Scilab Manual for Elements of Electrical Design by Prof Kaustubh Vyas Electrical Engineering Vishwakarma Government Engineering College¹

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Air gap MMF calculation for magnetic circuits using SCILAB

Scilab code Solution 1.1 Experiment1

```
slot opening in DC machine ( in range of 2-4 cm
15 L=input('Enter Value of gross core length in cm') //
      length of armature core (in range of 40 70 cm)
16 psi=input('Enter Value of pole arc in cm') // pole
      arc value in DC machine (in range of 15 3 25 cm)
17 lg=input('Enter Value of airgap length in cm') //
     length of airgap between armature and stator in
     DC machine ( in range of 0.4 - 0.7 cm)
18 phi=input('Enter Value of flux per pole in Wb') //
      airgap flux (in range of 0.04 - 0.08 Wb)
19 nd=input ('Enter no. of ventilating ducts') // radial
      ventilating ducts (in range of 4 - 10 ducts)
20 bd=input('Enter opening of each ventilating duct')
     // duct opening ( in range of 1 - 1.5 cm)
21
22
   // Actual calculations begin
23
24 \text{ slot_ratio} = \text{yo/lg}
25 if slot_ratio <= 1 then
26 kcs = 0.15 // carter's coefficient for slots
27 elseif slot_ratio <= 2 then
28
       kcs = 0.28 // carter's coefficient for slots
29 elseif slot_ratio <= 3 then
30
       kcs = 0.37 // carter's coefficient for slots
31 elseif slot_ratio <= 3.6 then
32
       kcs = 0.41 // carter's coefficient for slots
33 else
       kcs = 0.43 // carter's coefficient for slots
34
35 end
36
37 duct_ratio = bd/lg
38 if duct_ratio <= 1 then
39 kcd = 0.15 // carter's coefficient for ducts
40 elseif duct_ratio <= 2 then
41 kcd = 0.28 // carter's coefficient for ducts
42 elseif duct_ratio <= 3 then
43 kcd = 0.37 // carter's coefficient for ducts
```

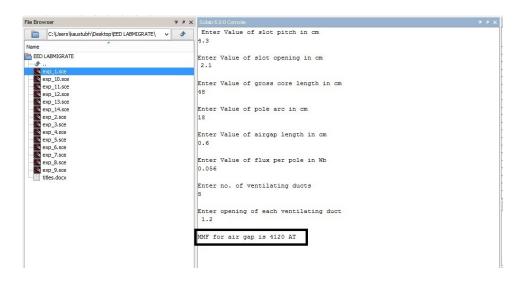


Figure 1.1: Experiment1

```
44 elseif duct_ratio <= 3.5 then
45 kcd = 0.41 // carter's coefficient for ducts
46 else
47    kcd = 0.43 // carter's coefficient for ducts
48 end
49
50 kgs = (ys)/(ys-kcs*yo) // gap contraction factor for slots
51 kgd = (L)/(L-kcd*nd*bd) // gap contraction factor for ducts
52 Bg = (phi*1e4)/(psi*L) // air gap flux density
53 ATg = 8e3*Bg*kgs*kgd*lg
54
55 mprintf('MMF for air gap is %d AT', ATg)</pre>
```

A SCILAB Code to compute Apparent flux density in teeth of Armature in a DC machine

Scilab code Solution 2.2 Experiment2

```
14 L=input ('Enter Value of gross core length in cm') //
       length of armature core (in range of 30 70 cm)
15 nd=input('Enter no. of ventilating ducts') // radial
       ventilating ducts (in range of 4-10 ducts)
16 bd=input('Enter opening of each ventilating duct')
      // duct opening (in range of 1 - 1.5 cm)
17 bt=input('Enter Value of tooth width in cm') //
      width of tooth section (in range of 1-3 cm)
18 yo=input('Enter Value of slot opening in cm') //
      slot opening in DC machine (in range of 1-4 cm
19 mu=input('Enter Value of permeability') //
      permeability corresponding to real flux density (
      in range of 30 x 10^{\circ}-6 - 40 x 10^{\circ}-6)
20 Sf=input('stacking factor') // Stacking factor ( in
      the range of 0.85 - 0.95)
21
22 // Actual calculations begin
23
24 H = Bm/mu // magnetization force in AT/m
25 Li = Sf*(L-nd*bd) // net iron length
26 \text{ ys} = \text{bt+yo} // \text{sloth pitch}
27 \text{ Ks} = (ys*L)/(bt*Li)
28
29 Bapp = Bm+4*\%pi*1e-7*H*(Ks-1)// apparent flux
      density
30
31 mprintf('Apparent flux density for given case is \%f,
      Wb/m^2, Bapp)
```

