

Scilab Textbook Companion for
The Performance And Design Of A.C.
Machines
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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

Introductory

Scilab code Exa 1.1 Ex1 1

```
1 clc;
2 clear;
3 //case1:
4 disp('To find no. of primary & secondary turns:')
5 Bm1=1.5; //Max flux density of primary in tesla
6 Vt1=10.7; //Terminal voltage of primary in volts
7 Bm2=1.46; //Max flux density of secondary in tesla
8 Vt2=10.46; //Terminal voltage of secondary in volts
9 V1=11000; //Primary RMS voltage in volts
10 V2=415; //Secondary RMS voltage in volts
11 P=300e3; //Input power in volt-amphere
12 N2=(V2)/(Vt2); //No. of turns in secondary
13 N1=(V1)/(Vt1); //No. of turns in primary
14 disp(N1, 'No of turns in primary is ')
15 disp(N2, 'No of turns in secondary is ')
16 //case2:
17 disp('To find rated current:')
18 I1=P/(V1);
19 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

```

20 disp(I1, 'The primary rated current in amps is ')
21 disp(I2, 'The secondary rated current in amps is ')
22 // case3:
23 disp('To find primary & secondary load impedance:')
24 Z1=(V1)/(I1);
25 Z2=(V2)/(I2);
26 disp(Z1, 'The primary load impedance in ohms is ')
27 disp(Z2, 'The secondary load impedance in ohms is ')

```

Scilab code Exa 1.2 Ex1 2

```

1 clc;
2 clear;
3 D=0.50; //Diameter of machine in m
4 l=0.20; //Lemgth of machine in m
5 lg=0.005; //Gap length in m

```

```

To find the torque with the machine windings arranged to give a 2-pole field:
ld:
Torque for 2-pole field in N-m is
- 262.57392
To find the torque with the machine windings arranged to give a 8-pole field:
ld:
Torque for 8-pole field in N-m is
- 65.64348
-->

```

Figure 1.2: Ex1 2

```

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

```

```
To find the rating of the transformer:
The rating of the transformer is
302097.6
-->
```

Figure 1.3: Ex1 3

Scilab code Exa 1.3 Ex1 3

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

```

To find the tangential force per length of gap periphery and per unit axial
length of the machine:

The specific electric loadings is:

34650.

The specific force is:

17325.

-->|

```

Figure 1.4: Ex1 4

Scilab code Exa 1.4 Ex1 4

```

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

```

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

Chapter 2

Magnetic circuits

Scilab code Exa 2.1 Ex2 1

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

```
To find the harmonic components ,mean gap density ,rms value:
The harmonic components are:
100.64
- 11.58
- 11.25
2.83
The mean gap density is :
60.437043
The rms value is:
72.100893
-->
```

Figure 2.1: Ex2 1

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

Scilab code Exa 2.4 Ex2 4

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

```

The sine distributed flux density of peak value:
0.11128

The magnetic pull per pole is :
3300.4167

The resultant u.m.p is:
1555.2847

The useful torque of machine is:
260.

The pheripheral force is:
1040.
-->

```

Figure 2.2: Ex2 4

```

12 Fo=4450; //Resultant gap mmf per pole
13 Mewo=1.25*10^(-7);
14 Bm=(Fo*Mewo)/lg;
15 disp(Bm, 'The sine distributed flux density of peak
    value: ')
16 Mp=((D*1)/(3*Mewo))*(Bm^2); //Magnetic pull per pole
17 disp(Mp, 'The magnetic pull per pole is :')
18 e1=0.001/0.005; //Eccentricity after displacement of
    'e'
19 Mu=((%pi*D*1)/(4*Mewo))*(Bm^2)*e1;
20 disp(Mu, 'The resultant u.m.p is:')
21 M=260;
22 F=M/0.25;
23 disp(M, 'The useful torque of machine is:')
24 disp(F, 'The pheripheral force is:')

```

Chapter 3

Windings

Scilab code Exa 3.1 Ex3 1

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

```

For a copper winding at 75 deg cel:
The conductor area is:
0.0000591
For a temp rise of 65 deg cel:
The power dissipated is:
641.44737
The field current is:
160.36184
The number of turns per pole is:
56.123077
The current density is:
2.8573245
-->

```

Figure 3.1: Ex3 1

