Scilab Textbook Companion for Electrical And Electronic Principles And Technology by J. Bird[1]

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November 29, 2013

[1]Funded by a grant from the National Mission on Education through ICT, http://spoken-tutorial.org/NMEICT-Intro. This Textbook Companion and Scilab codes written in it can be downloaded from the "Textbook Companion Project" section at the website http://scilab.in

Book Description

Title: Electrical And Electronic Principles And Technology

Author: J. Bird

Publisher: Elsevier, U.K.

Edition: 3

Year: 2007

ISBN: 9780750685566

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

Units associated with basic electrical quantities

Scilab code Exa 1.1 Example 1

```
//Chapter 1, Problem 1
clc;
I=5;                //current
T=2*60;             //time taken to flow current
Q=I*T;              //calculating quantity of electricity
printf("Quantity of electricity Q = %f C \n\n\n",Q);
```

Scilab code Exa 1.2 Example 2

```
//Chapter 1, Problem 2
clc;
M=5;                          //mass in kilogram
A=2;                             //acceleration in m/s2.
F=M*A;                           //calculating the force needed
```

```
printf("Force = %f N \n\n",F);                //displaying the result with unit
```

Scilab code Exa 1.3 Example 3

```
//Chapter 1, Problem 3
clc;
M=0.2;                    //mass in Kg
g=9.81                    // acceleration due to gravity
F=M*g;                    //calculating the force
//Force acting downwards = weight
printf("Force acting downwards = %f N",F);
```

Scilab code Exa 1.4 Example 4

```
//Chapter 1, Problem 4
clc;
F=200;                    //force in Newton
D=20;                     //distance in metre
T=25;                     //time in seconds
W=F*D;                    //calculating work done in kJ
printf("Work done = %f kJ\n\n\n",W)
P=W/T;                    //calculating Power in watt
printf("Average power utilized = %f W\n\n\n",P);
```

Scilab code Exa 1.5 Example 5

```
//Chapter 1, Problem 5
clc;
M=1000;                            //mass in kg
```

```
H=10;                             //height in metre
T=20;                             //time in seconds
g=9.81;                           //acceleration due to gravity
F=M*g;                            //calculating force from newtons law of motion
W=F*H;                            //calculating work
printf("(a) Work done = %f kJ\n\n\n",W/1000);
P=W/T;
printf("(b) Power developed = %f kW",P/1000);
```

Scilab code Exa 1.6 Example 6

```
//Chapter 1, Problem 6
clc;
R1=10;                        //Resistance of R1 in ohms
R2=5;                         //Resistance of R2 in kilohms
R3=100*10^-3;                 //Resistance of R3 in ohms
G1=1/R1;                      //calculating conductance
G2=1/R2;
G3=1/R3;
printf("Conductance of a conductor of resistance 10 ohms = %f S \n\n\n",G1);
printf("Conductance of a conductor of resistance 5 k.ohms = %f mS \n\n\n",G2);
printf("Conductance of a conductor of resistance 100 miliohms = %f S \n\n\n",G3);
```

Scilab code Exa 1.7 Example 7

```
//Chapter 1, Problem 7
clc;
```

```
V=5;                    //source emf
I=3;                    //current in ampere
T=10*60;                //time in seconds
E=V*I*T;                    //calculating energy
printf("Energy provided = %f kJ",E/1000);
```

Scilab code Exa 1.8 Example 8

```
//Chapter 1, Problem 8
clc;
E=1.8*10^6;                     //energy consumes by
   electric heater
T=30*60;                        //time in seconds
V=250;                      //supply voltage
P=E/T;                          //calculating power
   rating of the heater
printf("Power rating of heater = %f kW \n\n\n",P
   /1000);
I=P/V;                              //calculating
   current taken from the supply
printf("Current taken from supply = %f A \n\n\n",I);
```

Chapter 2

An introduction to electric circuits

Scilab code Exa 2.1 Example 1

```
//Chapter 2, Problem 1
clc;
Q=0.24;                         //Charge in coulombs
T=15*10^-3;                         //Time converted
    in seconds
I=Q/T;                          //Calculating
   current
printf("Current flows = %f A",I);
```

Scilab code Exa 2.2 Example 2

```
//Chapter 2, Problem 2
clc;
I=10;                           //Current flows
T=4*60;                     //Time converted in
   seconds
```

```
Q=I*T;                                  //Calculating charge
printf("Electricity transfered = %f C",Q);    //Displaying the result in coulombs
```

Scilab code Exa 2.3 Example 3

```
//Chapter 2, Problem 3
clc;
V=20;                   //Potential difference
I=0.8;                  //Current in ampere
R=V/I;                  //Calculating resistance using Ohm's law
printf("Resistance = %d ohms",R);
```

Scilab code Exa 2.4 Example 4

```
//Chapter 2, Problem 4
clc;
R=2*10^3;                      //Resistance in ohms
I=10*10^-3;                    //Current in ampere
V=R*I;                             //Calculating voltage
printf("Potential difference = %d V",V);
```

Scilab code Exa 2.5 Example 5

```
//Chapter 2, Problem 5
clc;
V=12;                         //voltage
```

```
I=50*10^-3;                 //current
R=V/I;                      //calculating resistance using Ohms law
printf("Resistance of coil = %d ohms",R);
```

Scilab code Exa 2.6 Example 6

```
//Chapter 2, Problem 6
clc;
V1=100;                     //Battery voltage
I1=5*10^-3;                     //Current of 5mA;
V2=25;                          //Voltage is now reduced to 25V
R=V1/I1;                        //Calculating resistance due to V1 using Ohms law
I2=V2/R;                        //Calculating current due to V2 using Ohms law
printf("Resistance of resistor = %d k.ohms\n\n\n",R/1000);
printf("Current when voltage is reduced to 25V = %f mA",I2*1000);
```

Scilab code Exa 2.7 Example 7

```
//Chapter 2, Problem 7
clc;
V=120;                      //Supply voltage
I1=50*10^-3;                        //Current of 50mA
I2=200*10^-6;                       //Current of 200uA
R1=V/I1;                                //Calculating resistance due to I1 using Ohms law
R2=V/I2;                                //Calculating resistance due to I1 using Ohms law
```

```
printf("Resistance of coil draws 50mA current = %f ohms\n\n\n",R1);
printf("Resistance of coil draws 100uA current = %f ohms\n\n\n",R2);
```

Scilab code Exa 2.8 Example 8

```
//Chapter 2, Problem 8, Figure 2.8
clc;
V1=20;                          //Voltage of resistor A
I1=20*10^-3;                    //Current of resistor A
V2=16;                          //Voltage of resistor B
I2=5*10^-3;                     //Current of resistor B
R1=V1/I1;                       //Calculating resistance of resistor A using Ohms law
R2=V2/I2;                       //Calculating resistance of resistor B using Ohms law
printf("Resistance of resistor A = %d k.ohms\n\n\n",R1/1000);
printf("Resistance of resistor B = %f k.ohms\n\n\n",R2/1000);
```

Scilab code Exa 2.9 Example 9

```
//Chapter 2, Problem 9
clc;
P=100;                //power in watt
V=250;                //voltage
I=P/V;                //calculating current
R=V/I;                //calculating resistance using Ohms law
printf("(a) Current = %f A\n\n\n",I);
printf("(b) Resistance = %d ohms",R);
```

Scilab code Exa 2.10 Example 10

```
//Chapter 2, Problem 10
clc;
I=4e-3;                        //current in ampere
R=5e3;                         //resistance
P=I^2*R;                       //calculating power
printf("Power = %f W",P);
```

Scilab code Exa 2.11 Example 11

```
//Chapter 2, Problem 11
clc;
V=240;                    //voltage
R=30;                     //resistance
I=V/R;                    //calculating current using Ohms
    law
P=I*V;                    //calculating power
printf("Current = %d A\n\n\n",I);
printf("Power = %f kW",P/1000);
```

Scilab code Exa 2.12 Example 12

```
//Chapter 2, Problem 12
clc;
I=5;                           //Current in ampere
R=100;                         //Resistance in ohms
V=I*R;                         //Calculating voltage using
   Ohms law
```

```
P=V*I;                          //Calculating power in
   watt
printf("Potential difference across winding = %d V\n
   \n\n",V);
printf("Power dissipated by coil = %d W",P);
```

Scilab code Exa 2.13 Example 13

```
//Chapter 2, Problem 13
clc;
V=240;                  //voltage
R=960;                  //resistance
I=V/R;                  //calculating current using Ohms
    law
P=V*I;                  //calculating power
printf("Power rating P = %d W",P);
```

Scilab code Exa 2.14 Example 14

```
//Chapter 2, Problem 14
clc;
V=12;                   //voltage
R=40;                   //resistance
t=2*60;                 //time period
I=V/R;                  //calculating current using Ohms
    law
P=V*I;                  //calculating power
E=P*t;                  //calculating energy
printf("Current flowing in load = %f A\n\n\n",I);
printf("Power consumed = %f W\n\n\n",P);
printf("Energy dissipated = %f J",E);
```

Scilab code Exa 2.15 Example 15

```
//Chapter 2, Problem 15
clc;
V=15;                   //e.m.f
I=2;                    //current
t=6*60;                 //time period
E=V*t*I;                //calculating energy
printf("Energy = %f kJ",E/1000);
```

Scilab code Exa 2.16 Example 16

```
//Chapter 2, Problem 16
clc;
V=240;                  //supply voltage
I=13;                   //current
t=30;                   //time in hours
P=V*I;                  //power
E=P*t;                  //energy
printf("Energy used per week = %.1f kWh\n\n",E/1000)
   ;
printf("hence weekly cost of electricity = %.2f
   euro",(E*12.5/1000)/100);
```

Scilab code Exa 2.18 Example 18

```
//Chapter 2, Problem 18
clc;
I=10;                   //Curent in ampere
```

```
R=20;                   //Resistance in ohm
T=6;                    //Time in hours
unit=13;                    //Unit of cost of
    electricity
P=I^2*R;                    //Calculating power
    dissipated by electric fire
E=P*T;                      //Calculating Energy used
cost=E*unit;                    //Calculating cost of
    energy
cost=cost/100000;

printf("Power dissipated by element = %f kW\n\n\n",P
    /1000);
printf("Energy used in 6 hours = %f kWh\n\n\n",E
    /1000);
printf("Cost of energy =    %fp",cost);
```

Scilab code Exa 2.19 Example 19

```
//Chapter 2, Problem 19
clc;
P1=3000;                    //power in watts
P2=150;                     //power in watts
t1=20;                      //time in hours
t2=30;                      //time in hours
n1=2;                       //no of fires
n2=6;                       //no of light
m=14;                       //cost per unit
E1=P1*t1;
w1=n1*E1;
E2=P2*t2;
w2=n2*E2;
T=w1+w2;
c=m*(T/1000);
printf("\nIf the cost of electricity is 14 p per
```

```
unit\n")
printf("\n the weekly cost of electricity to the business = %f p",c);
printf("\n\t\t\t\t\t\t= %.2f euro",c/100);
```

Scilab code Exa 2.20 Example 20

```
//Chapter 2, Problem 20,
clc;
V=240;                                    //Supply voltage
P1=1000;                                   //Power rating of Electric toaster
P2=3000;                                   //Power rating of Electric fire
//Calculating fuse current for electric toaster
I1=P1/V;
//Calculating fuse current for electric fire
I2=P2/V;
I1=I1+1;
I2=I2+1;
printf("(i) Current in fuse for Electric toaster = %d A\n\n\n",I1);
printf("(ii) Current in fuse for Electric fire = %d A\n\n\n",I2);
```

Chapter 3

Resistance variation

Scilab code Exa 3.1 Example 1

```
//Chapter 3, Problem 1
clc;
R=600;                          //Resistance of wire
L=5;                            //Length of wire in metre
L1=8;                           //Length of the same wire in
    metre
R2=420;                         //Resistance of the same
   wire
K=R/L;                          //Calculating
   proportionality constant
R1=K*L1;                        //Calculating resistance of
   an 8m length of same wire
L2=R2/K;                    //Calculating length of same
   wire when resistance is 420ohm
printf("The resistance of an 8m length wire= %f ohm\
   n\n\n",R1);
printf("Length of the same wire when the resistance
   is 420 ohm = %fm",L2);
```

Scilab code Exa 3.2 Example 2

```
//Chapter 3, Problem 2
clc;
A=2;                        //Cross-sectional area in milimetre square
R=300;                      //Resistance of wire
A1=5;                      //Cross-sectional area of same wire
R2=750;                     //Resistance of same wire
K=R*A;                      //Calculating proportionality constant
R1=K/A1;                   //Calculating resistance with cross-sectional area 5mm2
A2=K/R2;                   //Calculating cross-sectional area with resistance 750ohm
printf("(a) Resistance of wire = %f ohm\n\n\n",R1);
printf("(b) Cross-sectional area of a wire = %f mm^2",A2);
```

Scilab code Exa 3.3 Example 3

```
//Chapter 3, Problem 3
clc;
R=0.16;                     //resistance of wire
l=8;                        //length of wire
a=3;                        //area of cross-section
//If the cross-sectional area is reduced to 1/3 of its original area then the length must be tripled to 3 8 ,
l1=3*l;
a1=a/3;
k=R*a/l;                          //calculating coefficient of proportionality
R1=k*(l1/a1);                     //calculating new
```

```
resistance with reduced area of cross-section
printf("Resistance of wire = %f ohm",R1);
```

Scilab code Exa 3.4 Example 4

```
//Chapter 3, Problem 4
clc;
L=2000;                    //length of wire
A=100*10^-6;               //area of cross section of wire
p=0.03*10^-6;              //resistivity
R=(p*L)/A;                 //calculating resistance
printf("Resistance of wire = %f ohm",R);
```

Scilab code Exa 3.5 Example 5

```
//Chapter 3, Problem 5
clc;
l=40;                      //length of wire
R=0.25;                    //resistance of wire
p=0.02*10^-6;              //resistivity
a=p*l/R;                   //calculating cross-sectional area of wire
printf("Cross-sectional area of wire = %f mm^2",a*10^6);
```

Scilab code Exa 3.6 Example 6

```
//Chapter 3, Problem 6
clc;
```

```
R=150;                  //resistance of wire
l=1500;                 //length of wire
a=0.17;                 //area of cross-section
p=R*a/l;                //calculating resistivity
printf("Resistivity of the wire = %f micro-ohm metre",p);
```

Scilab code Exa 3.7 Example 7

```
//Chapter 3, Problem 7
clc;
L=1200;                         //Length of copper cable in meter
D=12*10^-3;                     //Diameter of cable in meter
p=1.7*10^-8;                    //Resistivity of cable in ohm.meter
r=D/2;                          //Calculating radius
A=%pi*r^2;                      //Caculating area
R=(p*L)/A;                      //Calculating resistance
printf("Resistance of wire = %f ohm",R);
```

Scilab code Exa 3.8 Example 8

```
//Chapter 3, Problem 8
clc;
R0=100;                         //resistance at 0  C
T=70;                           //tempreture in  C
a=0.0043;                       //temperature coefficient of resistance at 0  C
Rt=R0*(1+(a*T));               //calculating resistance at 70  C
printf("Resistance at 70  C = %f ohm",Rt);
```

Scilab code Exa 3.9 Example 9

```
//Chapter 3, Problem 9
clc;
Rt=27;                    //resistance at 35  C
a0=0.0038;                //temperature coefficient of resistance at 0  C
T=35;                     //tempreture
R0=Rt/(1+(a0*T));         //calculating resistance at 0 C
printf("Resistance at 0 deg = %f ohm",R0);
```

Scilab code Exa 3.10 Example 10

```
//Chapter 3, Problem 10
clc;
R0=1000;                            //resistance at 0  C
T=80;                              //tempreture in   C
a=-0.0005;                          //temperature coefficient of resistance at 0  C
Rt=R0*(1+(a*T));                   //calculating resistance at 80  C
printf("Resistance at 80  C = %f ohm",Rt);
```

Scilab code Exa 3.11 Example 11

```
//Chapter 3, Problem 11
clc;
R0=10;                             //resistance at 20  C
```

```
T=20;                          //tempreture in  C
T1=100;                        //tempreture rises
a=0.004;                       //temperature coefficient of resistance at 0  C
Rt=R0*(1+(a*(T1-T)));              //calculating resistance at 100  C
printf("Resistance at 100  C = %f ohm",Rt);
```

Scilab code Exa 3.12 Example 12

```
//Chapter 3, Problem 12
clc
t=18                       //tempreture in celsius
R1=200                     //resistance in ohm
Rt=240                     //resistance in ohm
tc=0.0039                  //tempreture coefficient of resistance
t1=((Rt-R1)/(R1*tc))+t
printf("Tempreture = %.2f degree celsius",t1)
```

Scilab code Exa 3.13 Example 13

```
//Chapter 3, Problem 13
clc
t1=20                          //tempreture in celsius
t2=90                          //tempreture in celsius
R20=200                        //resistance in ohm
a0=0.004                       //coefficient of resistance
R90=(R20*(1+(a0*t2)))/(1+(a0*t1))
printf("Resistance of wire = %.2f ohm",R90)
```

Chapter 4

Batteries and alternative sources of energy

Scilab code Exa 4.1 Example 1

```
//Chapter 4, Problem 1
clc;
//There is eight cell with same emf and internal
   resistance
r=0.2;
emf=2.2;
//When connected in series
Temf=8*emf;
Tr=8*r;
//When connected in parallel
Tr1=(1/8)*r;
printf("Total emf in series = %f V\n\n\n",Temf);
printf("Total internal resistance in series = %f ohm
   \n\n\n",Tr);
printf("Total emf in parallel = %f V\n\n\n",emf);
printf("Total internal resistance in parallel = %f
   ohm\n\n\n",Tr1);
```

Scilab code Exa 4.2 Example 2

```
//Chapter 4, Problem 2
clc;
r=0.02;                                 //Internal resistance in ohm
emf=2.0;                                  //e.m.f
I1=5;                                     // Current in ampere
I2=50;
V1=emf-(I1*r);                            //Calculating Voltage
V2=emf-(I2*r);
printf("Terminal p.d when 5A current = %f V\n\n\n",V1);
printf("Terminal p.d when 50A current = %f V\n\n\n",V2);
```

Scilab code Exa 4.3 Example 3

```
//Chapter 4, Problem 3
clc;
emf=25;                               //e.m.f
V=24;                                 //Voltage
I=10;                                 //Current in ampere
r=(emf-V)/I;                          //Calculating internal resistance in ohm
printf("Internal resistance of the battery = %f ohm",r);
```

Scilab code Exa 4.4 Example 4

```
//Chapter 4, Problem 4
clc;
emf=1.5;
r=0.2;                          //Internal resistance of
     1 cell
R=58;                           //Resistance of load in
    ohm
E=10*emf;                       //Total battery e.m.f
rt=10*r;                        //Total internal
    resistance in ohm
Rt=R+rt;                        //Total resistance in
    ohm
I=E/Rt;                         //Current flowing in the
     circuit
V=E-(I*rt);                     //P.d. at battery
    terminals
printf("Current flowing in the circuit = %f A\n\n\n"
    ,I);
printf("P.d. at battery terminals = %f V",V);
```

Chapter 5

Series and parallel networks

Scilab code Exa 5.1 Example 1

```
//Chapter 5, Problem 1, Figure 5.2
clc;
V1=5;                                        //assigning the value to parameters
V2=2;
V3=6;
I=4;
V=V1+V2+V3;                                  //Calculating the Battery voltage
printf("Battery Voltage = %f V\n\n",V);      // Displaying the value
R=V/I;                                       //Calculating the total resistance
printf("Total circuit resistance = %f ohm\n\n",R);
R1=V1/I;                                     //Calculating the invidual resistance
R2=V2/I;
```

```
R3=V3/I;
printf("Resistance R1 = %f ohm\n\n",R1);
printf("Resistance R2 = %f ohm\n\n",R2);
printf("Resistance R3 = %f ohm\n\n",R3);
```

Scilab code Exa 5.2 Example 2

```
// Problem 2, Figure 5.3
clc;
R=100;                                  //Assigning the
   values to variable
V=25;
V1=10;
V2=4;
V3=V-V1-V2;                             //Calculating the
   voltage across Resistor R3
printf("Potential difference across R3 = %f V\n\n\n"
   ,V3);
I=V/R;                                  //Calculating the
   current
printf("Current flowing through each resistor = %f A
   \n\n\n",I);
R2=V2/I;                                //Calculating the
   resistance of R2
printf("Resistance R2 = %f ohm\n\n\n",R2);
```

Scilab code Exa 5.3 Example 3

```
//Chapter 5, Problem 3, Figure 5.4
clc;
R1=4;
R2=9;
R3=11;
```

```
V=12;
R=R1+R2+R3;                         //Calculating total resistance R
I=V/R;
printf("Current flowing through circuit = %f A\n\n\n",I);
V1=I*R2;
printf("Potential difference across R2 = %f V\n\n\n",V1);
P=(I^2)*R3;                         //Calculating power dissipated in the 11 ohm resistor
printf("Power dissipated in R3 = %f W\n\n\n",P);
```

Scilab code Exa 5.4 Example 4

```
//Chapter 5, Problem 4, Figure 5.6
clc;
V=(6/(6+4))*50;                     //Calculating the voltage by voltage divider rule
printf("Voltage = %f V\n\n\n",V);
```

Scilab code Exa 5.5 Example 5

```
//Chapter 5, Problem 5, Figure 5.8
clc;
V=24;
I=3;
R1=2;
T=50;
R=V/I;
                                    //Calculating total resistance
```

```
R2=R-R1;  //Calculating the value of unknown resistance
printf("Value of unknown resistance = %f ohm\n\n\n",R2);
V1=I*R1;  //Calculating the voltage across 2 ohm resistor
printf("Potential difference across 2 ohm resistor = %f V\n\n\n",V1);
E=(V*I)*T;
printf("Energy used = %f Wh",E);
```

Scilab code Exa 5.6 Example 6

```
//Chapter 5, Problem 6, Figure 5.13
clc;
//Potential difference across R1 is the same as the supply voltage V
R1=5;
R3=20;
I=11;
I1=8;
//Hence supply voltage is
V=R1*I1;
I3=V/R3;
//Reading on ammeter,
printf("Reading on ammeter = %f A\n\n\n",I3);
I2=I-I1-I3;
R2=V/I2;
//Current flowing through R2
printf("Resistance R2 = %f ohm\n\n\n",R2);
```

Scilab code Exa 5.7 Example 7

```
//Chapter 5, Problem 7, Figure 5.14
clc;
R1=3;
R2=6;
V=12;
//The total circuit resistance R is given by,
R=(R2*R1)/(R1+R2);
printf("Total circuit resistance = %f ohm\n\n\n",R);
//Current in the 3 ohm resistor is given by,
I1=V/R1;
printf("Current in the 3 ohm resistor = %f A\n\n\n",
   I1);
```

Scilab code Exa 5.8 Example 8

```
//Chapter 5, Problem 8, Figure 5.15
clc;
//Resistors R1, R2, R3 in ohm
R1=10;
R2=20;
R3=60;
//Current through R2 in ampere
I2=3;
//Calculating voltage and current
V=I2*R2;
I1=V/R1;
I3=V/R3;
I=I1+I2+I3;
printf("(a) Supply voltage = %f V\n\n\n",V);
printf("(b) Current I = %f A",I)
```

Scilab code Exa 5.10 Example 10

```
//Chapter 5, Problem 10, Figure 5.20
clc;
R1=1;
R2=2.2;
R3=3;
R4=6;
R5=18;
R6=4;
//R3, R4 and R5 are connected in parallel, their
    equivalent resistance R7 is
Z=(1/R3)+(1/R4)+(1/R5);
R7=1/Z;
//circuit is now equivalent to four resistors in
    series
R=R1+R2+R7+R6;
printf("Equivalent circuit resistance = %f ohm",R);
```

Scilab code Exa 5.11 Example 11

```
//Chapter 5, Problem 11, Figure 5.21
clc;
R1=10;
R2=20;
R3=30;
V=240;
//Resistor connected in series
Rs=R1+R2+R3;
Is=V/Rs;
//Resistor connected in parallel
Z=(1/R1)+(1/R2)+(1/R3);
Rp=1/Z;
Ip=V/Rp;
printf("Supply current when resistor in series = %f
```

```
    A\n\n\n",Is);
printf("Supply current when resistor in parallel =
    %f A\n\n\n",Ip);
```

Scilab code Exa 5.12 Example 12

```
//Chapter 5, Problem 12, Figure 5.24
clc;
R1=2.5;
R2=6;
R3=2;
R4=4;
V=200;
//Calculating equivalent resistance Rx of R2 and R3
    in parallel
Rx=(R2*R3)/(R2+R3);
//Calculating equivalent resistance RT of R1, Rx and
     R4 in series
Rt=R1+R4+Rx;
//Supply current
I=V/Rt;
//Calculating current through each resistor
I2=(R3/(R2+R3))*I;
I3=(R2/(R2+R3))*I;
//Calculating p.d across each resistor
V1=I*R1;
Vx=I*Rx;
V4=I*R4;
disp("(a)")
printf("Supply current = %f A\n\n\n",I);
disp("(b)")
printf("Current through R1 and R4 = %f A\n\n\n",I);
printf("Current through R2 = %f A\n\n\n",I2);
printf("Current through R3 = %f A\n\n\n",I3);
disp("(c)")
```

```
printf("p.d. across R1 = %f V\n\n\n",V1);
printf("p.d. across R2 and R3 = %f V\n\n\n",Vx);
printf("p.d. across R4 = %f V\n\n\n",V4);
```

Scilab code Exa 5.13 Example 13

```
//Chapter 5, Problem 13, Figure 5.26
clc;
R1=15;                          //in ohms
R2=10;                          //in ohms
R3=38;                          //in ohms
V=250;                          //in volts
Pt=2500;                        //in watts
I=Pt/V;                         //current in amperes
Rt=V/I;
r=(R1*R2)/(R1+R2);              //equivalent resistance of R1 and R2
V1=I*r;
V2=V-V1;
i=V2/R3;
rx=V2/i;
I1=(R2/(R1+R2))*I;
I2=(R1/(R1+R2))*I;
printf("\n(a) Value of resistor Rx = %d ohm\n\n",rx)
printf("\n(b) Current flowing in each of the four resistors \n I1 = %d A\n I2 = %d A\n I3 = I4 = %d A",I1,I2,i);
```

Scilab code Exa 5.14 Example 14

```
//Chapter 5, Problem 14, Figure 5.27
clc;
//Resistance R1 R2 R3 R4 R5
```

```
R1=2;
R2=9;
R3=1.4;
R4=2;
R5=8;
V=17;
R45=(R4*R5)/(R4+R5);
R34=R3+R45;
R23=(R2*R34)/(R2+R34);
R=R1+R23;
//the circuit is gradually reduced in stages as shown in Fig. 5.28(a)  (d).
I=V/R;
I1=(R2/(R2+R34))*I;
Ix=(R1/(R1+R5))*I1;
printf("From Fig. 5.27,\n\n");
printf("Current Ix = %f A",Ix);
```