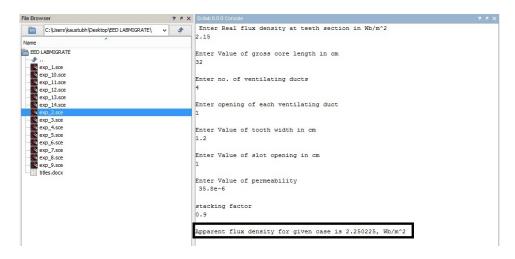


Figure 2.1: Experiment2

Design of starter for DC shunt motor through SCILAB code

Scilab code Solution 3.3 Experiment3

```
1 / Experiment -3
2 // windows 8.1 - 64-Bit
3 // Scilab - 6.0.0
5 //Aim : Design of starter for DC shunt motor through
      SCILAB code
6 // Data: Determine the resistance of each section of
      a strater to be used for DC shunt motor
8 clc
9 clear all
10
11 // Following data is to be taken form the user
12
13 N=input('Enter value of No. of studes in the starter'
     ) // no. of studs to determine the no. of element
      sections of starter ( in the range of 4-10)
14 V=input('Enter voltage rating of the motor')//
     voltage reating of the motor ( in the range of
```

```
220 - 400 \text{ V}
15 P=input('Power Rating of motor in kW') // Rating of
      motor in kW ( in the range of 15-50)
16 n=input ('Enter Efficiency in percentage') //
      efficiency of motor ( in the range of 85-95\%)
17 Ra=input ('Enter Value of Armature Resistance in Ohms
      ') // Armature resistance ( in the range of 0.1 -
       0.4 ohms)
18 Tm=input ('Enter the ratio of maximum torque to full
     load torque') // ratio of torque in per unit ( in
       the range of 1.2 - 1.8)
19
20 // Actual Calculations begin
21
22 Ia = (P*1e5)/(V*n); // Armature current
23 Im = Tm*Ia // Maximum value of full load current
24 el = N-1 // no. of resistance elements
25 R1 = V/Im // Resistance of first section
26 \text{ K} = (R1/Ra)^{(1/el)};
27 Il = Im/K // lower reange of current
28 R(1) = R1
29 \text{ for } i = 1:e1
30
       R(i+1)=R(i)/K
31
       r(i) = R(i) - R(i+1)
32
       mprintf ('Resistance value of section - %d is %f
          Ohms',i,r(i))
33
       mprintf('\n')
34 end
35
36 mprintf('Total Starter resistance is %f Ohms', sum(r)
37
       mprintf('\n')
38 mprintf('Resistance of motor is %f Ohms', Ra)
39
       mprintf('\n')
40 mprintf('Total Resistance at starting time is %f
     Ohms', Ra+sum(r))
       mprintf('\n')
41
42 mprintf('Upper range of Staring current is %f Amp',
```

