Scilab Textbook Companion for Electrical Engineering by R. Anandanatarajan[1]

Created by
Vinay V
B.Tech
Mechanical Engineering
Sastra University
College Teacher
Sriranjani .r
Cross-Checked by
Mukul R. Kulkarni

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Book Description

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

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

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

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

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Chapter 1

DC Machines

Scilab code Exa 1.1 To find generated emf

```
//Chapter-1, Example 1.1, Page 1.14
//=============================================================================

clc
clear

//INPUT DATA
I=450;//Load current in A
V=250;//Terminal voltage in V
Ra=0.04;//Armature resistance in ohm
Rf=50;//Shunt field resistance in ohm

//CALCULATIONS
Ia=(V/Rf)+I;//Total current in A
Eg=(V+(Ia*Ra));//Generated emf in V

//OUTPUT
mprintf('Generated emf is %3.1f V',Eg)

//=================================END OF PROGRAM
```

Scilab code Exa 1.2 To calculate induced emf and armature current

```
//Chapter-1, Example 1.2, Page 1.15
//=============================================================================
clc
clear

//INPUT DATA
Il=40;//Load current in A
V=400;//Terminal voltage in V
Ra=0.04;//Armature resistance in ohm
Rse=0.02;//Series field resistance in ohm
Rsh=300;//Shunt field resistance in ohm
V1=2;//Voltage drop across the brushes in V

//CALCULATIONS
 Ia=Il+(V/Rsh);//Armature current in A
 Eg=V+(Ia*Ra)+(Ia*Rse)+V1;//Generated emf in V

//OUTPUT
mprintf('Induced emf is %3.3f V \n Armature current
    is %3.2f A',Eg,Ia)

//=================================END OF PROGRAM
==============================
```

Scilab code Exa 1.3 To calculate induced emf and armature current

```
//Chapter-1, Example 1.3, Page 1.15
```

```
//
    ════════════════════════════════════════════════════════

clc
clear

//INPUT DATA
V=250;//Terminal voltage in V
IL=40;//Load current in A
Ra=0.04;//Armature resistance in ohm
Rse=0.03;//Series field resistance in ohm
Rsh=100;//Shunt field resistance in ohm
Vbr=2;//Voltage drop across brushes in V

//CALCULATIONS
Vsh=(V+(IL*Rse));//Voltage across shunt field in V
Ia=(IL+(Vsh/Rsh));//Armature current in A
Eg=(V+(IL*Rse)+(Ia*Ra)+Vbr);//Generated emf in V

//OUTPUT
mprintf('Induced emf is %3.1f V \nArmature current
   is %3.3f A',Eg,Ia)

//═══════════════════════════════════END OF PROGRAM
    ═══════════════════════════════
```

Scilab code Exa 1.4 To calculate the total power delivered

```
//Chapter-1, Example 1.4, Page 1.16
//
    ════════════════════════════════════════════════════════

clc
clear

```

```
//INPUT DATA
Ed=25000;//Power delivered by the generator in W
V=250;//Terminal voltage in V
Rsh=75;//Shunt field resistance in ohm
Ra=0.03;//Armature resistance in ohm

//CALCULATIONS
IL=(Ed/V);//Load current in A
If=(V/Rsh);//Field current in A
Ia=(IL+If);//Armature current in A
Eg=(V+(Ia*Ra));//Generated emf in V
Pg=(Eg*Ia)/1000;//Generated power in kW

//OUTPUT
mprintf('Total power delivered by the armature is %3
    .2f kW',Pg)

//==================================END OF PROGRAM
    ==================================
```

Scilab code Exa 1.5 To calculate the emf generated

```
//Chapter-1, Example 1.5, Page 1.17
//
    ==================================================================

clc
clear

//INPUT DATA
n=48;//Number of slots
z=16;//Number of conductors per slot
q=0.018;//Flux per pole in Wb
P=4;//Number of poles
N=1000;//Speed of armature in rpm
```

```
A=2;//Number of parallel paths

//CALCULATIONS
Z=(n*z);//Number of conductors
Eg=(q*Z*N*P)/(60*A);//Generated emf in V

//OUTPUT
mprintf('Generated emf is %3.1f V',Eg)

//==================================================END OF PROGRAM==============================================
```

Scilab code Exa 1.6 To calculate the speed

```
//Chapter-1, Example 1.6, Page 1.18
//=============================================================================================================

clc
clear

//INPUT DATA
P=4;//Number of poles
Z=400;//Number of conductors
q=0.03;//Flux per pole in Wb
Eg=250;//Generated emf in V
A1=4;//Number of parallel paths in lap wound
A2=2;//Number of parallel paths in wave wound

//CALCULATIONS
N1=(60*Eg*A1)/(q*Z*P);//Speed reqired in lap wound in rpm
N2=(60*Eg*A2)/(q*Z*P);//Speed reqired in wave wound in rpm

```

```
//OUTPUT
mprintf('Speed reqired in lap wound is %3.0f rpm \
   nSpeed reqired in wave wound is %3.0f rpm',N1,N2)

//=================================END OF PROGRAM
   ==============================
```

Scilab code Exa 1.7 To calculate the flux per pole

```
//Chapter-1, Example 1.7, Page 1.18
//
   =================================================================

clc
clear

//INPUT DATA
Eg1=250;//Existing generated emf in V
N1=800;//Existed rated speed in rpm
q1=0.03;//Existing flux in Wb
Eg2=300;//New generated emf in V
N2=1000;//New rated speed in rpm

//CALCULATIONS
q2=(q1*N1*Eg2)/(Eg1*N2);//New flux per pole in Wb

//OUTPUT
mprintf('New flux per pole is %3.4f Wb',q2)

//=================================END OF PROGRAM
   ==============================
```

Scilab code Exa 1.8 To calculate the terminal voltage

```
//Chapter-1, Example 1.8, Page 1.19
//=============================================================================
clc
clear

//NPUT DATA
n=200;//Number of turns
P=6;//Number of poles
A=P;//Since lap wound turns
Ra=0.0112;//Armature resistance in ohm
Ia=40;//Armature current in A
N=1000;//Armature speed in rpm
q=0.03;//Flux per pole in Wb

//CALCULATIONS
Z=(n*2);//Total number of conductors
Eg=(q*Z*N*P)/(60*A);//Generated emf in V
IaRa=(Ia*Ra);//Armature drop in VI
V=(Eg-IaRa);//Terminal voltage in V

//OUTPUT
mprintf('Terminal voltage is %3.3f V',V)

//=================================END OF PROGRAM==============================
```

Scilab code Exa 1.9 To calculate the speed

```
//Chapter-9, Example 1.9, Page 1.20
//=============================================================================
clc
```

```
clear

//INPUT DATA
P=4;//Number of poles
A=2;//Number of parallel paths for wave wound
Z=400;//Number of conductors
q=(20*10^-3);//Flux per pole in Wb
Ra=0.04;//Armature resistance in ohm
Rsh=75;//Shunt field resistance in ohm
V=250;//Terminal voltage in V
PL=(600*100);//Total load on the generator in W
Vld=10;//Line drop in V

//CALCULATIONS
IL=(PL/V);//Load current in A
Ish=(V/Rsh);//Shunt field current in A
Ia=(IL+Ish);//Armature current in A
Eg=(V+(Ia*Ra)+Vld);//Generated emf in V
N=(60*Eg*A)/(q*Z*P);//Speed at which the generator
    should be driven in rpm

//OUTPUT
mprintf('Speed at which the generator should be
    driven is %i rpm',N)

//==========================================END OF PROGRAM
    ========================================
```

Scilab code Exa 1.10 To calculate the properties of shunt generator

```
//Chapter-1, Example 1.10, Page 1.26
//
    ====================================================================

clc
```

```
clear

//INPUT DATA
IL=180;//Load current in A
V=220;//Terminal voltage in V
Ra=0.01;//Armature resistance in ohm
Rsh=40;//Shield field resistance in ohm
Wc=1000;//Constant losses in W
x=185;//Load current in A

//CALCULATIONS
Ia=(IL+(V/Rsh));//Armature current in A
Eg=(V+(Ia*Ra));//Generated emf in V
Pm=(V*x)+Wc+(Ia^2*Ra)+(V^2/Rsh);//Output of the
    prime mover in W
nm=((V*Ia)/Pm)*100;//Mechanical efficiency
ne=((V*IL)/(Eg*Ia))*100;//Electrical efficiency
no=((V*IL)/(Pm))*100;//Overall efficiency

//OUTPUT
mprintf('a)Generated emf is %3.3f V \n b)Output of
    the prime mover is %3.2f W \n c)Mechanical
    efficiency is %3.2f percent \n d)Electrical
    efficiency is %3.2f percent \n e)Overall
    efficiency is %3.2f percent',Eg,Pm,nm,ne,no)

//=================================END OF PROGRAM
    ==============================
```

Scilab code Exa 1.11 To calculate the back emf and total mechanical power

```
//Chapter-1, Example 1.11, Page 1.33
//
    ==================================================================
```

```
clc
clear


//INPUT DATA
IL=15;//Load current in A
V=220;//Terminal voltage in V
Rsh=180;//Field resistance in ohm
Ra=0.03;//Armature resistance in ohm

//CALCULATIONS
Ish=(V/Rsh);//Field current in A
Ia=(IL-Ish);//Armature current in A
Eb=(V-(Ia*Ra));//Back emf in V
Pm=(Eb*Ia)/1000;//Total mechanical power in kW

//OUTPUT
mprintf('i)Back emf is %3.2f V \nii)Total mechanical
    power developed in the armature is %3.2f kW',Eb,
   Pm)

//=================================END OF PROGRAM
   ==============================
```

Scilab code Exa 1.12 To find the change in back emf

```
//Chapter-1, Example 1.12, Page 1.34
//
   ==================================================================

clc
clear

//INPUT DATA
V=220;//Terminal voltage in V
```

```
IaFL=25;//Full load armature current in A
IaNL=5;//No load armature current in A
Ra=0.5;//Armature resistance in ohm

//CALCULATIONS
EbNL=(V-(IaNL*Ra));//Back emf at no load in V
Eb=(V-(IaFL*Ra));//Back emf at full load in V
E=(EbNL-Eb);//Change in back emf from no load to
   full load in V

//OUTPUT
mprintf('Change in back emf from no load to full
   load is %3.0f V',E)

//==================================END OF PROGRAM
   ================================
```

Scilab code Exa 1.13 To find the speed of the motor

```
//Chapter-1, Example 1.13, Page 1.34
//
   ====================================================================

clc
clear

//INPUT DATA
P=4;//Number of poles
V=500;//Terminal voltage in V
Ia=80;//Armature current in A
Ra=0.4;//Armature resistance in ohm
A=2;//Number of parallel paths
Z=522;//Number of conductors
q=0.025;//Useful flux per pole in Wb

```

```
//CALCULATIONS
Eb=(V-(Ia*Ra));//Back emf in V
N=(Eb*60*A)/(P*q*Z);//Speed of the motor in rpm

//OUTPUT
mprintf('Speed of the motor is %3.1f rpm',N)

//=================================END OF PROGRAM
    ===============================
```

Scilab code Exa 1.14 To find the armature resistance and maximum armature current

```
//Chapter-1, Example 1.14, Page 1.35
//
    ====================================================================

clc
clear

//INPUT DATA
Eb=225;//Back emf in V
IL=40;//Line current in A
Rsh=150;//Field  resistance in ohm
Ish=1.67;//Field current in A

//CALCULATIONS
V=(Ish*Rsh);//Terminal applied voltage in V
Ia=(IL-Ish);//Armature current in A
Ra=(V-Eb)/Ia;//Armature resistance in ohm
Ia=(V/Ra);//Maximum armature current in A

//OUTPUT
mprintf('i)Armature resistance is %3.2f ohm \nii)
   Armature current will be maximum at the moment of
```

```
start up and it is %3.2f A',Ra,Ia)

//==========================================END OF PROGRAM
    ======================================
```

