

Scilab Textbook Companion for  
Electrical Engineering Fundamentals  
by V. Del Toro<sup>1</sup>

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# Book Description

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

**Exa** Example (Solved example)

**Eqn** Equation (Particular equation of the above book)

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

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

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# Chapter 1

## The Fundamental laws of Electrical Engineering

Scilab code Exa 1.1 force between two like charges in free space

```
1 E0 = 1/(36*%pi*10^9); //permittivity in free space
2 k = 4*%pi*E0 ;
3 q1 = 1; // charge on the first particle in coulombs
4 q2 = 1; // charge on the second particle in coulombs
5 d = 1; // distance between the particles in meter
6 F = (q1*q2)/(k*d^2); //force between the two
   particles in newtons
7
8 disp(F, "force in free space between the two
   particles is in Newtons is:")
```

---

# Chapter 2

## The circuit elements

Scilab code Exa 2.1.a Determine the current flow and voltage drop across the resistor

```
1 V = 1; // voltage supply
2 R = 10; // resistance in ohms
3 I = V/R //current flowing through R
4 disp(" a")
5 disp(V,"voltage across the resistor (in volts)=")
6 disp(I,"current flowing through the resistor (in
    amps) =")
```

---

Scilab code Exa 2.1.b Determine the current flow and voltage drop across each resistor

```
1 V = 1; // voltage supply
2 R1 = 10; // first resistance in ohms
3 R2 = 5; //resistance of the second resistor
4 Vr1 = V * (R1/(R1 + R2)); //voltage across R1
5 Vr2 = V - Vr1; //voltage across R2
6 Ir = Vr1/R1; //current flowing through R
7
8 disp(Vr1,"voltage across the first resistor (in
    volts)=")
```

```
9 disp(Vr2,"voltage across the second resistor (in
   volts)=")
10 disp(Ir,"current flowing through the resistor (in
    amps) =")
```

---

Scilab code Exa 2.1.c Repeat parts A and B with the voltage source replaced by a current source

```
1 //c - a
2 R1 = 10; // first resistance in ohms
3 R2 = 5;
4 I = 1; // current source
5 V = I*R1; // voltage across R
6 disp("c - a")
7 disp(V,"voltage across the resistor (in volts)=")
8 disp(I,"current flowing through the resistor (in
   amps) =")
9
10 //c - b
11 Vr1 = I*R1; // voltage across R1
12 Vr2 = I*R2; //voltage across R2
13 disp("c - b")
14 disp(V,"voltage across the resistor (in volts)=")
15 disp(I,"current flowing through the resistor (in
   amps) =")
```

---

Scilab code Exa 2.2 From the given list of resistors choose a suitable resistor which can dissipate the power

```
1 R = 100; // resistance in ohms
2 I = 0.3; // current in amps
3 P = I^2 * R; // power
4 //power specification of the resistors available in
   the stock
5 Pa = 5;
```

```

6 Pb = 7.5;
7 Pc = 10;
8
9 if Pa > P then
10     disp("we should select resistor a")
11 end
12 if Pb > P then
13     disp("we should select resistor b")
14 end
15 if Pc > P then
16     disp("we should select resistor c")
17 end

```

---

**Scilab code Exa 2.3** Find the resistance of the round copper conductor having the g

```

1 L = 1; //length of the copper wire in meters
2 A = 1 * 10^-4; // cross sectional area of the wire
   in meter square
3 rho = 1.724 * 10^-8; // resistivity of copper in ohm
   meter
4 R = rho*L / A; // resistance of the wire in ohm
5
6 disp(R, "resistance of the wire (in ohms)=")

```

---

**Scilab code Exa 2.4** Find the resistance of the round copper conductor having the g

```

1 //1 inches = 0.0254meters
2 //1 foot = 0.3048 meters
3 d = 0.1*0.0254; // diameter of the wire in meters
4 L = 10*0.3048; //length of the wire in meters
5 rho = 1.724*10^-8; // resistivity of the wire in ohm
   -meter
6 A = %pi*(d/2)^2; // cross sectional area of the wire

```

```
7 R = rho*L/A; //resistance of the wire in ohm
8 disp(R,"resistance of the wire (in ohm)=")
```

---

Scilab code Exa 2.5 Find the time variation of the voltage drop appearing across t

```
1 L = 0.1; // inductance of the coil in henry
2 t1 = [0:0.001:0.1];
3 t2 = [0.101:0.001:0.3];
4 t3 = [0.301:0.001:0.6];
5 t4 = [0.601:0.001:0.7];
6 t5 = [0.701:0.001:0.9]
7 //current variation as a function of time
8 i1 = 100*t1;
9 i2 = (-50*t2) + 15;
10 i3 = -100*sin(%pi*(t3-0.3)/0.3);
11 i4 = (100*t4) - 60;
12 i5 = (-50*t5) + 45;
13
14 t = [t1,t2,t3,t4,t5];
15 i = [i1,i2,i3,i4,i5];
16 plot(t, i)
17
18 dt = 0.001;
19 di = diff(i);
20 V = L*di/dt; //voltage drop appearing across the
    inductor terminals
21 Tv = [0:0.001:0.899];
22 plot(Tv, V, "green")
```

---

Scilab code Exa 2.6 Find the time variation of the capacitor voltage

```
1 C = 0.01; // capacitance of the capacitor in Farads
2 t1 = [0:0.001:0.1];
3 t2 = [0.101:0.001:0.3];
4 t3 = [0.301:0.001:0.6];
5 t4 = [0.601:0.001:0.7];
6 t5 = [0.701:0.001:0.9]
7 //current variation as a function of time
8 i1 = 100*t1;
9 i2 = (-50*t2) + 15;
10 i3 = -100*sin(%pi*(t3-0.3)/0.3);
11 i4 = (100*t4) - 60;
12 i5 = (-50*t5) + 45;
13
14 t = [t1,t2,t3,t4,t5];
15 i = [i1,i2,i3,i4,i5];
16 plot(t, i)
17
18 // voltage across the capacitor as a function of
   time
19 V1 = (1/C)*integrate('100*t', 't', 0, t1);
20 V2 = (1/C)*integrate('(-50*t)+15', 't', 0.101, t2);
21 V3 = (1/C)*integrate('-100*sin(%pi*(t-0.3)/0.3)', 't',
   ,0.301, t3);
22 V4 = (1/C)*integrate('(100*t) - 60', 't', 0.601, t4);
23 V5 = (1/C)*integrate('(-50*t) + 45', 't', 0.701, t5);
24 V = [V1, V2, V3, V4, V5];
25
26 plot(t, V, "green")
```

