

Scilab Textbook Companion for
Electrical Machines-2
by T. Singh¹

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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

Synchronous machines

Scilab code Exa 1.1.p Distribution Factor

```
1 // Prob 1.1
2 clc;
3 clear;
4 close;
5 format('v',5);
6 // Given data
7 s=36;//no. of slots
8 p=4;//no. of poles
9 ph=3;//no. of phase
10 s1=s/ph;//no. of slots pe phase
11 m=s1/p;//no. of slots per pole per phase
12 alfa=180*p/s;//slot angle in degree
13 Kd=sind(m*alfa/2)/(m*sind(alfa/2));//distribution
    factor
14 disp(Kd,"Distribution factor for 36 slots : ");
```

Scilab code Exa 1.1 Single Layer Winding

```

1 //Exa 1.1
2 clc;
3 clear;
4 close;
5 //given data
6 slots=24;//no. of slots
7 NoOfPhase=3;//no of phase
8 MotorSpeed=1450;//in rpm
9 N=1500;//Synchronous Speed in rpm
10 f=50;//in Hz
11 disp("As the winding is in single layer , each slot
        contains one coil slide only.");
12 CoilSlidePerSlot=1;//coil slide per slot
13 CoilSlidePerCoil=2;//coil slide per Coil
14 TotalCoils=slots*CoilSlidePerSlot/CoilSlidePerCoil;
    //no. of coils
15 disp(TotalCoils,"Total no. of Coils : ");
16 P=120*f/N;//no. of poles
17 disp(P,"No. of poles : ");
18 PolesPitch=slots/P;//unitless
19 disp(PolesPitch,"Poles Pitch = ");
20 disp("In case of single layer winding , the pole
        pitch is generally taken in odd numbers only ,
        such as 5,7.9 etc. One slot will remain
        unoccupied , if the pitch is taken as even number.
        ");
21 disp("let pole pitch = 5(for short pitch winding)");
22 PolesPitch=5;//for short pitch winding
23 disp("Coil Span or coil through = 1-6");
24 CoilsPerPolePerPhase=TotalCoils/(P*NoOfPhase);//No.
    of Coils/Pole/Phase
25 disp(CoilsPerPolePerPhase,"No. of Coils/Pole/Phase =
        ");
26 pair_of_poles=2;//no. of pair of poles
27 TotalElectricalDegree=360*pair_of_poles;//in degree
28 ElectricalDegreesPerSlot=TotalElectricalDegree/slots
    ;//in degree electrical
29 disp(ElectricalDegreesPerSlot,"Electrical Degrees/

```

```

    Slot = ");
30 Slots_required=120/ElectricalDegreesPerSlot;//No. of
    slotes required for proper phase displacement
31 disp(Slots_required,"No. of slotes required for
    proper phase displacement = ");
32 disp("Winding Table is as follows :");
33 disp("Coil No.      Connection Lead from      Coil
    Span      Phase and Group No.");
34 disp("  1          A1          1-6
          A1");
35 disp("  2          C4          3-8
          C4");
36 disp("  3          B1          5-10
          B1");
37 disp("  4          A2          7-12
          A2");
38 disp("  5          C1          9-14
          C1");
39 disp("  6          B2          11-16
          B2");
40 disp("  7          A3          13-18
          A3");
41 disp("  8          C2          15-20
          C2");
42 disp("  9          B3          17-22
          B3");
43 disp(" 10         A4          19-24
          A4");
44 disp(" 11         C3          21-2
          C3");
45 disp(" 12         B4          23-4
          B4");

```

Scilab code Exa 1.2.p Distribution and pitch factor

```

1 // Prob 1.2
2 clc;
3 clear;
4 close;
5 format('v',5);
6 // Given data
7 s=24;//no. of slots
8 p=4;//no. of poles
9 ph=3;//no. of phase
10 s1=s/p;//no. of slots pe pole
11 alfa=180/s1;//slot angle in degree
12 m=s1/ph;//no. of slots per pole per phase
13 Kd=sind(m*alfa/2)/(m*sind(alfa/2));//distribution
    factor
14 disp(Kd,"Distribution factor : ");
15 Beta=alfa;//short pitched angle in degree
16 Kc=cosd(Beta/2);//coil span factor
17 disp(Kc,"Pitch factor : ");

```

Scilab code Exa 1.2 Coil basket winding

```

1 //Exa 1.2
2 clc;
3 clear;
4 close;
5 //given data
6 slots=24;//no. of slotes
7 P=4;//no. of poles
8 CoilPitch=5;//unitless
9 NoOfPhase=3;//no of phase
10 disp("As the winding is in double layer , each slot
    contains 2 coils per slide.");
11 CoilSlidePerSlot=2;//coil slide per slot
12 CoilSlidePerCoil=2;//coil slide per Coil
13 TotalCoils=slots*CoilSlidePerSlot/CoilSlidePerCoil;

```

```

//no. of coils
14 disp(TotalCoils,"Total no. of Coils : ");
15 PolesPitch=slots/P;//unitless
16 disp(PolesPitch,"Pole Pitch = ");
17 CoilsPerPolePerPhase=TotalCoils/(P*NoOfPhase);//No.
of Coils/Pole/Phase
18 disp(CoilsPerPolePerPhase,"No. of Coils/Pole/Phase =
");
19 pair_of_poles=2;//no. of pair of poles
20 TotalElectricalDegree=360*pair_of_poles;//in degree
21 ElectricalDegreesPerSlot=TotalElectricalDegree/slots
;//in degree electrical
22 disp(ElectricalDegreesPerSlot,"Electrical Degrees/
Slot = ");
23 Slots_required=120/ElectricalDegreesPerSlot;//No. of
slots required for proper phase displacement
24 disp(Slots_required,"No. of slots required for
proper phase displacement = ");
25 disp("ie. Phase A1 is brought out from slot no. = 1"
);
26 disp("Phase B1 at slot no. = 1+4 = 5");
27 disp("Phase C1 at slot no. = 5+4 = 9");
28 disp("Col Connection – end to start to start");
29 disp("Winding Table is as follows :");
30 disp("Coil No.      Connection Lead from      Coil
Span      Phase and Group No.");
31 disp("  1          A1          1-6
          A1");
32 disp("  2          2-7
          ");
33 disp("  3          3-8
          C4");
34 disp("  4          4-9
          ");
35 disp("  5          B1          5-10
          B1");
36 disp("  6          6-11
          ");

```

37	<code>disp(" 7</code>		7-12
		<code>A2");</code>	
38	<code>disp(" 8</code>		8-13
		<code>");</code>	
39	<code>disp(" 9</code>	C1	9-14
		<code>C1");</code>	
40	<code>disp(" 10</code>		10-15
		<code>");</code>	
41	<code>disp(" 11</code>		11-16
		<code>B2");</code>	
42	<code>disp(" 12</code>		12-17
		<code>");</code>	
43	<code>disp(" 13</code>		13-18
		<code>A3");</code>	
44	<code>disp(" 14</code>		14-19
		<code>");</code>	
45	<code>disp(" 15</code>		15-20
		<code>C2");</code>	
46	<code>disp(" 16</code>		16-21
		<code>");</code>	
47	<code>disp(" 17</code>		17-22
		<code>B3");</code>	
48	<code>disp(" 18</code>		18-23
		<code>");</code>	
49	<code>disp(" 19</code>		19-24
		<code>A4");</code>	
50	<code>disp(" 20</code>		20-1
		<code>");</code>	
51	<code>disp(" 21</code>		21-2
		<code>C3");</code>	
52	<code>disp(" 22</code>		22-3
		<code>");</code>	
53	<code>disp(" 23</code>		23-4
		<code>");</code>	
54	<code>disp(" 24</code>		24-5
		<code>B4");</code>	

Scilab code Exa 1.3.p Poles and Voltage

```
1 // Prob 1.3
2 clc;
3 clear;
4 close;
5 format('v',5);
6 // Given data
7 VL=11000; //in volt
8 N=1500; //in rpm
9 f=50; //in Hz
10 P=120*f/N; //no. of poles
11 disp(P,"No. of poles : ");
12 VP=VL/sqrt(3); //voltage per phase in volt
13 disp(VP,"Voltage per phase of alternator(in volt) :
    ");
```

Scilab code Exa 1.3 Pitch factor

```
1 //Exa 1.3
2 clc;
3 clear;
4 close;
5 //given data
6 format('v',4);
7 StatorSlots=36; //No. of stator slots
8 Poles=4; //No. of poles
9 coilSpan=1:8; //unitless
10 SlotsPerPole=StatorSlots/Poles; // no. of slots per
    pole
11 disp(SlotsPerPole,"Slots/Pole = ");
```

```

12 disp("Here the coil span falls short by, "+string
      ((2/9)*180)+" Degree");
13 alfa=40;//short pitch angle in degree
14 Kp=cosd(alfa/2);//Coil span Factor
15 disp(Kp,"Pitch Factor or coil span factor : ");

```

Scilab code Exa 1.4.p Distribution and pitch factor

```

1 // Prob 1.4
2 clc;
3 clear;
4 close;
5 format('v',7);
6 // Given data
7 s=36;//no. of slots
8 p=4;//no. of poles
9 ph=3;//no. of phase
10 CoilSpan=8;//short pitch winding
11 alfa=180/(s/p);//slot pitch in degree
12 m=s/(p*ph);//no. of slots per pole per phase
13 Kd=sind(m*alfa/2)/(m*sind(alfa/2));//distribution
    factor
14 disp(Kd,"Distribution factor : ");
15 CoilSpan1=s/p;//coil span for full pitch winding
16 slots_sp=CoilSpan1-CoilSpan;//slots by which coil is
    short pitched
17 Beta=slots_sp*alfa;//angle by which coil is short
    pitched
18 Kc=cosd(Beta/2);//Pitch factor
19 disp(Kc,"Pitch factor : ");

```

Scilab code Exa 1.4 Frequency phase and emf

```

1 //Exa 1.4
2 clc;
3 clear;
4 close;
5 //given data
6 format('v',8);
7 NoOfPhase=3;//no of phase
8 P=16;//No. of pole alternator
9 Slots=144;//No. of slots
10 Conductors=10;//per slot
11 fi=0.03;//in Weber
12 N=375;//machine speed in rpm
13 f=P*N/120;//in Hz
14 SlotsPerPole=Slots/P;//unitless
15 m=Slots/(P*NoOfPhase);//unitless
16 Beta=180/(SlotsPerPole);//in Degree
17 Kd=sind(m*Beta/2)/(m*sind(Beta/2));//unitless
18 TotalConductors=Conductors*Slots;//no. of conductors
19 TotalConductorsPerPhase=Conductors*Slots/NoOfPhase;
    //no. of conductors/phase
20 TurnsPerPhase=TotalConductorsPerPhase/2;//No. of
    turns per phase
21 EMFPerPhase=4.44*Kd*fi*f*TurnsPerPhase;//in Volt
22 LineVoltage=sqrt(3)*EMFPerPhase;//in Volt
23 disp(f,"Frequency in Hz : ");
24 disp(EMFPerPhase,"Phase Electromotive force in Volt
    : ");
25 disp(LineVoltage,"Line Electromotive force in Volt :
    ");

```

Scilab code Exa 1.5.p Frequency and line emf

```

1 // Prob 1.5
2 clc;
3 clear;

```

```

4  close;
5  format('v',6);
6  // Given data
7  ph=3;//no. of phase
8  P=16;//no. of poles
9  s=144;//no. of slots
10 con=10;//no. of conductors per slot
11 fi=0.035;//in Wb
12 N=375;//in rpm
13 f=P*N/120;//in Hz
14 disp(f,"Frequency in Hz : ");
15 s1=s/P;//no. of slots per pole
16 m=s1/ph;//no. of slots per pole per phase
17 alfa=180/s1;//slot angle in degree
18 Kd=sind(m*alfa/2)/(m*sind(alfa/2));//distribution
    factor
19 TotCon=s*con;//Total no. of conductors
20 TotCon1=s*con/ph;//Total no. of conductors
21 n=TotCon1/2;//no. of turns per phase
22 EMF=4.44*Kd*fi*f*n;//EMF per phase in volt
23 disp(EMF,"EMF per phase in volt : ");
24 VL=sqrt(3)*EMF;//line voltage in volt
25 disp(VL,"Line EMF in volt : ");

```

Scilab code Exa 1.5 Breadth factor

```

1  //Exa 1.5
2  clc;
3  clear;
4  close;
5  //given data
6  format('v',6);
7  NoOfPhase=3;//no of phase
8  SlotsPerPhase=3;//o. of slots
9  m=SlotsPerPhase;//no. of slots

```

```

10 SlotsPerPolePerPhase=SlotsPerPhase*NoOfPhase; //
    unitless
11 Beta=180/SlotsPerPolePerPhase; //in degree
12 disp("The phase difference difference between the
    induced emf in two coils lying in adjacent slots
    = "+string(Beta)+" degree");
13 Kb=sind(m*Beta/2)/(m*sind(Beta/2)); // unitless
14 disp(Kb,"The breadth factor : ");

```

Scilab code Exa 1.6.p Distribution factor and pitch factor

```

1 // Prob 1.6
2 clc;
3 clear;
4 close;
5 format('v',7);
6 // Given data
7 ph=3; //no. of phase
8 P=4; //no. of poles
9 s=36; //no. of slots
10 coilspan=8; //short pitch winding
11 alfa=180/(s/P); //slot pitch in degree
12 m=s/P/ph; //no. of slots per pole per phase
13 Kd=sind(m*alfa/2)/(m*sind(alfa/2)); //distribution
    factor
14 disp(Kd," Distribution factor : ");
15 coilspan1=s/P; //coil span for full pitch winding
16 s1=coilspan1-coilspan; //no. of slots by which the
    coil is short pitched
17 Beta=s1*alfa; //angle by which the coil is short
    pitched in degree
18 Kc=cosd(Beta/2); //pitch factor
19 disp(Kc," Pitch factor : ");

```

Scilab code Exa 1.6 Pitch factor

```
1 //Exa 1.6
2 clc;
3 clear;
4 close;
5 //given data
6 format('v',7);
7 StatorSlots=24//No. of stator slots
8 Poles=4;//No. of poles
9 SlotsPerPole=StatorSlots/Poles;// no. of slots per
   pole
10 coilSpan=1:6;//unitless
11 disp("If the sides of the coil are placed in slots 1
   and 7, then it is full pitched, but if the coil
   slides are placed in 1 and 6 then it is short
   pitched and the distance equal to 5/6th of pole-
   pitch.");
12 disp("Since it falls short by 1/6th of the pole-
   pitch, hence it is short by :")
13 theta=180/SlotsPerPole;//in Degree
14 disp(string(theta)+" Degree.")
15 Kp=cosd(theta/2);//unitless
16 disp(Kp," Pitch-factor Kp : ");
```

Scilab code Exa 1.7.p Useful flux per pole

```
1 // Prob 1.7
2 clc;
3 clear;
4 close;
5 format('v',6);
```

```

6 // Given data
7 EL=6600;//in volt
8 ph=3;//no. of phase
9 P=4;//no. of poles
10 f=50;//in Hz
11 s=60;//no. of slots
12 con=2;//no. of conductors/slot
13 coilslot=13-1;//
14 n=s/P;//Slot per pole
15 m=n/ph;//Slot per pole per phase
16 Zp=s*con/ph;//no. of conductors connected in series/
    phase
17 Beta=180/n;//in degree
18 Kd=sind(m*Beta/2)/(m*sind(Beta/2));//distribution
    factor
19 coilspan=coilslot*180/n;//coil span in degree
20 Kp=cosd((180-144)/2);//Coil span factor
21 //formu;a : EL=sqrt(3)*4.44*Kd*Kp*fi*f*T;//in volt
22 T=20;//assumed
23 fi=EL/(sqrt(3)*4.44*Kd*Kp*f*T);//in Wb
24 disp(fi,"Useful flux per pole in Wb : ");
25 //Note : Answer in the book is by mistake given in
    volts.