```

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

```

Scilab code Exa 3.2 Ex3 2

```

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

```

```
for 16 pole 3 phase machine :  
The integral slot winding is:  
2.25  
For 10 pole 3 phase machine :  
The integral slot winding is:  
3.6  
-->
```

Figure 3.2: Ex3 2

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

Scilab code Exa 3.3 Ex3 3

```
1 clc;  
2 clear;  
3 Mva=3.75;  
4 V=10;  
5 p1=10; //2p=10  
6 S=144;  
7 C=5;  
8 S1=12;  
9 x1=1;  
10 x2=2;
```

```

The slot angle is:
0.2181662
The fractional value of slot per pole per phase is:
4.8
The spacing between the starts of Aand B is:
24.
The spacing between the starts of A and C is:
48.
Kwn=
0.0652339
The emfs are:
5716.944
34.319282
6.1284432
-->

```

Figure 3.3: Ex3 3

```

11 thetaa1=0.116;
12 m=3;
13 r=(p1*%pi)/S;
14 disp(r,'The slot angle is:')
15 g1=S/(p1*m);
16 disp(g1,'The fractional value of slot per pole per
    phase is:')
17 Sab=g1*((3*x1)+2);
18 disp(Sab,'The spacing between the starts of Aand B
    is:')
19 Sac=g1*((3*x2)+4);
20 disp(Sac,'The spacing between the starts of A and C
    is:')
21 theta1=60*(1/2);
22 theta2=2*(1/2)*(1/2);
23 theta3=30*(1/2);
24 Kdn=(sin(theta1))/(24*sin(theta2));
25 Ken=cos(theta3);
26 Kwn=Kdn*Ken;
27 n=0:1:7;

```

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

Chapter 4

Loss Dissipation

Scilab code Exa 4.1 Ex4 1

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

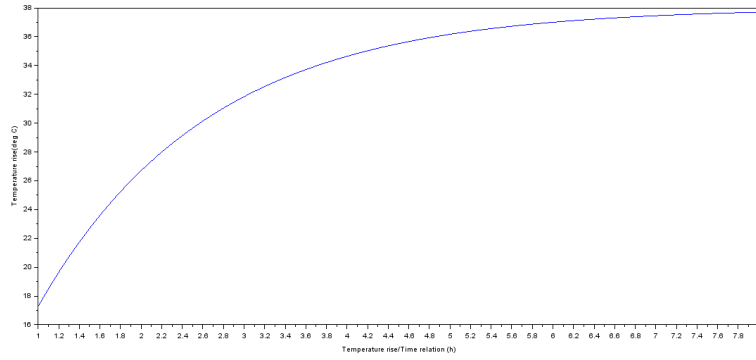


Figure 4.1: Ex4 1

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

Chapter 5

Transformers Theory and Performance

Scilab code Exa 5.1 Ex5 1