---

Scilab code Exa 2.7 Find A actual value of the voltage gain of the opamp circuit B

```
1 //a
2 Ri = 1;
```

```

3 Rf = 39;
4 A = 10^5; //open loop gain of the op-amp
5 G = A/(1 + (A*Ri/(Ri+Rf))); //actual voltage gain of
    the circuit
6 disp("a")
7 disp(G,"actual voltage of the circuit =")
8
9 //b
10 G1 = 1 + (Rf/Ri); // voltage gain of the circuit
    with infinite open loop gain
11 disp("b")
12 disp(G1,"for ideal case the voltage gain =")
13
14 //c
15 er = ((G1 - G)/G)*100; //percent error
16 disp("c")
17 disp(er,"percent error of the ideal value compared
    to the actual value=")

```

---

**Scilab code Exa 2.8** Design a non inverting opamp circuit of voltage gain 4

```

1 G = 4; // voltage gain of the circuit
2 r = G -1; // ratio of the resistances in the non-
    inverting op-amp circuit
3 disp(r,"Rf/Ri =")
4 //Result:
5 //A suitable choice for R1 is 10K, Hence Rf = 30K

```

---

**Scilab code Exa 2.9** Find the input resistance of an inverting opamp circuit with v

```

1 G = 4;
2 r = G; // ratio of the resistances in the inverting
    op-amp circuit

```



```
3 disp(r,"Rf/Ri")
4 //Result;
5 //A suitable choice for Rf=30K and R1=7.5K
6 //therefore input resistance R1 = 7.5K
```

---

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# Chapter 3

## Elementary network theory

Scilab code Exa 3.1 for the given circuit calculate the current flowing from the v

```
1 V = 100; // volatage supply in volts
2 Rs = 40; //resistance in series in ohms
3 // parallel resistances in ohms
4 Rp1 = 33.33;
5 Rp2 = 50;
6 Rp3 = 20;
7 Rpinv = (1/Rp1)+(1/Rp2)+(1/Rp3); //reciprocal of
    equivalent resistance in parallel
8 Req = Rs + (1/Rpinv) ;
9 I = V/Req; //current flowing from the voltage source
    in amps
10 disp(I,"current flowing from the voltage source(in
    amps) = ")
```

---

Scilab code Exa 3.2 Calculate the potential difference across terminals bc

```
1 V = 100; // volatage supply in volts
2 Rs = 40; //resistance in series in ohms
```

```

3 // parallel resistances in ohms
4 Rp1 = 33.33;
5 Rp2 = 50;
6 Rp3 = 20;
7 Rpinv = (1/Rp1)+(1/Rp2)+(1/Rp3); //reciprocal of
    equivalent resistance in parallel
8 Rp = 1/Rpinv; // equivalent resistance in parallel
9 Vbc = V*(Rp/(Rs + Rp)); // potential difference
    across bc
10 disp(Vbc,"potential difference across bc = ")

```

---

**Scilab code Exa 3.3** Determine the equivalent series circuit

```

1 // resistances in ohms
2 R1 = 25;
3 R2 = 300;
4 R3 = 80;
5 R4 = 30;
6 R5 = 60;
7
8 Rcd = R5*R4/(R5 + R4);
9 Rbd1 = Rcd + R3;
10 Rbd = Rbd1*R2/(Rbd1 + R2);
11 Req = Rbd + R1; // equivalent resistance
12 disp(Req, "equivalent resistance = ")

```

---

**Scilab code Exa 3.4** Value of E for which power dissipation in R5 is 15W R5 is 15

```

1 // resistances in ohms
2 R1 = 25;
3 R2 = 300;
4 R3 = 80;
5 R4 = 30;

```

```

6 R5 = 60;
7
8 P5 = 15; //power dissipated in R5 (in watt)
9
10 I5 = sqrt(P5/R5); //current flowing through R5
11 V5 = R5*I5 ; //voltage across R5
12 Vcd = V5; //voltage across cd
13
14 I4 = Vcd/R4; //current flowing through R4
15 Icd = I5 + I4; //current flowing through cd
16
17 Vbd = (Icd*R3)+Vcd ; //voltage across bd
18 Ibd = (Vbd/R2)+Icd; //current through bd
19
20 V1 = R1*Ibd; //voltage across R1
21
22 E = V1 + Vbd;
23 disp(E,"E = ")
24
25 //Result : Value of E for which power dissipation in
    R is 15W = 200V

```

---

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**Scilab code Exa 3.8** Find current flowing through all the branches of the circuit

```
1 //mesh equations:
2 //60*I1 - 20*I2 = 20
3 //-20*I1 + 80*I2 = -65
4
5 R = [60 -20;-20 80];
6 E = [120;-65];
7 I = inv(R)*E;
8 I1 = I(1,:); //current flowing in first mesh
9 I2 = I(2,:); //current flowing in second mesh
10
11 Ibd = I1 - I2; //current flowing through branch bd
12 Iab = I1; //current flowing through branch ab
13 Icb = -I2; //current flowing through branch cb
14
15 disp(Ibd, "current flowing through branch bd = ")
16 disp(Iab,"current flowing through branch ab = ")
17 disp(Icb,"current flowing through branch cb = ")
```

---

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downloaded from the website [www.scilab.in](http://www.scilab.in)

**Scilab code Exa 3.12** Find A current flowing through R1 B value of R1 for which the

```
1 //a
2 // circuit parameters
3 E1 = 120;
4 R1 = 40;
5 R2 = 20;
6 R3 = 60;
7
8 Voc = E1*R2/(R2 + R1); //open circuit voltage
   appearing at terminal 1
9 Ri = R3 + (R1*R2/(R1 + R2)); //equivalent resistance
   looking into the network from terminal pair
   01
10
11 function I = I1(R1)
12     I = Voc/(Ri + R1) //current through R1
13 endfunction
14
15 I11 = I1(10); //R1 = 10 ohm
16 I12 = I1(50); //R1 = 50 ohm
17 I13 = I1(200); //R1 = 200 ohm
18
19 disp(" a")
20 disp(I11," I1 (R1 = 10ohm) = ")
21 disp(I12," I1 (R1 = 50ohm) = ")
22 disp(I13," I1 (R1 = 200ohm) = ")
23
24 //b
25 //for maximum power R1 = Ri
26 R1 = Ri;
27 Plmax = (Voc/(2*Ri))^2 * Ri ; //maximum power to R1
28 disp(" b")
29 disp(Plmax," maximum power to R1(in Watt) = ")
```