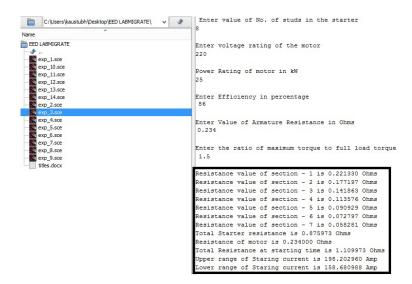


Figure 3.1: Experiment3

Design of starter for DC series motor through SCILAB code

Scilab code Solution 4.4 Experiment4

```
1 / Experiment -4
2 // windows 8.1 - 64-Bit
3 // Scilab - 6.0.0
 //Aim : Design of starter for DC series motor
     through SCILAB code
6 // Data: Determine the resistance of each section of
      a strater to be used for DC series motor
8 clc
9 clear all
10
11 // Following data is to be taken form the user
12
13 N=input('Enter value of No. of studes in the starter'
     ) // no. of studs to determine the no. of element
      sections of starter ( in the range of 4-10)
14 V=input('Enter voltage rating of the motor')//
     voltage reating of the motor ( in the range of
```

```
220 - 400 \text{ V}
15 Im=input ('Maximum Starting current') // Maximum
      required value of starting current (in the range
       of 150 - 250 \text{ Amp}
16 Il=input('Minimum Starting current') // Minimum
      required value of starting current ( in the range
       of 100 -200 \text{ Amp}
17 Ra=input ('Enter Value of Armature Resistance in Ohms
      ') // Armature resistance ( in the range of 0.1 -
       0.4 \text{ ohms}
18 Phi=input('Enter the ratio of maximum flux to
      minimum flux') // ratio of fluxes corresponing to
       minimum and maximum current (in per unit) (in
      the range of 1.05 - 1.25)
19
20 // Actual Calculations begin
21
22 K = Im/Il // ratio of currents
23 b = Phi / K
24 el=N-1 // No. of element sections
25 R(1) = V/Im
26
27 \text{ for } i = 1:el
       R(i+1)=b*R(i)+R(1)*(1-Phi)
28
       r(i)=R(i)-R(i+1)
29
30
       mprintf('Resistance value of section - %d is %f
          Ohms', i, r(i))
       mprintf('\n')
31
32 end
```

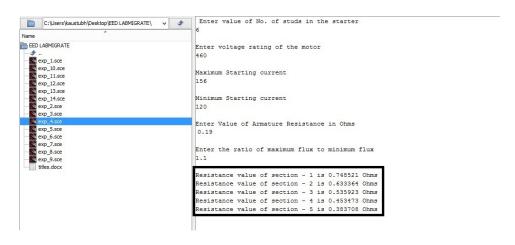


Figure 4.1: Experiment4

A SCILAB code to design rotor resistance starter of a slip-ring induction motor

Scilab code Solution 5.5 Experiment5

```
14 N=input ('Enter no. of studes for starter to be
      designed') // No. of studs ( in range of 5-10)
15 s=input('Enter full load slip in percentage') //
      full load slip ( in the range of 1-5\%)
16 R=input ('Enter value of rotor resistance per phase
      in Ohms') // rotor resistnace ( in the range of
      0.01 - 0.1 \text{ Ohms}
17
18 // Actual Calculations begin
20 el = N-1 // no. of resistance elements
21 R(1) = R*100/s // resistance at stud 1
22 \text{ K} = (s/100)^{(1/(N-1))}
23
24 for i=1:el
25 R(i+1) = K*R(i)
26 r(i) = R(i) - R(i+1)
27 mprintf('Resistance of section - %d is %f Ohms',i,r(
      i))
28 mprintf('\n')
29 end
```

