armature Current at 1000 rpm

```
//Exa:1.28
clc;
clear;
close;
I_ab=800;//Armature current (in amperes)
N1=1000;//in rpm
N2=500;//in rpm
I=I_ab*N1/N2;
disp(I,' Armature Current at 1000 rpm (in amperes)='
    )
```

Scilab code Exa 1.29 Find the value of additional resistance

```
//Exa:1.29
clc;
clear;
close;
f=50;//in hertz
P=4;//No.of poles
```

```
N_s=120*f/P;//Synchronous Speed (in rpm)
N=1440;//Full load speed (in rpm)
s1=(N_s-N)/N_s;//Full load Slip
N2=1200;//in rpm
s2=(N_s-N2)/N_s;//slip
R2=0.25;//ohms per phase
R=(s2*R2/s1)-R2;
disp(R,'Value of additional resistance (in ohms)=');
```

Scilab code Exa 1.30 Find the value of frequecncy of rotor currents and slip

```
//Exa:1.30
clc;
clear;
close;
f=50;//in hertz
P1=6;//No. of poles
P2=4;//No.of poles
N_sc=120*f/(P1+P2);//Synchronous Speed (in rpm)
s=0.02;//slip
N=N_sc*(1-s);//Actual Speed (in rpm)
N_s=120*f/P1;//Synchronous Speed of 6-pole motor
s1=(N_s-N)/N_s;
f1=s1*f;
disp(f1,'Frequency of rotor current of 6-pole motor (in Hertz)=');
disp(s1,'Slip reffered to 6-pole stator feild=');
N_s2=120*f1/P2;//Synchronous Speed of 4-pole motor
s2=(N_s2-N)/N_s2;
f2=s2*f1;
disp(f2,'Frequency of rotor current of 4-pole motor (in Hertz)=');
disp(s2,'Slip reffered to 4-pole stator feild=');
```

Scilab code Exa 1.31 Find the value of available speed and maximum load delievered and ratio of mechanical power

```
//Exa:1.31
clc;
clear;
close;
f=50;//in hertz
P1=6;//No. of poles
P2=4;//No.of poles
N_s1=120*f/P1;//Synchronous Speed of 6-pole motor
N_s2=120*f/P2;//Synchronous Speed of 4-pole motor
N_sc1=120*f/(P1+P2);//Concantenated Speed of set
    when cumulatively compounded (in rpm)
N_sc2=120*f/(P1-P2);//Concantenated Speed of set
    when differentially compounded (in rpm)
disp(' Available Speeds (in rpm) are :');
disp(N_s1,'');
disp(N_s2,'');
disp(N_sc1,'');
disp(N_sc2,'');
P_o=15;//in HP
disp(P_o,'Maximum Load which can be delievered (in
    HP)=');
r=P1/P2;
disp(r,'Ratio of Mechanical Power Output')
```

Scilab code Exa 1.32 Find the value of Resistance to be added to each slip ring

```
//Exa:1.32
clc;
```

```
clear;
close;
f=50;//in hertz
V=440;//in volts
P_o=110*1000;//in watts
P=24;//No.Of Poles
N_s=120*f/P;//Synchronous Speed (in rpm)
N=245;//in rpm
s_f=(N_s-N)/N_s;//Full load Speed
T_f=P_o/(2*%pi*N/60);//Full load Torque (in N-m)
R=0.04;//in ohms
R2=R/2;//Rotor resistance per phase (in ohms)
K=1.25;// ratio of stator turns to rotor turns
R_2=R2*K^2;//Rotor resistance reffered to stator (in
    ohms)
X_2=sqrt(((V^2*R_2*1.2/(T_f*500*%pi))-R_2^2)*(1/R2)
   ^2);//in ohms
s=(N_s-175)/N_s;//slip at 175 rpm
T=T_f*175^2/N^2;//Torque at 175 rpm (in N-m)
b=-(V^2*s*60/(T*2*%pi*N_s));
a=1;
c=(s*X_2)^2;
R_n=(-b+sqrt(b^2-4*a*c))/(2*a)
R_ext=(R_n-R_2)/K^2;
disp(R_ext,'Resistance to be added to each slip ring
    (in ohms)=')
```

Scilab code Exa 1.33 Find the value of Value of external resistance and initial braking torque and Braking Torque when speed reduced to 500 rpm

```
//Exa:1.33
clc;
clear;
close;
I_f=100;//in amperes
```

```
V=220;//in volts
N=1000;//in rpm
T_f=V*I_f/(2*%pi*N/60);//Full load torque (N-m)
E_bf=V;//Back emf (in volts)
V_a=V+E_bf;// Voltage across armature (in volts)
I_b=2*I_f;//braking current
R=(V_a/I_b);//in ohms
disp(R,'Value of external resistance (in ohms)=');
T_b=T_f*I_b/I_f;
disp(T_b,'Initial Braking Torque (in N-m)=');
E_b1=E_bf*500/N;//in volts
I_b1=(V+E_b1)/R;//in amperes
T_b1=T_f*I_b1/I_f;
disp(T_b1,'Braking Torque when speed reduced to 500 rpm (in N-m)=');
```