---

**Scilab code Exa 3.13** Find the current flowing through R2 by using Nortons current

```
1 //circuit parameters
2 //voltage sources
3 E1 = 120;
4 E2 = 65;
5 //resistances
6 R1 = 40;
7 R2 = 11;
8 R3 = 60;
9
10 I = (E1/R1) + (E2/R3); //norton's current source
11 Req = R1*R3/(R1 + R3); //equivalent resistance
12
13 I2 = I*Req/(Req + R2); //current flowing through R2
14
15 disp(I2,"current flowing through R2 = ")
```

---

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can be downloaded from the website [www.scilab.in](http://www.scilab.in)

## Chapter 4

# Circuit differential equations Forms and Solutions

Scilab code Exa 4.3 Determine the operational driving point impedances appearing a

```
1 //ad
2 Zab = complex(1,-0.5); //impedance appearing across
   terminals ab
3 Zbg = complex(1); //impedance appearing across
   terminals bg
4 Zbcd = complex(2+1,2); //impedance appearing across
   terminals bcd
5 Zad = Zab + (Zbg*Zbcd/(Zbg + Zbcd)); //impedance
   appearing across terminals ad
6 disp(Zad,"impedance appearing across terminals ad =
   ")
7
8 //dg
9 Zdg = Zbg + (Zab*Zbcd/(Zab+Zbcd)); //impedance
   appearing across terminals dg
10 disp(Zdg,"impedance appearing across terminals dg =
   ")
```

---



# Chapter 5

## Circuit dynamics and forced responses

This code can be downloaded from the website [www.scilab.in](http://www.scilab.in)

Scilab code Exa 5.2 Find the expression for the current flowing through the circuit

```
1 C = 10*10^-6 ; //capacitance(in farads)
2 R = 0.2*10^6; //resistance (in ohms)
3 Vi = 40; //initial voltage of the capacitor (in
    volts)
4 Wc = (1/2)*C*Vi^2; //energy stored in the capacitor
5 //current flowing in circuit as a function of time i
    (t) = 2*10^-4*exp(-t/2)
6 //power dissipated in the resistor = R*i^2
7 Wr = integrate('R*4*10^-8*exp(-t)', 't', 0, 100)
8 disp(Wc, "energy stored in the capacitor(in Joules) =
    ")
```

```
9 disp(Wr,"energy dissipated in the resistor(in Joules  
   ) = ")
```

---

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## Chapter 6

# The laplace transform method of finding circuit solutions

Scilab code Exa 6.1 Find the laplace transform of the given pulse

```
1 function F = laplace(s, T1, T2)
2     //pulse:
3     // f = u(t - T1) - u(t - T2)
4     F = integrate('exp(-s*t)', 't', T1, T2); //laplace
        transform of the pulse
5 endfunction
```

---

# Chapter 7

## Sinusoidal steady state response of circuits

Scilab code Exa 7.1 Find the average value of the given periodic function

```
1 Vm = 2; // assumption
2 //average value of the function
3 //v(t) = Vm*alpha/(%pi/3) for 0 <= alpha <= %pi/3
4 //      = Vm      for %pi/3 <= alpha <= %pi/2
5 Vav = (2/%pi)*integrate('Vm*alpha*(3/%pi)', 'alpha',
    ,0,%pi/3) + (2/%pi)*integrate('Vm*alpha/alpha', '
    alpha',%pi/3,%pi/2);
6 disp(Vav)
```

---

Scilab code Exa 7.2 Determine the power factor and average power delivered to the

```
1 theta = %pi/6; //phase difference between current
    and voltage
2 pf = cos(theta); //power factor
3 disp(pf,"power factor = ")
4
```

```

5 Vm = 170; //peak voltage
6 Im = 14.14; //peak current
7
8 Pav = Vm*Im*pf/2; //average power delivered to the
   circuit
9 disp(Pav," average power delivered to the circuit = "
   )

```

---

**Scilab code Exa 7.3** Find the expression for the sum of  $i_1$  and  $i_2$

```

1 // lets assume that i1 and i2 are stationary and the
   coordinate system is rotating with an angular
   frequency of w. And i1 lies on the x-axis (i.e.
   making an angle of 0 degree with the x-axis)
2 theta = %pi/3; //phase difference between i1 and i2;
3 I1 = 10*sqrt(2); // peak value of i1
4 I2 = 20*sqrt(2); // peak value of i2
5 I = sqrt(I1^2 + I2^2 + 2*I1*I2*cos(theta)); //peak
   value of the resultant current
6
7 phi = atan(I2*sin(theta)/(I1 + I2*cos(theta))); //
   phase difference between the resultant and i1(in
   radians)
8 disp(I,"peak value of the resultant current = ")
9 disp(phi,"phase difference between the resultant and
   i1 = ")
10 // result : i = I sin(wt + phi)

```

---

**Scilab code Exa 7.4** Find the effective value of the resultant current

```

1 I1 = 10; //peak value of i1
2 I2 = 20; //peak value of i2
3 theta = %pi/3; //phase difference between i1 and i2

```

```

4 // complex representation of the two currents
5 i1 = complex(10);
6 i2 = complex(20*cos(%pi/3),20*sin(%pi/3));
7
8 i = i1 + i2 ; //resultant current
9 I = sqrt (real(i)^2 + imag(i)^2); //calculating the
    peak value of the resultant current by using its
    real and imaginary parts
10 phi = atan(imag(i)/real(i)); //calculatig the phase
    of the resultant current by using its real and
    imaginary parts
11 disp(i,"resultant current = ")
12 disp(I,"peak value of the resultant current = ")
13 disp(phi,"phase of the resultant current = ")
14 //result : i = Isin(wt + phi)