```

Scilab code Exa 1.7 Flux per pole

```

1 //Exa 1.7
2 clc;
3 clear;
4 close;
5 //given data
6 format('v',7);
7 NoOfPhase=3;//no of phase
8 Eph=3300/sqrt(3);//in Volts
9 f=50;//in Hz

```

```

10 Poles=12; //No. of poles
11 StatorSlots=144 //No. of stator slots
12 SlotsPerPhase=StatorSlots/NoOfPhase; //no. of slots/
    phase
13 Conductors=5; //per slot
14 ConductorsPerphase=SlotsPerPhase*Conductors; //
    Conductors/Phase
15 S=ConductorsPerphase; //Conductors/phase
16 SlotsPerPolePerPhase=SlotsPerPhase/Poles; //no. of
    slots/phase
17 Kf=1.11; //Form Factor
18 Kb=0.96; //Breadth Factor
19 Kp=1; //For concentric winding
20 fi=Eph/(2*Kf*Kb*Kp*S*f); //in weber
21 disp(fi,"The Flux per pole in weber : ");

```

Scilab code Exa 1.8.p Regulation

```

1 // Prob 1.8
2 clc;
3 clear;
4 close;
5 format('v',5);
6 // Given data
7 ph=3; //no. of phase
8 P=10; //in KVA
9 VL=230; //in volt
10 Xs=1.2; //in ohms/phase
11 Ra=0.5; //in ohm/phase
12 VP=VL/sqrt(3); //in volt
13 I=P*10^3/(3*VP); //in Ampere
14 cosfi=0.8; //Power factor
15 sinfi=sind(acosd(cosfi)); //
16 //Power factor 0.8 lagging
17 Eo=sqrt((VP*cosfi+I*Ra)^2+(VP*sinfi+I*Xs)^2); //in

```

```

    volt
18 Regulation=(Eo-VP)/VP*100; //in %
19 disp(Regulation,"% regulation when power factor
    lagging : ");
20 //Power factor 0.8 leading
21 Eo=sqrt((VP*cosfi+I*Ra)^2+(VP*sinfi-I*Xs)^2); //in
    volt
22 Regulation=(Eo-VP)/VP*100; //in %
23 disp(Regulation,"% regulation when power factor
    leading : ");

```

Scilab code Exa 1.8 Speed and line emf

```

1 //Exa 1.8
2 clc;
3 clear;
4 close;
5 //given data
6 format('v',7);
7 Phase=3; //no. of phase
8 f=50; //in Hz
9 P=16; //No. of pole alternator
10 Slots=144; //No. of slots
11 conductors=10; //conductors per slot
12 fi=2.48*10^-2; //in weber
13 n=Slots/P; //No. of slots/pole
14 Zr=Slots*conductors/Phase; //No. of conductors/Phase
15 T=Zr/2; //N. of turns/phase
16 Beta=180/n; //Angular displacement between slots in
    degree
17 m=n/Phase; //No. of slots/pole/Phase
18 Kd=sind(m*Beta/2)/(m*sind(Beta/2)); //Distribution
    factor : unitless
19 disp("The coil span falls short of 2 slots i.e. "+
    string(2*180/9)+" degree.");

```

```

20 alfa=40;//short pitch angle in degree
21 Kp=cosd(alfa/2);//Unitless
22 //Formula : f=P*N/120;//in Hz
23 N=120*f/P;//in rpm
24 Ep=4.44*Kd*Kp*fi*f*T;//in Volts
25 LineVoltage=sqrt(3)*Ep;//in Volts
26 disp("The speed is "+string(N)+" in rpm");
27 disp("The line emf is "+string(LineVoltage)+" Volts"
    );
28 //Note : Answer in the book is not accurate.

```

Scilab code Exa 1.9.p No of armature conductor

```

1 // Prob 1.9
2 clc;
3 clear;
4 close;
5 format('v',5);
6 // Given data
7 f=50;//in Hz
8 ph=3;//no. of phase
9 EL=10000;//in volt
10 fi=15*10^-2;//in Wb
11 Kd=0.96;//unitless
12 Kp=1;//unitless
13 P=10;//in KVA
14 T=EL/(sqrt(3)*4.44*Kd*Kp*fi*f);//turns/phase
15 Zp=2*T;//armature conductor connected in series per
    phase
16 disp(Zp,"Armature conductor connected in series per
    phase : ");
17 //Note : Answer in the book is wrong.

```

Scilab code Exa 1.9 Full load percentage regulation

```
1 //Exa 1.9
2 clc;
3 clear;
4 close;
5 //given data
6 format('v',6);
7 RatedPower=100;//in KVA
8 RatedPower=100*1000;//in VA
9 VL=1040;//in Volt
10 Phase=3;//Machine phase
11 If=40;//in Ampere
12 Isc=200;//in Ampere
13 EL=1040;//in Volt
14 Eph=EL/sqrt(3);//in Volt
15 Zs=Eph/Isc;//in Ohm
16 Rs=0.2;//in Ohm
17 Xs=sqrt(Zs^2-Rs^2);//in Ohm
18 IL=19.25;//in Ampere
19 V=3000/sqrt(3);//in Volt
20 //At 0.8 power factor lagging
21 IRa=IL*0.2;//in Volt
22 IXs=IL*Xs;//in Volt
23 Vsin_fi=V*0.6;//in Volt
24 Vcos_fi=V*0.8;//in Volt
25 Eo=sqrt((Vcos_fi+IRa)^2+(Vsin_fi+IXs)^2);//in Volts
26 Regulation=((Eo-V)/V)*100;//in %
27 disp(Regulation,"Full load percentage regulation at a
    power factor of 0.8 lagging : ");
28
29 //At 0.8 power factor leading
30 Eo=sqrt((Vcos_fi+IRa)^2+(Vsin_fi-IXs)^2);//in Volts
31 Regulation=((Eo-V)/V)*100;//in %
32 disp(Regulation,"Full load percentage regulation at a
    power factor of 0.8 leading : ");
33 disp("Negative regulation due to leading power
    factor.");
```

Scilab code Exa 1.10.p No of Armature conductor

```
1 // Prob 1.10
2 clc;
3 clear;
4 close;
5 format('v',5);
6 // Given data
7 f=50; //in Hz
8 ph=3; //no. of phase
9 EL=10000; //in volt
10 fi=15*10^-2; //in Wb
11 Kd=0.96; //unitless
12 Kp=1; //unitless
13 P=10; //in KVA
14 T=EL/(sqrt(3)*4.44*Kd*Kp*fi*f); //turns/phase
15 Zp=2*T; //armature conductor connected in series per
    phase
16 disp(Zp,"Armature conductor connected in series per
    phase : ");
17 //Note : Answer in the book is wrong.
```

Scilab code Exa 1.10 Full load regulation

```
1 //Exa 1.10
2 clc;
3 clear;
4 close;
5 //given data
6 format('v',6);
7 RatedPower=50; //in KVA
```

```

8 RatedPower=50*1000; //in VA
9 VL=173; //in Volts
10 Ra=0.1; //in Ohm
11 VP=VL/sqrt(3); //in Volts
12 disp("Some exciting curent on short circuit produces
      a current of 100 A.");
13 OC_PhaseVoltage=100; //in Volt
14 SC_Current=100; //in Ampere
15 Zs=OC_PhaseVoltage/SC_Current; //n ohm
16 Xs=sqrt(Zs^2-Ra^2); //in Ohm
17 disp(Xs,"Impedence of the alternator in Ohm : ");
18 V=400; //in Volts
19 I_FL=RatedPower/(sqrt(3)*V); //in Ampere
20 V=400/sqrt(3); //in Volts
21 Eo=sqrt((V+I_FL*Ra)^2+(I_FL*Xs)^2); //in Volts
22 Regulation=(Eo-V)*100/V; //in %
23 disp(Regulation," Regulation at U.P.F. in % :");

```

Scilab code Exa 1.11.p Min current and emf

```

1 // Prob 1.11
2 clc;
3 clear;
4 close;
5 format('v',5);
6 // Given data
7 VL=400; //in volt
8 Output=10; //in HP
9 Output=Output*735.5; //in watts
10 m=3; //no. of phase
11 Xo=10; //in ohm/phase
12 Eff=85; //in %
13 Input=Output/(Eff/100); //in watts
14 //Formula : Input=sqrt(3)*VL*IL*cosfi
15 ILcosfi=Input/sqrt(3)/VL; //in Ampere

```

```

16 ILmin=ILcosfi; //in Ampere
17 disp(ILcosfi,"Minimum current by putting cosfi=1 in
    Ampere is : ");
18 ER=ILmin*Xo; //in ohm
19 V=VL/sqrt(3); //supply voltage per phase in volt
20 E=sqrt(V^2+ER^2); //in volt
21 LineEMF=sqrt(3)*E; //in volt
22 disp(LineEMF,"Line Induced emf in volt : ");

```

Scilab code Exa 1.11 Voltage regulation at Full load

```

1 //Exa 1.11
2 clc;
3 clear;
4 close;
5 //given data
6 format('v',7);
7 OutputPower=500; //in KVA
8 OutputPower=500*1000; //in VA
9 VL=3300; //in Volts
10 Ra=0.3; //in Ohm
11 Xs=4; //in Ohm
12 PF=0.8; //Lagging Power factor
13 //Formula : outputPower=sqrt(3)*VL*IL
14 IL=OutputPower/(sqrt(3)*VL); //in Ampere
15 disp("For a star connected alternator, line current
    is equal to phase current. Therefore Ia=IL");
16 Ia=IL; //in Ampere
17 //PF=cosd(fi)=0.8 and sind(fi)=0.6
18 cos_fi=0.8; //Power factor
19 sin_fi=0.6; //Unitless
20 VPerPhase=VL/sqrt(3); //in Volts
21 E=sqrt((VPerPhase*cos_fi+Ia*Ra)^2+(VPerPhase*sin_fi+
    Ia*Xs)^2); //in Volts/Phase
22 Regulation=(E-VPerPhase)*100/VPerPhase; //in %

```

```
23 disp(Regulation," Voltage Regulation at Full Load in
    % :");
```

Scilab code Exa 1.12.p Line EMF

```
1 // Prob 1.12
2 clc;
3 clear;
4 close;
5 format('v',6);
6 // Given data
7 P=6;//no. of poles
8 phase=3;//no. of phase
9 f=50;//in Hz
10 S=12;//slots per pole
11 C=4;//conductor per slot
12 FullPitch=5/6;//unitless
13 fi=25;//in mwb
14 fi=fi*10^-3;//in wb
15 Zph=C*S*P/phase;//no. of conductors in series per
    phase
16 T=Zph/2;//no. of turns per phase
17 alfa=180*(1-FullPitch);//in degree
18 Kc=cosd(alfa/2);//unitless
19 m=S/phase;//no. of slot per pole per phase
20 Beta=180/S;//in degree
21 Kd=sind(m*Beta/2)/m/sind(Beta/2);//unitless
22 Eph=4.44*Kc*Kd*f*fi*T;//in volt
23 EL=sqrt(3)*Eph;//in volt
24 disp(EL,"Line emf in volt : ");
```

Scilab code Exa 1.12 Voltage regulation

```

1 //Exa 1.12
2 clc;
3 clear;
4 close;
5 //given data
6 format('v',7);
7 V=2000; //in Volt
8 Ia=100; //in Ampere
9 OC_Voltage=500; //in Volt
10 SC_Current=100; //in Ampere
11 Zs=OC_Voltage/SC_Current; //in ohm
12 Ra=0.8; //in Ohm
13 Xs=sqrt(Zs^2-Ra^2); //in Ohm
14 //formula : Induced EMF,  $E=\sqrt{(V*\cos_{fi}+Ia*Ra)^2+(V*\sin_{fi}+Ia*Xs)^2}$ 
15 //Part (a) : at unity pf
16 cos_fi=1; // Unitless
17 sin_fi=0; // Unitless
18 E=sqrt((V*cos_fi+Ia*Ra)^2+(V*sin_fi+Ia*Xs)^2)
19 Regulation=(E-V)*100/V; //in %
20 disp(Regulation,"Regulation at U.P.F. in % :");
21
22 //Part (b) : at 0.71 pf lagging
23 cos_fi=0.71; // Unitless
24 sin_fi=0.704; // Unitless
25 E=sqrt((V*cos_fi+Ia*Ra)^2+(V*sin_fi+Ia*Xs)^2)
26 Regulation=(E-V)*100/V; //in %
27 disp(Regulation,"Regulation at 0.71 pf lagging in % :");
28
29 //Part (c) : at 0.8 pf leading
30 cos_fi=0.8; // Unitless
31 sin_fi=0.6; // Unitless
32 E=sqrt((V*cos_fi+Ia*Ra)^2+(V*sin_fi-Ia*Xs)^2)
33 Regulation=(E-V)*100/V; //in %
34 disp(Regulation,"Regulation at 0.8 pf leading in % :");

```

Scilab code Exa 1.13.p Power current and power factor

```
1 // Prob 1.13
2 clc;
3 clear;
4 close;
5 format('v',7);
6 // Given data
7 V=2300;//in volt
8 P=1200//in KW
9 IA=200;//in Ampere
10 cosfi_a=0.9;//lagging power factor
11 PA=V*IA*cosfi_a*10^-3;//in KW
12 fi_a=acosd(cosfi_a);//in degree
13 Pra=PA*tand(fi_a);//in KVAR
14 Pr=0;//because pf is unity
15 Prb=Pr-Pra ;//in KVAR
16 PB=P-PA;//in KW
17 disp(PB,"Power of alternator B in KW : ");
18 tanfi_b=Prb/PB;//unitless
19 cosfi_b=cosd(atan(tanfi_b));//leading power factor
20 disp(cosfi_b,"Leading power factor of alternator B :
    ");
21 IB=PB*10^3/V/cosfi_b;//in Ampere
22 disp(IB,"Current in alternator B in Ampere : ");
```

Scilab code Exa 1.13 Internal voltage drop

```
1 //Exa 1.13
2 clc;
3 clear;
4 close;
```

```

5 //given data
6 Ia=60;//in Ampere
7 disp("EMF induced on 900 Volt on open circuit can be
      regarded as being responsible for circulating
      short circuit current of 150 mA, through the
      synchronous impedance of the winding when the
      excitation current is 10 mA.");
8 disp("The value of synchronous impedance at this
      excitation :") ;
9 OC_Voltage=900;//in Volt
10 SC_Current=150;//in Ampere
11 Zs=OC_Voltage/SC_Current;//in ohm
12 disp("Zs equals to "+string(Zs)+" Ohm");
13 disp("Internal Voltage drop when tthe load current
      is 60A=Ia*Zs="+string(Ia*Zs)+" Volts");

```

Scilab code Exa 1.14.p KW output and PF

```

1 // Prob 1.14
2 clc;
3 clear;
4 close;
5 format('v',7);
6 // Given data
7 P1=600//Lightning load in KW
8 cosfi_1=1;
9 tanfi_1=tand(acosd(cosfi_1));
10 P2=800//Inductive load in KW
11 cosfi_2=.9;//lagging
12 tanfi_2=tand(acosd(cosfi_2));
13 P3=800//Capacitive load in KW
14 cosfi_3=.8;//leading
15 tanfi_3=-tand(acosd(cosfi_3));//taken -ve
16 PA=1000;//in KW
17 cosfi_A=.85;//lagging pf

```

```

18 tanfi_A=tand(acosd(cosfi_A));
19 Pre=P1*tanfi_1;//in KVAR
20 Pri=P2*tanfi_2;//in KVAR
21 Prc=P3*tanfi_3;//in KVAR
22 P=P1+P2+P3;//in KW
23 Pr=Pre+Pri+Prc;//in KVAR
24 Pra=PA*tanfi_A;//in KVAR
25 PB=P-PA;//in KW
26 disp(PB,"Active power supplied by alternator B in KW
      : ");
27 Prb=Pr-Pra;//in KVAR
28 tanfi_B=Prb/PB;//unitless
29 cosfi_B=cosd(atan(tanfi_B));//unitless
30 disp(cosfi_B,"Power factor of alternator B(leading)
      : ");

