

Scilab Textbook Companion for
Fundamental of Electrical and Electronic
Principles
by C. R. Robertson¹

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

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

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

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

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Chapter 1

Fundamentals

Scilab code Exa 1.1 Standard form and Scientific notation

```
1 // Scilab code Ex1.1: Pg 3 (2008)
2 clc; clear;
3 I = .000018; // Electric current, A
4 V = 15000; // Electric potential, V
5 P = 250000000 // Electric Power, W
6 // Display standard form
7 printf("\\nStandard form:");
8 printf("\\n=====");
9 printf("\\n%f A = %3.1e A", I, I);
10 printf("\\n%5.0f V = %3.1e V", V, V);
11 printf("\\n%9.0f W = %3.1e W", P, P);
12 // Display scientific notation
13 printf("\\n\\nScientific form:");
14 printf("\\n=====");
15 printf("\\n%f A = %2d micro-ampere", I, I/1e-06);
16 printf("\\n%5.0f V = %2d kilo-volt", V, V/1e+03);
17 printf("\\n%9.0f W = %3d mega-watt", P, P/1e+06);
18
19 // Result
20 // Standard form:
21 // =====
```

```

22 // 0.000018 A = 1.8e-005 A
23 // 15000 V = 1.5e+004 V
24 // 250000000 W = 2.5e+008 W
25
26 // Scientific form:
27 // =====
28 // 0.000018 A = 18 micro-ampere
29 // 15000 V = 15 kilo-volt
30 // 250000000 W = 250 mega-watt

```

Scilab code Exa 1.2 Quantities in scientific notation

```

1 // Scilab code Ex1.2: Pg.4 (2008)
2 clc; clear;
3 I = 25e-05; // Electric Current, A
4 P = 3e+04; // Electric Power, W
5 W = 850000; // Work done, J
6 V = 0.0016; // Electric Potential, V
7 printf("\n\nScientific (Engineering) notation:");
8 printf("\n=====");
9 printf("\n%2e A = %3d micro-ampere = %3.2f mA", I, I
    /1e-06, I/1e-03);
10 printf("\n%1.0e W = %3d micro-watt", P, P/1e-06);
11 printf("\n%6d J = %3d kJ = %3.2f MJ", W, W/1e+03, W
    /1e+06);
12 printf("\n%5.4f V = %3.1f milli-volt", V, V/1e-03);
13
14 // Result
15 // Scientific (Engineering) notation:
16 // =====
17 // 2.500000e-004 A = 250 micro-ampere = 0.25 mA
18 // 3e+004 W = -64771072 micro-watt
19 // 850000 J = 850 kJ = 0.85 MJ
20 // 0.0016 V = 1.6 milli-volt

```

Scilab code Exa 1.3 Resulting acceleration of the mass

```
1 // Scilab code Ex1.3: Pg.5 (2008)
2 clc; clear;
3 m = 750/1e+03; // Mass of the body, kg
4 F = 2; // Force acting on the mass, N
5 // Since  $F = m * a$ , (Newton's Second Law of motion),
   solving for a
6 a = F/m; // Acceleration produced in the body,
   metre per second square
7 printf("\n\nThe acceleration produced in the body = %5
   .3f metre per second square", a)
8
9 // Result
10 // The acceleration produced in the body = 2.667
   metre per second square
```

Scilab code Exa 1.4 Current flowing between two points

```
1 // Scilab code Ex1.4: Pg.9 (2008)
2 clc; clear;
3 Q = 35e-03; // Electric charge, C
4 t = 20e-03; // Time for transference of charge
   between two points, s
5 // Since  $Q = I * t$ , solving for I
6 I = Q/t; // Electric current flowing between the
   two points, A
7 printf("\n\nThe value of electric current flowing = %4
   .2f A", I);
8
9 // Result
10 // The value of electric current flowing = 1.75 A
```

Scilab code Exa 1.5 Amount of charge transferred in a given time

```
1 // Scilab code Ex1.5: Pg.9 (2008)
2 clc; clear;
3 I = 120e-06; // Electric current, A
4 t = 15; // Time for transference of charge
   between two points, s
5 // Since  $I = Q/t$ , solving for Q
6 Q = I*t; // Electric charge transferred, C
7 printf("\nThe value of electric charge transferred =
   %3.1f mC", Q/1e-03);
8
9 // Result
10 // The value of electric charge transferred = 1.8 mC
```

Scilab code Exa 1.6 Time for current flow

```
1 // Scilab code Ex1.6: Pg.10 (2008)
2 clc; clear;
3 Q = 80; // Electric charge, C
4 I = 0.5; // Electric current, A
5 // Since  $Q = I*t$ , solving for t
6 t = Q/I; // Time for transference of charge
   between two points, s
7 printf("\nThe duration of time for which the current
   flowed = %3d s", t);
8
9 // Result
10 // The duration of time for which the current flowed
   = 160 s
```

Scilab code Exa 1.7 Potential difference developed across a resistor

```
1 // Scilab code Ex1.7: Pg.13 (2008)
2 clc; clear;
3 I = 5.5e-03;           // Electric current, A
4 R = 33000;             // Resistance, ohms
5 // From Ohm's law,  $V = I \cdot R$ 
6 V = I*R;               // Potential difference across
    resistor, V
7 printf("\\nThe potential difference developed across
    resistor = %5.1f V",V)
8
9 // Result
10 // The potential difference developed across
    resistor = 181.5 V
```

Scilab code Exa 1.8 Current flowing through a resistor

```
1 // Scilab code Ex1.8: Pg 14 (2008)
2 clc; clear;
3 V = 24;                // Potential difference, V
4 R = 15;                // Resistance, ohms
5 // From Ohm's law,  $V = I \cdot R$ , then solving for I
6 I = V/R;               // Electric current, A
7 printf("\\nThe current flowing through the resistor =
    %3.1f A", I)
8
9 // Result
10 // The current flowing through the resistor = 1.6 A
```

Scilab code Exa 1.9 Terminal potential difference for a given current

```
1 // Scilab code Ex1.9: Pg 16 (2008)
2 clc; clear;
3 E = 6;           // E.m.f of battery , V
4 r = 0.15;        // Internal resistance of battery ,
    ohm
5 I_1 = .5;        // Electric current , A
6 I_2 = 2;         // Electric current , A
7 I_3 = 10;        // Electric current , A
8 // Using relation  $V = E - I \cdot R$  and substituting the
    values of I_1 , I_2 and I_3 one by one in it
9 V_1 = E - I_1*r; // Terminal potential
    difference , V
10 V_2 = E - I_2*r; // Terminal potential
    difference , V
11 V_3 = E - I_3*r; // Terminal potential
    difference , V
12 printf("\\nThe terminal potential difference
    developed across resistor for a current of %3.1f
    A = %5.3f V",I_1,V_1)
13 printf("\\nThe terminal potential difference
    developed across resistor for a current of %1d A
    = %3.1f V",I_2,V_2)
14 printf("\\nThe terminal potential difference
    developed across resistor for a current of %2d A
    = %3.1f V",I_3,V_3);
15
16 // Result
17 // The terminal potential difference developed
    across resistor for a current of 0.5 A = 5.925 V
18 // The terminal potential difference developed
    across resistor for a current of 2 A = 5.7 V
19 // The terminal potential difference developed
    across resistor for a current of 10 A = 4.5 V
```

Scilab code Exa 1.10 Resistances in a battery circuit

```
1 // Scilab code Ex1.10: Pg 16 (2008)
2 clc; clear;
3 E = 12;           // E.m.f, V
4 I = 5;           // Electric current, A
5 V = 11.5;        // Terminal potential difference, V
6 // Using relation  $V = E - I \cdot r$ , solving for r
7 r = (E - V)/I;    // Internal resistance of
    battery, ohm
8 // From Ohm's law,  $V = I \cdot R$ , then solving for R
9 R = V/I;          // Resistance, ohms
10 printf("\nThe internal resistance of battery = %3.1f
    ohm", r)
11 printf("\nThe resistance of external circuit = %3.1f
    ohm", R)
12
13 // Result
14 // The internal resistance of battery = 0.1 ohm
15 // The resistance of external circuit = 2.3 ohm
```

Scilab code Exa 1.11 Potential difference and energy dissipated across a resistor

```
1 // Scilab code Ex1.11:Pg 17 (2008)
2 clc; clear;
3 I = 200e-03;      // Electric current, A
4 t = 300;          // Time for which current flows,
    s
5 R = 750;          // Resistance, ohms
6 // Using Ohm's law,  $V = I \cdot R$ 
7 V = I*R;          // Electric potential difference
    , V
```

```

8 W = I^2*R*t;           // Energy dissipated , joule
9 printf("\nThe potential difference developed across
    the resistor = %3d V\nThe energy dissipated
    across the resistor = %4.0f J or %1d kJ", V, W, W
    *1e-03)
10
11 // Result
12 // The potential difference developed across the
    resistor = 150 V
13 // The energy dissipated across the resistor = 9000
    J or 9 kJ

```

Scilab code Exa 1.12 Potential difference and current from electric power

```

1 // Scilab code Ex1.12: Pg 18 (2008)
2 clc; clear;
3 R = 680;           // Resistance , ohms
4 P = 85e-03;        // Electric power , W
5 // Using  $P = V^2/R$ , solving for V
6 V = sqrt( P*R );   // Potential difference , V
7 // Using  $P = I^2*R$ , solving for I
8 I = sqrt( P/R );   // Electric current , A
9 printf("\nThe potential difference developed across
    the resistance = %3.1f V\nThe current flowing
    through the resistor = %5.2f mA", V, I/1e-03)
10
11 // Result
12 // The potential difference developed across the
    resistance = 7.6 V
13 // The current flowing through the resistor = 11.18
    mA

```

Scilab code Exa 1.13 Potential difference and power across a resistor

```

1 // Scilab code Ex1.13:Pg 19 (2008)
2 clc; clear;
3 I = 1.4;           // Electric current , A
4 t = 900;           // Time for which current flows ,
    s
5 W = 200000;        // Energy dissipated , J
6 // Using relation  $W = V \cdot I \cdot t$ , solving for V
7 V = W/( I*t );     // Potential difference , V
8 // Using relation  $P = V \cdot I$ 
9 P = V*I;           // Electric power , W
10 // From Ohm's law,  $V = I \cdot R$ , solving for R
11 R = V/I;           // Resistance , ohm
12 printf("\\nThe potential difference developed = %5.1f
    V\\nThe power dissipated = %5.1f W\\nThe
    resistance of the circuit = %5.1f ohm", V, P, R)
13
14 // Result
15 // The potential difference developed = 158.7 V
16 // The power dissipated = 222.2 W
17 // The resistance of the circuit = 113.4 ohm

```

Scilab code Exa 1.14 Cost of machine operation

```

1 // Scilab code Ex1.14: Pg 20 (2008)
2 clc; clear;
3 P = 12.5;          // Power of the machine , kW
4 t = 8.5;           // Time for which the machine is
    operated , h
5 W = P*t;           // Electric energy , kWh
6 // Cost per unit = 7.902 p, therefore calculating the
    cost of 106.25 units
7 cost = ( W*7.902 ); // Cost for operating
    machine , p
8 printf("\\nThe cost of operating the machine = %4.2f
    pounds", cost*1e-02)

```

```

9
10 // Result
11 // The cost of operating the machine = 8.40 pounds

```

Scilab code Exa 1.15 Cost of unit energy and total electricity bill

```

1 // Scilab code Ex1.15: Pg 20 (2008)
2 clc; clear;
3 Total_bill = 78.75;           // pounds
4 Standing_charge = 15.00;      // pounds
5 Units_used = 750;             // kWh
6 Cost_per_unit = ( Total_bill - Standing_charge ) /
    Units_used;                 // p
7 Cost_of_energy_used = 67.50;   // pounds
8 Total_bill = Cost_of_energy_used + Standing_charge;
    // pounds
9 printf("\\nThe cost per unit = %5.3f pounds or %3.1f
    p\\nTotal bill = %5.2f pounds",Cost_per_unit,
    Cost_per_unit/1e-02,Total_bill);
10
11 // Result
12 // The cost per unit = 0.085 Pounds or 8.5 p
13 // Total bill = 82.50 pounds

```

Scilab code Exa 1.16 Resistance of the copper coil

```

1 // Scilab code Ex1.16: Pg 22 (2008)
2 clc; clear;
3 l = 200;           // Length of Cu wire, metre
4 rho = 2e-08;       // Resistivity of Cu, ohm-metre
5 A = 8e-07;         // Cross sectional area of Cu
    wire, metre square
6 // Using relation  $R = ( \rho * l ) / A$ 

```

```

7 R = ( rho*l )/A;           // Resistance , ohm
8 printf("\nThe resistance of the coil = %ld ohm", R)
9
10 // Result
11 // The resistance of the coil = 5 ohm

```

Scilab code Exa 1.17 Resistance of wire wound resistor

```

1 // Scilab code Ex1.17: Pg 22 (2008)
2 clc; clear;
3 l = 250;           // Length of Cu wire , metre
4 d = 5e-04;        // Diameter of Cu wire , metre
5 rho = 1.8e-08;     // Resistivity of Cu wire , ohm-
    metre
6 A = ( %pi*d^2 )/4; // Cross sectional area
    of Cu wire , metre square
7 // Using relation R = rho*l/A
8 R = rho*l/A;       // Resistance , ohm
9 printf("\nThe resistance of the coil = %5.2f ohm", R
    )
10
11 // Result
12 // The resistance of the coil = 22.92 ohm

```

Scilab code Exa 1.18 Variation of resistance with temperature

```

1 // Scilab code Ex1.18: Pg 23 (2008)
2
3 clc; clear;
4 R_1 = 250;         // Resistance of field coil ,
    ohm
5 Theta_1 = 15;     // Initial temperature of motor
    , degree celcius

```

```

6 Theta_2 = 45;           // Final temperature of motor ,
   degree celcius
7 Alpha = 4.28e-03;       // Temperature coefficient of
   resistance , per degree celcius
8 // Using relation ,  $R_1/R_2 = (1 + \text{Alpha} \cdot \text{Theta}_1) / (1 + \text{Alpha} \cdot \text{Theta}_2)$  , solving for R_2
9 R_2 = R_1 * (( 1 + Alpha*Theta_2 )/( 1 + Alpha*
   Theta_1 ));           // Resistance , ohms
10 printf("\nThe resistance of field coil at %2d degree
   celcius = %5.1f ohm",Theta_2, R_2)
11
12 // Result
13 // The resistance of field coil at 45 degree celcius
   = 280.2 ohm

```

Scilab code Exa 1.19 Resistance of wire at given temperature

```

1 // Scilab code Ex1.19: Pg 24 (2008)
2
3 clc; clear;
4 R_0 = 350;              // Resistance , ohms
5 Theta_1 = 60;           // Temperature, degree celcius
6 Alpha = 4.26e-03;       // Temperature coefficient ,
   per degree celcius
7 // Using relation  $R_1 = R_0 * (1 + \text{Alpha} \cdot \text{Theta}_1)$ 
8 R_1 = R_0 * ( 1 + Alpha*Theta_1 );           //
   Resistance , ohms
9 printf("\nThe resistance of the wire at %2d degree
   celcius = %5.1f ohm",Theta_1, R_1)
10
11 // Result
12 // The resistance of the wire at 60 degree celcius =
   439.5 ohm

```

Scilab code Exa 1.20 Resistance of carbon composite resistor at a given temperature

```
1 // Scilab code Ex1.20: Pg. 24 (2008)
2 clc; clear;
3 R_1 = 120;           // Resistance , ohms
4 Theta_1 = 16;        // Temperature, degree celcius
5 Theta_2 = 32;        // Temperature, degree celcius
6 Alpha = -4.8e-04;    // Temperature coefficient ,
    per degree celcius
7 // Using relation ,  $R_1/R_2 = (1 + \text{Alpha} \cdot \text{Theta}_1) / (1 + \text{Alpha} \cdot \text{Theta}_2)$ , solving for R_2
8 R_2 = R_1 * (( 1 + Alpha*Theta_2 )/( 1 + Alpha*
    Theta_1 ));        // Resistance , ohm
9 printf("\nThe resistance of carbon resistor at %2d
    degree celcius = %5.1f ohm",Theta_2, R_2)
10
11 // Result
12 // The resistance of field coil at 32 degree celcius
    = 119.1 ohm
```

Chapter 2

DC circuits

Scilab code Exa 2.1 Electrical parameters of resistances in series

```
1 // scilab code Ex2.1: Pg 32 (2008)
2 clc; clear;
3 E = 24;           // E.m.f of battery ,V
4 R1 = 330;         // Resistance , ohms
5 R2 = 1500;        // Resistance , ohms
6 R3 = 470;         // Resistance , ohms
7 // As resistances R1, R2 & R3 are joined end-to-end
  hence, they are in series & in series connection ,
  circuit resistance is the sum of individual
  resistances present in the circuit
8 R = R1 + R2 + R3; // Resistance of circuit , ohms
9 I = E/R;          // Circuit current , A
10 // As the resistances are in series so same current
  flows through each resistor & potential drop
  across each resistor is equal to the product of
  circuit current & its respective resistance( from
  Ohm's law ,  $V = I \cdot R$  )
11 V1 = I*R1;        // Potential difference
  developed across resistance R1, V
12 V2 = I*R2;        // Potential difference
  developed across resistance R2, V
```

```

13 V3 = I*R3;           // Potential difference
    developed across resistance R3, V
14 P = E*I;           // Electric power dissipated
    by the complete circuit , W
15 printf("\nThe circuit resistance = %4d ohms or %3.1f
    kilo-ohms", R, R*1e-03);
16 printf("\nThe circuit current = %5.2f milli-ampere",
    I/1e-03);
17 printf("\nThe potential drop across resisatnce R1 =
    %4.2f volts\nThe potential drop across resistance
    R2 = %5.2f volts\nThe potential drop across
    resistance R3 = %4.2f volts", V1, V2, V3);
18 printf("\nThe power dissipated by the complete
    circuit = %4.2f watt or %3d milli-watt", P,P/1e
    -03 );
19
20 // Result
21 // The circuit resistance = 2300 ohms or 2.3 kilo-
    ohms
22 // The circuit current = 10.43 milli-ampere
23 // The potential drop across resisatnce R1 = 3.44
    volts
24 // The potential drop across resistance R2 = 15.65
    volts
25 // The potential drop across resistance R3 = 4.90
    volts
26 // The power dissipated by the complete circuit =
    0.25 watt or 250 milli-watt