```

---

Scilab code Exa 7.5 Find the time expression for the resultant current

```

1 I1 = 3; //peak value of i1
2 I2 = 5; //peak value of i2
3 I3 = 6; //peak value of i3
4 theta1 = %pi/6; //phase difference between i2 and i1
5 theta2 = -2*%pi/3; //phase difference between i3 and
    i1
6 // complex representation of the currents
7 i1 = complex(3);
8 i2 = complex(5*cos(%pi/6),5*sin(%pi/6));
9 i3 = complex(6*cos(-2*%pi/3),6*sin(-2*%pi/3));
10
11 i = i1 + i2 + i3; //resultant current
12 I = sqrt (real(i)^2 + imag(i)^2); //calculating the
    peak value of the resultant current by using its
    real and imaginary parts
13 phi = atan(imag(i)/real(i)); //calculatig the phase
    of the resultant current by using its real and

```

```

    imaginary parts
14 disp(I,"peak value of the resultant current = ")
15 disp(phi,"phase of the resultant current = ")
16 //result : i = Isin(wt + phi)

```

---

Scilab code Exa 7.6 Find the value of the given expression

```

1 //find V*Z1/Z2
2 V = complex(45*sqrt(3), -45);
3 Z1 = complex(2.5*sqrt(2), 2.5*sqrt(2));
4 Z2 = complex(7.5, 7.5*sqrt(3));
5 // we have to find V*Z1/Z2
6 Z = V*Z1/Z2;
7 disp(Z,"V*Z1/Z2 = ")

```

---

Scilab code Exa 7.7 Find A value of steady state current and the relative phase an

```

1 //a
2 f = 60; //frequency of the volatge source
3 V = complex(141); //voltage supply V = 141sin(wt)
4 R = 3; //resistance of the circuit
5 L = 0.0106; // inductance of the circuit
6 Z = complex(R,2*%pi*f*L); //impedance of the circuit
    = R + jwL
7 i = V/Z; //current
8 I = sqrt(real(i)^2 + imag(i)^2); //calculating the
    peak value of the current by using its real and
    imaginary parts
9 phi = atan(imag(i)/real(i)); //calculatig the phase
    of the resultant current by using its real and
    imaginary parts
10 disp(" a")

```

```

11 disp(I,"effective value of the steady state current
    = ")
12 disp(phi,"relative phase angle = ")
13
14 //b
15 // expression for the instantaneous current can be
    written as
16 //i = I sin(wt + phi)
17
18 //c
19 R = complex(3);
20 vr = V*R/Z; // voltage across the resistor
21 Vr = sqrt (real(vr)^2 + imag(vr)^2); //peak value of
    the voltage across the resistor
22 phi1 = atan(imag(vr)/real(vr)); //phase of the
    voltage across the resistor
23
24 vl = V - vr; //voltage across the inductor
25 V1 = sqrt (real(vl)^2 + imag(vl)^2); //peak value of
    the voltage across the inductor
26 phi2 = atan(imag(vl)/real(vl)); //phase of the
    voltage across the inductor
27 disp("c")
28 disp(Vr,"effective value of the voltage drop across
    the resistor = ")
29 disp(phi1,"phase of the voltage drop across the
    resistor = ")
30 disp(V1,"effective value of the voltage drop across
    the inductor = ")
31 disp(phi2,"phase of the voltage drop across the
    inductor = ")
32
33 //d
34 Pav = V*I*cos(phi); //average power dissipated by
    the circuit
35 disp("d")
36 disp(Pav,"average power dissipated by the circuit =
    ")

```



```

37
38 //e
39 pf = cos(phi); //power factor
40 disp("e")
41 disp(pf,"power factor = ")

```

---

**Scilab code Exa 7.8** Find the equivalent impedance appearing between points a and c

```

1 //impedances in the circuit
2 Z1 = complex(10,10);
3 Z2 = complex(15,20);
4 Z3 = complex(3,-4);
5 Z4 = complex(8,6);
6
7 Ybc = (1/Z2)+(1/Z3)+(1/Z4); //admittance of the
   parallel combination
8 Zbc = (1/Ybc); //impedance of the parallel
   combination
9
10 Z = Z1 + Zbc; // equivalent impedance of the circuit
11
12 disp(Z,"equivalent impedance of the circuit = ")

```

---

**Scilab code Exa 7.9** Find the current which flows through branch Z3

```

1 V1 = complex(10);
2 V2 = complex(10*cos(-%pi/3),10*sin(-%pi/3));
3 Z1 = complex(1,1);
4 Z2 = complex(1,-1);
5 Z3 = complex(1,2);
6
7 //by mesh analysis we get the following equations:
8 //I1*Z11 - I2*Z12 = V1

```

```

9 // -I1*Z21 + I2*Z22 = -V2; where I1 and I2 are the
   currents flowing in the first and second meshes
   respectively
10 Z11 = Z1 + Z1;
11 Z12 = Z1 + Z2;
12 Z21 = Z12;
13 Z22 = Z2 + Z2;
14
15 // the mesh equations can be represented in the
   matrix form as I*Z = V
16 Z = [Z11, -Z12; -Z21, Z22]; //impedance matrix
17 V = [V1; -V2]; //voltage matrix
18 I = inv(Z)*V; //current matrix = [I1;I2]
19
20 I1 = I(1,:); // I1 = first row of I matrix
21 I2 = I(2,:); // I1 = second row of I matrix
22
23 Ibr = I1 - I2; //current flowing through Z3
24
25 disp(Ibr,"current flowing through Z3 = ")

```

---

**Scilab code Exa 7.10** Find the current in the Z3 branch by using the Nodal method

```

1 V1 = complex(10);
2 V2 = complex(10*cos(-%pi/3),10*sin(-%pi/3));
3 Z1 = complex(1,1);
4 Z2 = complex(1,-1);
5 Z3 = complex(1,2);
6 //By applying the nodal analysis we get the following
   equation:
7 //Va((1/Z1)+(1/Z2)+(1/Z3)) = (V1/Z1) + (V2/Z2)
8
9 Y = (1/Z1)+(1/Z2)+(1/Z3);
10 Va = (1/Y)*((V1/Z1) + (V2/Z2)); //voltage of node a
11

```

```
12 Ibr = Va/Z3; //current flowing through Z3
13
14 disp(Ibr,"current flowing through Z3 = ")
```