```
1  clc ;
2  clear ;
3  w=400 ;
4  V1=11 ;
5  V2=415 ;
6  Hv1=2.46 ; //I^2R loss for HV side
7  Lv1=1.95 ; //Lv loss
8  X=0.055 ; //Total leakage reactance
9  Vph1=11 ;
10 Vph2o=V2/(3^(1/2)) ;
11 Vph2=V2/(3^(1/2)*1000) ;
12 Iph1=12.1 ;
13 Iph2=555 ;
14 H1v1=0.82 ; //HV losses per phase
15 L1v1=0.65 ; //LV losses per phase
16 r1=820/((Iph1)^2) ;
17 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

```
18 disp(r1, 'r1=')
19 disp(r2, 'r2=')
20 R1=r1+(r2*((Vph1/Vph2)^2));
21 R2=(r1*((Vph2/Vph1)^2))+r2;
22 disp(R1, 'The total resistance at HV side:')
23 disp(R2, 'The total resistance at LV side:')
24 P1=(Iph1^2)*R1; //for HV side
25 disp(P1, 'For HV side Iph1^2R1:')
26 X1=(X*11000)/Iph1; //where 11KV=11000
27 //Reactance at HV side
28 X2=X1*(Vph2o/11000)^2; //Reactance at LV side
29 x1=X1/2;
30 x2=X2/2;
31 disp(x1, 'The reactance of HV side is:')
32 disp(x2, 'The reactance of LV side is:')
```

```

When both secondary voltages are 400V:
The per unit impedance for common base value 500 KVA:
0.01 + 0.05i
0.03 + 0.05i
0.04 + 0.19i
The total active power is :
600.
When the open circuit secondary voltages are respectively 400 and 415
Load impedance:
0.0032 + 0.016i
Load impedance:
0.0096 + 0.0256i
The secondary terminal voltage is :
393.15985 - 11.195553i
The internal volt drop in the first transformer:
11.840123 + 11.195553i

The internal volt drop in the second transformer is :
21.840123 + 11.195553i
Current for first transformer:
815.11882 - 576.98391i
Current for second transformer:
663.89036 - 604.17091i
Load at first transformer in VA:
314012.36 - 235872.63i
Load at second transformer in VA:
254251.03 - 248968.38i
The combined load in VA is:
568263.39 - 480941.01i

```

Figure 5.2: Ex5 5

Scilab code Exa 5.5 Ex5 5

```

1  clc;
2  clear;
3  W1=500;
4  R1=0.010; // Resistance
5  XL1=0.05; //leakage reactance
6  W2=750;
7  disp('when both secondary voltages are 400V:')
8  pf=0.8; //lag pf with 250KVA
9  W3=250;
10 R2=0.015; // Resistance value
11 XL2=0.04; //Reactance value
12 Z1=(R1+((XL1)*%i));
13 Z2=2*(R2+((XL2)*%i));
14 Z=Z1+Z2;
15 disp(Z1,'The per unit impedance for common base
    value 500 KVA:')
16 disp(Z2)
17 disp(Z)
18 theta=acos(0.8);

```

```

19 S=W2*(pf-(sin(theta)*%i));
20 S1=S*(Z2/Z);
21 S2=S*(Z1/Z);
22 SA=real(S1)+real(S2); //Real parts of the calculated
    power
23 disp(SA, 'The total active power is :')
24 SR=W2*(sin(acos(0.8)));
25 disp('When the open circuit secondary voltages are
    respectively 405 and 415')
26 R3=0.0032; //from millman theorem
27 R4=0.0096; //from millman theorem
28 XL3=0.0160; //from millman theorem
29 XL4=0.0256; //from millman theorem
30 Z3=R3+((XL3)*%i);
31 Z4=R4+((XL4)*%i);
32 disp(Z3, 'Load impedance:')
33 disp(Z4, 'Load impedance:')
34 Z5=0.166+(0.125*%i); //Impedance value for the
    assured voltage 395V
35 E1=405+(0*%i);
36 E2=415+(0*%i);
37 Ez=(E1/Z3)+(E2/Z4);
38 Zo=(Z5*Z3*Z4)/((Z3*Z4)+(Z5*Z4)+(Z5*Z3));
39 V=(Ez*Zo);
40 disp(V, 'The secondary terminal voltage is :')
41 Vi1=E1-V;
42 disp(Vi1, 'The internal volt drop in the first
    transformer:')
43 Vi2=E2-V;
44 disp(Vi2, 'The internal volt drop in the second
    transformer is :')
45 I1=Vi1/Z3;
46 I2=Vi2/Z4;
47 disp(I1, 'Current for first transformer:')
48 disp(I2, 'Current for second transformer:')
49 S3=V*I1;
50 S4=V*I2;
51 disp(S3, 'Load at first transformer in VA:')