Scilab code Exa 5.15 Example 15

```
//Chapter 5, Problem 15
clc;
r1=1000                              //in ohms
r2=4000                              //in ohms
r3=5000                              //in ohms
r4=1500                              //in ohms
V=24                                 //in volts
rt=(((r1+r2)*r3)/(r1+r2+r3))+r4       //equivalent resistance of r1,r2,r3
it=V/rt;                             //total circuit current
i1=(r3/(r1+r2+r3))*it;               //current across top branch
v=i1*r2;                             //volt drop across r2
```

```
i2=((r1+r2)/(r1+r2+r3))*it;          //current across r3
p=it^2*r4;                           //power in wats
printf("(a) volt drop across 4 k resistor = %d V\n\n",v)
printf("(b) Current through the 5 k resistor = %d mA\n\n",i1*10e2)
printf("(c) Power in the 1.5 k resistor = %d mW\n\n",p*10e2)
```

Scilab code Exa 5.16 Example 16

```
//Chapter 5, Problem 16
clc;
R=150;                    //Combined resistance
R1=3*R;                       //Calculating individual resistance
printf("The resistance of one lamp = %f ohm",R1);
```

Chapter 6

Capacitors and capacitance

Scilab code Exa 6.1 Example 1

```
//Chapter 6, Problem 1
clc;
C=4*10^-6;                    //Capacitance in farad
Q=5*10^-3;                    //Charge in coulomb
C1=50*10^-12;                 //Capacitance in farad
V1=2000;                      //Voltage
V=Q/C;
Q1=C*V;
disp("(a)")
printf("Potential difference V = %f V\n\n\n",V);
disp("(b)")
printf("Charge Q = %f C",Q1);
```

Scilab code Exa 6.2 Example 2

```
//Chapter 6,Problem 2
clc;
I=4;                  //Current in ampere
```

```
t=3*10^-3;                //time in seconds
C=20*10^-6;               //Capacitance in farad
Q=I*t;                    //Calculating Charge
V=Q/C;                    //Calculating voltage
printf("p.d. between the plates = %f V",V);
```

Scilab code Exa 6.3 Example 3

```
//Chapter 6,Problem 3
clc;
C=5*10^-6;                //Charge in coulomb
I=2*10^-3;                //Current in ampere
V=800;                    //Voltage
Q=C*V;                    //Calculating charge
t=Q/I;                    //Calculating time of current 2mA to discharge
printf("The capacitor can provide an average discharge current of 2mA = %f sec",t);
```

Scilab code Exa 6.4 Example 4

```
//Chapter 6, Problem 4
clc;
l=20*10^-2;
b=40*10^-2;
Q=0.2*10^-6;                  //Charge
V=0.25*10^3;                  //Voltage
d=5*10^-3;                    //Distance between plates
A=l*b;                        //Calculating area of restangular plated
D=Q/A;                        //Calculating electric flux density
```

```
E=V/d;                              //Calculating electric field strength
printf("Electric fulx density D = %f C/m2 \n\n\n",D);
printf("Electric field strength E = %f V/m",E);
```

Scilab code Exa 6.5 Example 5

```
//Chapter 6, Problem 5
clc;
D=2*10^-6;                              //Flux density
e0=8.85*10^-12;                         //permittivity of free space
er=5;                                   //relative permittivity
E=D/(e0*er);                            //Calculating voltage gradient
disp("Since D/E =  0  r  , hence voltage gradient,");
printf("\n\n\n Voltage gradient = %f V/m",E);
```

Scilab code Exa 6.6 Example 6

```
//Chapter 6, Problem 6
clc;
V=200;                        //Voltage across plates
d=0.8*10^-3;                  //Distance between plates
E=V/d;                        //Calculating electric field density
e=8.85*10^-12;
er=2.3;
D1=E*e;                           //Calculating electric flux density for air
```

```
D2=E*e*er;                        //Calculating electric
    flux density for polythene
printf("Electric field strength = %f kV/m\n\n",E
    /1000);
disp("(a)");
printf("Electric flux density = %f  C/m2\n\n",D1
    *10^6);
disp("(b)");
printf("Electric flux density = %f  C/m2",D2*10^6);
```

Scilab code Exa 6.7 Example 7

```
//Chapter 6, Problem 7
clc;
Q=1.2*10^-6;                      //Charge
A=4*10^-4;                        //Area of plates
d=0.1*10^-3;                      //Distance between
    plates
e0=8.85*10^-12;
er=100;
C=(e0*er*A)/d;                    //Calculating
    capacitance
V=Q/C;                               //Calculating
    potential difference
disp("(a)");
printf("Capacitance = %f pF\n\n\n",C*10^12);
disp("(b)");
printf("p.d. between the plates = %f V",V);
```

Scilab code Exa 6.8 Example 8

```
//Chapter 6, Problem 8
clc
```

```
A=800e-4                         //area of paper
C=4425e-12                       //capacitance in pF
e0=8.85e-12                      //permitivity of free
   space
er=2.5                           //dielectric
d=(e0*er*A)/C                    //thickness of paper
printf("The thickness of the paper = %.1f mm",d
   *10^3)
```

Scilab code Exa 6.9 Example 9

```
//Chapter 6, Problem 9
clc;
n=19;                                //No of interleaved
   plates
n=n-1;
A=(75*10^-3)*(75*10^-3);                 //Calculating
   area of plates
er=5;
e0=8.85*10^-12;
d=0.2*10^-3;                     //Distance between
   plates
C=(e0*er*A*n)/d;                 //Calculating
   capacitance of the capacitor
printf("Capacitance of capacitor = %f nF",C*10^9);
```

Scilab code Exa 6.10 Example 10

```
//Chapter 6, Problem 10
clc;
C1=6*10^-6;                          //Capacitance of
   capacitor1
```

```
C2=4*10^-6;                          //Capacitance of capacitor2
C3=C1+C2;                            //Calculating equivalent capacitance in parallel
C4=(C1*C2)/(C1+C2);                  //Calculating equivalent capacitance in series
disp("(a)");
printf("In parallel, equivalent capacitance = %f uF",C3*10^6);
disp("(b)")
;printf("In series, equivalent capacitance = %f uF",C4*10^6);
```

Scilab code Exa 6.11 Example 11

```
//Chapter 6, Problem 11
clc;
C=12*10^-6;                    //Equivalent capacitance
C1=30*10^-6;                   //Capacitance of capacitor1
C2=(C*C1)/(C1-C);              //Calculating capacitance of capacitor2
printf("Unknown capacitance = %f uF",C2*10^6);
```

Scilab code Exa 6.12 Example 12

```
//Chapter 6, Problem 12
clc;
C1=1*10^-6;                          //Capacitance
C2=3*10^-6;
C3=5*10^-6;
C4=6*10^-6;
```

```
V=100;                                    //Voltage across capacitor
C=C1+C2+C3+C4;                            //Calculating equivalent capacitance in series
Q=C*V;                                    //Calcuating total charge
Q1=C1*V;                                  //Calculating charge on each capacitor
Q2=C2*V;
Q3=C3*V;
Q4=C4*V;
disp("(a)");
printf("Equivalent capacitance C for parallel = %f uF\n\n\n",C*10^6);
disp("(b)");
printf("Total charge = %f mC\n\n",Q*1000);
disp("(2)");
disp("Charge on each capacitor");
printf("Charge on capacitor1 = %f mC\n",Q1*1000);
printf("Charge on capacitor2 = %f mC\n",Q2*1000);
printf("Charge on capacitor3 = %f mC\n",Q3*1000);
printf("Charge on capacitor4 = %f mC\n",Q4*1000);
```

Scilab code Exa 6.13 Example 13

```
//Chapter 6, Problem 13, Figure 6.8
clc;
C1=3*10^-6;                               //Capacitance on each capacitor
C2=6*10^-6;
C3=12*10^-6;
V=350;                                    //Total voltage across capacitors
C=(1/C1)+(1/C2)+(1/C3);                   //Calculating equivalent capacitance
```

```
C=1/C;
Q=C*V;
V1=Q/C1;                          //Calculating voltage across each capacitor
V2=Q/C2;
V3=Q/C3;
disp("(a)");
printf("Equivalent circuit capacitance = %f uF\n\n\n",C*10^6);
disp("(b)");
printf("Charge on each capacitor = %f uF\n\n",Q*10^6);
disp("(c)");
printf("Voltage across 3uF capacitor = %f V\n",V1);
printf("Voltage across 6uF capacitor = %f V\n",V2);
printf("Voltage across 12uF capacitor = %f V\n",V3);
```

Scilab code Exa 6.15 Example 15

```
//Chapter 6, Problem 15
clc;
V=1.25*10^3;                          //Voltage across terminals
C=0.2*10^-6;                          //Capacitance of capacitor
E=50*10^6;                            //Dielectric strength
e0=8.85*10^-12;
er=6;
d=(V/E);                                      //Calculating distance between plates
A=(C*d)/(e0*er);                              //Calculating area of plates
disp("(a)")
printf("Thickness of the mica needed = %f mm\n\n",d
```

```
*10^3);
disp("(b)")
printf("Area of a plate = %f cm2",A*10^4);
```

Scilab code Exa 6.16 Example 16

```
//Chapter 6, Problem 16
clc;
C=3*10^-6;                          //Capacitance
V=400;                              //Voltage across capacitor
t=10*10^-6;                         //Time in sec
W=(1/2)*C*V^2;                      //Calculating energy stored
P=W/t;                              //Calculating power
disp("(a)");
printf("Energy stored in a 3  F capacitor = %f J\n\n",W);
disp("(b)");
printf("Average power = %f kW",P/1000);
```

Scilab code Exa 6.17 Example 17

```
//Chapter 6, Problem 17
clc;
C=12*10^-6;                         //Capacitance
W=4;                                //Energy stored
V=sqrt((2*W)/C);                    //Calculating voltage to which the capacitor must be charged
printf("Potential difference = %f V",V);
```

Scilab code Exa 6.18 Example 18

```
//Chapter 6, Problem 18
clc;
Q=10*10^-3;                    //Charge
W=1.2;                         //Energy stored
V=(2*W)/Q;                     //Calculating voltage
C=Q/V;                         //Calculating capacitance
disp("(a)");
printf("Voltage = %f V\n\n",V);
disp("(b)");
printf("Capacitance = %f uF",C*10^6);
```

Chapter 7

Magnetic circuits

Scilab code Exa 7.1 Example 1

```
//Chapter 7, Problem 1
clc;
phi=150*10^-6;                  //Flux
A=200*100*10^-6;                //Cross sectional area
B=phi/A;                        //Calculating flux
    density
printf("Flux density = %f T",B);
```

Scilab code Exa 7.2 Example 2

```
//Chapter 1, Problem 2
clc;
phi=353*10^-3;                  //Flux
B=1.8;                          //Flux density
A=phi/B;                        //Area of pole face
r=sqrt(A/%pi);                  //Radius
printf("The radius of the pole face = %f mm",r*1000)
    ;
```

Scilab code Exa 7.3 Example 3

```
//Chapter 7, Problem 3
clc;
H=8000;                                  //Magnetic field
    strength
d=30*10^-2;                              //Diameter of
   coil
l=%pi*d;                             //Length
N=750;                               //No of turns
I=(H*l)/N;                           //Calculating
   current in the coil
printf("Current in the coil = %f A",I);
```

Scilab code Exa 7.4 Example 4

```
//Chapter 7, Problem 4
clc;
B=1.2;                               //Magnetic flux
   density
H=1250;                              //Magnetic field
   strength
uo=4*%pi*10^-7;                      //permeability of
   free space
ur=B/(uo*H);                         //Calculating
   relative permeability
printf("Relative permeability = %f",ur);
```

Scilab code Exa 7.5 Example 5

```
//Chapter 7, Problem 5
clc;
B=0.25;                                 //Magnetic flux density
u0=4*%pi*10^-7;                         //permeability of free space
l=12*10^-3;                             //Length
H=B/u0;                                 //Calculating magnetic field strength
mmf=H*l;                                //Calculating magnetomotive force
printf("Magnetic field strength = %d A/m\n\n\n",H);
printf("m.m.f = %d A",mmf);
```

Scilab code Exa 7.6 Example 6

```
//Chapter 7, Problem 6
clc;
N=300;                              //No of turns
I=5;                                //Current in the coil
l=40*10^-2;                         //Length
A=4*10^-4;                          //Area of cross-sectional
H=(N*I)/l;                          //Calculating magnetic field strength
u0=4*%pi*10^-7;                     //permeability of free space
B=u0*H;                             //Flux density
phi=B*A;                            //Fux
disp("(a)");
printf("Magnetic field strength = %d A/m\n\n\n",H);
disp("(b)");
printf("Flux density = %f mT\n\n\n",B*1000);
disp("(c)");
printf("Flux = %f  Wb",phi*10^6);
```

Scilab code Exa 7.7 Example 7

```
//Chapter 7, Problem 7
clc;
d=10*10^-2;                                                //Diameter
N=2000;                                                    //No of turns
I=0.25;                                                    //Current in the coil
B=0.4;                                                     //Magnetic flux density
u0=4*%pi*10^-7;                                            //permeability of free space
l=%pi*d;                                                   //Calculating length of coil
H=(N*I)/l;                                                 //Calculating magnetic field strength
ur=B/(u0*H);                                               //Calculating relative permeability
disp("(a)");
printf("Magnetic field strength = %f A/m\n\n\n",H);
disp("(b)");
printf("Relative permeability = %d",ur);
```

Scilab code Exa 7.8 Example 8

```
//Chapter 7, Problem 8
clc;
A=10*10^-4;                           //cross-sectional area
l=0.2;                                   //mean circumference in meter
```

```
phi=0.3*10^-3;                    //flux
B=phi/A;                          //flux density
H=1000;
mmf=H*l;                          //magnetomotive
    force
disp("From the magnetisation curve for cast iron on
    page74,")
printf("m.m.f = %f A",mmf);
```

Scilab code Exa 7.10 Example 10

```
//Chapter 7, Problem 10
clc;
l=150*10^-3;                                //length
u0=4*%pi*10^-7;                             //
    permeability of free space
ur=4000;                                    //relative
    permeability
A=1800*10^-6;                               //cross-
    sectional area
S=l/(u0*ur*A);                              //
    Calculating reluctance
u=u0*ur;                                    //
    Calculating absolute permeability
printf("Reluctance = %f H^-1\n\n\n",S);
printf("Absolute permeability = %f H/m",u*1000);
```

Scilab code Exa 7.11 Example 11

```
//Chapter 7, Problem 11
clc;
r=50*10^-3;                            //radius
```

```
A=400*10^-6;                          //cross-sectional area
I=0.5;                                //current in the coil
u0=4*%pi*10^-7;                       //permeability of free space
phi=0.1*10^-3;                        //flux
ur=200;                               //relative permeability
l=2*%pi*r;
S=l/(u0*ur*A);                        //Calculating reluctance
N=(S*phi)/I;                          //Calculating no of turns
printf("Reluctance = %f /H\n\n\n",S);
printf("Number of turns = %d turns",N);
```

Scilab code Exa 7.12 Example 12

```
//Chapter 7, Problem 12
clc;
l1=6*10^-2;                       //length 1
A1=1*10^-4;                       //area 1
l2=2*10^-2;                       //length 2
A2=0.5*10^-4;                     //area 2
N=200;                            //no of turns
I=0.4;                            //current in the coil
u0=4*%pi*10^-7;                   //permeability of free space
ur=750;                           //relative permeability
S1=l1/(u0*ur*A1);                 //calculating reluctance for 6 cm long path
S2=l2/(u0*ur*A2);                 //calculating
```

```
reluctance for 2 cm long path
S=S1+S2;                          //calculating total reluctance
phi=(N*I)/S;                      //calculating flux
B=phi/A2;                         //calculating flux density in 2cm path
printf("Flux density in 2cm path = %f T",B);
```

Scilab code Exa 7.13 Example 13

```
//Chapter 7, Problem 13
clc;
l1=40*10^-2;;                               //length of iron path
l2=2*10^-3;                                 //radial air gap
u0=4*%pi*10^-7;
phi=0.7*10^-3;                              //flux
A=5*10^-4;                                  //cross-sectional area
H1=1650;                                    //from B H curve for silicon iron
//Calculation for the silicon iron:
B=phi/A;
mmf1=H1*l1;
//Calculation for the air gap:
H2=B/u0;
mmf2=H2*l2;
mmf=mmf1+mmf2;
disp("From the B H curve for silicon iron on page 74, when B=1.4T, H =1650A/m.");
printf("Hence m.m.f for the iron path = %d A\n\n\n",mmf1);
disp("The flux density will be the same in the air gap as in the iron,");
printf("Hence m.m.f for the air gap = %d A\n\n\n",
```

```
mmf2);
printf("Total m.m.f to produce a flux of 0.6mWb = %d A\n\n\n",mmf);
```

Scilab code Exa 7.15 Example 15

```
//Chapter 7, Problem 15, Figure 7.6
clc;
u0=4*%pi*10^-7;
ur=1;
B=0.80;                          //flux density
H=750;                           //field intensity from B-H curve
l1=25*10^-2;                     //length of cast steel core
l2=1*10^-3;                      //air gap
A=2*10^-4;                       //cross-sectional area
N=5000;                          //no of turns
//for cast steel core
S1=(l1*H)/(B*A);
//For the air gap:
S2=l2/(u0*ur*A);
//Total reluctance
S=S1+S2;
phi=B*A;
I=(S*phi)/N;
printf("Current in the coil to produce a flux density of 0.80T = %f A",I);
```

Chapter 8

Electromagnetism

Scilab code Exa 8.2 Example 2

```
//Chapter 8, Problem 2
clc;
B=0.9;                    //flux density
I=20;                     //current
l=30*10^-2;               //length of the conductor
//Calculating force when conductor is at right angle
F=B*I*l;
//Calculating force when conductor is inclined at 30 to the field
F1=B*I*l*sin(%pi/6);
printf("Force when conductor is at right angle = %f N\n\n\n",F);
printf("Force when conductor is inclined at 30  to the field = %f N",F1);
```

Scilab code Exa 8.3 Example 3

```
//Chapter 8, Problem 3
```

```
clc;
F=1.92;
l=400*10^-3;
B=1.2;
I=F/(B*l);
printf("Current = %f A\n\n\n",I);
printf("If the current flows downwards, the direction of its");
printf(" magnetic field due to the current alone will be clockwise when viewed from above.\n");
printf("The lines of flux will reinforce (i.e. strengthen) the main magnetic field at");
printf("the back of the conductor and will be in opposition in the front (i.e. weaken the field).\n");
disp("Hence the force on the conductor will be from back to front (i.e. toward the viewer).");
```

Scilab code Exa 8.4 Example 4

```
//Chapter 8, Problem 4
clc;
l=350*10^-3;                            //length of conductor
I=10;                                   //current
r=0.06;                                 //radius of pole
phi=0.5*10^-3;                          //flux
A=%pi*r^2;                              //area of pole
B=phi/A;                                //calculating flux density
F=B*I*l;                                //calculating force
printf("Force = %f N",F);
```

Scilab code Exa 8.6 Example 6

```
//Chapter 8, Problem 6
clc;
B=0.8;
l=30*10^-3;
I=50*10^-3;
F=B*I*l;
F1=300*F;
printf("For a single-turn coil, force on each coil side\n");
printf("Force = %f N\n\n\n",F);
printf("When there are 300 turns on the coil there are effectively 300 parallel conductors each carrying a current of 50 mA.\n");
printf("Thus the total force produced by the current is 300 times that for a single-turn coil. Hence force on coil side,\n");
printf("Force = %f N",F1);
```

Scilab code Exa 8.7 Example 7

```
//Chapter 8, Problem 7
clc;
Q=1.6*10^-19;                    //charge in coulombs
v=3*10^7;                        //velocity of charge
B=18.5*10^-6;                    //flux density
F=Q*v*B;                         //Calculating force
printf("Force = %f x10^-17 N",F*10^17);
```

Chapter 9

Electromagnetic induction

Scilab code Exa 9.1 Example 1

```
//Chapter 9, Problem 1
clc;
B=1.25;                           //flux density
v=4;                              //conductor velocity
l=300*10^-3;                      //conductor length
R=20;                             //resistance
E=B*l*v;                          //calculating emf
I=E/R;                            //calculating current
   from ohms law
disp("(a)");
disp("If the ends of the conductor are open
   circuited, no current will flow.");
disp("(b)");
disp("If its ends are connected to a load of 20ohm
   resistance, then");
printf("Current = %f A",I);
```

Scilab code Exa 9.2 Example 2

```
//Chapter 9, Problem 2
clc;
E=9;                        //emf
B=0.6;                      //flux density
l=75*10^-3;                 //length of conductor
//since the conductor, the field and the direction
   of motion are mutually perpendicular
//calculating velocity
v=E/(B*l);
printf("Velocity = %f m/s",v);
```

Scilab code Exa 9.3 Example 3

```
//Chapter 9, Problem 3
clc;
v=15;                           //velocity of conductor
l=0.02;                         //length of conductor
A=2*2*10^-4;                    //area of conductor
phi=5*10^-6;                    //flux
Q1=%pi/2;                       //converting 90 degree
   into radian
Q2=%pi/3;                       //converting 60 degree
   into radian
Q3=%pi/6;                       //converting 30 degree
   into radian
B=phi/A;                        //calculating flux
   density
E90=B*l*v*sin(Q1);              //calculating emf
E60=B*l*v*sin(Q2);
E30=B*l*v*sin(Q3);
disp("(a)");
printf("E.M.F at 90    =%f V\n\n",E90*1000);
disp("(b)");
printf("E.M.F at 60    =%f V\n\n",E60*1000);
disp("(c)");
```

```
printf("E.M.F at 30      =%f V\n\n",E30*1000);
```

Scilab code Exa 9.4 Example 4

```
//Chapter 9, Problem 4
clc;
B=40*10^-6;                    //flux density
l=36;                          //legnth of conductor
v=(400*1000)/(60*60);          //velocity of conductor
E=B*l*v;                       //calculating emf
printf("E.M.F = %f V",E);
```

Scilab code Exa 9.6 Example 6

```
//Chapter 9, Problem 6
clc;
B=1.4;                         //flux density
l=12*10^-2;                    //length
N=80;                          //no of turns
n=1200/60;                     //rotation in sec
E1=90;                         //emf
r=(8*10^-2)/2;
Q90=%pi/2;
//calculating velocity
v=2*%pi*n*r;
//calculating maximum emf
E=2*N*B*v*l*sin(Q90);
//calculating velocity with emf 90V
v=E1/(2*N*B*l*sin(Q90));
//calculating speed of coil
```

```
w=v/r;
w1=(w*60)/(2*%pi);
disp("(a)");
printf("Maximum emf induced = %f V",E);
disp("(b)");
printf("Speed of coil in rev/min = %d rev/min",w1);
```

Scilab code Exa 9.7 Example 7

```
//Chapter 9, Problem 7
clc;
N=200;                          //no of turns
dphi=25*10^-3;                      //change in flux
dt=50*10^-3;                        //change in time
E=-N*(dphi/dt);                     //calculating
    induced emf
printf("Induced emf E = %d V",E);
```

Scilab code Exa 9.8 Example 8

```
//Chapter 9, Problem 8
clc;
N=150;
//Since the flux reverses, the flux changes from+400
     Wb to  400 Wb,
// a total change of flux of 800 Wb.
dphi=800*10^-6;                     //change in flux
dt=40*10^-3;                        //change in time
E=-N*(dphi/dt);                     //calculating
    induced emf
printf("Induced emf = %f V",E);
```

Scilab code Exa 9.9 Example 9

```
//Chapter 9, Problem 9
clc;
L=12;                                   //inductance
dI=4;                                   //change in current
dt=1;                                   //change in time
E=-L*(dI/dt);                           //calculating
   induced emf
printf("Induced emf E = %d V",E);
```

Scilab code Exa 9.10 Example 10

```
//Chapter 9, Problem 10
clc;
E=1.5*10^3;                             //emf
dI=4;                                   //change in flux
dt=8*10^-3;                             //change in time
D=dI/dt;
L=E/D;
printf("Inductance L = %d H",L);
```

Scilab code Exa 9.11 Example 11

```
//Chapter 9, Problem 11
clc;
L=150*10^-3;
E=40;
//since the current is reversed, dI =6  (  6 )=12A
```

```
dI=12;
//calculating change in time dt
dt=(L*dI)/E;
printf("Change in time dt = %f sec",dt);
```

Scilab code Exa 9.12 Example 12

```
//Chapter 9, Problem 12
clc;
L=8;                          //inductance
I=3;                          //current in coil
W=(1/2)*L*I^2;                //calculating energy
    stored in inductor
printf("Energy stored = %d joules",W)
```

Scilab code Exa 9.13 Example 13

```
//Chapter 9, Problem 13
clc;
N=800;                                  //no of turns
phi=5*10^-3;                            //flux
I=4;                                    //current in
    coil
L=(N*phi)/I;                            //calculating
    inductance
printf("Inductance of coil = %f H",L);
```

Scilab code Exa 9.14 Example 14

```
//Chapter 9, Problem 14
```

```
clc;
N=1500;                                    //no of turns
phi=25*10^-3;                              //flux
I=3;                                       //current in coil
dI=3-0;                                    //change in current
dt=150*10^-3;                              //change in time
L=(N*phi)/I;                               //calculating inductance
W=(1/2)*L*I^2;                             //calculating energy stored
E=-L*(dI/dt);                              //calculating induced emf
disp("(a)");
printf("Inductance = %f H\n\n",L);
disp("(b)");
printf("Energy stored = %f J\n\n",W);
disp("(c)");
printf("Induced e.m.f = %d V",E);
```

Scilab code Exa 9.15 Example 15

```
//Chapter 9, Problem 15
clc;
L=0.60;                                //inductance
I=1.5;                                 //current in coil
phi=90*10^-6;                          //flux
N=(L*I)/phi;                           //calculating no of turns
printf("No of turns = %d turns",N);
```

Scilab code Exa 9.16 Example 16

```
//Chapter 9, Problem 16
clc
N=750                               //no of turns
L=3                                 //inductance in henry
I=2                                 //current in ampere
t=20e-3                             //time in milisec
phi=(L*I)/N
E=-(N*phi)/t
printf("Flux linking the coil = %d mWb\n\n",phi*1000)
printf("Induced emf = %d V",E)
```