Scilab code Exa 1.34 Find the value of resistance and breaking torque

```
//Exa:1.34
clc;
clear;
close;
P_o=17.6*1000;//in watts
Eff=0.8;//Efficiency
V=220;//in volts
I_f=P_o/(V*Eff);//in amperes
I_af=I_f;//in amperes
R_a=0.1;//in ohms
N=1200;//in rpm
T_f=P_o/(2*%pi*N/60);//Full load torque (N-m)
E_bf=V-I_af*R_a;//Back emf (in volts)
V_a=V+E_bf;// Voltage across armature (in volts)
I_b=2*I_f;//braking current
R=(V_a/I_b)-R_a;//in ohms
disp(R,'Value of external resistance (in ohms)=');
```

```
E_b1=E_bf*400/N;//in volts
I_b1=(V+E_b1)/(R+R_a);//in amperes
T_b1=T_f*I_b1/I_f;
disp(T_b1,'Braking Torque when speed reduced to 400
    rpm (in N-m)=');
```

Scilab code Exa 1.35 Find the value of Value of external resistance and Braking Torque when speed reduced to 400 rpm

```
//Exa:1.35
clc;
clear;
close;
V=220;//in volts
P_o=400*9.81*2.5;//(in watts)
Eff=0.85;//efficiency of motor
Eff_h=0.8
P_in=P_o/(Eff*Eff_h);//in watts
I=P_in/V;//in amperes
disp(I,'Current Drawn (in amperes)=');
P_out=P_o*Eff*Eff_h;//in watts
R=V^2/P_out;
disp(R,'Value of additional resistance (in ohms)=')
```

Scilab code Exa 1.36 Find the value of Current Drawn and Value of additional resistance

```
//Exa:1.36
clc;
clear;
close;
T=245;//in N-m
N=250;//in rpm
```

```
P_in=T*2*%pi*N/60;//in watts
//Corresponding to the value of P_in we found I=27.5
   A and E=233 V from the given curve shown in fig
   .1.102
E=233;//in volts
I=27.5;//in amperes
r=E/I;//resistance of the circuit
R=r-1;//External Resistance to be inserted (in ohms)
disp(R,'External Resistance to be inserted (in ohms)
   =')
```

Scilab code Exa 1.37 Find the value of speed under regenerative braking plugging and dynamic braking

```
//Exa:1.37
clc;
clear;
close;
P_o=45*1000;//in watts
R_a=0.2;//in ohms
V=500;//in volts
Eff=0.9;//Efficiency
I_lf=P_o/(V*Eff);//Rated Line current (in amperes)
R_sh=200;//in ohms
I_sh=V/R_sh;//Shunt feild Current (in amperes)
I_af=I_lf-I_sh;//Armature current on full load (in
   Amperes)
E_f=V-I_af*R_a;//emf induced (in volts)
N_f=600;//in rpm
E1=V+I_af*R_a;//in volts
N1=E1*N_f/E_f;
disp(N1,'Speed under regenerative braking(in rpm)=')
   ;
E2=I_af*(5.5+R_a)-V;//in volts
N2=E2*N_f/E_f;
```

```
disp(N2,'Speed under plugging (in rpm)=');
E3=I_af*(2.6+R_a);//in volts
N3=E3*N_f/E_f;
disp(N3,'Speed under dynamic braking(in rpm)=');
```

Scilab code Exa 1.38 Find the value of speed

```
//Exa:1.38
clc;
clear;
close;
V=230;//in volts
I_a=100;//in amperes
R_a=0.05;//in ohms
E_b=V-I_a*R_a;//in volts
N=870;//in rpm
T=E_b*I_a/(2*%pi*N/60);//torque developed (in N-m)
T_l=400;//in N-m
I_an=I_a*T_l/T;//in amperes
E=V+I_an*R_a;//in volts
N1=N*E/230;
disp(N1,'Speed (in rpm)=')
```

Scilab code Exa 1.39 Find the reduction in flux and motor speed

```
//Exa:1.39
clc;
clear;
close;
I_a1=100;//in Amperes
V=230;//in volts
R_a=0.1;//in ohms
E_b1=V-I_a1*R_a;//in volts
```

```
N1=500;//in rpm
N2=800;//in rpm
x=(V-sqrt((V^2)-4*10*352))/(2*10);
disp('Flux is reduced by');
disp(x^-1,);
disp('times to get motor speed of 800 rpm');
I_a2=I_a1*x;//in amperes
E_b2=V-I_a2*R_a;//in volts
T_2=E_b2*I_a2*60/(2*%pi*N2);//in N-m
T_3=800;//in N-m
I_a3=I_a2*T_3/T_2;//in Amperes
E_b3=V+I_a3*R_a;//in amperes
N3=E_b3*N2/E_b2;
disp(ceil(N3),'Speed (in rpm)=');
```

Scilab code Exa 1.40 Find the value of plugging torque

```
//Exa:1.40
clc;
clear;
close;
f=50;//in hertz
P=4;//Number of poles
N_s=120*f/P;//Synchronous Speed (in rpm)
s_f=0.05;//Full load Slip
N_f=N_s*(1-s_f);//Full load speed (in rpm)
P_d=30*1000;//in watts
T_f=P_d/(2*%pi*N_f/60);//In N-m
s_2=2-s_f;//Slip at plugging
T_p=(s_2/s_f)*T_f*(1+16*s_f^2)/(1+16*s_2^2);
disp(T_p,'Plugging Torque (in N-m)=')
```