---

Scilab code Exa 7.11 Find the current flowing through Z3 by using Thevinins theorem

```
1 V1 = complex(10);
2 V2 = complex(10*cos(-%pi/3),10*sin(-%pi/3));
3 Z1 = complex(1,1);
4 Z2 = complex(1,-1);
5 Z3 = complex(1,2);
6
7 Zth = Z3 + (Z1*Z2/(Z1+Z2)); // thevinin resistance
8
9 I = (V1 - V2)/(Z1 + Z2); // current flowing through
   the circuit when R3 is not connected
10 Vth = V1 - I*Z1; //thevinin voltage
11
12 Ibr = Vth/Zth; //current flowing through Z3
13
14 disp(Ibr,"current flowing through Z3 = ")
```

---

# Chapter 9

## Semiconductor electronic devices

Scilab code Exa 9.2 Find the values of self bias source resistance and drain load

```
1 // Quiescent point
2 Idq = 0.0034; // drain current
3 Vdq = 15; // drain voltage
4 Vgq = 1; // gate voltage
5
6 Vdd = 24; //drain supply voltage
7
8 Rs = Vgq/Idq;
9 disp(Rs,"The value of self bias source resistance is
    (in ohm): ")
10
11 Rd = (Vdd - Vdq)/Idq ;
12 disp(Rd,"The value of drain load resistance is(in
    ohm): ")
```

---

Scilab code Exa 9.3 Find A midband frequency current gain of the first stage B ban

```

1 //a
2 //transistor parameters
3 R2 = 0.625;
4 hie = 1.67;
5 Rb = 4.16;
6 Rl = 2.4;
7 Roe = 150;
8
9 Cc = 25 * 10^-6;
10 rBB = 0.29;
11 rBE = 1.375;
12 Cd = 6900 * 10^-12;
13 Ct = 40 * 10^-12;
14 gm = 0.032;
15
16 Req = (Rl*Roe)/(Rl + Roe);
17 hfe = 44;
18 a = 1 + (R2/Req);
19 b = 1 + (hie/Rb);
20 Aim = -hfe/(a*b); // mid band frequency gain
21 disp("a")
22 disp(Aim,"The mid band frequency gain of the first
    stage of the circuit is: ")
23
24 //b
25 Tl = 2*pi*(Req + R2)*Cc*(10^3);
26 Fl = 1/Tl;
27
28 Rp = (Req*R2)/(Req + R2);
29 C = Cd + Ct*(1 + gm*Rp*10^3);
30 d = Rb + hie ;
31 e = rBE * (Rb + rBB)* 10^3 * C ;
32 Fh = d/(2*pi*e);
33
34 BW = Fh - Fl;
35 disp("b")
36 disp(BW, "The bandwidth of the first stage
    amplifier in Hz is :")

```



# Chapter 11

## Binary logic Theory and Implimentation

Scilab code Exa 11.1 Determine th decimal equivalentents of the binary numbers A 101

```
1 //a
2 N2 = '101'; //binary ordered sequence
3 N = bin2dec(N2); //decimal equivalent of N2
4 disp("a")
5 disp(N, "decimal equivalent of 101 = ")
6
7 //b
8 N2 = '11011'; //binary ordered sequence
9 N = bin2dec(N2); //decimal equivalent of N2
10 disp("b")
11 disp(N, "decimal equivalent of 11011 = ")
```

---

Scilab code Exa 11.2 Determine the decimal equivalent of A octal number 432 B hexa

```
1 //a
2 N8 = '432'; //octal number
```

```
3 N = oct2dec(N8); //decimal representation of N8
4 disp("a")
5 disp(N,"decimal equivalent of 432 = ")
6
7 //b
8 N16 = 'C4F'; //hexadecimal number
9 N = hex2dec(N16); //decimal representation of N16
10 disp("b")
11 disp(N,"decimal equivalent of C4F = ")
```

---

**Scilab code Exa 11.3** Find the binary and octal equivalents of 247

```
1 N = 247;
2 N2 = dec2bin(N); //binary equivalent of N
3 N8 = dec2oct(N); //octal equivalent of N
4 disp(N2, "binary equivalent of 247 = ")
5 disp(N8, "octal equivalent of 247 = ")
```

---



# Chapter 12

## Simplifying logical functions

This code can be downloaded from the website [www.scilab.in](http://www.scilab.in) This code

can be downloaded from the website [www.scilab.in](http://www.scilab.in) This code can be down-

loaded from the website [www.scilab.in](http://www.scilab.in)

# Chapter 15

## Magnetic circuit computations

Scilab code Exa 15.1 Find A magneto motive force B current C relative permeability

```
1 //a
2 phi = 6*10^-4; //given magnetic flux (in Wb)
3 A = 0.001; // cross sectional area (in meter square)
4 B = phi/A ; //
5 Ha = 10; //magnetic field intensity of material a
   needed to establish the given magnetic flux
6 Hb = 77; // magnetic field intensity of material b
7 Hc = 270; // magnetic field intensity of material c
8 La = 0.3; //arc length of material a (in meters)
9 Lb = 0.2; //arc length of material b (in meters)
10 Lc = 0.1; //arc length of material c (in meters)
11
12 F = Ha*La + Hb*Lb + Hc*Lc; //magnetomotive force
13 disp("a")
14 disp(F, "magnetomotive force needed to establish a
   flux of 6*10^-4(in At) = ")
15
16 //b
17 N = 100; //no. of turns
18 I = F/N; //current in amps
19 disp("b")
```

```

20 disp(I,"current that must be made to flow through
    the coil(in amps) = ")
21
22 //c
23 MU0 = 4*%pi*10^-7;
24 MUa = B/Ha; //permeability of material a
25 MUb = B/Hb; //permeability of material b
26 MUb = B/Hc; //permeability of material c
27
28 MUra = MUa/MU0; //relative permeability of material
    a
29 Murb = MUb/MU0; //relative permeability of material
    b
30 Murb = MUb/MU0; //relative permeability of material
    c
31
32 Ra = Ha*La/phi; //reluctance of material a
33 Rb = Hb*Lb/phi; //reluctance of material b
34 Rc = Hc*Lc/phi; //reluctance of material c
35
36 disp("c")
37 disp(MUra,"relative permeability of material a = ")
38 disp(Murb,"relative permeability of material b = ")
39 disp(Murb,"relative permeability of material c = ")
40 disp(Ra,"reluctance of material a = ")
41 disp(Rb,"reluctance of material b = ")
42 disp(Rc,"reluctance of material c = ")