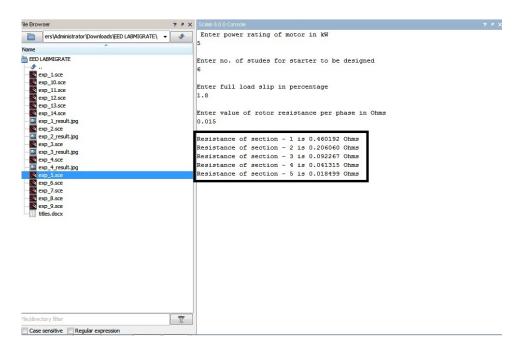


Figure 5.1: Experiment5

Design of a small single phase transformer using SCILAB coding

Scilab code Solution 6.6 Exp6

```
1 //Experiment-5
2 // windows 8.1 - 64-Bit
3 //Scilab - 6.0.0
4
5
6 //Aim : Design of a small single phase transformer using SCILAB coding
7 //Data: Design a small single phase transformer for given ratings
8
9 clc
10 clear all
11
12 // Following data is to be taken form the user
13 Vo=input('Enter value of output voltage of transformer') // output voltage of the transformer (in the range of 5 - 12 volts)
```

```
14 Io=input ('Enter value of output current of
      transformer') // output current of the
      transformer (in the range of 2-5 Amp.)
15 Vi=input ('Enter value of input voltage of
      transformer') // input voltage of the transformer
      (in the range of 110 - 230 volts)
16 f=input('Enter value of operating frequency in Hz')
      // operating frequency of the transformer (in the
       range of 50 - 60 \text{ Hz})
17
18 // Assuming following
20 n = 0.9 // assuming 90\% eficiency
21 Et = 9 // \text{emf per turn}
22 Bm = 1 // \text{maximum flux density}
23 Ks = 0.9 // stacking factor
24 del = 2.3 // current density in conductor
25
26 // Actual Calculations begin
27
28 P = Vo*Io // output rating of transformer
29 phi_m = (1/(4.44*f*Et)) // maximum flux in the core
30 Ac = phi_m/Bm // net area of core
31 Ag = Ac/Ks // gross core area
32 A = sqrt(Ag) // width of central limb assuming
     square cross section
33 Np = Vi*Et // No. of turns in primary
34 Ns = ceil(1.05*Vo*Et) // No. of turns in secondary
35 Ip = P/(n*Vi) // Current in primary winding
36 Ap = Ip / del // corss sectional area of bare
     primary conductor
37 dp = sqrt(4*Ap/\%pi) // diameter of bare primary
      conductor
38 dpi = dp+0.3 // diameter of insulated primary
      conductor
39 Api = (\%pi*dpi^2)/4 // corss sectional area of
      insulated primary conductor
40 As = Io / del // corss sectional area of bare
```

```
secondary conductor
41 ds = 0.2 + \text{sqrt} (4 * \text{As} / \% \text{pi}) / \text{diameter of bare}
      secondary conductor
42 dsi = ds+0.1 // diameter of insulated secondary
      conductor
43 Asi = (\%pi*dsi^2)/4 // corss sectional area of
      insulated secondary conductor
44 sfp = 0.8*(dp/dpi)^2 // space factor of primary
      winding
45 Awp = ceil(Np*Api/sfp) // window area for primary
      winding
46 sfs = 0.8*(ds/dsi)^2 // space factor of secondary
      winding
47 Aws = ceil(Ns*Asi/sfs) // window area for secondary
      winding
48 Aw = 1.2*(Aws+Awp) // gross window area required
49
50 mprintf('No. of urns required in Primary is %d', Np)
51 mprintf('\n')
52 mprintf('No. of urns required in Secondary is %d', Ns
      )
53 mprintf(' \ n')
54 mprintf('Power Rating of the transformer is %d VA',P
      )
55 mprintf(' \ n')
56 mprintf('Diameter of insulated primary conductor is
      %f mm', dpi)
57 mprintf('\n')
58 mprintf('Diameter of insulated secondary conductor
      is %f mm', dsi)
59 mprintf('\n')
60 mprintf('Gross window area required is %d mm^2', Aw)
```