Scilab code Exa 1.41 Find the value of initial braking torque in case of plugging and dc dynamic braking

```
//Exa:1.41
clc;
clear;
close;
R2=0.5;//in ohms
X2=2.4;//in ohms
a=0.5;//ratio
s_f=0.05;//slip
f=50;//in hertz
P=8;//Number of Poles
R_2=R2*a^2;//in ohms
X_2=X2*a^2;//in ohms
s=2-s_f;//Slip during Plugging
N_s=120*f/P;//in rpm
V=400/sqrt(3);//in volts
R_L=2;//in ohms
R_1=0.1;//in ohms
X_1=0.6;//in ohms
I_2=V/sqrt(((R_1+(R_2+R_L)/s)^2)+(X_1+X_2)^2);//in
    amperes
T_b=3*60*I_2^2*(R_2+R_L)/(2*%pi*N_s*s);
disp(int(T_b),'Initial Braking Torque (in N-m)=');
E_2=V*sqrt(((R_2/s_f)^2+(X_2^2))/((((R_2/s_f)+R_1)^2)
    +1.2^2)/sqrt(3);
S=1-s_f;//Slip during breaking
I_2b=E_2/sqrt((X_2^2)+((R_L+R_2)/S)^2);
T_bn=3*60*I_2b^2*(R_2+R_L)/(2*%pi*N_s*S);
disp(T_bn,'Initial Braking Torque during dc dynamic
    braking(in N-m)=');
```

Scilab code Exa 1.42 Find the value of time taken and number of revolutions in case of plugging and rheostatic braking

```
//Exa:1.42
clc;
clear;
close;
J=630;//in kg-m^2
T_f=1.4*9.81;//in N-m
T_e=165*9.81;//in N-m
T_b=T_e+T_f;//in N-m
Beta=T_b/J;//in rad/sec^2
f=50;//in hertz
P=8;//no of poles
N_s=120*f/P;//in rpm
w_1=2*%pi*N_s/60;//in rad/sec
t=w_1/Beta;
disp(t,'Time taken to stop the motor (in seconds)=')
    ;
n=w_1^2/(2*%pi*Beta*2);
disp(n,'Number of revolutions made=');
```

Scilab code Exa 1.43 Find the value of time taken and number of revolutions

```
//Exa:1.43
clc;
clear;
close;
P_o=37.5*1000;//in Watts
N=750;//in rpm
Eff=0.9;//Efficiency
V_L=400;//in Volts
pf=0.85;//Power Factor
R_b=2.5;//in ohms
T_f=P_o*60/(2*%pi*N);//in N-m
I_L=P_o/(sqrt(3)*V_L*pf*Eff);//in Amperes
I_b=V_L/(sqrt(3)*R_b);//in Amperes
```

```
T_E=T_f*I_b/I_L;//in N-m
T_i_total=T_f+T_E;//in N-m
w=2*%pi*N/60;//in rad/sec
K=T_E/w;
J=20;//kg-m^2
t=(J/K)*log((T_f+K*w)/T_f);
disp(t,'Time taken (in Seconds)=');
n=(1/(2*%pi*K))*(((J/K)*(T_f+K*w)*(1-exp(-K*t/J)))-
   T_f*t);
disp(n,'Number of Revolutions Made=')
```

Scilab code Exa 1.44 Find the value of time taken

```
//Exa:1.44
clc;
clear;
close;
E=240;//in volts
R=15;//in ohms
N=1500;//in rpm
P=E^2/R;//in Watts
T_b=P*60/(2*%pi*N);//in N-m
T_e=T_b;
w_1=2*%pi*N/60;//in rad/sec
K=T_e/w_1;
J=20;//kg-m^2
t=(J/K)*log(w_1/62.832);
disp(t,'Time taken to bring motor from 1500 rpm to
   600 rpm (in seconds)=');
T_f=1.5*9.81;//in N-m
t_o=(J/K)*log((T_f+T_e)/(T_f+(T_e*600/1500)));
disp(t_o,'Time taken for fall of speed if there
   exist frictional torque (in seconds)=');
```

Scilab code Exa 1.45 Find the value of final temperature rise and heating time constant

```
//Exa:1.45
clc;
clear;
close;
d=0.65;//in meters
l=1;//in meters
P_o=12*735.5;//in watts
Eff=0.9;//Efficiency
P_in=P_o/Eff;//in watts
P_L=P_in-P_o;//in watts
m=400;//in kg
C_p=700;//in J/Kg/Celcius
alpha=12;//in watts/m^2/Celcius
S=%pi*d*l;//in m^2
Theta=P_L/(S*alpha);//in Celcius
t=m*C_p/(S*alpha);
disp(Theta,'Final temperatur rise (in degree celcius
    )=');
disp(ceil(t),'Heating time constant (in seconds)=');
```

Scilab code Exa 1.47 Find the value of heating time constant and final steady temperature rise and one hour rating of motor

```
//Exa:1.47
clc;
clear;
close;
theta_1=20;//in degree celcius
theta_2=34;//in degree celcius
```

```
t=-1/log((theta_2/theta_1)-1);//in hours
disp(t,'Heating time constant (in hours)=');
theta_F=theta_1/(1-exp(-1/t));
disp(theta_F,'Final steady temperature rise (in
    degree celcius)=');
theta_f=theta_F/(1-exp(-1/t));
x=sqrt(2*(theta_f/theta_F)-1);
disp('one hour rating of motor is');
disp(x,'times full load rating');
```