Scilab code Exa 1.15 To find the back emf

```
//Chapter-1, Example 1.15, Page 1.36
//
    ====================================================================================

clc
clear

//INPUT DATA
V=400;//Terminal voltage in V
P=8000;//Motor output power in W
n=0.9;//Motor efficiency
Rsh=180;//Field resistance in ohm
Ra=0.6;//Armature resistance in ohm

//CALCULATIONS
If=(V/Rsh);//Field current in A
Pi=(P/n);//Input power in W
IL=(Pi/V);//Load current in A
Ia=(IL-If);//Armature current in A
Eb=(V-(Ia*Ra));//Back emf in V

//OUTPUT
mprintf('Back emf is %3.0f V',Eb)

//==========================================END OF PROGRAM
    ======================================
```

Scilab code Exa 1.16 To find the total power developed

```
//Chapter-1, Example 1.16, Page 1.37
//=============================================================================

clc
clear

//INPUT DATA
P=30000;//Power rating of the dc machine in W
V=300;//Terminal voltage in V
Ra=0.04;//Armature resistance in ohm
Rsh=120;//Shunt field resistance in ohm

//CALCULATIONS
IL=(P/V);//Load current in A
Ia=(IL+(V/Rsh));//Armature current in A
Eg=(V+(Ia*Ra));//Generated emf in V
P=(Eg*Ia);//Power developed in the armature in W
Ish=(V/Rsh);//Field current in A
Ia2=(IL-Ish);//Armature current in motor in A
Eb=(V-(Ia2*Ra));//Back emf in V
P1=(Eb*Ia2);//Power developed in the armature in W

//OUTPUT
mprintf('Total power developed in the armature when \ni)the dc machine is operated as a generator is %3.0f W \nii)when the dc machine is operated as a motor is %3.1f W',P,P1)

//=================================END OF PROGRAM==============================
```

Scilab code Exa 1.17 To find the armature torque and armature current

```
//Chapter-1, Example 1.17, Page 1.43
//=============================================================================
clc
clear

//INPUT DATA
P=4;//Number of poles
Z=726;//Number of conductors
A=2;//Number of parallel paths
q=(30*10^-3);//Flux per pole in Wb
Ia=45;//Total armature current in A

//CALCULATIONS
Ta=(0.159*Z*q*Ia*P)/A;//Armature toque in N.m

//OUTPUT
mprintf('Armature torque is %3.2f N.m',Ta)

//=================================END OF PROGRAM==============================
```

Scilab code Exa 1.18 To calculate the current taken and diameter of the motor pulley

```
//Chapter-1, Example 1.18, Page 1.43
//=============================================================================
```

```
clc
clear

//INPUT DATA
N=(1800/60);//Speed of the motor in rps
V=200;//Terminal voltage in V
Nl=(900/60);//Lathe speed in rps
F=300;//Force exerted in N
r=0.2;//Radius of the shaft in m
n=0.9;//Efficiency of the motor
Dp=0.3;//Diamter of the Lathe pulley in m

//CALCULATIONS
Tsh=(F*r);//Shaft torque in N.m
Psh=(Tsh*2*3.14*Nl);//Shaft power in W
Pi=(Psh/n);//Input power in W
I=(Pi/V);//Current taken by the motor in A
Dm=((Nl*Dp)/N)*100;//Diameter of the motor pulley in
    cm

//OUTPUT
mprintf('Current taken by the motor is %3.1f A \
   nDiameter of the motor pulley is %3.0f cm',I,Dm)

//==========================================END OF PROGRAM
    ======================================
```

Scilab code Exa 1.19 To calculate the armature torque and horse power

```
//Chapter-1, Example 1.19, Page 1.45
//
    ====================================================================================

clc
clear
```

```

//INPUT DATA
N=(300/60);//Speed of the motor in rps
P=4;//Number of poles
Z=732;//Number of conductors
I=80;//Current through each conductor in A
l=0.35;//Length of the conductor in m
n=0.8;//Efficiency of flux distribution
B=0.8;//Flux densty in Wb/m^2
D=0.8;//Diameter of the armature in m

//CALCULATIONS
Ze=(Z*n);//Number of effective conductors
q=(B*l*2*3.14*(D/2))/4;//Flux per pole in Wb
Ta=(0.159*q*Ze*I*P);//Armature torque in N.m
F=(B*I*l);//Force on each conductor in N
T=(F*(D/2));//Torque due to on econductor in N.m
T1=(T*Ze);//Torque due to all conductors in N.m
Br=(2*3.14*N*60*T1)/(60*746);//Brake Horse power in
    HP

//OUTPUT
mprintf('Armature torque is %3.0f N.m \n Horse power
    output is %3.1f HP',Ta,Br)

//==================================END OF PROGRAM
    ================================
```

Scilab code Exa 1.20 To find the armature torque

```
//Chapter-1, Example 1.20, Page 1.46
//
    ================================================================================
clc
```

```
clear


//INPUT DATA
IL=50;//Load current in A
V=220;//Terminal voltage in V
Ra=0.3;//Armature resistance in ohm
Rsh=220;//Field resistance in ohm
N=1200;//Speed of the motor in rpm

//CALCULATIONS
Ish=(V/Rsh);//Field current in A
Ia=(IL-Ish);//Armature current in A
Eb=(V-(Ia*Ra));//Back emf in V
Ta=(9.55*Eb*Ia)/N;//Armature torque in N.m

//OUTPUT
mprintf('Armature torque is %3.0f N.m',Ta)

//=================================END OF PROGRAM
==============================
```

Scilab code Exa 1.21 To determine the speed and electro magnetic torque

```
//Chapter-1, Example 1.21, Page 1.49
//
==================================================================
clc
clear

//INPUT DATA
V=220;//Terminal voltage in V
P=(10*746);//Rating of the motor in W
Iao=5;//No load armature current in A
```

```
No=1200;//No load speed in rpm
Ra=0.3;//Armature resistance in ohm
Ial=35;//Armature load current in A

//CALCULATIONS
Nl=(No*((V-(Ial*Ra))/(V-(Iao*Ra))));//Speed at load
    in rpm
Ebo=218.5;//Back emf at no load in V
EbL=209.5;//Back emf at full load in V
Tao=(9.55*Ebo*Iao)/No;//No load torque in N.m
TaL=(9.55*EbL*Ial)/Nl;//Load torque in N.m

//OUTPUT
mprintf('Load speed is %3.0f rpm \n Load torque is
    %3.2f N.m',Nl,TaL)

//=================================END OF PROGRAM
    ==============================
```

Scilab code Exa 1.22 To calculate the speed of the motor

```
//Chapter-1, Example 1.21, Page 1.49
//
    ======================================================================

clc
clear

//INPUT DATA
V=220;//Terminal voltage in V
Io=4;//No load current in A
No=800;//No load speed in rpm
IL=24;//Load current in A
Ra=0.25;//Armature resistance in ohm
Rsh=220;//Shunt field resistance in ohm
```

```
No=800;//No load speed in rpm

//CALCULATIONS
Ish=(V/Rsh);//Field current in A
Iao=Io-Ish;//Armature current at no load in A
IaL=IL-Ish;//Armature current at load in A
Nl=(No*((V-(IaL*Ra))/(V-(Iao*Ra))));//Speed at load in rpm

//OUTPUT
mprintf('Speed of the motor at load is %3.0f rpm',Nl)

//==================================END OF PROGRAM==============================
```

Scilab code Exa 1.23 To calculate the speed of a motor

```
//Chapter-1, Example 1.21, Page 1.49
//==================================================================================

clc
clear

//INPUT DATA
P=6;//Number of poles
A=6;//Number of parallel paths for lap wound
Z=600;//Number of conductors
IL=100;//Load current in A
V=120;//Terminal voltage in V
Ra=30;//Armature resistance in ohm
Rsh=0.06;//Shunt field resistance in ohm
q=(30*10^-3);//Flux per pole in Wb

```

```
//CALCULATIONS
Ish=(V/Ra);//Field current in A
Ia=(IL-Ish);//Armature current in A
Eb=(V-(Ia*Rsh));//Back emf in V
N=(60*Eb*A)/(q*Z*P);//Speed of the motor in rpm

//OUTPUT
mprintf('Speed of the lap wound shunt motor is %3.0f rpm',N)

//=================================END OF PROGRAM==============================
```

Scilab code Exa 1.24 To calculate the speed

```
//Chapter-1, Example 1.21, Page 1.49
//=============================================================================

clc
clear

//INPUT DATA
Pg=120000;//Power delivered when generator in W
Ng=1000;//Prime mover speed in rpm
Vg=600;//Terminal voltage given by the generator in V dc
Pm=120000;//Power taken as motor in W
Vm=600;//Terminal voltage when motor in V dc
Ra=0.05;//Armature resistance in ohm
Rsh=200;//Field resistance in ohm
Vb=1;//Brush drop in V
Ng=1000;//Speed of the generator in rpm

//CALCULATIONS
```

```

//When operated as a generator
IL1=(Pg/Vg);//Load current in A
If1=(Vg/Rsh);//Filed current in A
Ia1=(IL1+If1);//Armature current in A
Eg=(Vg+(Ia1*Ra)+Vb);//Generated emf in V

//When operated as a motor
IL2=(Pm/Vm);//Load current in A
If2=(Vm/Rsh);//Field current in A
Ia2=(IL2-If2);//Armature current in A
Eb=(Vm-(Ia2*Ra)-Vb);//Back emf in V

Nm=(Ng*Eb)/Eg;//Speed of the motor in rpm

//OUTPUT
mprintf('Speed of the dc machine when operated as a
    motor is %3.0f rpm',Nm)

//==================================END OF PROGRAM
    ===============================
```

Scilab code Exa 1.25 To find the speed and torque

```
//Chapter-1, Example 1.21, Page 1.49
//
    ====================================================================

clc
clear

//INPUT DATA
R=0.05;//Total resistance of the motor in ohm
IL1=120;//Load current in A
V=220;//Terminal voltage in V
```

```
N=1200;//Speed in rpm
IL2=60;//Half load current in A

//CALCULATIONS
//Tnew=0.25*Told
//Hence percentage change in torque is 75% since it
   is (Told-Tnew)/Told*100
Ebnew=(V-(IL1*R));//New back emf in V
Ebold=(V-(IL2*R));//Old back emf in V
Nnew=(N*Ebnew*IL1)/(Ebold*IL2);//New speed in rpm
Pspeed=(Nnew/N)*100;//Percentage change in speed in
   %
//Ianew=(Iaold/sqrt(2))
I=sqrt(2)*100;//Percentage in current
N1new=(sqrt(2)*Ebnew*N)/Ebold;//New speed in rpm
P1speed=(N1new/N)*100;//Percentage change in speed
   in %

//OUTPUT
mprintf('i)Percentage in speed is %3.2f and
   Percentage in torque is 75\nii)New speed is %3.0f
    rpm and new current is (1/sqrt(2)) times old
   current',Pspeed,N1new)

//==========================================END OF PROGRAM
   ================================================
```

