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

Created by
Sumit Joshi
B.Tech
Electrical Engineering
College Of Engineering Roorkee
College Teacher
Vivek Sharma
Cross-Checked by
Madhu Belur

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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.

Contents

List of Scilab Codes

Chapter 2

DC Machines

Scilab code Exa 2.3 Find the current per path of armature

```
//Caption:Find the current per path of armature
//Exam:2.3
clc;
clear;
close;
I_a=200;//rated armature current(in Amp)
P=12;//number of poles in machine
A_1=2;//number of parallel paths with wave winding
A_2=P;//number of parallel paths with lap winding
I_1=I_a/A_1;//current per path in case of wave
    winding(in Amp)
disp(I_1,'current per path in case of wave winding(
    in Amp)=');
I_2=I_a/A_2;//current per path in case of lap
    winding(in Amp)
disp(I_2,'current per path in case of lap winding(in
     Amp)=');
```

Scilab code Exa 2.4 Calculate the induced emf in machine

```
//Caption:Calculate the induced emf in machine
//Exam:2.4
clc;
clear;
close;
N_1=500;//starting speed of machine(in rpm)
E_1=200;//emf of the machine at N_1 (in V)
N_2=600;//new speed of machine(in rpm)
E_2=E_1*N_2/N_1;//emf of the machine atN_2 (in V)
disp(E_2,'induced emf while the machine is running
    at 600 rpm(in V)=');
```

Scilab code Exa 2.5 calculate the generated emf

```
//Caption:calculate the generated emf
//Exam:2.5
clc;
clear;
close;
S_1=80;//Number of armature slots
```

```
S_2=6;//Number of conductor per slot
Z=S_1*S_2;//Number of armature conductors
F=50;//Flux per pole(in mWb)
F_1=F*10^-3;//(in Wb)
P=6;//Number of poles
A=P;//Number of parallel paths
N=1200;//armature speed(in rpm)
E_g=F_1*Z*N*P/(60*A);//EMF generated in 6 pole lap
    wound dc generator (in Volts)
disp(E_g,'EMF generated in 6 pole lap wound dc
    generator (in Volts)=');
```

Scilab code Exa 2.6 Calculate the voltage generated in 4 pole generator

```
//Caption:Calculate the voltage generated in 4 pole
    generator
//Exam:2.6
clc;
clear;
close;
S_1=51;//Number of slots
S_2=20;//Number of conductor per slot
Z=S_1*S_2;//number of armature conductors
F=7;//flux per pole(in mWb)
F_1=F*10^-3;//flux per pole(in Wb)
P=4;//Number of poles
A=2;//Number of parallel paths (armature is wave
    wound)
N=1500;//speed of the machine(in rpm)
E_g=F_1*Z*N*P/(60*A);//generated emf
disp(E_g,'voltage generated in machine (in Volts)=')
```

;

Scilab code Exa 2.7 Find out the speed for 6 pole machine

```
//Caption:Find out the speed for 6 pole machine
//Exam:2.7
clc;
clear;
close;
F=60;//flux per pole(in m Wb)
F_1=F*10^-3;//flux per pole(in Wb)
Z=480;//Number of armature conductors
P=6;//Number of poles
A=2;//Number of parallel paths(Armature wave wound)
E_g=320;//generated emf (in V)
N=E_g*60*A/(F_1*Z*P);//speed(in rpm)
disp(N,'speed of the machine (in rpm)=');
```

Scilab code Exa 2.8 calculate the suitable number of conductor per slot hence determine the actual value of flux

```
//Caption:calculate the suitable number of conductor
    per slot hence determine the actual value of
   flux
//Exam:2.8
```

```
clc;
clear;
close;
F_1=0.05;//flux per pole(in Wb )
N=350;//speed(in rpm)
P=8;//no of poles
A=P;//no of parallel path
E_g=240;//voltage generated (in V)
Z_1=E_g*60*A/(F_1*N*P);//total no of armature
    conductor required
C_s=ceil(Z_1/120);//number of conductor per slot
disp(C_s,'number of conductor per slot=');
A_s=120;//armature slots
Z_2=A_s*C_s;//total conductors in armature slot
F_2=E_g*60*A/(N*Z_2*P);//Actual value of flux(in Wb)
disp(F_2,'Actual value of flux(in Wb)=');
```

Scilab code Exa 2.9 Calculate the emf if the speed is 1500 rpm

```
//Caption:Calculate the emf if the speed is 1500 rpm
//Exam:2.9
clc;
clear;
close;
P=8;//Number of poles
F=2;//flux per pole (in mWb)
F_1=2*10^-2;//flux per pole (in Wb)
Z=960;//number of conductor
A=P;//Number of parallel paths(lap winding)
N=1500;//speed (in rpm)
E_g=P*F*Z*N/(60*A);//emf generated (in Volts)
```

```
disp(E_g,'emf generated (in Volts)=');
```

Scilab code Exa 2.10 Calculate the increase of main field flux in percentage

```
//Caption:Calculate the increase of main field flux
    in percentage
//Exam:2.10
clc;
clear;
close;
N_1=750;//speed of dc machine(in rpm)
E_1=220;//induced emf in dc machine when running at
    N_1
N_2=700;//speed of dc machine second time (in rpm)
E_2=250;//induced emf in dc machine when running at
    N_2
F=E_2*N_1/(E_1*N_2);
Inc=(F-1);
disp(Inc*100,'increase in main field flux of the dc
    machine=');
```

Scilab code Exa 2.11 find the emf generated in a 6 pole machine and find speed at which machine generated 550 V emf

```
//caption: a)find the emf generated in a 6 pole
    machine  b)find speed at which machine generated
    550 V emf
//Exam:2.11
clc;
clear;
close;
F_1=0.06;//Flux per pole(in Wb)
N_1=250;//speed of the rotor(in rpm)
A=2;//number of parllel (paths armature wave wound)
P=6;//poles in machine
Z=664;//total conductor in machine
E_g=P*F_1*N_1*Z/(60*A);//emf generated
disp(E_g,'emf generated in machine(in Volts)=');
E_2=550;//new emf generating machine(in V)
F_2=0.058;//flux per pole (in Wb) for generating E_2
N_2=60*E_2*A/(P*F_2*Z);//new speed at which machine
    generating E_2(in rpm)
disp(N_2,'new speed of the rotor(in rpm)=');
```

Scilab code Exa 2.12 determine the value of torque

```
//Caption :determine the value of torque in Nw-m
//Exam:2.12
clc;
clear;
close;
F=24;//flux per pole (in m Wb)
F_1=F*10^-3;//flux per pole (in Wb)
Z=760;//number of conductors in armature
P=4;//number of pole
```

```
A=2;//number of parallel paths
I_a=50;//armature cuurrent(in Amp)
T_a=0.159*F_1*Z*P*I_a/A;//torque develope(in Nw-m)
disp(T_a,'torque developed in machine(in Nw-m)=');
```

Scilab code Exa 2.13 calculate the total torque

```
//Caption: calculate the total torque in Nw-m
//Exam:2.14
clc;
clear;
close;
P=6;//poles
A=P;//number of parallel paths
S=60;//slots in motor
C_s=12;//conductor per slot
Z=S*C_s;//total conductor in machine
I_a=50;//armature current(in Amp)
F_1=20//flux per pole(in m Wb)
F_2=F_1*10^-3;//flux per pole)(in Wb)
T=0.15924*F_2*Z*P*I_a/A;//total torque (in Nw-m)
disp(T,'total torque by motor (in Nw-m)=');
```

Scilab code Exa 2.14 Calculate the drop in speed when motor takes 51 Amp

```
//Caption:Calculate the drop in speed when motor
    takes 51 Amp
//Exam2.13
clc;
clear;
close;
V=220;//supply voltage(in V)
R_sh=220;//shunt field resistance(in Ohm)
R_a=0.2;//armature resistance(in Ohm)
I_sh=V/R_sh;//shunt field current(in Amp)
N_1=1200;//starting speed of the motor(in rpm)
I_1=5.4;//at N_1 speed current in motor(in Amp)
I_a1=I_1-I_sh;//armature current at speed N_1(in Amp
    )
E_b1=V-I_a1*R_a;//emf induced due to I_a1(in V)
I_2=51;//new current which motor taking(in Amp)
I_a2=I_2-I_sh;//armature current at I_2(in Amp)
E_b2=V-I_a2*R_a;//emf induced due to I_a2(in V)
N_2=E_b2*N_1/E_b1;//speed of the motor when taking
    I_2 current(in rpm)
N_r=ceil(N_1-N_2);//reduction in speed(in rpm)
disp(N_r,'reduction in speed(in rpm)=');
```

Scilab code Exa 2.15 In a dc machine Calculate induced emf and Electro magnetic torque and armature copper loss

```
//Caption:In a dc machine Calculate (a)induced emf
    (b)Electro magnetic torque (c)armature copper
    loss
//Exam:2.15
clc;
```

```
clear;
close;
V=220;//voltage at the armature of dc motor
I_a=15;//current through armature(in Amp)
R_a=1;//armature resistance(in Ohm)
w=100;//speed of the machine(in radian/sec)
E=V-I_a*R_a;//induced emf(in V)
disp(E,'induced emf (in V)=');
T=E*I_a/w;//electro magnentic torque developed(in Nw-m)
disp(T,'electro magnentic torque developed(in Nw-m)=');
L=(I_a^2)*R_a;//Armature copper loss(in Watt)
disp(L,'Armature copper loss(in Watt)=');
```

Scilab code Exa 2.16 Calculate the electro magnetic torque

```
//Caption:Calculate the electro magnetic torque
//Exam:2.16
clc;
clear;
close;
E=250;//emf induced in dc machine(in V)
I_a=20;//current flowing through the armature(in Amp)
N=1500;//speed(in rpm)
T_e=0.1591*E*I_a*60/N;//torque developed in machine(in Nw-m)
disp(T_e,'electro magnetic torque developed in dc machine(in Nw-m)=');
```

Scilab code Exa 2.17 calculate the gross torque in dc machine

```
//Caption:calculate the gross torque in dc machine
//Exam:2.17
clc;
clear;
close;
P=4;//number of poles
Z=1600;//number of armature conductor
F=0.027;//flux per pole(in Wb)
A=2;//number of parallel paths (wave wound)
I=75;//current in machine(in Amp)
N=1000;//speed of the motor(in rpm)
T=0.1591*P*F*Z*I/A;//torque generate in machine(in
    Nw-m)
disp(T,'Torque generated in machine (in Nw-m)=');
```

Scilab code Exa 2.18 Calculate the value of back emf

```
//Caption:Calculate the value of back emf
//Exam:2.18
clc;
clear;
close;
```

```
V=230;//applied voltage (in V)
R_a=0.1;//armature resistance(in Ohm)
I_a=60;//armature current (in Amp)
E_b=V-I_a*R_a;//back emf(in Volts)
disp(E_b,'back emf produced by machine in (in V)=');
```

Scilab code Exa 2.19 find the change in back emf from no load to load

```
//Capyion:find the change in back emf from no load
   to load
//Exam:2.19
clc;
clear;
close;
V=220;//given voltage to machine(in V)
R_a=0.5;//armature circuit resistance(in ohm)
I_1=25;//full load armature current(in Amp)
I_2=5;//no load armature current(in Amp)
E_1=V-I_1*R_a;//back emf at full load(in V)
E_2=V-I_2*R_a;//back emf at no load(in V)
E=E_2-E_1;//change in back emf no load to load
disp(E,'change in back emf from no load to load(in
   Volts)=');
```

Scilab code Exa 2.20 Determine the back emf in dc shunt motor

```
//Caption: Determine the back emf in dc shunt motor
//Exam:2.20
clc;
clear;
close;
V=220;//voltage(in V)
R_a=0.7;//Armature resistance(in Ohm)
R_f=200;//field resistant(in Ohm)
P_1=8*10^3;//motor output power(in Watt)
P_2=8*10^3/0.8;//motor input power(in Watt)
I_m=P_2/V;//motor input current(in Amp)
I_sh=V/R_f;//shunt field current (in Amp)
I_a=I_m-I_sh;//Armature current(in Amp)
E_b=V-I_a*R_a;//Back emf (in V)
disp(E_b,'Back emf produced in motor(in Volts)=');
```