Scilab code Exa 9.17 Example 17

```
//Chapter 9, Problem 17, Figure 9.10
clc;
N=800;                          //no of turns
I=0.5;                          //current in coil
l=%pi*120*10^-3;                //length of coil
u0=4*%pi*10^-7;                 //permeability of free space
ur=3000;                        //relative permeability
dI=0.5-0;                       //change in current
dt=80*10^-3;                    //change in time
A=400*10^-6;                     //cross sectional area
S=l/(u0*ur*A);                  //calculating reluctance
L=N^2/S;                        //calculating inductance
E=-L*(dI/dt);                   //calculating induced emf
printf("Self inductance L = %f H\n\n\n",L);
printf("Induced emf E = %d V",E);
```

Scilab code Exa 9.18 Example 18

```
//Chapter 9, Problem 18
clc;
D=200;                          //rate of change of current w.r.t time
E=1.5;                          //induced emf
M=E/D;                          //mutual inductance
printf("Mutual inductance M = %f H",M);
```

Scilab code Exa 9.19 Example 19

```
//Chapter 9, Problem 19
clc;
E=0.72;                         //induced emf
M=0.018;                        //mutual inductance
D=E/M;                          //calculating rate of change of current
printf("Rate of change of current = %d A/s", D);
```

Scilab code Exa 9.20 Example 20

```
//Chapter 9, Problem 20
clc;
M=0.2;
dI=10-4;
dt=10*10^-3;
N=500;
E=-M*(dI/dt);
dphi=(E*dt)/N;
printf("Induced emf = %d V\n\n\n",E);
printf("Change of flux = %f mWb",dphi*1000);
```

Scilab code Exa 9.21 Example 21

```
//Chapter 9, Problem 21, Figure 9.11
clc;
dI=6-1;
dt=200*10^-3;
E=15;
Np=1000;
Ns=480;
M=E/(dI/dt);
S=(Np*Ns)/M;
Lp=Np^2/S;
printf("Mutual Inductance = %f H\n\n\n",M);
printf("Reluctance = %d A/Wb\n\n\n",S);
printf("Primary self-inductance Lp = %f H",Lp);
```

Chapter 10

Electrical measuring instruments and measurements

Scilab code Exa 10.1 Example 1

```
//Chapter 10, Problem 1, figure 10.5
clc;
Ia=40*10^-3;                    //maximum permissible current
I=50;                           //total circuit current
ra=25;                          //resistance of instrument
Is=I-Ia;                        //current flowing in shunt
V=Ia*ra;                        //voltage
Rs=V/Is;                        //resistance in shunt
printf("Shunt resistance Rs = %f miliohm\n\n\n",Rs*1000);
printf("A resistance of value 20.02 miliohm needs to be connected in parallel with the instrument.")
```

Scilab code Exa 10.2 Example 2

```
//Chapter 10, Problem 2, figure 10.6
clc;
I=0.008;                          //total circuit current
ra=10;                            //resistance of instrument
V=100;                            //total  p.d
Va=I*ra;                          //calculating voltage across moving coil instrument
Rm=(V-(I*ra))/I;                  //calculating value of multiplier
printf("Multiplier Rm = %f K.ohm\n\n\n",Rm/1000);
printf("A resistance of value 12.49 k ohm needs to be connected in series with the instrument.");
```

Scilab code Exa 10.3 Example 3

```
//Chapter 10, Problem 3, figure 10.9
clc;
S=10000;                     //voltmeter sensitivity
V=100;                       //total voltage
fsd=200;                     //full scale deflection
R1=250;                      //load 1
R2=2e6;                      //load 2
Rv=S*fsd;                    //resistance of voltmeter,
Iv=V/Rv;                     //current flowing in voltmeter
P=V*Iv;                      //calculating power dissipated by voltmeter
Ir1=V/R1;                    //calculating current in load 1
Ir2=V/R2;                    ////calculating current in load 2
```

```
P1=V*Ir1;                    //calculating Power dissipated in load 1
P2=V*Ir2;                    ////calculating Power dissipated in load 2
printf("Power dissipated by voltmeter = %f mW\n\n\n",P*1000);
printf("(a) Power dissipated in load 250 ohm = %f W\n\n\n",P1);
printf("(b) Power dissipated in load 2 M.ohm = %f mW\n\n\n",P2*1000);
```

Scilab code Exa 10.4 Example 4

```
//Chapter 10, Problem 4, figure 10.10
clc;
R=500;                  //load resistance
V=10;                   //supply voltage
ra=50;                  //ammeter resistance
Ie=V/R;                 //calculating expected current
Ia=V/(R+ra);            //calculating actual current
P=Ia^2*ra;              //calculating power dissipated in the ammeter
Pl=Ia^2*R;              //calculating power dissipated in load resistor
printf("(a) Expected ammeter reading = %f mA\n\n\n",Ie*1000);
printf("(b) Actual ammeter reading = %f mA\n\n\n",Ia*1000);
printf("(c) Power dissipated in the ammeter = %f mW\n\n\n",P*1000);
printf("(d) Power dissipated in the load resistor = %f mW\n\n\n",Pl*1000);
```

Scilab code Exa 10.5 Example 5

```
//Chapter 10, Problem 5, figure 10.11, figure 10.12
clc;
V=100;                    //f.s.d of voltmeter
S=1600;                   //sensitivity
R1=40e3;                  //resistor 1
R2=60e3;                  //resistor 2
V1=(R1/(R1+R2))*V;        //voltage between A and B
R=V*S;                    //resistance of voltmeter
R3=((R1*R)/(R1+R));       //equivalent resistance of
   parallel network
V2=(R3/(R2+R3))*V;        //voltage indicated by
   voltmeter
printf("(a) Value of voltage V1 with the voltmeter
   not connected = %f V\n\n\n",V1);
printf("(b) Voltage between A and B = %f V\n\n\n",V2
   );
```

Scilab code Exa 10.6 Example 6

```
//Chapter 10, Problem 6, figure 10.13
clc;
I=20;                     //current flows through a
   load
R=2;                      //load
r=0.01;                   //wattmeter coil resistance
P=I^2*R;                  //power dissipated in the
   load
Rt=R+r;                   //total resistance
P1=I^2*Rt;                //wattmeter reading
printf("(a) Power dissipated in the load = %f W\n\n\
   n",P);
printf("(b) Wattmeter reading = %f W",P1);
```

Scilab code Exa 10.7 Example 7

```
//Chapter 10, Problem 7, figure 10.17
clc;
tc = 100e-6;                    // in s/cm
Vc = 20;                        // in V/cm
w = 5.2;                         // in cm ( width of one
    complete cycle )
h = 3.6;                         // in cm ( peak−to−peak
    height of the display )

//calculation:
T = w*tc
f = 1/T
ptpv = h*Vc

printf("\n (a)The periodic time, T = %.2f ms\n", T
    *10^3)
printf("\n (b)Frequency, f = %.2f kHz\n",f/1000)
printf("\n (c)The peak−to−peak voltage = %.0f V\n",
    ptpv)
```

Scilab code Exa 10.8 Example 8

```
//Chapter 10, Problem 8, figure 10.18
clc;
tc = 50e-3;                         // in s/cm
Vc = 0.2;                           // in V/cm
w = 3.5;                            // in cm ( width of one
    complete cycle )
h = 3.4;                            // in cm ( peak−to−peak
    height of the display )
```

```
//calculation:
T = w*tc
f = 1/T
ptpv = h*Vc
printf("\n\n (a)The periodic time, T = %.2f ms",T
    *10^3)
printf("\n\n (b)Frequency, f = %.2f Hz",f)
printf("\n\n (c)The peak-to-peak voltage = %.2f V",
    ptpv)
```

Scilab code Exa 10.9 Example 9

```
//Chapter 10, Problem 9, figure 10.19
clc;
tc = 500e-6;                // in s/cm
Vc = 5;                     // in V/cm
w = 4;                      // in cm ( width of one
    complete cycle )
h = 5;                      // in cm ( peak-to-peak
    height of the display )
//calculation:
T = w*tc
f = 1/T
ptpv = h*Vc
Amp = ptpv/2
Vrms = Amp/(2^0.5)
printf("\n\n (a)Frequency, f = %.0f Hz",f)
printf("\n\n (b)the peak-to-peak voltage = %.0f V",
    ptpv)
printf("\n\n (c)Amplitude = %.1f V",Amp)
printf("\n\n (d)r.m.s voltage = %.2f V",Vrms)
```

Scilab code Exa 10.10 Example 10

```
//Chapter 10, Problem 10, figure 10.20
clc;
tc = 100E-6;              // in s/cm
Vc = 2;                   // in V/cm
w = 5;                    // in cm ( width of one complete cycle for both waveform )
h1 = 2;                   // in cm ( peak-to-peak height of the display )
h2 = 2.5;                 // in cm ( peak-to-peak height of the display )

//calculation:
T = w*tc
f = 1/T
ptpv1 = h1*Vc
Vrms1 = ptpv1/(2^0.5)
ptpv2 = h2*Vc
Vrms2 = ptpv2/(2^0.5)
phi = 0.5*360/w

printf("\n\n (a)Frequency, f = %f kHz",f/1000)
printf("\n\n (b1)r.m.s voltage of 1st waveform = %.2f V",Vrms1)
printf("\n\n (b2)r.m.s voltage of 2nd waveform = %.2f V",Vrms2)
printf("\n\n (c)Phase difference = %.0f ",phi)
```

Scilab code Exa 10.12 Example 12

```
//Chapter 10, Problem 12, figure 10.30
clc;
rP1 = 3;              // ratio of two powers
rP2 = 20;             // ratio of two powers
rP3 = 400;            // ratio of two powers
rP4 = 1/20;           // ratio of two powers
```

```
//calculation:
X1 = 10*log10(3)
X2 = 10*log10(20)
X3 = 10*log10(400)
X4 = 10*log10(1/20)

printf("\n\n (a)decibel power ratio for power ratio 3 = %.2f dB ",X1)
printf("\n\n (b)decibel power ratio for power ratio 20 = %.1f dB ",X2)
printf("\n\n (c)decibel power ratio for power ratio 400 = %.1f dB ",X3)
printf("\n\n (d)decibel power ratio for power ratio 1/20 = %.1f dB ",X4)
```

Scilab code Exa 10.13 Example 13

```
//Chapter 10, Problem 13
clc;
I2=20;                    //current in amperes
I1=5;                     //current in amperes
d=20*log10(I2/I1);        //in decibel
printf("decibel current ratio = %d dB",d);
```

Scilab code Exa 10.14 Example 14

```
//Chapter 10, Problem 14
clc;
P1=100;                   //input power
P2=6;                     //ouput power
d=10*log10(P2/P1);            //decibel power ratio
printf("decibel power loss = %f dB",d);
```

Scilab code Exa 10.15 Example 15

```
//Chapter 10, Problem 15
clc;
d=14;                              //amplifier gain
P1=8e-3;                           //input power
P2=10^(14/10)*P1;                  //calculating output
    power using logarithm
printf("Output power = %f mW",P2*1000);
```

Scilab code Exa 10.16 Example 16

```
//Chapter 10, Problem 16
clc;
g1=12;                  //gain of stage 1
g2=15;                  //gain of stage 2
g3=-8;                  //gain of stage 3
P=g1+g2+g3;             //Power ratio
P1=10^(P/10);           //calculating overall power gain
printf("Overall power gain (P2/P1) = %f ",P1);
```

Scilab code Exa 10.17 Example 17

```
//Chapter 10, Problem 17
clc;
V2=4;                        //output voltage
V=27;                        //voltage gain in decibels
V1=V2/(10^(V/20));           //calculating input voltage
    using logarithm
printf("Input voltage = %f V",V1);
```

Scilab code Exa 10.18 Example 18

```
//Chapter 10, Problem 18
clc;
BC=100;                    //resistance between point B
    and C
DA=400;                    //resistance between point D
    and A
CD=10;                     //resistance between point C
    and D
Rx=BC*DA/CD;               //calculating unknown
   resistance using balance equation
printf("unknown resistance = %f K ohms",Rx/1000);
```

Scilab code Exa 10.19 Example 19

```
//Chapter 10, Problem 19
clc;
E1=1.0186;                 //emf of standard cell
I1=400e-3;                 //balance length when using
   standard cell
I2=650e-3;                 //balance length when using
   dry cell
E2=E1*(I2/I1);             //calculating emf of dry
   cell
printf("e.m.f of dry cell = %f V",E2);
```

Scilab code Exa 10.20 Example 20

```
//Chapter 10, Problem 20, figure 10.35
clc;
//resistance of coil
R1=400;
R2=400;
R3=5000;
//value of capacitance
C=7.5e-6;
//calculating the value of inductance
L=R1*R2*C;
//calculating the value unknown resistance
r=(R1*R2)/R3;
printf("Inductance = %f H\n\n\n",L);
printf("Resistance = %d ohm",r);
```

Scilab code Exa 10.21 Example 21

```
//Chapter 10, Problem 20, figure 10.35
clc;
fr=400e3;                    //resonant frequency
Qf=100;                      //Q factor
C=400e-12;                   //capacitance
L=((2*%pi*fr)^2*C)^-1;         //calculating inductance
R=2*%pi*fr*L/Qf;               //calculating resistance
printf("(a) Inductance = %f mH\n\n\n",L*1000);
printf("(b) Resistance of inductor = %f ohm",R);
```

Scilab code Exa 10.22 Example 22

```
//Chapter 10, Problem 22
clc
I=2.5e-3                              //current in amperes
R=5000                                //resistance in ohm
```

```
e1=0.4                                    //error tolerance
e2=0.5                                    //error tolerance
V=I*R
emax=e1+e2
V1=(emax/100)*V
printf("V = %.1f V\n accuracy = %.2f V\n",V,V1)
```

Scilab code Exa 10.23 Example 23

```
//Chapter 10, Problem 23
clc
V=36.5                                    //voltage
V1=50                                     //max voltage of
    voltameter
I1=10                                     //max current of
    ammeter
I=6.25                                    //current in amperes
ev=2
R=V/I
ev1=(2/100)*V1
ev2=ev1*100/V
ei1=(ev/100)*I1
ei2=ei1*100/I
eiv=ev2+ei2
r=eiv*R/100
printf("Maximum relative error = %.2f percent or %.2
    f ohm\n\n",eiv,r)
printf("Resistance = %.2f ohm",R)
```

Scilab code Exa 10.24 Example 24

```
//Chapter 10, Problem 24
clc
```

```
R2=100                              //resistamce in ohm
R3=432.5                            //resistamce in ohm
R1=1000                             //resistamce in ohm
e1=1                                //error of R1 in percent
e2=0.5                              //error of R2 in percent
e3=0.2                              //error of R3 in percent
Rx=R2*R3/R1
et=e1+e2+e3
et1=et*Rx/100
printf("Unknown resistance = %.2f ohm \n\n",Rx)
printf("Maximum relative error = %.1f percent\n",et)
printf("Maximum relative erroe in ohm = %.2f ohm",et1)
```

Chapter 12

Transistors

Scilab code Exa 12.2 Example 2

```
//Chapter 12, Problem 2
clc;
Ic=100*10^-3;                   //emitter current
Ie=102*10^-3;                   //collector current
Ib=Ie-Ic;                       //calculating base
   current
printf("Value of base current Ib = %d mA",Ib*1000);
```

Scilab code Exa 12.6 Example 6

```
//Chapter 12, Problem 6
clc;
hFE=125;                        //common-emitter current
    gain
Ic=50*10^-3;                    //collector current
Ib=Ic/hFE;                      //calculating base
   current
printf("Base current Ib = %d microampere",Ib*10^6);
```

Scilab code Exa 12.9 Example 9

```
//Chapter 12, Problem 9
clc;
Id=100*10^-3;                           //operating drain current
dVgs=-0.1;                              //change in gate-source voltage
gfs=0.25;
dId=dVgs*gfs;                           //calculating change in drain current
Id1=Id+dId;                             //new value of drain current
disp("(a)");
printf("Change in drain current = %d mA\n\n\n",dId*1000);
disp("(b)");
printf("New value of drain current = %d mA",Id1*1000);
```

Chapter 13

DC circuit theory

Scilab code Exa 13.1 Example 1

```
//Chapter 13, Problem 1, Figure 13.3,
clc;
//branch currents in figure 13.3 (a)
I1=50-20;
I2=20+15;
I3=I1-120;
I4=15-I3;
I5=120-40;
disp("(a)   from Fig. 13.3(a).");
disp("For junction B:");
printf("I1 = %d A",I1);
disp("For junction C:");
printf("I2 = %d A",I2);
disp("For junction D:");
printf("I3 = %d A",I3);
disp("For junction E:");
printf("I4 = %d A",I4);
disp("For junction F:");
printf("I5 = %d A\n\n\n",I5);
disp("(b)   from Fig. 13.3(b).");
printf("Applying Kirchhoff s voltage law and
```

```
    moving clockwise around the loop,\n");
printf("starting at point A, we get,\n");
//from figure 13.3(b)
I=2;
E=I*(2+2.5+1.5+1)-(3+6-4);
printf("emf E = %d V",E);
```

Scilab code Exa 13.2 Example 2

```
//Chapter 13, Problem 2, Figure 13.4
clc;
A=[6 4;4 5];
B=[4;2];
X=A\B;
I1=X(1,1);                    //I1 and I2 is a branch
    current
I2=X(2,1);
disp("From figure 13.5");
disp("Using Kirchhoff s current law and labeling
    the current directions on the circuit");
disp("Divide the circuit into two loops and apply
    Kirchhoff s voltage law to each.");
printf("we get \n 6I1 + 4I2 = 4 \n 4I1 + 5I2 =2\n\n"
    );
printf(" By solving both equations, we get \n");
printf("I1 = %.3f A\n",I1);
printf("I2 = %.3f A\n",I2);
printf("I1+I2 = %.3f A",I1+I2);
```

Scilab code Exa 13.3 Example 3

```
//Chapter 13, Problem 3, Figure 13.7
clc;
```

```
A=[0.5 2;-5 7];
B=[16;12];
X=A\B;
I1=X(1,1);                    //I1 and I2 is a branch current
I2=X(2,1);
disp("From figure 13.8");
disp("The network is divided into two loops");
printf("Applying Kirchhoff s voltage law to both loops gives,");
printf("16 = 0.5I1 + 2I2 \n12 =   5I1 + 7I2\n\n\n");
printf("Solving these equation we get,\n");
printf("I1 = %.2f A\n",I1);
printf("I2 = %.2f A\n",I2);
printf("Current flowing in R3 = %.2f A",I1-I2);
```

Scilab code Exa 13.4 Example 4

```
//Chapter 13, Problem 4, Figure 13.9
clc;
I=8;                         //total current
A=[13 -11;16 32];
B=[54;112];
X=A\B;
I1=X(1,1)                    //I1 and I2 is a branch current
I2=X(2,1);
disp("from figure 13.10");
printf("Applying Kirchhoff s voltage law to loop 1 and 2, we get");
printf("13I1     11I2 = 54\n 16I1 + 32I2 = 112\n\n\n");
printf("Solving the above simultaneous equations, we get\n");
```

```
printf("I1 = %d A\n",I1);
printf("I2 = %d A\n",I2);
printf("I-I1 = %d A\n",I-I1);
printf("I1-I2 = %d A\n",I1-I2);
printf("I-I1+I2 = %d A\n\n\n",I-I1+I2);
printf("Therefore,\n");
printf("Current flowing in the 2ohm resistor = %f A\n",I1);
printf("Current flowing in the 14ohm resistor = %f A\n",I-I1);
printf("Current flowing in the 32ohm resistor = %f A\n",I2);
printf("Current flowing in the 11ohm resistor = %f A\n",I1-I2);
printf("Current flowing in the 3ohm resistor = %f A\n",I-I1+I2);
```

Scilab code Exa 13.5 Example 5

```
//Chapter 13, Problem 5, figure 13.16
clc;
E1=4;                           //e.m.f source 1
E2=2;                           //e.m.f source 2
R=4                             //resistor
r1=2;                           //internal resistance 1
r2=1;                           //internal resistance 2
Rr2=(R*r2)/(R+r2);              //equivalent resistance
//calculating I2, I3, I4, I5, I6 by using current division formula
I1=E1/(r1+Rr2);
I2=(r2/(R+r2))*I1;
I3=(R/(R+r2))*I1;
Rr1=(R*r1)/(R+r1);
I4=E2/(Rr1+r2);
I5=(r1/(R+r1))*I4;
```

```
I6=(R/(R+r1))*I4;
printf("Redraw the original circuit with sourceE2 removed,being replaced by r2 only, as shown in Fig. 13.17(a)\n\n");
printf("From the equivalent circuit of Fig. 13.17(a) and (b),\n");
printf("I1 = %.3f A\n",I1);
printf("I2 = %.3f A\n",I2);
printf("I3 = %.3f A\n\n\n",I3);
printf("Redraw the original circuit with sourceE1 removed, being replaced by r1 only, as shown in Fig. 13.18(a)\n\n");
printf("From the equivalent circuit of Fig. 13.18(a) and (b)\n")
printf("I4 = %.3f A\n",I4);
printf("I5 = %.3f A\n",I5);
printf("I6 = %.3f A\n\n",I6);
printf("Superimpose Fig. 13.18(a) on to Fig. 13.17(a) as shown in Fig. 13.19\n\n");
printf("Resultant current flowing through source 1 = %.3f A (discharging)\n",I1-I6);
printf("Resultant current flowing through source 2 = %.3f A (charging)\n",I4-I3);
printf("Resultant current flowing through resistor R = %.4f A\n\n",I2+I5);
printf("The resultant currents with their directions are shown in Fig. 13.20");
```

Scilab code Exa 13.6 Example 6

```
//Chapter 13, Problem 6, figure 13.21
clc;
E1=8;                          //e.m.f source 1
E2=3;                          //e.m.f source 2
R=18                           //resistor
```

```
r1=3;                          //internal resistance 1
r2=2;                          //internal resistance 2
Rr2=(R*r2)/(R+r2);             //equivalent resistance
//calculating I2, I3, I4, I5, I6 by using current division formula
I1=E1/(r1+Rr2);
I3=(r2/(R+r2))*I1;
I2=(R/(R+r2))*I1;
Rr1=(R*r1)/(R+r1);
I4=E2/(Rr1+r2);
I6=(r1/(R+r1))*I4;
I5=(R/(R+r1))*I4;
I36=I3-I6;
V=I36*R;
printf("Redraw the original circuit with source E2 removed,being replaced by r2 only, as shown in Fig. 13.22(a)\n\n");
printf("From the equivalent circuit of Fig. 13.22(a) and (b),\n");
printf("I1 = %.3f A\n",I1);
printf("I2 = %.3f A\n",I2);
printf("I3 = %.3f A\n\n\n",I3);
printf("Redraw the original circuit with sourceE1 removed, being replaced by r1 only, as shown in Fig. 13.23(a)\n\n");
printf("From the equivalent circuit of Fig. 13.23(a) and (b)\n")
printf("I4 = %.3f A\n",I4);
printf("I5 = %.3f A\n",I5);
printf("I6 = %.3f A\n\n",I6);
printf("Superimpose Fig. 13.23(a) on to Fig. 13.22(a) as shown in Fig. 13.24\n\n");
printf("Resultant current flowing through 18 ohm resistor = %.3f A\n",I36);
printf("P.d. across the 18ohm resistor = %.3f V\n",V);
printf("Resultant current flowing in the 8V battery = %.3f A (discharging)\n",I1+I5);
```

```
printf("Resultant current flowing in the 3V battery
    = %.3f A(charging)\n\n",I2+I4);
printf("The resultant currents with their directions
     are shown in Fig. 13.24");
```

Scilab code Exa 13.7 Example 7

```
//Chapter 13, Problem 7, figure 13.37
clc;
E1=10;                              //e.m.f source 1
R1=2;                               //resistor 1
R3=5;                                //resistor 2
R2=8;                               //resistor 3
R=10;                               //resistor 4
I1=E1/(R1+R2);
V2=I1*R2;
r=R3+((R1*R2)/(R1+R2));
I=V2/(R+r);
printf("(i) The 10 resistance is removed from the
    circuit as shown in Fig. 13.38(a)\n\n");
printf("(ii) There is no current flowing in the 5
    resistor and current I1 is given by\n");
printf("I1 = %.3f A\n",I1);
printf("P.d across R2 is given by\n E = %.3f V\n\n",
    V2);
printf("(iii) Removing the source of e.m.f. gives
    the circuit of Fig. 13.38(b) Resistance,\n");
printf("r = %.3f ohm\n\n",r);
printf("(iv) The equivalent Th venin s circuit is
     shown in Fig. 13.38(c)");
printf("Hence the current flowing in the 10 resistor
     of Fig. 13.37 is \n");
printf("I = %.3f A",I);
```

Scilab code Exa 13.8 Example 8

```
//Chapter 13, Problem 8, figure 13.39
clc;
E1=12;                          //e.m.f source
R1=1;                          //resistance in ohm
R3=4;                            //resistance in ohm
R2=5;                          //resistance in ohm
R=0.8;                          //resistance in ohm
I1=E1/(R1+R2+R3);                  //current in amperes
V1=R3*I1;
Req=R1+R2;                               //equivalent resistance
r=(R3*Req)/(R3+Req);                             //equivalent resistance
I=V1/(r+R);
printf("(i) The 0.8ohm resistor is removed from the circuit as shown in Fig. 13.40(a).\n\n");
printf("(ii) Current I1 = %f A \n P.d. across 4ohm resistor = %f V\n\n\n",I1,V1);
printf("(iii) Removing the source of e.m.f. gives the circuitshown in Fig. 13.40(b). The equivalent circuitof Fig. 13.40(b) is shown in Fig. 13.40(c), from which, resistance\n");
printf("r = %f ohm \n\n",r);
printf("(iv) The equivalent Th venin s circuit is shown in Fig. 13.40(d), from which, current\n");
printf("Current in the 0.8ohm resistor I = %f A",I);
```

Scilab code Exa 13.9 Example 9

```
//Chapter 13, Problem 9, figure 13.41
```

```
clc;
E1=4;                          //e.m.f source 1
E2=2;                          //e.m.f source 2
r1=2;                           //resistance in ohm
r2=1;                           //resistance in ohm
R=4;                           //resistance in ohm
I1=(E1-E2)/(r1+r2);            //current in amperes
E=E1-(I1*r1);
r=(r1*r2)/(r1+r2);
I=E/(r+R);
P=I^2*R;                          //power dissipated in watt
printf("(i) The 4ohm resistor is removed from the circuit as shown in Fig. 13.42(a)\n\n");
printf("(ii) Current I1 = %f A \n P.d across AB = %f V\n\n",I1,E);
printf("(iii) Removing the sources of e.m.f. gives the circuit shown in Fig. 13.42(b), from which, resistance\n r = %f ohm\n\n",r);
printf("(iv) The equivalent Th venin s circuit is shown in Fig. 13.42(c), from which, current,\n I = %f A\n\n",I);
printf("Power dissipated in the 4 resistor, \nP = %f W",P);
```