Scilab code Exa 1.48 Find the half hour rating of the motor

```
//Exa:1.48
clc;
clear;
close;
P=25;//in KW
t=1.5;//in hours
P_L=sqrt((((1/(1-exp(-0.5/t)))*1.9)-0.9)*P^2);
disp(P_L,'Half hour rating of a 25KW Motor (in KW)='
    )
```

Scilab code Exa 1.49 Find the running time of the motor

```
//Exa:1.49
clc;
clear;
close;
t=60;//in minutes
theta_F=20;//in degree celcius
P_L1=2.5625;//Total losses at P KW
P_L2=7.25;//Total losses at 2P KW
theta_f=theta_F*P_L2/P_L1;//in degree celcius
```

```
t_o=t*log(1/(1-(theta_F/theta_f)));
disp(t_o,'Time of operation (in minutes)=');
```

Scilab code Exa 1.51 Find out the continuous rating of the motor

```
//Exa:1.51
clc;
clear;
close;
Eff=0.8;//Efficiency
P1=400;//in watts
t1=60;//in minutes
t2=15;//in minutes
P=sqrt((((2.5625/(1-exp(-t2/t1)))-1)^(-1))*(P1/Eff)^2);
disp(P,'Continuous Rating of Motor (in Watts)=');
```

Scilab code Exa 1.52 Find the value of temperature rise and maximum steady state temperature rise and time taken for increase in temperature

```
//Exa:1.52
clc;
clear;
close;
theta_1=50;//in degree Celcius
theta_F=80;//in degree celcius
t=0.75;//in hours
theta=theta_F*(1-exp(-1/t));
disp(theta_F,'Temperature rise after 1 hour (in degree celcius)=');
theta_f=theta_F/(1-exp(-1/t));
disp(theta_f,'Steady state temperature rise at 1 hour rating (in degree celcius)=');
```

```
T=-t*log(1-(theta_1/theta_f));
disp(60-T*60,'Time taken to increase temperature from 50 to 80 degree celcius (in minutes)=');
```

Scilab code Exa 1.53 Find the value of load

```
//Exa:1.53
clc;
clear;
P_cont=100;//in KWs
Eff=0.8;//Efficiency
T_1=50;//in minutes
T_2=70;//in minutes
t_1=10;//in minutes
t_2=10;//in minutes
r=(1-exp(-((t_1/T_1)+(t_2/T_2))))/(1-exp(-t_1/T_1)); // r=theta_f/theta_F
P_L=2.5625;//Losses at 100 KW Load
P_L1=Eff*P_cont;//in Kws
P=sqrt(((P_L*r)-1)*P_L1^2);
disp(P,'Value of Load in KW during load period=');
```

Scilab code Exa 1.54 Find the value of final temperature rise and heating time constant

```
//Exa:1.54
clc;
clear;
close;
theta_1=20;//in degree celcius
theta_2=30;//in degree celcius
t_1=30;//in minutes
t_2=60;//in minutes
```

```
t=-(t_2-t_1)/log((theta_2/theta_1)-1);//in minutes
theta_F=theta_1/(1-exp(-t_1/t));
disp(t,'Heating Time Contant (in minutes)=');
disp(theta_F,'Final Temperature Rise (in Degree
    Celcius)=');
```

Scilab code Exa 1.55 Find the value of maximum overload

```
//Exa:1.55
clc;
clear;
close;
theta_1=30;//in degree celcius
theta_2=40;//in degree celcius
t_1=1;//in hours
t_2=2;//in hours
x=(theta_2/theta_1)-1;
theta_F=theta_1/(1-x);//in degree celcius
theta_f=50/(1-x);//in degree celcius
P_L=25;//in KWs
P=P_L*sqrt(theta_f/theta_F);
disp(P,'Maximum Overload (in KWs)=')
```

Scilab code Exa 1.56 Find the value of temperature rise

```
//Exa:1.56
clc;
clear;
close;
theta_1=20;//in degree celcius
theta_2=35;//in degree celcius
t_1=1/2;//in hours
t_2=1;//in hours
```

```
t=-(t_2-t_1)/log((theta_2/theta_1)-1);//in minutes
theta_F=theta_1/(1-exp(-t_1/t));
theta=theta_F*(1-exp(-2/t));
disp(theta,'Temperature Rise After 2 hrs (in Degree Celcius)=');
theta_F1=theta_F*0.8;//in Degree Celcius
t_o=0.8*t;//in hours
theta_o=theta_F1*(1-exp(-1/t_o));
disp(theta_o,'Temperature Rise from cold After 1 hr at full load (in Degree Celcius)=');
```

Scilab code Exa 1.57 Determine the suitable size of continuously rated motor

```
//Exa:1.57
clc;
clear;
close;
P_1=100;//in KWs
P_2=50;//in KWs
t_1=10;//in minutes
t_2=8;//in minutes
t_3=5;//in minutes
t_4=4;//in minutes
P=sqrt(((t_1*P_1^2)+(t_2*P_2^2))/(t_1+t_2+t_3+t_4));
disp(P,'Rating Of Continuously Rated Motor (in KWs)=');
disp('Adequate rating of motor=70 Kws');
```