```

Scilab code Exa 1.14 Change in terminal voltage

```

1 //Exa 1.14
2 clc;
3 clear;
4 close;
5 //given data
6 format('v',5);
7 V=6600;//in Volts
8 OutputPower=2000;//in KVA
9 OutputPower=2000*1000;//in VA
10 //Formula : outputPower=sqrt(3)*VL*IL
11 IL=OutputPower/(sqrt(3)*V);//in Ampere
12 Ia=IL;//in Ampere
13 Ra=0.4;//in Ohm
14 Xs=4.5;//in Ohm
15 //PF=cosd(fi)=0.8 and sind(fi)=0.6
16 cos_fi=0.8;//Power factor
17 sin_fi=0.6;//Unitless

```

```

18 VPerPhase=V/sqrt(3); //in Volts
19 E=sqrt((VPerPhase*cos_fi+Ia*Ra)^2+(VPerPhase*sin_fi+
    Ia*Xs)^2); //in Volts/Phase
20 Regulation=(E-VPerPhase)*100/VPerPhase; //in %
21 disp(Regulation,"Percentage Change in Terminal
    Voltage :");

```

Scilab code Exa 1.15.p EMF and Angular retardation

```

1 // Prob 1.15
2 clc;
3 clear;
4 close;
5 format('v',7);
6 // Given data
7 P=1000 //in KVA
8 VL=11000; //in volt
9 m=3; //no. of phase
10 Ra=3.5; //in ohm/phase
11 Xa=40; //in ohm/phase
12 Ia=P*1000/(VL*sqrt(3)); //in Ampere
13 V=VL/sqrt(3); //in volt
14 cosfi=0.8;
15 fi=acosd(cosfi); //in degree
16 Va_resistance=Ia*Ra; //drop in resistance in volt
17 Va_reactance=Ia*Xa; //drop in reactance in volt
18 ER=sqrt(Va_resistance^2+Va_reactance^2);
19 tan_theta=Xa/Ra; //unitless
20 theta=atand(tan_theta); //in degree
21 //Part (a)
22 Eb=sqrt(V^2+ER^2-2*V*ER*cosd(theta)); //in V/phase
23 Eline=sqrt(3)*Eb; //in Volt
24 disp(Eline,"(a) Induced emf(V) : ");
25 //Applying sine rule
26 alfa=asind(ER/Eb*sind(theta)); //in degree

```

```

27 disp(" Angular retardation "+string(floor(alfa))+
      degree "+string(floor(60*(alfa-floor(alfa))))+"
      min");
28 //Part (b)
29 Eb=sqrt(V^2+ER^2-2*V*ER*cosd(theta-fi));//in V/phase
30 Eline=sqrt(3)*Eb;//in Volt
31 disp(Eline,"(b) Induced emf(V) : ");
32 //Applying sine rule
33 alfa=asind(ER/Eb*sind(theta-fi));//in degree
34 disp(" Angular retardation "+string(floor(alfa))+
      degree "+string(floor(60*(alfa-floor(alfa))))+"
      min");
35 //Part (c)
36 Eb=sqrt(V^2+ER^2-2*V*ER*cosd(theta+fi));//in V/phase
37 Eline=sqrt(3)*Eb;//in Volt
38 disp(Eline,"(c) Induced emf(V) : ");
39 //Applying sine rule
40 alfa=asind(ER/Eb*sind(theta+fi));//in degree
41 disp(" Angular retardation "+string(floor(alfa))+
      degree "+string(floor(60*(alfa-floor(alfa))))+"
      min");
42 //Note : Figure given in this question is not a plot
      . It is just drawn to represent data and can't be
      plotted.
43 //Note : Answers in the book is not as much accurate
      as calculated by Scilab.

```

Scilab code Exa 1.15 Regulation on full load

```

1 //Exa 1.15
2 clc;
3 clear;
4 close;
5 //given data
6 format('v',7);

```

```

7 OutputPower=1200; //in KVA
8 OutputPower=1200*1000; //in VA
9 V=3300; //in Volt
10 Ra=0.25; //in Ohm
11 //Formula : outputPower=sqrt(3)*VL*IL
12 IL=OutputPower/(sqrt(3)*V); //in Ampere
13 Ia=IL; //in Ampere
14 VPerPhase=V/sqrt(3); //in Volts
15 OC_Voltage=1100; //in Volt
16 SC_Current=200; //in Ampere
17 Zs=OC_Voltage/(sqrt(3)*SC_Current); //in ohmRa
18 Xs=sqrt(Zs^2-Ra^2); //in Ohm
19 //formula : Induced EMF, E=sqrt((V*cos_fi+Ia*Ra)^2+(
    V*sin_fi+Ia*Xs)^2)
20
21 //Part (a) : For lagging pf load
22 cos_fi=0.8; //Unitless
23 sin_fi=0.6; //Unitless
24 E=sqrt((VPerPhase*cos_fi+Ia*Ra)^2+(VPerPhase*sin_fi+
    Ia*Xs)^2);
25 Regulation=(E-VPerPhase)*100/VPerPhase; //in %
26 disp(Regulation,"Regulation at U.P.F. in % :");
27
28 //Part (b) : For leading pf load
29 cos_fi=0.8; //Unitless
30 sin_fi=0.6; //Unitless
31 E=sqrt((VPerPhase*cos_fi+Ia*Ra)^2+(VPerPhase*sin_fi-
    Ia*Xs)^2)
32 Regulation=(E-VPerPhase)*100/VPerPhase; //in %
33 disp(Regulation,"Regulation at 0.71 pf lagging in %
    :");
34 //Note: For leading power factor load, the
    regulation s negative.

```

Scilab code Exa 1.16.p Terminal voltage and reactive power

```

1 // Prob 1.16
2 clc;
3 clear;
4 close;
5 format('v',7);
6 // Given data :
7 EP=6000;//in volt
8 Em=EP;//in Volt
9 Xs=1.5;//in ohm/phase
10 IL=1000;//in Ampere
11 VT=Em-IL*Xs;//in volt
12 disp(VT,"Terminal voltage in volt : ");
13 VL=sqrt(3)*VT;//in volt
14 sinfi=1;
15 Preactive=sqrt(3)*VL*IL*sinfi;//in VAR
16 disp(Preactive/10^6,"Reactive Power(MVAR) : ");

```

Scilab code Exa 1.16 Terminal voltage

```

1 //Exa 1.16
2 clc;
3 clear;
4 close;
5 //given data
6 OutputPower=1500;//in KVA
7 OutputPower=1500*1000;//in VA
8 V=6600;//in Volt
9 Ra=0.4;//in Ohm
10 Xs=6;//in Ohm per phase
11 pf=0.8;//lagging power factor
12 //Formula : outputPower=sqrt(3)*VL*IL
13 Ia=OutputPower/(sqrt(3)*V);//in Ampere
14 VPerPhase=V/sqrt(3);//in Volts
15 //formula : Induced EMF, E=sqrt((V*cos_fi+Ia*Ra)^2+(
    V*sin_fi+Ia*Xs)^2)

```

```

16 cos_fi=0.8; // Unitless
17 sin_fi=0.6; // Unitless
18 E=sqrt((VPerPhase*cos_fi+Ia*Ra)^2+(VPerPhase*sin_fi+
    Ia*Xs)^2); //in volt
19 disp(E,"Induced emf in volt : ");
20 disp("As excitation remains constant , E at 4364 volt
    remains constant.");
21 E=4364; //in Volt
22 disp("Let the terminal voltage for the same
    excitation and load current at 0.8 power factor
    leading be V.");
23 disp("4364=sqrt((V*cos_fi+Ia*Ra)^2+(VPerPhase*sin_fi
    +Ia*Xs)^2)");
24 disp("V=4743 Volts");
25 V=4743; //in Volts
26 TerminalVoltage=sqrt(3)*V; //in Volts
27 disp(TerminalVoltage,"Terminal voltage line to line
    in Volts : ");
28 //Note ans of 1st part is wrong in the book.s

```

Scilab code Exa 1.17.p EMF and Torque

```

1 // Prob 1.17
2 clc;
3 clear;
4 close;
5 format('v',6);
6 // Given data :
7 Poles=4; //no. of poles
8 m=3; //no. of phase
9 f=50; //in Hz
10 V=7000; //in volt/phase
11 I=1400; //in A/phase
12 Xs=1.2; //in ohm/phase
13 E=sqrt(V^2+(I*Xs)^2); //in volt

```

```

14 disp(E,"Induced emf in volt : ");
15 cosfi=1;//for resistive load
16 P=3*V*I*cosfi;//in watts
17 P=P/10^6;//in MWatts
18 N=120*f/Poles;//in rpm
19 w=2*%pi*N/60;//in radian per sec
20 T=P*10^6/w;//in Nw-m
21 T=T/9.81;//in Kg-m
22 disp(T,"Torque in Kg-m : ");
23 //Note : Answers in the book is not as much accurate
    as calculated by Scilab.
24 //Note : Figure given in this question is not a plot
    . It is just drawn to represent data and can't be
    plotted.

```

Scilab code Exa 1.17 KW output and pf

```

1 //Exa 1.17
2 clc;
3 clear;
4 close;
5 //given data
6 OutputPower=2500;//in KVA
7 OutputPower=2500*1000;//in VA
8 V=6600;//in Volt
9
10
11 //For first load i.e. Lighting load :
12 KW1=2500;//in KWatts
13 KVAR1=0;//KWatts
14 //For second load i.e. Motor load :
15 KW2=5000;//in KWatts
16 cos_fi=0.707;//unitless
17 sin_fi=0.707;//unitless
18 KVAR2=KW2*sin_fi/cos_fi;//KWatts

```

```

19 //For total load
20 TotalKW=KW1+KW2;//in KWatts
21 TotalKVAR=KVAR1+KVAR2;//Kwatts
22 //For first Machine
23 KWm=4000;//in KWatts
24 cos_fi=0.8;//unitless
25 sin_fi=0.6;//unitless
26 KVARm=KWm*sin_fi/cos_fi;//Kwatts
27 //so, second machine will be supplying
28 KW=TotalKW-KWm;//in Kwatts
29 disp(KW,"KW output of second machine : ");
30 KVAR=TotalKVAR-KVARm;//in KWatts
31 tan_fi=KVAR/KW;//unitless
32 fi=atand(tan_fi);//ib degree
33 //Power factor of other machine
34 pf=cosd(fi);//unitless
35 disp("Power factor of other machine : "+string(pf)+"
      lagging");

```

Scilab code Exa 1.18.p Current per phase

```

1 // Prob 1.18
2 clc;
3 clear;
4 close;
5 format('v',6);
6 // Given data :
7 Poles=2;//no. of poles
8 m=3;//no. of phase
9 f=50;//in Hz
10 Ep=5700;//in volt
11 Xs=1.5;//in ohm/phase
12 Iphase=Ep/Xs;//in Ampere
13 IL=Iphase;//in Ampere
14 disp(IL,"Line current in Ampere : ");

```

Scilab code Exa 1.18 KW output and pf

```
1 //Exa 1.18
2 clc;
3 clear;
4 close;
5 //given data
6 //Load1 :
7 KW1=500; //in KWatts
8 KVAR1=0; //Kwatts
9 //Load2 :
10 KW2=1000; //in KWatts
11 pf=0.9; //lagging
12 cos_fi=0.9; // unitless
13 fi=acosd(pf);
14 sin_fi=sind(fi); // unitless
15 KVAR2=KW2*sin_fi/cos_fi; //Kwatts
16 //Load3 :
17 KW3=800; //in KWatts
18 pf=0.8; //lagging
19 cos_fi=0.8; // unitless
20 fi=acosd(pf);
21 sin_fi=sind(fi); // unitless
22 KVAR3=KW3*sin_fi/cos_fi; //Kwatts
23 //Load4 :
24 KW4=500; //in KWatts
25 pf=0.9; //lagging
26 cos_fi=0.9; // unitless
27 fi=acosd(pf);
28 sin_fi=sind(fi); // unitless
29 KVAR4=-KW4*sin_fi/cos_fi; //Kwatts
30 //TotalKW and TotalKVAR
31 TotalKW=KW1+KW2+KW3+KW4; //in KWatts
32 TotalKVAR=KVAR1+KVAR2+KVAR3+KVAR4; //in KWatts
```

```

33 //For the first Machine :
34 KW=1500;//n Kwatts
35 cos_fi=0.95;//unitless
36 sin_fi=0.3123;//unitless
37 KVAR=KW*sin_fi/cos_fi;//Kwatts
38
39 KW1=TotalKW-KW;//in KWatts
40 KVAR1=TotalKVAR-KVAR;//in Volts
41 disp("KW supplied by other machine : "+string(
    TotalKW-KW));
42 disp("KVAR supplied by other machine : "+string(
    TotalKVAR-KVAR));
43 tan_fi=KVAR1/KW1;//unitless
44 //fi=atand(tan_fi);//in degree
45 cos_fi=cosd(atand(tan_fi));//unitless
46 disp("Power factor of the other machine : "+string(
    cos_fi));

```

Scilab code Exa 1.19.p Torque and Speed

```

1 // Prob 1.19
2 clc;
3 clear;
4 close;
5 format('v',8);
6 // Given data :
7 Poles=2;//no. of poles
8 m=3;//no. of phase
9 f=50;//in Hz
10 VT=15;//in volt
11 Ps=100;//in MVA
12 cosfi=0.8;//lagging
13 Xs=0.7;//in ohm/phase
14 VP=VT/sqrt(3);//in Volt
15 AC=VT*cosfi;//in KV

```

```

16 sinfi=sind(acosd(cosfi));
17 BC=VT*sinfi;//in KV
18 IL=Ps*10^6/sqrt(3)/(VT*10^3);//in Ampere
19 BL=IL*Xs;//voltage drop in volt
20 LC=BL+BC;//in volt
21 AL=sqrt(AC^2+LC^2);//in volt
22 EmLine=AL*sqrt(3);//in volt
23 Ns=120*f/Poles;//ion rpm
24 P=Ps*10^6*cosfi;//in watts
25 T=P*60/2/%pi/Ns;//in Nw-m
26 disp(T,"Torque in Nw-m : ");
27 disp(Ns,"Speed in rpm is ");
28 //Note : Figure given in this question is not a plot
    . It is just drawn to represent data and can't be
    plotted.