Scilab code Exa 13.10 Example 10

```
//Chapter 13, Problem 10, figure 13.43
clc;
E1=4;                         //e.m.f source 1
E2=12;                         //e.m.f source 1
r1=0.5;                          //resistance in ohm
r2=2;                            //resistance in ohm
R3=5;                            //resistance in ohm
I1=(E1-(-E2))/(r1+r2);             //current in ampere
```

```
E=E1-(I1*r1);                              //p.d in volts
r=(r1*r2)/(r1+r2);                         //resistance in ohm
I=E/(r+R3);
V=I*R3;
Ia=(E1-V)/r1;
Ib=(E2+V)/r2;
printf("(i) The 5ohm resistance is removed from the
   circuit as shown in Fig. 13.44(a)\n\n");
printf("(ii) Current I1 = %f A \n P.d across AB = %f
    V\n\n",I1,E);
printf("(iii) Removing the sources of e.m.f. gives
   the circuit shown in Fig. 13.44(b), from which,
   resistance\n r = %f ohm\n\n",r);
printf("(iv) The equivalent Th venin s circuit is
    shown in Fig. 13.44(c), from which, current,\n I
    = %f A\n\n",I);
printf("From Section 13.4(iii), Hence current \n Ia
   = %f A\n",Ia);
printf("From Fig. 13.44(d), Hence current \n Ib = %f
    A",Ib);
```

Scilab code Exa 13.13 Example 13

```
//Chapter 13, Problem 13, figure 13.54
clc;
E=10;                           //e.m.f source 1
R1=2;                              //resistance in ohm
R2=8;                              //resistance in ohm
R3=5;                              //resistance in ohm
R4=10;                              //resistance in ohm
Isc=E/R1;                            //short-circuit
   current in ampere
r=(R1*R2)/(R1+R2);
I=(r/(r+R3+R4))*Isc;
printf("(i) The branch containing the 10 resistance
```

```
is short-circuited as shown in Fig. 13.55(a)\n\n");
printf("(ii) Fig. 13.55(b) is equivalent to Fig. 13.55(a).\n Isc = %f A\n\n",Isc);
printf("(iii) If the 10V source of e.m.f. is removed from Fig. 13.55(a) the resistance  looking-in  at a break made between A and B is given by:\n");
printf("r = %f ohm\n\n",r);
printf("(iv) From the Norton equivalent network shown in Fig. 13.55(c) the current in the 10 resistance, by current division, is given by:\n");
printf("I = %f A",I);
```

Scilab code Exa 13.14 Example 14

```
//Chapter 13, Problem 14, figure 13.56
clc;
E1=4;                          //e.m.f source 1
E2=2;                          //e.m.f source 2
R1=2;                            //resistance in ohm
R2=1;                            //resistance in ohm
R3=4;                            //resistance in ohm
I1=E1/R1;                        //current in ampere
I2=E2/R2;                        //current in ampere
Isc=I1+I2;                      //short-circuit current
r=(R1*R2)/(R1+R2);
I=(r/(r+R3))*Isc;
printf("(i) The 4ohm branch is short-circuited as shown in Fig. 13.57(a)");
printf("(ii) From Fig. 13.57(a),\n  Isc = %f A\n\n",Isc);
printf("(iii) If the sources of e.m.f. are removed the resistance looking-in  at a break made
```

```
   between A and B is given by:\n");
printf("r = %f ohm\n\n",r);
printf("(iv) From the Norton equivalent network
   shown inFig. 13.56(b) the current in the 4ohm
   resistance isgiven by:\n");
printf("I = %f A",I);
```

Scilab code Exa 13.15 Example 15

```
//Chapter 13, Problem 15, figure 13.58
clc;
E1=4;                        //e.m.f source 1
E2=12;                        //e.m.f source 2
R1=0.5;                          //resistance in ohm
R2=2;                          //resistance in ohm
R3=5;                          //resistance in ohm
I1=E1/R1;                          //current in ampere
I2=E2/R2;                          //current in ampere
Isc=I1-I2;                   //short-circuit current
r=(R1*R2)/(R1+R2);
I=(r/(r+R3))*Isc;
printf("(i) The 5ohm branch is short-circuited as
   shown in Fig. 13.59(a)\n\n");
printf("(ii) From Fig. 13.59(a),\n Isc = %f A\n\n",
   Isc);
printf("(iii) If each source of e.m.f. is removed
   the resistance looking-in  at a break made
   between A and B is given by:\n");
printf("r = %f ohm\n\n",r);
printf("(iv) From the Norton equivalent network
   shown in Fig. 13.59(b) the current in the 5
   resistance is given by:\n");
printf("I = %f A",I);
```

Scilab code Exa 13.16 Example 16

```
//Chapter 13, Problem 16, figure 13.60
clc;
E1=24;                    //e.m.f source 1
R1=3;                      //resistance in ohm
R2=1.66;                      //resistance in ohm
R3=10;                      //resistance in ohm
R4=5;                      //resistance in ohm
R5=20;                      //resistance in ohm
Isc=E1/R4;                //short-circuit current
r=(R3*R4)/(R4+R3);
I=(r/(r+R2+R1))*Isc;
printf("(i) The branch containing the 3ohm
    resistance is shortcircuited as shown in Fig.
    13.61(a)\n\n");
printf("(ii) From the equivalent circuit shownin Fig
    . 13.61(b), \nIsc = %f A\n\n",Isc);
printf("(iii) If the 24V source of e.m.f. is removed
     the resistance  looking-in   at a break made
    betweenA and B is obtained from Fig. 13.61(c) and
     its equivalent circuit shown in Fig. 13.61(d)
    and is given by:\n");
printf("r = %f ohm\n\n",r);
printf("(iv) From the Norton equivalent network
    shown in Fig. 13.61(e) the current in the 3ohm
    resistance is given by: \n");
printf("I = %.1f A\n\n",I);
```

Scilab code Exa 13.17 Example 17

```
//Chapter 13, Problem 17, Figure 13.62
```

```
clc;
I1=15                                    //current source in ampere
R1=6;                                   //resistance in ohm
R2=4;                                    //resistance in ohm
R3=2;                                    //resistance in ohm
R4=8;                                    //resistance in ohm
R5=7;                                    //resistance in ohm
Isc=(R1/(R1+R2))*I1;                    //short-circuit current
R12=R1+R2;
R45=R4+R5;
r=(R12*R45)/(R12+R45);
I=(R1/(R1+R3))*Isc;
printf("(i) The 2ohm resistance branch is short-circuited as shown in Fig. 13.63(a)\n\n");
printf("(ii) Fig. 13.63(b) is equivalent to Fig. 13.63(a).\n");
printf("Hence Isc = %f A\n\n",Isc);
printf("(iii) If the 15A current source is replaced by an opencircuit then from Fig. 13.63(c),");
printf("the resistance looking-in  at a break made between A and B is given by (6+4)ohm in parallel with (8+7)ohm, i.e.\n r = %f ohm\n\n",r);
printf("(iv) From the Norton equivalent network shown in Fig. 13.63(d) the current in the 2ohm resistance isgiven by: \n");
printf("I = %f A",I);
```

Scilab code Exa 13.19 Example 19

```
//Chapter 13, Problem 19, figure 13.70
clc;
Isc=4;                          //short-circuit current
r=3;                            //resistance in ohm
E=Isc*r;                        //open-circuit voltage
printf("The open-circuit voltage E across terminals
   AB in Fig. 13.70 is given by:\n E = %d V\n\n",E);
printf("Hence the equivalent Th venin circuit is as
    shown in Fig. 13.71");
```

Scilab code Exa 13.20 Example 20

```
//Chapter 13, Problem 20, figure 13.72
clc;
E1=12;                                  //e.m.f source 1
E2=24;                                  //e.m.f source 2
r1=3;                                     //resistance in
   ohm
r2=2;                                       //resistance in
    ohm
R=1.8;                                    //resistance in
   ohm
Isc1=E1/r1;                                 //short-circuit
    current
Isc2=E2/r2;                                   //short-
   circuit current
Isc=Isc1+Isc2;                                  //short-
   circuit current
r=(r1*r2)/(r1+r2);
E=Isc*r;
I=(E/(r+R));
printf("For the branch containing the 12V source,
   converting to a Norton equivalent circuit gives \
   nIsc1 = %d A\n",Isc1);
printf("For the branch containing the 24V source,
```

```
converting to a Norton equivalent circuit gives \nIsc2 = %d A\n\n",Isc2);
printf("Thus Fig. 13.73(a) shows a network equivalent to Fig. 13.72");
printf("From Fig. 13.73(a) the total short-circuit current and the total resistance is given by\n");
printf("Isc = %f A\n r = %f ohm\n Thus Fig. 13.73(a) simplifies to Fig. 13.73(b).",Isc,r);
printf("The open-circuit voltage across AB of Fig. 13.73(b),\n E = %f V\n",E);
printf("Hence the Th venin equivalent circuit is as shown in Fig. 13.73(c).");
printf("When the 1.8 resistance is connected betweenterminals A and B of Fig. 13.73(c) the current Iflowing is given by\n I = %f A",I);
```

Scilab code Exa 13.21 Example 21

```
//Chapter 13, Problem 21, figure 13.74
clc;
E1=10;                          //e.m.f source 1
r1=2000;                        //resistance in ohm
E2=6;                           //e.m.f source 2
r2=3000;                        //resistance in ohm
I1=1*10^-3;                     //current in ampere
R1=600;                         //resistance in ohm
R2=200;                         //resistance in ohm
Isc1=E1/r1;                     //short-circuit current
Isc2=E2/r2;                     //short-circuit
```

```
current
Isc=Isc1+Isc2;                          //short-circuit current
R=(r1*r2)/(r1+r2);
Vcd=Isc*R;
Vef=I1*R1;
E=Vcd-Vef;
r=(R+R1);
I=E/(r+R2);
printf("For the branches containing the 10V sourceand 6V source, converting to a Norton equivalent network respectively gives\n");
printf("Isc1 = %f mA\nIsc2 = %f mA\n\n",Isc1*1000,Isc2*1000);
printf("Thus the network of Fig. 13.74 converts to Fig. 13.75(a).\n\n");
printf("Combining the 5mA and 2mA current sources gives the equivalent network of Fig. 13.75(b)\n");
printf("where the short-circuit current for the original two branches considered is 7mA and the resistance is \n = %f ohm\n\n",R);
printf("The open-circuit voltage across CD is \n = %f V\n",Vcd);
printf("The open-circuit voltage across EF is\n = %f V\n\n Thus Fig. 13.75(b) converts to Fig. 13.75(c).",Vef);
printf("Combining the two Thvenin circuits gives\n E = %f V\n r = %f ohm",E,r);
printf("\n\nHence the current I flowing in a 200 ohm resistance connected between A and B is given by\n");
printf(" I = %f mA",I*1000);
```

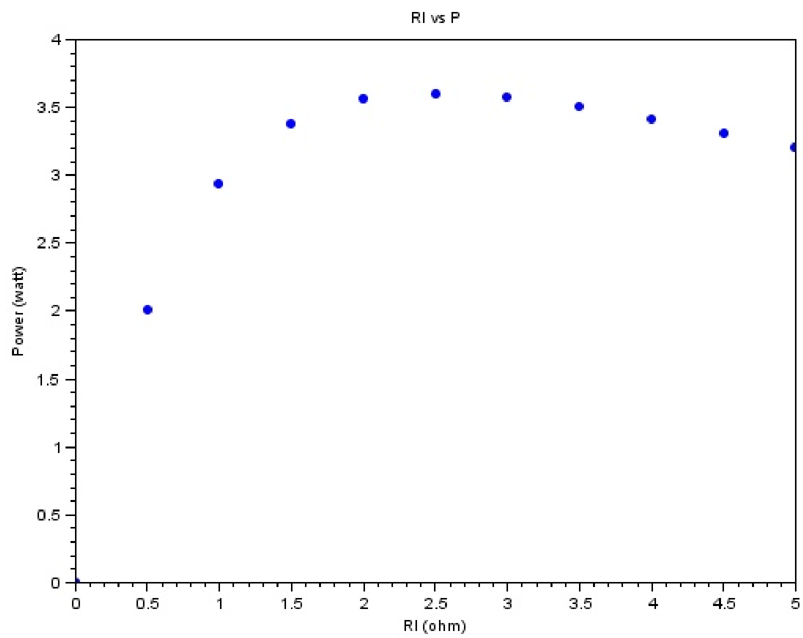

Figure 13.1: Example 22

Scilab code Exa 13.22 Example 22

```
//Chapter 13, Problem 22, figure 13.82
clc;
E=6;                            //in volt
r=2.5;                          //in ohm

//defining a function
function a = myfunction ( c,d,e)
b = c/(d+e);
a=b^2*e;
endfunction


for Rl=0:0.5:5
    P=myfunction(E,r,Rl)
    x=linspace(0,7,12);
y=linspace(0,5,12);
plot(Rl,P,".");
xtitle("Rl vs P","Rl (ohm)","Power (watt)");
end

printf("A graph of RL against P is shown\n");
printf("i.e. maximum power occurs when RL = R, which
    is what the maximum power transfer theorem
   states.");
```

Scilab code Exa 13.23 Example 23

```
//Chapter 13, Problem 23, figure 13.83
clc;
E=30;                              //e.m.f source
r=1.5;                           //resistance in ohm
Rl=r;
I=E/(r+Rl);                            //current in
```

```
ampere
P=I^2*Rl;                                //power in watt
printf("The circuit diagram is shown in Fig. 13.84.\n\n");
printf("From the maximum power transfer theorem, for maximum power dissipation, RL =r\n\n");
printf("maximum power dissipated = %f W",P);
```

Scilab code Exa 13.24 Example 24

```
//Chapter 13, Problem 24, figure 13.85
clc;
R1=3;                                    //resistance in ohm
R2=12;                                   //resistance in ohm
E=15;                                    //e.m.f source
E1=(R2/(R1+R2))*E;                       //p.d in volts
r=(R1*R2)/(R1+R2);                       //resistance in ohm
Rl=r
I=E1/(r+Rl);                             //current in amperes
P=I^2*Rl;                                //power in watt
printf("(i) Resistance RL is removed from the circuit as shown in Fig. 13.86(a)\n\n");
printf("ii) The p.d. across AB is the same as the p.d. across the 12 resistor. Hence\n");
printf("E = %d V\n\n",E1);
printf("(iii) Removing the source of e.m.f. gives the circuit of Fig. 13.86(b), from which, resistance,\n");
```

```
printf("r = %f ohm\n\n\n",r);
printf("(iv) The equivalent Th venin s circuit
   supplying terminalsAB is shown in Fig. 13.86(c),
   from which,\n");
printf("For maximum power, RL =r\n");
printf("Power, P, dissipated in load RL, = %d W",P);
```

Chapter 14

Alternating voltages and currents

Scilab code Exa 14.1 Example 1

```
//Chapter 14, Problem 1
clc;
f1=50;                          //frequency in hertz
f2=20*10^3;                     //frequency in hertz
T1=1/f1;                        //time period in sec
T2=1/f2;                        //time period in sec
printf("(a) Periodic time T = %f sec\n\n",T1);
printf("(b) Periodic time T = %f sec",T2);
```

Scilab code Exa 14.2 Example 2

```
//Chapter 14, Problem 2
clc;
t1=4*10**-3;                        //time period in sec
t2=4*10**-6;                        //time period in sec
f1=1/t1;                            //frequency in hertz
```

```
f2=1/t2;                              //frequency in hertz
printf("(a) Frequency F = %f Hz\n\n",f1);
printf("(b) Frequency F = %f KHz",f2/1000);
```

Scilab code Exa 14.3 Example 3

```
//Chapter 14, Problem 3
clc;
c=5;                        //no of sycle
t=8*10**-3;                 //time period in sec
T=t/c;
F=1/T;                      //frequency in hertz
printf("Frequency F = %f Hz\n\n",F);
```

Scilab code Exa 14.4 Example 4

```
//Chapter 14, Problem 4, Figure 14.5
clc;
funcprot(0)
deff('[freq]=function1(time)','freq=1/time')
deff('[ave]=function2(base,area)','ave=area/base')
deff('[rms]=function3(a1,a2,a3,a4)','rms=sqrt((a1^2+a2^2+a3^2+a4^2)/4)')
deff('[form]=function4(rms,ave)','form=rms/ave')
deff('[peak]=function5(max,rms)','peak=max/rms')

//from triangular waveform (Fig. 14.5(a))
t=20e-3;
b=t/2;
h=200;
v1=25;
v2=75;
v3=125;
```

```
v4=175;
f=function1(t);
a=(1/2)*b*h;
av=function2(b,a);
r=function3(v1,v2,v3,v4);
fr=function4(r,av);
p=function5(h,r);
disp("Triangular waveform")
printf("(i) Frequency = %d Hz \n\n",f);
printf("(ii) Average value of waveform = %d V\n\n",av);
printf("(iii) R.m.s value = %f V \n\n",r);
printf("(iv) Form factor = %f \n\n",fr);
printf("(v) peak factor = %f \n\n\n\n",p);

//from rectangular waveform (Fig. 14.5(b))
t1=16e-3;
b1=t1/2
i1=10;
f1=function1(t1);
a1=i1*b1;
av1=function2(b1,a1);
r1=function3(i1,i1,i1,i1);
fr1=function4(r1,av1);
p1=function5(i1,r1);
disp("Rectangular waveform")
printf("(i) Frequency = %f Hz \n\n",f1);
printf("(ii) Average value of waveform = %d A\n\n",av1);
printf("(iii) R.m.s value = %d A \n\n",r1);
printf("(iv) Form factor = %d \n\n",fr1);
printf("(v) peak factor = %d \n\n",p1);
```

Scilab code Exa 14.6 Example 6

```
//Chapter 14, Problem 6
clc;
I=20;                    //peak value current
Irms=0.707*I;            //rms value
printf("r.m.s. value of a sinusoidal current = %f A"
   ,Irms);
```

Scilab code Exa 14.7 Example 7

```
//Chapter 14, Problem 7
clc;
Vrms=240;                          //rms voltage
Vp=Vrms/0.707;                     //peak voltage
Vav=0.637*Vp;                      //average value of
   voltage
printf("Peak voltage = %f V\n\n",Vp);
printf("Mean value = %f V",Vav);
```

Scilab code Exa 14.8 Example 8

```
//Chapter 14, Problem 8
clc;
Vav=150;                           //average value of
   voltage
Vp=Vav/0.637;                      //peak voltage
Vrms=0.707*Vp;                          //rms voltage
printf("Maximum value = %f V\n\n",Vp);
printf("r.m.s value = %f V",Vrms);
```

Scilab code Exa 14.9 Example 9

```
//Chapter 14, Problem 9
clc;
//from eqn v=282.8(sin 314 t)
Vm=282.8;                                    //peak voltage
w=314;
t=4e-3;
Vrms=0.707*Vm;
f=w/(2*%pi);
v=282.8*sin(314*t);
printf("(a) Comparing Comparing v=282.8 sin 314 t with this general expression gives the peak voltage as 282.8V\n");
printf("v = %f V\n\n",Vrms);
printf("(b) Angular velocity w = 314 rad/s, therefore\n");
printf("f = %f Hz\n\n",f);
printf("(c) When t = 4ms\n");
printf("v = %f V",v);
```

Scilab code Exa 14.10 Example 10

```
//Chapter 14, Problem 10
clc;
Vm=75;                                //peak voltage
w=200*%pi;
phi=0.25;
Vpp=2*Vm;                             //peak to peak voltage
Vrms=0.707*Vm;                        //rms voltage
T=(2*%pi)/w;                          //time period
f=1/T;                                //frequency
angle=phi*(180/%pi);
printf("Comparing v=75 sin((200*pi*t)  0.25) with the general expression, we get\n");
printf("(a) Amplitude or peak value = %d V\n\n",Vm);
```

```
printf("(b) Peak-to-peak value = %d V\n\n",Vpp);
printf("(c) The r.m.s. value = %d V\n\n",Vrms);
printf("(d) The periodic time = %f sec\n\n",T);
printf("(e) Frequency f = %d Hz\n\n",f);
printf("(d) Phase angle = %f deg",angle);
```

Scilab code Exa 14.11 Example 11

```
//Chapter 14, Problem 11
clc;
T=0.01;                               //time period
Vm=40;                                 //peak voltage
w=(2*%pi)/T;
v=-20;
phi=asin(v/Vm);
printf("instantaneous voltage can be expressed as\n
   v=40*sin((200*pi*t)+phi)");
printf("When time t=0, v=-20\n")
printf("phi = %d",phi);
```

Scilab code Exa 14.12 Example 12

```
//Chapter 14, Problem 12
clc;
Imax = 120;                            //current in amperes
w = 100*%pi;                           // in rad/sec
phi = 0.36;                            // in rad
t1 = 0;                                // in secs
t2 = 0.008;                            // in secs
i = 60;                                // in amperes

//calculation:
//for a sine wave
```

```
f = w/(2*%pi)
T = 1/f
phid = phi*180/%pi
i0 = Imax*sin((w*t1) + phi)
i8 = Imax*sin((w*t2)+phi)
ti = (asin(i/Imax) - phi)/w
tm1 = (asin(Imax/Imax) - phi)/w

printf("\n (a)Peak value = %.0f A, Periodic time T = %.2f sec, Frequency, f = %.0f Hz Phase angle = %.1f  \n\n", Imax, T, f, phid)
printf("\n (b) When t = 0, i = %.1f A\n\n",i0)
printf("\n (c)When t = 8 ms = %.1f A\n\n", i8)
printf("\n (d)When i is 60 A, then time t = %.2E s\n\n",ti)
printf("\n (e)When the current is a maximum, time, t = %.2E s\n\n",tm1)
```

Chapter 15

Single phase series AC circuits

Scilab code Exa 15.1 Example 1

```
//Chapter 15, Problem 1
clc;
f1=50;                              //frequency in hertz
L1=0.32;                            //inductance
xl=124;                             //reactance
f2=5000;                            //frequency in hertz
Xl=2*%pi*f1*L1;                     //inductive
   reactance
L=xl/(2*%pi*f2);                    //inductance
printf("(a) Inductive reactance,\n Xl = %.1f ohm\n\n
   ",Xl);
printf("(d) Inductance,\n L = %.3f mH\n\n",L*1000);
```

Scilab code Exa 15.2 Example 2

```
//Chapter 15, Problem 2
clc;
f1=50;                          //frequency in hertz
```

```
L1=40e-3;                    //inductance
V=240;                       //voltage
V2=100;                      //voltage
f2=1000;                     //frequency in hertz
Xl=2*%pi*f1*L1;              //inductive reactance
Xl2=2*%pi*f2*L1;             //inductive reactance
I=V/Xl;                      //current
I2=V2/Xl2;                   //current
printf("(a) Inductive reactance, Xl = .2%f ohm \nCurrent I = %.2f A\n\n",Xl,I);
printf("(b) Inductive reactance, Xl = %.1f ohm \nCurrent I = %.3f A\n\n",Xl2,I2);
```

Scilab code Exa 15.3 Example 3

```
//Chapter 15, Problem 3
clc;
f=50;                        //frequency in hertz
f2=20e3;                     //frequency in hertz
C=10e-6;                     //capacitance in farad
Xc=1/(2*%pi*f*C);            //capacitive reactance
Xc2=1/(2*%pi*f2*C);          //capacitive reactance
printf("(a) Capacitive reactance Xc = %.1f ohm\n\n",Xc);
printf("(b) Capacitive reactance Xc = %.3f ohm\n\n",Xc2);
printf("Hence as the frequency is increased from 50 Hz to 20 kHz, XC decreases from %.1f to %.3f (see Fig. 15.5)",Xc,Xc2);
```

Scilab code Exa 15.4 Example 4

```
//Chapter 15, Problem 4
clc;
f=50;                           //frequency in hertz
Xc=40;                           //capacitive reactance
C=1/(2*%pi*f*Xc);                //capacitance in farad
printf("Capacitance C = %.2f uF",C*10^6);
```

Scilab code Exa 15.5 Example 5

```
//Chapter 15, Problem 5
clc;
f=50;                         //frequency in hertz
V=240;                           //voltage
C=23e-6;                         //capacitance
Xc=1/(2*%pi*f*C)                 //capacitive reactance
I=V/Xc;                          //current
printf("Current I = %.2f A",I)
```

Scilab code Exa 15.6 Example 6

```
//Chapter 15, Problem 6
clc;
Vr=12;                           //p.d. across the
   resistance
Vl=5;                            //p.d. across the
   inductance
//From the voltage triangle of Fig. 15.6,
```

```
V=sqrt(Vr^2+Vl^2);
phi=atan(Vl/Vr);
printf("Supply voltage V = %d V\n\n",V);
printf("Circuit phase angle = %.2f deg (lagging)",
   phi*(180/%pi));
```

Scilab code Exa 15.7 Example 7

```
//Chapter 15, Problem 7
clc;
R=4;                        //coil resistance
L=9.55e-3;                  //inductance
f=50                        //frequency in hertz
V=240;                      //supply voltage
Xl=2*%pi*f*L;               //inductive reactance,
Z=sqrt(R^2+Xl^2);           //impedance
I=V/Z;                      //current
phi=atan(Xl/R);
printf("(a) Inductive reactance Xl = %d ohm\n\n",Xl)
   ;
printf("(b) Impedance Z = %d ohm\n\n",Z);
printf("(c) Current I = %f A\n\n",I);
printf("The circuit and phasor diagrams and the
   voltage and impedance triangles are as shown in
   Fig. 15.6\n");
printf("phi = %f lagging",phi*(180/%pi));
```

Scilab code Exa 15.8 Example 8

```
//Chapter 16, Problem 8
clc;
L=0.20;                         //inductance
R=60;                            //resistance
```

```
C=20e-6;                            //capacitance
V=20;                              //supply voltage
fr=(2*%pi)^-1*sqrt((1/(L*C))-(R^2/L^2));
Xl=2*%pi*fr*L;                     //inductive reactance
Rd=L/(R*C);
Ir=V/Rd;
Q=Xl/R;
printf("(a) Resonant frequency of the circuit = %f Hz\n\n",fr);
printf("(b) Dynamic resistance Rd = %f ohm\n\n",Rd);
printf("(c) Current at resonance Ir = %f A\n\n",Ir);
printf("(d) Q factor of circuit = %f",Q);
```