Scilab code Exa 1.58 Find the power rating of the motor

```
//Exa:1.58
clc;
```

```
clear;
close;
T_1=240;//in N_m
T_2=140;//in N-m
T_3=300;//in N-m
T_4=200;//in N-m
t_1=20;//in minutes
t_2=10;//in minutes
t_3=10;//in minutes
t_4=20;//in minutes
T=sqrt(((t_1*T_1^2)+(t_2*T_2^2)+(t_3*T_3^2)+(t_4*T_4
   ^2))/(t_1+t_2+t_3+t_4));
N=720;//in rpm
P=T*2*%pi*N/60;
disp(P,'Power rating of Motor(in KWs)=');
```

Scilab code Exa 1.59 Determine the kW rating of the motor

```
//Exa:1.59
clc;
clear;
close;
t=90;//in seconds
T_eq=sqrt(40750/t);//in Kg-m
N=750;//in rpm
P=T_eq*9.81*2*%pi*N/60;
disp(P,'Power Rating Of Motor (in Kws)=');
```

Scilab code Exa 1.61 Find the value of speed at the end of deceleration period

```
//Exa:1.61
clc;
```

```
clear;
close;
T_l=100*9.81;//in N-m
t=10;//in seconds
J=1000;//kg-m^2
f=50;//in hertz
P=4;//no.of poles
N_s=120*f/P;//synchronous speed (in rpm);
s=0.06;//slip
w_s=s*N_s*2*%pi/60;//slip speed (in rad/sec)
K=w_s/(50*9.81);
T_m=T_l-T_l*exp(-t/(K*J));
N_sn=K*T_m*60/(2*%pi);//in rpm
N=N_s-N_sn;
disp(N,'Speed at the end of deceleration period (in rpm)=')
```

Scilab code Exa 1.62 Determine the value of inertia of the flywheel

```
//Exa:1.62
clc;
clear;
close;
P_o=500*735.5;//in watts
N_o=40;//in rpm
s_f=0.12;
N_f=N_o*(1-s_f);//full load speed (in rpm)
T_f=P_o/(2*%pi*N_f/60);//Full load torque (N-m)
T_m=2*T_f;//Motor torque (in N-m)
T_l=41500*9.81;//Load torque (in N-m)
t=10;//seconds
w_s=s_f*N_o*2*%pi/60;//slip speed (in rad/sec)
K=w_s/T_f;
J=-t/(K*log(1-(T_m/T_l)));
disp(J,'Moment of Inertia (in Kg-m^2)=')
```

Scilab code Exa 1.63 Find the value of weight of flywheel and time taken

```
//Exa:1.63
clc;
clear;
close;
P_o=50*1000;//in watts
f=50;//in hertz
s_f=0.04;//slip
P=6;//no.of poles
N_s=120*f/P;//Synchronous Speed (in rpm)
N_f=N_s*(1-s_f);
T_f=P_o/(2*%pi*N_f)
```

Scilab code Exa 1.64 Find the value of moment of inertia

```
//Exa:1.64
clc;
clear;
close;
T_L=600;//in N-m
T_m=450;//in N-m
N=600;//in rpm
w_o=2*%pi*N/60;//in rad/sec
s=0.08;//slip
w=s*w_o;//in rad/sec
K=w/T_m;//Torque constant
J=(-10/K)/log(0.25);//in Kg-m^2
J_m=10;//in Kg-m^2
J_F=J-J_m;
disp(J_F,'Moment Of Inertia Of Flywheel (in Kg-m^2)=
    ');
```

Scilab code Exa 1.65 Find the value of moment of inertia

```
//Exa:1.45
clc;
clear;
close;
```

Chapter 3

Thyristor Control Of Electric Motors

Scilab code Exa 3.1 Find the efficiency and form factor and ripple factor and transformer utilisation factor and peak inverse voltage of thyristor

```
//Exa:3.1
clc;
clear;
close;
V=120;//in Volts
V_dc=40.5;//in volts
V_rms=76.1;//in volts
R=10;//in ohms
I_dc=V_dc/R;//in Amperes
I_rms=V_rms/R;//in Amperes
P_dc=V_dc*I_dc;//in watts
P_ac=V_rms*I_rms;//in watts
Eff=P_dc/P_ac;//in per unit
disp(Eff,'(a) Efficiency (in Per Unit=)');
K_f=V_rms/V_dc;//in per unit
disp(K_f,'(b) Form Factor (in Per Unit=)');
Y=sqrt(K_f^2-1);
disp(Y,'(c) Ripple Factor (in Per Unit=)');
```

```
T_f=P_dc/(V*I_rms);
disp(T_f,'(d) Transformer Utilisation Factor=');
P_iv=sqrt(2)*V;
disp(P_iv,'(e) Peak Inverse Voltage (in volts)=')
```