```

Scilab code Exa 1.19 Load and pf

```

1 //Exa 1.19
2 clc;
3 clear;
4 close;
5 //given data
6 //Lighting Load :
7 MW1=20;//load in Mwatts
8 KW1=MW1*1000;//in KWatts
9 KVAR1=0;//Kwatts
10 //Motor Load :
11 MW2=40;//load in Mwatts
12 KW2=MW2*1000;//in KWatts
13 pf=0.8;//unitless
14 cos_fi=0.8
15 fi=acosd(pf);
16 sin_fi=sind(fi);//unitless
17 KVAR2=KW2*sin_fi/cos_fi;//Kwatts

```

```

18 //For Total Load :
19 TotalKW=KW1+KW2;//load in Mwatts
20 TotalKVAR=KVAR1+KVAR2;//in KWatts
21 //For first machine :
22 MWm=32;//load in Mwatts
23 KWm=MWm*1000;//in KWatts
24 cos_fi=0.866;//unitless
25 fi=acosd(cos_fi);
26 tan_fi=tand(fi);//unitless
27 KVARm=KWm*tan_fi;//in KWatts
28 //so, load supplied by the second machine
29 KW2=TotalKW-KWm;//in Kwatts
30 disp("Load of other machine ,KW : "+string(KW2));
31 KVAR2=TotalKVAR-KVARm;//in Kwatts
32 tan_fi=KVAR2/KW2;//unitless
33 fi=atand(tan_fi);//in degree
34 cos_fi=cosd(atand(tan_fi));//unitless
35 disp("Power factor of the other machine : "+string(
    cos_fi));

```

Scilab code Exa 1.20 pf of alternator

```

1 //Exa 1.20
2 clc;
3 clear;
4 close;
5 //given data
6 cos_fi=0.8;//unitless
7 fi=acosd(cos_fi);
8 tan_fi=tand(fi);//unitless
9 //For Alternator A :
10 cos_fi_A=0.9;//unitless
11 fi_A=acosd(cos_fi_A);
12 tan_fi_A=tand(fi_A);//unitless
13 //Formula : Active load , KW=V*I*cos_fi

```

```

14 //Formula : Reactive load , KVAR=V*I*sin_fi
15 ActiveLoad=8000;//in KW
16 ReactiveLoad=ActiveLoad*tan_fi;//in KVAR
17 //For A:
18 ActiveLoadA=5000;//in KW
19 ReactiveLoadA=ActiveLoadA*tan_fi_A;//in KVAR
20 //For B :
21 ActiveLoadB=ActiveLoad-ActiveLoadA;//in KW
22 ReactiveLoadB=ReactiveLoad-ReactiveLoadA;//in KVAR
23 tan_fi_B=ReactiveLoadB/ActiveLoadB;//unitless
24 fi_B=atand(tan_fi_B);//in degree
25 cos_fi=cosd(atand(tan_fi_B));//unitless
26 disp("Power factor of the other machine : "+string(
    cos_fi));

```

Scilab code Exa 1.21 KVA rating Current Rating and Power Input

```

1 //Exa 1.21
2 clc;
3 clear;
4 close;
5 //given data
6 format('v',7);
7 V=6600;//in Volts
8 KW=6000;//in KWatts
9 pf=0.8;//unitless
10 cos_fi=pf;//unitless
11 Eff=90;//in %
12 //Part (a) :
13 KVA=KW/cos_fi;//in KVAR
14 disp("KVA rating of the alternator : "+string(KVA)+"
    KVA");
15 //Part (b) :
16 TotalRating=KVA;//in KVA
17 VA=TotalRating*1000;//in VA

```

```

18 I=VA/(sqrt(3)*KW); //in Ampere
19 disp(I,"Current Rating in Ampere : ");
20 //Part (c) :
21 Input=KW/(Eff/100); //in KW
22 disp(Input,"Power Input(in KW) :");
23 Input=Input*1000/735.5; //in hp
24 disp(Input,"Power Input(in hp) :");

```

Scilab code Exa 1.22 Line Volt Current Rating and Power

```

1 //Exa 1.22
2 clc;
3 clear;
4 close;
5 //given data
6 format('v',7);
7 Ecoil=8000; //in Volts
8 Icoil=418; //in Ampere
9 pf=80; //in % lgging
10 pf=pf/100; //in fraction
11 cos_fi=pf; //unitless
12 //Part (i) :
13 EL=sqrt(3)*Ecoil; //in volt
14 disp(EL,"Line volts(in V): ");
15 //Part (ii) :
16 IL=Icoil; //in Ampere
17 disp(IL,"Line Current in Ampere : ");
18 //Part (iii) :
19 Rating=sqrt(3)*EL*IL/1000; //in KVA
20 disp(Rating,"Rating (in KVA) :");
21 //Part (iv) :
22 FullLoadPower=sqrt(3)*EL*IL*cos_fi/1000; //in KW
23 disp(FullLoadPower,"Full Load Power in KW :");

```

Chapter 2

Induction Motors

Scilab code Exa 2.1.p Synchronous Speed

```
1 //problem 2.1
2 clc;
3 clear;
4 close;
5 //given data :
6 P=8;//No. of poles
7 f=50;//in Hz
8 Ns=120*f/P;//in rpm
9 disp(Ns,"Synchronous speed in rpm : ");
```

Scilab code Exa 2.1 Synchronous speed and slip

```
1 //Exa 2.1
2 clc;
3 clear;
4 close;
5 //Given data :
6 P=2;//no. of poles
```

```

7 f=60; //in Hz
8 N=3460; //in rpm
9 Ns=120*f/P; //in rpm
10 Slip=Ns-N; //in rpm
11 PercentageSlip=(Ns-N)*100/Ns; //in %
12 disp(Ns,"Synchronous speed in rpm : ");
13 disp(round(PercentageSlip),"Percentage Slip : ");

```

Scilab code Exa 2.2.p Maximum Speed

```

1 //problem 2.2
2 clc;
3 clear;
4 close;
5 //given data :
6 P=2; //No. of poles(Assumed for induction motor)
7 f=50; //in Hz
8 N=120*f/P; //in rpm
9 disp(N,"Maximum speed in rpm : ");

```

Scilab code Exa 2.2 Synchronous speed Rotor frequency and slip

```

1 //Exa 2.2
2 clc;
3 clear;
4 close;
5 //Given data :
6 P=8; //no. of poles
7 f=50; //in Hz
8 N=700; //in rpm
9 //Part (a) :
10 Ns=120*f/P; //in rpm
11 disp(Ns,"Synchronous speed in rpm : ");

```

```

12 //Part (b) :
13 S=(Ns-N)*100/Ns;//in %
14 disp(S,"Slip(in %) : ");
15 //Part (c) :
16 //At the time of stsrst S=1;
17 fdash=f;//in Hz
18 disp(fdash,"Rotor frequency at the time of starting(
    in Hz) : ");
19 //Part (d) :
20 fdash=(S/100)*f;//in Hz
21 disp(fdash,"Rotor frequency at the given speed(in Hz)
    : ");

```

Scilab code Exa 2.3.p Actual Motor Speed

```

1 //problem 2.3
2 clc;
3 clear;
4 close;
5 //given data :
6 Pa=6;//No. of alternator poles
7 N=1000;//in rpm
8 Pm=16;//No. of motor poles
9 S=2.5;//in %
10 //Formula : N=120*f/Pa;//in rpm
11 f=N*Pa/120;//in Hz
12 Ns=120*f/Pm;//in rpm
13 disp(Ns,"Synchronous speed in rpm : ");
14 //formula : S=(Ns-Nr)/Ns*100
15 Nr=Ns-S/100*Ns;//in rpm
16 disp(Nr,"Actual speed of motor in rpm : ");

```

Scilab code Exa 2.3 Percentage slip and no of poles

```

1 //Exa 2.3
2 clc;
3 clear;
4 close;
5 //Given data :
6 P=10; //no. of poles
7 f=50; //in Hz
8 N=600; //in rpm
9 Nr=1440; //in rpm
10 f=P*N/120; //in Hz
11 //When P=2
12 P=2; //no. of poles
13 Ns=120*f/P; //in rpm
14 //When P=4
15 P=4; //no. of poles
16 Ns=120*f/P; //in rpm
17 disp("Induction motor speed is somewhat less than
      the synchronous speed. In this case induction
      motor speed, Nr is "+string(Nr)+" rpm.");
18 S=(Ns-Nr)*100/Ns; //Slip in %
19 disp("Percentage Slip (in %) : "+string(S));
20 disp("No. of poles : "+string(S));

```

Scilab code Exa 2.4.p Frequency and slip

```

1 //problem 2.4
2 clc;
3 clear;
4 close;
5 //given data :
6 format('v',5);
7 P=14; //No. of poles
8 f=50; //in Hz
9 N=415; //in rpm
10 Ns=120*f/P; //in rpm

```

```

11 S=(Ns-N)/Ns*100; //in %
12 disp(S," Slip (%) : ");
13 fr=S/100*f; //in Hz
14 disp(fr," Rotor frequency(in Hz) : ");

```

Scilab code Exa 2.4 Motor speed and slip

```

1 //Exa 2.4
2 clc;
3 clear;
4 close;
5 //Given data :
6 P=8; //no. of poles
7 f=50; //in Hz
8 fr=1.5; //in Hz
9 //Formula : fr=S*f
10 S=fr/f; //slip (unitless)
11 Ns=120*f/P; //in rpm
12 //Formula : S=(Ns-Nr)/Ns
13 Nr=Ns-S*Ns; //in rpm
14 disp(round(Nr)," Motor running speed in rpm : ");
15 disp(S*100," Slip (in %) :");

```

Scilab code Exa 2.5.p Copper Loss and Mechanical Power

```

1 //problem 2.5
2 clc;
3 clear;
4 close;
5 //given data :
6 format('v',5);
7 MotorInput=50; //in KW
8 Slip=3; //in %

```

```

9 RotCuLoss=MotorInput*Slip/100;//in KW
10 disp(RotCuLoss,"Rotor Copper Loss(KW) : ");
11 TMechP=MotorInput-RotCuLoss;//in KW
12 disp(TMechP,"Total mechanical power developed(KW) : "
);

```

Scilab code Exa 2.5 Synchronous and actual speed and frequency and slip

```

1 //Exa 2.5
2 clc;
3 clear;
4 close;
5 //Given data :
6 P=2;//no. of poles
7 f=50;//in Hz
8 S=4;//in %
9 //Part (i) :
10 Ns=f/P;//in rps
11 Ns=Ns*60;//in rpm
12 disp(Ns,"Synchronous speed in rpm : ");
13 //Part (ii) :
14 disp("Slip = "+string(S)+"% or "+string(S/100));
15 //Part (iii) :
16 N=Ns*(1-S/100);//in rpm
17 disp(N,"Actual speed in rpm :");

```

Scilab code Exa 2.6.p Slip and Torque

```

1 //problem 2.6
2 clc;
3 clear;
4 close;
5 //given data :

```

```

6  format('v',6);
7  P=4; //No. of poles
8  m=3; //No. of phase
9  f=50; //in Hz
10 Eff=85; //in %
11 Pout=17; //useful output power in KW
12 StatorLosses=900; //in watts
13 Input=Pout/Eff*100; //in KW
14 TLosses=Input-Pout; //in KW
15 WnF_Losses=1100; //in Watts
16 CuLoss=TLosses*1000-StatorLosses-WnF_Losses; //in
    watts
17 RotorInput=Input-StatorLosses/1000; //in KW
18 S=CuLoss/1000/RotorInput; // unitless
19 disp(S,"Slip : ");
20 Ns=120*f/P; //in rpm
21 N=Ns-S*Ns; //in rpm
22 //Formula : MechPower=Omega*T=2*%pi*N/60*T;
23 T=RotorInput*1000/(2*%pi*N/60); //in Newton-meter
24 disp(T,"Torque Developed in Nw-m : ");
25 Tavail=Pout*1000/(2*%pi*N/60); //in Newtons
26 disp(Tavail,"Torque Available(Nw-m) : ");

```

Scilab code Exa 2.6 Motor speed and slip

```

1  //Exa 2.6
2  clc;
3  clear;
4  close;
5  //Given data :
6  P=4; //no. of poles
7  f1=50; //in Hz
8  fdash=1.5; //in Hz
9  S=fdash/f1; //unitless
10 disp(S,"Slip : ");

```

```

11 Ns=120*f1/P; //in rpm
12 N=Ns*(1-S); //in rpm
13 disp(N,"Speed of motor in rpm :");

```

Scilab code Exa 2.7.p Rotor input copper loss and mechanical power

```

1 //problem 2.7
2 clc;
3 clear;
4 close;
5 //given data :
6 format('v',5);
7 P=6; //No. of poles
8 m=3; //No. of phase
9 f=60; //in Hz
10 Eff=85; //in %
11 N=1152; //in rpm
12 T=70; //in Nm
13 Ns=120*f/P; //in rpm
14 Twatts=2*pi*Ns/60*T; //in watts
15 RotorInput=Twatts; //in watts
16 disp(RotorInput/1000,"Total Input to the rotor (KW) :
    ");
17 S=(Ns-N)/Ns; //unitless
18 CuLoss=S*RotorInput; //in watts
19 disp(CuLoss,"Rotor Copper Loss (watts) : ");
20 Tdev=2*pi*N/60*T; //in Watts
21 disp(Tdev,"Mechanical Power developed (in Watts)");
22 //Note : Answer in the book is calculated right but
    in the end printed wrong.

```

Scilab code Exa 2.7 No of poles slip and speed

```

1 //Exa 2.7
2 clc;
3 clear;
4 close;
5 //Given data :
6 N=1440;//in rpm
7 f=50;//in Hz
8 disp("For this speed of 1440 rpm the synchronous
      speed may be either 1500 rpm or 3000 rpm.");
9 disp("If the synchronous speed is 3000 rpm then in
      generl case the speed will not be too slow. o the
      synchronous speed for this motor is 1500 rpm and
      and no. of poles corresponding to this speed is
      4.");
10 Ns=1500;//in rpm
11 P=4;//no. of poles
12 disp(P,"No. of poles : ");
13 Slip=(Ns-N)*100/Ns;//in %
14 disp(Slip,"Slip(in %) : ");
15 speed1=Ns-N;//Speed of rotor flux with respect to
      rotor
16 disp(speed1,"Speed of rotor flux with respect to
      rotor in rpm : ");
17 speed2=(speed1)+N;//Speed of rotor flux with respect
      to stator
18 disp(speed2,"Speed of rotor flux with respect to
      stator in rpm :");

```

Scilab code Exa 2.8.p Rotor current and slip

```

1 //problem 2.8
2 clc;
3 clear;
4 close;
5 //given data :

```

```

6 format('v',5);
7 m=3;//No. of phase
8 Vrotor=100;//in volts
9 Xo=1;//in ohm/phase
10 R2=0.2;//in ohm/phase
11 Eo=Vrotor/sqrt(3);//Rotor phase voltage in volts
12 S=4;//in %
13 I2=S/100*Eo/sqrt(R2^2+(S/100*Xo)^2);//in Ampere
14 disp(I2,"Rotor current in Ampere : ");
15 //For Max Torque S=R2/Xo
16 S=R2/Xo;//unitless
17 disp("For developing maximum torque");
18 disp(S,"Slip is : ");
19 I2=S*Eo/sqrt(R2^2+(S*Xo)^2);//in Ampere
20 disp(I2,"Rotor current in Ampere : ");

```

Scilab code Exa 2.8 Rotor current and phase difference

```

1 //Exa 2.8
2 clc;
3 clear;
4 close;
5 //Given data :
6 E2=100;//in volt
7 R2=0.05;//in ohm
8 X2=0.1;//in ohm
9 E2perphase=E2/sqrt(3);//in volt
10 //part (a) :
11 S=0.04;//slip
12 I2=S*E2perphase/sqrt(R2^2+(S*X2)^2);//in Ampere
13 disp(I2,"At 4% slip , Rotor current in Ampere : ");
14 fi2=acosd(R2/sqrt(R2^2+(S*X2)^2));//in degree
15 disp(fi2,"At 4% slip , Phase angle between rotor
    voltage and rotor current in degree :");
16 //part (b) :

```

```

17 S=1; //slip
18 I2=S*E2perphase/sqrt(R2^2+(S*X2)^2); //in Ampere
19 disp(I2,"At 100% slip , Rotor current in Ampere : ");
20 fi2=acosd(R2/sqrt(R2^2+(S*X2)^2)); //in degree
21 disp(fi2,"At 100% slip , Phase angle between rotor
    voltage and rotor current in degree :");

```

Scilab code Exa 2.9.p External Rotor resistance

```

1 //problem 2.9
2 clc;
3 clear;
4 close;
5 //given data :
6 format('v',5);
7 P=6; //No. of poles
8 m=3; //No. of phase
9 f=50; //in Hz
10 Xo_int=1; //in ohm/phase
11 Rrotor_int=0.1; //in ohm/phase
12 //S=1 for starting
13 S=1; //unitless
14 disp("Max. Torque condition : R2=X2");
15 //Rext+Rrotor_int=Xo_int
16 Rext=Xo_int-Rrotor_int; //in ohm/phase
17 disp(Rext,"External resistance to be added(ohm/phase
    ) : ");

```

Scilab code Exa 2.9 Rotor current

```

1 //Exa 2.9
2 clc;
3 clear;

```

```

4 close;
5 //Given data :
6 E2=100; //in volt
7 R2=0.4; //in ohm
8 X2=2.25; //in ohm
9 E2perphase=E2/sqrt(3); //in volt
10 S=4; //in %
11 E=(S/100)*E2perphase; //rotor induced emf at a slip=4
    % in volt
12 Z2=sqrt(R2^2+((S/100)*X2)^2);
13 I2=E/Z2; //in Ampere
14 disp(I2,"Rotor currentt in Ampere : ");