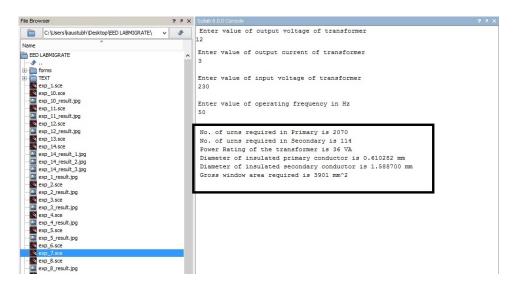


Figure 6.1: Exp6

Design of an iron cored choke coil using SCILAB coding

Scilab code Solution 7.7 Experiment7

```
1 //Experiment-7
2 //windows 8.1 - 64-Bit
3 //Scilab - 6.0.0
4
5 //Aim : Design of an iron cored choke coil using SCILAB coding
6 ///Data: Design a single phase variable choke coil
7
8 clc
9 clear
10
11 //Following data are to be taken from user
12
13 V=input('Enter value of supply voltage') // supply voltage (in the range of 230 - 440 V)
14 f=input('Enter frequency of supply') // supply frequency = 50 Hz in India and 60 Hz in US
15 I=input('Enter value of current to be carried in Amp ') // currentn carrying capacity in Amp ( in the
```

```
range of 5-25 Amp)
16 lg=input('Enter maximum airgap length in cms') //
      airgap length varies between 0 and 10 cms being
      variable choke coil
17
18 // Actual Calculations begin
19
20 uo=4*%pi*1e-7 // permeability of free space
21 Sf=0.9 // stacking factor
22 K = (uo*V*I)/(2*\%pi*f*2*lg/100)
23 i = 1
24 for Bg=0.2:0.1:0.8
25
      A_root(i)=sqrt(K)/Bg
26
      i=i+1
27 end
28 \text{ Bgm} = 0.45
29 A_root=0.0225
30 A_i=A_root^2 // net iron area
31 Agi=A_i/Sf; // gross iron area
32 A = sqrt(Agi) // width of limb
33 ATg = Bgm*2*lg/100/uo // airgap mmf
34 ATt = 1.1*ATg // total mmf
35 N = ceil(ATt / I) // no. of turns
36 del=2.4 // current density
37 a = I/del // conductor area in mm^2
38 d = sqrt(4*a/\%pi)+.05 // diameter of conductor in
     mm
39 d1 = 2.488 // diameter of insulated conductor
40 a1 = (\%pi/4)*d1^2 // cross sectional area of
      insulated conductor
41 sf = 0.8*(d/d1)^2 // space factor
42 Aw = N*a1/sf // area of window
43 AW = 1.2*Aw // gross window area in mm<sup>2</sup>
44 Ww = sqrt(AW/2) // width of window in mm
45 Hw = 2*Ww // height of window assuming H/W ratio is
46 hf = Hw-20 // height of winding
47 Nh = ceil(hf/d1) // no. of conductors in height
```

```
48 Nd = N/(2*Nh) // no. of conductors in depth
49 dc = ceil(Nd*d1) // depth of coil
50 \text{ dc1} = \text{dc+5} // \text{ actual depth of coil}
51 hf1 = ceil(hf+10) // actual height of winding
52 \text{ dw} = \text{ceil}(\text{Ww} - 2*\text{dc1}) // \text{distance betwen two coils}
53 D = ceil(Ww + A*1000) // distance between limbs
54 WC = ceil(D+A*1000) // width of core in mm
55 HC = ceil(Hw+2*A*1000+lg*10) // height of core in mm
56 Z = V/I
57 mprintf('Diameter of insulated conductor is %f mm',
      d1)
58 mprintf(' \ n')
59 mprintf('Area of insulated conductor is %f mm^2', a1
      )
60 mprintf('\n')
61 mprintf('Height of coil is %d mm', hf1)
62 mprintf(' \ n')
63 mprintf('Depth of coil is %d mm', dc1)
64 mprintf(' \ n')
65 mprintf('Height of core is %d mm', HC)
66 mprintf('\n')
67 mprintf('Width of core is %d mm', WC)
68 mprintf('\n')
69 mprintf('Impedance of the coil is %d Ohms',Z)
```

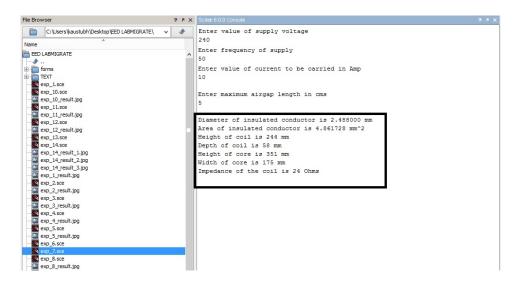


Figure 7.1: Experiment7

A SCILAB code to workout design of simplex lap winding in DC machines

Scilab code Solution 8.8 Exp8

```
1 //Experiment-8
2 // windows 8.1 - 64-Bit
3 //Scilab - 6.0.0
4
5 //Aim : A SCILAB code to workout design of simplex lap winding in DC machines
6 //Data: Workout details of simplex lap winding for DC generator
7
8 clc;
9 clear all;
10
11 // Following data is to be aken from user
12
13 p=input('Enter No. of poles') // no. poles (in the range of 2 - 12) always an even number
14 s=input('Enter No. of slots in armature') // no. of
```