Scilab code Exa 2.21 Determine the total armature power developed when working as a Generator and motor

```
//Caption :Determine the total armature power
    developed when working as a)Generator b)motor
//Exam:21
clc;
clear;
close;
P=25*10^3;//output generator power(in Watt)
V=250;//output generator voltage(in V)
R_f=125;//field resistance(in Ohm)
R_a=0.05;//armature resistance(in Ohm)
I_sh=V/R_f;//shunt field current(in Amp)
//IN case of generator
```

```
I_o=P/V;//output generator current(in Amp)
I_a1=I_o+I_sh;//armature current for a generator(in
    Amp)
E_a1=250+I_a1*R_a;//generated emf in armature(in V)
P_a1=E_a1*I_a1;//generated power in armature when
    working as a generator(in Watt)
P_g=P_a1*10^-3;//generated power in armature when
    working as a generator(in kW)
disp(P_g,'power developed in armature when working
    as a generator(in KW)=');
//IN case of motor
I_in=P/V;//motor input current(in Amp)
I_a2=I_in-I_sh;//armature current for a motor(in Amp
    )
E_a2=250-I_a2*R_a;//generated emf in armature when
    working as a motor(in V)
P_a2=E_a2*I_a2;//generated power in armature when
    working as a motor(in Watt)
P_m=P_a2*10^-3;//generated power in armature when
    working as a motor(in KW)
disp(P_m,'power developed in armature when working
    as a motor(in KW)=');
```

Scilab code Exa 2.22 Calculated power developed in armature when machine running as a Generator and Motor

```
//Caption :Calculated power developed in armature
    when machine running as (a)Generator (b)Motor
//Exam:2.22
clc;
clear;
```

```
close;
V=250;//line voltage(in V)
R_sh=125;//shunt field resistance(in Ohm)
I_sh=V/R_sh;//shunt field current(in Amp)
I_l=80;//line current(in Amp)
R_a=0.1;//armature resistance(in Ohm)
//As A Generator
I_a1=I_l+I_sh;//armature current in generator(in Amp)
E_g=V+I_a1*R_a;//generated emf(in V)
P_1=E_g*I_a1*10^-3;//power developed in armature (in KW)
disp(P_1,'power developed in armature when machine running as a generator(in KW)=');
//As A Motor
I_a2=I_l-I_sh;//armature current in motor(in Amp)
E_b=V-I_a2*R_a;//back emf in motor(in V)
P_2=E_b*I_a2*10^-3;//power developed in armature (in KW)
disp(P_2,'power developed in armature when machine running as a Motor(in KW)=');
```

Scilab code Exa 2.23 Calculated speed of the motor when the current is 10 Amp

```
//Caption:Calculated speed of the motor when the current is 10 Amp
//Exam:2.23
clc;
clear;
close;
```

```
V=230;//supply voltage(in V)
R_a=0.8;//armature resistance(in Ohm)
R_f=0.8//field resistance(in Ohm)
I_1=20;//dc motor taking current from supply(in Amp)
E_1=V-R_a*I_1;//emf generated due to I_1(in V)
N_1=600;//speed of the motor due to I_1
I_2=10;//current(in Amp) at which speed of the motor need to calculate
E_2=V-R_a*I_2;//emf generated due to I_2(in Volts)
N_2=E_2*I_1*N_1/(E_1*I_2);//speed of the motor when machine drawing 10(in Amp) current
disp(N_2,'speed of the motor when machine drawing 10 Amp current(in rpm)=');
```

Scilab code Exa 2.24 Percentage change in speed of a dc motor

```
//Caption:Percentage change in speed of a d.c. motor
//Exam:2.24
clc;
clear;
close;
V=240;//supply voltage(in V)
R_a=0.5;//armature resistance(in Ohm)
I_1=100;//armature current (in Amp)
I_2=50;//changed armature current(in Amp)
E_1=V-R_a*I_1;//induced emf(in V)
E_2=V-R_a*I_2;//changed induced emf due to I_2
//flux per pole is constant
N_r=E_2/E_1;//ratio of speed in machine due to voltage change
N_rp=(N_r-1)*100;//Percentage change in speed of d.
```

```
    c. motor
disp(N_rp,'Percentage change in speed of  d.c. motor
    ==');
```

Scilab code Exa 2.25 Find the speed at which motor will run when connected in series with a 4 Ohm resistance

```
//Caption:Find the speed at which motor will run
    when connected in series with a 4 Ohm resistance
//Exam:2.25
clc;
clear;
close;
V=200;//supply voltage (in V)
R_m=1;//motor resistance b/w terminals(in Ohm)
I_1=15;//motor input current(in Amp)
N_1=800;//speed of the motor (in rpm)
E_1=V-(I_1*R_m);//back emf developed(in V)
R=4;//resistance connected in series with motor (in
    Ohm)
I_2=I_1;//when resistance of 4 Ohm connected in
    series with the motor ,motor input current is
    same
E_2=V-I_2*(R_m+R);//back emf developed when R
    connected in series with motor(in V)
N_2=E_2*N_1/E_1;//speed of the motor when it
    connected in series with a 4 Ohm resistance(in
    rpm)
disp(N_2,'speed of the motor when it connected in
    series with a 4 Ohm resistance(in rpm)=');
```

Scilab code Exa 2.26 Determine the speed when armature current is 75 Amp and the excitation is increased by 15 percent

```
//Caption:Determine the speed when armature current is 75 Amp and the excitation is increased by 15 %
//Exam:2.26
clc;
clear;
close;
V=220;//supply voltage(in V)
R_a=0.03;//armature resistance(in Ohm)
R_se=0.07;//field resistance(in Ohm)
I_a1=40;//armature current in first case(in Amp)
N_1=900;//motor running speed at 40 Amp armature current(in rpm)
E_1=V-I_a1*(R_a+R_se);//induced emf due to 40 Amp armature current (in V)
I_a2=75;//armature current in second case(in Amp)
E_2=V-I_a2*(R_a+R_se);//induced emf due to 75 Amp armature current (in V)
//Flux is F_1 when I_a1 and F_2 when I_a2. F_2=1.15*F_1 because Excitation is increased by 15% so F=(F_1/F_2)
F=1.15;//Ratio of F_2/F_1
N_2=ceil(N_1*E_2/(F*E_1));//motor speed when armature current is 75 Amp and the excitation is increased by 15 %(in rpm)
disp(N_2,'motor speed when armature current is 75 Amp and the excitation is increased by 15 %(in rpm)=');
```

Scilab code Exa 2.27 Calculate HP is being transmitted by the shaft of motor

```
//Caption:Calculate H.P. is being transmitted by the
    shaft of motor
//Exam:2.27
clc;
clear;
close;
V=220;//supply voltage(in V)
N=900;//running speed of a shunt motor(in rpm)
T=1000;//torque exerted by motor (in Nw-m)
w=2*3.14159*N/60;//angular speed(in rad/sec)
P=w*T;//power transmitted (in Watt)
H_p=P/735.5;//power transmitted in H.P.(metric)
disp(H_p,'power transmitted by the shaft of motor(in
    H.P.(metric))=');
```

Scilab code Exa 2.28 Calculate the torque

```
//Caption:Calculate the torque
//Exam:2.28
clc;
clear;
```

```
close;
P_1=70;//power transmitted by the shaft of a motor
    in H.P(metric)
P_2=P_1*735.5;//power (in Watts)
N=500;//speed of the motor(in rpm)
w=2*3.1416*N/60;//angular speed (in radian/sec)
T=P_2/w;//torque in motor (in Nw-m)
disp(T,'torque in motor (in Nw-m)=');
```

Scilab code Exa 2.29 Find the speed when the armature takes 70 Amp

```
//Caption:Find the speed when the armature takes 70
    Amp
//Exam:2.29
clc;
clear;
close;
V=400;//voltage for a shunt motor (in V)
R_a=0.2;//armature resistance(in Ohm)
I_a1=100;//starting armature current(in Amp)
N_1=1000;//speed of the motor when I_a1 armature
    current flows in armature
E_1=V-I_a1*R_a;//emf induced at I_a1 armature
    current (in V)
I_a2=70;//changed armature current(in Amp)
E_2=V-I_a2*R_a;//emf induced for I_a2 current(in V)
//flux is constant
N_2=ceil(E_2*N_1/E_1);//speed of the motor when 70
    Amp current flowing through armature
disp(N_2,'speed of the motor when 70 Amp current
    flowing through armature(in rpm)=');
```

Scilab code Exa 2.30 resistance required to be connected in series to reduced speed of machine to 800 rpm

```
//Caption:resistance required to be connected in
    series to reduced speed of machine to 800 rpm (in
     Ohm)
//Exam:2.30
clc;
clear;
close;
V=400;//voltage applied across the motor(in V)
R_sh=100;//shunt resistance of motor(in Ohm)
I=70;//total current flowing through motor(in Amp)
I_sh=V/R_sh;//current flowing through the shunt
    resistance(in Amp)
I_a1=I-I_sh;//current flowing through the armature(
    in Amp)
R_a1=0.03;//resistance of armature(in Ohm)
R_se=0.5;//series resistance with armature(in Ohm)
R_a=R_a1+R_se;//total resistance in armature circuit
    (in Ohm)
E_1=V-I_a1*R_a;//emf induced due to this R_a
    resistance(in V)
N_1=900;//given speed of the motor(in r.p.m.)
N_2=800;//desired speed of the motor(in r.p.m.)
E_2=E_1*(N_2/N_1);//emf induced due to armature
    resistance when motor spped is 800(in V)
R_a2=(400-E_2)/66;//resistance required to be
    connected in series(in Ohm)
disp(R_a2,'net resistance of armature which reduce
```

```
    speed of the machine to 800 rpm (in Ohm)=');
R=R_a2-R_a1;//additional resistance required to be connected in series to reduced speed of machine to 800 rpm (in Ohm)
disp(R,'additional resistance required to be connected in series to reduced speed of machine to 800 rpm (in Ohm)==');
```

Scilab code Exa 2.31 Motor speed at full load

```
//Caption:Motor speed at full load
//Exam:2.31
clc;
clear;
close;
V=230;//supply voltage
I_a1=2;//no load current(in Amp)
N_1=1500;//speed of the motor at no load
R_a=0.3;//Armature resistance(in Ohm)
I_a2=50;//full load current(in Amp)
E_1=V-I_a1*R_a;//emf generated at no load
E_2=V-I_a2*R_a;//emf generated at full load
N_2=(E_2/E_1)*N_1;//full load speed (flux assumed constant)
disp(ceil(N_2),'D.c. motor speed at full load when flux assumed constant(In rpm)=');
```

Scilab code Exa 2.32 calculate the speed of a dc shunt generator when it running as dc motor and taking 50 KW power at 250 volt

```
//Caption:calculate the speed of a d.c. shunt generator when it running as d.c. motor and taking 50 KW power at 250 volt
//Exam:2.32
clc;
clear;
close;
//calculation when machine is running as generator
V=250;//applied voltage to d.c. shunt generator
P_1=50000;//power delivers by d.c. shunt generator at V_1
N_1=400;//generator running at V_1 ,P_1
R_a=0.02;//armature resistance(in Ohm)
R_sh=50;//field resistance(in Ohm)
I_l=P_1/V;//load current(in Amp)
I_sh=V/R_sh;//field current(in Amp)
I_a1=I_l+I_sh;//armature current when machine working as a generator(in Amp)
C_d=1;//contact drop (in volt per brush)
E_1=V+I_a1*R_a+2*C_d;//induced emf by machine when working as a generator(in V)
//calculation when machine is running as motor
I_a2=I_l-I_sh//armature current when machine working as a motor(in Amp)
E_2=V-I_a2*R_a-2*C_d;//induced emf by machine when working as a motor(in V)
N_2=(E_2/E_1)*N_1;//speed of the machine when
```

```
running as shunt motor(in r.p.m.)
disp(N_2,'speed of the machine when running as shunt
    motor and taking 50 KW power at 250 volt(in r.p.
   m.)=');
```

