# Scilab Textbook Companion for The Performance And Design Of A.C. Machines by M.G. Say[1]

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# Book Description

**Title:** The Performance And Design Of A.C. Machines

**Author:** M.G. Say

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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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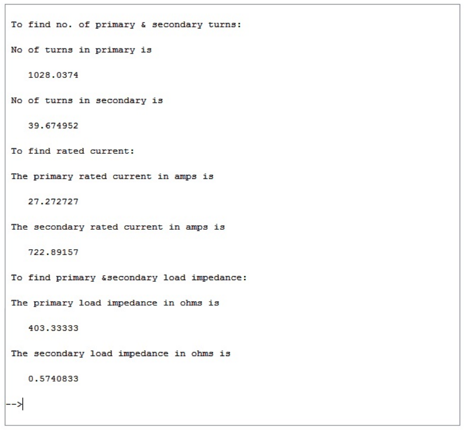
# Chapter 1

# Introductory

**Scilab code Exa 1.1** Ex1 1

```
clc;
clear;
//case1:
disp('To find no. of primary & secondary turns:')
Bm1=1.5;//Max flux density of primary in tesla
Vt1=10.7;//Terminal voltage of primary in volts
Bm2=1.46;//Max flux density of secondary in tesla
Vt2=10.46;//Terminal voltage of secondary in volts
V1=11000;//Primary RMS voltage in volts
V2=415;//Secondary RMS voltage in volts
P=300e3;//Input power in volt-amphere
N2=(V2)/(Vt2);//No.of turns in secondary
N1=(V1)/(Vt1);//No.of turns in primary
disp(N1,'No of turns in primary is')
disp(N2,'No of turns in secondary is')
//case2:
disp('To find rated current:')
I1=P/(V1);
I2=P/(V2);
```



```
To find no. of primary & secondary turns:

No of turns in primary is

   1028.0374

No of turns in secondary is

   39.674952

To find rated current:

The primary rated current in amps is

   27.272727

The secondary rated current in amps is

   722.89157

To find primary &secondary load impedance:

The primary load impedance in ohms is

   403.33333

The secondary load impedance in ohms is

   0.5740833

-->
```

Figure 1.1: Ex1 1

```
disp(I1,'The primary rated current in amps is')
disp(I2,'The secondary rated current in amps is')
//case3:
disp('To find primary &secondary load impedance:')
Z1=(V1)/(I1);
Z2=(V2)/(I2);
disp(Z1,'The primary load impedance in ohms is')
disp(Z2,'The secondary load impedance in ohms is')
```

**Scilab code Exa 1.2** Ex1 2

```
clc;
clear;
D=0.50;//Diameter of machine in m
l=0.20;//Lemgth of machine in m
lg=0.005;//Gap length in m
```

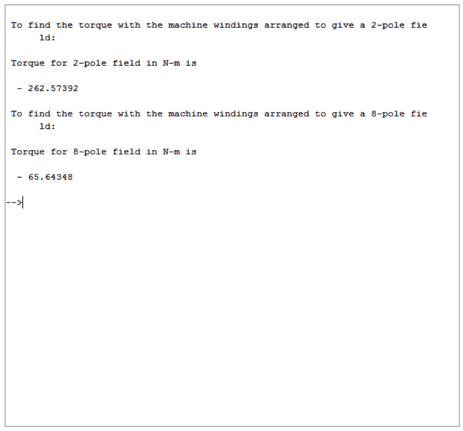



Figure 1.2: Ex1 2

```
A1=12800;//Current density of stator
A2=9600;//Current density of rotor
Lamda=%pi/3;//Electrical torque angle
sin(Lamda)==0.87;
S=sin(Lamda);
Mewzero=4*%pi*(1e-7);//Permeability constant
F1=((A1)*D)/2;//MMF of stator
F2=((A2)*D)/2;//MMF of rotor
M=-((%pi*D*l*(F1)*(F2)*S*(Mewzero))/(2*(lg)));//
    Torque produced
//case1:
disp('To find the torque with the machine windings
    arranged to give a 2-pole field:')
M1=M/1;//Torque produced with 2-pole field
disp(M1,'Torque for 2-pole field in N-m is')
//case2:
disp('To find the torque with the machine windings
    arranged to give a 8-pole field:')
M2=M/4;//Torque produced with 8-pole field
disp(M2,'Torque for 8-pole field in N-m is')
```

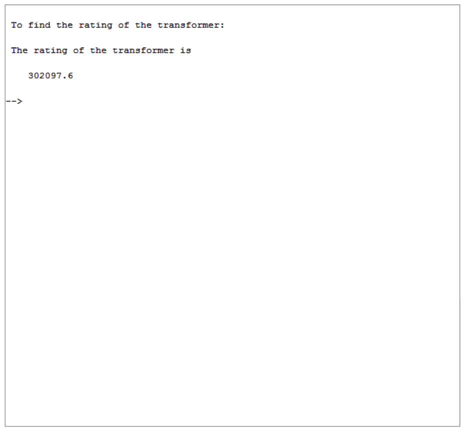



Figure 1.3: Ex1 3

**Scilab code Exa 1.3** Ex1 3

```
clc;
clear;
f=50;//Frequency of transformer in Hz
Ai=0.032;//Ferromagnetic area in m^2
Aw=0.07;//Window area in m^2
Bm=1.5;//Flux density in T
J=2.7;//RMS current density
Kw=0.3;//Space factor
//case1:
disp('To find the rating of the transformer:')
S=2.22*f*(Bm)*J*(Ai)*(Aw)*(Kw)*(1e6);//Rating of
    transformer in VA
disp(S,'The rating of the transformer is')
```