```

Scilab code Exa 2.2 Series combination of resistors

```

1 // Scilab code Ex2.2: Pg 34 (2008)
2 clc; clear;
3 E = 12;           // E.m.f of battery , V
4 R_BC = 16;        // Resistance across branch

```

```

        BC, ohms
5  P_BC = 4;                                // Electric power
    dissipated by resistance R_BC, W
6  // using relation  $P = I^2/R$ , solving for I
7  I = sqrt( P_BC/R_BC);                    // Electric current, A
8  R = E/I;                                // Total circuit
    resistance , ohms
9  R_AB = R - R_BC;                          // Resistance across
    branch AB, ohms
10 printf("\nThe circuit current = %3.1f A\nThe value
    of other resistor = %ld ohms", I, R_AB);
11
12 // Result
13 // The circuit current = 0.5 A
14 //The value of other resistor = 8 ohms

```

Scilab code Exa 2.3 Resistances in parallel

```

1 // Scilab code Ex2.3: Pg 37 (2008)
2 clc; clear;
3 E = 24;                                // E.m.f of battery , V
4 R_1 = 330;                             // Resistance , ohms
5 R_2 = 1500;                             //Resistance , ohms
6 R_3 = 470;                             //Resistance , ohms
7 // Since one end of each resistor is connected to
    positive terminal of battery and the other end to
    the negative terminal, therefore, the resistors
    are in parallel & in parallel connection the
    equivalent resistance of the circuit is equal to
    the reciprocal of the sum of conductances of
    individual resistances present in the circuit i.e
     $1/R = 1/R_1 + 1/R_2 + 1/R_3$ , solving for R
8 R = (R_1*R_2*R_3)/( R_1*R_2 + R_2*R_3 + R_3*R_1);
    // Equivalent resistance of circuit , ohms
9 // Since the resistances are in parallel so potential

```

```

        difference across each resistor is same & in our
        case is equal to e.m.f of battery & from Ohm's
        law,  $V = I \cdot R$ , solving for I
10  I_1 = E/R_1;           // Current through resistor
    R_1, A
11  I_2 = E/R_2;           // Current through resistor
    R_2, A
12  I_3 = E/R_3;           // Current through resistance
    R_3, A
13  // Current drawn from battery is equal to the sum of
    branch currents
14  I = I_1 + I_2 + I_3;    // Current drawn
    from battery, A
15  printf("\nThe total resistance of the circuit = %6.2
    f ohms",R);
16  printf("\nThe branch current I1 = %5.2f mA\nThe
    branch current I2 = %2d mA\nThe branch current I3
    = %5.2f mA", I_1/1e-03, I_2/1e-03, I_3/1e-03);
17  printf("\nThe current drawn from the battery = %5.1f
    mA", I/1e-03);
18
19  // Result
20  // The total resistance of the circuit = 171.68 ohms
21  // The branch current I1 = 72.73 mA
22  // The branch current I2 = 16 mA
23  // The branch current I3 = 51.06 mA
24  // The current drawn from the battery = 139.8 mA

```

Scilab code Exa 2.4 Two parallel resistances across a voltage source

```

1  // scilab code Ex2.4: Pg 39 (2008)
2  clc; clear;
3  E = 12;           // E.m.f of battery, V
4  R1 = 6;           // Resistance, ohms
5  R2 = 3;           // Resistance, ohms

```

```

6 // Since the two resistances are in parallel ,
   therefore effective resistance of the circuit is
   equal to the reciprocal of the sum of
   conductances ( 1/Resistance) of individual
   resistances present in the circuit i.e  $1/R = 1/R1$ 
   +  $1/R2$ , simplifying for R
7 R = ( R1*R2)/(R1 + R2);           // Effective
   resistance of the circuit , ohms
8 // Fron Ohm's law,  $V = I*R$ , solving for I
9 I = E/R;                          // Circuit current , A
10 I1 = E/R1;                       // Current through
   resistance R1, A
11 I2 = E/R2;                       // Current through
   resistance R2, A
12 printf("\nEffective resistance of the circuit = %1d
   ohms", R);
13 printf("\nThe current drawn from the battery = %1d A
   ", I);
14 printf("\nThe current through resistor R1 = %1d A",
   I1);
15 printf("\nThe current through R2 resistor = %1d A",
   I2);
16
17 // Result
18 // Effective resistance of the circuit = 2 ohms
19 // The current drawn from the battery = 6 A
20 // The current through resistor R1 = 2 A
21 // The current through R2 resistor = 4 A

```

Scilab code Exa 2.5 Effective resistance in series and parallel connected resistor

```

1 // Scilab code Ex2.5: Pg 39–40 (2008)
2 clc; clear;
3 R1 = 10;           // Resistance , ohm
4 R2 = 20;           // Resistance , ohm

```

```

5 R3 = 30;                                // Resistance , ohm
6 // Part (a)
7 // Since in sreies combination , the equivalent
  resistance of the circuit is the sum of the
  individual resistances present in the circuit i.e
   $R = R1 + R2 + R3$ 
8 R_s = R1 + R2 + R3;                    // Equivalent series
  resistance of the circuit , ohms
9 // Part (b)
10 // Since in parallel combination , the equivalent
  resistance of the circuit is the reciprocal of
  the sum of the conductances of the individual
  resistances present in the circuit i.e  $1/R = 1/R1$ 
   $+ 1/R2 + 1/R3$ , solving for R;
11 R_p = ( R1*R2*R3 )/( R1*R2 + R2*R3 + R3*R1 );
  // Equivalent parallel resistance of the circuit ,
  ohms
12 printf("\nEquivalent series resistance of the
  circuit = %2d ohm", R_s);
13 printf("\nEquivalent parallel resistance of the
  circuit = %4.2f ohm", R_p);
14
15 // Result
16 // Equivalent series resistance of the circuit = 60
  ohm
17 // Equivalent parallel resistance of the circuit =
  5.45 ohm

```

Scilab code Exa 2.6 Series parallel combination across a voltage source

```

1 // Scilab code Ex2.6: Pg 43 (2008)
2 clc; clear;
3 E = 64;                                // E.m.f of battery , V
4 R1 = 6;                                // Resistance , ohm
5 R2 = 4;                                // Resistance , ohm

```

```

6 // Part (a)
7 // Since R1 & R2 are parallel to one another hence,
  their equivalent resistance is equal to the sum
  of reciprocal of their individual resistances
8 R_BC = ( R1*R2)/( R1 + R2 ); // Equivalent
  resistance across branch BC, ohm
9 R_AB = 5.6; // Resistance
  across branch AB, ohm
10 // Since R_AB & R_BC are in series, therefore, their
  equivalent resistance is equal to the sum of
  their individual resistances
11 R_AC = R_AB + R_BC; // Total
  circuit resistance, ohm
12 // From Ohm's law,  $V = I \cdot R$ , solving for I
13 I = E/R_AC; // Total
  circuit current, A
14 // Part (b)
15 V_BC = I*R_BC; //
  Potential difference across branch BC, V
16 I1 = V_BC/R1; //
  Electric current through resistor R1, A
17 // Part (c)
18 // Since  $P = I^2 \cdot R$ 
19 P_AB = I^2*R_AB; // Power
  dissipated by 5.6 ohm resistance, W
20 printf("\nThe current drawn from the supply = %1d A
  ", I);
21 printf("\nThe current through %1d ohm resistor = %3
  .1 f A", R1, I1);
22 printf("\nThe power dissipated by %3.1 f ohm resistor
  = %5.1 f W", R_AB, P_AB);
23
24 // Result
25 // The current drawn from the supply = 8 A
26 // The current through 6 ohm resistor = 3.2 A
27 // The power dissipated by 5.6 ohm resistor = 358.4
  W

```

Scilab code Exa 2.7 Electrical potential and current distribution in a series para

```
1 // Scilab code Ex2.7: Pg 46 (2008)
2 clc; clear;
3 E = 18; // E.m.f of battery , V
4 R1 = 4; // Resistance , ohm
5 R2 = 6; // Resistance , ohm
6 R3 = 5; // Resistance , ohm
7 R4 = 3; // Resistance , ohm
8 R5 = 6; // Resistance , ohm
9 R6 = 8; // Resistance , ohm
10 // Part (a)
11 // Since resistance R1 & R2 are in parallel ,
    therefore , equivalent resistance across branch AB
    will be equal to the reciprocal of the sum of
    conductances ( 1/Resistance ) of individual
    resistances present in the circuit i.e  $1/R_{AB} =$ 
     $1/R1 + 1/R2$ , simplifying for  $R_{AB}$ 
12 R_AB = ( R1*R2 )/( R1 + R2); //
    Resistance , ohm
13 R_BC = R3; //
    Resistance across branch BC, ohm
14 // Since resistance R4, R5 & R6 are in parallel ,
    therefore , equivalent resistance across branch CD
    will be equal to the reciprocal of the sum of
    conductances ( 1/Resistance ) of individual
    resistances present in the circuit i.e  $1/R_{CD} =$ 
     $1/R4 + 1/R5 + 1/R6$ , simplifying for  $R_{CD}$ 
15 R_CD = ( R4*R5*R6 )/( R4*R5 + R5*R6 + R6*R4 );
    // Resistance , ohm
16 // Since R_AB, R_BC & R_CD forms series combination ,
    therefore circuit resistance will be their
    series sum
17 R = R_AB + R_BC + R_CD; // Circuit
```

```

    resistance , ohm
18 I = E/R; // Supply current , A
19 // Part (b)
20 // AS resistances R1 & R2 are parallel , therefore
    there will be same potential difference across
    them, denoted by V_AB
21 V_AB = I*R_AB; //
    Potential difference , V
22 // AS resistances R4, R5 & R6 are parallel ,
    therefore there will be same potential difference
    across them, denoted by V_CD
23 V_CD = I*R_CD; // Potential
    difference , V
24 V_BC = I*R_BC; // Potential
    difference , V
25 // Part (c)
26 I1 = V_AB/R1; // Current through
    R1 resistor , A
27 I2 = V_AB/R2; // Current through
    R2 resistor , A
28 I4 = V_CD/R4; // Current through R4
    resistor , A
29 I5 = V_CD/R5; // Current through R5
    resistor , A
30 I6 = V_CD/R6; // Current through R6
    resistor , A
31 // Part (d)
32 P3= I^2*R3; // Power dissipated ,
    W
33 printf("\nThe current drawn from the source = %1d A"
    , I);
34 printf("\nThe p.d. across resistor %1d ohm & %1d ohm
    = %3.1f V", R1, R2, V_AB);
35 printf("\nThe p.d. across resistor %1d ohm, %1d ohm
    & %1d ohm = %3.1f V", R4, R5, R6, V_CD);
36 printf("\nThe p.d. across resistor %1d ohm = %2d V",
    R3, V_BC);
37 printf("\nThe current through resistor %1d ohm = %3

```

```

        .1 f A", R1, I1);
38 printf("\nThe current through resistor %1d ohm = %3
        .1 f A", R2, I2);
39 printf("\nThe current through resistor %1d ohm = %1d
        A", R3, I);
40 printf("\nThe current through resistor %1d ohm = %5
        .3 f A", R4, I4);
41 printf("\nThe current through resistor %1d ohm = %5
        .3 f A", R5, I5);
42 printf("\nThe current through resistor %1d ohm = %3
        .1 f A", R6, I6);
43 printf("\nThe power dissipated by the %1d ohm
        resistor = %2d W", R3, P3);
44
45 // Result
46 // The current drawn from the source = 2 A
47 // The p.d. across resistor 4 ohm & 6 ohm = 4.8 V
48 // The p.d. across resistor 3 ohm, 6 ohm & 8 ohms =
        3.2 V
49 // The p.d. across resistor 5 ohm = 10 V
50 // The current through resistor 4 ohm = 1.2 A
51 // The current through resistor 6 ohm = 0.8 A
52 // The current through resistor 5 ohm = 2 A
53 // The current through resistor 3 ohm = 1.067 A
54 // The current through resistor 6 ohm = 0.533 A
55 // The current through resistor 8 ohm = 0.4 A
56 // The power dissipated by the 5 ohm resistor = 20 W

```

Scilab code Exa 2.8 Electric current distribution in a network

```

1 // Scilab code Ex2.8: 49 (2008)
2 clc; clear;
3 // Applying Kirchhoff's current law (the sum
        of the currents arriving at a junction is equal
        to the sum of the currents leaving that junction)

```

```

        at junction A
4  I2 = 40 + 10;                                // Electric current ,
    A
5  // Applying Kirchhoff's current law at
    junction C
6  I1 = 80 - I2;                                // Electric current ,
    A
7  // Applying Kirchhoff's current law at
    junction D
8  I3 = 80 + 30;                                // Electric current ,
    A
9  // Applying Kirchhoff's current law at
    junction E
10 I4 = I3 - 25;                                // Electric current ,
    A
11 // Applying Kirchhoff's current law at
    junction F
12 I5 = 30 - 85;                                // Electric current ,
    A
13 printf("\nCurrent I1 = %2d A\nCurrent I2 = %2d A\
    nCurrent I3 = %3d A\nCurrent I4 = %2d A\nCurrent
    I5 = %2d A,", I1, I2, I3, I4, I5);
14
15 // Result
16 // Current I1 = 30 A
17 // Current I2 = 50 A
18 // Current I3 = 110 A
19 // Current I4 = 85 A
20 // Current I5 = -55 A

```

Scilab code Exa 2.9 Kirchhoff laws applied to an electrical network

```

1 // Scilab code Ex2.9: Pg 52–53 (2008)
2 clc; clear;
3 R1 = 3;                                // Resistance , ohms

```

```

4 R2 = 2;           // Resistance , ohms
5 R3 = 10;          // Resistance , ohms
6 E1 = 10;          // E.m.f, V
7 E2 = 4;           // E.m.f, V
8 // Applying Kirchhoff's Current Law(the sum
  of the currents arriving at a junction is equal
  to the sum of the currents leaving that junction)
9 A = [3 -2; 13 10];
10 B = [6; 10];
11 X = inv(A)*B;
12 I1 = X(1,:);      // Electric current
  through branch FA, A
13 I2 = X(2,:);      // Electric
  current through branch EB, A
14 I3 = ( I1 + I2 ); // Electric current
  through branch CD, A
15 V_CD = R3*I3;      // P.d.across R3
  resistor , V
16 printf("\nThe current through branch FA = %6.3f A",
  I1);
17 printf("\nThe current through branch EB = %5.3f A",
  I2);
18 printf("\nThe current through branch CD = %5.3f A",
  I3);
19 printf("\np.d.across %2d resistor = %4.2f V", R3,
  V_CD);
20
21 // Result
22 // The current through branch FA = 1.429 A
23 // The current through branch FA = -0.857 A
24 // The current through branch FA = 0.571 A
25 // p.d.across %2d resistor = 5.71 V

```

Scilab code Exa 2.10 Electric current and voltage from Kirchhoff law

```

1 // Scilab code Ex2.10: Pg 53 (2008)
2 clc; clear;
3 E1 = 6; // E.m.f of battery , V
4 E2 = 4.5; // E.m.f of battery , V
5 R1 = 1.5; // Resistance , ohm
6 R2 = 2; // Resistance , ohm
7 R3 = 5; // Resistance , ohm
8 // Part (a)
9 // Using matrix method for solving set of equations
10 A = [6.5 5; 5 7];
11 B = [6; 4.5];
12 X = inv(A)*B;
13 I1 = X(1,:); // Electric current through
    branch FA, A
14 I2 = X(2,:); // Electric current through
    branch DC, A
15 I3 = ( I1 + I2); // Electric current through
    branch BE, A
16 // Part (b)
17 V_BE = I3*R3; // P.d across resistor R3,
    V
18 printf("\\nElectric current through branch FA = %5.3 f
    A", I1);
19 printf("\\nElectric current through branch DC = %6.4 f
    A", I2);
20 printf("\\nElectric current through branch BE = %5.3 f
    A", I3);
21 printf("\\np.d across resistor %1d ohms = %5.3 f V",
    R3, V_BE);
22
23 // Result
24 // Electric current through branch FA = 0.951 A
25 // Electric current through branch DC = -0.0366 A
26 // Electric current through branch FA = 0.915 A
27 // p.d across resistor %1d ohms = 4.573 V

```

Scilab code Exa 2.11 Current distribution in a wheatstone bridge network using Kir

```

1 // Scilab code Ex2.11: Pg 57 (2008)
2 clc; clear;
3 R_AB = 6; // Resistance , ohm
4 R_BC = 4; // Resistance , ohm
5 R_DC = 1; // Resistance , ohm
6 R_AD = 3; // Resistance , ohm
7 R_BD = 5; // Resistance , ohm
8 // Using matrix method for solving the set of
  equations
9 A = [6 -3 5; -4 1 10; 0 4 1];
10 B = [0; 0; 10];
11 X = inv(A)*B;
12 I1 = X(1,:); // Electric
  current , A
13 I2 = X(2,:); // Electric
  current , A
14 I3 = X(3,:); // Electric current
  , A
15 I_BC = I1 - I3; // Electric current ,
  A
16 I_DC = I2 + I3; // Electric current ,
  A
17 I = I1 + I2; // Suplly current , A
18 printf("\\nThe current through %1d ohm resistor = %5
  .3 f A", R_AB, I1);
19 printf("\\nThe current through %1d ohm resistor = %4
  .2 f A", R_BC, I_BC);
20 printf("\\nThe current through %1d ohm resistor = %5
  .3 f A", R_DC, I_DC);
21 printf("\\nThe current through %1d ohm resistor = %5
  .3 f A", R_AD, I2);
22 printf("\\nThe current through %1d ohm resistor = %5

```

```

        .3 f A", R_BD, I3);
23 printf("\nThe supply current = %5.3 f A", I)
24
25 // Result
26 // The current through 6 ohm resistor = 1.074 A
27 // The current through 4 ohm resistor = 0.89 A
28 // The current through 1 ohm resistor = 2.638 A
29 // The current through 3 ohm resistor = 2.454 A
30 // The current through 5 ohms resistor = 0.184 A
31 // The supply current = 3.529 A