```

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

Chapter 8

Induction Machines Theory and Performance

Scilab code Exa 8.4 Ex8 4

```
1  clc;
2  clear;
3  V=3.3;
4  f=50;
5  P=10;
6  S=0.03;
7  I=4; //Magnetizing current
8  Lc=30; //core loss
9  Zs1=0.18+(1.6*%i); //stator leakage impedance
10 Zr1=0.4+(1.6*%i); //Rotor stand still leakage
    impedance
11 W=27*10^2;
12 Vph=1.9; //Rated phase voltage
13 Ibsc=W/(3*Vph); //Bus bar short circuit current level
14 Zs1=(Vph/Ibsc)*%i; //The effective system impedance
15 disp('When the machines running at slip 0.03:')
16 Z1=((real(Zs1)+(real(Zr1)/S))+(imag(Zs1)+imag(Zr1))*
```

```

When the machines running at slip 0.03:
The total impedance is:
13.513333 + 3.2i
I2=
133.13617
P2=
709009.55
Pm=
687739.26
Me=
11289.961
Io=
5.2631579 - 40.1
I1=
138.39932 - 71.527065i

Power factor=
0.8910065
During the starting torque with ON-line switching:
Z2=
3.65
I2=
520.54795
Ma=
5177.7738
-->

```

Figure 8.1: Ex8 4

```

%i);
17 disp(Z1, 'The total impedance is:');
18 I2o=1900/Z1;
19 I2=real(I2o);
20 disp(I2, 'I2=')
21 P2=3*I2^2*((real(Zr1))/S);
22 disp(P2, 'P2=')
23 Pm=P2*(1-S);
24 disp(Pm, 'Pm=')
25 Me=P2/62.8;
26 disp(Me, 'Me=')
27 Io=(P/Vph) - (40*%i);
28 disp(Io, 'Io=')
29 I1=Io+I2o;
30 disp(I1, 'I1=')
31 pf1=cosd(-27)
32 disp(pf1, 'Power factor=')
33 disp('During the starting torque with ON-line
switching: ')
34 Z2=(Zr1+Zs1); //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 limited to 2pu
The motor phase voltage,motor phase current line current and torque during
auto transformer starting with the motor current limited to 2pu switch-
ing are:
0.33
1.98
1.98
0.594
auto transformer starting with the motor current limited to 2pu switch-
ing 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

```

35 Z2=3.65;
36 disp(Z2,'Z2=')
37 I2=(Vph*10^3)/Z2;
38 disp(I2,'I2=')
39 Ms=3*I2^2*(real(Zr1)/62.8);
40 disp(Ms,'Ms=')

```

Scilab code Exa 8.5 Ex8 5

```

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

```

```

7 Ila=6*Vmp;
8 Ta=0.3*Imp;
9 disp(Ta,Ila,Imp,Vmp,'The motor phase voltage ,motor
    phase current line current and torque during
    direct switching are:')
10 disp('During stator resistance switching:')
11 Vmpb=0.33;
12 Impb=6*Vmpb;
13 Ilb=6*Vmpb;
14 Tb=0.3*Impb;
15 disp(Tb,Ilb,Impb,Vmpb,'The motor phase voltage ,motor
    phase current line current and torque during
    stator resistance switching are:')
16 disp('During auto transformer starting with the
    motor current limied to 2pu')
17 Vmpc=0.33;
18 Impc=6*Vmpc;
19 Ilc=6*Vmpc;
20 Tc=0.3*Impc;
21 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:')
22 disp('During star delta starting:')
23 Vmpd=0.58;
24 Impd=6*Vmpd;
25 Ild=6*Vmpd;
26 Td=0.3*Impd;
27 disp(Td,Ild,Impd,Vmpd,'The motor phase voltage ,motor
    phase current line current and torque during
    star delta starting are:')
28 disp('For full load torque ')
29 Ilat=(0.75^2);
30 disp('times the full load current',Ilat,'The line
    current is:')
31 //The results in the book are tabulated using
    various expressions already found.Proper solution
    is not given in the text book.

```



```
The total time and speed is:  
5.0149771  
104.71976  
-->
```

Figure 8.3: Ex8 7 a

Scilab code Exa 8.7.a Ex8 7 a

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

```

At Constant torque
The slip power is:
 63.90593
Efficiency is:
 0.5
The actual rotor resistance is:
 541.46533
At torque proportional 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

```

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

```

Scilab code Exa 8.7 Ex8 7

```

1 clc;
2 clear;
3 W=375;
4 V=3;
5 f=50;
6 P=10;
7 r2=0.39; //Rotor resistance
8 X1=5.75; //Leakage reactance