Scilab code Exa 15.9 Example 9

```
//Chapter 15, Problem 9
clc;
L=318.3e-3;                  //inductance
R=200;                        //resistance
V=240;                       //supply voltage
f=50;                         //frequency in hertz
Xl=2*%pi*f*L;                //inductive reactance,
Z=sqrt(R^2+Xl^2);            //impedance
I=V/Z;
Vl=I*Xl;
Vr=I*R;
phi=atan(Xl/R);
printf("(a) Inductive reactance = %f ohm\n\n",Xl);
printf("(b) Impedance Z = %.1f ohm\n\n",Z);
printf("(c) Current I = %.3f A\n\n",I);
printf("(d) The p.d. across the coil = %1f V\n\n",Vl);
printf("    The p.d. across the resistor =  %.1f V\n\n",Vr);
printf("(e) From the impedance triangle, angle = %f
```

```
deg (lagging)\n\n",phi*(180/%pi));
```

Scilab code Exa 15.10 Example 10

```
//Chapter 15, Problem 10
clc;
//from eqn v=200 (sin 500t)
Vm=200;
w=500;
V=0.707*200;
L=200e-3;                        //inductance
R=100;                           //resistance
Xl=w*L;                          //inductive reactance
Z=sqrt(R^2+Xl^2);                //impedance
I=V/Z;
Vl=I*Xl;
Vr=I*R;
phi=atan(Xl/R);
printf("(a) Inductive reactance = %d ohm\n\n",Xl);
printf("(b) Impedance Z = %.1f ohm\n\n",Z);
printf("(c) Current I = %f A\n\n",I);
printf("(d) The p.d. across the coil = %f V\n\n",Vl);
printf("    The p.d. across the resistor =  %f V\n\n",Vr);
printf("(e) Phase angle between voltage and current is given by,\n angle = %d deg\n\n",phi*(180/%pi));
```

Scilab code Exa 15.11 Example 11

```
//Chapter 15, Problem 11
clc;
```

```
L=1.273e-3;                 //inductance
Vr=6;                       //pd across resistor
R=30;                       //resistor
f=5e3;                      //frequency in hertz
I=Vr/R;                     //current
Xl=2*%pi*f*L;               //inductive reactance
Z=sqrt(R^2+Xl^2);           //impedance
V=I*Z;                      //supply voltage
Vl=I*Xl;                    //voltage across inductor
printf("From circuit in Fig. 15.7(a)\n\n");
printf("Supply voltage V = %f V\n\n",V);
printf("Voltage across the 1.273mH inductance Vl = %f V\n\n",Vl);
printf("The phasor diagram is shown in Fig. 15.7(b)");
```

Scilab code Exa 15.12 Example 12

```
//Chapter 15, Problem 12
clc;
L=159.2e-3;                    //inductance in henry
Rc=20;                         //resistance in ohm
R1=60;                         //resistance in ohm
f=50;                          //frequency in hertz
V=240;                         //supply voltage
R=Rc+R1;
Xl=2*%pi*f*L;                  //inductive reactance
Z=sqrt(R^2+Xl^2);              //impedance
I=V/Z;
phi=atan(Xl/R);
Vr=I*R1;
Zcoil=sqrt(Rc^2+Xl^2);
Vcoil=I*Zcoil;
Vl=I*Xl;
Vrcoil=I*Rc;
```

```
printf("(a) Circuit impedance, Z = %.2f ohm\n\n",Z);
printf("(b) Circuit current, I = %.3f A\n\n",I);
printf("(c) Circuit phase angle, phi = %d deg
    Lagging\n\n",phi*(180/%pi));
printf("From Fig. 15.8(a):\n\n");
printf("p.d. across the 60ohm resistor, Vr = %.1f V\
    n\n",Vr);
printf("p.d. across the coil, Vcoil = %.1f V\n\n",
    Vcoil);
printf("The 240V supply voltage is the phasor sum of
     VCOIL and VR as shown in the phasor diagram in
    Fig. 15.9");
printf("From circuit in Fig. 15.8(a)\n\n");
```

Scilab code Exa 15.13 Example 13

```
//Chapter 15, Problem 13
clc;
R=25;                          //resistance in ohm
C=45e-6;                        //capacitance in farad
V=240;                          //supply voltage
f=50;                           //supply frequency
Xc=1/(2*%pi*f*C);               //capacitive reactance
Z=sqrt(R^2+Xc^2);               //impedance
I=V/Z;                          //current
a=atan(Xc/R);
printf("(a) Impedance, Z = %.2f ohm\n\n",Z);
printf("(b) Current, I = %.2f A\n\n",I);
printf("Phase angle between the supply voltage and
    current, = %.2f deg (leading)\n\n",a*(180/%pi));
```

Scilab code Exa 15.14 Example 14

```
//Chapter 15, Problem 14
clc;
I=3;
Z=50;                                   //impedance
R=40;                                 //resistance in ohm
f=60;                                   //supply frequency
Xc=sqrt(Z^2-R^2);                        //capacitive reactance
C=1/(2*%pi*f*Xc);                      //capacitance in farad
V=I*Z;                                 //voltage
a=atan(Xc/R);
Vr=I*R;
Vc=I*Xc;
printf("(a) Capacitance, C = %.2f uF\n\n",C*10^6);
printf("(b) Supply voltage V = %d V\n\n",V);
printf("(c) Phase angle between the supply voltage and current, = %.2f deg (leading)\n\n",a*(180/%pi));
printf("(d) p.d. across resistor, Vr = %d V\n\n",Vr);
printf("p.d. across the capacitor, Vc = %d V\n\n",Vc);
printf("The phasor diagram is shown in Fig. 15.11, where the supply voltage V is the phasor sum of VR and VC.");
```

Scilab code Exa 15.15 Example 15

```
//Chapter 15, Problem 15, Fig 15.13
clc;
R=5;                                   //resistance in ohm
```

```
L=120e-3;                                          //inductance in henry
C=100e-6;                                          //capacitance in farad
V=300;                                             //supply voltage
f=50;                                              //supply frequency
Xl=2*%pi*f*L;                                      //inductive reactance
Xc=1/(2*%pi*f*C);                                  //capacitive reactance
X=Xl-Xc;
Z=sqrt(R^2+X^2);                                   //impedance
I=V/Z;                                             //current
phi=atan(X/R);
Zcoil=sqrt(R^2+Xl^2);                              //impedance of coil
Vcoil=I*Zcoil;                                     //voltage across coil
phi2=atan(Xl/R);
Vc=I*Xc;                                           //voltage across capacitor
printf("(a) Current, I = %f A\n\n",I);
printf("(b) Phase angle = %f deg (leading)\n\n",phi*(180/%pi));
printf("(c) Phase angle of coil = %f deg (lagging)\n\n",phi2*(180/%pi));
printf("(d) Voltage across capacitor, Vc = %f V\n\n",Vc);
printf("The phasor diagram is shown in Fig. 15.14. The supply voltage V is the phasor sum of VCOIL and VC.");
```

Scilab code Exa 15.16 Example 16

```
//Chapter 15, Problem 16, Fig 15.16
clc;
V=40;                                   //supply voltage
f=20e3;                                 //supply frequency
R1=8;                                   //resistance in ohm
L=130e-6;                               //inductance in henry
R2=5;                                   //resistance in ohm
R3=10;
C=0.25e-6;                              //capacitance in farad
Re=R1+R2+R3;                            //eqv resistance
Xl=2*%pi*f*L;                           //inductive reactance
Xc=1/(2*%pi*f*C);                       //capacitive reactance
X=Xc-Xl;
Z=sqrt(Re^2+X^2);                       //impedance
I=V/Z;                                  //current
phi=atan(X/Re);
Z2=sqrt(R2^2+Xl^2);
Z3=sqrt(R3^2+Xc^2);
V1=I*R1;
V2=I*Z2;
V3=I*Z3;
printf("(a) Current, I = %.3f A\n\n",I);
printf("Phase angle = %.2f deg (leading)\n\n",phi*(180/%pi));
printf("V1 = %.2f V\n\nV2 = %.2fV\n\nV3 = %.2fV",V1,V2,V3)
```

Scilab code Exa 15.17 Example 17

```
//Chapter 15, Problem 17, Fig 15.17
clc;
R1=4;                                      //resistance in ohm
R2=8;                                      //resistance in ohm
I=5;                                            //current in ampere
f=5000;                                         //supply frequency
L=0.286e-3;                                   //inductance in henry
C=1.273e-6;                                   //capacitance in farad
Xl=2*%pi*f*L;                                   //inductive reactance
Z1=sqrt(R1^2+Xl^2);
V1=I*Z1;
phi=atan(Xl/R1);
Xc=1/(2*%pi*f*C);                              //capacitive reactance
Z2=sqrt(R2^2+Xc^2);
V2=I*Z2;
phi2=atan(Xc/R2);
printf("Phase angle 1, phi = %.2f deg (lagging)\n\n",phi*(180/%pi));
printf("Phase angle 2, phi2 = %.2f deg (leading)\n\n",phi2*(180/%pi));
printf("The phasor diagram is shown in Fig. 15.18");
```

Scilab code Exa 15.18 Example 18

```
//Chapter 15, Problem 18
```

```
clc;
R=10;                                   //resistance in ohm
L=125e-3;                               //inductance in henry
C=60e-6;                                //capacitance in farad
V=120;                                  //supply voltage
fr=1/(2*%pi*sqrt(L*C));                 //resonant frequency
I=V/R;
printf("Frequency F at which resonance occur = %.2f Hz\n\n",fr);
printf("Current I flowing at the resonant frequency = %d A",I);
```

Scilab code Exa 15.19 Example 19

```
//Chapter 15, Problem 19
clc;
I=100e-6;
V=2e-3;                                 //supply voltage
f=200e3;                                //frequency
L=50e-6;                                //inductance in henry
R=V/I;                                  //resistance in ohm
C=1/((2*%pi*f)^2*L);                    //capacitance in farad
printf("(a) Circuit resistance, R = %d ohm\n\n",R);
printf("(b) Circuit capacitance, C = %.1f nF\n\n",C*10^9);
```

Scilab code Exa 15.20 Example 20

```
//Chapter 15, Problem 20
clc;
L=80e-3;                                    //inductance in
   henry
C=0.25e-6;                                   //capacitance
   in farad
R=12.5;                                      //resistance in
    ohm
V=100;                                      //supply voltage
fr=1/(2*%pi*sqrt(L*C));                     //resonant
   frequency
I=V/R;
Vl=I*2*%pi*fr*L;
Vc=I*1/(2*%pi*fr*C);
Vm=Vl/V;
printf("(a) Resonant frequency = %.1f Hz\n\n",fr);
printf("(b) Current at resonance = %d A\n\n",I);
printf(" Q-factor of the circuit = %.3f",Vm);
```

Scilab code Exa 15.21 Example 21

```
//Chapter 15, Problem 21
clc;
R=2;                                     //resistance in ohm
L=60e-3;                                  //inductance in
   henry
C=30e-6;                                 //capacitance in
   farad
Q=(1/R)*sqrt(L/C);                          //Q factor
printf("Q factor = %f ",Q);
```

Scilab code Exa 15.22 Example 22

```
//Chapter 15, Problem 22
clc;
R=10;                          //resistance in ohm
L=100e-3;                      //inductance in henry
C=2e-6;                        //capacitance in farad
V=50;                          //voltage
fr=1/(2*%pi*sqrt(L*C));        //resonant frequency
I=V/R;                         //current
Vl=I*2*%pi*fr*L;               //voltage across coil at resonance
Vc=I*1/(2*%pi*fr*C);           //voltage across capacitance at resonance
Vm=Vl/V;
printf("(a) Resonant frequency = %.1f Hz\n\n",fr);
printf("(b) Current at resonance = %d A\n\n",I);
printf("(c) Voltages across the coil and the capacitor at resonance\n Vl = %d V\nVc = %d V\n\n",Vl,Vc);
printf("(d)Q-factor of the circuit = %.2f",Vm);
```

Scilab code Exa 15.23 Example 23

```
//Chapter 15, Problem 23
clc;
R=10;                          //resistance in ohm
```

```
L=20e-3;                                //inductance in henry
f=5000;                                 //resonant frequency
w=2*%pi*f;
Qr=(w*L)/R;                             //Q-factor at resonance
B=f/Qr;                                 //bandwidth
printf("Bandwidth of the filter = %.2f Hz",B);
```

Scilab code Exa 15.24 Example 24

```
//Chapter 15, Problem 24
clc;
//from eqn i=250 sin   t
Im=0.250;
R=5000;                        //resistance in ohm
I=Im*0.707;                    //rms current
P=R*I^2;                       //power
printf("Power dissipated in the resistor = %.1f W",P);
```

Scilab code Exa 15.25 Example 25

```
//Chapter 15, Problem 25
clc;
L=75e-3;                              //inductance in henry
R=60;                                 //resistance in ohm
V=110;                                //voltage
f=60;                                 //frequency
Xl=2*%pi*f*L;                         //inductive reactance
```

```
Z=sqrt(R^2+Xl^2);                    //impedance
I=V/Z;                               //current
P=I^2*R;                             //power
printf("Power dissipated = %d W",P);
```

Scilab code Exa 15.26 Example 26

```
//Chapter 15, Problem 26
clc;
V=150;                          //voltage
f=50;                           //frequency
S=300;                          //apparent power
I=S/V;                          //current
Xl=V/I;                         //inductive reactance
L=(Xl/(2*%pi*f));               //inductance in henry
printf("Inductance L = %.3f H",L);
```

Scilab code Exa 15.27 Example 27

```
//Chapter 15, Problem 27
clc;
pf=0.8;                         //power factor
phi=acos(0.8);
VI=200e3;                       //power
P=VI*pf;
Q=VI*sin(phi);                       //reactive power
printf("Power output P = %d kW\n\n",P/1000);
printf("Reactive power Q = %d Kvar",Q/1000);
```

Scilab code Exa 15.28 Example 28

```
//Chapter 15, Problem 28
clc;
P=90*10^3;                    //power
pf=0.5;                       //power factor
S=P/pf;                       //apparent power
phi=acos(pf);
Q=S*sin(phi);                   //reactive power
printf("Reactive power = %.1f Kvar",Q/1000);
```

Scilab code Exa 15.29 Example 29

```
//Chapter 15, Problem 29
clc;
V=120;                                  //voltage
f=50;                                   //frequency in hertz
P=400;                                  //power in watt
I=8;                                    //current in ampere
R=P/I^2;                                //resistance in ohm
Z=V/I;                                  //impedance
Xl=sqrt(Z^2-R^2);                       //inductive reactance
pf=P/(V*I);                             //power factor
phi=acos(pf);
printf("(a) Resistance R = %.2f ohm\n\n",R);
printf("(b) Impedance Z = %d ohm\n\n",Z);
printf("(c) Reactance = %.2f ohm\n\n",Xl);
printf("(d) Power factor = %.4f\n\n",pf);
printf("(e) Phase angle = %.2f deg (lagging)\n\n",
   phi*(180/%pi));
```

Scilab code Exa 15.30 Example 30

```
//Chapter 15, Problem 30
clc;
V=100;                                    //voltage
f=60;                                    //frequency in hertz
P=100;                                   //power in watt
pf=0.5;                              //power factor
I=P/(pf*V);                            //current in ampere
R=P/I^2;                                  //resistance in ohm
Z=V/I;                                  //impedance
Xc=sqrt(Z^2-R^2);                         //capacitive reactance
C=1/(2*%pi*f*Xc);                         //capacitance
phi=acos(pf);
printf("(a) Current I = %d A\n\n",I);
printf("(b) Phase angle = %d deg (leading)\n\n",phi*(180/%pi));
printf("(c) Resistance R = %d ohm\n\n",R);
printf("(d) Impedance Z = %d\n\n",Z);
printf("(e) Capacitance C = %.2f uF\n\n",C*10^6);
```

Chapter 16

Single phase parallel AC circuits

Scilab code Exa 16.1 Example 1

```
//Chapter 16, Problem 1
clc;
V=60;                              //voltage
R=20;                              //resistance in ohm
f=1000;                            //frequency in hertz
L=2.387e-3;                        //inductance in henry
Ir=V/R;                            //current flowing in the resistor
Xl=2*%pi*f*L;                      //inductive reactance
Il=V/Xl;                           //current flowing in the inductance
I=sqrt(Ir^2+Il^2);                 //supply current from phasor diagram fig 16.1
phi=atan(Il/Ir);
Z=V/I;                             //impedance
P=V*I*cos(phi);                    //power consumed
printf("(a)  Current flowing in the resistor = %d A\
```

```
    n\tCurrent flowing in the inductance = %d A\n\n",
    Ir,Il);
printf("(b) Supply current = %d A\n\n",I);
printf("(c) Circuit phase angle = %.2f deg (lagging)
    \n\n",phi*(180/%pi));
printf("(d) Circuit impedance = %.1f ohm\n\n",Z);
printf("(e) Power consumed = %d W",P);
```

Scilab code Exa 16.2 Example 2

```
//Chapter 16, Problem 2
clc;
V=240;                          //voltage
R=80;                           //resistance in ohm
f=50;                           //frequency in hertz
C=30e-6;                        //capacitance in farad
Ir=V/R;                         //current flowing in
      the resistor
Xc=1/(2*%pi*f*C);               //capacitive
    reactance
Ic=V/Xc;                        //current flowing in
      the capacitor
I=sqrt(Ir^2+Ic^2);              //supply current
phi=atan(Ic/Ir);
Z=V/I;                          //impedance
P=V*I*cos(phi);                 //power consumed
S=V*I;                          //apparent power
    ,
printf("(a)  Current flowing in the resistor = %d A\
    n\tCurrent flowing in the capacitor = %.3f A\n\n"
    ,Ir,Ic);
printf("(b) Supply current = %.3f A\n\n",I);
printf("(c) Circuit phase angle = %.2f deg (leading)
    \n\n",phi*(180/%pi));
printf("(d) Circuit impedance = %.2f ohm\n\n",Z);
```

```
printf("(e) Power consumed = %d W\n\n",P);
printf("(f) Apparent power = %.1f VA",S);
```

Scilab code Exa 16.3 Example 3

```
//Chapter 16, Problem 3, Fig. 16.3
clc;
V=120;                                  //voltage
f=200;                                  //frequency in hertz
I=2;                                    //supply current
pf=0.6;                                 //power factor
phi=acos(pf);
Ir=I*pf;                                //current flowing in the resistor
Ic=I*sin(phi);                          //current flowing in the capacitor
R=V/Ir;                                 //resistance in ohm
C=Ic/(2*%pi*f*V);                       //capacitance in faradd
printf("Capacitance of capacitor = %f uF\n\n",C*10^6);
printf("Resistance of resistor = %f ohm\n\n",R);
```

Scilab code Exa 16.4 Example 4

```
//Chapter 16, Problem 4
clc;
L=120e-3;                       //inductance in henry
C=25e-6;                        //capacitance in farad
V=100;                          //voltage
f=50;                           //frequency in hertz
```

```
Xl=2*%pi*f*L;                         //inductive reactance
Xc=1/(2*%pi*f*C);                     //capacitive reactance
Il=V/Xl;                             //current flowing in the inductance
Ic=V/Xc;                              //current flowing in the capacitor
I=Il-Ic;
Z=V/I;
P=V*I*cos(90*%pi/180);
printf("(a) Branch current,\n Il = %.3f A\nIc = %.3f A\n\n",Il,Ic);
printf("(b) Supply current = %.3f A\nCurrent lags the supply voltage V by 90deg from Fig 16.4(i)",I);
printf("(c) Circuit impedance Z = %.3f ohm\n\n",Z);
printf("(d) Power consumed P = %d W",P);
```

Scilab code Exa 16.5 Example 5

```
//Chapter 16, Problem 5
clc;
L=120e-3;                          //inductance in henry
C=25e-6;                          //capacitance in farad
V=100;                                //voltage
f=150;                            //frequency in hertz
Xl=2*%pi*f*L;                         //inductive reactance
Xc=1/(2*%pi*f*C);                     //capacitive reactance
Il=V/Xl;                              //current flowing in the inductor
Ic=V/Xc;                              //current flowing in the capacitor
```

```
I=Ic-Il;
Z=V/I;
P=V*I*cos(90*%pi/180);
printf("(a) Branch current,\n Il = %.3f A\nIc = %.3f A\n\n",Il,Ic);
printf("(b) Supply current = %.3f A\nCurrent lags the supply voltage V by 90deg from Fig 16.4(i)",I);
printf("(c) Circuit impedance Z = %.3f ohm\n\n",Z);
printf("(d) Power consumed P = %d W",P);
```

Scilab code Exa 16.6 Example 6

```
//Chapter 16, Problem 6, Fig.16.6
clc;
L=159.2e-3;                    //inductance in henry
R=40;                          //resistance in ohm
C=30e-6;                       //capacitance in farad
V=240;                         //voltage
f=50;                          //frequency
Xl=2*%pi*f*L;                  //inductive reactance
Z1=sqrt(R^2+Xl^2);
Ilr=V/Z1;
phi1=atan(Xl/R);
Xc=1/(2*%pi*f*C);                  //capacitive reactance
Ic=V/Xc;
Ih=Ilr*cos(51.34*%pi/180);
a=-Ilr*sin(51.34*%pi/180);
b=Ic*sin(90*%pi/180);
Iv=a+b;
I=sqrt(Ih^2+(Iv)^2);
phi2=atan(-Iv/Ih);
```

```
Z=V/I;                                  //impedance
P=V*I*cos(phi2);
S=V*I;                                  //apparent power
Q=V*I*sin(phi2);                        //reactive power
printf("(a) Current in coil = %f A\n Phase angle = %f deg (lagging)\n\n",Ilr,phi1*180/%pi);
printf("(b) Current in capacitor, Ic = %f A\n A leading the supply voltage by 90deg\n\n",Ic);
printf("(c) Supply current I = %f A\n phase angle = %f deg (lagging)\n\n",I,phi2*180/%pi);
printf("(d) Circuit impedance Z = %f ohm\n\n",Z);
printf("(e) Power consumed P = %f W\n\n",P);
```

Scilab code Exa 16.7 Example 7

```
//Chapter 16, Problem 7, Fig.16.8
clc;
L=0.12;                     //inductance in henry
R=3000;                     //resistance in ohm
C=0.02e-6;                  //capacitance in farad
V=40;                       //voltage
f=5000;                     //frequency
Xl=2*%pi*f*L;               //inductive reactance
Z1=sqrt(R^2+Xl^2);
Ilr=V/Z1;
phi1=atan(Xl/R);
Xc=1/(2*%pi*f*C);           //capacitive reactance
Ic=V/Xc;
Ih=Ilr*cos(51.34*%pi/180);
a=-Ilr*sin(51.34*%pi/180);
b=Ic*sin(90*%pi/180);
Iv=a+b;
I=sqrt(Ih^2+(Iv)^2);
```

```
phi2=atan(-Iv/Ih);
Z=V/I;                                    //impedance
P=V*I*cos(phi2);
S=V*I;                                //apparent power
Q=V*I*sin(phi2);                       //reactive power
printf("(a) Current in coil = %.3f mA\n Phase angle = %.3f deg (lagging)\n\n",Ilr*1000,phi1*180/%pi);
printf("(b) Current in capacitor, Ic = %.3f mA\n A leading the supply voltage by 90deg\n\n",Ic*1000);
printf("(c) Supply current I = %.3f mA\n phase angle = %.3f deg \n\n",I*1000,-phi2*180/%pi);
printf("(d) Circuit impedance Z = %.3f Kohm\n\n",Z/1000);
printf("(e) Power consumed P = %.3f mW\n\n",P*1000);
```

Scilab code Exa 16.8 Example 8

```
//Chapter 16, Problem 8
clc;
L=150e-3;                       //inductance in henry
C=40e-6;                          //capacitance in farad
V=50;                             //voltage
fr=(2*%pi)^-1*sqrt(1/(L*C));        //resonant frequency
Xc=1/(2*%pi*fr*C);                  //capacitive reactance
Icir=V/Xc;                          //current circulating in L and C at resonance
printf("(a) Resonant frequency of the circuit = %.3f Hz\n\n",fr);
printf("(b) Current circulating in the capacitor and inductance at resonance = %.3f A",Icir);
```

Scilab code Exa 16.9 Example 9

```
//Chapter 16, Problem 9
clc;
L=0.20;                    //inductance in henry
R=60;                          //resistance in ohm
C=20e-6;                     //capacitance in farad
V=20;                        //voltage
fr=(2*%pi)^-1*sqrt((1/(L*C))-(R^2/L^2));
Xl=2*%pi*fr*L;                   //inductive reactance
Rd=L/(R*C);                        //dynamic resistance
Ir=V/Rd;                           //current at resonance
Q=Xl/R;                            //circuit Q-factor at resonance
printf("(a) Resonant frequency of the circuit = %.2f Hz\n\n",fr);
printf("(b) Dynamic resistance Rd = %.2f ohm\n\n",Rd);
printf("(c) Current at resonance Ir = %.2f A\n\n",Ir);
printf("(d) Q factor of circuit = %.2f",Q);
```

Scilab code Exa 16.10 Example 10

```
//Chapter 16, Problem 10
clc;
L=100e-3;                  //inductance in henry
R=800;                         //resistance in ohm
f=5000;                          //frequency
V=12;                        //voltage
w=2*%pi*f;
C=(L*(w^2+(R^2/L^2)))^-1;          //capacitance in farad
Xl=2*%pi*f*L;                  //inductive reactance
```

```
Rd=L/(R*C);                          //dynamic resistance
Ir=V/Rd;                             //current at resonance
Q=Xl/R;                              //circuit Q-factor at resonance
printf("(a) capacitance of the capacitor, = %f uF\n\n",C*10^6);
printf("(b) Dynamic resistance Rd = %.2f k.ohm\n\n",Rd/1000);
printf("(c) supply current Ir = %.3f mA\n\n",Ir*1000);
printf("(d) Q factor of circuit = %.2f",Q);
```

Scilab code Exa 16.11 Example 11

```
//Chapter 16, Problem 11, Fig 16.13(a)
clc;
f = 50;                          // in ohm
V = 240;                         // in Volts
pf = 0.6                         // power factor
Im = 50;                         // in amperes

//calculation:
phi = acos(pf)
phid = phi*180/%pi
Ic = Im*sin(phi)
I = Im*cos(phi)
printf("\n\n (a)The capacitor current Ic must be %.0f A for the power factor to be unity. ",Ic)
printf("\n\n (b)Supply current I = %.0f A ",I)
```