```

Scilab code Exa 2.10.p Resistance in series

```

1 //problem 2.10
2 clc;
3 clear;
4 close;
5 //given data :
6 format('v',6);
7 P=4; //No. of poles
8 m=3; //No. of phase
9 f=50; //in Hz
10 Tmax=162.8; //in Nw-m
11 R2=0.2; //in ohm per phase
12 Speed=1365; //in rpm
13 Ns=120*f/P; //in rpm
14 S=(Ns-Speed)/Ns; //unitless
15 //Max. Torque condition : S=R2/X2
16 X2=R2/S; //in ohm/phase
17 disp(" Tstarting=k*E2^2*R2/(R2^2+X2^2)=Tmax/2");
18 disp(" and Tmax=k*E2^2/(2*X2^2)");
19 disp(" This two eqn gives a polynomoial p for R2.");
20 p=[Tmax/2 -Tmax*2*X2 Tmax/2*X2^2];

```

```

21 R2=roots(p);
22 disp(" Additional resistance is "+string(R2(1))+ " ohm
    or "+string(R2(2))+ " ohm");
23 disp(" Higher value should be neglected. So answer is
    "+string(R2(2))+ " ohm.");

```

Scilab code Exa 2.10 Rotor current at various slip

```

1 //Exa 2.10
2 clc;
3 clear;
4 close;
5 //Given data :
6 f=50;//in Hz
7 R2=0.2;//in ohm
8 X2=2;//in ohm
9 E2=60;//in volt
10 E2perphase=E2/sqrt(3);//in volt
11 //case (i) : S=1
12 S=1;//unitless
13 Z2=sqrt(R2^2+(S*X2)^2);
14 I2=E2perphase*S/Z2;//in Ampere
15 disp(I2,"At standstill : Rotor current in Ampere : "
    );
16 //case (ii) : S=0.1
17 S=0.1;//unitless
18 Z2=sqrt(R2^2+(S*X2)^2);
19 I2=E2perphase*S/Z2;//in Ampere
20 disp(I2,"for 10% slip : Rotor current in Ampere : ")
    ;
21 //case (iii) : S=0.05
22 S=0.05;//unitless
23 Z2=sqrt(R2^2+(S*X2)^2);
24 I2=E2perphase*S/Z2;//in Ampere
25 disp(I2,"for 5% slip : Rotor current in Ampere : ");

```

```

26 //case (iv) : S=0.01
27 S=0.01;//unitless
28 Z2=sqrt(R2^2+(S*X2)^2);
29 I2=E2perphase*S/Z2;//in Ampere
30 disp(I2,"for 1% slip : Rotor current in Ampere : ");
31 //Note : Answer in the book is wrong for S=0.05 and
    S=0.01

```

Scilab code Exa 2.11.p No of poles and slip

```

1 //problem 2.11
2 clc;
3 clear;
4 close;
5 //given data :
6 N=290;//in rpm
7 f=50;//in Hz
8 disp("Motor running at full load, no. of poles
    should be 20");
9 P=20;//no. of poles
10 Ns=120*f/P;//in rpm
11 Slip=(Ns-N)/Ns*100;//in %
12 disp("T is proportional to S/R2 but T is same");
13 Slip=2*Slip;//doubling R2 also doubles the slip
14 disp(Slip,"New value of slip is : ");

```

Scilab code Exa 2.11 Current in each phase and power factor

```

1 //Exa 2.11
2 clc;
3 clear;
4 close;
5 //Given data :

```

```

6 R2=0.5; //in ohm
7 X=4.5; //im ohm
8 E=50; //line voltage in volt
9 Eperphase=E/sqrt(3); //in volt
10 //part (a) : Sliprings are short circuited
11 Z2=sqrt(R2^2+X^2); //in ohm
12 I2=Eperphase/Z2; //in Ampere
13 disp(I2,"Sliprings are short circuited , Rotor
    current in Ampere : ");
14 cosfi2=R2/Z2; //unitless
15 disp(cosfi2,"Power factor : ");
16 //part (b) : Sliprings are connected
17 R2=0.4; //in ohm
18 Z2=sqrt(R2^2+X^2); //in ohm
19 I2=Eperphase/Z2; //in Ampere
20 disp(I2,"Sliprings are short circuited , Rotor
    current in Ampere : ");
21 cosfi2=R2/Z2; //unitless
22 disp(cosfi2,"Power factor : ");
23 //Note : answer of part (a) I2 is not curate in the
    book.

```

Scilab code Exa 2.12.p Starting torque

```

1 //problem 2.12
2 clc;
3 clear;
4 close;
5 //given data :
6 //Isc=4*If;
7 Isc_by_If=4;
8 Slip=2.5; //in %
9 disp("Ts is proportional to Is^2");
10 disp("and Tf is proportional to If^2/S");
11 disp("From these eqn we get :")

```

```

12 Ts_by_Tf=(Isc_by>If)^2*(Slip/100); //ratio
13 disp("Starting torque is "+string(Ts_by_Tf*100)+" %
    of full load torque.");

```

Scilab code Exa 2.12 External Resistance per phase

```

1 //Exa 2.11
2 clc;
3 clear;
4 close;
5 //Given data :
6 R2=0.02; //in ohm
7 X2=0.1; //in ohm
8 //let external resistance per phase = r then R2=R2+r
    ohm
9 S=1; //slip at starting
10 disp("Torque at standing will be maximum if R2/X2=S
    =1");
11 disp("Since at start speed is zero and slip is ,
    therefore , unity or R2=X2");
12 r=X2-R2; //in ohm
13 disp(r,"External resistance per phase added to the
    rotor circuit in ohms : ");

```

Scilab code Exa 2.13.p Starting and Maximum Torque

```

1 //problem 2.13
2 clc;
3 clear;
4 close;
5 //given data :
6 format('v',6);
7 m=3; //No. of phase

```

```

8 P=6; //no. of poles
9 f=50; //in Hz
10 Xo=6; //in ohm per phase
11 R=1; //in ohm per phase
12 Eo=62.8; //in volt
13 Ns=120*f/P; //in rpm
14 Omega_s=2*pi*Ns/60; //in radians/sec
15 K=m/Omega_s;
16 S=1; //slip at starting
17 Ts=K*S*Eo^2*R/(R^2+(S*Xo)^2); //in Nw-m
18 disp(Ts,"Starting torque(Nw-m) : ")
19 S=R/Xo; //slip for max torque
20 Tmax=K*Eo^2/(2*Xo); //in Nw-m
21 disp(Tmax,"Maximum torque(Nw-m) : ")
22 //Note : Answer in the book is wrong due to
    calculation mistake.

```

Scilab code Exa 2.13 External Rotor Resistance per phase

```

1 //Exa 2.13
2 clc;
3 clear;
4 close;
5 //Given data :
6 P=4; //no. of poles
7 f=50; //in Hz
8 R2=0.03; //in ohm
9 X2=0.12; //in ohm
10 Smax=R2/X2; //unitless
11 Ns=120*f/P; //in rpm
12 N=Ns*(1-Smax); //in rpm
13 disp(N,"Speed corresponding to maximum torque(in rpm
    ) :");
14 disp("Let r be the external resistance introduced
    per phase in the rotor circuit. Ratio of rotor

```

```

        circuit resistance to rotor standstill resistance
        =alfa ");
15 // alfa=(R2+r)/X2
16 //Ratio of starting torque to max torque=75/100=2*
    alfa/(alfa^2+1)
17 //It gives : 3*alfa^2-8*alfa+3=0
18 //coefficients :
19 a=3;b=-8;c=3;
20 alfa1=(-b+sqrt(b^2-4*a*c))/(2*a);alfa2=(-b-sqrt(b
    ^2-4*a*c))/(2*a);
21 disp("rejecting higher values , alfa = "+string(alfa2
    ));
22 fdash=1.5;//in Hz
23 r=alfa2*X2-R2;//in ohm;
24 disp(r,"External rotor resistance per phase(in ohm)
    : ");

```

Scilab code Exa 2.14.p Total Torque

```

1 //problem 2.14
2 clc;
3 clear;
4 close;
5 //given data :
6 format('v',6);
7 m=3;//No. of phase
8 P=4;//no. of poles
9 f=50;//in Hz
10 VL=200;//in volt
11 R=0.1;//in ohm per phase
12 Xo=0.9;//in ohm per phase
13 TurnsRatio=0.67;//ratio
14 S=4;//in %
15 Vphase=VL/sqrt(3);//in volt
16 Vrotor=Vphase*TurnsRatio;//in volt

```

```

17 Ns=1500;//in rpm
18 Omega_s=2*pi*Ns/60;//in radians/sec
19 K=m/Omega_s;
20 S=S/100;//slip unitless
21 Ts=K*S*Vrotor^2*R/(R^2+(S*Xo)^2);//in Nw-m
22 disp(Ts,"Starting torque(Nw-m) : ")
23 //Note : Answer in the book is wrong due to
    calculation mistake.

```

Scilab code Exa 2.14 Speed develop max torque

```

1 //Exa 2.14
2 clc;
3 clear;
4 close;
5 //Given data :
6 P=4;//no. of poles
7 f=50;//in Hz
8 R2=0.024;//in ohm
9 X2=0.6;//in ohm
10 disp("Since the torque under running condition is
    maximum at that value of slip which makes rotor
    reactance per phase equal to the rotor resistance
    per phase.")
11 Sm=R2/X2;//slip corresponding to max torque
12 Ns=120*f/P;//in rpm
13 N=Ns*(1-Sm);//in rpm
14 disp(N,"Speed corresponding to maximum torque in rpm
    : ");

```

Scilab code Exa 2.15.p Resistance and Power

```

1 //problem 2.15

```

```

2  clc;
3  clear;
4  close;
5  //given data :
6  format('v',7);
7  m=3;//No. of phase
8  P=8;//no. of poles
9  f=50;//in Hz
10 Pout=15;//in KW
11 S=4;//in %
12 R2=0.2;//in ohm per phase
13 Xo=1.5;//in ohm per phase
14 N=400;//in rpm
15 Ns=120*f/P;//in rpm
16 Sdash=(Ns-N)/Ns*100;// unitless
17 R2dash=R2*Sdash/S;//in ohm/phase
18 Radded=R2dash-R2;//in ohm
19 disp(Radded,"Resistance to be added in ohm : ");
20 Mechpower=Pout;//in KW
21 RotorInput=Mechpower/(1-S/100);//in KW
22 disp(RotorInput*1000," Input to the rotor(in watts)
   : ");
23 RotorCuLoss=Sdash/100*RotorInput;//in KW
24 disp(RotorCuLoss*1000,"Rotor Copper Loss(in watts) :
   ");
25 OutPower=RotorInput-RotorCuLoss;//in KW
26 disp(OutPower*1000,"Output power(in Watts) : ");
27 disp(RotorInput*1000,"Input at a slip of 4%(in Watts
   ) : ");
28 //Note : Answer in the book is wrong due to
   calculation mistake.

```

Scilab code Exa 2.15 Speed and max torque in terms of full load torque

```
1 //Exa 2.15
```

```

2  clc;
3  clear;
4  close;
5  //Given data :
6  P=6; //no. of poles
7  f=50; //in Hz
8  Sf=4; //in %
9  R2=0.01; //in ohm
10 X2=0.05; //im
11 Ratio=((R2/X2)^2+(Sf/100)^2)/(2*R2*(Sf/100)/X2); //
    ratio of max torque to full load torque
12 disp("Maximum torque , Tmax="+string(Ratio)+" Tf");
13 disp("Since the torque under running condition is
    maximum at that value of slip which makes rotor
    reactance per phase equal to the rotor resistance
    per phase.")
14 Sm=R2/X2; //slip corresponding to max torque
15 Ns=120*f/P; //in rpm
16 N=Ns*(1-Sm); //in rpm
17 disp(N,"Speed corresponding to maximum torque in rpm
    : ");

```

Scilab code Exa 2.16.p Calculate Slip

```

1  //problem 2.16
2  clc;
3  clear;
4  close;
5  //given data :
6  format('v',6);
7  Eff=0.8; //unitless
8  Load=20; //in HP
9  Load=Load*735.5; //in watts
10 //IronLoss=K; //assumed
11 //MechLoss=K/3;

```

```

12 //RotorCuLoss=StatorCuLoss=IronLoss=K;
13 //TotLoss=K+K+K+K/3=10*K/3;//
14 Input=Load/Eff;//in watts
15 TotLoss=Input-Load;//in watts
16 K=TotLoss*3/10;//in watts
17 IronLoss=K;//in watts
18 StatorCuLoss=K;//in watts
19 RotorCuLoss=K;//in watts
20 MechLoss=K/3;//in watts
21 RotInput=Load+MechLoss+RotorCuLoss;//in watts
22 //Formula : RotorCuLoss=S*RotInput
23 S=RotorCuLoss/RotInput;//unitless
24 disp(S,"Slip is : ");

```

Scilab code Exa 2.16 Speed and ratio of max torque to full load torque

```

1 //Exa 2.16
2 clc;
3 clear;
4 close;
5 //Given data :
6 P=12;//no. of poles
7 f=50;//in Hz
8 R2=0.03;//in ohm
9 X2=0.5;//in
10 S=R2/X2;//unitless
11 Ns=120*f/P;//in rpm
12 N=Ns*(1-S);//in rpm
13 disp(N,"Speed at maximum torque in rpm : ");
14 S=(Ns-495)/Ns;//slip at 495 rpm speed
15 Ratio=(2*R2*S/X2)/((R2/X2)^2+S^2);//ratio of max
    torque to full load torque
16 disp(Ratio*100,"Ratio of full load torque to max
    torque(in %) :");

```

Scilab code Exa 2.17.p Motor current per phase

```
1 //problem 2.17
2 clc;
3 clear;
4 close;
5 //given data :
6 format('v',6);
7 m=3;//no. of phase
8 P=6;//no. of poles
9 f=50;//in Hz
10 Pin=20;//in KW
11 N=960;//in rpm
12 R2=1/3;//in ohm/phase
13 Ns=120*f/P;//in rpm
14 S=(Ns-N)/Ns;//unitless
15 RotCuLoss=S*Pin*1000;//in Watts
16 RotCuLoss=S*Pin*1000/m;//in Watts/phase
17 //Formula :  $I_2^2 * R_2 = \text{RotCuLoss}$  per phase
18 I2=sqrt(RotCuLoss/R2);//in Ampere
19 disp(I2,"Rotor current in Ampere : ");
```

Scilab code Exa 2.17 Resistance inserted in series

```
1 //Exa 2.17
2 clc;
3 clear;
4 close;
5 //Given data :
6 P=12;//no. of poles
7 f=50;//in Hz
8 R2=0.5;//in ohm
```

```

 9 N=475; //in rpm
10 Ns=120*f/P; //in rpm
11 S=(Ns-N)/Ns; //unitless
12 X2=R2/S; //in ohm
13 disp("At maximum torque, Tmax is proportional to
      1/2*X2 or 1/20");
14 disp("Now if a resistance R is to be inserted in
      series with each phase of the rotor to reduce the
      starting torque to 1/3 of maximum torque, then")
      ;
15 disp("Ts is proportional to (R2+R)/((R2+R)^2+X2^2)")
      ;
16 disp("Also, Ts is proportional to 1(20*3)");
17 disp("Equating the two eqn we have : (0.5*R)/(R2+R)
      ^2+X2^2");
18 //R^2-59R+70.25=0 :
19 //coefficients :
20 a=1;b=-59;c=70.25;
21 R=(-b-sqrt(b^2-4*a*c))/(2*a);
22 disp(R,"Resistance R to be inserted in series (in
      ohm) :");
23 //Note : answer in the book is wrong.