Scilab code Exa 2.33 Calculate the value of resistance to be connected in series with the armature to reduce the speed to 750 rpm

```
//Caption:Calculate the value of resistance to be
   connected in series with the armature to reduce
   the speed to 750 r.p.m.
//Exam:2.33
clc;
clear;
close;
V=220;//applied voltage to shunt motor(in V)
I_a1=40;//armature current in first case(in Amp)
R_a=0.5;//armature circuit resistance(in Ohm)
N_1=900;//speed of the motor at I_a1 (in rpm)
E_b1=V-I_a1*R_a;//emf generated in armature circuit
   due to I_a1(in V)
N_2=750;//desired motor speed (in rpm)
I_a2=30;//armature current in case of N_2 motor
   speed(in Amp)
E_b2=(N_2/N_1)*E_b1;//emf generated in second case
   when motor speed is N_2
//R resistance added in series with the armature
   circuit to reduced the speed of motor
R=(205-E_b2)/30;//resistance added in series with
   the armature circuit to reduced the speed of
   motor
```

```
disp(R,'resistance added in series with the armature circuit to reduced the speed of motor(in Ohm)=');
```

Scilab code Exa 2.34 what resistance should be placed in series with armature to reduced the speed of the motor to 700 rpm

```
//Caption:what resistance should be placed in series with armature to reduced the speed of the motor to 700 rpm
//Exam:2.34
clc;
clear;
close;
V=220;//applied voltage to shunt motor(in V)
R_a=0.3;//armature circuit resistance(in Ohm)
I_a=15;//armature current(in Amp)
E_b1=V-I_a*R_a;//emf generated in armature circuit(in V)
N_1=1000;//motor speed when E_b1 generated(in rpm)
N_2=700;//desired motor speed (in rpm)
E_b2=(N_2/N_1)*E_b1;//emf generated in second case when motor speed is N_2
R=(215.5-E_b2)/15;//resistance added in series with the armature circuit to reduced the speed of motor (in Ohm)
disp(R,'resistance added in series with the armature circuit to reduced the speed of motor (in Ohm)=');
```

Scilab code Exa 2.35 In a shunt motor find the resistance required in series with the armature circuit to reduce the speed of motor by 50 percent

```
//Caption:In a shunt motor find the resistance
    required in series with the armature circuit to
    reduce the speed of motor by 50 percent
//Exam:2.35
clc;
clear;
close;
I_a1=40;//Armature current(in Amp)
R_a=0.6;//Armature circuit resistance(in Ohm)
//T_1/T_2=I_a1/I_a2
//T_1=T_2
V=220;
I_a2=I_a1;//current when speed reduced 50%
E_b1=V-(R_a*I_a1);//emf induced in circuit
N_r=0.5;//Ratio of speed (N_2/N_1)
//E_b2=V-I_a2*R
//R is a total armature resistance in the second
    case
//N_2/N_1=E_b2/E_b1
//N_r=(V-I_a2*R)/E_b1
R=(V-(N_r*E_b1))/I_a2;//the resistance required in
    series with the armature circuit to reduce the
    speed of motor 50%
disp(R,'the resistance required in series with the
    armature circuit to reduce the speed of motor by
    50%(in Ohm)=');
```

Scilab code Exa 2.36 Calculate the induced emf in a DC machine for speed of 600 rpm

```
//Caption:Calculate the induced emf in a D.C.
    machine for speed of 600 rpm
//Exam:2.36
clc;
clear;
close;
//assuming the flux is constant
N_1=500;//primary speed of the motor(in rpm)
E_1=180;//induced emf in d.c. machine when running
    at N_1 (in V)
N_2=600;//secondary speed of the motor (in rpm)
E_2=(N_2/N_1)*E_1;//induced emf in d.c. machine when
     running at N_2 (in V)
disp(E_2,'the emf induced in a D.C. machine when
    machine running at 600 rpm speed(in V)=');
```

Scilab code Exa 2.37 In a dc machine calculate speed at which the induced emf will be 250 Volts and also calculate the increase in main flux of field in percentage for induced emf of 250 Volts and speed 700 rpm

```
//Caption:In a dc machine calculate speed at which the induced emf will be 250 Volts and also calculate the increase in main flux of field in percentage for induced emf of 250 Volts and speed 700 rpm
//Exam:2.37
clc;
clear;
close;
E_1=220;//Primary emf(in Volts)
N_1=750;//Speed of the machine at 220 Volts
E_2=250;//Secondary emf(in Volts)
N_2=(E_2/E_1)*N_1;//Speed of the machine at which emf will be 250 Volts
disp(N_2,'Speed of the machine at which emf will be 250 Volts=');
N_3=700;//Speed of the machine when main field flux increase
E_3=250;//induced emf when flux increase(in Volts)
F_x=(E_3/E_2)*(N_2/N_3);//Ratio of flux when speed is N_3 and N_2
F=(F_x-1)*100;//Percentage change in flux for induced emf of 250 Volts and speed 700 rpm(in %)
disp(F,'Percentage change in flux when induced emf 250 Volts and speed 700 rpm(in %)=');
```

Scilab code Exa 2.38 Calculate induced emf when running at speed of 1380 rpm

```
//Caption:Calculate induced emf when running at speed of 1380 rpm.
```

```
//Exam:2.38
clc;
clear;
close;
P=4;//Poles in d.c. machine
Z=594;//number of conductor in d.c. machine
F=0.0075;//flux per pole(in Wb)
N=1380;//speed of the motor
A=2;//number of parallel paths
E=P*F*N*Z/(60*A);//emf generated in machine when
    running at speed of 1380 rpm.
disp(ceil(E),'emf generated in machine when running
    at speed of 1380 rpm.(in V)=');
```

Scilab code Exa 2.39 Calculate the speed and calculate the electro magnetic torque

```
//Caption:Calculate the speed and calculate the
    electro magnetic torque.
//Exam:2.39
clc;
clear;
close;
V_1=230;//supply voltage(in V)
I_a1=100;//motor taking current from supply(in Amp)
N_1=600;//speed of the motor when I_a1 current
    taking from supply(in rpm)
R_a=0.12;//resistance of armature circuit(in Ohm)
R_f=0.03;//resistance of series winding(in Ohm)
R=R_a+R_f;//total resistance(in Ohm)
I_a2=50;//desired current of the motor
```

```
E_1=V_1-I_a1*R;//emf induced when current I_a1 flowing
E_2=V_1-I_a2*R;//emf induced when current I_a2 flowing
N_2=(E_2/E_1)*(I_a1/I_a2)*N_1;//speed of the motor when 50 Amp current taking from supply(in rpm)
disp(N_2,'speed of the motor when 50 Amp current taking from supply(in rpm)=');
T_1=E_1*I_a1*60/(2*3.14*N_1);//electro-magnetic torque generated when motor running at 600 rpm(in Nw-m)
disp(T_1,'electro-magnetic torque generatedwhen motor running at 600 rpm(in Nw-m)');
T_2=E_2*I_a2*60/(2*3.14*N_2);//electro-magnetic torque generated in second case(in Nw-m)
disp(T_2,'electro-magnetic torque generated in second case(in Nw-m)');
```

Scilab code Exa 2.40 What resistance must be inserted in series with the armature to reduce the speed to 500 rpm

```
//Caption:What resistance must be inserted in series with the armature to reduce the speed to 500 rpm
//Exam:2.40
clc;
clear;
close;
V=250;//applied voltage to a shunt motor(in V)
I_a=20;//armature current(in Amp)
R_a=0.5;//armature resistance(in Ohm)
N_1=1000;//speed of the motor due to these readings(
```

```
    in rpm)
E_1=V-I_a*R_a;//emf induced in machine(in V)
N_2=500;//desired speed of the motor(in rpm)
E_2=(N_2/N_1)*E_1;//emf in case of motor speed N_2
//R_1 additional resistance added to reduce the
    speed to 500 rpm
R_1=(V-E_2)/I_a-R_a;//resistance applied in series
    with armature to reduce the speed to 500 rpm
disp(R_1,'resistance applied in series with armature
     to reduce the speed to 500 rpm(in Ohm)=');
```

Scilab code Exa 2.41 Determine the torque in Kgm and HP and efficiency of the motor

```
//Caption:Determine the torque in Kgm.,H.P. &
    efficiency of the motor.
//Exam:2.41
clc;
clear;
close;
W_1=75;//load on one side of the brake(in Kg)
W_2=5;//load on other side of the brake(in Kg)
W=W_1-W_2;//effective force(in Kg)
R=1;//radius of the brake pulley (in m)
T=W*R;//torque(in Kg-m)
N=1200;//speed of the small shunt motor(in rpm)
H=(2*3.14)*(N*T)/33000;//torque in H.P.
disp(H,'torque (in H.P.)=');
H_P=735.5;//value of one H.P.
O_p=H*H_P;//output power(in Watt)
I_c=80;//input current(in Amp)
```

```
V=250;//input voltage(in V)
I_p=I_c*V;//input power(in Watt)
E=(O_p/I_p)*100;//efficiency of the motor
disp(E,'efficiency of the motor(in %)=');
```

Scilab code Exa 2.42 Determine the torque in Kgm and output in Watts and efficiency of the motor

```
//Caption:Determine the torque in Kgm.,output in
    Watts & efficiency of the motor.
//Exam:2.42
clc;
clear;
close;
W_1=40;//load on one side of the brake(in Kg)
W_2=5;//load on other side of the brake(in Kg)
W=W_1-W_2;//effective force(in Kg)
R=0.5;//radius of the brake pulley (in m)
T=W*R;//torque(in Kg-m)
N=1500;//speed of the small shunt motor(in rpm)
O=(2*3.14)*(N*T)/60;//output (in Kg-m/sec)
O_p=O*9.81;//output (in watts)
disp(ceil(O_p),'output (in watts)');
I_c=80;//input current(in Amp)
V=400;//input voltage(in V)
I_p=I_c*V;//input power(in Watt)
E=(O_p/I_p)*100;//efficiency of the motor
disp(E,'efficiency of the motor(in %)=');
```

Scilab code Exa 2.43 Calculate the efficiency of the motor

```
//Caption:Calculate the efficiency of the motor
//Exam:2.43
clc;
clear;
close;
W=10;//Spring reading (in Kg)
R=0.8;//brake arm length (in m)
T=W*R;//torque (in kg-m)
N=1200;//speed of the small shunt motor(in rpm)
O=(2*3.14)*(N*T)/60;//output (in Kg-m/sec)
O_p=O*9.81;//output (in watts)
V=250;//input voltage(in V)
I=50;//input current(in Amp)
I_p=V*I;//input power(in watts)
E=(O_p/I_p)*100;//efficiency of the motor
disp(E,'efficiency of the motor(in %)=');
```