```

Scilab code Exa 2.12 Current through central resistor in a balanced Wheatstone bridge

```

1 // Scilab code Ex2.12: Pg 58–59 (2008)
2 clc; clear;
3 R_AB = 6; // Resistance across branch
   AB, ohm
4 R_AD = 3; // Resistance across branch
   AD, ohm
5 R_BC = 4; // Resistance across branch
   BC, ohm
6 R_DC = 2; // Resistance across branch
   DC, ohm
7 // Since  $R_{AB}/R_{AD} = R_{BC}/R_{DC}$ , so the wheatstone
   bridge is balanced hence no current flows through
   branch BD
8 I3 = 0;
9 printf("\nThe current through branch BD i.e I3 = %1d
   A", I3);
10
11 // Result
12 // The current through branch BD i.e I3 = 0 A

```

Scilab code Exa 2.13 Balancing a wheatstone bridge

```
1 // Scilab code Ex2.13: Pg 62–63 (2008)
2 clc; clear;
3 R1 = 20; // Resistance , ohm
4 R2 = 10; // Resistance , ohm
5 R3 = 8; // Resistance , ohm
6 R4 = 5; // Resistance , ohm
7 R5 = 2; // Resistance , ohm
8 A = [20 -10 8; -5 2 15; 0 12 2];
9 B = [0; 0; 10];
10 X = inv(A)*B;
11 I3 = X(3,:); // Electric current
    through BD, A
12 V_BD = I3*R3; // P.d across branch BD,
    V
13 // For balance conditions i.e I3 = 0, R1/R2 = R4/R5,
    solving for R4
14 R_4 = ( R1*R5 )/R2; // Resistance , ohm
15 printf("\nThe p.d between terminals B and D = %5.3 f
    V", V_BD);
16 printf("\nThe value to which %ld ohm resistor must
    be adjusted in order to reduce the current
    through %ld ohm resistor to zero = %ld ohm", R4,
    R3, R_4);
17
18 // Result
19 // The p.d between terminals B and D = 0.195 V
20 // The value to which 5 ohm resistor must be
    adjusted in order to reduce the current through 8
    ohm resistor to zero = 4 ohm
```

Scilab code Exa 2.14 Measuring unknown resistances using Wheatstone bridge

```
1 // Scilab code Ex2.14: Pg 64 (2008)
```

```

2  clc; clear;
3  // For part (a)
4  Rm = 1000;           // Resistance , ohm
5  Rd = 1;              // Resistance , ohm
6  Rv = 3502;          // Resistance , ohm
7  // Using Wheatstone bridge balanced condition i.e  $R_x$ 
   //  $R_v = R_m/R_d$  , solving for  $R_x$ 
8  Rx = ( Rm/Rd ) * Rv; // Resistance ,ohm
9  printf("\\n\\nThe value of the resistance being measured
   = %5.3 f mega-ohm",Rx*1e-06);
10
11 // Part (b)
12 Rm = 1;              // Resistance , ohm
13 Rd = 1000;           // Resistance , ohm
14 Rv = 296;            // Resistance , ohm
15 // Using Wheatstone bridge balanced condition i.e  $R_x$ 
   //  $R_v = R_m/R_d$  , solving for  $R_x$ 
16 Rx = ( Rm/Rd ) * Rv; // Resistance ,ohm
17 printf("\\n\\nThe value of the resistance being measured
   = %5.3 f ohm",Rx);
18
19 // Result
20 // The value of the resistance being measured =
   3.502 mega-ohm
21 // The value of the resistance being measured =
   0.296 ohm

```

Scilab code Exa 2.15 Finding cells emf using a potentiometer

```

1  // Scilab code Ex2.15: Pg 67 (2008)
2  clc; clear;
3  l1 = 600e-03;        // Scale reading , metre
4  l2 = 745e-03;        // Scale reading , metre
5  l_s = 509.3e-03;     // Total scale length,
   metre

```

```

6 E_s = 1.0186;           // Source voltage , V
7 E1 = ( l1/l_s )*E_s;    // Voltage drop across
    length l1 , V
8 E2 = ( l2/l_s)*E_s;     // Voltage drop across
    length l2 , V
9 printf("\nThe emf of the first cell = %3.1f V ", E1)
10 printf("\nThe emf of the second cell = %3.2f V ", E2
    )
11
12 // Result
13 // The emf of the first cell = 1.2 V
14 // The emf of the first cell = 1.49 V

```

Chapter 3

Electric fields and capacitors

Scilab code Exa 3.1 Density of electric field between plates of capacitor

```
1 // Scilab code Ex3.1: Pg 79 (2008)
2 clc; clear;
3 Q = 50e-03; // Electric charge, C
4 A = 600e-06; // Area of plate, m^2
5 // Solving for electric field density, D
6 D = Q/A; // Electric field
   density, C/m^2
7 printf("\nThe density of the electric field existing
   between the plates = %4.1f C/m-square", D);
8
9 // Result
10 // The density of the electric field existing
   between the plates = 83.3 C/m-square
```

Scilab code Exa 3.2 Charge on plates of capacitor and electric field density between

```
1 // Scilab code Ex3.2: Pg 80 (2008)
2 clc; clear;
```

```

3 A = 400e-06;           // Cross-sectional area of
    plate , m^2
4 I = 50e-06;           // Source current , A
5 t = 3;                 // Flow time of current , s
6 // Since electric current is the rate of flow of
    charge i.e  $I = Q/t$ , solving for Q
7 Q = I*t;              // Amount of charge on
    plates , C
8 //Solving for density of the electric field between
    the plates
9 D = Q/A;              // Electric field
    density , C/m^2
10 printf("\nThe charge on the plates = %3d micro-
    coloumb", Q/1e-06);
11 printf("\nThe density of the electric field between
    the plates = %5.3f C/m-square", D);
12
13 // Result
14 // The charge on the plates = 150 micro-coloumb
15 // The density of the electric field between the
    plates =0.375 C/m-square

```

Scilab code Exa 3.3 Electric field strength and flux density of parallel plates ca

```

1 // Scilab code Ex3.3: Pg 83 (2008)
2 clc; clear;
3 d = 3e-03;             // Thickness of
    dielectric , m
4 Q = 35e-03;            // Electric charge on
    plates , C
5 V = 150;               // Supply voltage , V
6 A = 144e-06;           // Cross-sectional area of
    plates , m^2
7 // Part (a)
8 // Since electric field strength( $E$ ) = potential

```

```

    gradient therefore we have
9  E = V/d;                                // Electric field
    strength, V/m
10 // Part (b)
11 // Solving for electric field density, D
12 D = Q/A;                                // Electric field
    density, C/m^2
13 printf("\nThe electric field strength = %2d kV/m", E
    *1e-03);
14 printf("\nThe flux density = %5.1f C/m^2", D);
15
16 // Result
17 // The electric field strength = 50 kV/m
18 // The flux density = 243.1 C/m^2

```

Scilab code Exa 3.4 Characteristics of a parallel plate capacitor

```

1 // Scilab code Ex3.4: Pg 83–84 (2008)
2 clc; clear;
3 d = 4e-03;                                // Thickness of air, m
4 Q = 2e-04;                                // Electric charge on
    plates, C
5 V = 125;                                // Supply voltage, V
6 D = 15;                                // Electric field density,
    coulomb-per-metre-square
7 // Part (a)
8 // Since electric field strength(E) = potential
    gradient, therefore we have
9 E = V/d;                                // Electric field
    strength, V/m
10 // Part (b)
11 // Since D = Q/A, solving for A
12 A = Q/D;                                // Cross-sectional area of
    plates, m^2
13 // Part (c)

```

```

14 // Since  $Q = C \cdot V$ , solving for C
15 C = Q/V; // Capacitance of the
    plates, F
16 printf("\nThe electric field strength between the
    plates = %5.2f kV/m", E*1e-03);
17 printf("\nThe csa of the field between the plates =
    %4.1f mm^2", A/1e-06);
18 printf("\nThe capacitance of the plates = %3.1f
    micro-coulomb", C/1e-06);
19
20 // Result
21 // The electric field strength between the plates =
    31.25 kV/m
22 // The csa of the field between the plates = 13.3 mm
    ^2
23 // The capacitance of the plates = 1.6 micro-coulomb

```

Scilab code Exa 3.5 Capacitance and electric field strength of a parallel plate capacitor

```

1 // Scilab code Ex3.5: Pg 86 (2008)
2 clc; clear;
3 A = 6e-04; // Cross-
    sectional area of plates, m^2
4 d = 5e-04; // Thickness of
    mica sheet, m
5 Epsilon_r = 5.8; // Relative
    permittivity, unitless
6 Epsilon_0 = 8.854e-12; // Permittivity
    of Free Space
7 V = 200; // Potential
    difference, V
8 // Part (a)
9 // Since absolute permittivity,  $Epsilon = C \cdot (d/A)$ ,
    therefore solving for d & putting  $Epsilon =$ 
    Epsilon_0*Epsilon_r

```

```

10 C = ( Epsilon_r*Epsilon_0*A )/d;          //
    Capacitance , F
11 // Part (b)
12 // Since electric field strength(E) = potential
    gradient, therefore we have
13 E = V/d;                                // Electric field
    strength , V/m
14 printf("\nThe capacitance of the capacitor = %5.2 f
    pF", C/1e-12);
15 printf("\nElectric field strength = %3d kV/m",E*1e
    -03);
16
17 // Result
18 // The capacitance of the capacitor = 61.62 pF
19 // Electric field strength = 400 kV/m

```

Scilab code Exa 3.6 Thickness of paper between plates of a capacitor

```

1 // Scilab code Ex3.6: Pg 86 (2008)
2 clc; clear;
3 C = 0.224e-09;                          //Capacitance , F
4 A = 5625e-06;                          // Cross-sectional
    area of plates , m^2
5 Epsilon_r = 2.5;                        // Relative
    permittivity
6 Epsilon_0 = 8.854e-12;                  // Permittivity of
    Free Space
7 // Since absolute permittivity , Epsilon = C*(d/A) ,
    therefore solving for d & putting Epsilon =
    Epsilon_0*Epsilon_r
8 d = ( Epsilon_r*Epsilon_0*A )/C;          //
    Thickness of waxed paper dielectric , m
9 printf("\nThe thickness of paper required = %3.2 f mm
    ", d/1e-03);
10

```

```
11 // Result
12 // The thickness of paper required = 0.56 mm
```

Scilab code Exa 3.7 Relative permittivity of ceramic dielectric

```
1 // Scilab code Ex3.7: Pg 86 (2008)
2 clc; clear;
3 C = 4.7e-08; // Capacitance, F
4 A = 4e-04; // Cross-sectional area
   of plates, m^2
5 d = 1e-04; // Thickness of
   dielectric, m
6 Epsilon_0 = 8.854e-12; // Permittivity of
   Free Space
7 // Since absolute permittivity, Epsilon = C*(d/A),
   therefore solving for Epsilon_r & putting Epsilon
   = Epsilon_0*Epsilon_r
8 Epsilon_r = (C*d)/(Epsilon_0*A); //
   Relative permittivity
9 printf("\nRelative permittivity = %4d", Epsilon_r);
10
11 // Result
12 // Relative permittivity = 1327
```

Scilab code Exa 3.8 Electric flux and flux density produced in dielectric material

```
1 // Scilab code Ex3.8: Pg 87 (2008)
2 clc; clear;
3 V = 180; // Potential
   difference, V
4 d = 3e-03; // Thickness of
   dielectric, m
```

```

5 A = 4.2e-04;                                // Cross-
    sectional area of plates , m^2
6 Epsilon_r = 3.5;                            // Relative
    permittivity
7 Epsilon_0 = 8.854e-12;                      // Permittivity
    of Free Space
8 // Since absolute permittivity , Epsilon = C*(d/A) ,
    therefore solving for C & putting Epsilon =
    Epsilon_0*Epsilon_r
9 C = ( Epsilon_r*Epsilon_0*A )/d;            //
    Capacitance , F
10 // Since C = Q/V, solving for Q
11 Q = C*V;                                    // Electric
    charge , C
12 // Using D = Q/A,
13 D = Q/A;                                    // Electric
    field density , C/m^2
14 printf("\The flux thus produced = %3.2f nC.",Q/1e
    -09);
15 printf("\nThe flux density thus produced. = %3.2f
    micro-coulomb-per-metre-square", D/1e-06);
16
17 // Result
18 // The flux thus produced = 0.78 nC
19 // The flux density thus produced. = 1.86 micro-C/m
    ^2

```

Scilab code Exa 3.9 Effective capacitance of capacitors in parallel

```

1 // Scilab code Ex3.9: Pg 89 (2008)
2 clc; clear;
3 C_1 = 4.7e-06;                             //Capacitance , F
4 C_2 = 3.9e-06;                             //Capacitance , F
5 C_3 = 2.2e-06;                             //Capacitance , F
6 // The resulting capacitance of parallerly connected

```

```

        capacitors is the sum of the individual
        capacitance present in the circuit
7  C = C_1 + C_2 + C_3;           // Resulting
        capacitance of the circuit , F
8  printf("\nThe resulting capacitance of the
        combination = %4.1f micro-farad", C/1e-06);
9
10 // Result
11 // The resulting capacitance of the combination =
    10.8 micro-farad

```

Scilab code Exa 3.10 Characteristics of series combination of capacitors

```

1  // Scilab code Ex3.10: Pg 90–91 (2008)
2  clc; clear;
3  C_1 = 6e-06;           // Capacitance , F
4  C_2 = 4e-06;           // Capacitance , F
5  V = 150;               // Supply voltage , V
6  // Part (a)
7  // The reciprocal of the resulting capacitance of
        capacitors connected in series is the sum of the
        reciprocal of the individual capacitances present
        in the circuit i.e  $1/C = 1/C_1 + 1/C_2$ , solving
        for C
8  C = ( C_1*C_2 )/(C_1 + C_2); //
        Resulting capacitance , F
9  // Part (b)
10 Q = V*C;               //
        Electric charge on the capacitors , C
11 // Part (c)
12 V_1 = Q/C_1;           // P.d
        across capacitor C_1, V
13 V_2 = Q/C_2;           // P.d
        across capacitor C_2, V
14 printf("\nThe total capacitance of the combination =

```

```

        %3.1f micro-farad", C/1e-06);
15 printf("\nThe charge on each capacitor = %3d micro-
    coulomb", Q/1e-06);
16 printf("\nThe p.d. developed across %1d micro-farad
    capacitor = %2d V", C_1/1e-06, V_1);
17 printf("\nThe p.d. developed across %1d micro-farad
    capacitor = %2d V", C_2/1e-06, V_2);
18
19 // Result
20 // The total capacitance of the combination = 2.4
    micro-farad
21 // The charge on each capacitor = 360 micro-coulomb
22 // The p.d. developed across 6 micro-farad capacitor
    = 60 V
23 // The p.d. developed across 4 micro-farad capacitor
    = 90 V

```

Scilab code Exa 3.11 Potential difference across each capacitor in series combination

```

1 // Scilab code Ex3.11: Pg 91-92 (2008)
2 clc; clear;
3 C_1 = 3e-06; //Capacitance , F
4 C_3 = 12e-06; //Capacitance , F
5 C_2 = 6e-06; //Capacitance , F
6 V = 400; // Supply voltage , V
7 // The reciprocal of the resulting capacitance of
    capacitors connected in series is the sum of the
    reciprocal of the individual capacitances present
    in the circuit i.e  $1/C = 1/C_1 + 1/C_2 + 1/C_3$ ,
    solving for C
8 C = (C_1 * C_2 * C_3)/( C_1*C_2 + C_2*C_3 + C_3*C_1)
    ; // Resulting capacitance , F
9 Q = V*C; //
    Electric charge on the capacitors , C
10 // Part (c)

```

```

11 V_1 = Q/C_1;                                // P.d
    across capacitor C_1, V
12 V_2 = Q/C_2;                                // P.d
    across capacitor C_2, V
13 V_3 =Q/C_3;                                // P.d
    across capacitor C_2, V
14 printf("\nP.d across capacitor %1d micro-farad = %5
    .1f V", C_1/1e-06, V_1);
15 printf("\nP.d across capacitor %1d micro-farad = %5
    .1f V", C_2/1e-06, V_2);
16 printf("\nP.d across capacitor %2d micro-farad = %4
    .1f V", C_3/1e-06, V_3);
17
18 // Result
19 // P.d across capacitor 3 micro-farad = 228.6 V
20 // P.d across capacitor 6 micro-farad = 114.3 V
21 // P.d across capacitor 12 micro-farad = 57.1 V

```

Scilab code Exa 3.12 Charge stored and potential difference across capacitors

```

1 // Scilab code Ex3.12: Pg 92–95 (2008)
2 clc; clear;
3 V = 200;                                // Supply voltage ,
    voltage
4 C_AB = 2;                                // Capacitance across
    branch AB, micro-farad
5 C_BC = 3;                                // Capacitance across
    branch BC, micro-farad
6 C_CD = 6;                                // Capacitance across
    branch CD, micro-farad
7 C_EF = 8;                                // Capacitance across
    branch EF, micro-farad
8 C_BD = 4;                                // Capacitance across
    branch EF, micro-farad
9

```

```

10 // Part (a)
11 // Since 3-micro-farad & 6-micro-farad capacitors
    are in series & the reciprocal of the resulting
    capacitance of capacitors connected in series is
    the sum of the reciprocal of the individual
    capacitances present in the circuit , therefore i.
    e  $1/C = 1/C1 + 1/C2$ 
12 C_BCD = ( C_BC*C_CD )/(C_BC+C_CD); //
    Resulting capacitance across branch BCD, micro-
    farad
13 //Since C_BCD & 4-micro-farad capacitors are in
    parallel & the resulting capacitance of
    parallerly connected capacitors is the sum of the
    individual capacitance present in the circuit
14 C_BD = C_BCD + C_BD; // Resulting
    capacitance across branch BD, micro-farad
15 // Since 2-micro-farad & C_BD capacitors are in
    series & the reciprocal of the resulting
    capacitance of capacitors connected in series is
    the sum of the reciprocal of the individual
    capacitances present in the circuit , therefore ,
    we have
16 C_AD = (C_BD*C_AB)/(C_BD+C_AB); // Resulting
    capacitance across branch AD, micro-farad
17 //Since C_AD & C_EF capacitors are in parallel &
    the resulting capacitance of parallerly connected
    capacitors is the sum of the individual
    capacitance present in the circuit
18 C = C_AD + C_EF; // Resulting capacitance of
    the circuit , micro-farad
19 Q = V*C; //
    Electric charge drawn from the supply , C
20
21 // Part (b)
22 Q_EF = V*C_EF; // The charge
    on the 8 micro-farad capacitor , micro-coulomb
23
24 // Part (c)