```

---

**Scilab code Exa 15.3** Find the mmf produced by the coil

```

1 mu0 = 4*%pi*10^-7;
2 A = 0.0025; //cross sectional area of the coil
3 //dimensions of the coil (in meters)
4 Lg = 0.002; //air gap length (in meters)
5 Lbd = 0.025;

```

```

6 Lde = 0.1;
7 Lef = 0.025;
8 Lfk = 0.2;
9 Lbc = 0.175;
10 Lcab = 0.5;
11
12 Lbghc = 2*(Lbd + Lde + Lef + (Lfk/2)) - Lg; //length
    of the ferromagnetic material involved here
13
14 phig = 4*10^-4; //air gap flux (in Wb)
15 Bg = phig/A ; //air gap flux density (in tesla)
16 Hg = Bg/mu0 ; //feild intensity of the air gap
17 mmfg = Hg*Lg ; //mmf produced in the air gap (in At)
18
19 Bbc = 1.38 ; //flux density corresponding to cast
    steel
20
21 Hbghc = 125; //field intensity corresponding to flux
    density of 0.16T in the steel
22 mmfbghc = Hbghc*Lbghc ; // mmf corresponding to bghc
23
24 mmfbc = mmfg + mmfbghc ; //mmf across path bc
25 Hbc = mmfbc/Lbc;
26 phibc = Bbc*A ; //flux produced in bc
27
28 phicab = phig + phibc; //total fiux existing in leg
    cab
29 Bcab = phicab/0.00375; //flux density
30 Hcab = 690;
31 mmfcab = Hcab*Lcab; //mmf in leg cab
32
33 mmf = mmfbc + mmfcab ; //mmf produced by the coil
34
35 disp(mmf,"mmf produced by the coil(in At) = ")

```

---

Scilab code Exa 15.5 B Find the magnetic force exerted on the plunger

```
1 //b
2 mu0 = 4*%pi*10^-7 ;
3 //plunger magnet dimensions (in meters)
4 x = 0.025;
5 h = 0.05;
6 a = 0.025;
7 g = 0.00125;
8
9 mmf = 1414; //(in At)
10
11 F = %pi*a*mu0*(mmf^2)*(h^2)*(1/(x + h)^2)/g; //
    magnitude of the force
12 disp(F, "magnitude of the force (in Newtons) = ")
```

---

# Chapter 16

## Transformers

Scilab code Exa 16.1 Find A equivalent resistance and reactance referred to both t

```
1 //a
2 V1 = 1100; //higher voltage
3 V2 = 220; //lower voltage
4 a = V1/V2; //turns ratio
5 r1 = 0.1; //high voltage winding resistance(in ohms)
6 x1 = 0.3; //high voltage leakage reactance(in ohms)
7 r2 = 0.004; //low voltage winding resistance(in ohms
  )
8 x2 = 0.012; //low voltage leakage reactance(in ohms)
9
10 Re1 = r1 + (a^2)*r2 ; //equivalent winding
    resistance referred to the primary side
11 Xe1 = x1 + (a^2)*x2 ; //equivalent leakage reactance
    referred to the primary side
12 Re2 = (r1/a^2) + r2 ; //equivalent winding
    resistance referred to the secondary side
13 Xe2 = (x1/a^2) + x2 ; //equivalent leakage reactance
    referred to the secondary side
14
15 disp("a")
16 disp(Re1,"equivalent winding resistance referred to
```

```

    the primary side")
17 disp(Xe1,"equivalent leakage reactance referred to
    the primary side")
18 disp(Re2,"equivalent winding resistance referred to
    the secondary side")
19 disp(Xe2,"equivalent leakage reactance referred to
    the secondary side")
20
21 //b
22 P = 100; //power (in kVA)
23 I21 = P*1000/V1; //primary winding current rating
24 Vre1 = I21*Re1; //equivalent resistance drop (in
    volts)
25 VperR1 = Vre1*100/V1 ; // % equivalent resistance
    drop
26
27 Vxe1 = I21*Xe1; //equivalent reactance drop (in
    volts)
28 VperX1 = Vxe1*100/V1; // % equivalent reactance drop
29
30 disp("b")
31 disp(Vre1,"equivalent resistance drop expressed in
    terms of primary quantities(in volts) = ")
32 disp(VperR1,"% equivalent resistance drop expressed
    in terms of primary quantities = ")
33 disp(Vxe1,"equivalent reactance drop expressed in
    terms of primary quantities(in volts) =")
34 disp(VperX1,"% equivalent reactance drop expressed
    in terms of primary quantities = ")
35
36 //c
37 I2 = a*I21; // secondary winding current rating
38 Vre2 = I2*Re2; //equivalent resistance drop (in
    volts)
39 VperR2 = Vre2*100/V2 ; // % equivalent resistance
    drop
40
41 Vxe2 = I2*Xe2; //equivalent reactance drop (in volts

```

```

    )
42 VperX2 = Vxe2*100/V2; // % equivalent reactance drop
43
44 disp("c")
45 disp(Vre2,"equivalent resistance drop expressed in
    terms of secondary quantities(in volts) = ")
46 disp(VperR2,"% equivalent resistance drop expressed
    in terms of secondary quantities = ")
47 disp(Vxe2,"equivalent reactance drop expressed in
    terms of secondary quantities(in volts) =")
48 disp(VperX2,"% equivalent reactance drop expressed
    in terms of secondary quantities = ")
49
50 //d
51 Ze1 = complex(Re1,Xe1); //equivalent leakage
    impedance referred to the primary
52 Ze2 = Ze1/a ; //equivalent leakage impedance
    referred to the secondary
53
54 disp("d")
55 disp(Ze1,"equivalent leakage impedance referred to
    the primary = ")
56 disp(Ze2,"equivalent leakage impedance referred to
    the secondary = ")

```

---

**Scilab code Exa 16.2** Compute the 6 parameters of the equivalent circuit referred to

```

1 P1 = 396; //wattmeter reading on open circuit test
2 V1 = 120; //voltmeter reading on open circuit test
3 I1 = 9.65; //ammeter reading on open circuit test
4 a = 2400/120; //turns ratio
5
6 theata = acos(P1/(V1*I1)); //phase difference
    between voltage and current
7 Irl = I1*cos(theata); //resistive part of Im