```

Scilab code Exa 2.18.p Maximum Torque

```

1 //problem 2.18
2 clc;
3 clear;
4 close;
5 //given data :
6 format('v',6);
7 P=8; //no. of poles
8 f=50; //in Hz
9 R2=0.04; //in ohm/phase
10 N=645; //in rpm

```

```

11 Ns=120*f/P; //in rpm
12 S=(Ns-N)/Ns*100; //unitless
13 S=S/100; //unitless
14 //S=R2/X2; //at max torque
15 X2=R2/S; //in ohm per phase
16 a=R2/X2; //unitless
17 TstartBYTmax=2*a/(a^2+1); //ratio
18 TstartBYTmax=2*a/(a^2+1)*100; //in %
19 disp(round(TstartBYTmax),"% of max torque is : ");
20 S=3; //in %
21 S=3/100; //unitless
22 TflBYTmax=2*a*S/(a^2+S^2); //ratio
23 TflBYTmax=2*a*S/(a^2+S^2)*100; //in %
24 disp(round(TflBYTmax),"% of max torque at slip 3% is
      : ");

```

Scilab code Exa 2.18 Starting torque as a percentage of mx torque

```

1 //Exa 2.18
2 clc;
3 clear;
4 close;
5 //Given data :
6 P=4; //no. of poles
7 f=50; //in Hz
8 R2=0.04; //in ohm
9 N=1200; //in rpm(speed at max torque)
10 Ns=120*f/P; //in rpm(synchronous speed)
11 S=(Ns-N)/Ns; //unitless
12 X2=R2/S; //in ohm
13 //Starting torque is the torque developed when S=1:
    Tst=K*R2/(R2^2+X2^2)
14 //Let say, m=R2/(R2^2+X2^2) then Tst=K*m
15 m=R2/(R2^2+X2^2); //assumed
16 disp("Starting torque, Tst="+string(m)+"k");

```

```

17 disp("Maximum torque , Tm=K/" + string(2*X2));
18 disp("Thus, Tst in terms of Tm can be expressed as :
    ");
19 disp("Tst/Tm=" + string(0.96*0.4) + " or Tst=" + string
    (0.96*0.4) + "Tm");
20 disp("Therefore , starting torque is " + string
    (0.96*0.4*100) + "% of maximum torque.");

```

Scilab code Exa 2.19.p Current per phase and power factor

```

1 //problem 2.19
2 clc;
3 clear;
4 close;
5 //given data :
6 format('v',5);
7 m=3;//no. of phase
8 emf=50;//in volt
9 E2=emf/sqrt(3);//emf/phase
10 R2=0.5;//in ohm/phase
11 X2=4.5;//in ohm/phase
12 //(a) Sliprings are short circuited
13 Z2=sqrt(R2^2+X2^2);//in oghm per phase
14 I2=E2/Z2;//in Ampere
15 disp(I2,"Rotor current per phase(Ampere) : ");
16 cosfi2=R2/Z2;//unitless
17 disp(cosfi2,"Rotor power factor : ");
18 //(a) Sliprings are connected to star connected
    rheostat
19 R2=4+R2;//in ohm/phase
20 Z2=sqrt(R2^2+X2^2);//in oghm per phase
21 I2=E2/Z2;//in Ampere
22 disp(I2,"Rotor current per phase(Ampere) : ");
23 cosfi2=R2/Z2;//unitless
24 disp(cosfi2,"Rotor power factor : ");

```

Scilab code Exa 2.19 Speed slip and cu loss

```
1 //Exa 2.19
2 clc;
3 clear;
4 close;
5 //Given data :
6 P=6;//no. of poles
7 f=50;//in Hz
8 fr=3;//in Hz
9 R2=0.5;//in ohm
10 N=475;//in rpm
11 RotorInput=111.9;//in KW
12 Ns=120*f/P;//in rpm
13 S=fr*100/f;//unitless
14 disp(S,"% Slip : ");
15 N=Ns*(1-S/100);//in rpm
16 disp(N,"Speed of motor in rpm : ");
17 RotorCopperLoss=RotorInput*S/100;//in KW
18 RotorCopperLoss=RotorCopperLoss/3;//in KW/Phase
19 disp(RotorCopperLoss,"Rotor Copper Loss per phase(in
    KW) : ");
```

Scilab code Exa 2.20.p Ratio Tst and Tfl

```
1 //problem 2.20
2 clc;
3 clear;
4 close;
5 //given data :
6 format('v',6);
```

```

7 m=3; //no. of phase
8 TmaxBYTf1=2.5; //ratio
9 R2=0.5; //in ohm/phase
10 X2=5; //in ohm/phase
11 //Formula:  $T_{st}=K \cdot E_2^2 \cdot R_2 / (R_2^2 + X_2^2)$  and  $T_m=K \cdot E_2^2 / (2 \cdot X_2)$ 
12 TstBYTf1=TmaxBYTf1*2*X2*R2/(R2^2+X2^2); //ratio
13 disp(TstBYTf1,"(a) For direct on line starting ,
      ratio starting torque to Full load torque is : ")
      ;
14 //For star delta starting :
15 TstBYTf1=(1/3)*TmaxBYTf1*2*X2*R2/(R2^2+X2^2); //ratio
16 disp(TstBYTf1,"(b) For star delta starting , ratio
      starting torque to Full load torque is : ");
17 //For auto transformer starting with tapping at 75 %
18 TstBYTf1=(75/100)^2*TmaxBYTf1*2*X2*R2/(R2^2+X2^2); //
      ratio
19 disp(TstBYTf1,"(c) For star delta starting , ratio
      starting torque to Full load torque is : ");

```

Scilab code Exa 2.20 Mech power and Cu loss

```

1 //Exa 2.20
2 clc;
3 clear;
4 close;
5 //Given data :
6 phase=3; //no. of phase
7 Pin_stator=60; //Power input of stator in KW
8 TotalStatorLosses=1; //in KW
9 Pin_rotor=Pin_stator-TotalStatorLosses; //Power input
      of rotor in KW
10 S=3; //slip in %
11 RotorCopperLosses=(S/100)*Pin_rotor; //in KW
12 RotorCopperLosses=RotorCopperLosses/phase; //in KW

```

```

    per phase
13 disp(RotorCopperLosses*10^3,"Rotor Copper Losses per
    phase(in watts) : ");
14 TotalMechPowerDev=Pin_rotor*(1-S/100); //in KW
15 disp(TotalMechPowerDev,"Total mechanical power
    developed(in KW) : ") ;

```

Scilab code Exa 2.21 Speed and cu loss

```

1 //Exa 2.21
2 clc;
3 clear;
4 close;
5 //Given data :
6 P=6; //no. of poles
7 S=4; //slip in %
8 Output=20; //in KW
9 FrictionalLoss=250; //in watts
10 f=50; //in Hz
11 Ns=120*f/P; //in rpm
12 N=Ns-Ns*(S/100); //in rpm
13 disp(N,"Speed of motor(in rpm) : ");
14 MechPowerDeveloped=Output*10^3+FrictionalLoss; //in
    Watts
15 S=S/100; //unitless
16 RotorCopperLoss=(S/(1-S))*MechPowerDeveloped; //in
    watts
17 disp(RotorCopperLoss,"Rotor Copper Loss(in watts) :
    ");

```

Scilab code Exa 2.22 Slip Speed Power Loss Current

```

1 //Exa 2.22

```

```

2  clc;
3  clear;
4  close;
5  //Given data :
6  format('v',6);
7  phase=3;//no. of phase
8  P=6;//no. of poles
9  Pin_rotor=80;//Power input of rotor in KW
10 f=50;//in Hz
11 fdash=100;//alternations per minute
12 fdash=100/60;//in Hz
13 S=fdash/f;//unitless
14 disp(S,"Slip : ");
15 Ns=120*f/P;//synchronous speed in rpm
16 N=Ns-Ns*S;//in rpm
17 disp(round(N),"Rotor Speed(in rpm) : ");
18 MechPowerDev=Pin_rotor*(1-S)*10^3/735.5;//in H.P.
19 disp(MechPowerDev,"Total mechanical power developed(
    in KW) : ") ;
20 RotorCopperLoss=S*Pin_rotor*10^3;//in watts
21 disp(RotorCopperLoss,"Rotor Copper Loss(in watts) :
    ");
22 CopperLoss=RotorCopperLoss/phase;//in watts/phase
23 disp(CopperLoss,"Copper Loss per phase(in watts) : "
    );
24 I2=60;//in Ampere
25 R2=CopperLoss/I2^2;//in ohm
26 disp(R2,"Rotorresistance per phase(in ohm) : ");
27 //Note : Some answers are not accurate in the book.

```

Scilab code Exa 2.23 Copper Loss and Efficiency

```

1  //Exa 2.23
2  clc;
3  clear;

```

```

4 close;
5 //Given data :
6 format('v',6);
7 UsefulOutput=55;//in H.P.
8 MechLosses=2;//in H.P.
9 Stator_Losses=13.5;//in KW
10 MechPowerDev=UsefulOutput+MechLosses;//in H.P.
11 MechPowerDev=MechPowerDev*735.5/1000;//in KW
12 S=50;//in %
13 Pin_Rotor=MechPowerDev/(1-S/100);//in KW
14 RotorCopperLoss=(S/100)*Pin_Rotor;//in KW
15 disp(RotorCopperLoss,"Rotor Copper Loss(in KW) : ");
16 Pin_Motor=Pin_Rotor+Stator_Losses;//in KW
17 Efficiency=UsefulOutput*0.7355/Pin_Motor;//unitless
18 disp(Efficiency*100,"Efficiency(in %) :");

```

Scilab code Exa 2.24 Slip speed Loss Resistance Power

```

1 //Exa 2.24
2 clc;
3 clear;
4 close;
5 //Given data :
6 format('v',6);
7 phase=3;//no. of phase
8 P=6;//no. of poles
9 Pin_rotor=80;//Power input of rotor in KW
10 f=50;//in Hz
11 fdash=100;//alternations per minute
12 fdash=100/60;//in Hz
13 S=fdash/f;//unitless
14 disp(S,"Slip : ");
15 Ns=120*f/P;//synchronous speed in rpm
16 N=Ns-Ns*S;//in rpm
17 disp(round(N),"Rotor Speed(in rpm) : ");

```

```

18 RotorCopperLoss=S*Pin_rotor*10^3;//in watts
19 //disp(RotorCopperLoss,"Rotor Copper Loss(in watts)
    : ");
20 CopperLoss=RotorCopperLoss/phase;//in watts/phase
21 disp(CopperLoss,"Copper Loss per phase(in watts) : "
    );
22 I2=60;//in Ampere
23 R2=CopperLoss/I2^2;//in ohm
24 disp(R2,"Rotorresistance per phase(in ohm) : ");
25 MechPowerDev=Pin_rotor*(1-S)*10^3/735.5;//in H.P.
26 disp(MechPowerDev,"Total mechanical power developed(
    in H.P.) : ") ;
27 //Note : Some answers are not accurate in the book.

```

Scilab code Exa 2.25 Slip

```

1 //Exa 2.25
2 clc;
3 clear;
4 close;
5 //Given data :
6 format('v',9);
7 Efficiency=0.9;//unitless
8 Output=50;//in H.P.
9 //formula : Efficiency=Output/(Output+Losses)
10 Losses=((1-Efficiency)/Efficiency)*Output*735.5;//in
    watts
11 Losses=round(Losses);//round
12 //Let, Ststor Cu loss = Rotor Cu los = Iron loss=K
13 //Mechanical Loss = Iron Loss/3 = K/3
14 //TotalLosses=k+K+K+K/3
15 K=Losses*3/10;//in watts
16 Pin_rotor=Output*735.5+Losses;//in watts
17 Slip=K/Pin_rotor;//unitless
18 disp(Slip,"Slip :");

```

```
19 disp(" or " + string(Slip*100) + "%");
```

Scilab code Exa 2.26 Motor current per phase

```
1 //Exa 2.26
2 clc;
3 clear;
4 close;
5 //Given data :
6 format('v',6);
7 Pin_rotor=20; //Power input of rotor in KW
8 phase=3; //no. of phase
9 P=6; //no. of poles
10 f=50; //in Hz
11 N=960; //in rpm(Actual speed of motor)
12 Ns=120*f/P; //synchronous speed in rpm
13 S=(Ns-N)/Ns; //unitless
14 RotorCuLoss=S*Pin_rotor*10^3; //in watts
15 RotorCuLoss=RotorCuLoss/phase; //in watts/phase
16 R2=1/3; //in ohm(Rotor resistance per phase)
17 I2=sqrt(RotorCuLoss/R2); //in Ampere
18 disp(I2,"Motor current per phase(in Ampere) :");
```

Scilab code Exa 2.27 Slip Loss and Current

```
1 //Exa 2.27
2 clc;
3 clear;
4 close;
5 //Given data :
6 format('v',6);
7 V=500; //in volt
8 Pout_rotor=20; //Power output of rotor in H.P.
```

```

 9 phase=3;//no. of phase
10 P=6;//no. of poles
11 f=50;//in Hz
12 N=995;//in rpm(Actual speed of motor)
13 cosfi=0.87;//powerfactor(unitless)
14 Ns=120*f/P;//synchronous speed in rpm
15 S=(Ns-N)/Ns;//unitless
16 disp(S,"Slip : ");
17 RotorCuLoss=(S/(1-S))*Pout_rotor*735.5;//in watts
18 disp(RotorCuLoss,"Rotor Cu Loss(in watts) : ");
19 Pin_rotor=RotorCuLoss/S;//in watts
20 disp(Pin_rotor/10^3,"Power input to rotor(in KW) :")
    ;
21 LineCurrent=Pin_rotor/(sqrt(3)*V*cosfi);//in Ampere
22 disp(LineCurrent,"Line Current(in A) :");
23 RotorFreq=S*f;//in Hz
24 disp(RotorFreq,"Rotor Frequency(in Hz) :");

```

Scilab code Exa 2.28 Pull on belt

```

1 //Exa 2.28
2 clc;
3 clear;
4 close;
5 //Given data :
6 format('v',6);
7 phase=3;//no. of phase
8 Efficiency=90;//in %
9 Speed=480;//in rpm
10 VL=400;//in volt
11 IL=75;//in Ampere
12 cosfi=0.77;//powerfactor(unitless)
13 d=0.75;//diameter of pulley in meter
14 Pin_motor=sqrt(3)*VL*IL*cosfi;//Power input of motor
    in watts

```

```

15 OutputPower=Pin_motor*Efficiency/100; //in watts
16 Omega=Speed*2*pi/60; //angular speed in radians/sec
17 Torque=OutputPower/Omega; //in N-meter
18 Torque=Torque/9.81; //in Kg-meter
19 PullOnBelt=Torque/(d/2); //in Kg
20 disp(PullOnBelt,"Pull On Belt(in Kg.) : ");

```

Scilab code Exa 2.29 Mechanical Power output

```

1 //Exa 2.29
2 clc;
3 clear;
4 close;
5 //Given data :
6 format('v',6);
7 //At 3% slip
8 OutputPower=24; //in KW(At 3% slip)
9 S=3; //in %
10 Efficiency=(1-S/100); //unitless
11 InputPower=OutputPower/Efficiency; //in KW
12 //At 5% slip
13 S=5; //in %
14 Efficiency=(1-S/100); //unitless
15 OutputPower=InputPower*Efficiency; //in KW
16 disp(OutputPower,"Mechanical power output at a slip
of 5%(in KW) : ");

```

Scilab code Exa 2.30 Cu loss and efficiency

```

1 //Exa 2.30
2 clc;
3 clear;
4 close;

```

```

5 //Given data :
6 format('v',6);
7 //At 50% speed of synchronous speed
8 S=50; //in %
9 UsefulOutput=55; //in H.P.
10 MechLoss=2; //in H.P.
11 StatorLoss=13.5; //in KW
12 Pout_rotor=UsefulOutput+MechLoss; //in H.P.
13 Pout_rotor=Pout_rotor*0.7355; //in KW
14 Efficiency=(1-S/100); //unitless
15 RotorInputPower=Pout_rotor/Efficiency; //in KW
16 RotorCuLoss=RotorInputPower-Pout_rotor; //in KW
17 disp(RotorCuLoss,"Cu Loss in the rotor circuit(in KW
    ) :");
18 TotalLosses=StatorLoss+RotorCuLoss+MechLoss*0.7355;
    //in KW
19 MotorEfficiency=UsefulOutput*0.7355/(UsefulOutput
    *0.7355+TotalLosses);
20 disp(MotorEfficiency*100,"Motor Efficiency(in %) : "
    );

```

Scilab code Exa 2.31 Slip Torque Cu loss and line current

```

1 //Exa 2.31
2 clc;
3 clear;
4 close;
5 //Given data :
6 format('v',6);
7 P=4; //no. of poles
8 phase=3; //no. of phase
9 N=1440; //in rpm(Actual speed of motor)
10 Power_dev=10; //Power developed in H.P.
11 VL=400; //in volt
12 cosfi=0.8; //powerfactor(unitless)

```

```

13 f=50; //in Hz
14 Ns=120*f/P; //in rpm
15 S=(Ns-N)/Ns; //fractional slip (unitless)
16 disp(S," Slip :");
17 Omega=N*2*pi/60; //angular speed in radians/sec
18 Torque=Power_dev*735.5/Omega; //in N-meter
19 Torque=Torque/9.81; //in Kg-meter
20 disp(Torque," Torque(in Kg-meter) :");
21 RotorCuLoss=(S/(1-S))*Power_dev*735.5; //in watts
22 disp(RotorCuLoss/3," Rotor Cu Loss per phase(in watts
   ) : ");
23 Pin_rotor=RotorCuLoss/S; //in watts
24 disp(Pin_rotor/10^3," Power input to rotor(in KW) :")
   ;
25 LineCurrent=Pin_rotor/(sqrt(3)*VL*cosfi); //in Ampere
26 disp(LineCurrent," Line Current(in A) :");

```

Scilab code Exa 2.32 Slip speed Loss Resistance Power

```

1 //Exa 2.32
2 clc;
3 clear;
4 close;
5 //Given data :
6 format('v',6);
7 VL=440; //in volt
8 f=50; //in Hz
9 P=6; //no. of poles
10 phase=3; //no. of phase
11 Pin_rotor=80; //in KW
12 fr=100; //revolutions/min
13 fr=100/60; //in Hz
14 S=fr/f; //slip (unitless)
15 disp(S," Slip : ");
16 Ns=120*f/P; //in rpm

```

```

17 N=Ns*(1-S); //in rpm(Speed of Rotor)
18 disp(round(N),"Rotor speed(in rpm) : ");
19 RotorCuLoss=S*Pin_rotor*10^3; //in watts
20 disp(RotorCuLoss/phase,"Rotor Cu Loss per phase(in
    watts) : ");
21 I2=65; //in Ampere
22 R2=(RotorCuLoss/phase)/I2^2; //in ohm
23 disp(R2,"Rotor resistance per phase(in ohm) : ");
24 Pout_rotor=Pin_rotor-RotorCuLoss/10^3; //in KW
25 disp(Pout_rotor/0.735,"Output power of rotor(in H.P
    .) : ");
26 //Note : answers of few part are not accurate in the
    book.

