Scilab Textbook Companion for Electrical Machines-2 by T. Singh[1]

Created by
Suhaib Alam
B.Tech
Electrical Engineering
Uttarakhand Tech. University
College Teacher
Arshad Khan
Cross-Checked by
Lavitha Pereira

December 12, 2013

Book Description

Title: Electrical Machines-2

Author: T. Singh

Publisher: S. k. Katariya & Sons, New Delhi

Edition: 2

Year: 2006

ISBN: 81-85749-58-2

Scilab numbering policy used in this document and the relation to the above book.

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

AP Appendix to Example(Scilab Code that is an Appednix to a particular Example of the above book)

For example, Exa 3.51 means solved example 3.51 of this book. Sec 2.3 means a scilab code whose theory is explained in Section 2.3 of the book.

Contents

List of Scilab Codes

5

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

```scilab
1  //Exa 1.1
2  clc;
3  clear;
4  close;
5  //given data
6  slots=24;//no. of slotes
7  NoOfPhase=3;//no of phase
8  MotorSpeed=1450;//in rpm
9  N=1500;//Synchonous 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
       ppitch 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                                            3−8
                        C4");
36  disp("    3                          B1                5−10
                        B1");
37  disp("    4                                            7−12
                        A2");
38  disp("    5                          C1                9−14
                        C1");
39  disp("    6                                            11−16
                        B2");
40  disp("    7                                            13−18
                        A3");
41  disp("    8                                            15−20
                        C2");
42  disp("    9                                            17−22
                        B3");
43  disp("    10                                           19−24
                        A4");
44  disp("    11                                           21−2
                        C3");
45  disp("    12                                           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;
```

```scilab
   //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
       slotes required for proper phase displacement
24 disp(Slots_required,"No. of slotes 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
                     ");
```

12

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

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;
```

16

```
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 apan 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

```scilab
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 perentage 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 perentage 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

```scilab
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

```scilab
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(atand(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

```scilab
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
        ragarded as being responsible for circulationg
      short circuit current of 150 mA, through the
      synchronous impedence of the winding when the
      excitation current is 10 mA.");
8  disp("The value of synchronous impedence 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(atand(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

```scilab
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
```

44

```
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 stsrt S=1;
17  fdash=f;//in Hz
18  disp(fdash,"Rotor frequeny at the time of starting (
        in Hz) : ");
19  //Part (d) :
20  fdash=(S/100)*f;//in Hz
21  disp(fdash,"Rotor frequeny 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 indution
        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 devloped(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 Devloped 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 Nw-m
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 devloped (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;//im 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;//im 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;//im 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;//im  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;//im 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;//im
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

```scilab
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 : I2^2*R2=RorCuLoss 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

```scilab
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
```

68

```
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 torquea 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  devloped  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, staring 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  TmaxBYTfl =2.5; // ratio
 9  R2 =0.5; // in ohm/ phase
10  X2 =5; // in ohm/ phase
11  // Formula: Tst=K*E2^2*R2/(R2^2+X2^2) and Tm=K*E2
       ^2/(2*X2)
12  TstBYTfl = TmaxBYTfl *2* X2 * R2 /( R2 ^2+ X2 ^2) ; // ratio
13  disp ( TstBYTfl ," (a) For direct on line starting ,
       ratio starting torque to Full load torque is : ")
       ;
14  // For star delta starting :
15  TstBYTfl =(1/3) * TmaxBYTfl *2* X2 * R2 /( R2 ^2+ X2 ^2); // ratio
16  disp ( TstBYTfl ," (b) For star delta starting , ratio
       starting torque to Full load torque is : ");
17  // For auto transformer starting with tapping at 75 %
18  TstBYTfl =(75/100) ^2* TmaxBYTfl *2* X2 * R2 /( R2 ^2+ X2 ^2); //
       ratio
19  disp ( TstBYTfl ," (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 mechanial 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 mechanial 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,"Effiiency(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  mechanial  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 devloped(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=RotorCuLoss/Pin_rotor=3*I2^2*R2/
       Pin_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 )  :") ;
```

93

Scilab code Exa 2.48 Starting torque

```scilab
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

```scilab
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
```

94

```
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 TsBYTfl=K^2*(ISCbyIFL)^2*Slip;//ratio  of  starting
        torque  to  full  load  torque
13 disp("Starting  torque  is  "+string(TsBYTfl*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 TsBYTfl=(1/3)*(ISCbyIFL)^2*Slip;//ratio of starting
       torque to full load torque
12 disp("Starting torque is "+string(TsBYTfl*100)+"% of
        full load value.");
13 disp("For an auto transformer :");
14 K=70.70;//in %
15 K=70.70/100;//in fraction
16 TsBYTfl=K^2*(ISCbyIFL)^2*Slip;//ratio of starting
       torque to full load torque
17 disp("Starting torque is "+string(TsBYTfl*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 imples that 2*IFL=K^2*(V/VL)*IFL
```

```
14  K=sqrt(2/(V/VL));//in fraction
15  disp(K*100,"Necessary tapping(in %) :");
16  TsBYTfl=K^2*(ISCbyIFL)^2*S;//ratio of starting
        torque to full load torque
17  disp("Starting torque is "+string(TsBYTfl*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  TsBYTfl=(1/K^2)*(ISCbyIFL)^2*S;//ratio of starting
        torque to full load torque
15  disp(TsBYTfl,"Ratio of starting torque to full load
        torque :");
16  disp("or Starting torque is "+string(TsBYTfl*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 Vl=500;//in volt
12 Input=Output/Efficiency;//in watts
13 //Formula : Input=sqrt(3)*Vl*Il*cosfi
14 Il=Input/(sqrt(3)*Vl*cosfi);//in Ampere
15 ISCbyIFL=3.5;//ratio of SC current to full load
      current
16 ISC=ISCbyIFL*Il;//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 Vl=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)*Vl*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  IstBYIfl=1.75;//ratio of starting current to full
       load current
10 ISCBYIs=sqrt(3);//ratio of SC current to starting
       current
11 ISCBYIfl=sqrt(3)*IstBYIfl;//ratio of SC current to
       full load current
12 //Formula : TstBYTfl=(ISCBYIfl)^2*S
13 S=TstBYTfl/(ISCBYIfl)^2;//in fraction
14 disp(S,"Full load Slip : ");
15 //With auto transformer with winding in delta :
16 Ip=sqrt(3)*1.750*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

```scilab
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 : ");
```