Scilab code Exa 1.26 To find the efficiency of the motor

```
//Chapter-1, Example 1.21, Page 1.49
//
   ==========================================================================

clc
clear
```

```

//INPUT DATA
V=220;//Terminal voltage in V
ILo=5;//No load current in A
Ra=0.3;//Armature resistance in ohm
Rsh=220;//Field resistance in ohm
IL=50;//Load current in A

//CALCULATIONS
Lo=(ILo*V);//No load losses in W
Ish=(V/Rsh);//Shunt current in A
Iao=(ILo-Ish);//No load armature current in A
Lco=((Iao^2*Ra)+(Ish^2*Rsh));//No load copper losses in W
Ifl=(Lo-Lco);//Iron and friction losses in W
Ia=(IL-Ish);//Armature current in A
Vl=(Ia^2*Ra);//Variable losses in W
Tl=(Vl+Lco+Ifl);//Total losses in W
P=(V*IL);//Input power in W
n=((P-Tl)/P)*100;//Efficiency

//OUTPUT
mprintf('Efficiency of the motor is %3.1f percent',n)

//==========================================END OF PROGRAM========================================
```

Scilab code Exa 1.27 To calculate the properties of shunt motor

```
//Chapter-1, Example 1.21, Page 1.49
//==================================================================================
clc
```

```
clear

//INPUT DATA
V=250;//Terminal voltage in V
IL=50;//Load current in A
N=1000;//Speed in rpm
Wi=1200;//Iron and friction losses in W
Ra=0.05;//Armature resistance in ohm
Rsh=125;//Field resistance in ohm

//CALCULATIONS
Ish=(V/Rsh);//Field current in A
Ia=(IL-Ish);//Armature current in A
Eb=(V-(Ia*Ra));//Back emf in V
Cu=((V*IL)-(Eb*Ia));//Copper losses in W
Ta=(9.55*Eb*Ia)/N;//Armature torque in N.m
Ts=(9.55*((Eb*Ia)-Wi))/N;//Shaft torque in N.m
n=(((Eb*Ia)-Wi)/(V*IL))*100;//Efficiency of the
    motor

//OPUTPUT
mprintf('(i)Copper loss is %3.1f W\n(ii)Armature
    torque is %3.1f N.m\n(iii)Shaft torque is %3.2f N
    .m\n(iv)Efficiency is %3.1f percent',Cu,Ta,Ts,n)

//=================================END OF PROGRAM
    ==============================
```

Scilab code Exa 1.28 To find the speed and load current and speed regulation

```
//Chapter-1, Example 1.21, Page 1.49
//
    ================================================================
```

```
clc
clear

//INPUT DATA
A=2;//Number of parallel paths
Z=926;//Number of conductors
P=4;//Nmber of poles
V=220;//Line voltage in V
Io=3;//No load ine current in A
If=0.8;//No load field current in A
q=(6*10^-3);//No load field flux in Wb
Ra=0.9;//Armature resistance in ohm
T=30;//Load torque in N.m

//CALCULATIONS
Ebo=(V-((Io-If)*Ra));//No load back emf in V
No=(Ebo*60*A)/(q*Z*P);//No load speed in rpm
Ia=(A*T)/(0.159*q*Z*P);//Armature current in A
IL=(Ia+If);//Load current in A
Eb=(V-(Ia*Ra));//Back emf in V
N=(Eb*60*A)/(q*Z*P);//Speed at load in rpm
R=((No-N)/No)*100;//Speed regulation in percent

//OUTPUT
mprintf('No load speed is %3.0f rpm\nSpeed at load
    is %3.1f rpm\nSpeed regulation is %3.2f percent',
    No,N,R)

//=================================END OF PROGRAM
    ==================================
```

Scilab code Exa 1.29 To find the change in speed

```
//Chapter-1, Example 1.21, Page 1.49
//
```

```
==================================================================================

clc
clear

//INPUT DATA
V=250;//Terminal voltage in V dc
N1=800;//Existing speed in rpm
Ra=0.05;//Armature resistance in ohm
Ia1=40;//Existing armature current in A
R=0.1;//Reduction in field flux

//CALCULATIONS
Ia2=(Ia1/(1-R));//New armature current in A
N2=(N1*(V-(Ia1*Ra)))/((V-(Ia2*Ra))*(1-R));//New
   speed in rpm

//OUTPUT
mprintf('New speed is %3.0f rpm',N2)

//=================================END OF PROGRAM
   ==============================
```

Scilab code Exa 1.30 To find the resistance to be included

```
//Chapter-1, Example 1.21, Page 1.49
//
   ==================================================================================

clc
clear

//INPUT DATA
V=300;//Terminal voltage in V
N1=600;//Existing speed in rpm
```

```
IL=30;//Load current in A
N2=800;//New speed in rpm
Ra=0.5;//Armature resistance in ohm
Rsh=125;//Field resistance in ohm

//CALCULATIONS
Ish1=(V/Rsh);//Field current in A
Ia1=(IL-Ish1);//Armature current in A
Ia2=(V-sqrt((V^2)-(4*Ra*(V-(Ia1*Ra))*Ia1*(N2/N1))));//New armature current in A
Ish2=(Ish1*Ia1)/Ia2;//New field current in A
Rsh2=(V/Ish2);//New field resistance in ohm
FR=(Rsh2-Rsh);//Field rheostat in ohm

//OUTPUT
mprintf('The value of resistance to be included in the field is %3.2f ohm',FR)

//==========================================END OF PROGRAM==========================================
```

Scilab code Exa 1.31 To find the resistance required

```
//Chapter-1, Example 1.21, Page 1.49
//==================================================================================

clc
clear

//INPUT DATA
N1=1000;//Initial speed in rpm
N2=600;//Final speed in rpm
Ia1=40;//Initial armature current in A
Ia2=30;//Final armature current in A
```

```
V=250;//Terminal voltage in V
Ra=0.5;//Armature resistance in ohm

//CALCULATIONS
R=(V-((N2/N1)*(V-(Ia1*Ra))))/30;//Total resistance in ohm
Rs=(R-Ra);//Series resistance in ohm

//OUTPUT
mprintf('Resistance required in series is %3.2f ohm',Rs)

//==================================END OF PROGRAM==============================
```

Scilab code Exa 1.32 To find the additional field resistance to be included

```
//Chapter-1, Example 1.21, Page 1.49
//=============================================================================

clc
clear

//INPUT DATA
N1=1200;//Initial speed in rpm
N2=1500;//Final speed in rpm
Ia1=80;//Initial armature current in A
Ia2=100;//Final armature current in A
V=220;//Terminal voltage in V
Ra=0.05;//Armature resistance in ohm
Rsh1=220;//Initial shunt resistance in ohm

//CALCULATIONS
Rsh2=((N2/N1)*(V-(Ia1*Ra))*Rsh1)/(V-(Ia2*Ra));//New
```

```
shunt resistance in ohm
Rs=(Rsh2-V);//Field resistance in ohm

//OUTPUT
mprintf('Additional field resistance to be included in the field is %3.2f ohm',Rs)

//==============================================END OF PROGRAM==========================================
```

Scilab code Exa 1.33 To find the speed

```
//Chapter-1, Example 1.21, Page 1.49
//=============================================================================================

clc
clear

clc
clear
//INPUT DATA
N1=1500;//Initial speed in rpm
N2=1200;//Final speed in rpm
Ia1=30;//Initial armature current in A
V=300;//Terminal voltage in V
Ra1=0.5;//Initial armature resistance in ohm

//CALCULATIONS
R=(V-((N2/N1)*(V-(Ia1*Ra1))))/Ia1;//Total resistance in ohm
Rs=(R-Ra1);//Resistance to be added in ohm
n=((V-(Ia1*R))/V)*100;//Armature circuit efficiency
Nn2=(N2*(V-((Ia1/2)*R)))/(V-(Ia1*R));//New speed at half of the full load torque in rpm
```

```
//OUTPUT
mprintf('Resistance to be added to the existing armature resistance is %3.1f ohm \n Speed at half of the full load torque is %3.1f rpm',Rs,Nn2)

//===================================END OF PROGRAM==================================
```

Scilab code Exa 1.34 To find the properties of shunt motor

```
//Chapter-1, Example 1.21, Page 1.49
//=============================================================================

clc
clear

//INPUT DATA
Pi=8800;//Input power in W
Ra=0.5;//Armature resistance in ohm
No=1260;//Speed of the motor at no load in rpm
V=240;//Line voltage in V
Pm=18800;//Gross mechanical power in W
V=240;//treminal voltage in V

//CALCULATIONS
K=(V/No);//Constant of proportionality
Eb1=(240-sqrt((V^2)-(4*(Pi/2))))/2;//Back emf in V
Eb2=(240+sqrt((V^2)-(4*(Pi/2))))/2;//Back emf in V
I=(Pi/V);//Rated current in A
Ia=(V-Eb1)/Ra;//Armature current in A
Nn=(Eb2/K);//New speed in rpm
Ia2=(V-Eb2)/Ra;//Armature current in A
T=(60*Pi)/(2*3.14*Nn);//Torque developed in N.m
```

```
K2=(T/Ia2);//New constant
//TN=(0.5*10^-4)Nn^2
Nnn1=(-((K2*K)/Ra)+sqrt((((K2*K)/Ra))^2+(4*(0.5*10^-4)*((V*K2)/Ra))))/(2*0.5*10^-4);//New speed in rpm

//OUTPUT
mprintf('Armature current is %3.0f A \n Torque developed is %3.2f N.m \n New speed of the motor is %3.0f rpm',Ia2,T,Nnn1)

//==================================================END OF PROGRAM==============================================
```

Scilab code Exa 1.35 To find the torque and power and speed

```
//Chapter-1, Example 1.21, Page 1.49
//=============================================================================

clc
clear

//INPUT DATA
N1=1500;//Initial speed in rpm
V1=270;//Terminal voltage in V
T=300;//Full load torque in N.m
N2=1200;//New speed in rpm
V2=(2*V1);//New terminal voltage in V
Ra=0.31;//Armature resistance in ohm

//CALCULATIONS
Ia=(T*2*3.14*N1)/(V1*60);//Full load current in A
Eb=(V1*(N2/N1));//Back emf in V
Pm=(Eb*Ia)/1000;//Mechanical power developed in kW
```

```
Eb2=(V2-(Ia*Ra));//Back emf at new terminal volatge in V
N=(Eb2*Ia*60)/(2*3.14*T);//New speed in rpm
Pm2=(Eb2*Ia/1000);//Mechanical power in kW

//OUTPUT
mprintf('i)Full load current is %3.1f A, Full load power is %3.1f kW, Armature resistance is %3.2f ohm\nii)New motor torque is %3.0f N.m, Motor power is %3.1f kW, Motor speed is %3.0f rpm',Ia,Pm,Ra,T,Pm2,N)

//==================================================END OF PROGRAM==================================================
```

Scilab code Exa 1.36 To find the series resistance required

```
//Chapter-1, Example 1.21, Page 1.49
//=============================================================================

clc
clear

//INPUT DATA
V=200;//Terminal voltage in V
Ra=0.05;//Armature resistance in ohm
Rse=0.03;//Field resistance in ohm
N1=1000;//Present speed in rpm
N2=800;//Required speed in rpm
Ia=40;//Armature current in A

//CALCULATIONS
R=(V-((N2/N1)*(V-(Ia*(Ra+Rse)))))/Ia;//Total resistance in ohm
```

```
R1=(R-Ra-Rse);//Series resistance required to be
    connected in series with armature and field
    resistance in ohm

//OUTPUT
mprintf('Series resistance required to be connected
    in series with armature and field resistance is
    %3.3f ohm',R1)

//===============================================END OF PROGRAM
    ===============================================
```