```

Scilab code Exa 2.33 Motor current per phase

```

1 //Exa 2.33
2 clc;
3 clear;
4 close;
5 //Given data :
6 format('v',6);
7 VL=440; //in volt
8 f=50; //in Hz
9 P=6; //no. of poles
10 phase=3; //no. of phase
11 Pin_rotor=20; //in KW
12 N=960; //in rpm(Speed of Motor)
13 Ns=120*f/P; //in rpm
14 S=(Ns-N)/Ns; //slip(unitless)
15 RotorCuLoss=S*Pin_rotor*10^3; //in watts
16 RotorCuLoss=RotorCuLoss/phase; //in watts/phase
17 R2=1/3; //Rotor Resistance in ohm per phase
18 I2=sqrt(RotorCuLoss/R2)
19 disp(I2,"Motor current per phase(in Ampere) :");

```

Scilab code Exa 2.34 Slip loss input Current and cycles

```
1 //Exa 2.34
2 clc;
3 clear;
4 close;
5 //Given data :
6 format('v',7);
7 VL=500; //in volt
8 f=50; //in Hz
9 P=6; //no. of poles
10 phase=3; //no. of phase
11 Pout_rotor=20; //in H.P.
12 cosfi=0.87; //power factor
13 N=995; //in rpm(Speed of Motor)
14 Ns=120*f/P; //in rpm
15 S=(Ns-N)/Ns; //slip (unitless)
16 disp(S,"Slip : ");
17 RotorCuLoss=(S/(1-S))*Pout_rotor*735.5; //in watts
18 disp(RotorCuLoss,"Rotor Cu Loss(in watts) :");
19 Pin_rotor=RotorCuLoss/S; //in watts
20 disp(Pin_rotor/10^3,"Power input to rotor(in KW) :")
    ;
21 IL=Pin_rotor/(sqrt(3)*VL*cosfi); //in Ampere
22 disp(IL,"Line current (in Ampere) :");
23 Rotorfreq=S*f; //in Hz
24 disp(Rotorfreq,"Rotor frequency(in Hz) :");
```

Scilab code Exa 2.35 Slip and Torque

```
1 //Exa 2.35
```

```

2  clc;
3  clear;
4  close;
5  //Given data :
6  format('v',6);
7  f=50;//in Hz
8  P=4;//no. of poles
9  phase=3;//no. of phase
10 Efficiency=85;//in %
11 OutputPower=17;//in KW
12 OutputPower=17*10^3;//in watts
13 StatorLosses=900;//in watt
14 MechLosses=1100;//in watt
15 Pin=OutputPower/(Efficiency/100);//in watts
16 //Stator input or rotor input :
17 Pin_rotor=Pin-StatorLosses;//in watts
18 P_MechDev=OutputPower+MechLosses;//in watts
19 RotorCuLosses=Pin_rotor-P_MechDev;//in watts
20 S=RotorCuLosses/Pin_rotor;//slip (unitless)
21 disp(S,"Slip :");
22 Ns=120*f/P
23 N=Ns*(1-S);//in rpm(Speed of Motor)
24 Omega=2*%pi*N/60;//angular speed in rad/sec
25 Torque=P_MechDev/Omega;//in Nm
26 disp(Torque,"Torque developed(in Nm) :");
27 Tm=OutputPower/Omega;//in Nm
28 Tm=Tm/9.81;//in Kg-meter
29 disp(Tm,"Torque at the shaft(in Kg-meter) :");

```

Scilab code Exa 2.36 power I²R loss and efficiency

```

1 //Exa 2.36
2 clc;
3 clear;
4 close;

```

```

5 //Given data :
6 format('v',7);
7 VL=500;//in volt
8 f=50;//in Hz
9 P=6;//no. of poles
10 phase=3;//no. of phase
11 Pin_stator=50;//in KW
12 Statorlosses=2;//in KW
13 MechLosses=1;//in KW
14 Pin_rotor=Pin_stator-Statorlosses;//in KW
15 S=3;//in %
16 RotorI2RLoss=(S/100)*Pin_rotor;//in KW
17 disp(RotorI2RLoss,"Rotor I2R Loss(in KW) :");
18 disp("Rotor core loss at 3% slip is very less and
      can be neglected.");
19 Power_dev=Pin_rotor-RotorI2RLoss;//in KW
20 disp(Power_dev/0.7355,"Power developed by the rotor(
      in H.P.) : ");
21 Outputpower=Power_dev-MechLosses;//in KW
22 Efficiency=Outputpower/Pin_stator;//unitless
23 disp(Efficiency*100,"Efficiency of the motor(in %) :
      ");

```

Scilab code Exa 2.37 I2R loss and speed

```

1 //Exa 2.37
2 clc;
3 clear;
4 close;
5 //Given data :
6 format('v',7);
7 f=50;//in Hz
8 P=4;//no. of poles
9 phase=3;//no. of phase
10 MotorOutput=20;//in H.P.

```

```

11 MotorOutput=20*735.5; //in watts
12 S=4; //full load slip in %
13 MechLosses=500; //in watts
14 Pdev_rotor=MotorOutput+MechLosses; //in watts
15 S=S/100; //fractional slip
16 RotorI2RLoss=(S/(1-S))*Pdev_rotor; //in watts
17 disp(RotorI2RLoss,"Rotor I2R Loss(in watts) :");
18 Ns=120*f/P; //in rpm
19 Nr=Ns-Ns*S; //in rpm
20 disp(Nr,"Rotor speed(in rpm) :");

```

Scilab code Exa 2.38 Speed and external rotor resistance

```

1 //Exa 2.38
2 clc;
3 clear;
4 close;
5 //Given data :
6 format('v',6);
7 f=50; //in Hz
8 P=6; //no. of poles
9 phase=3; //no. of phase
10 R2=0.02; //in ohm
11 X2=0.1; //in ohm
12 S=R2/X2; //slip (unitless)
13 Ns=120*f/P; //in rpm
14 Nr=Ns-Ns*S; //in rpm
15 //At starting S=1
16 S=1; //slip
17 //Formula :  $T=K*S*R2/(R2^2+X2^2)$ 
18 //Starting torque,  $Tst=K*R2/(R2^2+S^2*X2^2)$ 
19 //Maximum torque,  $Tm=K/(2*X2)$ 
20 //Tst=(2/3)*Tm : gives a equation
21 //100*R2^2-30*R2+1=0
22 a=100; b=-30; c=1;

```

```

23 R21=(-b+sqrt(b^2-4*a*c))/(2*a); //in ohm
24 R22=(-b-sqrt(b^2-4*a*c))/(2*a); //in ohm
25 //This R2 is the value of rotor circuit resistance.
26 RotWinResistance=0.02; //in ohm per phase
27 Extra_R1=R21-RotWinResistance; //in ohm
28 Extra_R2=R22-RotWinResistance; //in ohm
29 disp("Extra Resistance(in ohm) : "+string(Extra_R1)+
      " ohm or "+string(Extra_R2)+" ohm.");

```

Scilab code Exa 2.39 I2R loss and torque

```

1 //Exa 2.39
2 clc;
3 clear;
4 close;
5 //Given data :
6 format('v',7);
7 f=50; //in Hz
8 P=4; //no. of poles
9 phase=3; //no. of phase
10 MotorShaftOutput=20; //in H.P.
11 MotorShaftOutput=20*735.5; //in watts
12 MechLosses=MotorShaftOutput*2/100; //in watts(2% of
    the output)
13 Pdev_rotor=MotorShaftOutput+MechLosses; //in watts
14 S=3; //slip in %
15 S=S/100; //fractional slip
16 RotorI2RLoss=(S/(1-S))*Pdev_rotor; //in watts
17 disp(RotorI2RLoss,"Rotor I2R Loss(in watts) :");
18 disp("Rotor iron loss at 3% slip is very small and
    can be neglected.");
19 RotorInput=Pdev_rotor+RotorI2RLoss; //in watts
20 disp(RotorInput,"Rotor Input(in Watts) :");
21 Ns=120*f/P; //in rpm
22 Nr=Ns-Ns*S; //in rpm

```

```

23 Nr=Nr/60; //in rps
24 T=MotorShaftOutput/(2*%pi*Nr); //in Nm
25 disp(T,"Output torque(in Nm) : ");

```

Scilab code Exa 2.40 Slip loss and efficiency

```

1 //Exa 2.40
2 clc;
3 clear;
4 close;
5 //Given data :
6 format('v',6);
7 VL=500; //in volt
8 f=50; //in Hz
9 P=6; //no. of poles
10 phase=3; //no. of phase
11 Nr=975; //in rpm
12 Ns=120*f/P; //in rpm
13 S=(Ns-Nr)/Ns; //slip
14 disp(S,"Slip :");
15 Pin_stator=40; //in KW
16 StatorLosses=1; //in KW
17 Pin_rotor=Pin_stator-StatorLosses; //in KW
18 RotorCuLosses=S*Pin_rotor; //in KW
19 disp(RotorCuLosses,"Rotor Cu Losses(in KW) :");
20 RotorOutput=Pin_rotor-RotorCuLosses; //in KW
21 OutputHP=RotorOutput/0.735; //in H.P.
22 disp(OutputHP,"Output Horse Power : ");
23 Efficiency=RotorOutput/Pin_stator; //unitless
24 disp(Efficiency*100,"Efficiency(in %) :");

```

Scilab code Exa 2.41 Slip speed Loss Resistance Power

```

1 //Exa 2.41
2 clc;
3 clear;
4 close;
5 //Given data :
6 format('v',6);
7 VL=440;//in volt
8 f=50;//in Hz
9 P=6;//no. of poles
10 phase=3;//no. of phase
11 Ns=120*f/P;//in rpm
12 fr=120;//alternations per minute
13 fr=fr/60;//in Hz
14 S=fr/f;//slip
15 disp(S,"Slip : ");
16 Nr=Ns-S*Ns;//in rpm
17 disp(Nr,"Rotor speed(in rpm) :");
18 Rotor_input=80;//in KW
19 RotorCuLoss=S*Rotor_input;//in KW
20 disp(RotorCuLoss*10^3/phase,"Rotor Cu Loss per phase
    (in watts) :");
21 P_Mechdev=Rotor_input*10^3-RotorCuLoss*10^3;//in
    watts
22 P_Mechdev=P_Mechdev/735.5;//in H.P.
23 disp(P_Mechdev,"Mechanical power developed(in H.P.) :
    ");
24 Ir=60;//in Ampere
25 R2=(RotorCuLoss*10^3/phase)/Ir^2;//in ohm
26 disp(R2,"Rotor resistance per phase(in ohm) :");

```

Scilab code Exa 2.43 Resistance to be added

```

1 //Exa 2.43
2 clc;
3 clear;

```

```

4 close;
5 //Given data :
6 format('v',6);
7 f=50;//in Hz
8 P=6;//no. of poles
9 R2=0.2;//rotor resistance per phase in ohm
10 Nr=960;//in rpm
11 Nr_dash=600;//in rpm
12 Ns=120*f/P;//in rpm
13 S=(Ns-Nr)/Ns;//slip(unitless)
14 Sdash=(Ns-Nr_dash)/Ns;//slip(unitless)
15 //Let the new value of resistance is R2dash=(R+0.2)
16 R=R2*(Sdash/S)-R2;//Resistance to be added in ohm
17 disp(R,"Resistance to be added(in ohm) : ");

```

Scilab code Exa 2.44 External Rotor Resistance per phase

```

1 //Exa 2.44
2 clc;
3 clear;
4 close;
5 //Given data :
6 format('v',6);
7 f=50;//in Hz
8 P=6;//no. of poles
9 phase=3;//no. of phase
10 RotorIntResistance=0.1;//in ohm per phase
11 X2=1;//in ohm/phase
12 Rext=X2-RotorIntResistance;//in ohm
13 disp(Rext,"External resistance to be included(in ohm
    /phase) : ");

```

Scilab code Exa 2.45 Additional Rotor Resistance

```

1 //Exa 2.45
2 clc;
3 clear;
4 close;
5 //Given data :
6 format('v',6);
7 f=50; //in Hz
8 P=6; //no. of poles
9 phase=3; //no. of phase
10 R2=0.2; //rotor resistance per phase in ohm
11 N1=960; //Full load speed in rpm
12 Ns=120*f/P; //in rpm
13 S1=(Ns-N1)/Ns; //Full load slip (unitless)
14 N2=N1*(1-10/100); //New speed in rpm (reduced 10%)
15 S2=(Ns-N2)/Ns; //New slip (unitless)
16 //Formula :  $S = \frac{\text{Rotor Cu Loss}}{\text{Pin}_{\text{rotor}}} = \frac{3 \cdot I_2^2 \cdot R_2}{\text{Pin}_{\text{rotor}}}$ 
17 //Let the additional resistance is R
18 R=R2*S2/S1-R2; //Resistance to be added in ohm
19 disp(R,"Additional Rotor Resistance (in ohm) : ");

```

Scilab code Exa 2.46 Ratio of torque

```

1 //Exa 2.46
2 clc;
3 clear;
4 close;
5 //Given data :
6 format('v',5);
7 R2inner=0.4; //in ohm
8 X2inner=2; //in ohm
9 R2outer=2; //in ohm
10 X2outer=0.4; //in ohm
11 //At standstill :
12 S=1; //unitless

```

```

13 Ratio=(R2outer*S/(R2outer^2+S^2*X2outer^2))/(R2inner
    *S/(R2inner^2+S^2*X2inner^2)); // unitless
14 disp(Ratio,"Ratio of torque produced by two cages at
    standstill : ");
15 //At Full load :
16 S=5; //in %
17 S=5/100; //fractional
18 Ratio=(R2outer*S/(R2outer^2+S^2*X2outer^2))/(R2inner
    *S/(R2inner^2+S^2*X2inner^2)); // unitless
19 disp(Ratio,"Ratio of torque produced by two cages at
    full load (slip=5%) : ");