Scilab code Exa 2.44 Estimate the output and efficiency of a shunt motor when the input current is 20Amp and 100Amp

```
//Caption:Estimate the output and efficiency of a
   shunt motor when the input current is 20Amp and
```

```
    100Amp
//Exam:2.44
clc;
clear;
close;
V=500;//applied voltage(in V)
R_sh=500;//field resistance (in Ohm)
R_a=0.2;//armature resistance(in Ohm)
I_o=4;//no load current (in Amp)
I_sh=V/R_sh;//field current(in Amp)
I_a=I_o-I_sh;//armature current(in Amp)
L_cf=V*I_sh;//copper losses in field(in watts)
L_ca=(I_a^2)*R_a;//copper losses in armature(in
    watts)
L_tc=L_cf+L_ca;//total copper losses
L_t=V*I_o;//input power to motor on no load(in watts
    )
L_m=L_t-L_tc;//iron & mechanical losses(in watts)
L_c=L_m+L_cf;//constant losses(in watts)
//(a) when input current is 20 Amp
I_l1=20;//input current(in Amp)
I_a1=I_l1-I_sh;//armature current when I_l1 input
    current(in Amp)
L_ca1=(I_a1^2)*R_a;//copper losses in armature when
    I_l1 input current(in watts)
L_T1=L_c+L_ca1;//total losses at this load(in watts)
I_p=V*I_l1;//input power(in watts)
O_p1=I_p-L_T1;//output power when input current is
    20 Amp(in watts)
disp(O_p1,'output power when input current is 20 Amp
    (in watts)=');
E_1=(O_p1/I_p)*100;//efficiency of the shunt motor
    when input current is 20 Amp
disp(E_1,'efficiency of the shunt motor when input
    current is 20 Amp(in %)=');
//(b) when input current is 100 Amp
I_l2=100;//input current(in Amp)
I_a2=I_l2-I_sh;//armature current when I_l2 input
```

```
current(in Amp)
L_ca2=(I_a2^2)*R_a;//copper losses in armature when I_l2 input current(in watts)
L_T2=L_c+L_ca2;//total losses at this load(in watts)
I_p=V*I_l2;//input power(in watts)
O_p2=I_p-L_T2;//output power when input current is 100 Amp(in watts)
disp(O_p2,'output power when input current is 100 Amp(in watts)=');
E_2=(O_p2/I_p)*100;//efficiency of the shunt motor when input current is 100 Amp
disp(E_2,'efficiency of the shunt motor when input current is 100 Amp(in %)=');
```

Scilab code Exa 2.45 Calculate the motor output and HP and efficiency when the total current taken from the mains is 35 Amp

```
//Caption:Calculate the motor output, H.P. and efficiency when the total current taken from the mains is 35 Amp
//Exam:2.45
clc;
clear;
close;
V=230;//applied voltage(in V)
R_sh=230;//field resistance (in Ohm)
R_a=0.3;//armature resistance(in Ohm)
I_o=2.5;//no load current (in Amp)
I_sh=V/R_sh;//field current(in Amp)
I_a=I_o-I_sh;//armature current(in Amp)
L_cf=V*I_sh;//copper losses in field(in watts)
```

```
L_ca=(I_a^2)*R_a;//copper losses in armature(in watts)
L_tc=L_cf+L_ca;//total copper losses
L_t=V*I_o;//input power to motor on no load(in watts)
L_m=L_t-L_tc;//iron & mechanical losses(in watts)
L_c=L_m+L_cf;//constant losses(in watts)
// when input current is 35 Amp(On load condition)
I_l=35;//input current(in Amp)
I_a1=I_l-I_sh;//armature current when I_l input current(in Amp)
L_ca1=(I_a1^2)*R_a;//copper losses in armature when I_l input current(in watts)
L_T1=L_c+L_ca1;//total losses at this load(in watts)
I_p=V*I_l;//input power(in watts)
O_p=I_p-L_T1;//output power(in watts)
disp(O_p,'output power of motor(in watts)=');
H.p=O_p/746;//the shunt motor H.P
disp(H.p,'the shunt motor H.P.=');
E_1=(O_p/I_p)*100;//efficiency of the shunt motor when input current is 35 Amp
disp(E_1,'efficiency of the shunt motor when input current is 35 Amp(in %)=');
```

Scilab code Exa 2.46 Calculate the full load motor output and its efficiency

```
//Caption:Calculate the full load motor output and its efficiency
//Exam:2.46
clc;
```

```
clear;
close;
V=500;//applied voltage(in V)
R_sh=250;//field resistance (in Ohm)
R_a=0.2;//resistance of armature including brushes(
    in Ohm)
I_o=5;//no load current (in Amp)
I_sh=V/R_sh;//shunt field current(in Amp)
I_a=I_o-I_sh;//armature current(in Amp)
L_a=(I_a^2)*R_a;//armature brush drop(in watts)
L_t=V*I_o;//input to motor on no load(in watts)
L_c=L_t-L_a;//constant losses(in watts)
//On full load condition
I_l=52;//input current(in Amp)
I_a1=I_l-I_sh;//armature current when I_l1 input
    current(in Amp)
L_a1=(I_a1^2)*R_a;//losses in armature when I_l1
    input current(in watts)
L_T1=L_c+L_a1;//total losses at this load(in watts)
I_p=V*I_l;//input power(in watts)
O_p=I_p-L_T1;//output power(in watts)
disp(O_p,'output of the motor(in watts)=');
H.p=O_p/735.5;//the shunt motor H.P
disp(H.p,'the shunt motor H.P.=');
E_1=(O_p/I_p)*100;//efficiency of the full load
    shunt motor when input current is 52 Amp
disp(E_1,'efficiency of the full load shunt motor
    when input current is 52 Amp(in %)=');
```

Scilab code Exa 2.47 Determine the input in Watts and efficiency of the generator

```
//Caption:Determine the input in Watts & efficiency
   of the generator
//Exam:2.47
clc;
clear;
close;
O_p=50;//output of a machine (in KW)
O_p1=50*(10)^3;//output (in watts)
L_i=4000;//internal losses(in watts)
I_p=O_p1+L_i;//input(in watts)
disp(I_p,'input(in watts)=');
E=(O_p1/I_p)*100;//efficiency of the generator
disp(E,'efficiency of the generator(in %)=');
```

Scilab code Exa 2.48 Determine the internal losses and torque and efficiency of the motor

```
//Caption:Determine the internal losses,torque &
   efficiency of the motor
//Exam:2.48
clc;
clear;
close;
V=240;//supply voltage(in V)
I=80;//motor taking current(in Amp)
H.p=20;//motor giving H.P.
I_p=V*I;//input (in watts)
O_p=H.p*735.5;//output (in watts)
L_i=I_p-O_p;//internal losses(in watts)
disp(L_i,'internal losses in motor(in watts)=');
N=1300;//motor speed (in rpm)
```

```
T=O_p*60/(2*3.14*N);//torque generated in motor(in Nw-m)
disp(T,'torque generated in motor(in Nw-m)=');
E=(O_p/I_p)*100;//efficiency of the motor
disp(E,'efficiency of the motor(in %)=');
```

Scilab code Exa 2.49 Find the copper losses iron and friction losses and commerical efficiency

```
//Caption:Find the copper losses,iron& friction losses and commerical efficiency.
//Exam:2.49
clc;
clear;
close;
V=250;//supply voltage(in V)
R_sh=100;//shunt field resistance(in Ohm)
R_a=0.1;//armature resistance(in Ohm)
I_sh=V/R_sh;//field current(in Amp)
I_l=197.5;//motor taking current(in Amp)
I_a=I_l+I_sh;//Armature current(in Amp)
E=V+I_a*R_a;//E.M.F generated(in V)
H.p=80;//motor giving H.P.
P_m=H.p*735.5;//mechanical power input (in watts)
P_a=E*I_a;//electrical power developed in armature(in watts)
L_i=P_m-P_a;//iron & friction losses(in watts)
disp(L_i,'iron & friction losses in motor(in watts)=');
O_p=V*I_l;//electrical power output
L_c=P_a-O_p;//copper losses(in watts)
```

```
disp(L_c,'copper losses in a shunt generator(in
    watts)=');
L_t=L_i+L_c;//Total losses(in Watts)
I_p=O_p+L_t;//Input(in Watts)
E_f=(O_p/I_p)*100;//Commerical efficiency
disp(E_f,'commerical efficiency(in %)=');
```

Scilab code Exa 2.50 Determine Copper losses and total losses and Output and BHP

```
//Caption:Determine Copper losses and total losses
    and Output and BHP of the motor and efficiency of
     the motor
//Exam:2.50
clc;
clear;
close;
V=230;//supply voltage(in V)
I_l=200;//line current(in Amp)
I_p=V*I_l;//input power (in watts)
R_sh=50;//shunt field resistance(in Ohm)
R_a=0.04;//armature resistance (in ohm)
I_sh=V/R_sh;//shunt field currrent(in Amp)
I_a=I_l-I_sh;//armature current(in Amp)
L_cf=V*I_sh;//copper losses in the field(in watts)
L_ca=(I_a^2)*R_a;//copper loses in armature(in watts
    )
L_ct=L_cf+L_ca;//Total copper losses(in watts)
disp(L_ct,'copper losses of the motor(in watts)=');
L_s=1500;//Stray losses (in watts)
L_t=L_ct+L_s;//total losses(in watts)
```

```
disp(L_t,'total losses of the motor(in watts)=');
O_p=I_p-L_t;//output of the motor(in watts)
disp(O_p,'Output of the motor(in watts)=');
B.h.p=O_p/735.5;//B.H.P. of the motor (in H.P.)
disp(B.h.p,'B.H.P. of the motor (in H.P.)=');
E=(O_p/I_p)*100;//efficiency of the motor(in %)
disp(E,'efficiency of the motor(in %)=');
```

Scilab code Exa 2.51 Calculate the speed and BHP of the motor

```
//Caption:Calculate the speed and BHP of the motor
//Exam:2.51
clc;
clear;
close;
V=250;//applied emf(in V)
R_sh=0.05;//field resistance (in Ohm)
R_a=0.1;//armature resistance(in Ohm)
I=80;//motor current(in Amp)
A_s=240;//armature slots
C_s=4;//number of conductor per slot
Z=A_s*C_s;//total number of conductor
E_b=V-I*(R_a+R_sh);//Back emf(in V)
A=2;//number of parallel paths for wave wound
P=6;//poles
F=1.75;//flux per pole (in megalines)
F_1=1.75*10^-2;//flux per pole (in Wb)
N=E_b*60*A/(F_1*Z*P);//speed of the motor (in rpm)
disp(N,'speed of the motor (in rpm)=');
I_p=V*I;//input to the motor(in watts)
L_c=(I^2)*(R_a+R_sh);//copper losses(in watts)
```

```
L_i=900;//iron and friction losses(in watts)
L_t=L_c+L_i;//total losses(in watts)
O_p=I_p-L_t;//output(in watts)
B.H.P=O_p/746;//B.H.P. of the motor
disp(B.H.P,'B.H.P. of the motor(in H.P)=');
```

Chapter 3

Transformer Single Phase

Scilab code Exa 3.1 Calculate the number of turns on both primary and secondary winding in a single phase transformer

```
//Caption:Calculate the number of turns on both
   primary and secondary winding in a single phase
   transformer
//Exam:3.1
clc;
clear;
close;
E_1=500;//primary induced emf(in Volts)
E_2=250;//secondary induced emf(in Volts)
F=50;//supply frequency(in Hz)
B_max=1.2;//maximum flux density(in T)
a=0.009;//cross sectional area(in square meter)
F_x=B_max*a;//maximum value of flux(in Wb)
N_1=ceil(E_1/(4.44*F*F_x));//number of primary turns
disp(N_1,'number of primary turns in transformer=');
N_2=ceil(E_2/(4.44*F*F_x));//number of secondary
```

```
   turns
disp(N_2,'number of secondary turns in transformer='
   );
```

Scilab code Exa 3.2 In a loss less transformer calculate Number of turns on high voltage side and The primary current and The secondary current

```
//Caption:In a loss less transformer calculate (a)
   Number of turns on high voltage side (b)The
   primary current (c)The secondary current
//Exam:3.2
clc;
clear;
close;
V_1=110;//primary voltage(in Volts)
V_2=220;//secondary voltage(in Volts)
N_1=130;//low voltage side turns
N_2=N_1*V_2/V_1;//high voltage side turns
disp(N_2,'Number of turns on high voltage side=');
O_p=1;//Output of the transformer in KVA
I_2=O_p*1000/V_2;//Secondary current(in Amp)
I_1=O_p*1000/V_1;//Primary current(in Amp)
disp(I_1,'Primary current(in Amp)=');
disp(I_2,'Secondary current(in Amp)=');
```