Scilab code Exa 1.37 To find the series resistance to be added

```
//Chapter-1, Example 1.21, Page 1.49
//
    =============================================================================

clc
clear

//INPUT DATA
V=500;//Terminal voltage in V dc
I=30;//Line current in A
N1=600;//Initial speed in rpm
N2=500;//Required speed in rpm
R=0.5;//Total resistance in ohm

//CALCULATIONS
Eb1=(V-(I*R));//Back emf in V
Ka=(Eb1*60)/(I*N1);//Proportionality constant
T1=(Ka*I^2)/(2*3.14);//Torque developed at speed 600
     rpm
T2=(T1*(N2/N1)^2);//Torque developed at speed 500
    rpm
```

```
I2=sqrt((2*3.14*T2)/Ka);//New lin ecurrent in A
Eb2=(Ka*I2*N2)/60;//New back emf in V
R1=(V-Eb2)/I2;//Required series resistance in ohm

//OUTPUT
mprintf('Series resistance to be added to armature field circuit is %3.1f ohm',R1)

//==========================================END OF PROGRAM==========================================
```

Scilab code Exa 1.38 To calculate the Resistance

```
//Chapter-1, Example 1.21, Page 1.49
//==============================================================================

clc
clear

//INPUT DATA
V=200;//Terminal voltage in V dc
I1=25;//Line current in A
Ra=0.5;//Armature resistance in ohm
Rse=0.3;//Field resistance in ohm

//CALCULATIONS
//N2=0.75*N1
I2=sqrt((I1^2*(0.75)^3));//New line current in A
Eb1=(V-(I1*(Ra+Rse)));//Back emf in V
X=(V*I2);//X value for Resistance
R=(X-(0.75*Eb1))/I2^2;//Total resistance in ohm
Rs=(R-Ra-Rse);//Resistance to be connected in ohm

//OUTPUT
```

```
mprintf('Resistance to be connected is %3.1f ohm',Rs
    )

//========================================END OF PROGRAM
    ========================================
```

Chapter 2

Transformers

Scilab code Exa 2.1 Number of turns and full load current

```
//Chapter-2, Example 2.1, Page 2.4
//=============================================================================

clc
clear

//INPUT DATA
V1=1000;//Voltage in primary circuit in V
V2=100;//Voltage in secondary ciricut in V
N2=60;//Number of turns in secondary
R=10000;//Rating of transformer in VA

//CALCULATIONS
K=(V2/V1);//Voltage transformation ratio
N1=(N2/K);//Number of turns in primary
I1=(R/V1);//Current in the primary in A
I2=(R/V2);//Current in the secondary in A

//OUTPUT
mprintf('a)Number of turns in the primary is %3.0f
```

```
    turns \nb)Current in the primary is %3.0f A and
    Current in the secondary is %3.0f A',N1,I1,I2)

//==========================================END OF PROGRAM
    ======================================
```

Scilab code Exa 2.2 Properties of an ideal transformer

```
//Chapter-2, Example 2.2, Page 2.5
//
    ================================================================================

clc
clear

//INPUT DATA
N1=400;//Number of turns in the primary
N2=30;//Number of turns in the secondary
Q=20000;//Rating of the transformer in VA
V1=2000;//Primary voltage in V
f=50;//Power supply frequency in Hz

//CALCULATIONS
K=(N2/N1);//Voltage transformation ratio
I1=(Q/V1);//Current in the primary in A
I2=(I1/K);//Current in the secondary in A
V2=(K*V1);//Secondary voltage in V
q=(V1/(4.44*f*N1));//Maximum flux in the core in Wb

//OUTPUT
mprintf('(a)Full load primary current is %3.0f A and
     secondary current is %3.2f A \n(b)Induced emf in
     the secondary is %3.0f V \n(c)Maximum flux in
    the core is %3.3f Wb',I1,I2,V2,q)

```

```
//================================================END OF PROGRAM
    ============================================
```

Scilab code Exa 2.3 Number of turns and induced emf

```
//Chapter-2, Example 2.3, Page 2.6
//
    ================================================================================================

clc
clear

//INPUT DATA
A=(40*10^-4);//Area of cross section of the core A
    in m^2
B=8;//Maximum flux density in the core B in Wb/m^2
V1=2000;//Primary voltage in V
V2=200;//Secondary voltage in V
f=50;//Frequency in Hz

//CALCULATIONS
N1=(V1/(4.44*B*A*f));//Number of turns in the
    primary
N2=(V2/(4.44*f*A*B));//Number of turns in the
    secondary

//OUTPUT
mprintf('Number of turns in the primary is %3.0f \
    nNumber of turns in the secondary is%3.0f',N1,N2)

//================================================END OF PROGRAM
    ============================================
```

Scilab code Exa 2.4 Number of turns

```
//Chapter-2, Example 2.4, Page 2.7
//=============================================================================

clc
clear

//INPUT DATA
V1=2500;//primary voltage in V
V2=200;//Secondary voltage in V
e=(30*0.9);//Effective side of magnetic core in cm
A=(30*30*0.9*0.9*10^-4);//Area of cross section of the limb in m^2
B=1;//Maximum flux density in Wb/m^2
q=(B*A);//Maximum flux in Wb
f=50;//Frequency of power supply in Hz

//CALCULATIONS
N1=(V1/(4.44*f*q));//Number of turns in the primary
N2=(V2/(4.44*f*q));//Number of turns in the secondary

//OUTPUT
mprintf('Number of turns in the primary are %3.0f turns and Number of turns in the secondary are %3.0f turns',N1,N2)

//=================================END OF PROGRAM==============================
```

Scilab code Exa 2.5 Magnetising and iron loss components

```
//Chapter-2, Example 2.5, Page 2.10
```

```
//==========================================================================
clc
clear

//INPUT DATA
Io=0.8;//No load primary current in A
Wo=75;//No load primary poewr in W
V1=220;//Primary voltage in V
f=50;//Supply frequency in Hz

//CALCULATIONS
Iw=(Wo/V1);//Iron loss component in A
Im=sqrt(Io^2-Iw^2);//Magnetising component in A

//OUTPUT
mprintf('Iron loss component is %3.2f A \nMagnetising component is %3.3f A',Iw,Im)

//=================================END OF PROGRAM==============================
```

Scilab code Exa 2.6 Core and iron loss and magnetising current

```
//Chapter-2, Example 2.6, Page 2.11
//==========================================================================
clc
clear

//INPUT DATA
Io=6;//No load primary current in A
cosq=0.3;//Power factor
```

```
V1=220;//Primary voltage in V
V2=2200;//Secondary voltage in V

//CALCULATIONS
Wo=(V1*Io*cosq);//Core loss in W
Iw=(Io*cosq);//Iron loss current in A
Im=sqrt(Io^2-Iw^2);//Magnetsising current in A

//OUTPUT
mprintf('(a)Core loss is %3.0f W\n(b)Iron loss current is %3.1f A\n(c)Magnetising current is %3.2f A',Wo,Iw,Im)

//==================================================END OF PROGRAM=============================================
```

Scilab code Exa 2.7 Properties of a transformer

```
//Chapter-2, Example 2.7, Page 2.12
//=============================================================================

clc
clear

//INPUT DATA
V1=200;//Primary voltage in V
V2=2000;//Secondary voltage in V
Io=7;//Primay no load current in A
Wo=180;//Primary no load power in W
R1=0.05;//Primary winding resistance in ohm

//CALCULATIONS
Fe=(Wo-(Io^2*R1));//Iron loss or core loss alone in W
```

```
cosq=(Wo/(V1*Io));//No load power factor
Iw=(Wo/V1);//Working component of current in A
Im=sqrt(Io^2-Iw^2);//Magnetising current in A

//OUTPUT
mprintf('(a)The core loss is %3.2f W\n(b)No load
   power factor is %3.3f lagging\n(c)Working
   component of current is %3.1f A\n(d)Magnetising
   current is %3.2f A',Fe,cosq,Iw,Im)

//==================================END OF PROGRAM
   =================================
```

Scilab code Exa 2.8 Primary current

```
//Chapter-2, Example 2.8, Page 2.14
//
   ====================================================

clc
clear

//INPUT DATA
Io=6;//No load prmary current in A
cosqo=0.2;//Primary no load power factor
I2=125;//Secondary load current in A
cosq2=0.8;//Secondary load power factor
V1=400;//Primary terminal voltage in V
V2=100;//Secondary terminal voltage in V

//CALCULATIONS
K=(V2/V1);//Voltage transformation ratio
I2i=(K*I2);//Secondary current in A
q=(acos(cosqo)-acos(cosq2));//Value of angle in
   degees
```

```
I1=sqrt((Io^2)+(I2i^2)+(2*Io*I2i*cos(q)));//Primary
    current in A

//OUTPUT
mprintf('Primary current is %3.2f A',I1)

//==================================END OF PROGRAM
    ================================
```

Scilab code Exa 2.9 No load current and phase angle

```
//Chapter-2, Example 2.9, Page 2.16
//
    ================================================================

clc
clear

//INPUT DATA
N1=760;//Number of turns in the primary
N2=180;//Number of turns in the secondary
I2=70;//Secondary load current in A
cosq=0.8;//Secondary load power factor
I1=30;//Primary current in A
cosq1=0.71;//Primary current power factor

//CALCULATIONS
K=(N2/N1);//Ratio of turns
I2i=(K*I2);//Secondary current in A
I1i=complex((I1*cosq1),(I1*sind(acosd(cosq1))));//
    Primary current in A
I2c=complex((I2i*cosq),(I2i*sind(acosd(cosq))));//
    Secondary current in A
A1=sqrt((real(I1i))^2+(imag(I1i))^2);
A2=(atand(imag(I1i)/real(I1i)));
```

```
B1=sqrt((real(I2c))^2+(imag(I2c))^2);
B2=(atand(imag(I2c)/real(I2c)));
C=(A1*cosd(A2))-(B1*cosd(B2));
D=(A1*sind(A2))-(B1*sind(B2));
q=atand(D/C);//Phase angle in degree
p=cosd(q);//Power factor
Io=(D/sind(q));//No load current in A

//OUTPUT
mprintf('No load current of the transformer is %3.2f
    A and its phase angle is %3.2f degree',Io,q)

//==================================END OF PROGRAM
    ================================
```

Scilab code Exa 2.10 Primary current and power factor

```
//Chapter-2, Example 2.10, Page 2.17
//
    ==========================================================================

clc
clear

//INPUT DATA
Io=12;//Primary no load current in A
cosqo=0.25;//No load power factor
I2=220;//Secondary load current in A
cosq2=0.8;//Secondary power factor
K=(1/5);//Turn ratio

//CALCULATIONS
qo=acosd(cosqo);//phase angle in degree
q2=acosd(cosq2);//Phase angle in degree
Ioc=complex((Io*cosqo),(Io*sind(qo)));//Io value in
```

```
complex form
I2i=complex((K*I2*cosq2),(K*I2*sind(q2)));//I2i
   value in complex form
I1=(Ioc+I2i);//Primary current in A
X=sqrt((real(I1))^2+(imag(I1))^2);//Primary current
   in A
Y=cosd(atand(imag(I1)/real(I1)));//Power factor

//OUTPUT
mprintf('Primary current is %3.1f A and Primary
   power factor is %3.2f',X,Y)

//==================================END OF PROGRAM
   ===================================
```