Scilab code Exa 16.13 Example 13

```
//Chapter 16, Problem 13
clc;
eff = 0.8;                    // effficiency
f = 50;                       // in ohm
Pout = 4800;                  // in Watt
pf1 = 0.625                   // power factor
pf2 = 0.95                    // power factor
V = 240;                      // in Volts
//calculation:
Pin = Pout/eff
Im = Pin/(V*pf1)
phi1 = acos(pf1)
phi1d = phi1*180/%pi
//When a capacitor C is connected in parallel with the motor a current Ic flows which leads V by 90.
phi2 = acos(pf2)
phi2d = phi2*180/%pi
Imh = Im*cos(phi1)
//Ih = I*cos(phi2)
Ih = Imh
I = Ih/cos(phi2)
Imv = Im*sin(phi1)
Iv = I*sin(phi2)
Ic = Imv - Iv
C = Ic/(2*%pi*f*V)
kvar = V*Ic/1000
printf("\n\n (a)Current taken by the motor, Im = %.0f A",Im)
printf("\n\n (b)Supply current after p.f. correction, I = %.2f A ",I)
printf("\n\n (c)Magnitude of the capacitor current Ic = %.0f A",Ic)
printf("\n\n (d)Capacitance, C = %.0f  F ",(C/1E-6))
printf("\n\n (d)kvar rating of the capacitor = %.2f kvar ",kvar)
```

Chapter 17

Filter networks

Scilab code Exa 17.1 Example 1

```
//Chapter 17, Problem 1, Figure 17.8
clc;
L=200*10^-3;                    //inductance in henry
C=0.2*10^-6;                    //capacitance in farad
fc=1/(%pi*sqrt(L*C));           //cut-off frequency
R0=sqrt(L/C);                   //nominal impedance

disp("Comparing Fig. 17.8 with the low-pass section
    of Fig. 17.7(a),");
printf("Inductance L = %f H\n\n",L);
printf("Capacitance C = %f uF\n\n",C*10^6);
printf("Cut off frequency fc = %f KHz\n\n",fc/1000 )
    ;
printf("Nominal impedance R0 = %f Kohm\n\n",R0/1000)
    ;
```

Scilab code Exa 17.2 Example 2

```
//Chapter 17, Problem 2, Figure 17.9
clc;
C=2*200*10^-12;                  //capacitance in farad
L=0.4;                           //inductance in henry
fc=1/(%pi*sqrt(L*C));            //cut-off frequency
R0=sqrt(L/C);                    //nominal impedance
disp("Comparing Fig. 17.9 with the low-pass section of Fig. 17.7(a),");
printf("Inductance L = %f H\n\n",L);
printf("Capacitance C = %f pF\n\n",C*10^12);
printf("Cut off frequency fc = %.2f KHz\n\n",fc/1000);
printf("Nominal impedance R0 = %.2f Kohm\n\n",R0/1000);
```

Scilab code Exa 17.3 Example 3

```
//Chapter 17, Problem 3
clc;
R0=600;                       //nominal impedance
fc=5*10^6;                     //cut-off frequency
C=1/(%pi*R0*fc);              //capacitance in farad
L=R0/(%pi*fc);                  //inductance in henry
printf("Inductance L = %d uH\n\n",L*10^6);
printf("Capacitance C = %d pF\n\n",C*10^12);
printf("A low-pass T-section filter is shownin Fig. 17.10(a),\n\n");
printf("A low-pass pi-section filter is shownin Fig. 17.10(b),\n\n");
```

Scilab code Exa 17.4 Example 4

```
//Chapter 17, Problem 4, Figure 17.17
clc;
C=(0.2*10^-6)/2;                          //capacitance in farad
L=100*10^-3;                              //inductance in henry
fc=1/(4*%pi*sqrt(L*C));                   //cut-off frequency
R0=sqrt(L/C);                             //nominal impedance
disp("Comparing Fig. 17.17 with the low-pass section of Fig. 17.16(a),");
printf("Inductance L = %f H\n\n",L);
printf("Capacitance C = %f uF\n\n",C*10^6);
printf("Cut off frequency fc = %.1f Hz\n\n",fc );
printf("Nominal impedance R0 = %d Kohm\n\n",R0/1000);
```

Scilab code Exa 17.5 Example 5

```
//Chapter 17, Problem 5, Figure 17.18
clc;
L=(200*10^-6)/2;                          //inductance in henry
C=4000*10^-12;                            //capacitance in farad
fc=1/(4*%pi*sqrt(L*C));                   //cut-off frequency
R0=sqrt(L/C);                             //nominal impedance
disp("Comparing Fig. 17.18 with the low-pass section of Fig. 17.16(b),");
printf("Inductance L = %f H\n\n",L);
printf("Capacitance C = %f uF\n\n",C*10^6);
printf("Cut off frequency fc = %d KHz\n\n",fc/1000 );
printf("Nominal impedance R0 = %d ohm\n\n",R0);
```

Scilab code Exa 17.6 Example 6

```
//Chapter 17, Problem 6
clc;
fc=25*10^3;                                    //cut-off frequency
R0=600;                                        //nominal impedance
C=1/(4*%pi*R0*fc);                             //capacitance in farad
L=R0/(4*%pi*fc);                               //inductance in henry
printf("Inductance L = %f mH\n\n",L*10^3);
printf("Capacitance C = %f pF\n\n",C*10^12);
printf("A high-pass T-section filter is shownin Fig. 17.19(a),\n\n");
printf("A high-pass pi-section filter is shownin Fig. 17.19(b),\n\n");
```

Scilab code Exa 17.7 Example 7

```
//Chapter 17, Problem 7
clc;
R0=600;                                        //nominal impedance
fcl=15000;                                     //cut-off frequency of low pass
fch=10000;                                     //cut-off frequency of high pass
C1=1/(%pi*R0*fcl);                             //capacitance in farad
```

```
L1=R0/(%pi*fcl);                           //inductance
   in henry
C2=1/(4*%pi*R0*fch);                        //capacitance
    in farad
L2=R0/(4*%pi*fch);                          //inductance
    in henry
disp("Thus, from Fig. 17.7(a), the series arm
   inductances are each L/2");
printf("the series arm inductances L/2 = %f mH\n",(
   L1/2)*10^3);
printf("and the shunt arm capacitance = %f nF\n\n",
   C1*10^9);
disp("Thus, from Fig. 17.16(a), the series arm
   capacitances are each 2C");
printf("the series arm capacitances 2C = %f nF\n",2*
   C2*10^9);
printf("and the shunt arm inductance = %f mH\n\n",L2
   *10^3);
disp("The composite, band-pass filter is shown in
   Fig. 17.24.");
```

Chapter 18

DC transients

Scilab code Exa 18.1 Example 1

```
//Chapter 18, Problem 1
clc;
v=120;                  //dc supply
c=15e-6;                //capacitance in farad
r=47e3;                 //resistance in ohms
taw=r*c;                //time constant
t1=taw;
vcta= v*(1-%e^(-1*t1/taw));
vct = v/2;
t = 0:0.1:10
vc = v*(1-%e^(-1*t/taw));
plot(t,vc)
xtitle("capacitor voltage/time characteristic", "t", "Vc")
t = -1*taw*log(1 - vct/v);

printf("\n (a)The capacitor voltage at a time equal to one time constant = %.2f V",vcta)
printf("\n (b)The time for the capacitor voltage to
```

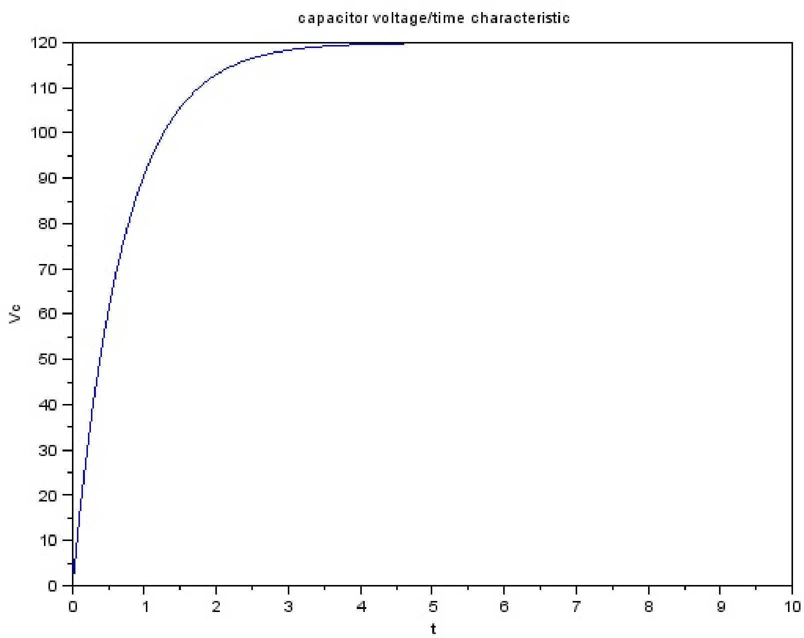

Figure 18.1: Example 1

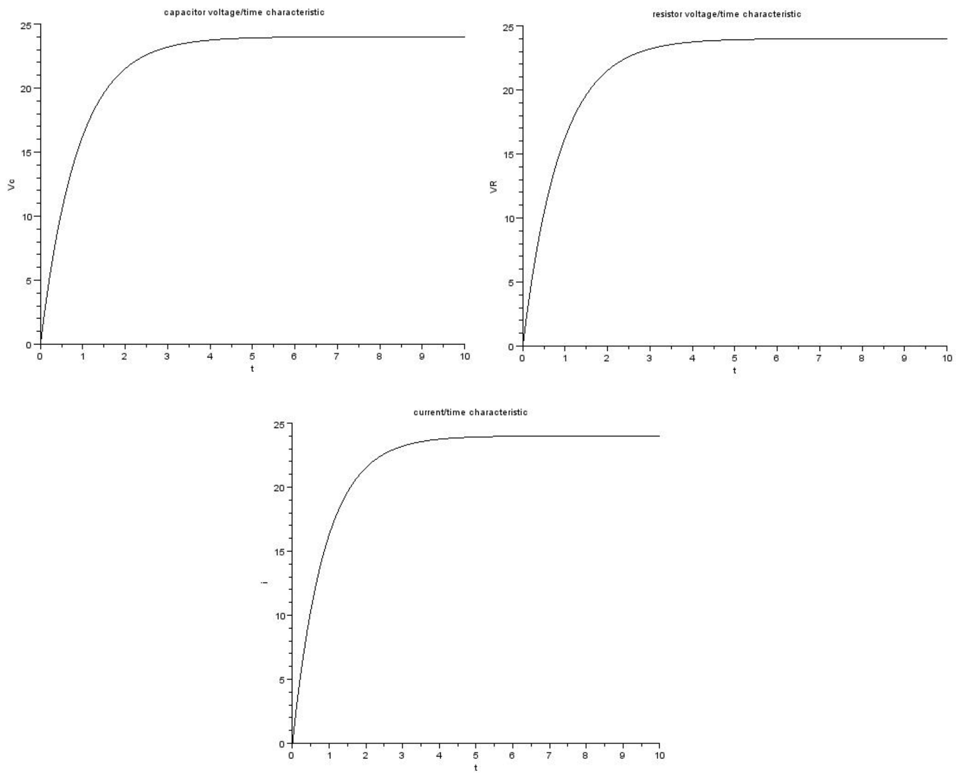

Figure 18.2: Example 2

```
reach one half of its steady state value = %.1f
sec",t)
```

Scilab code Exa 18.2 Example 2

```
//Chapter 18, Problem 2
clc;
//initializing the variables:
c = 4E-6;                              //capacitance in
```

```
    farad
r = 220000;                    //resistance in ohm
V = 24;                        //supply voltage
t1 = 1.5;

//calculation:
taw = r*c
t = 0:0.1:10
Vc = V*(1-%e^(-1*t/taw));
plot2d(t,Vc)
xtitle("capacitor voltage/time characteristic", "t", "Vc")
xset('window',1)
VR = V*(1-%e^(-1*t/taw));
plot2d(t,VR)
xtitle("resistor voltage/time characteristic", "t", "VR")
xset('window',2)
I = V/r
i = I*%e^(-1*t/taw)
plot2d(t,i)
xtitle("current/time characteristic", "t", "i")
Vct1 = V*%e^(-1*t1/taw)
VRt1 = V*%e^(-1*t1/taw)
it1 = I*%e^(-1*t1/taw)

printf("\n The value of capacitor voltage is %.2f V,\n\n resistor voltage is %.2f V,\n\n current is %.1E A at one and a half seconds after discharge has started.",Vct1, VRt1,it1)
```

Scilab code Exa 18.3 Example 3

```
//Chapter 18, Problem 3
clc;
```

```
//initializing the variables:
C = 20E-6;                              //capacitance in
    farads
R = 50000;                              //resistance in ohms
V = 20;                                 //supply voltage
t1 = 1;                                 // in secs
t2 = 2;                                 // in secs
VRt = 15;                               // in volts

//calculation:
taw = R*C
I = V/R
Vct1 = V*(1-%e^(-1*t2/taw))
t3 = -1*taw*log(VRt/V)
it1 = I*%e^(-1*t1/taw)


printf("\n (a)Initial value of the current flowing =
     %.4f mA\n\n",I*10^3)
printf("\n (b)Time constant of the circuit = %.0f
    sec\n\n",taw)
printf("\n (c)The value of the current one second
    after connection = %.3f mA\n\n",(it1/1E-3))
printf("\n (d)The value of the capacitor voltage two
     seconds after connection = %.2f V\n\n",Vct1)
printf("\n (e)The time after connection when the
    resistor voltage is 15 V = %.3f sec\n\n",t3)
```

Scilab code Exa 18.4 Example 4

```
//Chapter 18, Problem 4
clc;
t=12e-3;
    //time constant
v=10;                                                   //
```

```
supply voltage
t1=7e-3;                                                     //time period of capacitor
C=0.5e-6;                                                    //capacitance
R=t/C;                                                       //calculating resistance
vc=v*(1-exp(-t1/t));                                        //calculating capacitor voltage
printf("(a) Resistor = %d K.ohm\n\n",R/1000);
printf("(b) Capacitor voltage = %f V",vc);
```

Scilab code Exa 18.5 Example 5

```
//Chapter 18, Problem 5
clc;
//Initializing the variables
C=10*10^-6;                   //capacitance in farad
R=25*10^3;                    //resistance in ohm
V=100;                        //voltage dc supply
t1=0.5;                       //time in seconds
t2=0.1;                       //time in seconds
vc1=45;                       //capacitor voltage
Vm=V;

//Calculation
taw=C*R;                                     //time constant
Im=V/R;                                      //maximum current
vc=Vm*(1-exp(-t1/taw));                      //voltage across the capacitor
i=Im*exp(-taw/taw);                          //current flowing after one time constant
vr=V*exp(-t2/taw);                           //voltage
```

```
across the resistor
t3=-(log(1-(vc1/Vm))/log(exp(1)))*taw;   //time in seconds
vt=V/taw;                                //initial rate of voltage rise


printf("\n(a) Time constant = %f sec\n",taw);
printf("\n(b) Maximum current = %f mA\n",Im*10^3);
printf("\n(c) Voltage across the capacitor after 0.5 s = %f V\n",vc);
printf("\n(d) Current flowing after one time constant = %f mA\n",i*10^3);
printf("\n(e) Voltage across the resistor after 0.1 s = %f V\n",vr);
printf("\n(f) Time for the capacitor voltage to reach 45V = %f s\n",t3);
printf("\n(g) Initial rate of voltage rise = %f V\n",vt);
```

Scilab code Exa 18.6 Example 6

```
//Chapter 18, Problem 6
clc;

//initializing the variables:
R = 50000;               //resistance in ohms
V = 100;                 //supply voltage
Vc1 = 20;                // in volts
tou = 0.8;               // in secs
t1 = 0.5;                // in secs
t2 = 1;                  // in secs

//calculation:
C = tou/R
```

```
t = -1*tou*log(Vc1/V)
I = V/R
it1 = I*%e^(-1*t1/tou)
Vc = V*%e^(-1*t2/tou)


printf("\n (a)The value of the capacitor = %f uF\n\n",C*10^6)
printf("\n (b)The time for the capacitor voltage to fall to 20 V = %.2f sec\n\n",t)
printf("\n (c)The current flowing when the capacitor has been discharging for 0.5 s = %f mA\n\n",it1*10^3)
printf("\n (d)The voltage drop across the resistor when the capacitor has been discharging for one second = %.1f V\n\n",Vc)
```

Scilab code Exa 18.7 Example 7

```
//Chapter 18, Problem 7
clc;

//initializing the variables:
C = 0.1E-6;              //capacitance in farads
R = 4000;                //resistance in ohms
V = 200;                 //supply voltage
Vc1 = 2;                 // in volts

//calculation:
taw = R*C
I = V/R
t = -1*taw*log(Vc1/V)

printf("\n (a)Initial discharge current = %.2f A\n\n",I)
```

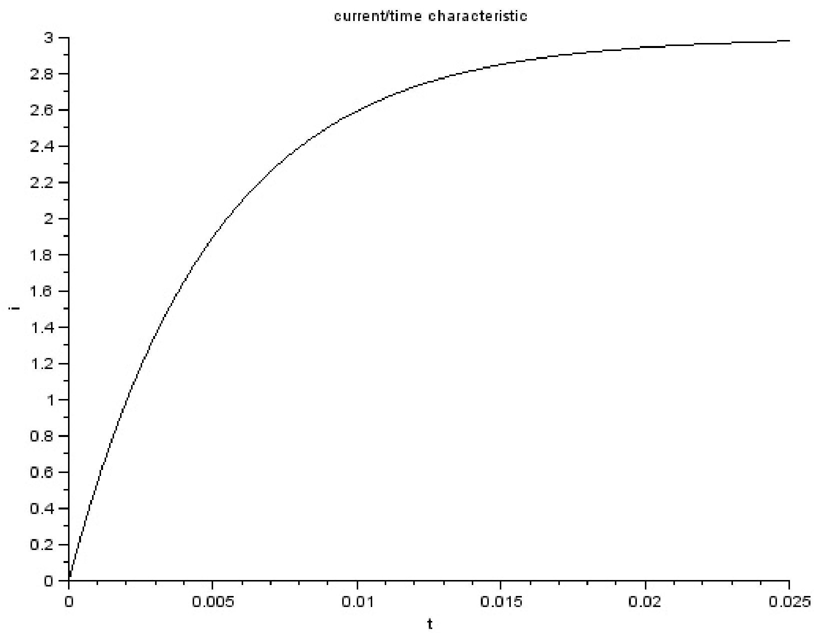

Figure 18.3: Example 8

```
printf("\n (b)Time constant tou = %.4f sec\n\n",taw)
printf("\n (c)Minimum time required for the voltage across the capacitor to fall to less than 2 V = %.3f sec",t)
```

Scilab code Exa 18.8 Example 8

```
//Chapter 18, Problem 8
clc;
//initializing the variables:
L = 0.1;                    //inductance in henry
```

```
R = 20;                        //resistance in ohms
V = 60;                        //supply voltage
i2 = 1.5;                      // in amperes

//calculation:
taw = L/R
t1 = 2*taw
t = 0:0.0001:0.025
I = V/R
i = I*(1 - %e^(-1*t/taw))
plot2d(t,i)
xtitle("current/time characteristic", "t", "i")
i1 = I*(1 - %e^(-1*t1/taw))
t2 = -1*taw*log(1 - i2/I)


printf("\n (a)The value of current flowing at a time
    equal to two time constants = %.3f A\n\n",i1)
printf("\n (b)The time for the current to grow to
   1.5 A = %.7f sec\n\n",t2)
```

Scilab code Exa 18.9 Example 9

```
//Chapter 18, Problem 9
clc;
//initializing the variables:
L = 0.04;                      //inductance in henry
R = 10;                        //resistance in ohms
V = 120;                       //supply voltage


//calculation:
taw = L/R
t1 = taw
I = V/R
```

```
i1 = I*(1 - %e^(-1*t1/taw))
i2 = 0.01*I
t2 = -1*taw*log(i2/I)

printf("(a)The final value of current = %.0f A\n\n", I);
printf("(b)Time constant of the circuit = %.3f sec\n\n",taw);
printf("(c)Value of current after a time equal to the time constant = %.2f A\n\n",i1);
printf("(d)The expected time for the current to rise to within 0.01 times of its final value = %.2f sec\n\n",t2);
```

Scilab code Exa 18.10 Example 10

```
//Chapter 18, Problem 10
clc;

//initializing the variables:
L = 3;                    //inductance in henry
R = 15;                   //resistance in ohms
V = 120;                  //supply voltage
t1 = 0.1;                 // in secs
t3 = 0.3;                 // in secs

//calculation:
taw= L/R
I = V/R
i2 = 0.85*I
VL = V*%e^(-1*t1/taw)
t2 = -1*taw*log(1 - (i2/I))
i3 = I*(1 - %e^(-1*t3/taw))

printf("(a)Steady state value of current = %.0f A\n\
```

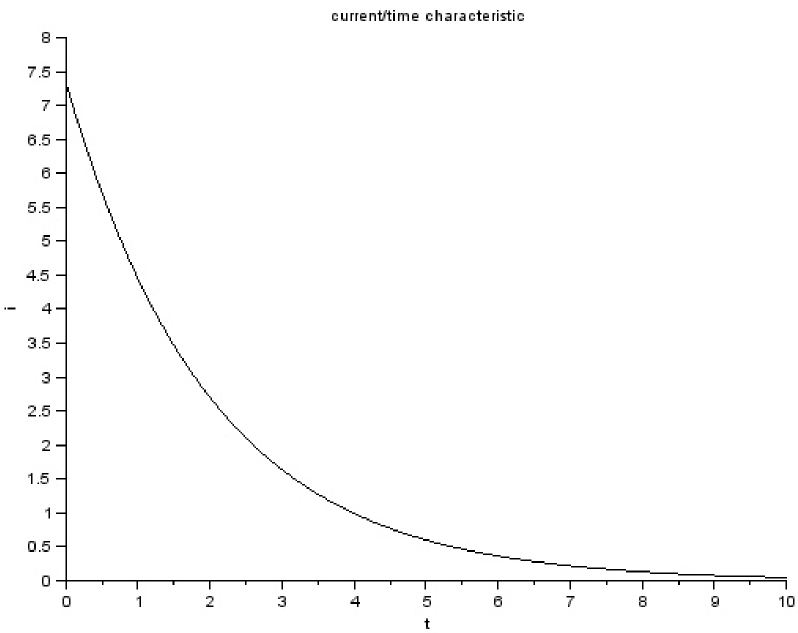

Figure 18.4: Example 11

```
   n",I)
printf("(b)Time constant of the circuit = %.3f sec\n
   \n",taw)
printf("(c)Value of the induced e.m.f. after 0.1 s =
    %.2f V\n\n",VL)
printf("(d)Time for the current to rise to 0.85
   times of its final values = %.3f sec\n\n",t2)
printf("(e)Value of the current after 0.3 s = %.3f A
   \n\n",i3)
```

Scilab code Exa 18.11 Example 11

```
//Chapter 18, Problem 11
clc;

//initializing the variables:
R = 15;                 //resistance in ohms
V = 110;                //supply voltage
taw = 2;                //time constant
t1 = 3;                 // in secs
i2 =5;                  // in amperes

//calculation:
L = taw*R
t = 0:0.1:10
I = V/R
i = I*(%e^(-1*t/taw))
plot2d(t,i)
xtitle("current/time characteristic", "t", "i")
i1 = I*(%e^(-1*t1/taw))
t2 = -1*taw*log((i2/I))


printf("\n Inductance is %.0f H\n\n",L)
printf("\n (a)The current flowing in the winding 3 s after being shorted-out = %.2f A\n\n",i1)
printf("\n (b)The time for the current to decay to 5 A = %.3f sec\n\n",t2)
```

Scilab code Exa 18.12 Example 12

```
//Chapter 18, Problem 12
clc;
//initializing the variables:
L = 6;              //inductance in henry
r = 10;             //resistance in ohms
V = 120;            //supply voltage
```

```
taw = 0.3;             //time constant
t1 = 1;                // in secs

//calculation:
R = (L/taw) - r
Rt = R + r
I = V/Rt
i2 = 0.1*I
i1 = I*(%e^(-1*t1/taw))
t2 = -1*taw*log((i2/I))

printf("\n (a)Resistance of the coil = %.0f ohm\n\n",R)
printf("\n (b)Current flowing in the circuit one second after the shorting link has been placed = %.3f A\n\n",i1)
printf("\n (c)The time for the current to decay to 0.1 times of initial value = %.3f sec\n\n",t2)
```

Scilab code Exa 18.13 Example 13

```
//Chapter 18, Problem 13
clc;
//initializing the variables:
L = 0.2;                       //inductance in henry
R = 1000;                      //resistance in ohms
V = 24;                        //supply voltage

//calculation:
taw = L/R
t1 = 1*taw // in secs
t2 = 2*taw // in secs
t3 = 3*taw // in secs
I = V/R
i1 = I*(1 - %e^(-1*t1/taw))
```

```
VL = V*(%e^(-1*t2/taw))
VR = V*(1 - %e^(-1*t3/taw))

printf("\n Time constant of the circuit is %.4f sec, and the steady-state value of the current is %.3f A",taw, I)
printf("\n (a) Current flowing in the circuit at a time equal to one time constant = %.5f A\n\n",i1)
printf("\n (b) Voltage drop across the inductor at a time equal to two time constants = %.3f V\n\n",VL)
printf("\n (c)The voltage drop across the resistor after a time equal to three time constants = %.2f V\n\n",VR)
```

Chapter 19

Operational amplifiers

Scilab code Exa 19.1 Example 1

```
//Chapter 19, Problem 1
clc;
A0=120;                        //voltage gain
V1=2.35;                       //input voltage
V2=2.45;                       //input voltage
V0=A0*(V2-V1);                 //output voltage
printf("Output voltage = %d V",V0);
```

Scilab code Exa 19.2 Example 2

```
//Chapter 19, Problem 2
clc;
cmrr=90;                  //CMRR
Ad=150e3;                 //differential gain
Ac=Ad/10^(cmrr/20);       //common mode gain
printf("Common mode gain = %.2f",Ac);
```

Scilab code Exa 19.3 Example 3

```
//Chapter 19, Problem 3
clc;
Av=120;                              //open-loop voltage gain
Vi=3;                                //input voltage
Vo=24*10^-3;                         //output voltage
Ac=Vo/Vi;                             //common mode gain
cmrr=20*log10(Av/Ac);                    //CMRR
printf("CMRR = %.2f dB",cmrr);
```

Scilab code Exa 19.4 Example 4

```
//Chapter 19, Problem 4
clc;
Ri=1000;                             //input resistance
Rf=2000;                             //feedback resistance
Vi1=0.4;                             //input voltage 1
Vi2=-1.2;                            //input voltage 2
V01=(-Rf/Ri)*Vi1;                    //output voltage 1
V02=(-Rf/Ri)*Vi2;                    //output voltage 2
printf("(a) When Vi = 0.4V,\n V0 = %.1f V\n\n",V01);
printf("(b) When Vi = -1.2V,\n V0 = %.1f V\n\n",V02)
   ;
```