```



```

8 Ix1 = I1*sin(theata); //reactive part of Im
9
10 r1 = V1/Ir1; //low voltage winding resistance
11 rh = (a^2)*r1; //rl on the high side
12 x1 = V1/Ix1; //magnetizing reactance referred to the
    lower side
13 xh = (a^2)*x1; //corresponding high side value
14
15 Ph = 810; //wattmeter reading on short circuit test
16 Vh = 92; //voltmeter reading on short circuit test
17 Ih = 20.8; //ammeter reading on short circuit test
18
19 Zeh = Vh/Ih; //equivalent impeadance referred to the
    higher side
20 Zel = Zeh/(a^2); //equivalent impedance referred to
    the lower side
21 Reh = Ph/(Ih^2); //equivalent resistance referred to
    the higher side
22 Rel = Reh/(a^2); //equivalent resistance referred to
    the lower side
23 Xeh = sqrt((Zeh^2) - (Reh^2)); //equivalent
    reactance referred to the higher side
24 Xel = Xeh/(a^2); //equivalent reactance referred to
    the lower side
25
26 disp(Zeh,"equivalent impeadance referred to the
    higher side = ")
27 disp(Zel,"equivalent impedance referred to the lower
    side = ")
28 disp(Reh,"equivalent resistance referred to the
    higher side = ")
29 disp(Rel,"equivalent resistance referred to the
    lower side = ")
30 disp(Xeh,"equivalent reactance referred to the
    higher side = ")
31 disp(Xel,"equivalent reactance referred to the lower
    side = ")

```

---

Scilab code Exa 16.3 For the transformer compute A efficiency B voltage regulation

```
1 //a
2 P = 50; //power rating (in kVA)
3 Ph = 810; //wattmeter reading on short circuit test
4 Pl = 396; //wattmeter reading on open circuit test
5 Ih = 20.8; //ammeter reading on short circuit test
6 pf = 0.8; //power factor = 0.8 lagging
7
8 losses = (Ph + Pl)/1000; //losses in kW
9 outputP = P*pf; //output power
10 inputP = outputP + losses ; //input power
11
12 efficiency = outputP/inputP ;
13 disp("a")
14 disp(efficiency," efficiency = ")
15
16 //b
17 Xeh = 4; //equivalent reactance referred to the
    higher side
18 Reh = 1.87; //equivalent resistance referred to the
    higher side
19 Zeh = complex(Reh, Xeh); //equivalent impedance
    referred to the higher side
20 ih = complex(Ih*pf, -Ih*sqrt(1 - (pf^2)));
21 V1 = 2400 + Zeh*ih ; //primary voltage
22
23 voltageRegulation = (real(V1)-2400)*100/2400; //
    percent voltage regulation
24 disp("b")
25 disp(voltageRegulation," percent voltage regulaton =
    ")
```

---

# Chapter 18

## The three phase Induction motor

Scilab code Exa 18.1 Find A input line current and power factor B developed electrical

```
1 //a
2 V1 = 440/sqrt(3);
3 s = 0.025; //slip
4 r1 = 0.1;
5 r2 = 0.12;
6 x1 = 0.35;
7 x2 = 0.4;
8
9 z = complex(r1 + r2/s, x1 + x2);
10 i2 = V1/z; //input line current
11 I2 = sqrt(real(i2)^2 + imag(i2)^2); //magnitude of
    input line current
12 disp("a")
13 disp(i2,"input line current = ")
14
15 i1 = complex(18*cos(-1.484), 18*sin(-1.484)); //
    magnetizing current
16 I1 = sqrt(real(i1)^2 + imag(i1)^2); //magnitude of
    magnetizing current
```

```

17 i = i1 + i2; //total current drawn from the voltage
    source
18 I = sqrt(real(i)^2 + imag(i)^2); //magnitude of
    total current
19 theta = atan(imag(i)/real(i)); //phase difference
    between current and voltage
20 pf = cos(theta); //power factor
21 disp(pf,"power factor = ")
22 if theta >= 0 then
23     disp("leading")
24 else disp("lagging")
25 end
26
27 //b
28 f = 60; //hertz
29 ns = 1800;
30 ws = 2*pi*ns/f; //stator angular velocity
31 Pg = 3*I^2*r2/s; //power
32 T = Pg/ws; //developed electromagnetic torque
33 disp("b")
34 disp(T,"developed electromagetic torque (in Newton-
    meter) = ")
35
36 //c
37 Prot = 950; //rotational losses (in watts)
38 Po = Pg*(1 - s) - Prot ; //output power
39 HPo = Po/746; //output horse power
40 disp("c")
41 disp(HPo,"output horse power = ")
42
43 //d
44 Pc = 1200; //core losses (in W)
45 SCL = 3*I^2*r1; //stator copper loss
46 RCL = 3*I2^2*r2; //rotar copper loss
47 loss = Pc + SCL + RCL + Prot; //total losses
48 Pi = real(3*V1*i); //input power
49 efficiency = 1 - (loss/Pi);
50 disp(efficiency,"efficiency = ")

```



# Chapter 19

## Computations of Synchronous Motor Performance

Scilab code Exa 19.1 Find A induced excitation voltage per phase B line current C

```
1 //a
2 efficiency = 0.9;
3 Pi = 200*746/efficiency; //input power
4 x = 11; //reactance of the motor
5 V1 = 2300/sqrt(3); //voltage rating
6 delta = 15*%pi/180; //power angle
7 Ef = Pi*x/(3*V1*sin(delta)); //the induced
   excitation voltage per phase
8 disp("a")
9 disp(Ef,"the induced excitation voltage per phase =
   ")
10
11 //b
12 z = complex(0,x); //impedance of the motor
13 ef = complex(Ef*cos(-delta),Ef*sin(-delta));
14
15 Ia = (V1 - ef)/z ; //armature current
16 disp("b")
17 disp(Ia,"armatur current = ")
```

```
18
19 //c
20 theata = atan(imag(Ia)/real(Ia)); //phase difference
    between Ia and V1
21 pf = cos(theata); //power factor
22
23 disp("c")
24 disp(pf,"power factor = ")
25
26 if sin(theata)> 0 then
27     disp("leading")
28 else
29     disp("lagging")
30 end
```