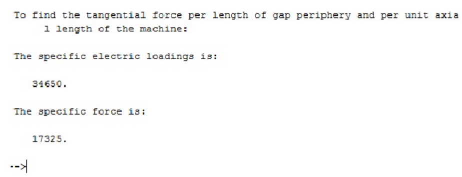



Figure 1.4: Ex1 4

**Scilab code Exa 1.4** `Ex1 4`

```
clc;
clear;
B=0.50;//Mean gap flux density
Ys=40;//Slot spacing
Cs=(35*12);//Conductor section
J=3.3;//Current density
//case:1
disp('To find the tangential force per length of gap
    periphery and per unit axial length of the
   machine:')
A=(Cs*J*1000)/Ys;
disp(A,'The specific electric loadings is:')
Fe=B*A;
```

```
disp(Fe,'The specific force is:')
```

# Chapter 2

# Magnetic circuits

**Scilab code Exa 2.1** Ex2 1

```
clc;
clear;
b1=10;//From plot
b2=31;//From plot
b3=68;//From plot
b4=100;//From plot
b5=100;//From plot
b6=100;//From plot
//Case:1
B1=0.86+5.16+16.72+28.9+32.3+16.7;
B3=2.36+10.32+16.04+0-23.6-16.7;
B5=3.23+5.16-16.04-28.9+8.6+16.7;
B7=3.23-5.16-16.04+28.9+8.6-16.7;
disp('To find the harmonic components ,mean gap
    density ,rms value:')
disp(B7,B5,B3,B1,'The harmonic components are:')
B8=((2/%pi)*(B1+((1/3)*B3)+((1/5)*B5)+((1/7)*B7)));
disp(B8,'The mean gap density is :')
B9=(((1/2)*(((B1)^2)+((B3)^2)+((B5)^2)+((B7)^2)))
```

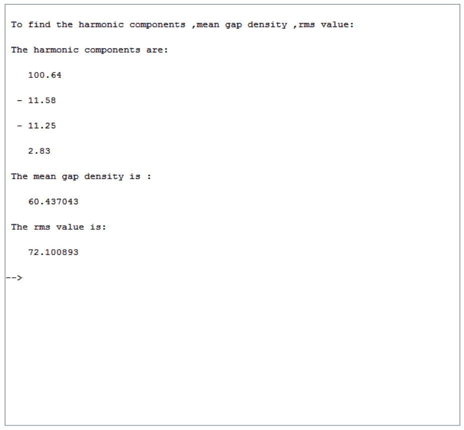



Figure 2.1: Ex2 1

```
    ^(1/2));
disp(B9,'The rms value is:')
```

**Scilab code Exa 2.4** Ex2 4

```
clc;
clear;
e=0.001;
D=0.50;
l=0.20;
lg=0.005;
A1=12800;//Stator peak current densities
A2=9600;//Rotor peak current densities
lamda=(%pi/3);//torque angle
F1=A1*D*(1/2);//mmf per pole
F2=A2*D*(1/2);//mmf per pole
```

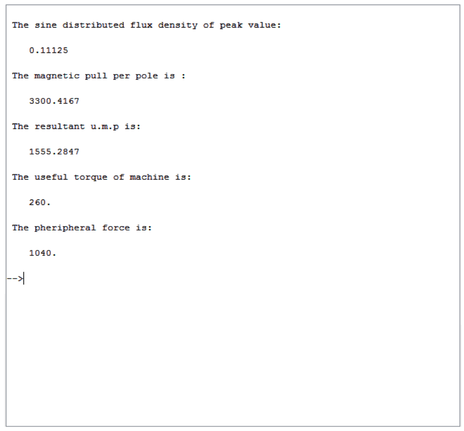



Figure 2.2: Ex2 4

```
Fo=4450;//Resultant gap mmf per pole
Mewo=1.25*10^(-7);
Bm=(Fo*Mewo)/lg;
disp(Bm,'The sine distributed flux density of peak
   value:')
Mp=((D*l)/(3*Mewo))*(Bm^2);//Magnetic pull per pole
disp(Mp,'The magnetic pull per pole is :')
e1=0.001/0.005;//Eccentricity after displacement of
   'e'
Mu=((%pi*D*l)/(4*Mewo))*(Bm^2)*e1;
disp(Mu,'The resultant u.m.p is:')
M=260;
F=M/0.25;
disp(M,'The useful torque of machine is:')
disp(F,'The pheripheral force is:')
```

# Chapter 3

# Windings

**Scilab code Exa 3.1** Ex3 1

```
clc;
clear;
hp=0.15;//from diagram
F=9000;
V=80;//Working voltage
Lmt=1.25;//Mean length of the turn
Vp=4;//voltage per pole
disp('For a copper winding at 75 deg cel:')
a=0.021*(10^(-6))*Lmt*(F/Vp);
disp(a,'The conductor area is:')
Vp=4;//voltage per pole
S=Lmt*hp;
C=0.019;//Assumed value
disp('For a temp rise of 65 deg cel:')
theta_m=65;//temperature rise
p=(theta_m*S)/C;
disp(p,'The power dissipated is:')
I=p/Vp;
disp(I,'The field current is:')
```

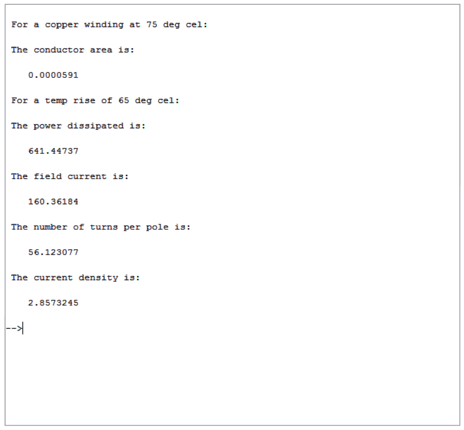



Figure 3.1: Ex3 1

```
N=F/I;
disp(N,'The number of turns per pole is:')
J=I/N;
disp(J,'The current density is:')
```