```

```

 9 Rsr=4.65//Stator to rotor turns ratio
10 Sf1=0.022;//Full load slip
11 Ws=62.8;//Synchronous speed
12 Wf1=125;//Full load output
13 Tf1=Wf1/(Ws*0.978);//Full load torque
14 Tp0=(1730^2)/(2*X1*Ws);//Pull out torque
15 disp('At Constant torque')
16 q=Tf1/Tp0;
17 R2=0.5*(X1/q)*(1+sqrt(1-(q*q)));
18 R=R2-r2;
19 R0=R/(Rsr*Rsr);
20 Sp2=0.5*(Wf1/0.978);
21 Eff=0.5;
22 Rrt=R/(Rsr^2);
23 Sp3=2.04*((0.5/0.978)^2);
24 q1=Sp3/Tp0;
25 R20=0.5*(X1/q1)*(1+sqrt(1-q1));
26 R1=R20-r2;
27 Sp4=16.6;
28 Eff=0.5;
29 Rrt2=R1/(Rsr^2);
30 R3=2.05;
31 disp(Sp2,'The slip power is:')
32 disp(Eff,'Efficiency is:')
33 disp(R0,'The actual rotor resistancer is:')
34 disp('At torque propotional to speed squared')
35 disp(Sp4,'The slip power is:')
36 disp(Eff,'The efficiency is:')
37 disp(R3,'The actual rotor resistance is:')
38 //The above values are written n such a way that
    alternate solutions are not possible

```

Scilab code Exa 8.8 Ex8 8

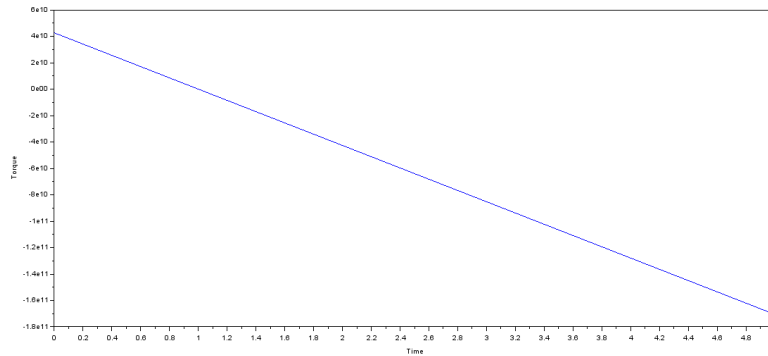


Figure 8.5: Ex8 8

```

1  clc;
2  clear;
3  W=1000;
4  P=10;
5  T=573; //Full load torque
6  Ke=9; //Kinetic energy stored
7  Sf1=0.10; //Slip for full load torque
8  Mo=5; //idling torque
9  M1=40; //instantaneous torque
10 Tf1=16.7; //Rated full load torque
11 S=0.1; //Rated full load torque is developed at 0.1
12 K=167;
13 M=K*S;
14 alpha=7;
15 t=[0:0.1:5];
16 J=Ke*(10^6)*(1/2)*(60^2);
17 Ws=62.8; //Synchronous speed
18 M=((M1-Mo+(alpha*((J*Ws)/K)))*(1-exp((-K)/(J*Ws))*t)
    )+Mo-(alpha*t);
19 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(125-204)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

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

Scilab code Exa 8.9 Ex8 9

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

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

Chapter 10

Synchronous Machines Theory and Performance

Scilab code Exa 10.2 Ex10 2

```
1  clc;
2  clear;
3  W=500;
4  V=3.3;
5  f=50;
6  R=0.02; //Resistance
7  Xl=0.08; //Leakage reactance
8  Pap=0.67; //pole arc to pole pitch ratio
9  Kr=0.34; //Reaction coefficient
10 Vpu=1; //Per unit voltage corresponding to the
    voltage 3.3
11 rsc=1; //short circuit ratio
12 xsdu=1.25; //Unsaturated synchronous reactance
13 disp('Simple mmf method')
14 Foa=1;
15 F1a=1;
16 F2a=1.78;
```