Scilab code Exa 3.3 Calculate the secondary voltage and the volts per turn

```
//Caption:Calculate the secondary voltage and the
    volts per turn
//Exam:3.3
clc;
clear;
close;
N_1=800;//Primary turns in a transformer
N_2=200;//Secondary turns in a transformer
V_1=100;//Primary voltage
V_2=V_1*(N_2/N_1);//Secondary voltage
disp(V_2,'Secondary voltage (in Volts)=');
V_n=V_1/N_1;//Volts per turn
disp(V_n,'Volts per turn=');
```

Scilab code Exa 3.4 Calculate the primary current in a single phase transformer

```
//Caption:Calculate the primary current in a single
    phase transformer
//Exam:3.4
clc;
clear;
close;
V_1=230;//Primary voltage(in Volts)
V_2=460;//Secondary voltage(in Volts)
I_2=10;//secondary current(in Amp)
I_1=I_2*(V_2/V_1);//Primary current(in Amp)
disp(I_1,'Primary current (in Amp)=');
```

Scilab code Exa 3.5 Calculate the approximate values of the primary and secondary currents and the approimate number of primary turns

```
//Caption:Calculate (a)the approximate values of the
    primary and secondary currents (b)the approimate
    number of primary turns
//Exam:3.5
clc;
clear;
close;
V_1=6600;//Primary voltage(in Volts)
V_2=400;//Secondary voltage(in Volts)
N_2=100;//secondary turns
O_p=200;//output of a transformer in KVA
I_1=O_p*1000/V_1;//Full load primary current(in Amp)
disp(I_1,'Full load primary current(in Amp)=');
I_2=O_p*1000/V_2;//Full load secondary current(in
   Amp)
disp(I_2,'Full load secondary current(in Amp)=');
N_1=N_2*(V_1/V_2);//Number of primary turns
disp(N_1,'Number of primary turns=');
```

Scilab code Exa 3.6 Find voltage in secondary terminal

```
//Caption:Find voltage in secondary terminal
//Exam:3.6
clc;
clear;
close;
V_1=100;//Primary voltage(in Volts)
N_1=20;//Number of primary turns
N_2=40;//Number of secondary turns
V_2=(N_2/N_1)*V_1;//voltage of the secondary
    terminal(in Volts)
disp(V_2,'voltage of the secondary terminal(in Volts
    )=');
```

Scilab code Exa 3.7 Calculate the rms value of the induced emf in the secondary coil

```
//Caption:Calculate the r.m.s value of the induced
    emf in the secondary coil.
//Exam:3.7
clc;
clear;
close;
F_x=0.02;//Maximum value of flux(in Wb)
N_2=55;//Number of secondary turns
F=50;//Supply frequency(in Hz)
E_2=4.44*F*F_x*N_2;//r.m.s value of induced emf in
    the secondary (in Volts)
disp(E_2,'r.m.s value of induced emf in the
    secondary (in Volts)=');
```

Scilab code Exa 3.8 In single phase transformer Calculate The maximum flux density in the core and induced emf in the secondary

```
//Caption:In single phase transformer Calculate (a)
    The maximum flux density in the core and (b)
    induced emf in the secondary
//Exam:3.8
clc;
clear;
close;
N_1=80;//Primary turns
N_2=240;//secondary turns
f=50;//Supply frequency(in Hz)
E_1=240;//Supply voltage(in Volts)
F_max=E_1/(4.44*f*N_1);//Maximum value of the flux
    in the core
a=200;//Cross sectional area of core(in cm^2)
A=a*10^-4;//Cross sectional area of core(in m^2)
B_max=F_max/A;//Peak value of flux density in the
    core(in T)
disp(B_max,'Peak value of flux density in the core(
    in T)=');
E_2=E_1*(N_2/N_1);//Induced emf in the secondary
    winding(in Volts)
disp(E_2,'Induced emf in the secondary winding(in
    Volts)=');
```

Scilab code Exa 3.9 Calculate Primary and secondary currents on full load and the maximum value of flux and the number of primary turns

```
//Caption:Calculate (a)Primary and secondary
   currents on full load (b)the maximum value of
   flux (c)the number of primary turns.
//Exam:3.9
clc;
clear;
close;
O_p=200;//Rated output (in KVA)
V_1=3300;//Primary voltage (in Volts)
V_2=240;//Secondary voltage (in Volts)
N_2=100;//Secondary turns
f=50;//supply frequency(in Hz)
I_1=O_p*1000/V_1;//Primary current(in Amp)
disp(I_1,'Primary current on full load (in Amp)=');
I_2=O_p*1000/V_2;//secondary current(in Amp)
disp(I_2,'secondary current on full load (in Amp)=')
   ;
F_x=V_2/(4.44*f*N_2);//Maximum value of flux(in Wb)
disp(F_x,'Maximum value of flux(in Wb)=');
N_1=N_2*(V_1/V_2);//Primary turns
disp(N_1,'Primary turns=');
```

Scilab code Exa 3.10 In a single phase transformer primary side is open Find core loss and loss component of current and Magnetising current

```
//Caption:In a single phase transformer primary side
   is open , Find (a)core loss , (b)loss component
   of current ,(c)Magnetising current.
//Exam:3.10
clc;
clear;
close;
O_p=50;//output (in KVA)
V_2=230;//Secondary voltage(in Volts)
P=187;//meter's power reading (in watt)
I_w=P/V_2;//Loss component of current(in Amp)
I_o=6.5;//meter's current reading (in Amp)
I_m=((I_o)^2-(I_w)^2);//Magnetising current(in Amp)
P=V_2*I_w;//Core loss(in watt)
disp(P,'Core loss(in watt)=');
disp(I_w,'Loss component of current(in Amp)=');
disp(I_m,'Magnetising current(in Amp)=');
```

Scilab code Exa 3.11 In a transformer Calculate Magnetising component of no load current and the iron loss also find the maximum value of flux in the core

```
//Caption:In a transformer Calculate (a)Magnetising
    component of no load current (b)the iron loss (c)
    the maximum value of flux in the core.
//Exam:3.11
clc;
clear;
close;
V_1=460;//supply voltage(in Volts)
I_o=15;//No load current (in Amp)
p=acosd(0.2);//power angle(when power factor is 0.2)
n=sind(p);
I_m=I_o*n;//Magnetising component of no load current
disp(I_m,'Magnetising component of no load current (
    in Amp)=');
L_ir=V_1*I_o*cosd(p)/1000;//the iron loss in
    transformer(in kWatt)
disp(L_ir,'the iron loss in transformer(in kWatt)=')
    ;
E_1=V_1;//at no load condition
N_1=550;//primary winding
f=50;//supply frequency (in Hz)
F_m=E_1/(4.44*N_1*f);//the maximum value of flux in
    the core(in Wb)
disp(F_m,'the maximum value of flux in the core(in
    Wb)=');
```

Scilab code Exa 3.12 In a single phase transformer Find The magnetising current and The iron loss current

```
//Caption:In a single phase transformer, Find (a)The
     magnetising current (b)The iron loss current
```

```
//Exam:3.12
clc;
clear;
close;
p=acosd(0.22);//power angle(when power factor is
   0.22)
I_o=0.3;//no load current(in Amp)
I_m=I_o*sind(p);//Magnetising current(in Amp)
disp(I_m,'Magnetising current(in Amp)=');
I_w=I_o*cosd(p);//Iron loss current (in Amp)
disp(I_w,'Iron loss current (in Amp)=');
```

Scilab code Exa 3.13 Find the active and reactive components of a single phase transformer

```
//Caption:Find the active and reactive components of
    a single phase transformer.
//Exam:3.14
clc;
clear;
close;
V_1=440;//supply Voltage(in Volts)
p=acosd(0.3);//power angle when power factor is 0.3
P_o=80;//power input to the hv winding(in Watt)
I_o=P_o/(V_1*cosd(p));//No load current (in Amp)
I_w=I_o*cosd(p);//Active component of no  load
   current (in Amp)
disp(I_w,'Active component of no load current (in
   Amp)=');
I_m=I_o*sind(p);//Reactive component of no load
   current (in Amp)
```

```
disp(I_m,'Reactive component of no load current (in Amp)=');
```

Scilab code Exa 3.14 In a single phase transformer Calculate the current taken by the primary winding

```
//Caption:In a single phase transformer Calculate the current taken by the primary winding.
//Exam:3.14
clc;
clear;
close;
V_1=6600;//Primary voltage(in Volts)
V_2=400;//Secondary voltage(in Volts)
I_o=0.7;//NO load current(in Amp)
p_o=0.24;//No load power factor
q_o=acosd(p_o);//power angle when no load power factor is 0.24
I_2=100;//Secondary current(in Amp)
p_2=0.8;//Secondary power factor
q_2=acosd(p_2);//power angle when secondary power factor is 0.8
K=V_2/V_1;//ratio of primary to secondary voltage
I_1=K*I_2;//primary current(in Amp)
Q=q_o-q_2;//resultant power angle
I=((I_o)^2 + (I_1)^2+2*I_o*I_1*cosd(Q))^(1/2);//Resultant current taken by the primary(in Amp)
disp(I,'Resultant current taken by the primary(in Amp)=');
```

Scilab code Exa 3.15 In a single phase transformer Calculate the current taken by the primary winding

```
//Caption:In a single phase transformer Calculate
   the current taken by the primary winding.
//Exam:3.15
clc;
clear;
close;
V_1=440;//Primary voltage(in Volts)
V_2=110;//Secondary voltage(in Volts)
I_o=5;//NO load current(in Amp)
p_o=0.2;//No load power factor
q_o=acosd(p_o);//power angle when no load power
   factor is 0.24
I_2=120;//Secondary current(in Amp)
p_2=0.8;//Secondary power factor
q_2=acosd(p_2);//power angle when secondary power
   factor is 0.8
K=V_2/V_1;//ratio of primary to secondary voltage
I_1=K*I_2;//primary current(in Amp)
Q=q_o-q_2;//resultant power angle
I=((I_o)^2 + (I_1)^2+2*I_o*I_1*cosd(Q))^(1/2);//
   Resultant current taken by the primary(in Amp)
disp(I,'Resultant current taken by the primary(in
   Amp)=');
```

Scilab code Exa 3.16 In a single phase transformer Calculate Equivalent resistance as referred to primary and Equivalent resistance as referred to secondary and Equivalent reactance as referred to both primary and secondary also find Equivalent impedence as referred to both p

```
//Caption:In a single phase transformer Calculate Equivalent resistance as referred to primary and Equivalent resistance as referred to secondary and Equivalent reactance as referred to both primary and secondary also find Equivalent impedence as referred to both primary and secondary.
//Exam:3.16
clc;
clear;
close;
V_1=4400;//Primary voltage (in Volts)
V_2=220;//Secondary voltage (in Volts)
R_1=3.45;//Primary resistance (in Ohm)
X_1=5.2;//Primary reactances (in Ohm)
R_2=0.009;//secondary resistance (in Ohm)
X_2=0.015;//secondary reactance (in Ohm)
K=V_2/V_1;//voltage ratio
R_o1=R_1+(R_2/K^2);//Equivalent resistance as referred to primary(in Ohm)
disp(R_o1,'Equivalent resistance as referred to primary(in Ohm)=');
R_o2=R_2+(R_1*K^2);//Equivalent resistance as referred to secondary(in Ohm)
disp(R_o2,'Equivalent resistance as referred to
```

```
    secondary(in Ohm)=');
X_o1=X_1+(X_2/K^2);//Equivalent reactance as
    referred to primary(in Ohm)
disp(X_o1,'Equivalent reactance as referred to
    primary(in Ohm)=');
X_o2=X_2+X_1*(K^2);//Equivalent reactance as
    referred to secondary(in Ohm)
disp(X_o2,'Equivalent reactance as referred to
    secondary(in Ohm)=');
Z_o1=((R_o1)^2 + (X_o1)^2)^(1/2);//Equivalent
    impedence as referred to primary(in Ohm)
disp(Z_o1,'Equivalent impedence as referred to
    primary(in Ohm)=');
Z_o2=((R_o2)^2 + (X_o2)^2)^(1/2);//Equivalent
    impedence as referred to secondary(in Ohm)
disp(Z_o2,'Equivalent impedence as referred to
    secondary(in Ohm)=');
```