**Scilab code Exa 3.2** Ex3 2

```
clc;
clear;
S=108;//slot
m=3;
P1=16;//2p=16
disp('for 16 pole 3 phase machine :')
g1=S/(P1*m);
disp(g1,'The integral slot winding is:')
disp('For 10 pole 3 phase machine :')
```

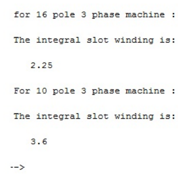



Figure 3.2: Ex3 2

```
P2=10;//2p=10
g2=S/(P2*m);
disp(g2,'The integral slot winding is:')
```

**Scilab code Exa 3.3** Ex3 3

```
clc;
clear;
Mva=3.75;
V=10;
p1=10;//2p=10
S=144;
C=5;
S1=12;
x1=1;
x2=2;
```

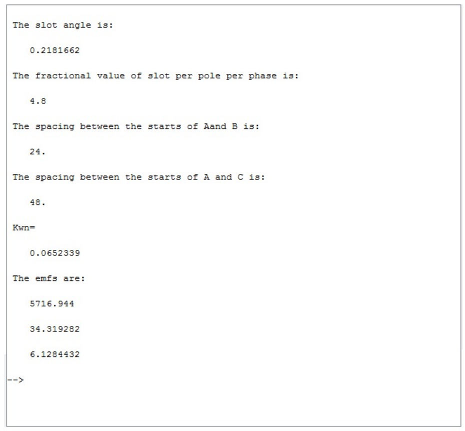



Figure 3.3: Ex3 3

```
thetaa1=0.116;
m=3;
r=(p1*%pi)/S;
disp(r,'The slot angle is:')
g1=S/(p1*m);
disp(g1,'The fractional value of slot per pole per phase is:')
Sab=g1*((3*x1)+2);
disp(Sab,'The spacing between the starts of Aand B is:')
Sac=g1*((3*x2)+4);
disp(Sac,'The spacing between the starts of A and C is:')
theta1=60*(1/2);
theta2=2*(1/2)*(1/2);
theta3=30*(1/2);
Kdn=(sin(theta1))/(24*sin(theta2));
Ken=cos(theta3);
Kwn=Kdn*Ken;
n=0:1:7;
```

```
disp(Kwn,'Kwn=')
Eph1=4.44*0.925*50*240*thetaa1;
Eph5=(5750*(0.049/0.925)*(11.2*100.6))/10000;
Eph7=(5750*(0.035/0.925)*(2.8*100.6))/10000;
disp(Eph7,Eph5,Eph1,'The emfs are:')
```

# Chapter 4

# Loss Dissipation

**Scilab code Exa 4.1** Ex4 1

```
clc;
clear;
G=41;//Mass
P=110;//Total loss
S=0.1;//Cooling surface area
lamda=29;//Emissivity
Cp=420;//Specific heat of the machine
theta_m=P/(S*lamda);
disp(theta_m,'Final steady temperature rise:')
Tow=(G*Cp)/(S*lamda);
disp(Tow,'Time constant is:')
t=[1:0.01:8];
T=((-t)/(Tow/3600));
theta=38*(1-exp(T));//The temperature rise time
    relation is
theta_t=theta_m/Tow;
disp(theta_t,'Initial rate of rise is:')
plot(t,theta);
xlabel('Temperature rise/Time relation (h)');
```

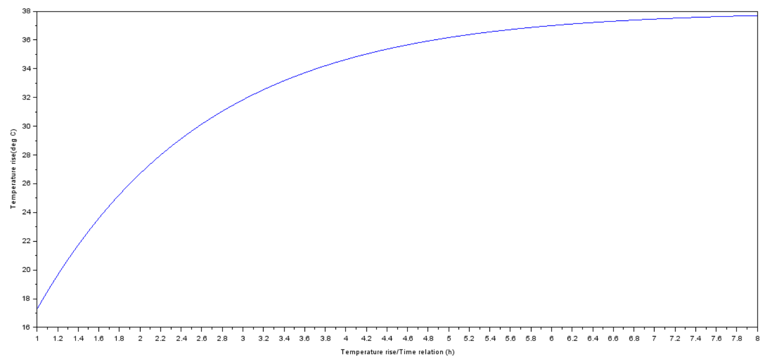



Figure 4.1: Ex4 1

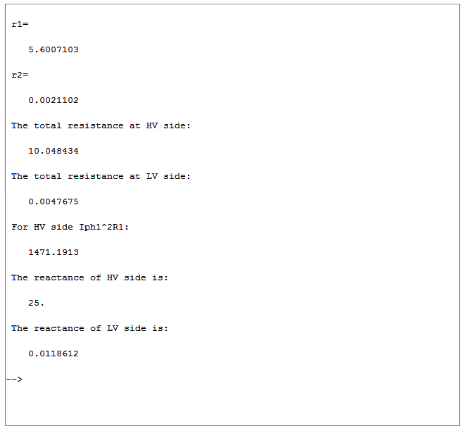
```
ylabel('Temperature rise(deg C)')
```

# Chapter 5

# Transformers Theory and Performance

**Scilab code Exa 5.1** Ex5 1

```
clc;
clear;
w=400;
V1=11;
V2=415;
Hvl=2.46;//I^2R loss for HV side
Lvl=1.95;//Lv loss
X=0.055;//Total leakage reactance
Vph1=11;
Vph2o=V2/(3^(1/2));
Vph2=V2/(3^(1/2)*1000);
Iph1=12.1;
Iph2=555;
H1vl=0.82;//HV losses per phase
L1vl=0.65;//LV losses per phase
r1=820/((Iph1)^2);
r2=650/((Iph2)^2);
```



```
r1=

   5.6007103

r2=

   0.0021102

The total resistance at HV side:

   10.048434

The total resistance at LV side:

   0.0047675

For HV side Iph1^2R1:

   1471.1913

The reactance of HV side is:

   25.

The reactance of LV side is:

   0.0118612

-->
```