Scilab code Exa 3.2 Find the value of feild current and firing angle and input power factor

```
//Exa:3.2
clc;
clear;
close;
alpha_f=0;
R_f=250;//in ohms
K_f=0.8;//torque constant
R_a=0.2;//in ohms
V_const=0.8;//in volt/Amperes-radian/sec
N=1000;// in rpm
T_d=50;//In Newton-meter
V_rms=220;//in volts
V_f=int(V_rms*sqrt(2)*(1+cosd(alpha_f))/%pi);//Feild Circuit Voltage (in volts)
I_f=V_f/R_f;//in Amperes
disp(I_f,'(a) Feild Current (in Amperes)=');
I_a=T_d/(K_f*I_f);//in amperes
w=2*N*%pi/60;// in radian/sec
E_b=V_const*w*I_f;//Back emf (in volts)
V_a=E_b+(I_a*R_a);//armature voltage (in volts)
alpha_a=acosd(((V_a*%pi/(V_rms*sqrt(2)))-1);
disp(alpha_a,'(b) Firing angle of the converter (in degrees)=');
P_o=int(V_a*I_a);//in watts
I=52.66;//in amperes
pf=P_o/(V_rms*I);
disp(pf,'(c) Power factor of the converter=')
```

Scilab code Exa 3.3 Find the value of speed of motor and motor torque

```
//Exa:3.3
clc;
clear;
close;
alpha_a=45;//in degrees
V=230;//in volts
K=1.668;//K_a*Phy (in volt/radian/second)
R_a=0.2;//in ohms
I_a=30;//in amperes
V_a=2*V*sqrt(2)*cosd(alpha_a)/%pi;//in volts
E_b=V_a-(I_a*R_a);// in volts
w=E_b/K;//in radian/seconds
N=ceil(w*60/(2*%pi));
disp(N,'(a) Speed Of Motor (in rpm)=')
T=K*I_a;
disp(T,'(b) Motor Torque (in Newton-meter)=')
```

Scilab code Exa 3.4 Find the value of firing angle

```
//Exa:3.4
clc;
clear;
close;
R_a=0.06;//in ohms
N1=875;// in rpm
N2=750;//in rpm
V_rms=220;//in volts
V_dc=200;//in volts
I_a=150;//in amperes
```

```
E_b1=V_dc-(I_a*R_a);//Back emf (in volts)
E_b2=E_b1*(N2/N1);// in volts
V_a=E_b2+(I_a*R_a);//armature voltage (in volts)
alpha_a=acosd((V_a*%pi/(2*V_rms*sqrt(2))));
disp(alpha_a,'Firing angle (in degrees)=');
```

Scilab code Exa 3.5 Find the value of average load voltage and load current and input paower factor

```
//Exa:3.5
clc;
clear;
close;
alpha=30;//in degrees
V=230;//in volts
R=2;//in ohms
V_avg=2*V*sqrt(2)*cosd(alpha)/%pi;//in volts
I_avg=V_avg/R;//in amperes
disp(V_avg,'(a) Average Load Voltage (in Volts)=');
disp(I_avg,'(b) Average Load Current (in Amperes)=')
I_rms=I_avg;//in amperes (as ripple free)
P=V_avg*I_avg;//in watts
Q=2*V*sqrt(2)*I_avg*sind(alpha)/%pi;// in VAR
pf=cosd(atand(Q/P));
disp(pf,'(c) Input Power Factor (lagging)=')
```

Scilab code Exa 3.6 Find the value of motor armature current and motor speed

```
//Exa:3.6
clc;
clear;
close;
```

```
alpha=60;//in degrees
V=250;//in volts
T=140;//in Newton-Meter
K_a=2.5;//motor voltage constant (in Volt/radian/sec)
R_a=0.2;//in ohms
V_a=2*V*sqrt(2)*cosd(alpha)/%pi;//in volts
I_a=T/K_a;//in amperes
disp(I_a,'(a) Motor Armature Current (in amperes)=');
E_b=V_a-(I_a*R_a);//in volts
w=E_b*I_a/T;
disp(w,'(b) Motor Speed (in radian/sec)=')
```

Scilab code Exa 3.7 Find the value of firing angle

```
//Exa:3.7
clc;
clear;
close;
V_dc=220;//in volts
V=230;//in volts
I_a1=10;//in amperes
N1=1500;//in rpm
N2=500;//in rpm
N3=-1000;//in rpm
R_a=2;//in ohms
E_b1=V_dc-(I_a1*R_a);//in volts
E_b2=E_b1*(N2/N1);//in volts
I_a2=I_a1/2;//in amperes
V_a1=E_b2+(I_a2*R_a);//in volts
alpha_a1=acosd((V_a1*%pi/(2*V*sqrt(2))));
disp(alpha_a1,'(a) Firing angle (in degrees) at half the rated torque=');
E_b3=E_b1*(N3/N1);//in volts
```

```
I_a3=I_a1;//in amperes
V_a2=E_b3+(I_a3*R_a);//in volts
alpha_a2=acosd((V_a2*%pi/(2*V*sqrt(2))));
disp(alpha_a2,'(b) Firing angle (in degrees) at
    rated motor torque=');
```

Scilab code Exa 3.8 Find the value of torque developed and motor speed

```
//Exa:3.8
clc;
clear;
close;
alpha_f=0;//in degrees
alpha_a=30;//in degrees
V=220;//in volts
I_a=40;//in amperes
R_a=0.2;//in amperes
K_t=1.12;//motor voltage constant (in Volt/radian/
    sec)
R_f=200;//in ohms
V_f=2*V*sqrt(2)*cosd(alpha_f)/%pi;//in volts
I_f=V_f/R_f;//in amperes
V_a=2*V*sqrt(2)*cosd(alpha_a)/%pi;//in volts
E_b=V_a-(I_a*R_a);//in volts
T_d=K_t*I_a*I_f;
disp(T_d,'(a) Torque developed (in N-m)=');
N=E_b*60/(2*%pi*K_t*I_f);
disp(ceil(N),'(b) Motor Speed (in rpm)=')
```