Scilab code Exa 2.11 Properties of an ideal step up transformer

```
//Chapter-2, Example 2.11, Page 2.18
//
   =====================================================================

clc
clear

//INPUT DATA
K=(330/110);//Turn ratio
N1=110;//Number of turns in the primary
N2=330;//Number of turns in the secandary
V1=4000;//Primary voltage in V
f=50;//Supply frquency in Hz
Z2=complex(120,40);//Secondary load

//CALCULATIONS
q=(V1/(4.44*N1*f));//Flux in Wb
V2=(K*V1);//Secondary voltage in V
```

```
I2=(V2/Z2);//Secondary current in A
I1=K*I2;//Primary current in A
S=(V1*I1)/1000;//Transformer rating
P1=(V1*sqrt((real(I1))^2+(imag(I1))^2)*cosd((atand(imag(I1)/real(I1)))))/1000;//Real power in kW
R1=(V1*sqrt((real(I1))^2+(imag(I1))^2)*sind(-(atand(imag(I1)/real(I1)))))/1000;//Reactive power in KVAR
Zeq=(V1/I1);//Transformer equivalent impedence
a1=sqrt((real(I1))^2+(imag(I1))^2);
a2=sqrt((real(I2))^2+(imag(I2))^2);
b1=real(Zeq);
b2=imag(Zeq);

//OUTPUT
mprintf('a)Maximum flux in the core is %3.3f Wb\n(b)Primary current is %3.2f A and Secondary current is %3.2f A\n(c)Real power is %3.0f KW and Reactive power is %3.0f KVAR\n(d)Value of impedence consumed is %3.1f+j%3.1f',q,a1,a2,P1,R1,b1,b2)

//==================================================END OF PROGRAM==================================================
```

Scilab code Exa 2.12 Primary current and peak value of flux

```
//Chapter-2, Example 2.12, Page 2.20
//==================================================

clc
clear

//INPUT DATA
```

```
N1=100;//Number of turns in the primary
N2=2000;//Number of turns in the secondary
V1=220;//Primary volatge in V
f=50;//Supply frequency in Hz
I2=3;//Secondary current in A

//CALCULATIONS
K=(N2/N1);//Turn ratio
I1=(K*I2);//Primary current in A
q=(V1/(4.44*f*N1))*1000;//Peak vaue of flux linked
    with the secondary in m.Wb

//OUTPUT
mprintf('(a)The value of primary current is %3.0f A
    \n(b)The peak value of flux linked with the
    secondary is %3.1f m.Wb',I1,q)

//==================================================END OF PROGRAM
    ==============================================
```

Scilab code Exa 2.13 Secondary voltage and primary and secondary current

```
//Chapter-2, Example 2.13, Page 2.21
//
    ==========================================================================================

clc
clear

//INPUT DATA
N1=1100;//Number of turns in the primary
N2=550;//Number of turns in the secandary
V1=200;//Primary voltage in V
R2=5;//Resistance in the secondary in ohm
```

```

//CALCULATIONS
K=(N2/N1);//Turn ratio
V2=(K*V1);//Secondary voltage in V
I2=(V2/R2);//Current in the secondary in A
I1=(K*I2);//Current in the primary in A

//OUTPUT
mprintf('(a)Secondary voltage is %3.0f V\n(b)Primary current is %3.0f A\n(c)Secondary current is %3.0f A',V2,I2,I1)

//==================================END OF PROGRAM==============================
```

Scilab code Exa 2.14 Primary current

```
//Chapter-2, Example 2.16, Page 2.30
//=============================================================================

clc
clear

//INPUT DATA
N1=400;//Number of turns in the primary
N2=100;//Number of turns in the secondary
Io=4;//No load current in A
qo=0.3;//No load current power factor
I2=120;//Secondary current in A
q2=0.8;//Secondary current power factor

//CALCULATIONS
K=(N2/N1);//Turn ratio
I2i=(K*I2);//Secondary current in A
```

```
I2ic=complex((I2i*q2),(I2i*sind(acosd(q2))));//Ixi in complex form
Ioc=complex((Io*qo),(Io*sind(acosd(qo))));//Ixi in complex form
Iic=(I2ic+Ioc);//Primary current in complex form
a1=sqrt((real(Iic))^2+(imag(Iic))^2);
a2=atand(imag(Iic)/real(Iic));
q=cosd(a2);//Phase angle in degree

//OUTPUT
mprintf('Current taken by the primary is %3.2f A and power factor is %3.2f',a1,q)

//==================================END OF PROGRAM==================================
```

Scilab code Exa 2.15 Power delivered and current taken

```
//Chapter-2, Example 2.15, Page 2.23
//====================================================================================

clc
clear

//INPUT DATA
V1=6000;//Primary volatge in V
V2=500;//Secondary voltage in V
Z2=complex(4,3)

//CALCULATIONS
K=(V2/V1);//Voltage transformation ratio
I2=(V2/Z2);//Secondary current in A
a1=sqrt((real(I2))^2+(imag(I2))^2);
a2=atand(imag(I2)/real(I2));
```

```
q=cosd(a2);//Phase angle in degree
P2=(V2*a1*q)/1000;//Power delivered in kW
I1=(K*a1);//Primary current in A

//OUTPUT
mprintf('Power delivered is %3.0f kW \nCurrent taken
    by an ideal transformer is %3.2f A',P2,I1)

//=================================END OF PROGRAM
==============================
```

Scilab code Exa 2.16 Parameters of a transformer

```
//Chapter-2, Example 2.1, Page 2.4
//
===================================================================

clc
clear

//INPUT DATA
Q=25;//Rating of a transformer in KVA
V1=2000;//Primary voltage in V
V2=200;//Secondary volatge in V
R1=0.15;//Primary winding resistance in ohm
X1=0.25;//Primary leakage reactance in ohm
R2=0.04;//Secondary winding resistance in ohm
X2=0.015;//Secondary leakage reactance in ohm

//CALCULATIONS
K=(V2/V1);//Voltage transformation ratio
Ro1=(R1+(R2/K^2));//Resistance referred to primary
   in ohm
Xo1=(X1+(X2/K^2));//Reactance referred to primary in
    ohm
```

```
Zo1=sqrt(Ro1^2+Xo1^2);//Impedence referred to primary in ohm
Ro2=(R2+(R1*K^2));//Resistance referred to secndary in ohm
Xo2=(X2+(X1*K^2));//Reactance referred to secondary in ohm
Zo2=sqrt(Ro2^2+Xo2^2);//Impedence referred to secondary in ohm

//OUTPUT
mprintf('(a)Resistance referred to primary is %3.2f ohm \n Reactance referred to primary is %3.2f ohm \n Impedence referred to primary is %3.1f ohm \n \n(b)Resistance referred to secndary is %3.4f ohm \n Reactance referred to secondary is %3.4f ohm \n Impedence referred to secondary is %3.3f ohm',Ro1,Xo1,Zo1,Ro2,Xo2,Zo2)

//==================================================END OF PROGRAM==================================================
```

Scilab code Exa 2.17 Parameters of a transformer

```
//Chapter-2, Example 2.17, Page 2.32
//=============================================================================

clc
clear

//INPUT DATA
R1=3.5;//Primary Resistance in ohm
X1=5.2;//Primary reactance in ohm
R2=0.01;//Secondary Resistance in ohm
X2=0.02;//Secondary reactance in ohm
```

```
Q=40000;//Rating of the transformer in VA
V1=4000;//Primary voltage in V
V2=200;//Secondary voltage in V

//CALCULATIONS
Z1=complex(R1,X1);//Primary impedence
Z2=complex(R2,X2);//Secondary impedence
I1=(Q/V1);//Primary current in A
I2=(Q/V2);//Secondary current in A
K=(I1/I2);//Current ratio
Ro1=(R1+(R2/K^2));//Resistance referred to primary in ohm
Xo1=(X1+(X2/K^2));//Reactance referred to primary in ohm
Zo1=(Z1+(Z2/K^2));//Impedence referred to primary in ohm
Ro2=(R2+(R1*K^2));//Resistance referred to secndary in ohm
Xo2=(X2+(X1*K^2));//Reactance referred to secondary in ohm
Zo2=(Z2+(Z1*K^2));//Impedence referred to secondary in ohm
a1=real(Zo1);
a2=imag(Zo1);
a3=real(Zo2);
a4=imag(Zo2);

//OUTPUT
mprintf('(a)Resistance referred to primary is %3.1f ohm \n Reactance referred to primary is %3.1f ohm \n Impedence referred to primary is %3.1f+j%3.1f ohm \n\n(b)Resistance referred to secndary is %3.5f ohm \n Reactance referred to secondary is %3.3f ohm \n Impedence referred to secondary is %3.5f+j%3.3f ohm',Ro1,Xo1,a1,a2,Ro2,Xo2,a3,a4)

//==========================================END OF PROGRAM==========================================
```

Scilab code Exa 2.18 Parameters of a transformer

```
//Chapter-2, Example 2.18, Page 2.34
//=============================================================================
clc
clear

//INPUT DATA
Q=(40*1000);//Transformer rating in VA
V1=1600;//Primary voltage in V
V2=160;//Secondary voltage in V
f=50;//Frequency in Hz
R=10;//Turn ratio

//CALCULATIONS
K=0.1;//Turn ratio
I2=(Q/V2);//Full load secondary current in A
Z2=(V2/I2);//Load impedence in ohm
Zo1=(Z2/K^2);//Impedence referred to high tension side in ohm
I2i=(K*I2);//Value of current referred to high tension side in A

//OUTPUT
mprintf('(a)Load impedence required for full load current is %3.2f ohm \n(b)Impedence referred to high tension side is %3.0f ohm\n(c)Value of current referred to high tension side is %3.0f A',Z2,Zo1,I2i)

//=================================END OF PROGRAM==============================
```

Scilab code Exa 2.19 Priamary and secondary resistance and reactance

```
//Chapter-2, Example 2.19, Page 2.35
//=============================================================================

clc
clear

//INPUT DATA
Q=80;//Transformer rating in KVA
V1=11000;//Primart voltage in V
V2=440;//Secondary voltage in V
Pcu=0.75;//Primary copper loss in kW
Scu=0.5;//Secondary copper loss in kW

//CALCULATIONS
I2=(Q*1000)/V2;//Full load secondary current in A
I1=(Q*1000)/V1;//Full load primary current in A
R1=((Pcu)/I1^2)*1000;//Primary resistance in ohm
R2=(Scu*1000)/I2^2;//Secondary resistance in ohm
Xo1=(0.04*V1)/I1;// Equivalent primary reactance in
    ohm
K=(I1/I2);//Current ratio
X1=(Xo1/((R1+(R2/K))/(R2/K)));//Primary reactance in
     ohm
X2i=(Xo1/X1);//Equivalent secondary reactance in ohm
X2=(X2i*K);//Secondary reactance in ohm

//OUTPUT
mprintf('a)Primary resistance is %3.2f ohm and
    Secondary resistance in is  %3.3f ohm\nb)Primary
    reactance is %3.2f ohm and Secondary reactance is
     %3.3f ohm',R1,R2,X1,X2)
```

```

//==============================================END OF PROGRAM
    ===========================================
```