Scilab code Exa 3.17 In a single phase transformer Calculate the secondary terminal voltage at full load

```
//Caption:In a single phase transformer Calculate
    the secondary terminal voltage at full load.
//Exam:3.17
clc;
clear;
close;
V_1=2000;//Primary voltage at no load or full load(
    in Volts)
V_2=400;//Secondary voltage at no load (in Volts)
K=V_2/V_1;//Ratio of transformation
```

```
R_1=5;//Primary resistance(in Ohm)
R_2=0.2;//Secondary resistance(in Ohm)
X_1=12;//Primary reactance(in Ohm)
X_2=0.48;//Secondary reactance(in Ohm)
R_o2=R_2 + (K^2)*R_1;//Equivalent resistance as referred to secondary(in Ohm)
X_o2=X_2 + (K^2)*X_1;//Equivalent reactance as referred to secondary(in Ohm)
O_p=10;//Rated output(i KVA)
I_2=O_p*1000/V_2;//Full load secondary current(in Amp)
p=0.8;//power factor
a=acosd(p);//power angle
V_d=I_2*R_o2*cosd(a) + I_2*X_o2*sind(a);//Voltage drop (in Volts)
V=V_2-V_d;//Secondary terminal voltage at full load (in Volts)
disp(V,'Secondary terminal voltage at full load (in Volts)=');
```

Scilab code Exa 3.18 In a single phase transformer Calculate the secondary terminal voltage at full load

```
//Caption:In a single phase transformer Calculate the secondary terminal voltage at full load.
//Exam:3.18
clc;
clear;
close;
V_1=11000;//Primary voltage at no load or full load(in Volts)
```

```
V_2=400;//Secondary voltage at no load (in Volts)
K=V_2/V_1;//Ratio of transformation
R_1=4;//Primary resistance(in Ohm)
R_2=0.2;//Secondary resistance(in Ohm)
X_1=10;//Primary reactance(in Ohm)
X_2=0.4;//Secondary reactance(in Ohm)
R_o2=R_2 + (K^2)*R_1;//Equivalent resistance as referred to secondary(in Ohm)
X_o2=X_2 + (K^2)*X_1;//Equivalent reactance as referred to secondary(in Ohm)
O_p=10;//Rated output(in KVA)
I_2=O_p*1000/V_2;//Full load secondary current(in Amp)
Z_o2=((R_o2)^2 +(X_o2)^2)^(1/2);//Equivalent impedance as referred to secondary(in Ohm)
V=V_2-I_2*Z_o2;//Secondary terminal voltage at full load (in Volts)
disp(V,'Secondary terminal voltage at full load (in Volts)=');
```

Scilab code Exa 3.19 In a single phase transformer Determine equivalent resistance referred to secondary side and equivalent reactance referred to secondary side

```
//Caption:In a single phase transformer Determine equivalent resistance referred to secondary side and equivalent reactance referred to secondary side
//Exam:3.19
clc;
clear;
```

```
close;
V_1=2000;//Primary voltage at no load or full load(in Volts)
V_2=400;//Secondary voltage at no load (in Volts)
K=V_2/V_1;//Ratio of transformation
R_1=5.2;//Primary resistance(in Ohm)
R_2=0.2;//Secondary resistance(in Ohm)
X_1=12.5;//Primary reactance(in Ohm)
X_2=0.5;//Secondary reactance(in Ohm)
R_o2=R_2 + (K^2)*R_1;//Equivalent resistance as referred to secondary(in Ohm)
disp(R_o2,'Equivalent resistance as referred to secondary(in Ohm)=');
X_o2=X_2 + (K^2)*X_1;//Equivalent reactance as referred to secondary(in Ohm)
disp(X_o2,'Equivalent reactance as referred to secondary(in Ohm)=');
```

Scilab code Exa 3.20 Determine equivalent resistance and reactance of primary referred to secondary and total resistance and reactance referred to secondary and equivalent resistance and reactance of secondary referred to primary and total resistance and reactance of secondar

```
//Caption:Determine equivalent resistance and reactance of primary referred to secondary and total resistance and reactance referred to secondary and equivalent resistance and reactance of secondary referred to primary and total resistance and reactance of secondary referred to primary.
//Exam:3.20
```

```
clc;
clear;
close;
V_1=2000;//Primary voltage at no load or full load(in Volts)
V_2=200;//Secondary voltage at no load (in Volts)
K=V_2/V_1;//Ratio of transformation
R_1=2;//Primary resistance(in Ohm)
R_2=0.025;//Secondary resistance(in Ohm)
X_1=4;//Primary reactance(in Ohm)
X_2=0.04;//Secondary reactance(in Ohm)
R_eq12=(K^2)*R_1;//equivalent resistance of primary referred to secondary(in Ohm)
disp(R_eq12,'equivalent resistance of primary referred to secondary(in Ohm)=');
X_eq12=(K^2)*X_1;//equivalent reactance of primary referred to secondary(in Ohm)
disp(X_eq12,'equivalent reactance of primary referred to secondary(in Ohm)=');
R_e2=(K^2)*R_1 + R_2;//total resistance of primary referred to secondary(in Ohm)
disp(R_e2,'total resistance of primary referred to secondary(in Ohm)=');
X_e2=(K^2)*X_1 + X_2;//total reactance of primary referred to secondary(in Ohm)
disp(X_e2,'total reactance of primary referred to secondary(in Ohm)=');
R_eq21=R_2/(K^2);//equivalent resistance of secondary referred to primar(in Ohm)
disp(R_eq21,'equivalent resistance of secondary referred to primar(in Ohm)=');
X_eq21=X_2/(K^2);//equivalent reactance of secondary referred to primar(in Ohm)
disp(X_eq21,'equivalent reactance of secondary referred to primar(in Ohm)=');
R_e1=R_1 + R_2/(K^2);//total resistance of secondary referred to primary(in Ohm)
disp(R_e1,'total resistance of secondary referred to
```

```
    primary(in Ohm)=');
X_e1=X_1 + X_2/(K^2);//total reactance of secondary
   referred to primary(in Ohm)
disp(X_e1,'total reactance of secondary referred to
   primary(in Ohm)=');
```

Scilab code Exa 3.21 Determine Primary resistance referred to secondary and secondary resistance referred to primary and total resistance of transformer referred to primary

```
//Caption:Determine Primary resistance referred to
   secondary and secondary resistance referred to
   primary and total resistance of transformer
   referred to primary.
//Exam:3.21
clc;
clear;
close;
V_1=2000;//Primary voltage at no load or full load(
   in Volts)
V_2=220;//Secondary voltage at no load (in Volts)
R_1=1.06;//Primary resistance(in Ohm)
R_2=0.013;//Secondary resistance(in Ohm)
K=V_2/V_1;//Ratio of transformation
R_eq1=(K^2)*R_1;//Primary resistance referred to
   secondary(in Ohm)
disp(R_eq1,'Primary resistance referred to secondary
   (in Ohm)=');
R_eq2=R_2/(K^2);//secondary resistance referred to
   primary(in Ohm)
disp(R_eq2,'secondary resistance referred to primary
```

```
    (in Ohm)=');
R_e1=R_1 + R_eq2;//total resistance of transformer
    referred to primary(in Ohm)
disp(R_e1,'total resistance of transformer referred
    to primary(in Ohm)=');
```

Scilab code Exa 3.22 In a single phase transformer Find Full load regulation at a power factor lagging unity and leading

```
//Caption:In a single phase transformer Find Full
    load regulation at a power factor (a) 0.8 lagging
     (b) unity (c) 0.8 leading.
//Exam:3.22
clc;
clear;
close;
V_1=6600;//Primary voltage (in Volts)
V_2=250;//Secondary voltage (in Volts)
K=V_2/V_1;//Ratio of transformation
R_1=10;//Primary resistance (in Ohm)
R_2=0.02;//Secondary resistance (in Ohm)
X_o1=35;//Total leakage reactance referred to the
    primary winding(in Ohm)
R_o2=R_2 + R_1*(K^2);//Equivalent resistance
    reffered to the secondary(in Ohm)
X_o2=X_o1*(K^2);//Equivalent reactance reffered to
    the secondary(in Ohm)
O_p=40;//Rated output (in KVA)
I_2=O_p*1000/250;//Secondary current(in Amp)
P_1=0.8;//Power factor
q=acosd(P_1);
```

```
V_r1=((I_2*R_o2*cosd(q) + I_2*X_o2*sind(q))/V_2)*100;//Voltage regulation at 0.8 lagging power factor(in %)
disp(V_r1,'Voltage regulation at 0.8 lagging power factor(in %)=');
V_r0=(I_2*R_o2/V_2)*100;//Voltage regulation at unity power factor(in %)
disp(V_r0,'Voltage regulation at unity power factor(in %)=');
V_r2=((I_2*R_o2*cosd(q) - I_2*X_o2*sind(q))/V_2)*100;//Voltage regulation at 0.8 leading power factor(in %)
disp(V_r2,'Voltage regulation at 0.8 leading power factor(in %)=');
```

Scilab code Exa 3.23 Calculate the regulation of transformer

```
//Caption:Calculate the regulation of transformer
//Exam:3.23
clc;
clear;
close;
//(I_2*R_a2/E_2)*100=1
Rs_d=1;//Percentage resistive drop
//(I_2*X_a2/E_2)*100=5
Re_d=5;//Percentage reactive drop
//power factor=cosd(q1)=0.8 (lagging)
q1=acosd(0.8);
//Voltage regulation= ((I_2*R_a2*cosd(q1)+I_2*X_a2*sind(q1))/100)*100
//V_r=(I_2*R_a2/E_2)*100*cosd(q1)+(I_2*X_a2/E_2)
```

```
    *100*sind(q1)
V_r1=Rs_d*cosd(q1)+Re_d*sind(q1);//Voltage
    regulation when power factor is 0.8 lagging
disp(V_r1,'Voltage regulation when power factor is
    0.8 lagging(in %)=');
q2=-acosd(0.8);
//V_r2=(I_2*R_a2/E_2)*100*cosd(q2)+(I_2*X_a2/E_2)
    *100*sind(q2);//Voltage regulation when power
    factor is 0.8 leading
V_r2=Rs_d*cosd(q2)+Re_d*sind(q2);//Voltage
    regulation when power factor is 0.8 leading
disp(V_r2,'Voltage regulation when power factor is
    0.8 leading(in %)')
```

Scilab code Exa 3.25 In a single phase transformer Calculate the efficiency at unity power at Full load and Half load

```
//Caption:In a single phase transformer Calculate
    the efficiency at unity power at Full load and
    Half load.
//Exam:3.25
clc;
clear;
close;
P_c=400;//Full load copper loss(in Watts)
P_C=P_c/1000;//Full load copper loss(in KW)
P_i=350;//Full load iron loss(in Watts)
P_I=P_i/1000;//Full load iron loss(in KW)
P_f=1;//Power factor
KVA=25;//Rating of the transformer
O_p=KVA*P_f;//Output at full load condition(in KW)
```

```
L_1=P_C+P_I;//Losses at full load condition(in KW)
I_p=O_p+L_1;//Input at full load condition(in KW)
E_fL=(O_p/I_p)*100;//Efficiency in full load
    condition
disp(E_fL,'Efficiency of the tranformer at full load
     condition(in %)=');
//At half load condition
O_P=(1/2)*KVA*P_f;//Output of the transformer at
    half load condition
L_2=((1/2)^2)*P_C+P_I;//Losses at half load
    condition(in KW)
I_P=O_P+L_2;//Input at half load condition
E_hL=(O_P/I_P)*100;//Efficiency of the transformer
    at half load condition(in %)
disp(E_hL,'Efficiency of the transformer at half
    load condition(in %)=');
```