```

```

25 Q_AD = Q - Q_EF; // The
    charge on the 4 micro-farad capacitor, C
26 Q_BD = Q_AD; // Charge in series combination of
    capacitors, micro-farad
27 // Since  $Q = C \cdot V$ , solving for V
28 V_BD = Q_BD/C_BD; // The p.d.
    across the 4 F capacitor, V
29
30 // Part(d)
31 Q_BCD = V_BD*C_BCD; // Electric
    charge across branch BCD, C
32 Q_BC = Q_BCD; // Electric
    charge, C
33 V_BC = Q_BC/C_BC; // The p.d.
    across the 3 micro-farad capacitor
34 printf("\nThe charge drawn from the supply = %3.1f
    mC", Q/1e+03);
35 printf("\nThe charge on the %1d micro-farad
    capacitor = %3.1f mC", C_EF, Q_EF/1e+03);
36 printf("\nThe p.d. across the %1d micro-farad
    capacitor= %2d V", C_BD, V_BD);
37 printf("\nThe p.d. across the %1d micro-farad
    capacitor = %5.2f V", Q_BC, V_BC);
38
39 // Result
40 // The charge drawn from the supply = 1.9 mC
41 // The charge on the 8 micro-farad capacitor = 1.6
    mC
42 // The p.d. across the 6 micro-farad capacitor= 50 V
43 // The p.d. across the 100 micro-farad capacitor =
    33.33 V

```

Scilab code Exa 3.13 Capacitance of parallel plate capacitor with mica sheet

```
1 // Scilab code Ex3.13: Pg 96 (2008)
```

```

2  clc; clear;
3  N = 20;                                // Number of plates in a
    capacitor
4  A = 6400e-06;                          // Cross – sectional area
    of plate , m^2
5  d = 1.5e-03;                          // Distance between plates ,
    m
6  epsilon_r = 6.4;                      // Relative permittivity
    for mica
7  epsilon_o = 8.854e-12;                // Relative permittivity
    for free space
8  // Calculating the capacitance of the capacitor
9  C = ((epsilon_o)*(epsilon_r)*A*(N-1))/d;    //
    Capacitance , F
10 printf("\\n The capacitance of the capacitor = %3.1 f
    nF", C/1e-09);
11
12 // Result
13 // The capacitance of the capacitor = 4.6 nF

```

Scilab code Exa 3.14 Thickness of mica between parallel plates of a capacitor

```

1  // Scilab code Ex3.14: Pg 96–97 (2008)
2  clc; clear;
3  N = 9;                                // Number of plates in a
    capacitor
4  A = 1200e-06;                          // Cross – sectional
    area of plate , m^2
5  C = 3e-10;                            // Capacitance , F
6  epsilon_r = 5;                        // Relative permittivity
    for mica
7  epsilon_o = 8.854e-12;                // Relative permittivity
    for free space
8  // Using the formula of capacitance ,  $C = ((\epsilon_o) * (\epsilon_r) * A * (N-1)) / d$  and solving for d, we

```

```

    have
9  d = ((epsilon_o)*(epsilon_r)*A*(N-1))/C;          //
    Distance between plates , m
10 printf("\nThe thickness of mica between parallel
    plates of a capacitor = %4.2f mm", d/1e-03);
11
12 // Result
13 // The thickness of mica between parallel plates of
    a capacitor = 1.42 mm

```

Scilab code Exa 3.15 Capacitance of a parallel plate capacitor with air gap

```

1 // Scilab code Ex3.15: Pg 97 (2008)
2 clc; clear;
3 N = 11;          // Number of plates in
    a capacitor
4 r = 25e-03;      // Radius of circular
    plate , m
5 A = (%pi*r^2);   // Cross - sectional
    area of plate , m^2
6 d = 5e-04;       // Distance between
    plates , m
7 epsilon_r = 1;    // Relative
    permittivity for air
8 epsilon_o = 8.854e-12; // Relative
    permittivity for free space
9 // Calculating the capacitance of the capacitor
10 C = ((epsilon_o)*(epsilon_r)*A*(N-1))/d; //
    Capacitance , F
11 printf("\n The capacitance of the capacitor = %3.2f
    pF", C/1e-10);
12
13 // Result
14 // The capacitance of the capacitor = 3.48 pF

```

Scilab code Exa 3.16 Charging and energy storing ability of capacitor

```
1 // Scilab code Ex3.16: Pg 99 (2008)
2 clc; clear;
3 C_1 = 3e-06; //
   Capacitance , F
4 C_2 = 6e-06; //
   Capacitance , F
5 V_1 = 250; //
   Voltage across capacitor C_1, V
6 // Since each capacitor will take charge according
   to its capacitance , so we have
7 Q = C_1*V_1; //
   Charge on first capacitor C_1, C
8 W_1 = 0.5*C_1*(V_1^2); //
   Energy stored , J
9 // When the two capacitors are connected in parallel
   the 3 micro-farad will share its charge with 6
   micro-farad capacitor. Thus the total charge in
   the system will remain unchanged, but the total
   capacitance will now be different
10 C = C_1 + C_2; // Total
   capacitance , F
11 // Since  $Q = C*V$ , solving for V
12 V = Q/C; //
   Voltage across capacitor C_2, V
13 W = 0.5*C*(V^2); // Total
   energy stored by the combination , J
14 printf("\nThe charge and energy stored by %1d micro-
   F capcitor are %3.2f mC and %5.2f mJ respectively
   ", C_1/1e-06, Q/1e-03 , W_1/1e-03);
15 printf("\nThe p.d. between the plates = %5.2f V", V)
   ;
16 printf("\nThe energy stored by the combination of
```

```

    %1d micro-F and %1d micro-F capacitors = %5.2f mJ
    ", C_1/1e-06, C_2/1e-06, W/1e-03);
17
18 // Result
19 // The charge and energy stored by 3 micro-F
    capacitor are 0.75 mC and 93.75 mJ respectively
20 // The p.d. between the plates = 83.33 V
21 // The energy stored by the combination of 3 micro-F
    and 6 micro-F capacitors = 31.25 mJ

```

Scilab code Exa 3.17 Charging and discharging capacitors

```

1 // Scilab code Ex3.17: Pg 99–100 (2008)
2 clc; clear;
3 V = 200; // Supply voltage, V
4 C_1 = 10e-06; // Capacitance, farad
5 C_2 = 6.8e-06; // Capacitance, farad
6 C_3 = 4.7e-06; // Capacitance, farad
7 // Part (a)
8 // Since each capacitor will take charge according
    to its capacitance, so we have
9 Q_1 = V*C_1; // Charge sored on
    capacitor C_1, C
10 W_1 = 0.5*C_1*(V^2); // Energy sored on
    capacitor C_1, J
11 // Part (b)
12 // Since C_2 and C_3 are in series and hence, their
    equivalent capacitance is given by their series
    combination
13 C_4 = (C_2 * C_3)/(C_2 + C_3); //
    Equivalent capacitance of C_2 and C_3, F
14 // Since C_1 and C_4 are in parallel and hence,
    their equivalent capacitance is given by their
    parallel combination
15 C = C_1 + C_4; // Total capacitance of

```

```

        circuit , F
16 // Since  $Q = C \cdot V$ , solving for V
17 V_1 = Q_1/C;                                // New p.d
        across C_1, V
18 W = 0.5*C*(V_1^2);                            // Total energy
        remaining in the circuit , J
19 energy_used = W_1 - W;                        // Energy , J
20 printf("\nThe charge and energy stored by %2d micro-
        F capacitor are %1d mC and %2.1f J respectively "
        , C_1/1e-06, Q_1/1e-03, W_1);
21 printf("\nThe new p.d across %2d micro-F capacitor =
        %5.1f V", C_1/1e-06, V_1);
22 printf("\nThe amount of energy used in charging %3.1
        f micro-F and %3.2f micro-F capacitors from %2d
        micro-F capacitor = %4.3f J", C_2/1e-06, C_3/1e
        -06, C_1/1e-06, energy_used/1e-03);
23
24 // Result
25 // The charge and energy stored by 10 micro-F
        capacitor are 2 mC and 0.2 J respectively
26 // The new p.d across 10 micro-F capacitor = 156.5 V
27 // The amount of energy used in charging 6.8 micro-F
        and 4.70 micro-F capacitors from 10 micro-F
        capacitor = 43.495 J

```

Scilab code Exa 3.18 Minimum required thickness of dielectric material

```

1 // Scilab code Ex3.18: Pg 101 (2008)
2 clc; clear;
3 V = 400;                                // Supply voltage , V
4 E = 0.5e06;                            // Dielectric strength , V/m
5 // Since  $E = V/d$ , solving for d
6 d = V/E;                                // Thickness of dielectric , m
7 printf("\nThe minimum thickness of dielectric
        required = %3.1fmm", d/1e-03);

```

```

8
9 // Result
10 // The minimum thickness of dielectric required =
    0.8 mm

```

Scilab code Exa 3.19 Maximum voltage of capacitor and thickness of dielectric material

```

1 // Scilab code Ex3.19: Pg 101–102 (2008)
2 clc; clear;
3 C = 270e-12; // Capacitance, F
4 A = 60e-04; // Cross-sectional area of
    plate, m^2
5 E = 350e03; // Dielectric strength, V/
    m
6 epsilon_r = 2.1; // Relative permittivity
7 epsilon_o = 8.854e-12; // Permittivity of free
    space
8 // Part (a)
9 // Since formula for capacitance,  $C = ((\epsilon_o) * (\epsilon_r) * A) / d$ , solving for d
10 d = ((epsilon_o)*(epsilon_r)*A)/C; // Thickness
    of dielectric, m
11 // Part (b)
12 // Since  $E = V/d$ , solving for V
13 V = E*d; // Maximum
    possible working voltage, V
14 printf("\\nThe thickness of Teflon sheet required =
    %5.4f mm", d/1e-03);
15 printf("\\nThe maximum possible working voltage for
    the capacitor = %5.1f V", V);
16
17 // Result
18 // The thickness of Teflon sheet required = 0.413 mm
19 // The maximum possible working voltage for the
    capacitor = 144.6 V

```


Chapter 4

Magnetic fields and circuits

Scilab code Exa 4.1 Flux density at the pole face

```
1 // Scilab code Ex4.1: Pg 116 (2008)
2 clc; clear;
3 A = 6e-04; // Cross-sectional area
   of pole face, metre-square
4 phi = 30e-06; // Flux, Wb
5 B = phi/A; // Flux density, T
6 printf("\nThe flux desity at the pole face = %2d mT"
   , B/1e-03);
7
8 // Result
9 // The flux desity at the pole face = 50 mT
```

Scilab code Exa 4.2 Magnetic Flux

```
1 // Scilab code Ex4.2: Pg 116 (2008)
2 clc; clear;
3 A = 45e-06; // Cross sectional
   area of pole face, metre-square
```

```

4 B = 0.6; // Flux density , T
5 // Using formula B = phi/A, solving for phi
6 phi = B*A; // Flux, Wb
7 printf("\nThe flux produced by pole face = %2d micro
-wWb", phi/1e-06);
8
9 // Result
10 //The flux produced by pole face = 27 micro-Wb

```

Scilab code Exa 4.3 Magnetomotive force and flux density produced in a toroid

```

1 // Scilab code Ex4.3: Pg 117 (2008)
2 clc; clear;
3 N = 1500; // Number of turns in
a coil
4 A = 5e-04; // Cross-sectional
area of of coil , metre-square
5 phi = 0.2e-03; // Flux, Wb
6 I = 0.75; // Coil-current, A
7 // Since m.m.f is the product of the current and the
number of turns, therefore, we have
8 F = N*I; // Magnetomotive force
, At
9 B = phi/A; // Flux density, T
10 printf("\nThe m.m.f and flux density produced are %4d
At and %3.1f T respectively", F, B);
11
12 // Result
13 // The m.m.f and flux density produced are 1125 At
and 0.4 T respectively

```

Scilab code Exa 4.4 Excitation current required to produce required magnetomotive

```

1 // Scilab code Ex4.4:Pg 117 (2008)
2 clc; clear;
3 N = 600; // Number of turns in
    a coil
4 F = 1500; // Magnetomotive
    force , At
5 // Since magnetomotive force , $F = N \cdot I$ , solving for I
6 I = F/N; // Excitation-current ,
    A
7 printf("\\nThe excitation current required = %3.1f A"
    , I);
8
9 // Result
10 // The excitation current required = 2.5 A

```

Scilab code Exa 4.5 Magnetic field strength inside a toroid

```

1 // Scilab code Ex4.5: Pg 118 (2008)
2 clc; clear;
3 I = 0.4; // Current , A
4 N = 550; // Number of turns in a
    coil
5 d = 8e-02; // Diameter , m
6 l = (%pi*d); // Average length of the
    magnetic circuit , m
7 // Since magnetic field strength is defined as the
    mmf per metre length of the magnetic circuit ,
    therefore , we have
8 H = (N*I)/l; // Magnetic field
    strength , At/m
9 printf("\\nThe magnetic field strength inside the
    toroid = %6.2f At/m", H);
10
11 // Result
12 // The magnetic field strength inside the toroid =

```

Scilab code Exa 4.6 Flux and flux density with changed permeability

```
1 // Scilab code Ex4.6: Pg 119–120 (2008)
2 clc; clear;
3 A = 15e-04; // Cross-sectional
    area of core, metre-square
4 mew_r1 = 65; // Relative
    permeability of core
5 phi_1 = 2e-04; // Flux, Wb
6 mew_r2 = 800; // Changed relative
    permeability of core
7 B_1 = phi_1/A; // Flux density, T
8 mew_r = mew_r2/mew_r1; // Relative
    permeability of core
9 // Since cross-sectional area of core A remains
    constant, therefore, we have mew_r = B_1/B_2,
    solving for B_2
10 B_2 = mew_r*B_1; // New flux density,
    T
11 // Since B_2 = phi_2/A, solving for phi_2
12 phi_2 = B_2*A; // New flux, Wb
13 printf("\\nThe new flux and flux density are %5.3f
    mWb and %5.3f T respectively", phi_2/1e-03, B_2);
14
15 // Result
16 // The new flux and flux density are 2.462 mWb and
    1.641 T respectively
```

Scilab code Exa 4.7 Magnetic properties of toroid

```
1 // Scilab code Ex4.7: Pg 120 (2008)
```

```

2  clc; clear;
3  r = 0.04;                                // Mean radius
      of torod , m
4  A = 3e-04;                                // Csa of toroid
      , m^2
5  mew_o = 4*(%pi)*1e-07;                    // Permeability
      of free space
6  mew_r = 150;                              // Relative
      permeability of toroid
7  N = 900;                                  // Number of
      turns on coil
8  I = 1.5;                                  // Coil current ,
      A
9  l = 2*(%pi)*r;                            // Effective
      length of toroid , m
10
11 // Part (a)
12 // Since m.m.f is the product of the current and the
      number of turns , therefore , we have
13 F = N*I;                                  // Magnetomotive
      force , At
14 printf("\\nThe m.m.f of toroid = %4d At", F);
15
16 // Part (b)
17 // Since magnetic field strength is defined as the
      mmf per metre length of the magnetic circuit ,
      therefore , we have
18 H = F/l;                                  // Magnetic
      field strength , At/m
19 printf("\\nThe magntic field strength = %6.1f At/m",
      H);
20
21 // Part (c)
22 B = (mew_r*mew_o*H);                      // Flux
      density , T
23 phi = B*A;                                // Flux , Wb
24 printf("\\nThe flux and flux density are %6.2f micro-
      weber and %6.4f T respectively", phi/1e-06, B)

```

```

25
26 // Result
27 // The m.m.f of toroid = 1350 At
28 // The magntic field strength = 5371.5 At/m
29 // The flux and flux density are 303.75 micro-weber
    and 1.0125 T respectively

```

Scilab code Exa 4.8 Coil current to produce desired flux

```

1 // Scilab code Ex4.8: Pg 120–121 (2008)
2 clc; clear;
3 r = 3e-02; // Radius of
    toroid, m
4 A = 4.5e-04; // Cross-
    sectional area of toroid, metre-square
5 N = 500; // Number of
    turns
6 phi = 250e-06; // Flux, Wb
7 mew_o = 4*(%pi)*(1e-07); //
    Permeability of free space
8 mew_r = 300; // Relative
    permeability
9 l = 2*(%pi)*r; // Effective
    length, m
10 B = phi/A; // Flux
    density, T
11 // Since  $B = (\text{mew}_r) * (\text{mew}_o) * H$ , solving for H
12 H = B / ((mew_r)*(mew_o)); // Magnetic
    field strength, At/m
13 // Since  $H = F/l$ , solving for F
14 F = H*l; //
    Magnetomotive force, At
15 // Since mmf,  $F = N*I$ , solving for I
16 I = F/N; // Electric
    current, A

```

```

17 printf("\nThe value of current needs to be passed
    through the coil = %4.2f A", I);
18
19 // Result
20 // The value of current needs to be passed through
    the coil = 0.56 A

```

Scilab code Exa 4.9 Charactersistic measurements in a coil

```

1 // Scilab code Ex4.9: Pg 121–122 (2008)
2 clc; clear;
3 // Part (a)
4 I = 0.2; // Electric current, A
5 l = 5e-02; // Effective length, m
6 A = 7e-04; // Cross-sectional area,
    metre-square
7 d = 0.5e-03; // Diametre, m
8 mew_r = 1; //Relative permeability
    for wood
9 mew_o = 4*(%pi)*1e-07; // Pemeability for free
    space
10 N = 1/d; // Number of turns
11 // Since mmf is the product of the current and the
    number of turns, therefore, we have
12 F = N*I; // Magnetomotive force,
    At
13 // Part (b)
14 // Since magnetic field strength is defined as the
    mmf per metre length of the magnetic circuit,
    therefore, we have
15 H = F/l; // Magnetic
    field strength, At/m
16 B = ( mew_r * mew_o * H ); // Flux
    density, T
17 // Part (c)