Figure 5.1: Ex5 1

```
disp(r1,'r1=')
disp(r2,'r2=')
R1=r1+(r2*((Vph1/Vph2)^2));
R2=(r1*((Vph2/Vph1)^2))+r2;
disp(R1,'The total resistance at HV side:')
disp(R2,'The total resistance at LV side:')
P1=(Iph1^2)*R1;//for HV side
disp(P1,'For HV side Iph1^2R1:')
X1=(X*11000)/Iph1;//where 11KV=11000
//Reactance at HV side
X2=X1*(Vph2o/11000)^2;//Reactance at LV side
x1=X1/2;
x2=X2/2;
disp(x1,'The reactance of HV side is:')
disp(x2,'The reactance of LV side is:')
```

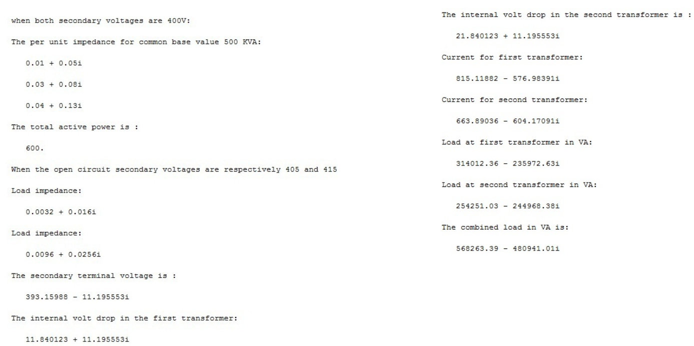



Figure 5.2: Ex5 5

**Scilab code Exa 5.5** Ex5 5

```
clc;
clear;
W1=500;
R1=0.010;//Resistance
XL1=0.05;//leakage reactance
W2=750;
disp('when both secondary voltages are 400V:')
pf=0.8;//lag pf with 250KVA
W3=250;
R2=0.015;//Resistance value
XL2=0.04;//Reactance value
Z1=(R1+((XL1)*%i));
Z2=2*(R2+((XL2)*%i));
Z=Z1+Z2;
disp(Z1,'The per unit impedance for common base value 500 KVA:')
disp(Z2)
disp(Z)
theta=acos(0.8);
```

```
S=W2*(pf-(sin(theta)*%i));
S1=S*(Z2/Z);
S2=S*(Z1/Z);
SA=real(S1)+real(S2);//Real parts of the calculated
    power
disp(SA,'The total active power is :')
SR=W2*(sin(acos(0.8)));
disp('When the open circuit secondary voltages are
    respectively 405 and 415')
R3=0.0032;//from millman theorem
R4=0.0096;//from millman theorem
XL3=0.0160;//from millman theorem
XL4=0.0256;//from millman theorem
Z3=R3+((XL3)*%i);
Z4=R4+((XL4)*%i);
disp(Z3,'Load impedance:')
disp(Z4,'Load impedance:')
Z5=0.166+(0.125*%i);//Impedance value for the
    assured voltage 395V
E1=405+(0*%i);
E2=415+(0*%i);
Ez=(E1/Z3)+(E2/Z4);
Zo=(Z5*Z3*Z4)/((Z3*Z4)+(Z5*Z4)+(Z5*Z3));
V=(Ez*Zo);
disp(V,'The secondary terminal voltage is :')
Vi1=E1-V;
disp(Vi1,'The internal volt drop in the first
    transformer:')
Vi2=E2-V;
disp(Vi2,'The internal volt drop in the second
    transformer is :')
I1=Vi1/Z3;
I2=Vi2/Z4;
disp(I1,'Current for first transformer:')
disp(I2,'Current for second transformer:')
S3=V*I1;
S4=V*I2;
disp(S3,'Load at first transformer in VA:')
```

```
disp(S4,'Load at second transformer in VA:')
S5=S3+S4;
disp(S5,'The combined load in VA is:')
```

# Chapter 8

# Induction Machines Theory and Performance

**Scilab code Exa 8.4** Ex8 4

```
clc;
clear;
V=3.3;
f=50;
P=10;
S=0.03;
I=4;//Magnetizing current
Lc=30;//core loss
Zsl=0.18+(1.6*%i);//stator leakage impedance
Zrl=0.4+(1.6*%i);//Rotor stan still leakage
    impedance
W=27*10^2;
Vph=1.9;//Rated phase voltage
Ibsc=W/(3*Vph);//Bus bar short circuit current level
Zs1=(Vph/Ibsc)*%i;//The effective system impedance
disp('When the machines running at slip 0.03:')
Z1=((real(Zsl)+(real(Zrl)/S))+(imag(Zsl)+imag(Zrl))*
```