Scilab code Exa 3.9 Find the value of firing angle

```
//Exa:3.9
clc;
```

```
clear;
close;
R_a=0.2;//in ohms
alpha_f=0;//in degrees
V=400;//in volts
R_f=250;//in ohms
K=1.3;//Volts/Ampere-radian/second
N=1200;//in rpm
I_a=60;//in amperes
V_f=3*sqrt(3)*V*sqrt(2)/(sqrt(3)*%pi);//in volts
I_f=V_f/R_f;//in amperes
E_b=K*I_f*2*%pi*N/60;//in volts
V_a=E_b+(I_a*R_a);//in volts
alpha_a=acosd((V_a*%pi)/(3*V*sqrt(2)));
disp(alpha_a,'Firing Angle (in degrees)=')
```

Scilab code Exa 3.10 Find the value of no load speed and firing angle

```
//Exa:3.10
clc;
clear;
close;
alpha_a=45;//in degrees
R_a=0.2;//in ohms
K=0.25;//in volts/rpm
V=400;//in volts
I_ao=5;//in amperes (no load armature current)
N=1500;//in rpm
I_a=100;//in amperes
V_ao=3*sqrt(3)*V*sqrt(2)*(1+cosd(alpha_a))/(sqrt(3)*
    %pi*2);//in volts
E_bo=V_ao-(I_ao*R_a);//in volts
N_o=E_bo/K;
disp(int(N_o),'No-Load Speed (in rpm)=');
E_b=N*K;//in volts
```

```
V_a=E_b+(I_a*R_a);//in volts
alpha_ao=acosd(((V_a*%pi*2)/(3*V*sqrt(2)))-1);
disp(alpha_ao,'Firing Angle (in degrees)=')
```

Scilab code Exa 3.12 Find the value of average load voltage and average current and diode current and effective input resistance

```
//Exa:3.12
clc;
clear;
close;
alpha=0.4;//duty cycle
V_dc=200;//in volts
R=10;//in ohms
V_a=alpha*V_dc;
disp(V_a,'(a) Average Load Voltage (in volts)=');
I=V_a/R;
disp(I,'(b) Average thyristor current (in amperes)=');
I_d=0;
disp(I_d,'(c) Diode Current (in amperes)=');
R_eff=R/alpha;
disp(R_eff,'(d) Effective input resistance (in ohms)=')
```

Scilab code Exa 3.13 Find the value of average load current and firing angle

```
//Exa:3.13
clc;
clear;
close;
V_dc=220;//in volts
```

```
V_a=250;//average load voltage (in volts)
R=10;//in ohms
alpha=1-(V_dc/V_a);
I=V_a/R;
disp(I,'Average Load Current (in amperes)=')
disp(alpha,'Firing Angle (in degrees)=')
```

Scilab code Exa 3.14 Find the value of frequency of switching pulse

```
//Exa:3.14
clc;
clear;
close;
V_dc=125;//in volts
V_a=200;//average output voltage (in volts)
T_on=1*10^-3;//in seconds
alpha=V_a/(V_a+V_dc);//duty cycle
f=alpha/T_on;
disp(f,'Frequency Of Switching pulse (in hertz)=')
```

Scilab code Exa 3.15 Find the value of frequency

```
//Exa:3.15
clc;
clear;
close;
alpha=0.25;//duty cycle
V=400;//in volts
L=0.5;//in henery
I=10;//ripple current (in amperes)
V_a=alpha*V;//in volts
T_on=L*I/(V-V_a);//in seconds
T=T_on/alpha;//in seconds
```

```
f=1/T;
disp(f,'Frequency (in hertzs)=')
```

Scilab code Exa 3.16 Find the range of speed control and duty cycle

```
//Exa:3.16
clc;
clear;
close;
V_a=120;//in volts
I_a=20;//in amperes
R_a=0.5;//in ohms
K=0.05;//Motor constant (in volts/rpm)
E_b=V_a-(I_a*R_a);//in volts
N=E_b/K;//in rpm
disp('Range of Speed Control is :');
disp('Lowest Speed (in rpm) = 0');
disp(N,'Highest Speed (in rpm)=');
E_bo=0;//in volts
V_a1=E_bo+(I_a*R_a);//in volts
alpha=V_a1/V_a;
disp('Range of duty cycle is :');
disp(alpha,'lowest value of duty cycle=');
disp('Highest value of duty cycle= 1')
```

Scilab code Exa 3.17 Find the value of duty cycle of the chopper

```
//Exa:3.17
clc;
clear;
close;
V=200;//in volts
I_a=100;//in amperes
```

```
R_a=0.02;//in ohms
N1=940;//in rpm
N2=500;//in rpm
E_b1=V-(I_a*R_a);//in volts
E_b2=E_b1*N2/N1;//in volts
V_a=E_b2+(I_a*R_a);//in volts
alpha=V_a/V;
disp(alpha,'Duty Cycle Of The Chopper=')
```