```

```

18 phi = B * A; // Flux, Wb
19 printf("\nThe mmf produced = %2d At", F);
20 printf("\nThe flux density produced = %3d micro-
    tesla", B/1e-06);
21 printf("\nThe flux produced = %5.3 f micro-weber",
    phi/1e-06);
22
23 // Result
24 // The mmf produced = 20 At
25 // The flux density produced = 502 micro-tesla
26 // The flux produced = 0.352 micro-weber

```

Scilab code Exa 4.10 Coil current and relative permeability

```

1 // Scilab code Ex4.10: Pg 125 (2008)
2 clc; clear;
3 N = 1000; //
    Number of turns on coil
4 r = 0.1; //
    Mean radius of toroid, m
5 phi = 0.1775e-03; //
    Flux density(value from graph), Wb
6 A = %pi*1e-04; // Csa
    of toroid, m^2
7 H = 88; //
    Magnetic field strength(value from graph), At/m
8 B = phi/A; //
    Flux density, T
9
10 // Part (a)
11 l = 2*%pi*r; //
    Effective length of toroid, m
12 // Since  $H = (N \cdot I) / l$ , solving for I
13 I = (H*l)/N; //
    Electric current in coil, A

```

```

14 printf("\nCoil current = %4.1f mA", I/1e-03);
15
16 // Part (b)
17 mew_o = 4*(%pi)*1e-07; //
    Pemeability for free space
18 // Since  $B = \mu_o * \mu_r * H$ , solving for  $\mu_r$ 
19 mew_r = B/(mew_o*H); //
    Relative permeability of toroid
20 printf("\nThe relative permeability of toroid = %4d"
    ,mew_r);
21
22 // Result
23 // Coil current = 55.3 mA
24 // The relative permeability of toroid = 5109

```

Scilab code Exa 4.11 Flux density and relative permeability of toroid

```

1 // Scilab code Ex4.11: Pg 125–126 (2008)
2 clc; clear;
3 mew_o = 4*(%pi)*1e-07; // Pemeability for
    free space
4 l = 0.15; // Mean length, m
5 N = 2500; // Number of turns
6 I = 0.3; // Electric current,
    A
7 // Since magnetic field strength is defined as the
    mmf per metre length of the magnetic circuit,
    therefore, we have
8 H = (N*I)/l; // Magnetic field
    strength, At/m
9 B = 0.75; // Flux density(
    value taken from graph ), T
10 // Since  $B = (\mu_r * \mu_o * H)$ , solving for
    mew_r
11 mew_r = B/(mew_o * H); // Relative

```

```

    permeability
12 printf("\nThe flux desity of given toroid = %3.2f T
    ", B);
13 printf("\nThe relative permeability of given toroid
    = %5.1f", mew_r);
14
15 // Result
16 // The flux desity of given toroid = 0.75 T
17 // The relative permeability of given toroid = 119.4

```

Scilab code Exa 4.12 Currents in differently configured toroids with same flux

```

1 // Scilab code Ex4.12: Pg 126–127 (2008)
2 clc; clear;
3 mew_o = 4*(%pi)*1e-07;           // Permeability
    for free space
4 l = 0.1875;                       // Mean length ,
    m
5 A = 8e-05;                         // Cross-
    sectional area of of coil , metre-square
6 N = 750;                           // Number of
    turns
7 phi = 112e-06;                     // Flux , Wb
8 l_gap = 0.5e-03;                   // Average
    length of the magnetic circuit ,m
9 B = phi/A;                         // Flux density ,
    Wb
10 H = 2000;                         // Magnetic
    field strength( value taken from graph ), At/m
11 F_Fe = H*l;                       // The m.m.f in
    the iron part of the circuit , At
12 // Since F = I*N, solving for I
13 I = F_Fe/N;                       // Coil current
    under normal conditions , A
14 // Since B = mew_o * H_gap, solving for H_gap

```

```

15 H_gap = B/mew_o;           // Magnetic
    field strength , At/m
16 // Since H_gap = F_gap/l_gap , solving for F_gap
17 F_gap = H_gap * l_gap;     // The mmf in
    the air part of the circuit , At
18 F = F_Fe + F_gap;         // Total circuit
    mmf, At
19 I_new = F/N;               // Current
    required to maintain the flux at its original
    value , A
20 printf("\nThe coil current required to produce a
    flux of %3d micro-weber in the toroid = %3.1f A "
    , phi/1e-06, I);
21 printf("\nCurrent required to maintain the flux at
    its original value = %5.3f A", I_new);
22
23 // Result
24 // The coil current required to produce a flux of
    112 micro-weber in the toroid = 0.5 A
25 // Current required to maintain the flux at its
    original value = 1.243 A

```

Scilab code Exa 4.13 Coil current in a magnetic circuit

```

1 // Scilab code Ex4.13: Pg 127–128 (2008)
2 clc; clear;
3 l_A = 0.25;                 // Mean length of
    circuit A, m
4 l_B = 0.15;                 // Mean length of
    circuit A, m
5 A_A = 11.5e-04;             // Cross-sectional area
    of circuit A, metre-square
6 A_B = 12e-04;               // Cross-sectional area
    of circuit B, metre-square
7 phi = 1.5e-03;              // Flux, Wb

```

```

8 N = 1000; // Number of turns
9 B_A = phi/A_A; // Flux density linked
    with circuit A, T
10 B_B = phi/A_B; // Flux density linked
    with circuit B, T
11 H_A = 1470; // Magnetic field
    strength of circuit A( value taken from graph ),
    At/m
12 H_B = 845; // Magnetic field
    strength of circuit B( value taken from graph ),
    At/m
13 // Since  $H = F/l$ , solving for F
14 F_A = H_A * l_A; // Magnetic field
    strength of circuit A, At/m
15 F_B = H_B * l_B; // Magnetic field
    strength of circuit B, At/m
16 F = F_A + F_B; // Total circuit m.
    m.f, At/m
17 I = F/N; // Coil current, A
18 printf("\Coil current in the magnetic circuit = %5.3
    f A", I);
19
20 // Result
21 // Coil current in the magnetic circuit = 0.494 A

```

Scilab code Exa 4.14 Magnetomotive force required by ring for generating desired f

```

1 // Scilab code Ex4.14: Pg 129–130 (2008)
2 clc; clear;
3 A = 8e-04; // Cross-
    sectional area, metre-square
4 d = 24e-02; // Mean
    diameter of iron ring, m
5 phi = 1.2e-03; // Flux,
    Wb

```

```

6 mew_r = 1200; //
    Relative permeability
7 mew_o = 4*(%pi)*1e-07; //
    Pemeability for free space
8 mew_air = 1; //
    Pemeability for air
9 l_gap = 3e-03; // Mean
    length, m
10 l_Fe = (%pi) * d; // Mean
    length of iron circuit, m
11 S_Fe = l_Fe/(mew_r * mew_o *A); //
    Reluctance of iron circuit, At/Wb
12 S_gap = l_gap/(mew_air * mew_o *A); //
    Reluctance of gap, At/Wb
13 S = S_Fe + S_gap; // Total
    circuit reluctance, At/Wb
14 // Since phi = F/S, solving for F
15 F = phi*S; //
    Magnetomotive force, At
16 printf("\nThe required mmf = %5.1 f At", F);
17
18 // Result
19 // The required mmf = 4331 At

```

Scilab code Exa 4.15 Reluctance and current in a circuit placed in magnetic field

```

1 // Scilab code Ex4.15: Pg 130–131 (2008)
2 clc; clear;
3 N = 500; //
    Number of turns on first section's coil
4 phi = 2e-03; //
    Flux produced by first section, Wb
5 l_1 = 85e-02; //
    Length of first section, m
6 l_2 = 65e-02; //

```

```

    Length of second section , m
7  l_3 = 0.1e-02;                                     //
    Length of third section , m
8  A_1 = 10e-04;                                       //
    Csa of first section , m^2
9  A_2 = 15e-04;                                       //
    Csa of second section , m^2
10 A_3 = 12.5e-04;                                    //
    Csa of second section , m^2
11 mew_o = 4*(%pi)*1e-07;                             //
    Pemeability for free space
12 mew_r1 = 600;                                       //
    Relative permeability of first section
13 mew_r2 = 950;                                       //
    Relative permeability of second section
14 mew_r3 = 1;                                         //
    Relative permeability of third section
15
16 // Part (a)
17 S_1 = l_1/(mew_r1 * mew_o * A_1);                 //
    Reluctance of first section , At/Wb
18 S_2 = l_2/(mew_r2 * mew_o * A_2);                 //
    Reluctance of first section , At/Wb
19 S_3 = l_3/(mew_r3 * mew_o * A_3);                 //
    Reluctance of first section , At/Wb
20 S = S_1 + S_2 + S_3;                               //
    Total reluctance of the circuit , At/Wb
21 printf("\nTotal reluctance of the circuit = %4.2fe
    +06 At/Wb", S*1e-06);
22
23 // Part (b)
24 // Since phi = F/S, solving for F
25 F = phi*S;                                          //
    Magnetomotive force , At
26 // Since F = N*I, solving for I
27 I = F/N;                                           //
    Electric current in first section , A
28 printf("\nElectric current in first section = %4.2f

```

```
    A'' , I);  
29  
30 // Result  
31 // Total reluctance of the circuit = 2.13e+06 At/Wb  
32 // Electric current in first section = 8.51 A
```

Chapter 5

Electromagnetism

Scilab code Exa 5.1 Average emf induced into coil

```
1 // Scilab code Ex5.1: Pg 145 (2008)
2 clc; clear;
3 N = 100; // Number
    of turns
4 delta_phi = 10e-03; // Flux
    linked with coil, Wb
5 delta_t = 2e-03; // Time
    during which flux changes, s
6 e =((-N)*delta_phi)/delta_t; // Average
    induced emf, V
7 printf("\nThe average emf induced in the coi = %3d V
    ", e);
8
9 // Result
10 // The average emf induced in the coi = -500 V
```

Scilab code Exa 5.2 Changing flux and induced emf in the coil

```

1 // Scilab code Ex5.2: Pg 146 (2008)
2 clc; clear;
3 N = 250; //
    Number of turns
4 delta_phi1 = 20e-03; // Flux
    linked with coil, Wb
5 delta_phi2 = -16e-03; // Flux
    linked with coil, Wb
6 delta_t1 = 0.05; // Time
    , s
7 delta_t2 = 0.01; // Time
    , s
8 e_1 =((-N)*delta_phi1)/delta_t1; //
    Average induced emf, V
9 e_2 =((-N)*delta_phi2)/delta_t2; //
    Average induced emf, V
10 printf("\\nChange in flux in first case = %4.2f weber
    ", delta_phi1);
11 printf("\\nEmf induced in first case = %3d volts",e_1
    );
12 printf("\\nChange in flux in second case = %4.2f
    weber", delta_phi2);
13 printf("\\nEmf induced in second case = %3d volts",
    e_2);
14
15 // Result
16 // Change in flux in first case = 0.02 Wb
17 // Emf induced in first case = -100 V
18 // Change in flux in second case = -0.02 Wb
19 // Emf induced in second case = 400 V

```

Scilab code Exa 5.3 Number of turns on coil

```

1 // Scilab code Ex5.3: Pg 147 (2008)
2 clc; clear;

```

```

3 e = 100;                                     //
    Induced emf, V
4 // For simplification let (delta_phi)/(delta_t) = k
5 k = 0.1;                                     //
    Rate of change of flux linked with coil, Wb/s
6 // Since e =((-N)*delta_phi)/delta_t, solving for N
7 N = (e)/k;                                   //
    Number of turns
8 printf("\nThe number of turns on the coil = %4d", N)
    ;
9
10 // Result
11 // The number of turns on the coil = 1000

```

Scilab code Exa 5.4 Emf induced in conductor moving in uniform magnetic field

```

1 // Scilab code Ex5.4: Pg 149 (2008)
2 clc; clear;
3 v = 5;                                       // Velocity, m
    ^2
4 theta =(%pi/3);                             // Angle,
    degrees
5 phi = 1.6e-03;                             // Flux, Wb
6 l = 0.1;                                    // Length of
    pole face, m
7 d = 0.4;                                    // Breadth of
    pole face, m
8 A = l*d;                                    // Cross-
    sectional area of pole face, m^2
9 B = phi/ A;                                 // Flux
    density, T
10 e =( B*l*v)*sin(theta);                   // Induced emf
    , V
11 printf("\nThe emf induced = %5.4 f V", e);
12

```

```

13 // Result
14 // The emf induced = 0.0173 V

```

Scilab code Exa 5.5 Density of magnetic field

```

1 // Scilab code Ex5.5: Pg 149 (2008)
2 clc; clear;
3 l = 0.15; //
   Effective length of conductor, m
4 v = 8; //
   Velocity, m^2
5 theta = (%pi/180)*55; // Angle,
   degrees
6 e = 25; // Induced
   emf, V
7 // Since e = B*l*v*sin(theta), solving for B
8 B = e/(l*v*sin(theta)); // Flux
   density, T
9 printf("\nThe density of the field = %5.3f tesla", B
   );
10
11 // Result
12 // The density of the field = 25.433 T

```

Scilab code Exa 5.6 Emf induced in axle travelling in vertical component of earth

```

1 // Scilab code Ex5.6: Pg 149 (2008)
2 clc; clear;
3 l = 2.2; //
   Effective length of conductor, m
4 B = 38e-06; // Flux
   density, T

```

```

5 theta = (%pi/2);                                // Angle ,
   degrees
6 v = 800/36;                                     // Velocity
   , m^2
7 e = B*l*v*sin(theta);                          // Induced
   emf, V
8 printf("\The emf induced in the axle = %4.2 f mV", e
   /1e-03);
9
10 // Result
11 // The emf induced in the axle = 1.86 mV

```

Scilab code Exa 5.7 Force exerted on current carrying conductor

```

1 // Scilab code Ex5.7:Pg 152 (2008)
2 clc; clear;
3 l = 0.22;                                         //
   Effective length of conductor, m
4 B = 0.35;                                       // Flux
   density, T
5 I = 3;                                          // Current ,
   A
6 theta = (%pi/2);                               // Angle ,
   degrees
7 // Since the force exerted on the conductor placed
   in magnetic field is directly proportional to the
   flux density , the value of current flowing
   through the conductor, and the length of
   conductor lying inside the field , therefore
8 F = B*I*l*sin(theta);                         // Force, N
9 printf("\n\The force exerted on the conductor = %5.3 f
   N", F);
10
11 // Result
12 // The force exerted on the conductor = 0.231 N

```

Scilab code Exa 5.8 Current carrying conductor in magnetic field

```
1 // Scilab code Ex5.8: Current carrying conductor in
   magnetic field: Pg 153 (2008)
2 clc; clear;
3 phi = 2.5e-03; // Flux,
   Wb
4 l = 0.05; //
   Effective length of pole, m
5 d = 0.03; //
   Effective width of pole, m
6 F = 1.25; // Force
   exerted on conductor, N
7 A = l*d; // Cross-
   sectional area of pole face, m^2
8 B = phi/A; // Flux
   density, T
9 theta = (%pi/2); // Angle,
   degrees
10 // Since  $F = B \cdot I \cdot l \cdot \sin(\theta)$ , solving for I
11 I = F/(B*l*sin(theta)); // Current
   in conductor, A
12 theta_2 = (%pi/4); // New
   angle, degrees
13 F_2 = B*I*l*sin(theta_2); // Force
   exerted on conductor, N
14 printf("\nThe value of the current = %2g A", I);
15 printf("\nThe force exerted on conductor when placed
   at 45 degrees to the field = %5.3f newton", F_2)
   ;
16
17 // Result
18 // The value of the current = 14 A
19 // The force exerted on conductor when placed at 45
```

degrees to the field = 0.884 N

Scilab code Exa 5.9 Torque acting on current carrying conductor placed in magnetic field

```
1 // Scilab code Ex5.9: Pg 154 (2008)
2 clc; clear;
3 l = 0.015; //
   Length of coil , m
4 d = 0.006; //
   Width of coil , m
5 B = 1.2; //
   Flux density , T
6 I = 1e-02; //
   Current , a
7 r = d/2; //
   Radius of rotation , m
8 // Since torque is given by the product of force and
   distance , therefore , we have
9 T = 2*B*I*l*r; //
   Torque , Nm
10 printf("\nThe torque exerted on the coil = %4.2 f
   micro-Nm", T/1e-06);
11
12 // Result
13 // The torque exerted on the coil = 1.08 micro-Nm
```

Scilab code Exa 5.10 Flux density produced by magnetic pole pieces

```
1 // Scilab code Ex5.10: Pg 155 (2008)
2 clc; clear;
3 N = 80; // Number of
   turns
```

```

4 l = 0.02;                                // Length of
    coil, m
5 r = 0.012;                                // Radius of
    coil, m
6 I = 45e-06;                                // Current
    in coil, A
7 T = 1.4e-06;                                // Torque
    exerted on coil, Nm
8 A = l*r;                                    // Cross-
    sectional area of coil, m^2
9 // Since  $T = 2*B*I*l*r$ , solving for B
10 B = T/(2*A*N*I);                          // Flux
    density, T
11 printf("\nThe flux density produced by the pole
    pieces = %4.2f T", B);
12
13 // Result
14 // The flux density produced by the pole pieces =
    0.81 T

```

Scilab code Exa 5.11 Force exerted between current carrying parallel conductors

```

1 // Scilab code Ex5.11: Pg 158 (2008)
2 clc; clear;
3 d = 0.035;                                // Distance between
    two parallel conductors, m
4 I_1 = 50;                                  // Electric current
    in first coil, A
5 I_2 = 40;                                  // Electric current
    in second coil, A
6 F = ((2e-07)*I_1*I_2)/d;                  // Force exerted by
    conductors, N
7 printf("\nThe force exerted between the conductors =
    %4.1f mN", F/1e-03);
8

```

```

9 // Result
10 // The force exerted between the conductors = 11.4
    mN