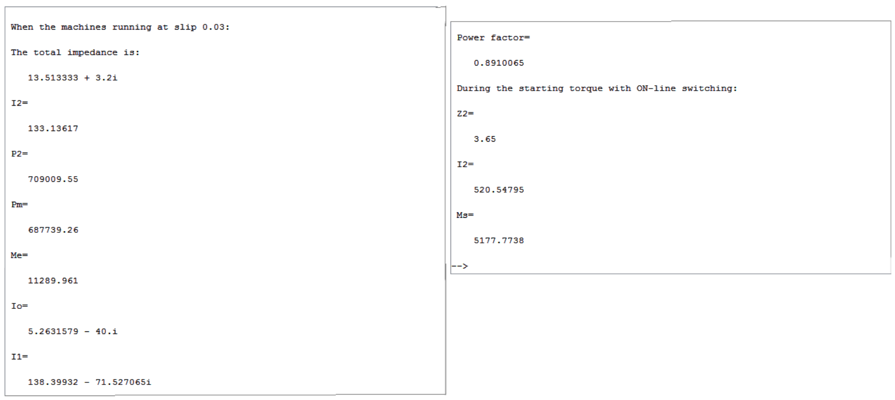
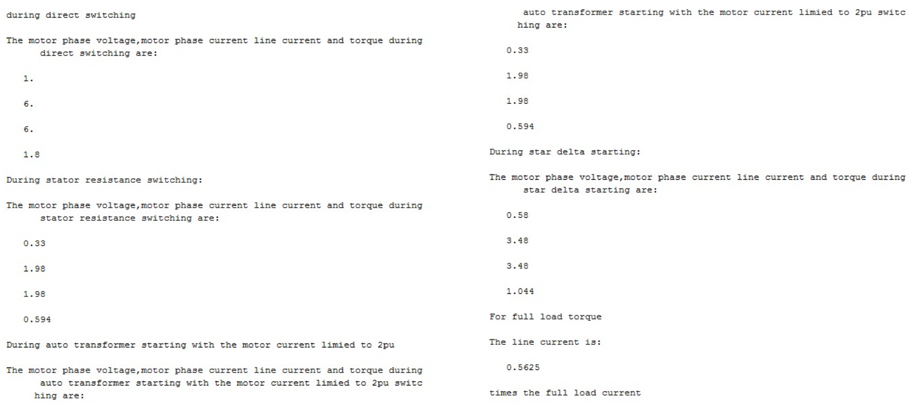



Figure 8.1: Ex8 4

```
    %i);
disp(Z1,'The total impedance is:')
I2o=1900/Z1;
I2=real(I2o);
disp(I2,'I2=')
P2=3*I2^2*((real(Zrl))/S);
disp(P2,'P2=')
Pm=P2*(1-S);
disp(Pm,'Pm=')
Me=P2/62.8;
disp(Me,'Me=')
Io=(P/Vph)-(40*%i);
disp(Io,'Io=')
I1=Io+I2o;
disp(I1,'I1=')
pf1=cosd(-27)
disp(pf1,'Power factor=')
disp('During the starting torque with ON-line
    switching:')
Z2=(Zrl+Zsl);//The impedance value is increased to
```



```
during direct switching

The motor phase voltage,motor phase current line current and torque during
      direct switching are:

   1.

   6.

   6.

   1.8

During stator resistance switching:

The motor phase voltage,motor phase current line current and torque during
      stator resistance switching are:

   0.33

   1.98

   1.98

   0.594

During auto transformer starting with the motor current limied to 2pu

The motor phase voltage,motor phase current line current and torque during
      auto transformer starting with the motor current limied to 2pu switc
     hing are:

   0.33

   1.98

   1.98

   0.594

During star delta starting:

The motor phase voltage,motor phase current line current and torque during
      star delta starting are:

   0.58

   3.48

   3.48

   1.044

For full load torque

The line current is:

   0.5625

times the full load current
```

Figure 8.2: Ex8 5

```
    3.65
Z2=3.65;
disp(Z2,'Z2=')
I2=(Vph*10^3)/Z2;
disp(I2,'I2=')
Ms=3*I2^2*(real(Zrl)/62.8);
disp(Ms,'Ms=')
```

**Scilab code Exa 8.5** Ex8 5

```
clc;
clear;
Sfl=0.05;//slip of full load current
disp('during direct switching')
Vmp=1;
Imp=6*Vmp;
```

```
Ila=6*Vmp;
Ta=0.3*Imp;
disp(Ta,Ila,Imp,Vmp,'The motor phase voltage,motor
    phase current line current and torque during
    direct switching are:')
disp('During stator resistance switching:')
Vmpb=0.33;
Impb=6*Vmpb;
Ilb=6*Vmpb;
Tb=0.3*Impb;
disp(Tb,Ilb,Impb,Vmpb,'The motor phase voltage,motor
     phase current line current and torque during
    stator resistance switching are:')
disp('During auto transformer starting with the
    motor current limied to 2pu')
Vmpc=0.33;
Impc=6*Vmpc;
Ilc=6*Vmpc;
Tc=0.3*Impc;
disp(Tc,Ilc,Impc,Vmpc,'The motor phase voltage,motor
     phase current line current and torque during
    auto transformer starting with the motor current
    limied to 2pu switching are:')
disp('During star delta starting:')
Vmpd=0.58;
Impd=6*Vmpd;
Ild=6*Vmpd;
Td=0.3*Impd;
disp(Td,Ild,Impd,Vmpd,'The motor phase voltage,motor
     phase current line current and torque during
    star delta starting are:')
disp('For full load torque ')
Ilat=(0.75^2);
disp('times the full load current',Ilat,'The line
    current is:')
//The results in the book are tabulated using
    various expressions already found.Proper solution
     is not given in the text book.
```

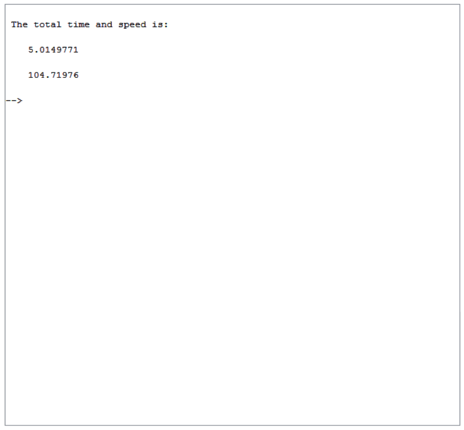
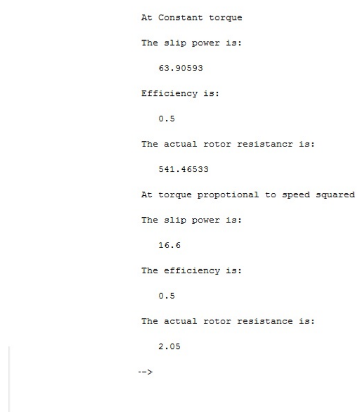