Scilab code Exa 3.26 Calculate the single phase transformer efficiency for 75 percent of the full load output at power factor unity and lagging

```
//Caption:Calculate the single phase transformer
    efficiency for 75% of the full load output at
    power factor unity and 0.8 lagging.
//Exam:3.26
clc;
clear;
close;
P_i=1.5;//Core loss(in KW)
P_c=4.5;//Full load copper loss(in KW)
P_C=((3/4)^2)*P_c;//Copper loss at 75% of full load(
    in KW)
```

```
P_t=P_i+P_C;//Total loss at 75% of full load output(in KW)
KVA=300;//Rating of the transformer(in KVA)
P_f1=1;//power factor value when it is unity
P_f2=0.8;//power factor value when it is 0.8 lagging
O_p1=0.75*KVA*P_f1;//Output at 75% of full load and at unity power factor(in KW)
E_f1=(O_p1/(O_p1+P_t))*100;//Efficiency of the transformer for 75% of full load output at power factor unity(in %)
disp(E_f1,'Efficiency of the transformer for 75% of full load output at power factor unity(in %)=');
O_p2=0.75*KVA*P_f2;//Output at 75% of full load and at 0.8 lagging power factor(in KW)
E_f2=(O_p2/(O_p2+P_t))*100;//Efficiency of the transformer for 75% of full load output at power factor 0.8 lagging(in %)
disp(E_f2,'Efficiency of the transformer for 75% of full load output at power factor 0.8 lagging(in %)=');
```

Scilab code Exa 3.27 In a single phase transformer Calculate The efficiency at full load unity power factor and The efficiency at full load lagging power factor and also find The efficiency at full load leading power factor

```
//Caption:In a single phase transformer Calculate (a)The efficiency at full load, unity power factor. (b)The efficiency at full load, 0.8 lagging power factor. (c)The efficiency at full load, 0.8 leading power factor.
//Exam:3.27
```

```
clc;
clear;
close;
P_f1=1;//power factor unity
P_f2=0.8;//power factor 0.8 lagging or leading
KVA=25;//Rating of the transformer(in KVA)
O_p1=KVA*P_f1;//Output at unity power factor(in KW)
P_c=400;//copper losses(in Watt)
P_C=P_c/1000;//copper losses(in KW)
P_i=320;//iron losses(in Watt)
P_I=P_i/1000;//iron losses(in KW)
P_T=P_I+P_C;//total losses(in KW)
I_p1=O_p1+P_T;//Input (in KW)
E_f1=(O_p1/I_p1)*100;//Efficiency of the transformer at full load and unity power factor(in %)
disp(E_f1,'Efficiency of the transformer at full load and unity power factor(in %)=');
O_p2=KVA*P_f2;//output at 0.8 lagging power factor(in KW)
I_p2=O_p2+P_T;//input incase of 0.8 power factor(in KW)
E_f2=(O_p2/I_p2)*100;//Efficiency of the transformer at full load and 0.8 lagging power factor(in %)
disp(E_f2,'Efficiency of the transformer at full load and 0.8 lagging power factor(in %)=');
E_f3=E_f2;//At 0.8 leading power factor. since there is no change in input and output, so efficiency is unchanged
disp(E_f3,'At 0.8 leading power factor. since there is no change in input and output, so efficiency is unchanged(in %)=');
```

Scilab code Exa 3.28 Calculate the efficiency of the transformer on Half load and Full load

```
//Caption:Calculate the efficiency of the transformer on Half load and Full load.
//Exam:3.28
clc;
clear;
close;
KVA=100;//rating of the(in KVA)
P_f=0.8;//power factor
O_p=(1/2)*KVA*P_f;//Output at half load(in KW)
P_i=700;//iron loss (in Watt)
P_i1=P_i/1000;//iron loss at half and full load(in KW)
P_c=400;//copper losses (in Watt)
P_c1=((1/2)^2)*P_c/1000;//copper losses at half load condition (in KW)
P_t=P_c1+P_i1;//Total losses in half load condition(in KW)
E_f=(O_p/(O_p+P_t))*100;//Efficiency of the transformer on half load in percentage
disp(E_f,'Efficiency of the transformer on half load (in %)=');
O_P=KVA*P_f;//Output in case of full load(in KW)
P_c2=P_c/1000;//Copper losss at full load condition(in KW)
P_T=P_c2+P_i1;//Total losses in full load condition(in KW)
E_F=(O_P/(O_P+P_T))*100;//Efficiency of the transformer on full load condition in percentage
disp(E_F,'Efficiency of the transformer on full load condition (in %)=');
```

Scilab code Exa 3.29 In a single phase transformer Calculate the efficiency at full load unity power factor and At half full load power factor lag also determine the load for maximum efficiency

```
//Caption:In a single phase transformer Calculate the efficiency at full load unity power factor and At half full load 0.8 power factor lag also determine the load for maximum efficiency
//Exam:3.29
clc;
clear;
close;
KVA=25;//Rating of the transformer(in KVA)
P_c=400;//Full load copper loss(in Watt)
P_c1=P_c/1000;//Full load copper loss(in KW)
P_i=350;//Iron loss(in Watt)
P_i1=P_i/1000;//Iron loss (in KW)
P_f=1;//Power factor unity
P_f1=0.8;//Power factor 0.8 lagging
O_p1=KVA*P_f;//Output at full load and unity power factor(in KW)
P_t1=P_c1+P_i1;//Total losses at full load and unity power factor(in KW)
I_p1=O_p1+P_t1;//Input at full load and unity power factor(in KW)
E_f1=(O_p1/I_p1)*100;//Efficiency of the transformer at full load and unity power factor(in KW)
disp(E_f1,'Efficiency of the transformer at full load and unity power factor(in KW)=');
O_p2=(1/2)*KVA*P_f1;//Output At half full load, 0.8
```

```
power factor lag.(in KW)
P_c2=((1/2)^2)*P_c1;//Copper loss At half full load, 0.8 power factor lag.(in KW)
P_t2=P_c2+P_i1;//Total loss At half full load, 0.8 power factor lag.(in KW)
I_p2=O_p2+P_t2;//Input At half full load, 0.8 power factor lag.(in KW)
E_f2=(O_p2/I_p2)*100;//Efficiency of the transformer at half full load and 0.8 lagging power factor(in KW)
disp(E_f2,'Efficiency of the transformer at half full load and 0.8 lagging power factor(in KW)=');
//Maximum efficiency occurs when Copper loss = Iron loss,let the maximum efficiency occcur at x times full load
x=(P_i/P_c)^(1/2);
L=x*KVA;//load in KVA corresponding to maximum efficiency
disp(L,'the load for maximum efficiency(in KVA)=');
```

Scilab code Exa 3.30 In a single phase transformer Calculate the efficiency of full load current and value of this

```
//Caption:In a single phase transformer Calculate the efficiency of full load current (a)at unity power factor (b)at a power factor of 0.8 ,also calculate the load at which the maximum efficiency occurs and what is it's value.
//Exam:3.30
clc;
clear;
```

```
close;
KVA=50;//Rating of the transformer(in KVA)
V_1=6600;//Primary voltage(in Volt)
V_2=200;//Secondary voltage(in VOlt)
I_1=KVA*1000/6600;//Full load primary current(in Amp
    )
P_f1=1;//power factor at unity
P_f2=0.8;//Power factor at 0.8
O_p1=KVA*P_f1;//Output at unity power factor(in KW)
P_i=650;//Iron loss(in Watt)
P_i1=P_i/1000;//Iron loss (in KW)
P_c=885;//Copper loss(in Watt)
P_c1=P_c/1000;//Copper loss(in KW)
I_p1=O_p1+P_c1+P_i1;//Input at unity power factor(in
    KW)
E_f1=(O_p1/I_p1)*100;//Efficiency of the transformer
    at unity power factor
disp(E_f1,'Efficiency of the transformer at unity
    power factor(in %)=');
O_p2=KVA*P_f2;//Output at 0.8 power factor(in KW)
//Maximum efficiency occurs when Copper loss = Iron
    loss,let the maximum efficiency occcur at x times
    full load
x=(P_i1/P_c1)^(1/2);
disp(x,'the maximum efficiency occurs at the full
    load of=');
O_P=x*KVA*P_f2;//Output at maximum efficiency(in KW)
E_F=(O_P/(O_P+P_i1+P_c1))*100;//Maximum Efficiency
    of the transformer at 0.8 power factor
disp(E_F,'Maximum Efficiency of the transformer(in %
    )=');
```

Scilab code Exa 3.31 find the ratio of iron and copper loss such that maximum efficiency occurs at 75 percent of full load

```
//Caption:In the single phase transformer,find the
   ratio of iron and copper loss such that maximum
   efficiency occurs at 75% of full load.
//Exam:3.31
clc;
clear;
close;
x=75/100;//the value of load which is 75% of full
   load
P_r=x^2;//Ratio of the iron loss and copper loss for
    maximum efficiency
disp(P_r,'Ratio of the iron and copper loss for the
   maximum efficiency=');
```

Scilab code Exa 3.32 In a single phase transformer Calculate the iron losses and the full load copper losses

```
//Caption:In a single phase transformer Calculate
   the iron losses and the full load copper losses.
//Exam:3.32
clc;
clear;
close;
KVA=400;//Rating of the transformer(in KVA)
E_f1=0.9877;//Transformer efficiency when delivering
    full load at 0.8 power factor
P_f1=0.8;//power factor at full load
P_f2=1;//power factor at half load
```

```
O_p1=KVA*P_f1;//Output on full load when power factor is 0.8(in KW)
I_p1=(O_p1/E_f1);//Input on full load when power factor is 0.8(in KW)
P_t1=I_p1-O_p1;//Total losses on full load when power factor is 0.8(in KW)
O_p2=(1/2)*KVA*P_f2;//Output at half load when power factor is 1
E_f2=0.9913;//Transformer efficiency when delivering half load at 1 power factor
I_p2=O_p2/E_f2;//Input at half load when power factor is 1
P_t2=I_p2-O_p2//Total losses at half load when power factor is 1
//P_t1=P_c+P_i
//P_t2=(1/4)P_c+P_i
P_c=(4/3)*(P_t1-P_t2);//Full load and copper losses
P_i=(1/3)*(4*P_t2-P_t1);//iron losses
disp(P_c,'full load and copper losses(in KW)=');
disp(P_i,'iron loss(in KW)=');
```

Scilab code Exa 3.33 In a transformer find all day efficiency

```
//Caption:In a transformer find all day efficiency
//Exam:3.33
clc;
clear;
close;
KVA=15;//Rating of the transformer(in KVA)
E_f=0.98;//Efficiency of the transformer
P_F=1;//for unity power factor
```

```
O_P=KVA*P_F;//Output of the transformer at unity power factor(in KW)
I_P=O_P/E_f;//Input to the transformer(in KW)
P_T=I_P-O_P;//Total losses(in KW)
//At Maximum efficiency
P_C=P_T/2;//copper loss for maximum efficiency(in KW)
P_I=P_C;//iron losss at maximum efficiency copper loss=iron loss
L_1=2;//load for 12 hours (in KW)
L_2=12;//load for 6 hours (in KW)
L_3=18;//load for next 6 hours (in KW)
P_f1=0.5;//Power factor at L_1 load
P_f2=0.8;//Power factor at L_2 load
P_f3=0.9;//Power factor at L_3 load
T_1=12;//Time when L_1 working(in hours)
T_2=6;//Time when L_2 working(in hours)
T_3=6;//Time when L_3 working(in hours)
O_p1=L_1*T_1+L_2*T_2+L_3*T_3;//All day output(in KWh)
P_i1=P_I*24;//Iron losses for 24 hours(in KWh)
P_c1=T_1*P_C*((L_1/P_f1)/KVA)^2+T_2*P_C*((L_2/P_f2)/KVA)^2+T_3*P_C*((L_3/P_f3)/KVA)^2;//Copper loss for 24 hours(in KWh)
P_t=P_c1+P_i1;//Total losses of transformer for 24 hours(in KWh)
I_p1=O_p1+P_t;//All day input(in KWh)
E_f1=(O_p1/I_p1)*100;//All day efficiency of transformer
disp(ceil(E_f1),'All day efficiency of transformer(in %)=');
```