```

Scilab code Exa 5.12 Force on a conductor due to current in the other conductor

```

1 // Scilab code Ex5.12: Pg 158 (2008)
2 clc; clear;
3 d = 2; // Distance between
    two parallel conductors, m
4 I_1 = 1000; // Electric current
    in first coil, A
5 I_2 = 300; // Electric current
    in second coil, A
6 mew_o = 4*(%pi)*1e-07; // Permeability for
    free space
7 B = (mew_o*I_1)/d; // Flux density due
    to first coil, T
8 F = ((2e-07)*I_1*I_2)/d; // Force exerted by
    conductors, N
9 printf("\\nThe flux density at a distance of %1d m
    from the centre of a conductor carrying a current
    of %4d A = %5.3f mT", d, I_1, B/1e-03);
10 printf("\\nForce exerted by conductors = %2d mN", F/1
    e-03);
11
12 // Result
13 // The flux density at a distance of 2 m from the
    centre of a conductor carrying a current of 1000
    A = 0.628 mT
14 // Force exerted by conductors = 30 mN

```

Scilab code Exa 5.13 Shunt resistance to increase the range of ammeter

```

1 // Scilab code Ex5.13: Pg 163 (2008)
2 clc; clear;
3 R_c = 40; // Resistance of
    coil, ohm
4 I_fsd = 5e-04; // Full-scale
    deflection current, A
5 I = 3; // Current
    reading, A
6 V_c = I_fsd*R_c; // Potential
    difference, V
7 // Since  $I = I_s + I_{fsd}$ , solving for  $I_s$ 
8 I_s = I - I_fsd; // Shunt
    current, A
9 // From Ohm's law,  $V_c = I_s * R_s$ , solving for  $R_s$ 
10 R_s = V_c / I_s; // Shunt
    resistance, ohm
11 printf("\\nThe value of required shunt resistance =
    %4.2f milli-ohm", R_s/1e-03);
12
13 // Result
14 // The value of required shunt resistance = 6.67
    milli-ohm

```

Scilab code Exa 5.14 Multiplier resistance to increase the range of voltmeter

```

1 // Scilab code Ex5.14: Pg 163–164 (2008)
2 clc; clear;
3 R_c = 40; // Resistance of
    coil, ohm
4 I_fsd = 5e-04; // Full-scale
    deflection current, A
5 I_fsd = 5e-04; // Full-scale
    deflection current, A
6 V = 10; // Voltage
    reading range, V

```

```

7  V_c = 0.02;                                // Potential
    difference across coil resistance , V
8  // From Ohm's law , V = I_fsd*R, solving for R
9  R = V/I_fsd;                                // Total
    resistance , ohm
10 // Since R = R_m + R_c , solving R_m
11 R_m = R - R_c;                                // Multiplier
    resistance , ohm
12 printf("\nThe required value of multiplier
    resistance = %5.2f kilo-ohms", R_m*1e-03);
13
14 // Result
15 // The required value of multiplier resistance =
    19.96 kilo-ohms

```

Scilab code Exa 5.15 Shunt and multiplier resistance for a moving coil multimeter

```

1  // Scilab code Ex5.15: Pg 164-165 (2008)
2  clc; clear;
3  R_c = 1500;                                // Coil
    resistance , ohm
4  I_fsd = 75e-06;                            // Full-
    scale deflection current , A
5  I = 5;                                    // Current
    range , A
6  V = 10;                                    // Voltage
    range , V
7  // Part (a)
8  // Using Ohm's law ,
9  V_c = I_fsd*R_c;                            //
    Potential difference across coil resistance , V
10 // Since I = I_s + I_fsd , solving for I_s
11 I_s = I-I_fsd;                            // Shunt
    current , A
12 // From Ohm's law , V_c = I_s*R_s , solving for R_s

```

```

13 R_s = V_c/I_s;                                // Shunt
    resistance , ohm
14 // Part (b)
15 // Since  $V = V_m + V_c$ , solving for  $V_m$ 
16 V_m = V - V_c;                                // Potential
    difference across multiplier resistance , V
17 // From Ohm's law,  $V_m = I_{fsd} * R_m$ , solving for  $R_m$ 
18 R_m = V_m/I_fsd                                // Multiplier
    resistance , ohm
19 printf("\nThe required value of shunt resistance =
    %4.1f mega-ohm", R_s/1e-03);
20 printf("\nThe required value of multiplier
    resistance = %4.1f mega-ohm", R_m*1e-03);
21
22 // Result
23 // The required value of shunt resistance = 22.5
    mega-ohm
24 // The required value of multiplier resistance =
    131.83 mega-ohm

```

Scilab code Exa 5.16 Potential difference indicated by AVO and percentage error in

```

1 // Scilab code Ex5.16: Pg 166 (2008)
2 clc; clear;
3 R_1 = 30;                                        // Resistance ,
    ohm
4 R_2 = 70;                                        // Resistance ,
    ohm
5 R_in = 200;                                    // Internal
    resistance of meter , ohm
6 V = 12;                                        // Supply
    voltage , V
7 // Using voltage divider rule , we have
8 V_2t = (R_2 /(R_1 + R_2))*V                    // True
    value of p.d across resistance R_2, V

```

```

9 // Since the rsistances R_2 and R_in are parallel ,
   so their equivalent resistance is given their
   parallel combination
10 R_BC = (R_2 * R_in)/(R_2 + R_in);
           // Resistance , ohms
11 // Using the potential divider technique ,
12 V_2i = (R_BC / ( R_BC + R_1 ))*V
           // Indicated value of p.d
           across by voltmeter , volts
13 err = (( V_2i-V_2t ) / V_2t)*100
           // Percentage error in the
           reading
14 printf("\nThe p.d. indicated by the meter = %3.1f V"
   , V_2i);
15 printf("\nThe percentage error in the reading = %4.2
   f percent" , err);
16
17
18 // Result
19 // The p.d. indicated by the meter = 7.6 V
20 // The percentage error in the reading = -9.50
   percent

```

Scilab code Exa 5.17 Potential difference measured by multimeter and percentage error

```

1 // Scilab code Ex5.17: Pg 168–169 (2008)
2 clc; clear;
3 R_in = 200; //
   Internal resistance of meter, kilo-ohms
4 V = 10; //
   Supply voltage , volts
5 R_1 = 10; //
   Resistance , kilo-ohms
6 R_2 = 47; //
   Resistance , kilo-ohms

```

```

7  V_1 = R_1/(R_1+R_2)*V // P.d
    across resistance R_1, V
8  V_2 = R_2/(R_1+R_2)*V // P.d
    across resistance R_2, V
9  // Part (a)
10 R_AB = (R_1 * R_in)/(R_1 + R_in);
    // Resistance , kilo-ohms
11 V_AB = (R_AB / ( R_AB + R_2 ))*V
    // True value of p.d across
    by voltmeter , V
12 R_BC = (R_2 * R_in)/(R_2 + R_in);
    // Resistance , kilo-ohms
13 V_BC = (R_BC / ( R_BC + R_1 ))*V
    // Indicated value of p.d
    across by voltmeter , V
14 // Part (b)
15 // Error for V_1 measurement
16 error_AB = (V_AB - V_1)/V_1*100
    // Percentage error in the
    reading
17 //Error for V_2 measurement
18 error_BC = (V_BC-V_2)/V_2*100
    // Percentage error in
    the reading
19 printf("\nThe p.d. indicated by the meter across
    first resistor = %4.2f V", V_AB);
20 printf("\nThe p.d. indicated by the meter across
    second resistor = %4.2f V", V_BC);
21 printf("\nPercentage error for V_1 measurement = %4
    .2f percent", error_AB);
22 printf("\nPercentage error for V_2 measurement = %4
    .2f percent", error_BC);
23
24 // Result
25 // The p.d. indicated by the meter across first
    resistor = 1.68 V
26 // The p.d. indicated by the meter across second
    resistor = 7.92 V

```

```

27 // Percentage error for V_1 measurement = -3.96
    percent
28 // Percentage error for V_2 measurement = -3.96
    percent

```

Scilab code Exa 5.18 Emf induced in coil due to changing current

```

1 // Scilab code Ex5.18: Pg 176 (2008)
2 clc; clear;
3 L = 0.25;
    // Self-inductance, H
4 delta_I = 250e-03;
    // Change in current, A
5 delta_t = 25e-03;
    // Time, s
6 e = ((-L)*delta_I)/(delta_t);
    // Induced emf, V
7 printf("\nThe value of emf induced = %3.1f V", e);
8
9 // Result
10 // The value of emf induced = 2.5 V

```

Scilab code Exa 5.19 Inductance of a circuit with changing current

```

1 // Scilab code Ex5.19: Pg 176 (2008)
2 clc; clear;
3 e = 30; // Induced emf, V
4 // For simplicity, let rate of change of current i.e
    delta_I/delta_t = k
5 k = 200; // Rate of
    change of current, ampere-second
6 // Since  $e = ((-L)*\text{delta\_I})/(\text{delta\_t})$ , solving for L

```

```

7 L = e/k;                                // Self-
   inductance , H
8 printf("\nThe inductance of the circuit = %4.2f H",
   L);
9
10 // Result
11 // The inductance of the circuit = 0.15 H

```

Scilab code Exa 5.20 Required rate of change of current to induce desired emf in a

```

1 // Scilab code Ex5.20: Pg 176 (2008)
2 clc; clear;
3 L = 50e-03;                                // Self-
   inductance , H
4 e = 8;                                    // Induced
   emf, V
5 // Since  $e = (-L) \cdot \Delta I / (\Delta t)$ , solving for
    $\Delta I / \Delta t$ , and for simplicity letting the
   rate of change of current i.e  $\Delta I / \Delta t = k$ 
6 k = e/L;                                // Rate of change of
   current, As
7 printf("\nThe rate of change of current = %3d A/s", k
   );
8
9 // Result
10 // The rate of change of current = 160 A/s

```

Scilab code Exa 5.21 Inductance of coil and emf induced in it

```

1 // Scilab code Ex5.21: Pg 178 (2008)
2 clc; clear;
3 N = 150;                                // Number of
   turns in a coil

```

```

4 I = 10;                                // Electric
    current flowing through coil , A
5 phi = 0.10;                            // Flux , Wb
6 delta_t = 0.1;                         // Time, s
7 // Part (a)
8 L = (N * phi)/I                        // Self-
    inductance , H
9 delta_I = 20;                          // Change in
    current , A
10 // Part (b)
11 e = abs((-L*delta_I)/(delta_t));        // Induced
    emf, V
12 printf("\nThe inductance of the coi = %3.1f H", L);
13 printf("\nThe emf induced in the coil = %2d V", e);
14
15 // Result
16 // The inductance of the coi = 1.5 H
17 // The emf induced in the coil = 300 V

```

Scilab code Exa 5.22 Emf induced in coil due to decreasing current

```

1 // Scilab code Ex5.22: Pg 178 (2008)
2 clc; clear;
3 I_1 = 8;                                //
    Electric current , A
4 I_2 = 2;                                //
    Electric current , A
5 N = 3000;                               // Number
    of turns in a coil
6 phi_1 = 4e-03;                          // Flux ,
    Wb
7 delta_t = 0.1; // Reversal time of current , s
8 L = (N * phi_1)/I_1;                    // Self-
    inductance , H
9 delta_I = I_1 - I_2;                     //

```

```

    Change in current , A
10 e = ((L)*delta_I)/(delta_t);          // Induced emf,
    V
11 printf("\nThe emf induced in the coil = %2d volts",
    e);
12
13 // Result
14 // The emf induced in the coil = 90 V

```

Scilab code Exa 5.23 Factors affecting inductance

```

1 // Scilab code Ex5.23: Pg 179–180 (2008)
2 clc; clear;
3 N_1 = 600;                                // Number
    of turns in a coil in first case
4 N_2 = 900;                                // Number
    of turns in a coil in secnd case
5 N_3 = 900;                                // Number
    of turns in a coil in third case
6 l = 45e-03;                               //
    Effective length of coil , m
7 A = 4e-04;                                // Cross-
    sectional area of coil , m^2
8 mew_o = 4*(%pi)*1e-07;                   //
    Pemeability for free space
9 mew_r1 = 1;                               //
    Relative permeability in first case
10 mew_r2 = 1;                              //
    Relative permeability in second case
11 // Part (a)
12 mew_r3 = 75;                             //
    Relative permeability in third case
13 L_1 = (mew_o*mew_r1*(N_1^2)*A)/l;        // Self-
    inductance of coil in first case , H
14 // Part (b)

```

```

15 // Since self-inductance of a coil is directly
    proportional to the number of turns in a coil ,
    therefore , we have  $L_2/L_1 = (N_2^2)/(N_1^2)$  ,
    solving for  $L_2$ 
16 L_2 = (L_1*(N_2^2))/(N_1^2); // Self-
    inductance of coil in second case , H
17 // Part (c)
18 // Since  $\mu_{r3} = 75*\mu_{r2}$  , keeping all other
    quantities same we have
19 L_3 =  $\mu_{r3}*L_2$ ; // Self-inductance of
    coil in third case , H
20 printf("\nSelf-inductance of coil in first case = %4
    .2f mH", L_1/1e-03);
21 printf("\nSelf-inductance of coil in second case =
    %5.3f mH", L_2/1e-03);
22 printf("\nSelf-inductance of coil in third case = %5
    .3f H", L_3);
23
24 // Result
25 // Self-inductance of coil in first case = 4.02 mH
26 // Self-inductance of coil in second case = 9.048 mH
27 // Self-inductance of coil in third case = 0.679 H

```

Scilab code Exa 5.24 elf and mutual inductances of coil

```

1 // Scilab code Ex5.24: SPg 182 (2008)
2 clc; clear;
3 N_A = 2000; //
    Number of turns in a coil A
4 N_B = 1500; //
    Number of turns in a coil B
5 I_A = 0.5; //
    Electric current in coil A, A
6 phi_A = 60e-06; // Flux
    linked with coil A, Wb

```

```

7 // Part (a)
8 L_A = (N_A*phi_A)/I_A; // Self-
    inductance of coil A
9 phi_B = 0.83*(60e-06); // Flux
    linked with coil B, Wb
10 // Part (b)
11 M = (N_B*phi_B)/I_A; //
    Mutual inductance of the two coils, H
12 printf("\nSelf-inductance of coil A = %4.2f H", L_A)
13 printf("\nMutual inductance of the two coils = %5.3f
    H", M)
14
15 // Result
16 // Self-inductance of coil A = 0.24 H
17 // Mutual inductance of the two coils = 0.149 H

```

Scilab code Exa 5.25 Self inductance of coil

```

1 // Scilab code Ex5.25: Pg 183 (2008)
2 clc; clear;
3 N = 400; // Number
    of turns in a coil
4 l = 0.25; //
    Effective length of coil, m
5 A = 4.5e-04; // Cross-
    sectional area, m^2
6 mew_r = 180; // Relative
    permeability
7 mew_o = 4*(%pi)*1e-07; //
    Pemeability for free space
8 L = (mew_o*mew_r*(N^2)*A)/l // Self-
    inductance of coil, H
9 printf("\nThe self inductance of the coil = %2d
    milli-henry", L/1e-03);
10

```

```

11 // Result
12 // The self inductance of the coil = 65 mH

```

Scilab code Exa 5.26 Mutual inductance of coils and emf induced in them

```

1 // Scilab code Ex5.26: Pg 183 (2008)
2 clc; clear;
3 L_1 = 65e-03; // Self-
    inductance of first coil , H
4 delta_I = 1.5; // Change in
    current , A
5 delta_t = 3e-03; // Time, s
6 k = 0.95; // 95 percent
    of flux produced
7 N_1 = 400; // Number
    of turns in a coil A
8 N_2 = 650; // Number
    of turns in a coil B
9 // Part (a)
10 // Since self-inductance of a coil is directly
    proportional to the number of turns in a coil ,
    therefore , we have  $L_2/L_1 = (N_2^2)/(N_1^2)$  ,
    solving for L_2
11 L_2 = (L_1*(N_2^2))/(N_1^2) // Self-
    inductance of second coil , H
12 // Part (b)
13 M = k*sqrt(L_1*L_2); // Mutual
    inductance of two coils , H
14 // Part (c)
15 e_1 = ((L_1)*delta_I)/(delta_t); //
    Induced emf in first coil , V
16 // Part (d)
17 e_2 = (M*delta_I)/delta_t; //
    Induced emf in second coil , V
18 printf("\\nThe self-inductance of coil 2 = %3d mH" ,

```

```

    L_2/1e-03)
19 printf("\nThe value of mutual inductance = %3d mH",
    M/1e-03)
20 printf("\nThe self-induced emf in coil 1 = %4.1f V",
    e_1)
21 printf("\nThe mutually induced emf in coil 2 = %2d V
    ", e_2)
22
23 // Result
24 // The self-inductance of coil 2 = 171 mH
25 // The value of mutual inductance = 100 mH
26 // The self-induced emf in coil 1 = 32.5 V
27 // The mutually induced emf in coil 2 = 50 V

```

Scilab code Exa 5.27 Energy stored in an inductor

```

1 // Scilab code Ex5.27: Pg 185 (2008)
2 clc; clear;
3 L = 50e-03; // Self-
    inductance of coil, H
4 I = 0.75; //
    Electric current in coil, A
5 W = (L*(I^2))/2 // Energy
    stored, J
6 printf("\nEnergy stored in the inductor = %4.1f mJ",
    W/1e-03)
7
8 // Result
9 // Energy stored in the inductor = 14.1 mJ

```

Scilab code Exa 5.28 Energy stored in series and parallel combination of inductors

```

1 // Scilab code Ex5.28: Pg 185–186 (2008)

```

```

2  clc; clear;
3  L_1 = 25e-03; // Self-
    inductance of first coil, H
4  L_2 = 40e-03; // Self-
    inductance of second coil, H
5  I = 0.25; //
    Electric current in coils, A
6  k = 0.8; //
    Coupling coefficient
7  // Part (a)
8  W_1 = (L_1*(I^2))/2; // Energy
    stored in first coil, J
9  W_2 = (L_2*(I^2))/2; // Energy
    stored in second coil, J
10 M = k*sqrt(L_1*L_2); // Mutual
    inductance of coils
11 // Part (b)
12 W_M = M*(I)*(I); // Energy
    stored due to mutual inductance of coils, J
13 W_sa = W_1 + W_2 + W_M; //
    Energy stored by two inductors when connected in
    series aiding, J
14 W_so = W_1 + W_2 - W_M; //
    Energy stored by two inductors when connected in
    series opposition, J
15 printf("\\nEnergy stored in first coil = %4.2f mJ",
    W_1/1e-03)
16 printf("\\nEnergy stored in second coil = %4.2f mJ",
    W_2/1e-03)
17 printf("\\nEnergy stored by two inductors when
    connected in series aiding = %3.1f mJ", W_sa/1e
    -03)
18 printf("\\nEnergy stored by two inductors when
    connected in series opposition = %4.2f mJ", W_so
    /1e-03)
19
20 // Result
21 // Energy stored in first coil = 0.78 mJ