Scilab code Exa 19.5 Example 5

```
//Chapter 19, Problem 5, Fig.19.6
clc;
Ib=100e-9;                           //input bias current
Ri=10e3;                             //input resistance
Rf=1e6;                              //feedback resistance
A=-Rf/Ri;                            //voltage gain
```

```
Vos=Ib*((Ri*Rf)/(Ri+Rf));    //output offset voltage
printf("(a) Voltage gain = %f \n\n",A);
printf("(b) Output offset voltage due to the input bias current = %.2f mV\n\n",Vos*1000);
printf("(c) The effect of input bias current can be minimised by ensuring that both inputs    see the same driving resistance.\n");
printf("This means that a resistance of value of 9.9 k (from part (b)) should be placed between the non-inverting (+) terminal and earth in Fig. 19.6");
```

Scilab code Exa 19.6 Example 6

```
//Chapter 19, Problem 6, Fig.19.6
clc;
Av=40;                              //voltage gain
B=5000;                              //bandwidth
Ri=10000;                            //input resistance
A=10^(Av/20);                        //voltage gain in decibels
Rf=A*Ri;                             //feedback resistance
f=A*B;                               //frequency
printf("Gain = %d\n\nFeedback Resistor Rf = %d Megaohm\n\nFrequency = %d Khz",A,Rf/10^6,f/1000);
```

Scilab code Exa 19.7 Example 7

```
//Chapter 19, Problem 7
clc;
R1=4.7e3;                     //resistance 1
R2=10e3;                      //resistance 2
```

```
Vi=-0.4;                    //input voltage
Av=1+(R2/R1);               //voltage gain
V0=Av*Vi;                   //output voltage
printf("(a) Voltage gain = %.2f \n\n",Av);
printf("(b) Output voltage = %.2f V\n\n",V0);
```

Scilab code Exa 19.8 Example 8

```
//Chapter 19, Problem 8, Fig.19.12
clc;
R1=10e3;                                            //resistance 1
R2=20e3;                                        //resistance 2
R3=30e3;                                        //resistance 3
V1=0.5;                                         //input voltage 1
V2=0.8;                                          //input voltage 2
V3=1.2;                                             //input voltage 3
Rf=50e3;                                            //feedback resistance
V0=-Rf*((V1/R1)+(V2/R2)+(V3/R3));                   //output voltage
printf("Output voltage = %f V",V0);
```

Scilab code Exa 19.10 Example 10

```
//Chapter 19, Problem 10
clc;
R=200e3;                              //resistance
```

```
Vi=-0.75;                              //input voltage
C=2.5e-6;                              //capacitance
Vo = (-1/(C*R))*integrate('-0.75', 't', 0, 0.1)
         //output voltage
printf("\n Output voltage is %.2f V",Vo)
```

Scilab code Exa 19.11 Example 11

```
//Chapter 19, Problem 11
clc;
R1=10e3;                        //resistance 1
R2=10e3;                        //resistance 2
R3=100e3;                        //resistance 3
Rf=100e3;                        //feedback resistance
V1=5e-3;                        //input voltage 1
V2=5e-3;                        //input voltage 2
V3=50e-3;                        //input voltage 3
V4=25e-3;                        //input voltage 4
V5=25e-3;                        //input voltage 5
V6=50e-3;                        //input voltage 6
V01=(-Rf/R1)*V1;                              //output
   voltage 1
V02=(R3/(R2+R3))*(1+(Rf/R1))*V2;          //output
   voltage 2
V03=(V3-V4)*(-Rf/R1);                         //output
   voltage 3
V04=(V6-V5)*(R3/(R2+R3))*(1+(Rf/R1));      //output
   voltage 4
printf("(a) V0 = %d mV\n\n",V01*1000);
printf("(b) V0 = %d mV\n\n",V02*1000);
printf("(c) V0 = %d mV\n\n",V03*1000);
printf("(d) V0 = %d mV\n\n",V04*1000);
```

Chapter 20

Three phase systems

Scilab code Exa 20.1 Example 1

```
//Chapter 20, Problem 1
clc;
Rp=30;                      //resistance in ohm
Vl=415;                     //3-phase supply
Vp=Vl/sqrt(3);              //phase voltage
Ip=Vp/Rp;                   //phase current
printf("(a) System phase voltage = %.1f V\n or 240 V
    ,correct to 3 significant figures\n\n",Vp);
printf("(b) Phase current = %.2f A\n\n",Ip);
printf("(c) For a star connection, Ip =IL hence the
    line current,\n Line current = %.2f A\n\n",Ip);
```

Scilab code Exa 20.2 Example 2

```
//Chapter 20, Problem 2
clc;
R=30;                               //resistance of coil
f=50;                               //supply frequency
```

```
L=127.3e-3;                          //inductance of coil
Ip=5.08;                             //line current
Xl=2*%pi*f*L;                        //inductive
   reactance
Zp=sqrt(R^2+Xl^2);                   //impedance of each
   phase
Vp=Ip*Zp;                            //phase voltage
Vl=sqrt(3)*Vp;                       //line voltage
printf("Line voltage = %.2f V",Vl);
```

Scilab code Exa 20.4 Example 4

```
//Chapter 20, Problem 4, Fig.20.7
clc;
Vl=415;                                  //3-phase supply
Pr=24000;                                //resistance in
   ohm
Py=18000;                                //resistance in
   ohm
Pb=12000;                                //resistance in
   ohm
Vp=Vl/sqrt(3);                           //phase voltage
Ir=Pr/Vp;                                //current in
   each line
Iy=Py/Vp;
Ib=Pb/Vp;

//calculating current in the neutral conductor
Irh=cos(90*%pi/180);
Iyh=cos(330*%pi/180);
Ibh=cos(210*%pi/180);
Irv=sin(90*%pi/180);
Iyv=sin(330*%pi/180);
Ibv=sin(210*%pi/180);
Ih=(Ir*Irh)+(Iy*Iyh)+(Ib*Ibh);
```

```
Iv=(Ir*Irv)+(Iy*Iyv)+(Ib*Ibv);
In=sqrt(Ih^2+Iv^2);

printf("(a) Ir = %d A\n\nIy = %d A\n\nIb = %d A\n\n",Ir,Iy,Ib);
printf("(b) The three line currents are shown in the phasor diagram of Fig. 20.8.\n");
printf("Since each load is resistive the currents are in phase with the phase voltages and are hence mutually displaced by 120  .");
printf("\nIn = %f A\n",In);
```

Scilab code Exa 20.5 Example 5

```
//Chapter 20, Problem 5
clc;
Zp=50;                              //phase impedance
Vp=440;                             //3 phase supply
Ip=Vp/Zp;                           //phase current
Il=sqrt(3)*Ip;                      //line current
printf("(a) Phase current = %.1f A\n\n",Ip);
printf("(b) For a delta connection Il = %.2f A",Il);
```

Scilab code Exa 20.6 Example 6

```
//Chapter 20, Problem 6
clc;
Il=15;                          //line current
Vl=415;                         //3 phase supply
f=50;                           //supply frequency
Ip=Il/sqrt(3);                  //phase current
```

```
Xc=Vl/Ip;                           //capacitive reactance
C=1/(2*%pi*f*Xc);                   //capacitance
printf("Capacitance = %.3f uF",C*10^6);
```

Scilab code Exa 20.7 Example 7

```
//Chapter 20, Problem 7
clc;
R=3;                            //resistance of coil
Xl=4;                           //inductive reactance
Vl=415;                         //3 phase supply
Vp1=415;                        //line voltage
Vp=Vl/sqrt(3);                  //phase voltage for star connection
Zp=sqrt(R^2+Xl^2);              //impedance per phase
Ip=Vp/Zp;                       //phase current
Ip1=Vp1/Zp;                     //phase voltage
Il1=Ip1*sqrt(3);                //line current
printf("(i) For star connection\n    (a) Line voltage = %d V\n    Phase voltage = %f V\n\n",Vl,Vp);
printf("    (b) Line current = %d V\n    Phase current = %f V\n\n\n",Ip,Ip);
printf("(ii) For delta connection\n    (a) Line voltage = %d V\n    Phase voltage = %d V\n\n",Vp1,Vp1);
printf("    (b) Line current = %f V\n    Phase current = %f V\n",Il1,Ip1);
```

Scilab code Exa 20.8 Example 8

```
//Chapter 20, Problem 8
```

```
clc;
Rp=12;                              //resistance
Vl=415;                             //3 phase supply
Vp=Vl/sqrt(3);                      //phase voltage
Ip=Vp/Rp;                           //phase current
Il=Ip;
pf=1;                               //power factor
P=sqrt(3)*Vl*Il*pf;                 //power dissipated
printf("Total power dissipated = %.2f kW",P/1000);
```

Scilab code Exa 20.9 Example 9

```
//Chapter 20, Problem 9
clc;
P=5000;                             //power
Vl=400;                             //line voltage
Il=8.6;                             //line current
pf=P/(sqrt(3)*Vl*Il);               //power factor
printf("Power factor = %.3f ",pf);
```

Scilab code Exa 20.11 Example 11

```
//Chapter 20, Problem 11
clc;
Po = 12750;                 // in Watts
pf = 0.77;                  // power factor
eff = 0.85;
VL = 415;                   // in Volts

//calculation:
//eff = power_out/power_in
Pi = Po/eff
```

```
//Power P = VL*IL*(3^0.5)*cos(phi)  or  P = 3*Ip*Ip*
   Rp)
IL = Pi/(VL*(3^0.5)*pf) // line current

//For a delta connection:
//IL = Ip*(3^0.5)
Ip = IL/(3^0.5)

printf("\n\n (a)Power input = %d W",Pi)
printf("\n\n (b)Line current = %.2f A",IL)
printf("\n\n (c)Phase current = %.2f A",Ip)
```

Scilab code Exa 20.13 Example 13

```
//Chapter 20, Problem 13
clc;
Vl=400;                          //supply voltage
Rp=30;                           //resistance
Xl=40;                           //inductive
   reactance
Zp=sqrt(Rp^2+Xl^2);              //phase impedance
Ip=Vl/Zp;                        //phase current
Il=sqrt(3)*Ip;                   //line current
pf=Rp/Zp;                        //power factor
P=sqrt(3)*Vl*Il*pf;              //power dissipated
S=sqrt(3)*Vl*Il;                 //alternator output
   KVA
printf("(a) Current is supplied by alternator = %.3f
    A\n\n",Il);
printf("(b) Output power = %.2f kW\n",P/1000);
printf("    Alternator ouput KVA = %.2f KVA",S/1000)
   ;
```

Scilab code Exa 20.14 Example 14

```
//Chapter 20, Problem 14
clc;
f=50;                               //supply frequency
Rp=30;                              //resistance
C=80e-6;                            //capacitance
Vl=400;                             //3 phase supply
Xc=1/(2*%pi*f*C);                   //capacitive
   reactance
Zp=sqrt(Rp^2+Xc^2);                 //phase impedance,
pf=Rp/Zp;                           //power factor
phi=acos(pf);                       //phase angle
Ip=Vl/Zp;                           //phase current
Il=sqrt(3)*Ip;                      //line current
P=sqrt(3)*Vl*Il*cos(phi);           //power dissipated
S=sqrt(3)*Vl*Il;                    //total KVA
printf("(a) Phase current = %.3f A\n\n",Ip);
printf("(b) Line current = %.2f A\n\n",Il);
printf("(c) Total power dissipated = %.3f kW\n\n",P
   /1000);
printf("(d) Total kVA = %.3f kVA\n\n",S/1000);
printf("The phasor diagram for the load is shown in
   Fig. 20.18");
```

Scilab code Exa 20.15 Example 15

```
//Chapter 20, Problem 15
clc;
P1=8;                       //power 1 in watt
P2=4;                       //power 2 in watt
P=P1+P2;                    //total input power
phi=atan(sqrt(3)*((P1-P2)/(P1+P2)));
pf=cos(phi);                        //load power factor
printf("(a) Total input power = %d kW\n\n",P);
```

```
printf("(b) Power factor = %.3f ",pf);
```

Scilab code Exa 20.16 Example 16

```
//Chapter 20, Problem 16
clc
P=12e3                          //total power
pf=0.6                          //power factor
ang=acos(pf)
ta=tan(ang)
P12=P*ta/3^(1/2)

//solving two equation by matrix method
A=[1 1;1 -1]
B=[12000;P12]
x=linsolve(A,-B)
printf("wattmeter 1 read = %.2f kW\n\n",x(1)/1000)
printf("wattmeter 2 read = %.2f kW\n\n",x(2)/1000)
```

Scilab code Exa 20.17 Example 17

```
//Chapter 20, Problem 17
clc;
P1=10;                          //power 1 in watt
P2=-3;                          //power 2 in watt
P=P1+P2;                        //total input power
phi=atan(sqrt(3)*((P1-P2)/(P1+P2)));
pf=cos(phi);                    //load power factor
disp("Since the reversing switch on the wattmeter
    had to be operated the 3kW reading is taken as
      3 kW");
printf("(a) Total input power = %f kW\n\n",P);
printf("(b) Power factor = %f ",pf);
```

Scilab code Exa 20.18 Example 18

```
//Chapter 20, Problem 18
clc;
R = 8;                          //resistance
XL = 8;                         //inductive reactance
VL = 415;                       //supply voltage

//calculation:
//For a star connection:
//IL = Ip
//VL = Vp*(3^0.5)
VLs = VL
Vps = VLs/(3^0.5)
//Impedance per phase,
Zp = (R*R + XL*XL)^0.5
Ips = Vps/Zp
ILs = Ips
//Power dissipated, P = VL*IL*(3^0.5)*cos(phi)  or
   P = 3*Ip*Ip*Rp)
pf = R/Zp
Ps = VLs*ILs*(3^0.5)*pf
//If wattmeter readings are P1 and P2 then P1 + P2 =
    Pst
Pst = Ps
// Pid = Pi1 - Pi2
phi = acos(pf)
Psd = Pst*tan(phi)/(3^0.5)
//Hence wattmeter 1 reads
Ps1 = (Psd + Pst)/2
//wattmeter 2 reads
Ps2 = Pst - Ps1

//For a delta connection:
```

```
//VL = Vp
//IL = Ip*(3^0.5)
VLd = VL
Vpd = VLd
Ipd = Vpd/Zp
ILd = Ipd*(3^0.5)
//Power dissipated , P = VL*IL*(3^0.5)*cos(phi)  or
   P = 3*Ip*Ip*Rp)
Pd = VLd*ILd*(3^0.5)*pf
//If wattmeter readings are P1 and P2 then P1 + P2 =
    Pdt
Pdt = Pd
// Pid = Pi1 - Pi2
Pdd = Pdt*tan(phi)/(3^0.5)
//Hence wattmeter 1 reads
Pd1 = (Pdd + Pdt)/2
//wattmeter 2 reads
Pd2 = Pdt - Pd1


printf("\n\n (a)When the coils are star-connected
   the wattmeter readings are %.3f kW and %.3f kW",
   Ps1/1000,Ps2/1000)
printf("\n\n (b)When the coils are delta-connected
   the wattmeter readings are are %.3f kW and %.3f
   kW",Pd1/1000,Pd2/1000)
```

Chapter 21

Transformers

Scilab code Exa 21.1 Example 1

```
//Chapter 21, Problem 1
clc;
n1=500;                    //primary turns
n2=3000;                   //secondary turns
v1=240;                    //primary voltage
v2=(v1*n2)/n1;             //secondary voltage
printf("Secondary voltage = %f V",v2);
```

Scilab code Exa 21.2 Example 2

```
//Chapter 21, Problem 2
clc;
N=2/7;               //turns ratio
v1=240;              //primary voltage
v2=v1/N;             //secondary voltage
printf("Output voltage = %f V",v2);
```

Scilab code Exa 21.3 Example 3

```
//Chapter 21, Problem 3
clc;
N=8/1;                      //turns ratio
i1=3;                       //primary current
v1=240;                     //primary voltage
v2=v1/N;                    //secondary voltage
i2=N*i1;                    //secondary current
printf("Secondary voltage = %f V\n\nSecondary
   current = %f A",v2,i2);
```

Scilab code Exa 21.4 Example 4

```
//Chapter 21, Problem 4
clc;
v1=240;                         //primary voltage
v2=12;                          //secondary voltage
P=150;                          //power
N=v1/v2;                        //turns ratio
i2=P/v2;                        //secondary current
i1=i2/N;                        //primary current
printf("Transformer turns ratio = %f\n\n",N);
printf("Current = %f A",i1);
```

Scilab code Exa 21.5 Example 5

```
//Chapter 21, Problem 5
clc;
v2=120;                             //secondary voltage
r2=12;                              //resistance in ohm
i1=4;                               //primary current
i2=v2/r2;                           //secondary current
```

```
v1=v2*(i2/i1);                          //primary voltage
printf("Primary voltage = %f V",v1);
```

Scilab code Exa 21.6 Example 6

```
//Chapter 21, Problem 6
clc;
N=10;                                       //turns ratio
v1=2.5e3;                                   //primary
    voltage
P=5000;                                     //power
v2=v1/N;                                    //secondary
    voltage
i2=P/v2;                                    //secondary
    current
Rl=v2/i2;                                   //resistance in
    ohm
i1=i2/N;                                    //primary
    current
printf("(a) Full-load secondary current = %d A\n\n",
    i2);
printf("(b) Minimum value of load resistance = %.1f
    ohms\n\n",Rl);
printf("(c) Primary current = %d A\n\n",i1);
```

Scilab code Exa 21.7 Example 7

```
//Chapter 21, Problem 7
clc;
v1=2400;                                            //
    primary voltage
v2=400;                                             //
    secondary voltage
```

```
i0=0.5;                                                //no load current
Pl=400;                                                //power
phi=acos(v2/(v1*i0));                                  //phase
im=i0*sin(phi);                                        //magnetising component
ic=i0*cos(phi);                                        //core loss component
printf("Magnetising loss component = %.3f A\n\n",im);
printf("Core loss component = %.3f A",ic);
```

Scilab code Exa 21.9 Example 9

```
//Chapter 21, Problem 9
clc;
v1=4000;                          //primary voltage
v2=200;                           //secondary voltage
f=50;                             //frequency
n2=100;                           //secondary turns
R=100e3;                          //resistance in ohm
E=v2;
i1=R/v1;                          //primary current
i2=R/v2;                          //secondary current
n1=(v1/v2)*n2;                    //primary turns
phim=E/(4.44*f*n2);               //flux max
printf("(a) Primary current = %f A\n\nSecondary currenr = %f A\n\n\n",i1,i2);
printf("(b) Primary turns = %f\n\n\n",n1);
printf("(c) maximum value of the flux = %f mWb",phim*1000);
```

Scilab code Exa 21.10 Example 10

```
//Chapter 21, Problem 10
clc;
f=50;                           //frequency
n1=25;                          //primary turns
n2=300;                         //secondary turns
A=300e-4;                       //cross-sectional area of the core
v1=250;                         //primary voltage
phim=v1/(4.44*f*n1);            //flux
Bm=phim/A;                      //maximum flux density
v2=v1*(n2/n1);                  //secondary voltage
printf("(a) Maximum flux density= %.2f T\n\n",Bm);
printf("(b) Secondary winding voltage = %d V",v2);
```

Scilab code Exa 21.11 Example 11

```
//Chapter 21, Problem 11
clc;
f=50;                               //frequency
v1=500;                             //primary voltage
v2=100;                             //secondary voltage
B=1.5;                              //maximum core flux density
A=50e-4;                            //effective core cross-sectional area
phim=B*A;                           //maximum flux
n1=v1/(4.44*f*phim);                //primary turns
n2=v2/(4.44*f*phim);                //secondary turns
printf("Primary turns = %d turns\n\n",n1);
printf("Seconadry turns = %d turns\n\n",n2);
```

Scilab code Exa 21.12 Example 12

```
//Chapter 21, Problem 12
clc;
v1=4500;                          //primary voltage
v2=225;                           //secondary voltage
f=50;                             //frequency
en=15;                            //e.m.f. per turn
B=1.4;                            //maximum core flux
   density
n1=v1/en;                         //primary turns
n2=v2/en;                         //secondary turns
phim=v1/(4.44*f*n1);              //maximum flux
A=phim/B;                         //effective core
   cross-sectional area
printf("(a) Primary turns = %f\n\nSecondary turns =
   %f\n\n\n",n1,n2);
printf("(b) cross-sectional area of the core = %f m2
   ",A);
```

Scilab code Exa 21.13 Example 13

```
//Chapter 21, Problem 13, Figure 21.5
clc
n1=2000                           //no of turns on
   primary
n2=800                            //no of turns on
   secondary
i2=100                            //secondary current
   in amperes
i1=44                             //current in amperes
    from phasor diagram
i0=5                              //no load current
i3=40                             //current from phaor
    diagram
pf0=0.2                           //power factor
a1=37
```

```
pf2=0.85
i1=i2*n2/n1
a2=acosd(pf2)
a0=acosd(pf0)
Icos=(i0*pf0)+(i3*pf2)
Isin=(i0*sin(a0*%pi/180))+(i3*sin(a2*%pi/180))
I1=sqrt(Isin^2+Icos^2)
ta=atand(Isin/Icos)
pf=cos(ta*%pi/180)
printf("I1 = %.3f A\n\n Power factor = %.3f degree\n
   \n",I1,pf)
```

Scilab code Exa 21.14 Example 14

```
//Chapter 21, Problem 14
clc;
n1=600;                                    //primary turns
n2=150;                                    //secondary
   turns
r1=0.25;                                   //primary
   resistance
r2=0.01;                                   //secondary
   resistance
x1=1;                                      //leakage
   reactance
x2=0.04;
re=r1+r2*(n1/n2)^2;                        //equivalent
   resistance
xe=x1+x2*(n1/n2)^2;                        //equivalent
   reactance
ze=sqrt(re^2+xe^2);                        //equivalent
   impedance
phie=acos(re/ze);                          //phase angle of
    the impedance
printf("(a) Equivalent resistance = %.2f ohms\n\n",
```

```
re);
printf("(b) Equivalent reactance = %.2f ohms\n\n",xe);
printf("(c) Equivalent impedance = %.2f ohms\n\n",ze);
printf("(d) Phase angle of the impedance = %.2f deg",phie*180/%pi);
```

Scilab code Exa 21.15 Example 15

```
//Chapter 21, Problem 15
clc;
e1=200;                         //primary voltage
e2=400;                         //secondary voltage
v2=387.6;                       //secondary terminal voltage
reg=((e2-v2)/e2)*100;           //regulation
printf("Regulation = %.1f percent",reg);
```

Scilab code Exa 21.16 Example 16

```
//Chapter 21, Problem 16
clc;
reg=2.5;                        //regulation
e2=240;                         //secondary voltage
v2=240-((reg*e2)/100);          //secondary terminal voltage
printf("Load voltage = %d V",v2);
```

Scilab code Exa 21.17 Example 17

```
//Chapter 21, Problem 17
clc;
vi=200e3;                        //rated transformer
pf=0.85;                         //power factor
lcu=1.5e3;                       //copper loss
lfe=1e3;                         //iron loss
po=vi*pf;                        //full-load output power
lt=lcu+lfe;                      //total losses
pi=po+lt;                        //input power
Ef=(1-(lt/pi));                  //efficiency
printf("Transformer efficiency at full load = %f
    percent",Ef*100);
```

Scilab code Exa 21.18 Example 18

```
//Chapter 21, Problem 18
clc;
vi=200e3;                            //rated transformer
pf=0.85;                             //power factor
lcu=(1/2)^2*1.5e3;                   //copper loss
lfe=1e3;                             //iron loss
p0=(1/2)*vi*pf;                      //full-load output
    power
lt=lcu+lfe;                          //total losses
pi=p0+lt;                            //input power
Ef=(1-(lt/pi));                      //efficiency
printf("Transformer efficiency at half load = %.3f
    percent",Ef*100);
```

Scilab code Exa 21.19 Example 19

```
//Chapter 21, Problem 19
clc
```

```
k=400000                                    //transformer rating
v1=5000                                     //primary current
v2=320                                      //secondary current
r1=0.5                                      //resistance in ohm
r2=0.001                                    //resistance in ohm
lfe=2500                                    //iron loss
pf=0.85                                     //power factor
i1=k/v1                                     //primary current
i2=k/v2                                     //secondary current
lcu=(i1^2*r1)+(i2^2*r2)                     //total copper loss
lt=lcu+lfe                                  //total loss
pt=k*pf                                     //total output power
pi=pt+lt                                    //input power
n=(1-(lt/pi))*100                           //efficiency
lc=lcu*(1/2)^2                              //total copper loss at half load
lh=lc+lfe                                   //total loss at half loss
ph0=(1/2)*pt                                //output power at half load
phi=(ph0+lh)                                //input power at half load
n1=(1-(lh/phi))*100                         //efficiency
printf("(a) Efficiency on full load = %.3f percent\n\n",n)
printf("(b) Efficiency at half load = %.3f percent\n\n",n1)
```

Scilab code Exa 21.20 Example 20

```
//Chapter 21, Problem 20
clc
c=4e3                              //coper loss
p=500e3                            //transformer rating
r=2.5e3                            //iron loss
pf=0.75                            //power factor
x=sqrt(r/c)
eff=x*p
los=2*r
po=eff*pf
pi=po-los
n=(1-(los/pi))*100
printf("(a) The Output KVA at maximum efficiency = %
    .2f kVA\n\n",eff/1000)
printf("(b) Maximum efficiency = %.2f percent",n)
```

Scilab code Exa 21.21 Example 21

```
//Chapter 21, Problem 21
clc;
N=4/1;                             //turns ratio
Rl=100;                            //load resistance
R1=N^2*Rl;                         //equivalent input
    resistance
printf("Equivalent input resistance = %d ohms",R1);
```

Scilab code Exa 21.22 Example 22

```
//Chapter 21, Problem 22
clc;
R1=112;                          //equivalent input
   resistance
Rl=7;                            //load resistance
N=sqrt(R1/Rl);                   //turns ratio
printf("Optimum turns ratio = %d : 1 ",N);
```

Scilab code Exa 21.23 Example 23

```
//Chapter 21, Problem 23
clc;
R1=150;                                  //equivalent
   input resistance
N=5;                                     //turns ratio
Rl=R1/(N^2);                             //load
   resistance
printf("Optimum value of load resistance = %d ohm",
   Rl);
```

Scilab code Exa 21.24 Example 24

```
//Chapter 21, Problem 24
clc;
v1=220;                                  //primary
   voltage
v2=1760;                                 //secondary
   voltage
R=2;                                     //cable
   resistance
Rl=1.28e3;                               //load across
   secondary winding
N=v1/v2;                                 //turns ratio
```

```
R1=N^2*Rl;                         //equivalent input resistance
Rin=R+R1;                          //total input resistance,
I1=v1/Rin;                         //primary current
I2=I1*N;                           //secondary current
P=I2^2*Rl;                         //power dissipated
printf("(a) Primary current = %d A\n\n",I1);
printf("(b) Power dissipated in load resistor = %d W",P);
```