```

Scilab code Exa 2.47 line current at instant of starting

```

1 //Exa 2.47
2 clc;
3 clear;
4 close;
5 //Given data :
6 format('v',6);
7 Output=10; //in H.P.
8 Output=Output*735.5; //in watts
9 cosfi=0.8; //unitless
10 ETA=0.83; //unitless
11 ISCbyIFL=3.5; //ratio of SC current to full load
    current
12 VL=500; //in volt
13 Input=Output/ETA; //in watts
14 IFL=Input/(sqrt(3)*VL*cosfi); //in Ampere
15 ISC=IFL*ISCbyIFL; //in Ampere
16 Is=ISC/3; //in Ampere
17 disp(Is,"Strting current(in Ampere) :");

```

Scilab code Exa 2.48 Starting torque

```
1 //Exa 2.48
2 clc;
3 clear;
4 close;
5 //Given data :
6 format('v',6);
7 ISCbyIFL=5;//ratio of SC current to full load
  current
8 S=0.04;//Full load slip
9 //(i) for star delta starter :
10 disp("for star delta starter : ");
11 Ratio=(1/3)*(ISCbyIFL)^2*S;//Ratio of starting
  torque to full load torque
12 disp("Starting torque is "+string(Ratio*100)+"% of
  full load torque.");
13 //(i) for auto transformer starter :
14 disp("for auto transformer starter : ") ;
15 K=50/100;//tappings
16 Ratio=K^2*(ISCbyIFL)^2*S;//Ratio of starting torque
  to full load torque
17 disp("Starting torque is "+string(Ratio*100)+"% of
  full load torque.");
```

Scilab code Exa 2.49 percentage Tapping

```
1 //Exa 2.49
2 clc;
3 clear;
4 close;
5 //Given data :
6 format('v',5);
7 ISCbyIFL=4;//ratio of SC current to full load
  current
```

```

8 TsBYTf=1/4;//ratio of atarting torque to full load
   torque
9 Slip=3;//in %
10 Slip=3/100;//in fraction
11 //Formula : TsBYTf=Percent_Tapping^2*ISCbyIFL^2*Slip
12 tapping=sqrt(TsBYTf/(Slip*ISCbyIFL^2));//in %
13 disp(tapping*100,"Tapping(in %) :");

```

Scilab code Exa 2.50 Starting torque in terms of full load torque

```

1 //Exa 2.50
2 clc;
3 clear;
4 close;
5 //Given data :
6 format('v',6);
7 ISCbyIFL=5;//ratio of SC current to full load
   current
8 Slip=5;//in %
9 Slip=5/100;//in fraction
10 //Formula : 3*IFL=K^2*ISC
11 K=sqrt(1/(ISCbyIFL/3));//unitless
12 TsBYTf1=K^2*(ISCbyIFL)^2*Slip;//ratio of starting
   torque to full load torque
13 disp("Starting torque is "+string(TsBYTf1*100)+"% of
   full load torque.");

```

Scilab code Exa 2.51 Starting torque of an Induction motor

```

1 //Exa 2.51
2 clc;
3 clear;
4 close;

```

```

5 //Given data :
6 format('v',5);
7 disp("Star delta starter :");
8 ISCbyIFL=6;//ratio of SC current to full load
  current
9 Slip=4;//in %
10 Slip=4/100;//in fraction
11 TsBYTf1=(1/3)*(ISCbyIFL)^2*Slip;//ratio of starting
  torque to full load torque
12 disp("Starting torque is "+string(TsBYTf1*100)+"% of
  full load value.");
13 disp("For an auto transformer :");
14 K=70.70;//in %
15 K=70.70/100;//in fraction
16 TsBYTf1=K^2*(ISCbyIFL)^2*Slip;//ratio of starting
  torque to full load torque
17 disp("Starting torque is "+string(TsBYTf1*100)+"% of
  full load torque.");

```

Scilab code Exa 2.52 Necessary tapping and starting torque

```

1 //Exa 2.52
2 clc;
3 clear;
4 close;
5 //Given data :
6 format('v',5);
7 V=400;//in volt
8 S=3.5;//in %
9 S=3.5/100;//in fraction
10 VL=92;//in volts
11 //ISC=(V/VL)*IFL;//in Ampere
12 ISCbyIFL=V/VL;//ratio of SC current to full load
  current
13 //2*IFL=K^2*ISC implies that 2*IFL=K^2*(V/VL)*IFL

```

```

14 K=sqrt(2/(V/VL)); //in fraction
15 disp(K*100," Necessary tapping(in %) :");
16 TsBYTf1=K^2*(ISCbyIFL)^2*S; //ratio of starting
    torque to full load torque
17 disp("Starting torque is "+string(TsBYTf1*100)+"% of
    full load value.");

```

Scilab code Exa 2.53 Auto transformer ratio

```

1 //Exa 2.53
2 clc;
3 clear;
4 close;
5 //Given data :
6 format('v',5);
7 ISCbyIFL=4; //ratio of SC current to full load
    current
8 ISbyIFL=2; //ratio of Supply current to full load
    current
9 S=2.5; //in %
10 S=2.5/100; //in fraction
11 //Formula : ISbyIFL=(1/K^2)*ISCbyIFL
12 K=sqrt(ISCbyIFL/ISbyIFL); //in fraction
13 disp(K,"Auto Transormation ratio :");
14 TsBYTf1=(1/K^2)*(ISCbyIFL)^2*S; //ratio of starting
    torque to full load torque
15 disp(TsBYTf1,"Ratio of starting torque to full load
    torque :");
16 disp("or Starting torque is "+string(TsBYTf1*100)+"%
    of full load value.");

```

Scilab code Exa 2.54 percentage Tapping

```

1 //Exa 2.54
2 clc;
3 clear;
4 close;
5 //Given data :
6 format('v',6);
7 ISCbyIFL=4;//ratio of SC current to full load
   current
8 S=3;//in %
9 S=3/100;//in fraction
10 TsBYTfl=1/4;//ratio of starting torque to full load
   torque
11 //Formula : TsBYTfl=ISCbyIFL^2*K^2*S
12 K=sqrt(TsBYTfl/(ISCbyIFL^2*S));//in fraction
13 disp(K*100,"Auto Transormation ratio (in %) :");

```

Scilab code Exa 2.55 line current at instant of starting

```

1 //Exa 2.55
2 clc;
3 clear;
4 close;
5 //Given data :
6 format('v',6);
7 Output=3;//in H.P.
8 Output=3*735.5;//in watts
9 Efficiency=0.83;//unitless
10 cosfi=0.8;//power factor
11 V1=500;//in volt
12 Input=Output/Efficiency;//in watts
13 //Formula : Input=sqrt(3)*V1*I1*cosfi
14 I1=Input/(sqrt(3)*V1*cosfi);//in Ampere
15 ISCbyIFL=3.5;//ratio of SC current to full load
   current
16 ISC=ISCbyIFL*I1;//in Ampere

```

```

17 LineCurrent=ISC/3;//in Ampere(for star delta starter
   )
18 disp(LineCurrent,"Line Current(in Ampere) :");
19 //Note : Ans in the book is not accurate.

```

Scilab code Exa 2.56 Ratio of starting to full load current

```

1 //Exa 2.56
2 clc;
3 clear;
4 close;
5 //Given data :
6 format('v',5);
7 Output=15;//in H.P.
8 Output=15*735.5;//in watts
9 V1=400;//in volt
10 ISCat200=40;//in Ampere(at 200 volt)
11 Efficiency=0.88;//unitless
12 cosfi=0.85;//power factor
13 ISCat400=ISCat200*(400/200);//in Ampere(at 400 volt)
14 Input=Output/Efficiency;//in watts
15 Ifl=Input/(sqrt(3)*V1*cosfi);//in Ampere
16 //starting line current with star delta starter
17 Is=ISCat400/3;//in Ampere
18 Ratio=Is/Ifl;//ratio of starting current to full
   load current
19 disp(Ratio,"Ratio of line current at starting to
   full load current :");

```

Scilab code Exa 2.57 Starting torque and current

```

1 //Exa 2.57
2 clc;

```

```

3  clear;
4  close;
5  //Given data :
6  format('v',6);
7  //With star delta starter :
8  TstBYTfl=0.35;//ratio of starting torque to full
   load torque
9  IstBYIf1=1.75;//ratio of starting current to full
   load current
10 ISCBYIs=sqrt(3);//ratio of SC current to starting
   current
11 ISCBYIf1=sqrt(3)*IstBYIf1;//ratio of SC current to
   full load current
12 //Formula : TstBYTfl=(ISCBYIf1)^2*S
13 S=TstBYTfl/(ISCBYIf1)^2;//in fraction
14 disp(S,"Full load Slip : ");
15 //With auto transformer with winding in delta :
16 Ip=sqrt(3)*1.75*0.8;//full voltage phase current in
   Ampere
17 IlBYIf=4.2;//ratio of Line current to full load
   current
18 Ratio=IlBYIf^2*S;//ratio of starting current to full
   load current
19 disp(Ratio,"Ratio of line current at starting to
   full load current :");

```

Scilab code Exa 2.58 Resistance to be added in series

```

1 //Exa 2.58
2 clc;
3 clear;
4 close;
5 //Given data :
6 format('v',6);
7 f=50;//in Hz

```

```

8 P=4; //no. of poles
9 phase=3; //no. of phase
10 R2=0.25; //in ohm per phase
11 S=2; //in %
12 S=2/100; //in fraction
13 Ns=120*f/P; //in rpm
14 Nr=Ns-Ns*S; //in rpm
15 //When speed reduced to 10%
16 NewSpeed=Nr*90/100; //in rpm
17 Sdash=(Ns-NewSpeed)/Ns; //in fraction
18 R2dash=(Sdash/S)*R2; //in ohm per phase
19 R=R2dash-R2; //in ohm
20 disp(R, "Value of resistance to be added(in ohm) :");

```

Scilab code Exa 2.59 External Resistance per phase

```

1 //Exa 2.59
2 clc;
3 clear;
4 close;
5 //Given data :
6 format('v',6);
7 f=50; //in Hz
8 P=4; //no. of poles
9 R2=0.25; //in ohm per phase
10 N=1440; //in rpm at full load
11 NewSpeed=1200; //in rpm
12 Ns=120*f/P; //in rpm
13 S=(Ns-N)/Ns; //in %
14 NewS=(Ns-NewSpeed)/Ns; //in fraction
15 S1=S; S2=NewS; //slip new and old
16 //Torque remaining same : S1/R2=S2/(R2+R)
17 R=S2*R2/S1-R2; //in ohm
18 disp(R, "External resistance per phase(in ohm) :");
19 Nr=Ns-Ns*S; //in rpm

```

```

20 //If S1 is taken as 0.03 and S2 as 0.127
21 S1=0.03;//slip in fraction
22 S2=0.127;//slip in fraction
23 R=S2*R2/S1-R2;//in ohm
24 disp(R,"External resistance per phase(in ohm) :");

```

Scilab code Exa 2.60 Resistance in series per phase

```

1 //Exa 2.60
2 clc;
3 clear;
4 close;
5 //Given data :
6 format('v',6);
7 f=50;//in Hz
8 P=4;//no. of poles
9 phase=3;//no. of phase
10 S=4;//in %
11 S=4/100;//in fraction
12 Ns=120*f/P;//in rpm
13 N1=Ns-Ns*S;//in rpm
14 //When speed reduced to 10%
15 N2=N1*85/100;//in rpm(NewSpeed)
16 disp(N2,"New speed (in rpm) :");
17 //New speed is reduced by 15 %
18 Sdash=(Ns-N2)/Ns;//in fraction
19 disp(Sdash,"New Slip : ");

```

Scilab code Exa 2.61 Rotor speed HP loss and efficiency

```

1 //Exa 2.61
2 clc;
3 clear;

```

```

4 close;
5 //Given data :
6 format('v',6);
7 f=50;//in Hz
8 P=4;//no. of poles
9 phase=3;//no. of phase
10 Pin=60;//in KW
11 StatorLoss=1.2;//in KW
12 WindingLoss=1.8;//in KW
13 S=4;//in %
14 S=4/100;//in fraction
15 Ns=120*f/P;//in rpm
16 Nr=Ns-Ns*S;//in rpm
17 disp(Nr,"Rotor speed(in rpm) :");
18 Pin_rotor=Pin-StatorLoss;//in KW
19 RotorCuLoss=S*Pin_rotor;//in KW
20 disp(RotorCuLoss,"Rotor Cu Loss(in KW) : ");
21 Pout_rotor=Pin_rotor-WindingLoss-RotorCuLoss;//in KW
22 Efficiency=(Pout_rotor/Pin)*100;//in %
23 disp(round(Efficiency),"Efficiency(in %) :");
24 HP=Pout_rotor*10^3/735.5;//in H.P.
25 disp(HP,"Horse Power(inH.P.) :");

```

Chapter 3

Fractional KW motors

Scilab code Exa 3.1 Capacitor in auxiliary winding

```
1 //Exa 3.1
2 clc;
3 clear;
4 close;
5 //Given data :
6 format('v',7);
7 Za=3+3*%i;//in ohm
8 Zm=6+3*%i;//in ohm
9 //Phase difference 90 degree : so angle between Im
   and V is 90-45 degree
10 theta=90-45;//in degree
11 f=50;//in Hz
12 //Formula : tand(theta)=(Xc-Xl)/R
13 Xl=3;//in ohm and Xc=1/(2*%pi*C)
14 R=6;//in ohm
15 C=1/(2*%pi*f*(tand(theta)*R+Xl));
16 disp(C*10^6,"Capacitance(in micro Farad) :");
```

Chapter 4

Special Purpose Machines

Scilab code Exa 4.1 Stepping angle

```
1 //Exa 4.1
2 clc;
3 clear;
4 close;
5 //Given data :
6 P=8;//no. of poles
7 T=5;//no. of teeteh in each pole
8 Nr=50;//no. of teeth in rotor
9 Ns=P*T;//no. of teeth
10 Beta=(Nr-Ns)*360/(Nr*Ns);//in degree
11 disp(Beta,"Stepping Angle(in degree) :");
```

Scilab code Exa 4.2 Resolution steps and shaft speed

```
1 //Exa 4.2
2 clc;
3 clear;
4 close;
```

```

5 //Given data :
6 Beta=2.5;//in degree
7 f=3600;//in PPs
8 Resolution=360;//in degree
9 disp(Resolution,"Resolution : ");
10 Beta1=Resolution/Beta;//steps/revolution
11 disp(Beta1,"Steps per revolution : ");
12 n=Beta*f/360;//in rps
13 disp(n,"Steps required for making 25 revolution(in
    rps) : ");

```

Scilab code Exa 4.3 No of rotor and stator poles

```

1 //Exa 4.3
2 clc;
3 clear;
4 close;
5 //Given data :
6 Beta=15;//in degree
7 Phase=3;//no. of phase
8 //Formula : Beta*Nr=(360/phase)
9 Nr=(360/Phase)/Beta;//unitless
10 disp(Nr,"No. of rotor :");
11 //Case (i) : when Ns>Nr : Formula : Beta=(Ns-Nr)
    *360/(Ns*Nr)
12 Ns=Nr/(1-Beta*Nr/360);
13 disp(Ns,"No. of stator poles if Ns>Nr :");
14 //Case (ii) : when Nr>Ns : Formula : Beta=(Nr-Ns)
    *360/(Ns*Nr)
15 Ns=Nr/(1+Beta*Nr/360);
16 disp(Ns,"No. of stator poles if Nr>Ns :");

```

Scilab code Exa 4.4 No of rotor and stator teeth

```
1 //Exa 4.4
2 clc;
3 clear;
4 close;
5 //Given data :
6 Beta=1.8;//in degree
7 m=4;//no. of phases
8 //Formula : Beta*Nr=(360/m)
9 Nr=(360/m)/Beta;//unitless
10 disp(Nr,"No. of rotor teeth :");
11 disp(Nr,"In multi stack motor rotor teeth equals to
    stator teeth equals to : ");
```