```

Simple mmf method
The regulations for simple mmf methods are:
    0.26
    - 0.06
Synchronous impedance method:
The regulation for synchronous impedance method:
    0.8
    - 0.1
Adjusted synchronous impedance method
The regulations for adjusted synchronous impedance method is:
    0.55
    - 0.15
Reaction method
The regulations for reaction method:
    0.28
    - 0.06
-->

```

Figure 10.1: Ex10 2

```

17 pf1=0.8;
18 pf2=acos(pf1);
19 Eta=1.26;
20 F2b=0.94;
21 Etb=0.94;
22 Ea=(Eta-Foa)/Foa;
23 Eb=(Etb-F1a)/F1a;
24 disp(Eb,Ea,'The regulations for simple mmf methods
    are:')
25 disp('Synchronous impedance method:')
26 Et1=1.80;
27 Et2=0.90;
28 E1a=(Et1-Foa);
29 E2a=Et2-F1a;
30 disp(E2a,E1a,'The regulation for synchronous
    impedance method:')
31 disp('Adjusted synchronous impedance method')
32 E1=Foa+((pf1+(pf2*%i))*(R+(Xl*%i)));
33 OF=1.4;
34 OH=1.06;

```



```

35 K1=OF/OH;
36 K2=1.5;
37 xsdu=1.25;
38 xsd=0.1+((xsdu-0.1)/((1.2*%i)*(1+0.76)^(1/2)));
39 Et3=1.55;
40 E1b=0.97;
41 OF1=1.18;
42 OH1=0.97;
43 K1o=OF1/OH1;
44 K2o=0.76;
45 xsd1=0.87;
46 Et4=0.85;
47 E3a=Et3-Foa;
48 E3b=Et4-F1a;
49 disp(E3b,E3a,'The regulations for adjusted
    synchronous impedance method is:')
50 disp('Reaction method')
51 Et5=1.28;
52 Et6=0.94;
53 E4a=Et5-Foa;
54 E4b=Et6-F1a;
55 disp(E4b,E4a,'The regulations for reaction method:')

```

Scilab code Exa 10.3 Ex10 3

```

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

```

```

The admittance summation is:
0.3649564 + 0.8294902i
The short circuit current is:
- 9.9565677 - 808.68643i
The common terminal voltage is:
667.16377 - 303.3942i
The individual load current are:
0
- 54.349476 + 1.3507349i
The circulating current is:
33.451095 - 0.9917151i
-->

```

Figure 10.2: Ex10 3

```

9 E2=V*(cosd(div)-sind(div)*%i);
10 Zo=(Z1*Z1*Z2)/((Z1*Z2)+(Z1*Z2)+(Z1*Z1));
11 disp(Zo,'The admittance summation is:')
12 Isc=(E1/Z1)+(E2/Z2);
13 disp(Isc,'The short circuit current is:')
14 V1=Isc*Zo;
15 disp(V1,'The common terminal voltage is:')
16 I1=(E1-V)/Z1;
17 I2=(E2-V)/Z2;
18 disp(I2,I1,'The individual load current are:')
19 P1=155;
20 P2=60;
21 Is=(E1-E2)/(Z1+Z2);
22 disp(Is,'The circulating current is:')

```

Scilab code Exa 10.5 Ex10 5

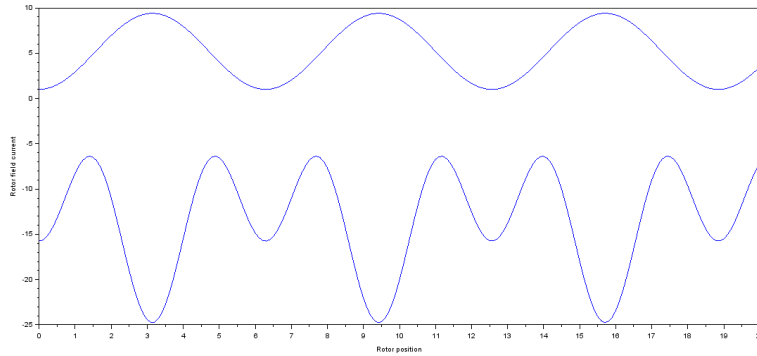


Figure 10.3: Ex10 5