Scilab code Exa 2.20 Primary voltage and power factor and efficiency

```
//Chapter-2, Example 2.20, Page 2.37
//
    =============================================================================

clc
clear

//INPUT DATA
K=(1/20);//Turn ratio
R1=30;//Primary resistance in ohm
R2=0.08;//Secondary resistance in ohm
X1=80;//Primary reactance in ohm
X2=0.3;//Secondary reactance in ohm
I=1.5;//No load current in A
cosqo=0.5;//Power factor
I2=200;//Load current in A
V2=500;//Secondary terminal voltage in V
cosq2=0.8;//Load power factor
q3=60;//Phase angle in degree

//CALCULATIONS
q2=(acosd(cosq2));//Phase angle in degree
I2i=complex((I2*cosd(q2)),(I2*sind(-q2)));//Load
    current in complex form
V2i=complex(V2,0);//Secondary terminal voltage in
    complex form
Z2=complex(R2,X2);//Impedence in complex form
E2=(V2i+(I2i*Z2));//Terminal voltage in V
E1=(sqrt((real(E2))^2+(imag(E2))^2)/K);//Primary
```

```
    voltage in V
I2c=(K*I2);//Secondary current in A
I21c=complex((I2c*cosd(q2)),(I2c*sind(-q2)));//Load
    current in complex form
Io=complex((I*cosd(-q3)),(I*sind(-q3)));//No load
    current in A
I1c=(Io+I21c);//Total current
Z1=complex(R1,X1);//Primary impedence
V1=(E1+(I1c*Z1));//Primary applied voltage
V1i=(sqrt((real(V1))^2+(imag(V1))^2));//Primary
    applied voltage in V
A=((atand(imag(V1)/real(V1)))-((atand(imag(I1c)/real
    (I1c)))));//Angle between V1 and I1 in degree
p=cosd(A);//Power factor
Cu=(I2^2*(R2+(K^2*R1)));//Copper losses in W
C=(V1i*sqrt((real(Io))^2+(imag(Io))^2)*cosqo);//
    Constant losses in W
P=(V2*I2*cosq2);//Output power in W
n=(P/(P+Cu+C))*100;//Efficiency

//OUTPUT
mprintf('Primary applied voltage is %3.2f V\nPrimary
     power factor is %3.2f \nEfficiency is %3.2f
    percent',V1i,p,n);

//==============================================END OF PROGRAM
    ==============================================
```

Scilab code Exa 2.21 Primary induced emf and current

```
//Chapter-2, Example 2.21, Page 2.39
//
    ==========================================================================

clc
```

```
clear

//INPUT DATA
V1=1000;//Primary voltage in V
V2=300;//Secondary voltage in V
R1=0.2;//Primary resistance in ohm
X1=0.75;//Primary reactance in ohm
I1=50;//Primary current in A
cosq1=0.8;//Power factor

//CALCULATIONS
E1=(V1-(I1*sqrt(R1^2+X1^2)));//Primary induced emf in V

//OUTPUT
mprintf('Primary induced emf is %3.1f V',E1)

//=================================END OF PROGRAM==============================
```

Scilab code Exa 2.22 Induced emf in the secondary

```
//Chapter-2, Example 2.22, Page 2.40
//=============================================================================

clc
clear

//INPUT DATA
L2=7500;//Load on secondary in W
V2=220;//Secondary voltage in V
cosq=0.8;//Power factor
R2=0.05;//Secondary resistance in ohm
X2=0.75;//Secondary reactance in ohm
```

```
V2i=200;//Secondary voltage in V

//CALCULATIONS
I2=(L2/(V2*cosq));//Secondary current in A
q=acosd(cosq);//Phase angle in degree
I2c=complex((I2*cosd(q)),(I2*sind(-q)));//I2 in
    complex form
Z2=complex(R2,X2);
E2=(V2i+(I2c*Z2));//Induced imf in V
a1=real(E2);
a2=imag(E2);

//OUTPUT
mprintf('Induced emf in the secondary is %3.2f+j%3.2
    f',a1,a2)

//=====================================END OF PROGRAM
    =================================
```

Scilab code Exa 2.23 Primary currrent

```
//Chapter-2, Example 2.23, Page 2.40
//
    ==========================================================================

clc
clear

//INPUT DATA
K=(1000/200);//Voltage transformation ratio
R1=2;//Primary resistance in ohm
R2=200;//Secondary resistance in ohm
Vo=360;//Volts in V

//CALCULATIONS
```

```
Z2i=(R2/K^2);//Equivalent secondary impedence in ohm
Zo1=(Z2i+R1);//Equivalent primary impedence in ohm
I1=(Vo/Zo1);//Primary current in A

//OUTPUT
mprintf('Primary current is %3.0f A',I1)

//==================================END OF PROGRAM
    ================================
```

Scilab code Exa 2.24 Secondary voltage and primary current

```
//Chapter-2, Example 2.24, Page 2.41
//
    ====================================================================

clc
clear

//INPUT DATA
K=(500/10);//Turn ratio in step up transformer
Z1=complex(0,6);//Primary reactance in ohm
Z2=complex(20000,-10000);//Secondary impedence in
    ohm
V1=100;//Primary voltage in V

//CALCULATIONS
Z2i=(Z2/K^2);//Equivalent secondary impedence in ohm
Zo1=(Z1+Z2i);//Equivalent primary impedence in ohm
I1=(V1/Zo1);//Primary current in A
V2i=(I1*Z2i);//Equivalent secondary voltage in V
V2=(K*V2i);//Secondary voltage in V
X=sqrt((real(V2))^2+(imag(V2))^2);//X value for
    secondary voltage
Y=-(45+atand(imag(V2)/real(V2)));//Phase angle in
```

```
    degree

//OUTPUT
mprintf('Secondary volatge is %3.0f V,%3.1f degree',
    X,Y)

//=========================================END OF PROGRAM
    =====================================
```

Scilab code Exa 2.25 Efficiency and regulation

```
//Chapter-2, Example 2.25, Page 2.44
//
    ================================================================================

clc
clear

//INPUT DATA
V1=2200;//Primary volatge in V
V2=220;//Secondary voltage in V
K=(V2/V1);//Voltage transformation ratio
R1=0.3;//Primary resistance in ohm
R2i=0.24;//Equivalent secondary resistance in ohm
Ro=300;//No load resistance in ohm
RL=0.4;//Load resistance in ohm
X1=0.8;//Primary reactance in ohm
X2i=0.9;//Equivalent secondary reactance in ohm
Xo=1100;//No load reactance in ohm
XL=0.3;//Load reactance in ohm

//CALCULATIONS
ZLi=(complex(RL,R1)/K^2);//Equivalent load impedence
     in ohm
Z1=complex(R1,X1);//Primary impedence
```

```
Z2i=complex(R2i,X2i);//Equivalent secondary
    impedence
Zo=complex(Ro,Xo);//No load impedence
Zeq=((Zo*(Z1+Z2i+ZLi))/(Zo+Z1+Z2i+ZLi));//Equivalent
     impedence
I1=(V1/Zeq);//Primary current in A
I2i=((I1*Zo)/(Zo+Z1+Z2i+ZLi));//Equivalent secondary
     current in A
Io=((I1*((Z1+Z2i+ZLi)/(Zo+Z1+Z2i+ZLi))));//No load
    current in A
Pi=(V1*sqrt((real(I1))^2+(imag(I1))^2)*cosd(atand(
    imag(I1)/real(I1))))/1000;//Input power in kW
Pcu1=(((real(I1))^2+(imag(I1))^2)*R1);//Primary
    copper losses in W
Pcu2=(((real(I1))^2+(imag(I1))^2)*R2i);//Primary
    copper losses in W
C=(((real(Io))^2+(imag(Io))^2)*Ro);//Constant losses
     in W
n=(((Pi*1000)-Pcu2-C)/(Pi*1000))*100;//Efficiency
R=((V1-(sqrt((real(I2i))^2+(imag(I2i))^2)*sqrt((real
    (ZLi))^2+(imag(ZLi))^2)))/((sqrt((real(I2i))^2+(
    imag(I2i))^2)*sqrt((real(ZLi))^2+(imag(ZLi))^2)))
    )*100;//Percentage Regulation

//OUTPUT
mprintf('Efficiency is %3.1f percent \nRegulation is
     %3.2f percent',n,R)

//==================================END OF PROGRAM
    ==================================
```

Scilab code Exa 2.26 Secondary terminal voltage at full load

```
//Chapter-2, Example 2.26, Page 2.49
//
```

```
clc
clear

//INPUT DATA
R1=6;//Primary resistance in ohm
R2=0.3;//Secondary resistance in ohm
X1=10;//Primary reactance in ohm
X2=0.5;//Secondary reactance in ohm
E1=2220;//primary induced emf in V
E2=220;//Secondary induced resistance in V
V1=2220;//Primary voltage drop in V
R=8;//Rate of transformer in KVA
K=E2/E1;//Transformer voltage ratio
cosQ=0.8;//Power factor
sinQ=0.6;//sine of Q

//CALCULATIONS
R02=R2+(K^2*R1);//Resistance refered to the
    secondary in ohms
X02=X2+(K^2*X1);//Reactance refered to the secondary
     in ohms
I2=((R*1000)/E2);//Secondary full load current in A
V02=(I2*R02*cosQ)+(I2*X02*sinQ);//Secondary voltage
    drop in V
V2=E2-V02;//Secondary terminal voltage in V

//OUTPUT
mprintf('Secondary terminal voltage at full load is
    %3.1f V',V2)

//=================================END OF PROGRAM
    ==============================
```

Scilab code Exa 2.27 Voltage regulation

```
//Chapter-2, Example 2.27, Page 2.49
//=============================================================================

clc
clear

//INPUT DATA
Tr=36;//Transformer rating in terms of KVA
E1=5000;//Primary induced emf in V
E2=500;//Secondary induced emf in V
R01=22;//Winding resistance referred to the primary
   in ohm
X01=36;//Winding reactance referred to primary in
   ohm
cosQ1=0.8;//Primary power factor
cosQ2=0.8;//Secondary power factor
sinQ1=0.6;//sine of Q1

//CALCULATIONS
I1=((X01*1000)/E1);//Full load primary current in A
Vd=(I1*R01*cosQ1)+(I1*X01*sinQ1);//Secondary voltage
    drop in V
V=(Vd/E1)*100;//Percentage voltage regulation in %

//OUTPUT
mprintf('Percentage voltage regulation is %3.1f
   percent',V)

//=================================END OF PROGRAM
   ==============================
```

Scilab code Exa 2.28 Voltage regulation

```
//Chapter-2, Example 2.28, Page 2.51
//=============================================================================
clc
clear

//INPUT DATA
Rp=1;//Percentage resistance drop in percentage
Xp=4;//Percentage reactance drop in percentage
cosQ1=0.8;//Lagging power factor
sinQ1=0.6;//Sine of Q1
cosQ2=1;//Power factor
sinQ2=0;//Sine of Q2
cosQ3=0.8;//Leading power factor
sinQ3=0.6;//Sine of Q3

//CALCULATIONS
Vla=(Rp*cosQ1)+(Xp*sinQ1);//Percentage secondary voltage drop for lagging power factor in percentage
V=(Rp*cosQ2)+(Xp*sinQ2);//Percentage secondary voltage drop for unity power factor in percentage
Vle=(Rp*cosQ3)-(Xp*sinQ3);//Percentage secondary voltage drop for leading power factor in percentage

//OUTPUT
mprintf('Secondary voltage drop for lagging power factor is %3.1f percent\nSecondary voltage drop for unity power factor is %3.1f percent\nsecondary voltage drop for leading power factor is %3.1f percent',Vla,V,Vle )

//=================================END OF PROGRAM==============================
```

Scilab code Exa 2.29 Power factor and regulation

```
//Chapter-2, Example 2.29, Page 2.52
//
    =============================================================================
clc
clear

//INPUT DATA
Resistance=3;//% Resistance drop
Reactance=6;//% Reactance drop

//CALCULATIONS
q=atand(Reactance/Resistance);//Phase angle in
    degree
cosq=cosd(q);//Power factor
Regulation=((Resistance*cosq)+(Reactance*sind(q)));
    //% Regulation at the power factor

//OUTPUT
mprintf('Power factor is %3.2f \nPercentage
    regulation at this power factor is %3.1f percent'
    ,cosq,Regulation)

//==================================END OF PROGRAM
    ================================
```