Scilab code Exa 3.34 In a transformer find all day efficiency

```
//Caption:In a transformer find all day efficiency
//Exam:3.34
clc;
clear;
close;
KVA=1500;//Rating of the transformer(in KVA)
P_C=4.5;//copper loss for maximum efficiency(in KW)
P_I=3.2;//iron losss at maximum efficiency copper
    loss=iron loss
L_1=1200;//load for 6 hours (in KW)
L_2=900;//load for next 10 hours (in KW)
L_3=300;//load for next 4 hours (in KW)
L_4=0;//load for next 4 hours (in KW)
P_f1=0.8;//Power factor at L_1 load
P_f2=0.75;//Power factor at L_2 load
P_f3=0.8;//Power factor at L_3 load
P_f4=0;//Power factor at L_4 load
T_1=6;//Number of hours when L_1 working(in hours)
T_2=10;//Number of hours when L_2 working(in hours)
T_3=4;//Number of hours when L_3 working(in hours)
T_4=4;//Number of hours when L_4 working(in hours)
O_p1=L_1*T_1+L_2*T_2+L_3*T_3;//All day output(in KWh
    )
P_i1=P_I*24;//Iron losses for 24 hours(in KWh)
P_c1=T_1*P_C*((L_1/P_f1)/KVA)^2+T_2*P_C*((L_2/P_f2)/
    KVA)^2+T_3*P_C*((L_3/P_f3)/KVA)^2;//Copper loss
    for 24 hours(in KWh)
P_t=P_c1+P_i1;//Total losses of transformer for 24
    hours(in KWh)
I_p1=O_p1+P_t;//All day input(in KWh)
E_f1=(O_p1/I_p1)*100;//All day efficiency of
    transformer
disp((E_f1),'All day efficiency of transformer(in %)
    =');
```

Scilab code Exa 3.35 In a transformer find all day efficiency

```
//Caption:In a transformer find all day efficiency
//Exam:3.35
clc;
clear;
close;
KVA=15;//Rating of the transformer(in KVA)
P_c=0.35;//Full load copper loss (in KW)
P_i=0.25;//iron losss
P_I=P_i*24;//Iron loss per day
L_1=1/4;//load for 9 hours of full load
L_2=1;//load for 7 hours of full load
L_3=3/4;//load for next 6 hours of full load
P_f1=0.6;//Power factor at L_1 load
P_f2=0.8;//Power factor at L_2 load
P_f3=1;//Power factor at L_3 load
T_1=9;//Time when L_1 working(in hours)
T_2=7;//Time when L_2 working(in hours)
T_3=6;//Time when L_3 working(in hours)
P_c1=((1/4)^2)*P_c;//Copper loss at 1/4 load
P_C1=9*P_c1;//Copper loss for 9 hours at 1/4 load
P_c2=P_c;//Copper loss at full load
P_C2=7*P_c2;//Copper loss for 7 hours at full load
P_c3=((3/4)^2)*P_c;//Copper loss at 3/4 load
P_C3=6*P_c3;//Copper loss for 6 hours at 3/4 load
P_C=P_C1+P_C2+P_C3;//Copper loss per day(in KW)
P_T=P_C+P_I;//Iron loss per day(in KW)
O_P=L_1*KVA*P_f1*T_1+L_2*KVA*P_f2*T_2+L_3*KVA*P_f3*
    T_3;//Total output per day(in KWh)
```

```
I_P=O_P+P_T;//Total input(in KWh)
E_F=(O_P/I_P)*100;//All day efficiency(in %)
disp(E_F,'All day efficiency(in %)=');
```

Scilab code Exa 3.36 Calculate the economy of copper in auto transformer and current distribution in primary

```
//Caption:Calculate the economy of copper in auto
   transformer and current distribution in primary
//Exam:3.36
clc;
clear;
close;
V_1=500;//Primary voltage
V_2=400;//Secondary voltage
I_2=100;//Secondary voltage
I_1=V_2*I_2/V_1;//Primary current
disp(I_1,'Current in primary winding(in Amp)=')
K=V_2/V_1;//Transformer ratio
S=K*100;//Saving (in %)
disp(S,'Economy of copper(in %)=')
```

Scilab code Exa 3.37 In a auto transformer determine Transformation ratio secondary current primary current and number of turns across secondary if total number of turns is 250

```
//Caption:In a auto transformer determine
   Transformation ratio secondary current primary
   current and number of turns across secondary if
   total number of turns is 250.
//Exam:3.37
clc;
clear;
close;
V_1=250;//Primary voltage(in Voltage)
V_2=125;//Secondary voltage(in Voltage)
K=V_2/V_1;//Transformation ratio
N_1=250;//Primary turns
disp(K,'Transformation ratio=')
P_f=1;//Unity power factor
L=5;//Value of load(in KW)
I_2=L*1000/(V_2*P_f);//Secondary current(in Amp)
disp(I_2,'Secondary current(in Amp)=');
I_1=K*I_2;//Primary current(in Amp)
disp(I_1,'Primary current(in Amp)=');
N_2=K*N_1;//Secondary turns
disp(N_2,'number of turns across secondary winding='
   );
```

Scilab code Exa 3.38 In an auto transformer determine current in different section and KVA output and power transferred inductively and power transferred conductively from input to output and saving in copper

```
//Caption:In an auto transformer determine current
   in different section and KVA output and power
   transferred inductively and power transferred
   conductively from input to output and saving in
```

```
copper
//Exam:3.38
clc;
clear;
close;
KVA=10;
V_1=2400;//Voltage in first winding
V_2=240;//Voltage in second winding
I_1=KVA*1000/V_1;//Current rating of 2400 Volts winding
I_2=KVA*1000/V_2;//Current rating of 240 Volts winding
I_l=I_1+I_2;//Total load current
disp(I_1,'Current rating of 2400 Volts winding(in Amp)=');
disp(I_2,'Current rating of 240 Volts winding(in Amp)=');
disp(I_l,'Total load current(in Amp)=');
KVA_r=V_1*I_l/1000;//KVA output rating
disp(KVA_r,'KVA output rating(in KVA)=');
P_i=V_1*I_1;//power transferred inductively
P_c=V_1*I_2;//power transferred conductively
disp(P_i,'power transferred inductively(in VA)=');
disp(P_c,'power transferred conductively(in VA)=');
N_1=2640;//Number Primary winding in case of two winding transformer
N_2=2400;//Number Secondary winding in case of two winding transformer
K=N_1/N_2;//Transformer ratio
Saving=(1/K)*100;//Saving in copper
disp(Saving,'Saving in copper(in %)=');
```

Scilab code Exa 3.39 In a transformer calculate Power output and power transformed and power conducted

```
//Caption:In a transformer calculate Power output and power transformed and power conducted
//Exam:3.39
clc;
clear;
close;
KVA=25;
V_s=2200;//Source voltage
V_1=2200;//Voltage in first winding
V_2=220;//Voltage in second winding
I_1=KVA*1000/V_1;//Current rating of 2200 V winding
I_2=KVA*1000/V_2;//Current rating of 220 V winding
V_o=V_1+V_2;//Output voltage
I_l=I_1+I_2;//Input line current
I_o=I_2;//Output current of auto transformer
KVA_r=V_o*I_2/1000;//KVA rating
P_f1=0.8;//
P_o=KVA*P_f1;//Power output at full load and 0.8 power factor
KVA_t=V_1*I_1/1000;//KVA transformed
disp(KVA_t,'KVA transformed(in KVA)=');
P_t=KVA_t*P_f1;//Power transformed(in KW)
disp(P_t,'Power transformed(in KW)=');
KVA_c=V_s*I_o/1000;//KVA conducted(in KVA)
P_c=KVA_c*P_f1;//Power conducted(in KW)
disp(P_c,'Power conducted(in KW)=');
//E_f=Output/(Output+Losses)
//Losses=((1/E_f)-1)*Output
E_f=0.9;//Efficiency of the two winding transformer
P_f2=0.85;//New power factor of the two einding transformer
O_p1=KVA_t*1000*P_f2;//Output of the two winding transformer
L=((1/E_f)-1)*O_p1;//losses in a 2-winding transformer
```

```
//Losses in auto transformer=losses in 2-winding
   transformer
O_P=KVA_r*1000*P_f2;//output of the auto transformer
E_F=(O_P/(O_P+L))*100;//Efficiency of the auto
   transformer(in %)
disp(E_F,'Efficiency of the auto transformer(in %)='
   );
```

Chapter 4

Three phase transformer

Scilab code Exa 4.1 Determines the turns per phase for the HV and LV winding of the 3 phase transformer

```
//Caption:Determines the turns per phase for the HV
   and LV winding of the 3 phase transformer.
//Exam:4.1
clc;
clear;
close;
F_max=0.024;//Maximum flux (in weber)
f=50;//Supply frequency(in Hz)
E_1p=11000;//Primary phase voltage(in Volts)
N_1=ceil(E_1p/(4.44*F_max*f));//Turns per phase on
   primary
disp(N_1,'turns per phase for the H.V. winding of
   the 3 phase transformer=');
E_2l=400;//Secondary line voltage(in Volts)
E_2p=E_2l/(3)^(1/2);//Secondary phase voltage(in
   Volts)
```

```
N_2=ceil(E_2p/(4.44*F_max*f));//turns per phase for
   the L.V. winding of the 3 phase transformer
disp(N_2,'turns per phase for the L.V. winding of
   the 3 phase transformer=');
```

Scilab code Exa 4.2 In a three phase transformer Calculate the secondary line voltage at no load when windings star delta connected and delta star connected

```
//Caption:In a three phase transformer Calculate the
    secondary line voltage at no load when windings
   star delta connected and delta star connected.
//Exam:4.2
clc;
clear;
close;
//when windings are star delta connected
V=3300;//the supply voltage(in Volts)
V_l1=V;//Primary line voltage in star delta
   conection
N_1=420;//turns on the primary side of the
   transformer
N_2=36;//turns on the secondary side of the
   transformer
V_p1=V_l1/(3)^(1/2);//Primary phase voltage in star
   delta connection
V_p2=V_p1*(N_2/N_1);//Secondary phase voltage in
   star delta connection
V_l2=V_p2;//Secondary line voltage when windings are
    star delta connected(in Volts)
disp(V_l2,'Secondary line voltage when windings are
```

```
    star delta connected(in Volts)=');
//when windings are delta star connected
V_P1=V;//Primary phase voltage(in Volts)
V_L1=V_P1;//Primary line voltage in delta star
    connection
V_P2=V_P1*(N_2/N_1);//Secondary phase voltage in
    delta star connection
V_L2=V_P2*(3)^(1/2);//Secondary line voltage when
    windings are delta star connected(in Volts)=;
disp(V_L2,'Secondary line voltage when windings are
    delta star connected(in Volts)=');
```

Scilab code Exa 4.3 Find the secondary no load voltage and primary secondary currents in a 3 phase transformer

```
//Caption:Find the secondary no load voltage and
    primary secondary currents in a 3 phase
    transformer
//Exam:4.3
clc;
clear;
close;
V_l=11000;//Input voltage(in Volts)
V_1ph=V_l/(3)^(1/2);//Phase voltage
KVA=50*10^(3);//
//KVA=((3)^(1/2))*V_l*I_l
I_1l=KVA/(((3)^(1/2))*V_l);//Line current
I_1ph=I_1l;//Star system value of phase current
disp(I_1ph,'Value of primary phase and line current(
    in Amp)=');
N_1=1000;//Primary turns
```

```
N_2=90;//Secondary turns
V_2ph=(N_2/N_1)*V_1ph;//secondary phase voltage(in
    Volts)
//V_2ph=V_2l delta system
disp(V_2ph,'Value of secondary phase and line
    voltage(in Volts)=');
I_2ph=(N_1/N_2)*I_1ph;//secondary phase current(in
    Amp)
disp(I_2ph,'Value of secondary phase current(in Amp)
    =');
I_2l=I_2ph*3^(1/2);//secondary line current(in Amp)
disp(I_2l,'Value of secondary line current(in Amp) =
    ');
```