Figure 8.3: Ex8 7 a

---

**Scilab code Exa 8.7.a** `Ex8 7 a`

```
clc;
clear;
V=420;
f=50;
P=6;
Z=1+(2*%i);//Both stator and rotor referred leakage
    impedance
J=3;//Total inertia of the drive
S1=1.96;
S2=1;
r1=1;
r2=1;
x1=4;
```


```
At Constant torque

The slip power is:

   63.90593

Efficiency is:

   0.5

The actual rotor resistancr is:

   541.46533

At torque propotional to speed squared

The slip power is:

   16.6

The efficiency is:

   0.5

The actual rotor resistance is:

   2.05

-->
```

Figure 8.4: Ex8 7

```
ti=((((r1^2)+(x1^2))/(2*r2))*((S2^2)-(S1^2)))+(2*r1
    *(S2-S1))+(r2*log(S2/S1));
Ws=2*%pi*(1000/60);
t=J*(105^2)*(-ti/(V^2));
disp(Ws,t,'The total time and speed is:')
```

**Scilab code Exa 8.7** Ex8 7

```
clc;
clear;
W=375;
V=3;
f=50;
P=10;
r2=0.39;//Rotor resistance
X1=5.75;//Leakage reactance
```

```
Rsr=4.65//Stator to rotor turns ratio
Sf1=0.022;//Full load slip
Ws=62.8;//Synchronous speed
Wf1=125;//Full load output
Tf1=Wf1/(Ws*0.978);//Full load torque
Tp0=(1730^2)/(2*X1*Ws);//Pull out torque
disp('At Constant torque')
q=Tf1/Tp0;
R2=0.5*(X1/q)*(1+sqrt(1-(q*q)));
R=R2-r2;
R0=R/(Rsr*Rsr);
Sp2=0.5*(Wf1/0.978);
Eff=0.5;
Rrt=R/(Rsr^2);
Sp3=2.04*((0.5/0.978)^2);
q1=Sp3/Tp0;
R20=0.5*(X1/q1)*(1+sqrt(1-q1));
R1=R20-r2;
Sp4=16.6;
Eff=0.5;
Rrt2=R1/(Rsr^2);
R3=2.05;
disp(Sp2,'The slip power is:')
disp(Eff,'Efficiency is:')
disp(R0,'The actual rotor resistancr is:')
disp('At torque propotional to speed squared')
disp(Sp4,'The slip power is:')
disp(Eff,'The efficiency is:')
disp(R3,'The actual rotor resistance is:')
//The above values are written n such a way that
   alternate solutions are not possible
```

**Scilab code Exa 8.8** Ex8 8

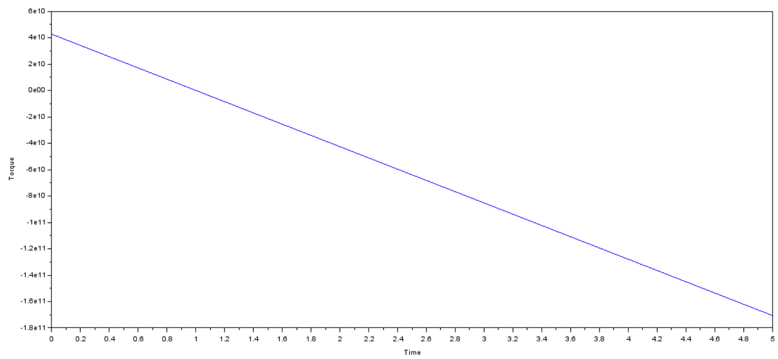
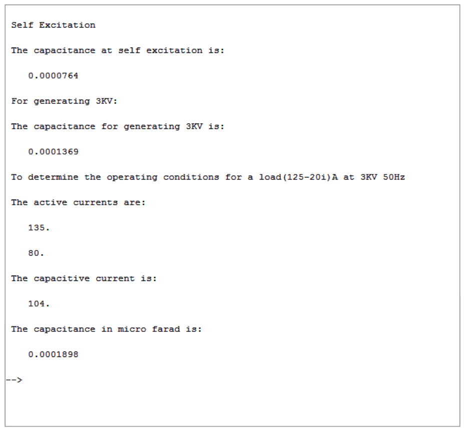



Figure 8.5: Ex8 8

```
clc;
clear;
W=1000;
P=10;
T=573;//Full load torque
Ke=9;//Kinetic energy stored
Sfl=0.10;//Slip for full load torque
Mo=5;//idling torque
M1=40;//instantaneous torque
Tfl=16.7;//Rated full load torque
S=0.1;//Rated full load torque is developed at 0.1
K=167;
M=K*S;
alpha=7;
t=[0:0.1:5];
J=Ke*(10^6)*(1/2)*(60^2);
Ws=62.8;//Synchronous speed
M=((M1-Mo+(alpha*((J*Ws)/K)))*(1-exp((-K)/(J*Ws))*t)
    )+Mo-(alpha*t);
plot(t,M);
```


```
Self Excitation

The capacitance at self excitation is:

   0.0000764

For generating 3KV:

The capacitance for generating 3KV is:

   0.0001369

To determine the operating conditions for a load(125-20i)A at 3KV 50Hz

The active currents are:

   135.

   80.

The capacitive current is:

   104.

The capacitance in micro farad is:

   0.0001898

-->
```