Scilab code Exa 2.30 Parameters of a transformer

```
//Chapter-2, Example 2.30, Page 2.57
```

```
//==========================================================================================
clc
clear

//INPUT DATA
V1=250;//Primary voltage in V
V2=100;//Secondary voltage in V
I1=0.4;//Primary current in A
Wo=36;//No load power input in W

//CALCULATIONS
K=(V2/V1);//Voltage transformation ratio
q=acosd(Wo/(V1*I1));//Phase angle in degree
Im=(I1*sind(q));//Magnetising current in A
Iw=(I1*cosd(q));//Working current in A
I=(I1*V1*cosd(q));//Iron loss in W

//OUTPUT
mprintf('(a)Turns ratio is %3.1f \n(b)Magnetising
    current is %3.3f A \n(c)Working current is %3.3f
    A \n(d)Iron loss is %3.0f W',K,Im,Iw,I)

//==================================================END OF PROGRAM
    ==================================================
```

Scilab code Exa 2.31 Primary voltage and power factor

```
//Chapter-2, Example 2.31, Page 2.58
//==========================================================================================
clc
clear
```

```

//INPUT DATA
I2=400;//Full load secondary current in A
I1=(I2*0.2);//Full load secondary current in A
K=(I1/I2);//Turns ratio
Z1=complex(0.5,1.5);//Transformer parameter
Z2=complex(0.02,0.05);//Transformer parameter

//CALCULATIONS
Zo1=Z1+(Z2/K^2);//Transformer parameter
Vsc=(I1*Zo1);//Primary voltage under short circuit
    test in V
[A B]=polar(Vsc);//Primary voltage under short
    circuit test in V in polar form
B=atand(imag(Zo1)/real(Zo1));//Phase angle in degree

//OUTPUT
mprintf('Primary voltage under short circuit test is
    %3.1f and %3.2f degree V (polar form)',A,B)

//==================================================END OF PROGRAM
    ==============================================
```

Scilab code Exa 2.32 Equivalent resistance and leakage reactance

```
//Chapter-2, Example 2.32, Page 2.58
//
    ====================================================================================================

clc
clear

//INPUT DATA
Q=250*1000;//Rating of a transformer in VA
V1=11000;//Rated primary voltage in V
```

```
V2=2200;//Rated secondary voltage in V
N1=1000;//Number of turns in the primary
N2=200;//Number of turns in the secondary
R1=1.5;//Primary resistance in ohm
R2=0.05;//Secondary resistance in ohm
Vsc=600;//Primary voltage when secondary is short
    circuited in V
n=0.99;//Efficiency of the transformer

//CALCULATIONS
K=(N2/N1);//Turn ratio
I1=(Q/(V1*n));//Full load primary current in A
Zo1=(Vsc/I1);//Equivalent reactance in ohm
R2i=(R2/K^2);//Equivalent secondary resistance in
    ohm
Ro1=(R1+R2i);//Equivalent primary resistance in ohm
Xo1=sqrt(Zo1^2-Ro1^2);//Equivalent ractance in ohm

//OUTPUT
mprintf('Equivalent resistance referred to primary
    is %3.2f ohm \nEquivalent reactance referred to
    primary is %3.2f ohm',Ro1,Xo1)

//=================================END OF PROGRAM
    ===============================
```

Scilab code Exa 2.33 Efficiency of transformer

```
//Chapter-2, Example 2.33, Page 2.64
//
    ==================================================================

clc
clear

```

```
//INPUT DATA
L=400;//Constant or Iron losses in W
C=700;//Full load copper loss in W
Q=40000;//Rating of transformer in VA
cosq=0.85;//Load power factor

//CALCULATIONS
P=(Q*cosq);//Full load output in W
LC=(L+C);//Total full load losses in W
IP=(P+LC);//Full load input in W
n=(P/IP)*100;//Full load efficiency
P2=(0.5*Q*cosq);//Half load output in W
LC2=(L+(0.5^2*C));//Total losses at half loads in W
IP2=(P2+LC2);//Half load input in W
n2=(P2/IP2)*100;//Half load efficiency

//OUTPUT
mprintf('Efficiency of the transformer at full load
   is %3.2f percent \nEfficiency of the transformer
   at half load is %3.2f percent',n,n2)

//==================================================END OF PROGRAM
   ====================================
```

Scilab code Exa 2.34 Parameters of a transformer

```
//Chapter-2, Example 2.34, Page 2.65
//
   ================================================================================

clc
clear

//INPUT DATA
Q=50000;//Rating of the transformer in VA
```

```
Pi=500;//Constat losses in W
Pcu=900;//Full load variable losses in W
cosq=0.8;//Power factor

//CALCULATIONS
nFL=((Q*cosq)/((Q*cosq)+Pi+Pcu))*100;//Full load
    efficiency
L=(Q*sqrt(Pi/Pcu))/1000;//Load at which transformer
    operates at maximum efficiency in KVA
n=((L*1000)/((L*1000)+Pi+Pi))*100;//Maximum
    efficiency

//OUTPUT
mprintf('a)Full load efficiency is %3.2f percent \nb
    )Load at which transformer operates at maximum
    efficiency is %3.2f KVA \nc)Maximum efficiency is
     %3.2f percent',nFL,L,n)

//==================================END OF PROGRAM
    ================================
```

Scilab code Exa 2.35 Efficiency at full load

```
//Chapter-2, Example 2.35, Page 2.66
//
    ==========================================================================

clc
clear

//INPUT DATA
V1=5000;//Primary voltage in V
V2=200;//Secondary voltage in V
Q=60000;//Rating of transformer in VA
R1=8;//Primary resistance in ohm
```

```
R2=0.009; //Secondary resistance in ohm
Io=0.4; //No load primary current in A
cosq=0.29; //Power factor

//CALCULATIONS
K=(V2/V1); //Turn ratio
Cu=((Q/V1)^2*(R1+(R2/K^2))); //Full load copper
    losses in W
C=(V1*Io*cosq); //Constant losses in W
I1=(Q/V1); //Primary current in A
nFL=((V1*I1*0.8)/((V1*I1*0.8)+(Cu+C)))*100; //Full
    load efficiency of the transformer

//CALCULATIONS
mprintf('Full load efficiency of the transformer is
    %3.2f percent',nFL)

//====================================END OF PROGRAM
    ==================================
```

Scilab code Exa 2.36 Secondary current and maximum efficiency

```
//Chapter-2, Example 2.36, Page 2.67
//
    ================================================================================

clc
clear

//INPUT DATA
V1=500; //Primary voltage in V
V2=100; //Secondary voltage in V
K=(V2/V1); //Turn ratio
R1=0.04; //Primary resistance in ohm
R2=0.03; //Secondary resistance in ohm
```

```
Pi=200;//Iron or constant lossses in W

//CALCULATIONS
I2=sqrt(Pi/(R2+(R1*K^2)));//Secondary current in A
nmax1=((V2*I2)/((V2*I2)+Pi+Pi))*100;//Maximum
    efficiency at unit power factor
nmax8=((V2*I2*0.8)/((V2*I2*0.8)+Pi+Pi))*100;//
    Maximum efficiency at 0.8 power factor

//OUTPUT
mprintf('Maximum efficiency at unit power factor is
    %3.2f percent \nMaximum efficiency at 0.8 power
    factor is %3.2f percent',nmax1,nmax8)

//=================================END OF PROGRAM
    ===============================
```

Scilab code Exa 2.37 Constant losses and full load copper losses

```
//Chapter-2, Example 2.37, Page 2.68
//
    ==================================================================

clc
clear

//INPUT DATA
nFL=0.98;//Efficiency of transformer at full load
    0.8 power factor
upf=0.99;//Efficiency of the transformer at half
    load
Q=500;//Transformer rating in KVA
cosq=0.8;//Power facotor

//CALCULATIONS
```

```
L=((Q*1000*cosq)/nFL)-(Q*1000*cosq);//Full load
    losses in W
L2=((0.5*Q*1000*100)/99)-(0.5*Q*1000);//Half load
    losses in W
A=[0.25,0.25;
    1,0.25]
B=[(0.25*L);
     L2]
A=inv(A)*B;//Soving for Pi and Pc


//OUTPUT
mprintf('Constant losses are %3.2f W\nFull load
    copper losses are %3.2f W',A(1),A(2))

//==================================END OF PROGRAM
    ================================
```

Scilab code Exa 2.38 All day efficiency

```
//Chapter-2, Example 2.38, Page 2.71
//
    ============================================================================

clc
clear

//INPUT DATA
T=4;//Total loss in kW
Q=120;//Rating of transformer in KVA
DF=4;//Duration of operation at full load in h
DH=4;//Duration of operation at half load in h
DN=16;//Duration of operation at no load in h

//CALCULATIONS
```

```
EF=(Q*1*T);//Energy delivered for 4 hours full load
    in kWh
EH=(0.5*Q*1*T);//Energy delivered for 4 hours half
    load in kWh
EN=0;//Energy delivered for 16 hours
E24=(EH+EF+EN);//Total energy deliverd for 24 hours
    in kWh
C=(1.5*24);//Constant losses for 24 hours in kWh
C4=(1.5*4);//full load copper losses for 4 hours in
    kWh
Ch4=(0.5^2*1.5*4);//Half load copper losses for 4
    hours in kWh
CN=0;//No load copper loss for 16 hours
TE=(C+C4+Ch4+CN);//Total energy losses for 24 hours
n=(E24/(E24+TE))*100;//All day efficiency

//OUTPUT
mprintf('All day efficiency is %3.1f percent',n)

//==============================END OF PROGRAM
    ========================================
```

Scilab code Exa 2.39 All day efficiency

```
//Chapter-2, Example 2.39, Page 2.72
//
    ==================================================================

clc
clear

//INPUT DATA
Q=10;//Rating of transformer in KVA
n=0.96;//Full load efficiency
DN=12;//Duration of no load in h
```

```
DH=6;//Duration of half load in h
D4=4;//Duration of 1/4th load in h
DF=2;//Duration of full load in h

//CALCULATIONS
O=(Q*1);//Full load output in kW
L=((O/n)-O)*1000;//Full load total losses in W
Fcu=(L/2);//Full load copper ;osses in W
Fc=Fcu;//Constant losses
LN=0;//No load energy delivered for 12 h
LF=(DF*O);//Full load energy delivered for 2 hours
L6=(DH*O*0.5);//Half load energy delivered for 6 hours
L4=(D4*O*0.25);//1/4th load energy delivered for 4 hours
TE=(LN+LF+L6+L4);//Total energy delivered for 24 hours in kWh
LLC=(Fc*24);//Constant losses for 24 h
LLF=(DF*Fc);//Full load copper losses delivered for 2 hours
LL6=(DH*Fc*0.5^2);//Half load copper losses delivered for 6 hours
LL4=(D4*Fc*0.25^2);//1/4th load copper losses delivered for 4 hours
LTE=(LLC+LLF+LL6+LL4)/1000;//Total copper losses delivered for 24 hours in kWh
nall=((TE/(TE+LTE))*100);//All day efficiency

//OUTPUT
mprintf('All day efficiency is %3.1f percent',nall)

//==================================END OF PROGRAM==================================
```