Scilab code Exa 3.18 Find the value of power input and speed and torque and maximum and minimum speed

```
//Exa:3.18
clc;
clear;
close;
alpha=0.6;//duty cycle
alpha1=0.1;//duty cycle
alpha2=0.9;//duty cycle
V=400;//in volts
R_a=0.1;//in ohms
K=4;//Motor Constant (in Volts/radians)
I_a=150;//in Amperes
P_in=alpha*V*I_a/1000;
disp(P_in,'(a) Power input (in Kilo-Watts)=');
V_a=alpha*V;//in volts
E_b=V_a-(I_a*R_a);//in volts
N=60*E_b/(2*%pi*K);
disp(int(N),'(b) Motor Speed (in rpm)=');
T=E_b*I_a*60/(2*%pi*N);
disp(T,'(c) Torque developed (in Newton-meter)=');
E_b1=(alpha1*V)-(I_a*R_a);//in volts
N1=60*E_b1/(2*%pi*K);
disp(ceil(N1),'(d) Minimum Speed (in rpm)=')
E_b2=(alpha2*V)-(I_a*R_a);//in volts
```

```
N2=60*E_b2/(2*%pi*K);
disp(ceil(N2),'     Maximum Speed (in rpm)=')
```

Scilab code Exa 3.19 Find the value of Average voltage and power dissipated and speed

```
//Exa:3.19
clc;
clear;
close;
alpha=0.4;//duty cycle
R_b=7.5;//in ohms
R_a=0.1;//in ohms
I_f=1.5;//in amperes
K=1.6;//Voltage Constant (in V/A-rad/sec)
I_a=150;//in amperes
V_b=(1-alpha)*R_b*I_a;
disp(V_b,'(a) Average Voltage (in volts)=');
P_b=I_a^2*R_b*(1-alpha);
disp(P_b/1000,'(b) Power Dissipated (in kilo-watts)=
    ');
E_g=V_b+(I_a*R_a);//in volts
N=60*E_g/(K*I_f*2*%pi);
disp(int(N),'(c) Speed (in rpm)=')
```

Scilab code Exa 3.20 Find the value of firing angle and power supplied

```
//Exa:3.20
clc;
clear;
close;
E_g=-163.53;//in volts
I_a=40;//in amperes
```

```
R_a=0.2;//in ohms
V=220;//in volts
V_a=E_g+(I_a*R_a);//in volts
alpha_a=acosd(V_a*%pi/(2*V*sqrt(2)));
disp(alpha_a,'Firing Angle (in degrees)=');
P=V_a*I_a*(-1);
disp(P/1000,'Power Supplied (in Kilo-Watts)=')
```

Scilab code Exa 3.21 Find the value of pulse width

```
//Exa:3.21
clc;
clear;
close;
E_b=100;//in volts
I_a=25;//in amperes
R=0.2;//(R_a+R_se) in ohms
V=220;//in volts
f=200;//in hertz
V_a=E_b+(I_a*R);//in volts
T_on=V_a/(V*f);
disp(T_on*1000,' Pulse Width (in mili-seconds)')
```

Scilab code Exa 3.22 Find the value of motor torque

```
//Exa:3.22
clc;
clear;
close;
N=1000;//in rpm
V=240;//in volts
w=2*%pi*N/60;//in rad/sec
alpha=30;//in degrees
```

```
R=0.25;//in ohms
K=0.025;//in Nm/A^2
disp('When controlled through semiconverter');
V_a1=sqrt(2)*V*(1+cosd(alpha))/%pi;//in volts
I_a1=V_a1/(R+(K*w));
disp(I_a1,'Armature Current (in Amperes)=');
T_1=K*I_a1^2;
disp(T_1,'Motor Torque (in N-m)=');
disp('When controlled through full converter');
V_a2=2*sqrt(2)*V*cosd(alpha)/%pi;//in volts
I_a2=V_a2/(R+(K*w));
disp(I_a2,'Armature Current (in Amperes)=');
T_2=K*I_a2^2;
disp(T_2,'Motor Torque (in N-m)=');
```

Scilab code Exa 3.23 Find average motor current and speed

```
//Exa:3.23
clc;
clear;
close;
V=230;//in volts
V_dc=sqrt(2)*V*2/%pi;//in volts
T_L=30;//in N-m
K_t=0.3;//torque constant (in N-m/A^2)
I_a=sqrt(T_L/K_t);
disp(I_a,'Average Motor Current (in Amperes)=');
w=(207-I_a)/(K_t*I_a);// in rad/sec
N=w*60/(2*%pi);
disp(N,'Speed (in rpm)=');
```

Scilab code Exa 3.24 Find the value of armature current and firing angle

```
//Exa:3.24
clc;
clear;
close;
I_a1=36;//in amperes
N1=400;//in amperes
N2=600;//in amperes
alpha_1=100;//in degrees
V=675;//in volts
R=0.4;//in ohms
V_a1=sqrt(2)*V*(1+cosd(alpha_1))/%pi;//in volts
E_b1=V_a1-I_a1*R;//in volts
I_a2=I_a1*N2/N1;//in amperes
E_b2=E_b1*I_a2*N2/(I_a1*N1);//in volts
V_a2=E_b2+21.6;///in volts
alpha=acosd((V_a2*%pi/(sqrt(2)*V))-1);
disp(I_a2,'Armature current (in Amperes)=');
disp(alpha,'Firing angle (in degrees)=');
```