---

# Chapter 20

## DC machines

Scilab code Exa 20.2 Caculate A electromagnetic torque B flux per pole C rotationa

```
1 //a
2 Vt = 230; //(in volts)
3 Ia = 73; //armature current (in amps)
4 If = 1.6; //feild current (in amps)
5 Ra = 0.188; //armature circuit resistance(in ohms)
6 n = 1150; //rated speed of the rotor(in rpm)
7 Po = 20*746; //output power (in watts)
8
9 Ea = Vt - (Ia*Ra); //armature voltage
10 wm = 2*pi*n/60; //rated speed of the rotor (in rad/
    sec)
11 T = Ea*Ia/wm ; //electromagnetic torque
12
13 disp("a")
14 disp(T,"electromagnetic torque = ")
15
16 //b
17 a = 4; //no. of parallel armature paths
18 p = 4; //no. of poles
19 z = 882; //no. of armature conductors
20 flux = Ea*60*a/(p*z*n); //flux per pole (in Wb)
```



```

21
22 disp("b")
23 disp(flux,"flux per pole = ")
24
25 //c
26 Prot = (Ea*Ia) - Po; //rotational loss (in watt)
27 disp("c")
28 disp(Prot,"rotational losses = ")
29
30 //d
31 losses = Prot + (Ia^2 * Ra) + (Vt * If) ;
32 Pi = (Ea*Ia) + (Ia^2 * Ra) + (Vt * If); //input
    power
33 efficiency = 1 - (losses/Pi);
34
35 disp("d")
36 disp(efficiency,"efficiency = ")

```

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**Scilab code Exa 20.3** Determine the new operating speed

```

1 // final flux = 0.8*initial flux
2 Ia1 = 73; //initial armature current (in amps)
3 Vt = 230; //(in volts)
4 Ra = 0.188; //armature circuit resistance
5 n1 = 1150; //initial rotor speed (in rpm)
6 Ea1 = 216.3; //initial armature voltage
7
8 Ia2 = (1/0.8)*Ia1 ; //final armature current
9 Ea2 = Vt - (Ia2*Ra); //final armature voltage
10
11 n2 = (Ea2/Ea1)*(1/0.8)*n1; //final rotor speed
12
13 disp(n2,"final rotor speed(in rpm) = ")

```

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Scilab code Exa 20.4 find A motor speed B required pulse frequency C repeat part A

```
1 //a
2 rop = 0.4; //ratio of ON time T0 to cycle time Tp
3 Vb =550; //rated terminal voltage of the dc motor
4 Ia = 30; //current drawn by the motor (in amps)
5 Ra = 1; //armature circuit resistance (in ohms)
6 ts = 5.94; //torque and speed parameter of the motor
    (in N-m/A)
7
8 Vm = rop*Vb; //average value of the armature
    terminal voltage
9 Ea = Vm - (Ia*Ra); //induced armature voltage
10
11 wm = Ea/ts; //motor speed (in rad/s)
12 disp("a")
13 disp(wm,"motor speed (in rad/s) = ")
14
15 //b
16 deltaI = 5; //change of armature current during the
    ON period
17 La = 0.1; //armature winding inductance (in H)
18 To = La*deltaI/(Vb - Ea); //ON time
19 Tp = To/rop; //cycle time
20
21 f = 1/Tp ; //required pulses per second
22 disp("b")
23 disp(f,"required pulses per second = ")
24
25 //c
26 rop = 0.7; //new ratio of ON time T0 to cycle time
    Tp
27 Vm = rop*Vb; //average value of the armature
    terminal voltage
```

```
28 Ea = Vm - (Ia*Ra); //induced armature voltage
29
30 wm = Ea/ts; //motor speed (in rad/s)
31 disp("c")
32 disp(wm,"motor speed with To/Tp equal to 0.7 (in rad
/s) = ")
33
34 To = La*deltaI/(Vb - Ea); //ON time
35 Tp = To/rop; //cycle time
36
37 f = 1/Tp ; //required pulses per second
38 disp(f,"required pulses per second with To/Tp equal
to 0.7 = ")
```

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# Chapter 23

## Principles of Automatic Control

Scilab code Exa 23.1 Determine the new transfer gain and feedback factor

```
1 deltaGi = 420 - 380; //variation in the without
   feedback gain
2 Gi = 400; //without feedback gain
3 T = 400; //transfer function of the closed loop
   system
4 // (variation in T)/T = (change in G)/G * (1/ 1+H*G)
   = 0.02
5 //1 + H*G = R
6 R = (deltaGi/Gi)/0.02;
7
8 G = T*R; //new direct transmission gain with
   feedback
9 H = (G/T - 1)/G; //feedback factor
10
11 disp(G,"new direct transmission gain with feedback =
   ")
12 disp(H,"feedback factors = ")
```

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# Chapter 24

## Dynamic behaviour of Control systems

Scilab code Exa 24.2 find A dynamic response of the system B position lag error C

```
1 //a
2 //parameter values
3 Kp = 0.5; //V/rad
4 Ka = 100; //V/V
5 Km = 2*10^-4 ; //lb-ft/V
6 F = 1.5*10^-4; //lb-ft/rad/s
7 J = 10^-5 //slug-ft^2
8
9 K = Kp*Ka*Km ; //loop propotional gain
10 dr = F/(2*sqrt(K*J)); //damping ratio
11 wn = sqrt(K/J);
12 ts = 5/(dr*wn);
13 wd = wn*sqrt(1 - dr^2); //frequency at which damped
    oscillations occur
14 disp("a")
15 disp(wd, "damped oscillations occur at a frequency =
    ")
16 disp(dr, "damping ratio = ")
17
```

```

18 //b
19 Tl = 10^-3; //load disturbance (lb-ft)
20 e = Tl/K; //position lag error
21 disp("b")
22 disp(e,"position lag error (in rad) = ")
23
24 //c
25 KaNew = (e/0.025)*Ka; //new loop gain
26 disp("c")
27 disp(KaNew,"new loop gain for which the position lag
      error is equal to 0.025rad = ")
28
29 //d
30 drNew = F/(2*sqrt(Kp*KaNew*Km*J)); //new damping
      ratio
31 disp("d")
32 disp(drNew,"new damping ratio = ")
33
34 //e
35 //for a maximum overshoot of 25% , (F + Qo)/2*sqrt(K
      *J) = 0.4
36 Qo = (0.4*2*sqrt(Kp*KaNew*Km*J)) - F ;
37 Ko = Qo/(KaNew*K) ; //output gain factor
38 disp("e")
39 disp(Ko,"output gain factor = ")

```

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