Scilab code Exa 2.40 Current and output of transformer

```
//Chapter-2, Example 2.40, Page 2.75
//
===================================================================
clc
clear

//INPUT DATA
VLP=11000;//Primary line voltage in V
VLS=440;//Secondary line voltage in V
Vphp=11000;//Primary phase voltage in V
Vphs=(440/sqrt(3));//Secondary phase voltage in V
ILP=4;//Primary line current in A
q=0.8;//Power factor

//CALCULATIONS
Iphp=(ILP/sqrt(3));//Primary phase current in A
K=(Vphs/VLP);//Turn ratio
I2ph=(Iphp/K);//Secondary phase current in A
P=(sqrt(3)*VLS*VLP*q)/10^5;//Output of the
   transformer in kW

//OUTPUT
mprintf('Primary phase current is %3.2f A and
   Secondary phase current is %3.0f A \nOutput of
   the transformer is%3.0f kW',Iphp,I2ph,P)

//=================================END OF PROGRAM
   ==============================
```

Scilab code Exa 2.41 Parameters of an ideal transformer

```
//Chapter-2, Example 2.41, Page 2.77
//
===================================================================
```

```
clc
clear

//INPUT DATA
VLP=2200;//Primary line voltage in V
Vphp=VLP;//Primary phase voltage in V
VLS=440;//Secondary line voltage in V
Vload=440;//Load line phase voltage in V
Z=complex(8,6);//Load impedence in complex form

//CALCULATIONS
X=sqrt((real(Z))^2+(imag(Z))^2);//X value for load
   current
Y=atand(imag(Z)/real(Z));//Phase angle in degree
ILS=(VLS/X);//Load current in A
PS=(sqrt(3)*VLS*ILS*cosd(Y))/1000;//Power delivered
   by secondary in kW
K=((Vload/sqrt(3))/VLP);//Turn ratio
IPS=(sqrt(3)*ILS);//Secondary phase current in A
IPP=(K*IPS);//Primary phase current in A

//OUTPUT
mprintf('a)Load delivered by the secondary is %3.1f
   kW \nb)Current in primary is %3.1f A and Current
   in secondary is %3.2f A',PS,IPP,IPS)

//==================================END OF PROGRAM
   ================================
```

Chapter 3

Three Phase Induction Motor

Scilab code Exa 3.1 Frequency of rotor current

```
//Chapter-3, Example 3.1, Page 3.6
//==========================================================================
clc
clear

//INPUT DATA
N=900;//Rotor speed in rpm
f=50;//Power supply frequency in Hz
P=6;//No. of poles

//CALCULATIONS
Ns=(120*f)/P;//Synchronous speed in rpm
s=((Ns-N)/Ns)*100;//%slip
f1=(s*f)/100;//Frequency of rotor current in Hz

//OUTPUT
mprintf('Slip of a 3 phase motor is %i percent\nFrequency of rotor current is %i Hz',s,f1)

```

```
//==================================================END OF PROGRAM
    ==============================================
```

Scilab code Exa 3.2 Full load speed of the motor

```
//Chapter-3, Example 3.2, Page 3.6
//
    =====================================================================================================

clc
clear

//INPUT DATA
N=600;//Speed of 12 pole 3 phase alternator in rpm
P=12;//No. of poles of alternator
n=6;//No. of poles in induction motor
s=2.5;//slip of the motor in %

//CALCULATIONS
f=(N*P)/120;//Alternator supply frequency in Hz
Ns=(120*f)/n;//Synchronous speed in rpm
N1=(Ns-((s*Ns)/100));//Full load speed of the motor
    when the slip is 2.5%

//OUTPUT
mprintf('Full load speed of the motor when the slip
    is 2.5 percent = %irpm',N1)

//==================================================END OF PROGRAM
    ==============================================
```

Scilab code Exa 3.3 Slip and speed of rotor

```
//Chapter-3, Example 3.3, Page 3.7
//=============================================================================

clc
clear

//INPUT DATA
P=6;//Number of poles
f=50;//Supply frequency in Hz
f1=3;//Rotor current frequency in Hz

//CALCULATIONS
s=(f1/f)*100;//Slip of the motor in %
Ns=(120*f)/P;//Synchronous speed in rpm
N=(Ns-((s*Ns)/100));//Speed of the motor in rpm

//OUTPUT
mprintf('Slip of the motor is %i percent\nSpeed of the motor is %i rpm',s,N)

//=================================END OF PROGRAM==============================
```

Scilab code Exa 3.4 Shaft output and torque

```
//Chapter-3, Example 3.4, Page 3.12
//=============================================================================

clc
clear

//INPUT DATA
VL=440;//Supply line voltage in V
```

```
P=4;//Number of poles
IL=75;//Line current in A
cosx=0.8;//Power factor
n=0.8;//Efficiency of the motor
s=0.03;//slip of the motor
f=50;//Frequency in Hz

//CALCULATIONS
Pm=(sqrt(3)*VL*IL*cosx*n);//Output power in W
Ns=(120*f)/P;//Synchronous speed in rpm
N=(1-s)*Ns;//Actual speed in rpm

//OUTPUT
mprintf('Shaft output power is %3.0f W\nActual speed
    is %i rpm',Pm,N)

//==================================================END OF PROGRAM
    ============================================
```

Scilab code Exa 3.5 Parameters of induction motor

```
//Chapter-3, Example 3.5, Page 3.13
//
    ==========================================================================================

clc
clear

//INPUT DATA
P=6;//Number of poles
f=50;//Supply frequency in Hz
Tm=120;//Shaft torque in N.m
f1=2;//Rotor current frequency in Hz
L=5;//Amount of constant losses in N.m
C=500;//Amount of core losses in W
```

```

//CALCULATIONS
Ns=(120*f)/P;//Synchronous speed in rpm
s=(f1/f);//Slip of the motor
N=(1-s)*Ns;//Actual speed in rpm
P=(2*3.14*N*Tm)/60;//Shaft power in W
Pm=(2*3.14*N*(Tm+L))/60000;//Mechanical power output
    in kW
R=(s*Pm)/(1-s);//Rotor copper losses in kW
I=(Pm+R+(L/10));//Motor input in kW
n=(Pm/I)*100;//Machine efficiency

//OUTPUT
mprintf('a)Mechanical power output is %3.3f kW\nb)
   Rotor copper losses is %3.2fkW\nc)Motor input is
   %3.3f kW\nd)Machine efficiency is %3.1f percent',
   Pm,R,I,n)

//=================================END OF PROGRAM
   ==============================
```

Scilab code Exa 3.6 Slip and torque

```
//Chapter-3, Example 3.6, Page 3.17
//
   ==========================================================================

clc
clear

//INPUT DATA
VL=11000;//Supply line voltage in V
P=12;//Number of poles
f=50;//Supply frequency in Hz
R2=0.2;//Rotor resistance in ohm
```

```
X2=1.2;//Rotor reactance at stand still in ohm
N=480;//Full load speed in rpm

//CALCULATIONS
s=(R2/X2);//Slip at maximum torque
Ns=(120*f)/P;//Synchronous speed in rpm
s1=(Ns-N)/Ns;//Slip at full load
T=((R2^2+(s1^2*X2^2))/((2*X2)*(s1*R2)));//Ratio of
    maximum and full load torque
T1=((R2^2+X2^2)/(2*X2*R2));//Ratio of maximum and
    starting torque

//OUTPUT
mprintf('a)Slip at maximum torque is %3.2f \nb)Ratio
     of maximum and full load torque is %3.2f \nc)
    Ratio of maximum and starting torque is %3.2f',s,
    T,T1)

//===================================END OF PROGRAM
    ================================
```

Scilab code Exa 3.7 Maximum torque and starting torque

```
//Chapter-3, Example 3.7, Page 3.18
//
    ===========================================================================

clc
clear

//INPUT DATA
P=6;//Number of poles
f=50;//Supply frequency in Hz
R2=0.4;//Rotor reisitance in ohm
X2=4;//Rotor standstill reactance in ohm
```

```
T1=2;//Ratio of maximum torque to starting torque

//CALCULATIONS
Ns=(120*f)/P;//Synchronous speed in rpm
Sm=(R2/X2);//Slip at maximum torque
NTM=(Ns*(1-Sm));//Speed of the motor at maximum
    torque in rpm
T=((R2^2+X2^2)/(2*R2*X2));//Ratio of maximum torque
    to starting torque
Rext=(sqrt(X2^2/((2*T1)-1))-R2);//Additional
    resistance required for the ratio of maximum
    torque to the statring torque to be 2 in ohm

//OUTPUT
mprintf('a)Speed of the motor at maximum torque is
    %i rpm \n b)Ratio of maximum torque to starting
    torque is %3.2f \n c)Additional resistance
    required for the ratio of maximum torque to the
    starting torque to be 2 is %3.1f ohm',NTM,T,Rext)

//=========================================END OF PROGRAM
    ======================================
```

Chapter 5

Synchronous and Special Machines

Scilab code Exa 5.1 Emf generated and line voltage

```
//Chapter-5, Example 5.1, Page 5.6
//
=============================================================================

clc
clear

//INPUT DATA
f=50;//Frequency in Hz
Z=200;//Number of conductors
kp=1;//Pitch factor
kd=0.96;//Distribution factor
q=0.05;//Flux in Wb

//CALCULATIONS
Eph=(2.22*kp*kd*f*q*Z);//EMF generated per phase in
    V
LV=(Eph*sqrt(3));//Line voltage in V

```

```
//OUTPUT
mprintf('(i)Emf generated per phase is %3.1f V \n(ii
    )Line voltage is %3.1f V',Eph,LV)

//==========================================END OF PROGRAM
    ======================================
```

Scilab code Exa 5.2 Induced emf per phase

```
//Chapter-5, Example 5.2, Page 5.7
//
    ==================================================================================

clc
clear

//INPUT DATA
P=8;//Number of poles
f=50;//Frequency in Hz
Z=(36*8);//Number of conductors
q=0.04;//Flux in Wb
kp=1;//Pitch factor
kd=1;//Distribution factor

//CALCULATIONS
Eph=(2.22*kp*kd*f*q*Z);//EMF generated per phase in
    V

//OUTPUT
mprintf('Induced emf per phase is %3.1f V',Eph)

//==========================================END OF PROGRAM
    ======================================
```

Scilab code Exa 5.3 Number of conductors

```
//Chapter-5, Example 5.3, Page 5.7
//=============================================================================
clc
clear

//INPUT DATA
P=8;//Number of poles
EL=11000;//Line voltage of the alternator in kV
Eph=(EL/sqrt(3));//Phase voltage per pole in V
kp=1;//Pitch factor
kd=0.98;//Distribution factor
q=0.17;//Flux in Wb
f=50;//Frequency in Hz

//CALCULATIONS
Z=(Eph/(2.22*kp*kd*f*q));//Number of conductors per phase

//OUTPUT
mprintf('Number of conductors per phase is %3.0f',Z)

//=================================END OF PROGRAM==============================
```

Scilab code Exa 5.4 Synchronous reactance

```
//Chapter-5, Example 5.3, Page 5.7
```

```
//
    ========================================================================================
clc
clear

//INPUT DATA
Eph=(6.6*10^3)/sqrt(3);//Phase voltage in V
Isc=145;//Short circuit current in A
Ra=1;//Resistance of stator winding in ohm

//CALCULATIONS
Zs=(Eph/Isc);//Synchronous impedence in ohm
Xs=sqrt(Zs^2-Ra^2);//Synchronous reactance in ohm

//OUTPUT
mprintf('Synchronous reactance is %3.2f ohm',Xs)

//==================================END OF PROGRAM
    ================================
```