Scilab code Exa 21.25 Example 25

```
//Chapter 21, Problem 25
clc;
V=24;                    //ac source
R1=15e3;                 //input resistance
N=25/1;                  //turns ratio
Rin=15e3;                //internal resistance
Rl=R1*(1/N)^2;           //load resistance
Rt=Rin+R1;               //total input resistance
I1=V/Rt;                 //primary current
I2=I1*N;                 //secondary current
P=I2^2*Rl;               //power dissipated
printf("(a) Load resistance = %d ohms\n\n",Rl);
printf("(b) Power dissipated in the load = %.1f mW",P*1000);
```

Scilab code Exa 21.26 Example 26

```
//Chapter 21, Problem 26
clc;
V1=320;                         //primary voltage
V2=250;                         //secondary voltage
Rg=20e3;                        //rating
I1=Rg/V1;                       //primary current
I2=Rg/V2;                       //secondary current
I=I2-I1;                        //current in common part of the winding
printf("Primary current = %.1f A\n\nSecondary current = %d A\n\n\n",I1,I2);
printf("Hence current in common part of the winding = %.1f A",I);
```

Scilab code Exa 21.27 Example 27

```
//Chapter 21, Problem 27
clc;
v1=200;                         //primary voltage of transformer 1
v2=150;                         //secondary voltage of transformer 1
v3=500;                         //primary voltage of transformer 2
v4=100;                         //secondary voltage of transformer 2
x=v2/v1;
V=(1-x)*100;
y=v4/v3;
W=(1-y)*100;
printf("(a) 200V:150V transformer,\n Volume of copper = %d percent\n",V);
disp("Hence the saving is 75%");
printf("\n\n(b) 500V:100V transformer,\nVolume of copper = %d percent\n",W);
```

```
disp("Hence the saving is 20%.");
```

Scilab code Exa 21.28 Example 28

```
//Chapter 21, Problem 28
clc;
n1=500;                          //primary turns
n2=50;                           //secondary
   turns
v1=2.4e3;                        //supply voltage
Vp=v1/sqrt(3);                   //primary phase
   voltage
Vp2=Vp*(n2/n1);                  //secondary
   phase voltage
Vp3=v1*(n2/n1);                  //secondary
   phase voltage 2
Vl=sqrt(3)*Vp3;                  //secondary line
    voltage
printf("(a) For star connection\n")
printf("Secondary line voltage = %.2f V\n\n",Vp2);
printf("(b) For delta connection\n");
printf("Secondary line voltage = %.2f V",Vl);
```

Scilab code Exa 21.29 Example 29

```
//Chapter 21, Problem 29
clc;
N1=1;                        //primary turns
N2=60;                       //secondary turns
I1=300;                      //primary current
Ra=0.15;                     //ammeter resistance
R2=0.25;                     //secondary winding
   resistance
```

```
I2=I1*(N1/N2);                          //secondary current
V2=I2*Ra;                               //secondary voltage
Rt=Ra+R2;                               //total resistance
    of secondary circuit
e2=I2*Rt;                               //induced e.m.f. in
    secondary
l=e2*I2;                                //load on secondary
printf("(a) Reading on the ammeter = %d A\n\n",I2);
printf("(b) P.d. across the ammeter = %.2f V\n\n",V2
    );
printf("(c) Total load (in VA) on the secondary = %d
     VA",l);
```

Chapter 22

DC machines

Scilab code Exa 22.1 Example 1

```
//Chapter 22, Problem 1
clc;
Z=600;                    //no of armature conductors
c=2;
p=8/2;                    //no of pairs of poles
n=625/60;                 //armature speed
phi=20e-3;                //flux
E=(2*p*phi*n*Z)/c;        //e.m.f
printf("emf = %f V",E);
```

Scilab code Exa 22.2 Example 2

```
//Chapter 22, Problem 2
clc;
E=240;                                  //e.m.f
Z=50*16;                                //no of armature
    conductors
phi=30e-3;                              //flux
```

```
p=4/2;                                    //no of pairs of
    poles
c=2*p;
n=(E*c)/(2*p*phi*Z);                    //armature speed
printf("Speed = %d rev/s",n);
```

Scilab code Exa 22.3 Example 3

```
//Chapter 22, Problem 3
clc;
p=8/2;                                    //no of pairs of
    poles
c=2*p;
phi=0.03;                                 //flux
n=500/60;                                 //armature speed
Z=1200;                                   //no of armature
    conductors
E=(2*p*phi*n*Z)/c;                        //e.m.f
printf("emf = %f V",E);
```

Scilab code Exa 22.4 Example 4

```
//Chapter 22, Problem 4
clc;
p=8/2;                                    //no of pairs of
    poles
c=2;
phi=0.03;                                 //flux
n=500/60;                                 //armature speed
Z=1200;                                   //no of armature
    conductors
E=(2*p*phi*n*Z)/c;                        //e.m.f
printf("emf = %f V",E);
```

Scilab code Exa 22.6 Example 6

```
//Chapter 22, Problem 6
clc;
E1=200;                            //generated e.m.f 1
n1=30;                             //armature speed 1
E2=250;                            //generated e.m.f 2
n2=20;                             //armature speed 2
phi1=1;                            //flux 1
phi2=(phi1*n1*E2)/(n2*E1);         //flux 2
printf("Increase in the flux per pole = %f percent",
   phi2*100);
```

Scilab code Exa 22.7 Example 7

```
//Chapter 22, Problem 7
clc;
E=200;                             //generated e.m.f
ia=30;                             //armature current
Ra=0.30;                           //armature
   resistance
V=E-(ia*Ra);                       //terminal voltage
printf("Terminal voltage = %f V",V);
```

Scilab code Exa 22.8 Example 8

```
//Chapter 22, Problem 8
clc;
```

```
ia=8;                                    //armature current
Ra=1;                                    //armature resistance
Rl=60;                                   //loadd resistance
V=ia*Rl;                                 //terminal voltage
E=V+(ia*Ra);                             //generated e.m.f
printf("(a) Terminal voltage = %f V\n\n",V);
printf("(b) Generated emf = %f V\n\n",E);
```

Scilab code Exa 22.9 Example 9

```
//Chapter 22, Problem 9
clc;
E1=150;                              //generated e.m.f 1
phi1=0.10;                           //flux 1
phi2=0.1;                            //flux 2
N1=20;                               //armature speed 1
N2=25;                               //armature speed 2
N3=24;                               //armature speed 3
N4=20                                //armature speed 4
phi3=0.08;                           //flux 3
phi4=0.07;                           //flux 4
E2=(E1*phi1*N2)/(phi2*N1);                       //generated e.m.f 2
E3=(E1*phi3*N4)/(phi2*N1);                       //generated e.m.f 3
E4=(E1*phi4*N3)/(phi2*N1);                       //generated e.m.f 4
printf("(a) emf = %.1f V\n\n\n",E2);
printf("(b) emf = %d V\n\n\n",E3);
printf("(c) emf = %d V\n\n\n",E4);
```

Scilab code Exa 22.10 Example 10

```
//Chapter 22, Problem 10
clc;
P=20e3;                    //power by shunt generator
V=200;                     //voltage
R=100e-3;                  //cable resistance
Rf=50;                     //field winding resistance
Ra=40e-3;                  //armature resistance
I=P/V;                     //load current
Vc=I*R;                    //voltage drop in cable
Vt=Vc+V;                   //terminal voltage
If=Vt/Rf;                  //field current
Ia=I+If;                   //armature current
E=Vt+(Ia*Ra);              //generated e.m.f
printf("(a) Terminal voltage = %d V \n\n",Vt);
printf("(b) Generated e.m.f. E = %.2f V",E);
```

Scilab code Exa 22.11 Example 11

```
//Chapter 22, Problem 11
clc;
I=80;                          //current
Rse=0.02;                      //series resistance
Ra=0.04;                       //armature resistance
Rf=40;                         //field resistance
V=200;                         //supply voltage
Vse=I*Rse;                     //volt drop in series winding
V1=V+Vse;                      //P.d. across the field winding
```

```
If=V1/Rf;                          //field current
Ia=I+If;                           //armature current
E=V1+(Ia*Ra);                      //generated e.m.f
printf("Generated e.m.f., E = %d V",E);
```

Scilab code Exa 22.12 Example 12

```
//Chapter 22, Problem 12
clc;
R=0.75                      //armature circuit
   resistance
Rf=125;                     //field resistance
Po=10e3;                    //power in watt
V=250;                      //supply voltage
C=600;                      //iron, friction and windage
    losses in watt
I=Po/V;                     //load current
If=V/Rf;                    //field current
Ia=If+I;                    //armature current
n=(Po/(Po+(Ia^2*R)+(If*V)+C))*100;           //
   efficiency
printf("Efficiency = %f percent",n);
```

Scilab code Exa 22.13 Example 13

```
//Chapter 22, Problem 13
clc;
V=240;                             //supply voltage
Ia=50;                             //armature current
Ra=0.2;                            //armature resistance
E=V-(Ia*Ra);                       //back e.m.f
printf("Back emf = %d V",E);
```

Scilab code Exa 22.14 Example 14

```
//Chapter 22, Problem 14
clc;
Ra=0.25;                              //armature
   resistance
V=300;                                //supply voltage
Ia1=100;                              //current 1
Ia2=80;                               //current 2
E1=V+(Ia1*Ra);                        //e.m.f (generator)
E2=V-(Ia2*Ra);                        //e.m.f (motor)
printf("(a) As a generator, generated e.m.f = %d V\n
   \n",E1);
printf("(b) As a motor, generated e.m.f = %d V",E2)
```

Scilab code Exa 22.15 Example 15

```
//Chapter 22, Problem 15
clc;
p=8/2;                            //pairs of poles
c=2;
phi=25e-3;                        //flux
Ia=30;                            //armature current
Z=900;
T=(p*phi*Z*Ia)/(%pi*c);               //torque
printf("Torque = %.1f Nm",T);
```

Scilab code Exa 22.16 Example 16

```
//Chapter 22, Problem 16
clc;
V=350;                          //supply voltage
Ra=0.5;                         //armature resistance
n=15;                           //motor speed in rev/sec
Ia=60;                          //armature current
E=V-Ia*Ra;                      //back e.m.f
T=(E*Ia)/(2*%pi*n);             //torque
printf("Torque,T = %.1f Nm",T);
```

Scilab code Exa 22.17 Example 17

```
//Chapter 22, Problem 17
clc;
V=250;                                  //supply voltage
p=6/2;                                  //pairs of poles
Z=500;                                  //conductors
Ra=1;                                   //armature resistance
phi=20*10^-3;                           //flux
Ia=40;                                  //armature current
c=2*p;
E=V-(Ia*Ra);                            //back e.m.f
n=E*c/(2*p*phi*Z);                      //rotating speed
T=(E*Ia)/(2*%pi*n);                     //torque
printf("(a) Speed = %f rev/min\n\n",n*60);
printf("(b) Torque, T = %.2f Nm",T);
```

Scilab code Exa 22.18 Example 18

```
//Chapter 22, Problem 18
clc;
T1=25;                          //torque of a shaft 1
T2=35;                          //torque of a shaft 2
Ia1=16;                         //armature current 1
phi2=0.85;                      //flux
Ia2=Ia1*T2/(phi2*T1);           //armature current 2
printf("Armature current = %.2f A",Ia2);
```

Scilab code Exa 22.19 Example 19

```
//Chapter 22, Problem 19
clc
V=100                       //supply voltage
I=15                        //current in ampere
T=12                        //torque in Nm
n=1500/60
n1=((V*I)/(T*2*%pi*n))*100
los=((T*2*%pi*n)-(V*I))
printf("(a) Efficiency = %.2f percent \n\n",n1)
printf("(b) Power loss = %f W",los)
```

Scilab code Exa 22.20 Example 20

```
//Chapter 22, Problem 20
clc;
Ra=0.4;                                 //armature
   resistance
```

```
V=240;                                  //supply voltage
Rf=150;                                 //field resistance
I=30;                                   //total current
If=V/Rf;                                //field current
Ia=I-If;                                //armature current
E=V-(Ia*Ra);                            //generated e.m.f
printf("(a) Armature current = %.1f A\n\n",Ia);
printf("(b) Back emf = %.2f V",E)
```

Scilab code Exa 22.21 Example 21

```
//Chapter 22, Problem 21
clc;
V=200;                                  //supply voltage
Ra=0.4;                                 //armature resistance
Ia=30;                                  //armature current
n1=1350/60;                             //rotating speed
Ia2=45;                                 //armature current 2
E1=V-(Ia*Ra);                           //e.m.f 1
E2=V-(Ia2*Ra);                          //e.m.f 2
n2=(n1*E2)/E1;                          //speed of the motor due to armature current 2
printf("Speed of the motor = %.3f rev/min",n2*60);
```

Scilab code Exa 22.23 Example 23

```
//Chapter 22, Problem 23
clc;
n1=24;                                  //rotating speed due to Ia = 15A
phi2=2;                                 //flux
V=240;                                  //supply voltage
```

```
Ia=15;                              //armature current
I2=30;                              //current
Ra=0.2;                             //armature
   resistance
Rf=0.3;                             //field resistance
E1=V-(Ia*(Ra+Rf));                  //e.m.f 1
E2=V-(I2*(Ra+Rf));                  //e.m.f 2
n2=n1*E2/(E1*phi2);                 //speed of motor
printf("(a) Generated e.m.f = %f V\n\n\n",E1);
printf("(b) Speed of motor n2 = %.1f rev/s",n2);
```

Scilab code Exa 22.24 Example 24

```
//Chapter 22, Problem 24
clc;
Ra=0.2                      //armature resistance
V=320;                      //supply voltage
Rf=40;                      //field resistance
I=80;                       //current
If=V/Rf;                    //field current
Ia=I-If;                    //armature current
C=1500;
n=(((V*I)-(Ia^2*Ra)-(If*V)-C)/(V*I))*100;
   //overall efficiency
printf("Efficiency = %.3f percent",n);
```

Scilab code Exa 22.25 Example 25

```
//Chapter 22, Problem 25
clc;
V=250;                      //supply voltage
I=40;                       //current
Ra=0.15;                    //armature resistance
```

```
Rf=0.05;                    //field resistance
n=(((V*I)-(2*I^2*(Ra+Rf)))/(V*I))*100;       //overall efficiency
printf("Efficiency = %.1f percent",n);
```

Scilab code Exa 22.26 Example 26

```
//Chapter 22, Problem 26
clc;
T=15;                            //torque
V=200;                           //supply voltage
n1=1200/60;                      //speed of motor
n=80;                            //efficiency
I=((T*2*%pi*n1)/(V*n))*100;          //current supplied
printf("Current supplied = %.2f A",I);
```

Scilab code Exa 22.27 Example 27

```
//Chapter 22, Problem 27
clc;
V=400;                                   //supply voltage
I=10;                                    //current
R=2;                                     //total resistance
C=300;                                   //iron, friction and windage losses
n=(((V*I)-(I^2*R)-C)/(V*I))*100;             //overall efficiency
printf("Efficiency = %.1f percent",n);
```

Scilab code Exa 22.28 Example 28

```
//Chapter 22, Problem 28, Fig.22.29(b)
clc;
V=500;                          //supply voltage
Ia=120;                         //armature current
Ia2=60;                         //armature current 2
Ra=0.2;                         //armature resistance
Ra1=0.5;                        //armature resistance 2
n1=10;                          //speed of motor
phi3=0.8;                       //flux
E1=V-(Ia*Ra);                   //e.m.f
E2=V-(Ia2*(Ra+Ra1));            //e.m.f 2
n2=n1*E2/E1;                    //speed of motor 2
E3=V-(Ia2*Ra);                  //e.m.f 3
n3=(n1*E3)/(phi3*E1);            //speed of motor 2
printf("(a) Speed n2 = %.2f rev/s\n\n",n2);
printf("(b) Speed n3 = %.2f rev/s\n\n",n3);
```

Scilab code Exa 22.29 Example 29

```
//Chapter 22, Problem 29
clc;
V=300;                                  //supply voltage
I=90;                                   //total current
Ra=0.1;                                 //armature resistance
n1=15;                                  //speed of motor
Rse=0.05;                               //series winding resistance
R1=0.2;                                 //diverter
E1=V-(I*(Ra+Rse));                      //e.m.f
R=(R1*Rse)/(R1+Rse);                        //equivalent resistance
I1=(R1/(R1+Rse));                           //current
```

```
Ia=sqrt(I^2/I1);                              //armature current
E2=V-(Ia*(Ra+R));                             //e.m.f
n2=(E2*I*n1)/(E1*I1*Ia);                      //speed of motor 2
printf("Speed n2 = %.3f rev/s\n\n",n2);
printf("Speed of the motor from %d rev/s to %.3f rev/s by inserting 0.2 ohm diverter resistance in parallel with the series winding.",n1,n2);
```

Scilab code Exa 22.30 Example 30

```
//Chapter 22, Problem 30
clc;
V=400;                        //supply voltage
I=25;                         //current
Ra=0.4;                       //armature resistance
n1=800;                       //motor speed 1
n2=600;                       //motor speed 2
Rse=0.2;                      //series winding resistance
R1=0.2;                       //series field resistance
E1=V-(I*(Ra+Rse));            //e.m.f 1
E2=E1*n2/n1;                  //e.m.f 2
R=((V-E2)/I)-(Ra+Rse);            //resistance
printf("Resistance = %f ohms\n\n",R);
printf("Thus the addition of a series resistance of %fohm has reduced the speed from 800 rev/min to 600 rev/min.",R);
```

Chapter 23

Three phase induction motors

Scilab code Exa 23.1 Example 1

```
//Chapter 23, Problem 1
clc;
f=50;                 //supply frequency
p=1;                  //pairs of poles
ns=(50/1)*60;         //synchronous speed
printf("The motor has a two-pole system, hence p,
   the number of pairs of poles, is 1. \nThus,\n\n")
   ;
printf("Synchronous speed = %f rev/min",ns);
```

Scilab code Exa 23.2 Example 2

```
//Chapter 23, Problem 2
clc;
ns=900/60;                    //synchrous speed
f=60;                         //supply frequency
p=f/ns;                       //no of pole pairs
printf("number of pole pairs = %d\n",p);
printf("therefore, number of poles = %d",p*2);
```

Scilab code Exa 23.3 Example 3

```
//Chapter 23, Problem 3
clc;
ns=6000/60;                 //synchronous speed
p=2/2;                      //pairs of poles
f=p*ns;                     //supply frequency
printf("Frequency = %f Hz",f);
```

Scilab code Exa 23.4 Example 4

```
//Chapter 23, Problem 4
clc;
f=50;                       //supply frequency
p=4/2;                      //pairs of poles
nr=1455/60;                 //rotor speed
ns=f/p;                     //synchronous speed
s=((ns-nr)/ns)*100;         //slip
printf("(a) synchronous speed = %f rev/s\n\n",ns);
printf("(b) Slip, s = %d percent",s);
```

Scilab code Exa 23.5 Example 5

```
//Chapter 23, Problem 5
clc;
f=60;                       //supply frequency
```

```
p=2/2;                                  //pairs of poles
ns=(f/p)*60;                            //synchronous speed
s=2;                                    //slip
nr=ns-((s*ns)/100);                     //rotor speed
printf("(a) synchronous speed = %d rev/min\n\n",ns);
printf("(b) Speed of the rotor = %d rev/sec\n\n",nr);
printf("(c) Frequency of the induced emf of the rotor = %.1f Hz\n\n",(ns-nr)/60);
```

Scilab code Exa 23.6 Example 6

```
//Chapter 23, Problem 6
clc;
f=50;                                   //supply frequency
nr=1200/60;                             //rotor speed
s=4;                                    //slip
ns=(nr/(1-(s/100)));                    //synchronous speed
printf("synchronous speed = %d rev/min",ns*60);
```

Scilab code Exa 23.7 Example 7

```
//Chapter 23, Problem 7
clc;
f=50;                          //supply frequency
fr=3;                          //rotor frequency
p=8/2;                         //pairs of poles
s=fr/f;                        //slip
ns=(f/p)*60;                   //synchronous speed
```

```
nr=ns-(s*ns);                         //rotor speed
printf("(a) Slip , s = %f \n\n",s);
printf("(b) rotor speed = %f rev/min",nr);
```

Scilab code Exa 23.8 Example 8

```
//Chapter 23, Problem 8
clc;
Psi = 32000;                     // in Watts
Psl = 1200;                      // in Watts
s = 0.05;                        // slip
Pfl = 750;                       // in Watts
//Input power to rotor = stator input power - stator losses
Pi =  Psi - Psl
//slip = rotor copper loss/rotor input
Pl = s*Pi
//Total mechanical power developed by the rotor = rotor input power - rotor losses
Pr = Pi - Pl
//Output power of motor = power developed by the rotor - friction and windage losses
Po = Pr - Pfl
//Efficiency of induction motor = (output power/input power)*100
eff = (Po/Psi)*100 // in percent
printf("\n\n(a) Rotor copper loss is %f kW",Pl/1000)
printf("\n\n(b) Total mechanical power developed by the rotor is %f kW",Pr/1000)
printf("\n\n(c) Output power of motor is %f kW",Po/1000)
printf("\n\n(d) Efficiency of induction motor is %.2f percent",eff)
```

Scilab code Exa 23.9 Example 9

```
//Chapter 23, Problem 9
clc
pi=30.8e3                        //input power to rotor
pi1=32e3                         //stator input power
ns=0.35                          //percent
l=0.75e3                         //friction and windage losses
s=1-ns
cl=s*pi
P=pi-cl
Po=P-l
n=(Po/pi1)*100
printf("(a) Rotor copper loss = %.3f kW\n\n",cl/1000)
printf("(b) Efficiency = %.2f percent",n)
```

Scilab code Exa 23.10 Example 10

```
//Chapter 23, Problem 10
clc;
nr = 24;                              // in rev/sec
p = 4/2;                               // no. of pole pairs
R2 = 0.35;                             // in Ohms
X2 = 3.5;                                 // in Ohms
V = 415;                              // in Volts
tr = 0.85;                             // turn ratio N2/N1
f = 50 ;                              // in Hz
Pl = 770;                             // in Watt
m = 3;                                // no. of phases
```

```

//ns is the synchronous speed, f is the frequency in hertz of the supply to the stator and p is the number of pairs of poles.
ns = f/p
//The slip, s
s = ((ns - nr)/ns)*100 // in percent
//Phase voltage, E1 = V/(3^0.5)
E1 = V/(3^0.5)
//Full load torque
T = [m*(tr^2)/(2*%pi*ns)]*[(s/100)*E1*E1*R2/(R2*R2 + (X2*(s/100))^2)]
//Output power, including friction losses
Pm = 2*%pi*nr*T
//power output
Po = Pm - Pl
//Maximum torque occurs when R2 = Xr = 0.35 ohm
//Slip
sm = R2/X2
//maximum torque, Tm
Tm = [m*(tr^2)/(2*%pi*ns)]*[sm*E1*E1*R2/(R2*R2 + (X2*sm)^2)]
//speed at which maximum torque occurs
nrm = ns*(1 - sm)
nrmrpm = nrm*60
//At the start, i.e., at standstill, slip, s=1
ss = 1
//starting torque
Ts = [m*(tr^2)/(2*%pi*ns)]*[ss*E1*E1*R2/(R2*R2 + (X2*ss)^2)]
printf("\n\n(a)Synchronous speed is %.0f rev/sec",ns)
printf("\n\n(b)Slip is %.0f percent",s)
printf("\n\n(c)Full load torque is %.2f Nm",T)
printf("\n\n(d)power output is %.2E W",Po)
printf("\n\n(e)maximum torque is %.2f Nm",Tm)
printf("\n\n(f)speed at which maximum torque occurs is %.0frev/min",nrmrpm)
```

```
printf("\n\n(g)starting torque is %.2f Nm",Ts)
```

Scilab code Exa 23.11 Example 11

```
//Chapter 23, Problem 11
clc;
nr = 24;                    // in rev/sec
f = 50 ;                    // in Hz
p = 4/2;                    // no. of pole pairs
V = 415;                     // in Volts
R2 = 0.35;                  // in Ohms
X2 = 3.5;                   // in Ohms
tr = 0.85;                   // turn ratio N2/N1
m = 3;                       // no. of phases
//ns is the synchronous speed, f is the frequency in hertz of the supply to the stator and p is the number of pairs of poles.
ns = f/p
//The slip, s
s = ((ns - nr)/ns)*100 // in percent
//Phase voltage, E1 = V/(3^0.5)
E1 = V/(3^0.5)
//rotor current,
Ir = (s/100)*E1*tr/((R2^2 + (X2*(s/100))^2)^0.5)
//Rotor copper loss
Pcl = m*R2*(Ir^2)
//starting current,
ss =1
I2 = ss*tr*E1/((R2^2 + (X2*ss)^2)^0.5)
printf("\n\n(a)Rotor current is %.2f A",Ir)
printf("\n\n(b)Total copper loss is %.2f W",Pcl)
printf("\n\n(c)Starting current is %.2f A",I2)
```

Scilab code Exa 23.12 Example 12

```
//Chapter 23, Problem 12
clc;
V = 415;                    // in Volts
Psl = 650;                  // in Watt
pf = 0.87;                  // power factor
Pm = 11770;                 // watts from part (d), Problem 22.10
Pcl = 490.35;               // watts, Rotor copper loss, from part (b), Problem 22.11

//Stator input power
P1 = Pm + Pcl + Psl

Po = 11000                  // watts, Net power output, from part (d), Problem 22.10
//efficiency = (output/input) *100
eff = (Po/P1)*100       // in percent

//Power input, P1 = (3^0.5)*VL*IL*cos(phi)
// pf = cos(phi)
//supply current, IL
I = P1/((3^0.5)*V*pf)
printf("\n\n(a) Stator input power is %.2f kW",P1/1000)
printf("\n\n(b) Efficiency is %.2f percent",eff)
printf("\n\n(c) Supply current is %.2f A",I)
```

Scilab code Exa 23.13 Example 13

```
//Chapter 23, Problem 13
clc;
p = 4/2;                    // no. of pole pairs
f = 50 ;                    // in Hz
```

```
nr = 24;                    // in rev/sec
V = 415;                    // in Volts
R2 = 0.35;                  // in Ohms
X2 = 3.5;                   // in Ohms

//At the moment of starting, slip,
s = 1

//Maximum torque occurs when rotor reactance equals rotor resistance
//for maximum torque
R2 = s*X2
printf("\n\nResistance of the rotor is %.1f Ohm",R2)
```