Figure 8.6: Ex8 9

```
xlabel('Time')
ylabel('Torque')
```

---

**Scilab code Exa 8.9** Ex8 9

```
clc;
clear;
disp('Self Excitation')
Sm=24*10^(-3);//minimum capacitive susceptance
C=Sm/314;
disp(C,'The capacitance at self excitation is:')
disp('For generating 3KV:')
Sm1=43*10^(-3);//Using method of interpolation we
    get 43ms for 1.73KV/Ph(3KV line)
C1=Sm1/314;
disp(C1,'The capacitance for generating 3KV is:')
```

```
disp('To determine the operating conditions for a
   load(125-20i)A at 3KV 50Hz')
Im=60;
It=10;
Ir=125;
Ix=20;
Ia=Ir+It;
Ia1=Ix+Im;
Ic=104;
Sm2=59.6*10^(-3);
C2=Sm2/314;
disp(Ia1,Ia,'The active currents are:')
disp(Ic,'The capacitive current is:')
disp(C2,'The capacitance in micro farad is:')
```

# Chapter 10

# Synchronous Machines Theory and Performance

**Scilab code Exa 10.2** Ex10 2

```
clc;
clear;
W=500;
V=3.3;
f=50;
R=0.02;//Resistance
Xl=0.08;//Leakage reactance
Pap=0.67;//pole arc to pole pitch ratio
Kr=0.34;//Reaction coefficient
Vpu=1;//Per unit voltage corresponding to the
    voltage 3.3
rsc=1;//short ciecuit ratio
xsdu=1.25;//Unsaturated synchronous reactance
disp('Simple mmf method')
Foa=1;
F1a=1;
F2a=1.78;
```

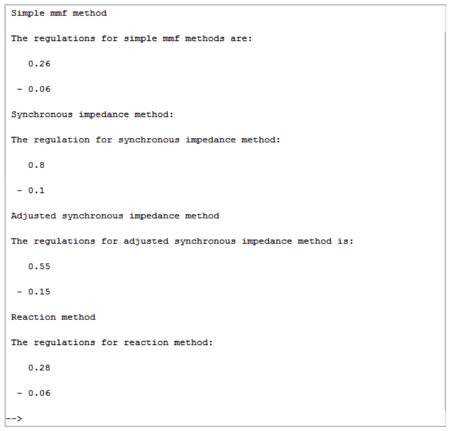



Figure 10.1: Ex10 2

```
pf1=0.8;
pf2=acos(pf1);
Eta=1.26;
F2b=0.94;
Etb=0.94;
Ea=(Eta-Foa)/Foa;
Eb=(Etb-F1a)/F1a;
disp(Eb,Ea,'The regulations for simple mmf methods are:')
disp('Synchronous impedance method:')
Et1=1.80;
Et2=0.90;
E1a=(Et1-Foa);
E2a=Et2-F1a;
disp(E2a,E1a,'The regulation for synchronous impedance method:')
disp('Adjusted synchronous impedance method')
E1=Foa+((pf1+(pf2*%i))*(R+(Xl*%i)));
OF=1.4;
OH=1.06;
```

```
K1=OF/OH;
K2=1.5;
xsdu=1.25;
xsd=0.1+((xsdu-0.1)/((1.2*%i)*(1+0.76)^(1/2)));
Et3=1.55;
E1b=0.97;
OF1=1.18;
OH1=0.97;
K1o=OF1/OH1;
K2o=0.76;
xsd1=0.87;
Et4=0.85;
E3a=Et3-Foa;
E3b=Et4-F1a;
disp(E3b,E3a,'The regulations for adjusted synchronous impedance method is:')
disp('Reaction method')
Et5=1.28;
Et6=0.94;
E4a=Et5-Foa;
E4b=Et6-F1a;
disp(E4b,E4a,'The regulations for reaction method:')
```

**Scilab code Exa 10.3** Ex10 3

```
clc;
clear;
V=1000;
Z1=(0.1+(2*%i));
Z2=(0.2+(3.2*%i));
Zl=(2+(1*%i));//load impedance
div=10;//divergence
E1=(V+(0*%i));
```

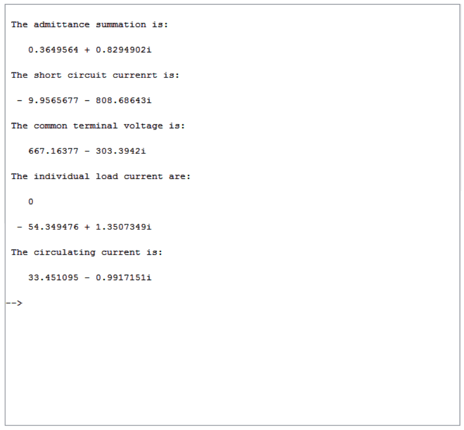



Figure 10.2: Ex10 3

```
E2=V*(cosd(div)-sind(div)*%i);
Zo=(Z1*Z1*Z2)/((Z1*Z2)+(Z1*Z2)+(Z1*Z1));
disp(Zo,'The admittance summation is:')
Isc=(E1/Z1)+(E2/Z2);
disp(Isc,'The short circuit currenrt is:')
V1=Isc*Zo;
disp(V1,'The common terminal voltage is:')
I1=(E1-V)/Z1;
I2=(E2-V)/Z2;
disp(I2,I1,'The individual load current are:')
P1=155;
P2=60;
Is=(E1-E2)/(Z1+Z2);
disp(Is,'The circulating current is:')
```