```

1  clc;
2  clear;
3  xad=1.5;
4  xaq=0.60;
5  x=0.1;
6  xf=0.13;
7  Vq=1;
8  theta_0=0;
9  xd1=((xad*xf)/(xad+xf))+x;
10 xsq=xaq+x;
11 Ifo=1;
12 t=[0:0.1:20];
13 Ia=4.5*(cos(t)-3-(1.5*(cos(2*t))));
14 If=4.2*(1-cos(t))+Ifo;
15 plot(t,Ia)
16 plot(t,If)
17 xlabel('Rotor position')
18 ylabel('Rotor field current')

```

```
Thye load loss is:
62.
The output is:
18720.
The input is:
19483.
The efficiency is:
0.9608377
-->
```

Figure 10.4: Ex10 9

Scilab code Exa 10.9 Ex10 9

```
1 clc;
2 clear;
3 W=23400; //KVA rating
4 pf=0.8;
5 Lb=68; //Bearing friction loss
6 Lv=220; //Windage loss
7 Lc=165; //Core loss
8 Lw=200; //Winding loss
9 Li=62; //I2R loss
10 Le=14; //Exciter loss
11 Ll=Lw-Li;
12 disp(Li, 'Thye load loss is:')
13 Lt=763; //Sum of totallosses
```

```
14 Po=W*pf; //output
15 disp(Po, 'The output is:')
16 Pi=Po+Lt;
17 disp(Pi, 'The input is:')
18 eff=Po/Pi;
19 disp(eff, 'The efficiency is:')
```

Chapter 12

Special Machines

Scilab code Exa 12.1 Ex12 1

```
1  clc;
2  clear;
3  w=200;
4  V=240;
5  f=50;
6  P=4; //no of poles
7  S=0.05; //slip
8  r1=11.4;
9  x1=14.5;
10 r2o=6.9;
11 x2o=7.2;
12 xmo=135;
13 Ls=32; //core and mechanical loss
14 S=0.05;
15 R1=((r2o)/S)+(x2o*%i);
16 R2=(xmo*%i);
17 M1=((R1*R2)/(R1+R2));
18 disp(M1, 'The rotor impedance for forward circuit is:
    ')
```

```

The rotor impedance for forward circuit is:
64.053489 + 68.997057i

The rotor impedance for backward circuit is:
2.8500905 + 1.4006855i

The total series input impedance is:
145.30358 + 70.397742i

The pf is:
0.66

E1f is
188.

E1b is
15.2

I2f is
1.3623188

I2b is
1.9

Mf is
256.11594

Mb is
12.773846

The net torque is:
211.3421

The shaft power is:
200.77499

The input power is :
316.8

The efficiency is :
0.6337594
-->

```

Figure 12.1: Ex12 1

```

19 R3=((r2o)/(2-S));
20 R4=(x2o*%i);
21 M2=(R3*R4)/(R3+R4);
22 disp(M2,'The rotor impedance for backward circuit is
: ')
23 Z1=78.4;
24 M3=Z1+M1+M2;
25 disp(M3,'The total series input impedance is:')
26 cos_theta=0.66; //power factor
27 disp(cos_theta,'The pf is:')
28 E1f=2*94;
29 E1b=2*7.6;
30 I2f=E1f/((r2o)/S);
31 I2b=E1b/8;
32 Mf=(I2f)^2*((r2o)/S);
33 Mb=(I2b)^2*((r2o)/(2-S));
34 disp(E1f,'E1f is ')
35 disp(E1b,'E1b is ')
36 disp(I2f,'I2f is ')
37 disp(I2b,'I2b is ')

```

```
38 disp(Mf, 'Mf is ')
39 disp(Mb, 'Mb is ')
40 M=Mf-Mb-Ls; //net torque
41 Ms=M*0.95; //shaft power
42 disp(M, 'The net torque is:')
43 disp(Ms, 'The shaft power is:')
44 Mi=V*2*cos_theta; //input power
45 disp(Mi, 'The input power is :')
46 eff=Ms/Mi;
47 disp(eff, 'The efficiency is :')
```