```

```

22 // Energy stored in second coil = 1.25 mJ
23 // Energy stored by two inductors when connected in
    series aiding = 3.6 mJ
24 // Energy stored by two inductors when connected in
    series opposition = 0.45 mJ

```

Scilab code Exa 5.29 Turns on a coil and turn ratio

```

1 // Scilab code Ex5.29: Pg 189 (2008)
2 clc; clear;
3 V_2 = 60; // Output voltage ,
    V
4 V_1 = 240; // Input voltage ,
    V
5 N_2 = 500; // Secondary turns
6 // Part (a)
7 // For simplicity let  $V_1/V_2 = N_1/N_2 = k$ 
8 k = V_1/V_2 // Turns ratio
9 // Part (b)
10 // Since  $V_1/V_2 = N_1/N_2$ , solving for N_1
11 N_1 = k*N_2; // Primary turns
12 printf("\\nThe required turns ratio = %1d:1", k)
13 printf("\\nThe number of primary turns = %4d", N_1)
14
15 // Result
16 // The required turns ratio = 4:1
17 // The number of primary turns = 2000

```

Scilab code Exa 5.30 Transformer rating and turn ratio

```

1 // Scilab code Ex5.28: Pg 189 (2008)
2 clc; clear;

```

```

3  R_L = 15;                                // Load
    resistor , ohms
4  V_2 = 240;                                // Terminal
    p.d at secondary , V
5  V_1 = 600;                                // Supply
    voltage , V
6  // Part (a)
7  // Since  $V_1/V_2 = N_1/N_2 = k$ 
8  k = V_1/V_2;                              // Turns
    ratio
9  // Part (b)
10 I_2 = V_2/R_L;                             // Current
    drawn by the load , A
11 P_2 = V_2*I_2;                             // Power
    drawn by the load , W
12 // Part (c)
13 I_1 = P_2/V_1                              // Current
    drawn from the supply , A
14 printf("\nThe transformer turns ratio = %3.1f:1", k)
    ;
15 printf("\nThe current drawn by the load = %2d A", I_2
    );
16 printf("\nThe power drawn by the load = %4.2f W",
    P_2*1e-03);
17 printf("\nThe current drawn from the supply = %3.1f
    A", I_1);
18
19 // Result
20 // The transformer turns ratio = 2.5:1
21 // The current drawn by the load = 16 A
22 // The power drawn by the load = 3.48 W
23 // The current drawn from the supply = 6.4 A

```

Chapter 6

Alternating Quantities

Scilab code Exa 6.1 Alternating Voltage

```
1 // Scilab code Ex6.1: Pg 202 (2008)
2 clc; clear;
3 // Comparing alternating voltage  $v = 35 \sin(314.2 \cdot t)$ 
  with the standard Eq.
4 // Part (a)
5  $V_m = 35$ ; // Maximum value of alternating voltage,
  volt
6
7 // Part (b)
8  $f = \text{poly}(0, "f")$ ; // Declare a variable for
  freq.
9  $f = \text{roots}(2 \cdot \%pi \cdot f - 314.2)$ ; // Frequency of
  waveform, Hz
10
11 // Part (c)
12  $T = 1/f$ ; // Time period of waveform, sec
13
14 // Part (d)
15  $t = 3.5$ ; // Time with reference to zero crossing,
  sec
16  $v = 35 \cdot \sin(2 \cdot \%pi \cdot 50 \cdot 3.5 \cdot 1e-03)$ ; // Volatge value
```

```

        after the waveform passes through zero, going
        positive
17
18 printf("\nThe maximum value of alternating voltage =
    %2d volt", V_m);
19 printf("\nThe frequency of alternating voltage = %2d
    Hz", f);
20 printf("\nThe time period of alternating voltage =
    %3.1f ms", T/1e-03);
21 printf("\nThe volatge value after the waveform
    passes through zero = %5.2f volt", v);
22
23 // Result
24 // The maximum value of alternating voltage = 35
    volt
25 // The frequency of alternating voltage = 50 Hz
26 // The time period of alternating voltage = 20.0 ms
27 // The volatge value after the waveform passes
    through zero = 31.19 volt

```

Scilab code Exa 6.2 Frequency and time for alternating current

```

1 // Scilab code Ex6.2: Pg 202 (2008)
2 clc; clear;
3 // Part (a)
4 f = poly(0, "f"); // Declare a variable for
    freq.
5 // Given  $i = 75 \sin(200 \times \pi \times t)$  mA which on comparing
    with the general expression gives
6 f = roots(2*%pi*f - 200*%pi); // Frequency of
    alternating current, Hz
7
8 // Part(b)
9 i = 35; // Alternating current after passing
    through zero, mA

```

```

10 t = asin(i/75)/(200*%pi*1e-03);    // Time taken for
    current to reach 35 mA, ms
11
12 printf("\nThe frequency of alternating current = %2d
    Hz", f);
13 printf("\nThe time taken for current to reach 35 mA
    = %5.3 f mA", t);
14
15 // Result
16 // The frequency of alternating current = 100 Hz
17 // The time taken for current to reach 35 mA = 0.773
    mA

```

Scilab code Exa 6.3 Standard expression for ac current from its average value

```

1 // Scilab code Ex6.3: Pg 204 (2008)
2 clc; clear;
3 V_av = 3.5;    // Average value of sinusoidal
    alternating voltage, V
4 T = 6.67e-03; // Time period of alternating
    current, s
5 V_m = V_av/0.637; // Peak value of alternating
    current, V
6 f = 1/T;    // Frequency of alternating voltage, Hz
7 printf("\nThe standard expression for %3.1f voltage
    = %3.1f sin(%3d*pi*t) volt", V_av, V_m, round(2*f
    ));
8
9 // Result
10 // The standard expression for 3.5 voltage = 5.5 sin
    (300*pi*t) volt

```

Scilab code Exa 6.4 Instantaneous value of sinusoidal alternating voltage

```

1 // Scilab code Ex6.4: Pg 204 (2008)
2 clc; clear;
3 V_av = 3.5;      // Average value of sinusoidal
                    alternating voltage, V
4 T = 6.67e-03;   // Time period of alternating
                    voltage, s
5 V_m = V_av/0.637; // Peak value of alternating
                    voltage, V
6 f = 1/T;       // Frequency of alternating voltage, Hz
7 // Part (a)
8 t = 0.5e-03;    // Time taken by the waveform after
                    passing through zero, s
9 v = V_m*sin(2*pi*f*t); // Instantaneous value
                    of alternating voltage, s
10 printf("\nThe instantaneous value of alternating
        voltage after %3.1f ms = %3.1f volt", t/1e-03, v)
    ;
11 // Part (b)
12 t = 4.5e-03;    // Time taken by the waveform after
                    passing through zero, s
13 v = V_m*sin(2*pi*f*t); // Instantaneous value
                    of alternating voltage, s
14 printf("\nThe instantaneous value of alternating
        voltage after %3.1f ms = %3.1f volt", t/1e-03, v)
    ;
15
16 // Part (c)
17 v = 3;          // Alternating voltage after passing
                    through zero, mA
18 t = asin(v/V_m)/(2*pi*f); // Time taken for
                    current to reach 3 V, s
19 printf("\nThe time taken for voltage to reach %1d
        volt = %5.3f ms", v, t/1e-03);
20
21 // Result
22 // The instantaneous value of alternating voltage
    after 0.5 ms = 2.5 volt
23 // The instantaneous value of alternating voltage

```

```

    after 4.5 ms = -4.9 volt
24 // The time taken for voltage to reach 3 volt =
    0.613 ms

```

Scilab code Exa 6.5 Amplitude fo the household supply voltage

```

1 // Scilab code Ex6.5: Pg 206 (2008)
2 clc; clear;
3 V = 240; // Rms vlaue of alternating voltage,
    volt
4 V_m = sqrt(2)*V; // Peak value of alternating
    voltage, volt
5 printf("\\nThe amplitude of household %3d volt supply
    = %5.1f volt", V, V_m);
6
7 // Result
8 // The amplitude of household 240 volt supply =
    339.4 volt

```

Scilab code Exa 6.6 Minimum voltage rating of capacitor

```

1 // Scilab code Ex6.6: Pg 207 (2008)
2 clc; clear;
3 pf = 2.5; // Peak factor of non-sinusoidal
    alternating voltage
4 V = 240; // Rms vlaue of alternating voltage,
    volt
5 V_m = pf*V; // Peak value of alternating voltage,
    volt
6 printf("\\nThe absolute minimum working voltage = %3d
    volt", V_m);
7
8 // Result

```

9 // The absolute minimum working voltage = 600 volt

Scilab code Exa 6.7 Rectangular coil rotating in uniform magnetic field

```
1 // Scilab code Ex6.7: Pg 207 (2008)
2 clc; clear;
3 l = 0.25; // Length of the rectangular coil, m
4 d = 0.2; // Width of rectangular coil, m
5 N = 80; // Number of turns of the rectangular
    coil
6 B = 0.075; // Magnetic flux density, tesla
7 n = 3000/60; // Frequency of revolution of the
    coil, rev/s
8 v = n*%pi*d; // Linear speed with which the coil
    sides move, m/s
9 t = 2e-03; // Time after the emf crosses zero,
    s
10
11 // Part (a)
12 // As  $e = 2NB*l*v*\sin(2*\%pi*f*t)$  volt, and for
    maximum value of  $\sin(2*\%pi*f*t) = 1$ 
13 E_m = 2*N*B*l*v*(1); // Amplitude of emf, volt
14 E = 0.707*E_m; // rms value of emf, volt
15 E_av = 0.637*E_m; // Average value of emf, volt
16 // For a two pole field system,
17 f = n; // Frequency of generated waveform, Hz
18
19 // Part (b)
20 T = 1/f; // Time period of generated waveform, Hz
21
22 // Part (c)
23 e = E_m*sin(2*%pi*f*t); // Instantaneous value
    at time 2 ms after zero, volt
24
25 printf("\\nThe amplitude, rms and average value of
```

```

    emf = %5.2f V, %5.2f V and %5.2f V resp.", E_m, E
    , E_av);
26 printf("\nThe frequency and time period of generated
    waveform = %2d Hz and %2d ms resp.", f, T/1e-03)
    ;
27 printf("\nThe instantaneous value of emf at time 2
    ms after crossing zero = %4.1f V", e);
28
29 // Result
30 // The amplitude, rms and average value of emf =
    94.25 V, 66.63 V and 60.04 V resp.
31 // The frequency and time period of generated
    waveform = 50 Hz and 20 ms resp.
32 // The instantaneous value of emf at time 2 ms after
    crossing zero = 55.4 V

```

Scilab code Exa 6.8 Value of multiplier required for required dc value

```

1 // Scilab code Ex6.8: Pg 212 (2008)
2 clc; clear;
3 R_c = 50; // Resistance of the coil of meter, ohm
4 K = 10e+03; // Figure of merit of the moving
    coil meter, ohm per volt
5 V = 10; // d.c. range of coil meter, volt
6
7 // Part (a)
8 I_fsd = 1/K; // Full scale deflection for moving
    coil meter, ampere
9 R = V/I_fsd; // Total meter resistance, ohm
10 // As  $R = R_m + R_c$ , solvign for  $R_m$ 
11 R_m = R - R_c; // Multiplier resistance
    required by the meter, ohm
12 printf("\nThe multiplier resistance required for 10
    V d.c. range = %5.2f k-ohm", R_m/1e+03);
13

```

```

14 // Part(b)
15 I_av = I_fsd; // Average value of ac current , A
16 I_rms = %pi/(2*sqrt(2))*I_av; // rms value of ac
    current , A
17 V = 10 ; // a.c. range of coil meter, volt
18 R = V/I_rms; // Total meter resistance , ohm
19 // As R = R_m + R_c, solvign for R_m
20 R_m = R - R_c; // Multiplier resistance
    required by the meter, ohm
21 printf("\nThe multiplier resistance required for 10
    V a.c. range = %5.2f k-ohm", R_m/1e+03);
22
23 // Result
24 // The multiplier resistance required for 10 V d.c.
    range = 99.95 k-ohm
25 // The multiplier resistance required for 10 V a.c.
    range = 89.98 k-ohm

```

Scilab code Exa 6.9 True rms values with moving coil meter

```

1 // Scilab code Ex6.9: Pg 213 (2008)
2 clc; clear;
3 // Case_I: Square_wave
4 ff = 1.11; // Form factor of calibrated meter
5 ff_square = 1; // Form factor for square wave
6 V_apparent = 5; // Meter reading for sqaure wave
    , volt
7 V_true = V_apparent*1*(ff_square/ff); // True rms
    value of square wave voltage , volt
8 printf("\nThe true rms value of square wave voltage
    = %5.3f V", V_true);
9
10 // Case_II: Triangular_wave
11 ff_triangle = 1.15; // Form factor for triangular
    wave

```

```

12 V_apparent = 5;      // Meter reading for triangular
    wave, volt
13 V_true = V_apparent*(ff_triangle/ff);    // True rms
    value of triangular wave voltage, volt
14 printf("\nThe true rms value of triangular wave
    voltage = %4.2f V", V_true);
15
16 // Result
17 // The true rms value of square wave voltage = 4.505
    V
18 // The true rms value of triangular wave voltage =
    5.18 V

```

Scilab code Exa 6.10 Three alternating currents

```

1 // Scilab code Ex6.10: Pg 215 (2008)
2 clc; clear;
3 // The general expression for alternating current is
    I = Io*sin(2*%pi*f*t + phi)
4 f = poly(0, 'f');    // Declare the variable for
    frequency
5 f = roots(2*%pi*f - 80*%pi);    // Frequency of
    alternating current, Hz
6
7 // I2 is the reference waveform with zero phase
    angle, so that
8 phi2 = 0;    // Phase angle for reference waveform I2
    , degrees
9 Im2 = 3;    // Current amplitude of reference
    waveform I2, A
10 Im1 = 5;    // Current amplitude of reference
    waveform I1, A
11 Im3 = 6;    // Current amplitude of reference
    waveform I3, A
12 phi1 = %pi/6*(180/%pi); // Phase angle for reference

```

```

        waveform I1, degrees
13 phi3 = %pi/4*(180/%pi); // Phase angle for reference
        waveform I3, degrees
14
15 printf("\nThe frequency of all three waveforms = %2d
        Hz", f);
16 printf("\nI1 leads I2 by = %2.0f degrees", phi1-phi2
        );
17 printf("\nI3 lags I2 by = %2d degrees", phi3-phi2);
18 printf("\nCurrent amplitude of reference waveform I1
        = %1d A", Im1);
19 printf("\nCurrent amplitude of reference waveform I2
        = %1d A", Im2);
20 printf("\nCurrent amplitude of reference waveform I3
        = %1d A", Im3);
21
22 // Result
23 // The frequency of all three waveforms = 40 Hz
24 // I1 leads I2 by = 30 degrees
25 // I3 lags I2 by = 45 degrees
26 // Current amplitude of reference waveform I1 = 5 A
27 // Current amplitude of reference waveform I2 = 3 A
28 // Current amplitude of reference waveform I3 = 6 A

```

Scilab code Exa 6.12 Standard expression for waveforms

```

1 // Scilab code Ex6.12: Pg 218 (2008)
2 clc; clear;
3 Im1 = 7; // Current amplitude of reference
        waveform I1, A
4 Im2 = 6; // Current amplitude of reference
        waveform I2, A
5 Im3 = 5; // Current amplitude of reference
        waveform I3, A
6 Im4 = 4; // Current amplitude of reference

```

```

        waveform I4, A
7  phi1 = 70*%pi/180;    // Phase angle for reference
        waveform I1, rad
8  phi2 = 0*%pi/180;    // Phase angle for reference
        waveform I2, rad
9  phi3 = -50*%pi/180;   // Phase angle for reference
        waveform I3, rad
10 phi4 = -90*%pi/180;   // Phase angle for reference
        waveform I4, rad
11 printf("\ni1 = %dsin(wt + %4.2 f) amp", Im1, phi1);
12 printf("\ni2 = %dsin wt amp", Im2);
13 printf("\ni3 = %dsin(wt + %4.2 f) amp", Im3, phi3);
14 printf("\ni4 = %dsin(wt + %4.2 f) amp", Im4, phi4);
15
16 // Result
17 // i1 = 7sin(wt + 1.22) amp
18 // i2 = 6sin wt amp
19 // i3 = 5sin(wt + -0.87) amp
20 // i4 = 4sin(wt + -1.57) amp

```

Scilab code Exa 6.13 Phasor sum of two voltages

```

1 // Scilab code Ex6.13: Pg 221 (2008)
2 clc; clear;
3 omega = 314;    // Angular frequency of voltage, rad
        per sec
4 Vm1 = 25;    // Peak value of first phasor, V
5 Vm2 = 15;    // Peak value of second phasor, V
6 H_C = Vm1*cosd(%pi/3*180/%pi)+Vm2*cosd(-%pi/6*180/
        %pi); // Horizontal component of phasor sum, V
7 V_C = Vm1*sind(%pi/3*180/%pi)+Vm2*sind(-%pi/6*180/
        %pi); // Vertical component of phasor sum, V
8 Vm = sqrt(H_C^2+V_C^2); // Peak value of phasor sum,
        V
9 phi = atan(V_C/H_C);    // Phase angle, degrees

```

```

10 printf("\nv = %5.2 fsin(%3dt + %5.3 f) volt", Vm,
    omega, phi);
11
12 // Result
13 // v = 29.15 sin(314t + 0.507) volt