**Scilab code Exa 10.5** Ex10 5

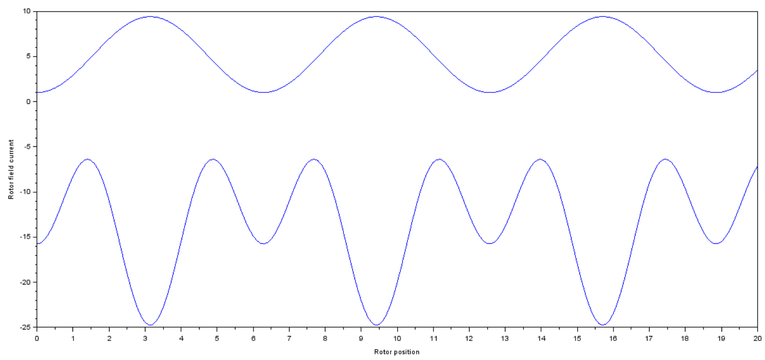



Figure 10.3: Ex10 5

```
clc;
clear;
xad=1.5;
xaq=0.60;
x=0.1;
xf=0.13;
Vq=1;
theta_0=0;
xd1=((xad*xf)/(xad+xf))+x;
xsq=xaq+x;
Ifo=1;
t=[0:0.1:20];
Ia=4.5*(cos(t)-3-(1.5*(cos(2*t))));
If=4.2*(1-cos(t))+Ifo;
plot(t,Ia)
plot(t,If)
xlabel('Rotor position')
ylabel('Rotor field current')
```

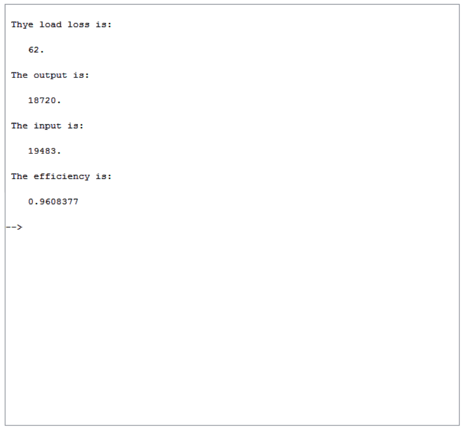



Figure 10.4: Ex10 9

**Scilab code Exa 10.9** `Ex10 9`

```
clc;
clear;
W=23400;//KVA rating
pf=0.8;
Lb=68;//Bearing friction loss
Lv=220;//Windage loss
Lc=165;//Core loss
Lw=200;//WInding loss
Li=62;//I^2R loss
Le=14;//Exciter loss
Ll=Lw-Li;
disp(Li,'Thye load loss is:')
Lt=763;//Sum of totallosses
```

```
Po=W*pf;//output
disp(Po,'The output is:')
Pi=Po+Lt;
disp(Pi,'The input is:')
eff=Po/Pi;
disp(eff,'The efficiency is:')
```

# Chapter 12

# Special Machines

**Scilab code Exa 12.1** Ex12 1

```
clc;
clear;
w=200;
V=240;
f=50;
P=4;//no of poles
S=0.05;//slip
r1=11.4;
x1=14.5;
r2o=6.9;
x2o=7.2;
xmo=135;
Ls=32;//core and mechanical loss
S=0.05;
R1=((r2o)/S)+(x2o*%i);
R2=(xmo*%i);
M1=((R1*R2)/(R1+R2));
disp(M1,'The rotor impedance for forward circuit is:
    ')
```

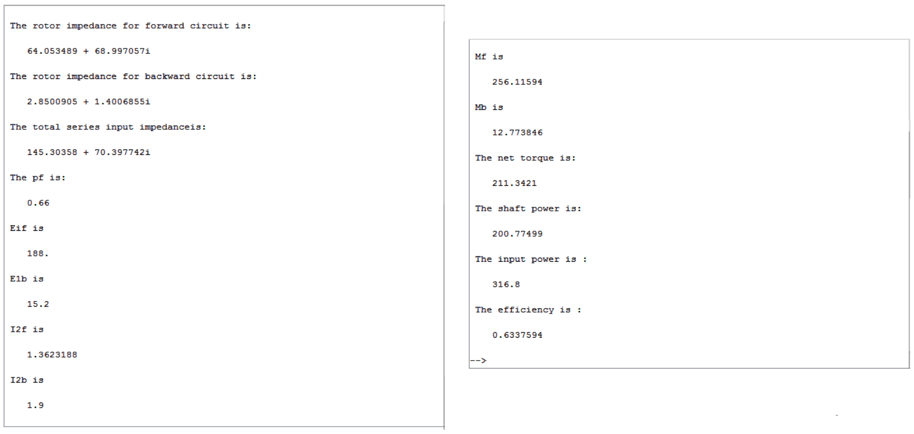



Figure 12.1: Ex12 1

```
R3=((r2o)/(2-S));
R4=(x2o*%i);
M2=(R3*R4)/(R3+R4);
disp(M2,'The rotor impedance for backward circuit is
    :')
Z1=78.4;
M3=Z1+M1+M2;
disp(M3,'The total series input impedanceis:')
cos_theta=0.66;//power factor
disp(cos_theta,'The pf is:')
E1f=2*94;
E1b=2*7.6;
I2f=E1f/((r2o)/S);
I2b=E1b/8;
Mf=(I2f)^2*((r2o)/S);
Mb=(I2b)^2*((r2o)/(2-S));
disp(E1f,'Eif is')
disp(E1b,'E1b is')
disp(I2f,'I2f is')
disp(I2b,'I2b is')
```

```
disp(Mf,'Mf is')
disp(Mb,'Mb is')
M=Mf-Mb-Ls;//net torque
Ms=M*0.95;//shaft power
disp(M,'The net torque is:')
disp(Ms,'The shaft power is:')
Mi=V*2*cos_theta;//input power
disp(Mi,'The input power is :')
eff=Ms/Mi;
disp(eff,'The efficiency is :')
```