```

Scilab code Exa 6.14 Phasor sum of three currents

```

1 // Scilab code Ex6.14: Pg 222 (2008)
2 clc; clear;
3 Im1 = 6; // Peak value of first phasor, A
4 Im2 = 8; // Peak value of second phasor, A
5 Im3 = 4; // Peak value of third phasor, A
6 H_C = Im1*cosd(0*180/%pi)+Im2*cosd(-%pi/2*180/%pi)+
    Im3*cosd(%pi/6*180/%pi); // Horizontal component
    of phasor sum, A
7 V_C = Im1*sind(0*180/%pi)+Im2*sind(-%pi/2*180/%pi)+
    Im3*sind(%pi/6*180/%pi); // Vertical component of
    phasor sum, A
8 Im = sqrt(H_C^2+V_C^2); // Peak value of phasor sum,
    V
9 phi = atan(V_C/H_C); // Phase angle, rad
10 printf("\ni = %4.1 fsin(wt%5.3 f) amp", Im, phi);
11
12 // Result
13 // i = 11.2 sin(wt-0.565) amp

```

Scilab code Exa 6.15 Phasor sum of three voltages

```

1 // Scilab code Ex6.15: Pg 222 (2008)
2 clc; clear;
3
4 // Part (a)

```

```

5 omega = 628;      // Angular frequency of voltage , rad
                     per sec
6 f = omega/(2*%pi); // Frequency of the waveforms ,
                     Hz
7 Vm1 = 10;        // Peak value of first phasor , V
8 Vm2 = 8;         // Peak value of second phasor , V
9 Vm3 = 12;        // Peak value of third phasor , V
10 phi1 = -%pi/6*180/%pi; // Phase angle for first
                        voltage , degrees
11 phi2 = %pi/3*180/%pi; // Phase angle for second
                        voltage , degrees
12 phi3 = %pi/4*180/%pi; // Phase angle for third
                        voltage , degrees
13 printf("\nThe frequency of all three waveforms = %3d
           Hz", f);
14 printf("\nThe phase angle and frequency of first
           voltage : %2d degrees , %2d V", phi1, Vm1);
15 printf("\nThe phase angle and frequency of second
           voltage : %2d degrees , %2d V", phi2, Vm2);
16 printf("\nThe phase angle and frequency of third
           voltage : %2d degrees , %2d V", phi3, Vm3);
17
18 // Part (b)
19 H_C = Vm1*cosd(phi1)+Vm2*cosd(phi2)+Vm3*cosd(phi3);
           // Horizontal component of phasor sum, V
20 V_C = Vm1*sind(phi1)+Vm2*sind(phi2)+Vm3*sind(phi3);
           // Horizontal component of phasor sum, V
21 Vm = sqrt(H_C^2+V_C^2); // Peak value of phasor sum,
                           V
22 phi = atan(V_C/H_C);    // Phase angle , rad
23 printf("\nv = %5.2 fsin(%3dt + %5.3f) volt", Vm,
           omega, phi);
24
25 // Result
26 // The frequency of all three waveforms = 99 Hz
27 // The phase angle and frequency of first voltage :
   -29 degrees , 10 V
28 // The phase angle and frequency of second voltage :

```

```

    59 degrees , 8 V
29 // The phase angle and frequency of third voltage :
    45 degrees , 12 V
30 //  $v = 23.57 \sin(628t + 0.458)$  volt

```

Scilab code Exa 6.16 Dual Beam Oscilloscope

```

1 // Scilab code Ex6.16: Pg 228 (2008)
2 clc; clear;
3
4 tb1 = 0.1e-03; // Timebase of channel 1, s/cm
5 tb2 = 10e-06; // Timebase of channel 2, s/cm
6 Y_amp1 = 5; // Y-amp setting for channel 1, V/cm
7 Y_amp2 = 0.5; // Y-amp setting for channel 2, V/cm
8
9 // Channel 1
10 V_pp = 3*Y_amp1; // Peak-to-peak value of
    waveform in channel 1, V
11 Vm = V_pp/2; // Amplitude of waveform in channel
    1, V
12 V = Vm/sqrt(2); // rms value of sine wave in channel
    1, V
13 T = 4*tb1; // Time period of sine wave, second
14 f = 1/(T*1000); // Frequency of sine wave, kHz
15 printf("\nThe amplitude of sine waveform in channel
    1 = %3.1f V", Vm);
16 printf("\nThe rms value of sine wave in channel 1 =
    %3.1f V", V);
17 printf("\nThe frequency of sine wave in channel 1 =
    %3.1f kHz", f);
18
19 // Channel 2
20 V_pp = 2*Y_amp2; // Peak-to-peak value of
    waveform in channel 2, V
21 Vm = V_pp/2; // Amplitude of waveform in channel

```

```

2, V
22 V = Vm; // rms value of square wave in channel 2, V
23 T = 2/3*tb2; // Time period of square wave, second
24 f = 1/(T*1000); // Frequency of square wave, kHz
25 printf("\nThe amplitude of square waveform in
    channel 2 = %3.1f V", Vm);
26 printf("\nThe rms value of square wave in channel 2
    = %3.1f V", V);
27 printf("\nThe frequency of square wave in channel 2
    = %3d kHz", f);
28
29
30 // Result
31 // The amplitude of sine waveform in channel 1 = 7.5
    V
32 // The rms value of sine wave in channel 1 = 5.3 V
33 // The frequency of sine wave in channel 1 = 2.5 kHz
34 // The amplitude of square waveform in channel 2 =
    0.5 V
35 // The rms value of square wave in channel 2 = 0.5 V
36 // The frequency of square wave in channel 2 = 150
    kHz

```

Chapter 7

DC Machines

Scilab code Exa 7.1 The shunt generator

```
1 // Scilab code Ex7.1: Pg 243 (2008)
2 clc; clear;
3 Rf = 200; // The resistance of field winding of a
    shunt generator, ohm
4 Po = 80e+03; // Power delivered by the machine,
    watt
5 V = 450; // The terminal voltage, volt
6 E = 475; // The generated emf, volt
7
8 // Part (a)
9 // Po = V*I_L, solving for I_L
10 I_L = Po/V; // Load current, A
11 I_f = V/Rf; // Current through field resistor, A
12 I_a = I_L + I_f; // Current through armature
    resistance, A
13 // As I_a*R_a = E - V, solving for R_a
14 R_a = 25/I_a; // Armature resistance, ohm
15
16 // Part (b)
17 Po = 50e+03; // Output power delivered by the
    machine, watt
```

```

18 V = 460;      // The terminal voltage, volt
19 I_L = Po/V;   // Load current, A
20 I_f = V/Rf;   // Current through field resistor, A
21 I_a = I_L + I_f; // Current through armature
    resistance, A
22 // As  $I_a R_a = E - V$ , solving for E
23 E = V + I_a * Ra; // The generated voltage, volt
24 printf("\nThe armature resistance = %5.3f ohm", Ra);
25 printf("\nThe value of generated emf = %5.1f V", E);
26
27 // Result
28 // The armature resistance = 0.139 ohm
29 // The value of generated emf = 475.4 V

```

Chapter 8

DC Transients

Scilab code Exa 8.1 Capacitor charging through a series resistor

```
1 // Scilab code Ex8.1: Pg 253 (2008)
2 clc; clear;
3
4 C = 8e-06;    // Value of capacitance of capacitor ,
               farad
5 R = 0.5e+06;  // Value of series resistor , ohm
6 E = 200;     // Value of d.c. voltage supply , volt
7
8 // Part (a)
9 tau = C*R;    // Time constant of the R-C circuit
               while charging , s
10 printf("\nThe circuit time constant while charging =
           %1d s", tau);
11
12 // Part (b)
13 I_0 = E/R;    // Initial charging current through
               capacitor , A
14 printf("\nThe initial charging current through
           capacitor = %3d micro-ampere", I_0/1e-06);
15
16 // Part (c)
```

```

17 t = 4; // Time after the supply is connected, s
18 v_C = 0.632*E; // p.d. across the capacitor 4s
    after the supply is connected, V
19 v_R = E - v_C; // p.d. across the resistor 4s after
    the supply is connected, V
20 printf("\nThe p.d. across resistor and capacitor %d
    s after the supply is connected = %5.1f V and %4
    .1f V respectively", t, v_C, v_R);
21
22 // Result
23 // The circuit time constant while charging = 4 s
24 // The initial charging current through capacitor =
    400 micro-ampere
25 // The p.d. across resistor and capacitor 4 s after
    the supply is connected = 126.4 V and 73.6 V
    respectively
26 //

```

Scilab code Exa 8.2 Capacitor discharging through a resistor

```

1 // Scilab code Ex8.2: Pg 255 (2008)
2 clc; clear;
3 C = 0.5e-06; // Value of capacitance of capacitor
    , farad
4 R1 = 220e+03; // Value of series resistor, ohm
5 R2 = 110e+03; // Value of parallel resistor, ohm
6 E = 150; // Value of d.c. voltage supply, volt
7
8 // Part (a)
9 tau = C*R1; // Time constant of the R1-C circuit
    while charging, s
10 printf("\nThe circuit time constant while charging =
    %4.2f s", tau);
11 I_0 = E/R1; // Initial charging current through
    capacitor, A

```

```

12 printf("\nThe initial charging current through
    capacitor = %3d micro-ampere", I_0/1e-06);
13
14 // Part (b)
15 tau = C*(R1+R2);    // Time constant of the R1-C-R2
    circuit while discharging, s
16 printf("\nThe circuit time constant while
    discharging = %4.2f s", tau);
17 I_0 = E/(R1 + R2);    // Initial discharging current
    through capacitor, ampere
18 i = 0.368*I_0;    // Discharge current after one
    time constant, ampere
19 V_R2 = i*R2;    // Potential difference across R2
    after one time constant, volt
20 printf("\nThe p.d. across R2 after one time constant
    while discharging = %4.1f volt", V_R2);
21
22
23 // Result
24 // The circuit time constant while charging = 0.11 s
25 // The initial charging current through capacitor =
    681 micro-ampere
26 // The circuit time constant while discharging =
    0.16 s
27 // The p.d. across R2 after one time constant while
    discharging = 18.4 volt

```

Scilab code Exa 8.3 The series RL circuit

```

1 // Scilab code Ex8.3: Pg 258 (2008)
2 clc; clear;
3 E = 110;    // Value of d.c. voltage supply, volt
4 L = 1.5;    // Inductor value, henry
5 R = 220;    // Value of series resistor, ohm
6

```

```

7 // Part (a)
8 di_dt = E/L;    // The initial rate of change of
    current through inductor, H
9 printf("\nThe initial rate of change of current
    through inductor = %5.2f A/s", di_dt);
10
11 // Part (b)
12 I = E/R;    // The final steady current, A
13 printf("\nThe final steady current through inductor
    = %3.1f A", I);
14
15 // Part (c)
16 tau = L/R;    // The time taken for the current to
    reach its final steady value, s
17 printf("\nThe time taken for the current to reach
    its final steady value = %4.1f ms", 5*tau/1e-03);
18
19 // Result
20 // The initial rate of change of current through
    inductor = 73.33 A/s
21 // The final steady current through inductor = 0.5 A
22 // The time taken for the current to reach its final
    steady value = 34.1 ms

```

Chapter 9

Semiconductor Theory and Devices

Scilab code Exa 9.1 The zener diode

```
1 // Scilab code Ex9.1: Pg 277 (2008)
2 clc; clear;
3 // Part (a)
4 V_Z = 9.1;      // Zener voltage of zener diode, volt
5 P_Z = 0.5;      // Power rating of zener diode at V_Z,
    W
6 r_Z = 1.5;      // Slope resistance of zener diode,
    ohm
7 V = 12;         // Nominal value of input voltage, volt
8 R_L = 2.5e+03;   // Load resistance across zener
    diode, ohm
9 I_Z = P_Z/V_Z*1e+03; // Zener current, mA
10 I_S = I_Z;      // Current through series resistor, mA
11 V_S = V - V_Z;   // Voltage drop across series
    resistor, volt
12 R_S = V_S/I_S*1e+03; // Value of series
    resistance, ohm
13 P_max = (I_S*1e-03)^2*R_S; // Maximum power
    rating of series resistance, W
```

```

14 printf("\nThe value of series resistance = %5.2f
    ohm", R_S);
15 printf("\nThe value of maximum power rating of
    series resistance = %4.2f W", P_max);
16 printf("\n(a) The suitable value of R_S should be 54
    ohm, 0.25 W");
17
18 // Part (b)
19 V_o = V_Z; // Output voltage across zener, volt
20 I_L = V_o/R_L*1e+03; // Load current, mA
21 I_Z = I_S - I_L; // Zener current, mA
22 printf("\n(b) The value of diode current with load
    resistance across zener = %5.2f mA", I_Z );
23
24 // Part (c)
25 V = 12 - (0.1*12); // Final value of input
    voltage after falling below 12 V, volt
26 R_S = 56; // Standard value of series resistance,
    ohm
27 I_S = (V - V_Z)/R_S*1e+03; // Current through
    series resistance, mA
28 I_Z = I_S - I_L; // Resulting diode current, mA
29 delta_I_Z = 51.36 - I_Z; // Change in zener
    current, mA
30 delta_V_Z = delta_I_Z*1e-03*r_Z; // Change in
    zener voltage, V
31 change = delta_V_Z/V_Z*100; // %age change in
    zener voltage
32
33 printf("\n(c) The percentage change in the p.d.
    across the load = %4.2f percent", change);
34
35 // Result
36 // The value of series resistance = 52.78 ohm
37 // The value of maximum power rating of series
    resistance = 159340.66 W
38 // The suitable value of R_S should be 54 ohm, 0.25
    W

```

Scilab code Exa 9.2 Zener diode as a voltage regulator

```
1 // Scilab code Ex9.2: Pg 279 (2008)
2 clc; clear;
3 // Part (a)
4 Diode = cell(3, 1); // Declare a diode cell
5 Diode(1).entries = [1 15 30 0.5 0.007]; // Data
    for 1st diode
6 Diode(2).entries = [2 15 15 1.3 0.20]; // Data
    for 2nd diode
7 Diode(3).entries = [1 15 2.5 5.0 0.67]; // Data
    for 3rd diode
8 Resistor = cell(5, 1) // Declare a resistor cell
9 Resistor(1).entries = [0.25, 0.026]; // Data for
    1st resistor
10 Resistor(2).entries = [0.5, 0.038]; // Data for 2
    nd resistor
11 Resistor(3).entries = [1.0, 0.055]; // Data for 3
    rd resistor
12 Resistor(4).entries = [2.5, 0.260]; // Data for 4
    th resistor
13 Resistor(5).entries = [7.5, 0.280]; // Data for 5
    th resistor
14 V = 24; // Input voltage, volt
15 V_Z = Diode(1).entries(2); // Zener voltage for
    1st diode, volt
16 V_S = V - V_Z; // Voltage drop across series
    resistor for all the three diodes, volt
17
18 // Diode 1
19 P_Z = Diode(1).entries(4); // Power rating of 1st
    diode, W
20 I_Z = P_Z/V_Z*1e+03; // Zener current, mA
21 R_S = V_S/I_Z*1e+03; // Value of series
```

```

        resistance , ohm
22 P_S = V_S^2/R_S;    // Power dissipation across
    series resistor , watt
23 printf("\nDiode 1:");
24 printf("\n=====");
25 printf("\nThe value of series resistance = %3d ohm"
    , R_S);
26 printf("\nThe value of power rating of series
    resistance = %3.1f W", P_S);
27 R_S = 270;    // Chosen value of series resistor ,
    ohm
28 P_S = 0.3;    // Chosen value of power rating , ohm
29 printf("\nThe suitable value of R_S should be %3d
    ohm, %3.1f W", R_S, P_S);
30 printf("\nTotal unit cost = %5.3f pounds\n", Diode
    (1).entries(5)+Resistor(2).entries(2));
31
32 // Diode 2
33 printf("\nDiode 2:");
34 printf("\n=====");
35 P_Z = Diode(2).entries(4);    // Power rating of 2nd
    diode , W
36 I_Z = P_Z/V_Z*1e+03;    // Zener current , mA
37 R_S = V_S/I_Z*1e+03;    // Value of series
    resistance , ohm
38 P_S = V_S^2/R_S;    // Power dissipation across
    series resistor , watt
39 printf("\nThe value of series resistance = %5.2f
    ohm", R_S);
40 printf("\nThe value of power rating of series
    resistance = %4.2f W", P_S);
41 R_S = 120;    // Chosen value of series resistor ,
    ohm
42 P_S = 1.0;    // Chosen value of power rating , ohm
43 printf("\nThe suitable value of R_S should be %3d
    ohm, %3.1f W", R_S, P_S);
44 printf("\nTotal unit cost = %4.2f pounds", Diode(2).
    entries(5)+Resistor(3).entries(2));

```

```

45
46 // Diode 3
47 printf("\nDiode 3:");
48 printf("\n=====");
49 P_Z = Diode(3).entries(4);    // Power rating of 3rd
    diode, W
50 I_Z = P_Z/V_Z*1e+03;        // Zener current, mA
51 R_S = V_S/I_Z*1e+03;        // Value of series
    resistance, ohm
52 P_S = V_S^2/R_S;            // Power dissipation across
    series resistor, watt
53 printf("\nThe value of series resistance = %3d ohm"
    , R_S);
54 printf("\nThe value of power rating of series
    resistance = %3.1f W", P_S);
55 R_S = 27;                    // Chosen value of series resistor, ohm
56 P_S = 7.5;                    // Chosen value of power rating, ohm
57 printf("\nThe suitable value of R_S should be %3d
    ohm, %3.1f W", R_S, P_S);
58 printf("\nTotal unit cost = %4.2f pounds", Diode(3).
    entries(5)+Resistor(5).entries(2));
59
60 // Part (b)
61 delta_V_Z = (5*15)/100;      // Allowable change in
    V_Z, volt
62 delta_I_Z = 30e-03;          // Allowable change in zener
    current, A
63 delta_VZ = zeros(3);
64 delta_VZ(1) = 30e-03*30;      // Change in zener
    voltage dor diode 1, V
65 delta_VZ(2) = 30e-03*15;      // Change in zener
    voltage dor diode 2, V
66 delta_VZ(3) = 30e-03*2.5;     // Change in zener
    voltage dor diode 3, V
67 printf("\nThe maximum value of zener voltage change
    = %4.2f V", max(delta_VZ(2), delta_VZ(3)));
68 printf("\nTo meet the specification at lowest cost,
    circuit 2 would be adopted");

```

```
69 // Result
70 // The value of series resistance = 52.78 ohm
71 // The value of maximum power rating of series
    resistance = 159340.66 W
72 // The suitable value of R_S should be 54 ohm, 0.25
    W
```