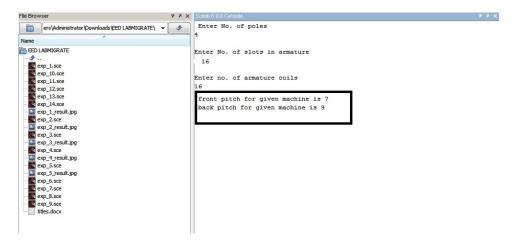


Figure 8.1: Exp8

```
armature slots (in the range of 16 - 48)
15 c=input('Enter no. of armature coils') // armature
      coils in multiple of armature slots (in the range
       of 16 - 48)
16
17 // Actual calculations begin
19 cs=c*2 // no. of coil sides
20 csps=cs/s // no. of coils sides per slot
21 cspp=cs/p // no. of coils sides per pole
22
23 yb = cspp+1 // back pitch
24 yf = cspp-1 //front pitch
25
26 mprintf('front pitch for given machine is %d',yf)
27 mprintf('\n')
28 mprintf('back pitch for given machine is %d',yb)
```

A SCILAB code to workout design of simplex Wave winding in DC machines

Scilab code Solution 9.9 Exp9

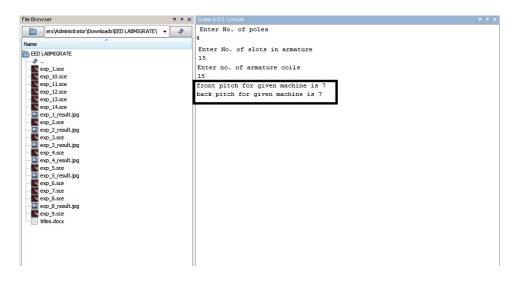


Figure 9.1: Exp9

```
armature slots (in the range of 10-48)
15 c=input('Enter no. of armature coils') // armature
      coils in multiple of armature slots (in the range
       of 10 - 48)
16
17 // Actual calculations begin
18
19 cs=c*2 // no. of coil sides
20 csps=cs/s // no. of coils sides per slot
21 cspp=cs/p // no. of coils sides per pole
22
23 yb = floor(cs/p) // back pitch
24 y = (cs-2)/(p/2) //winding pitch
25 \text{ yf} = \text{y-yb}
26
27 mprintf('front pitch for given machine is %d',yf)
28 mprintf('\n')
29 mprintf('back pitch for given machine is %d',yb)
```

Core Loss Calculations in magnetic materials using SCILAB Programming

Scilab code Solution 10.10 Experiment10

```
1 //Experiment-10
2 // windows 8.1 - 64-Bit
3 //Scilab - 6.0.0
4
5 //Aim : Core Loss Calculations in magnetic materials using SCILAB Programming
6 //Data: CAlculate core loss per kg in a specimen of ally sheet using user defined data
7
8 clear;
9 clc;
10
11
12 // Following data is to be taken from user
13
14 Bm=input('Enter value of Maximum flux density in Wb/m^2') // maxium flux density (in the range of 0.5)
```

```
-2.5 \text{ Wb/m}^2
15 f=input('Enter value of frequency in Hz') //
      frequency of flux reversal (genrally 50 Hz)
16 t=input ('Enter thickness of laminated plates in mm')
      // tickness of laminations (in range of 0.2 -
      0.6 \, \mathrm{mm}
17 r=input('Enter Resistivity of material in Ohm*m')//
      resistivity in Ohm*m (in the range of 0.2-0.6
      micro Ohm*m)
18 sg=input ('Enter specific gravity of material in kg/m
      ^3') // specific gravity (in the range of 7-10
      kg/m^3
19 hl=input('Enter value of hysterisis loss in in J*Hz/
     m<sup>3</sup>') // specific hysterisis loss (in range of
      400 - 800 \ J*Hz/m^3)
20
21 // Actual calculations begin
23 Pe=((\%pi^2)*(f^2)*(Bm^2)*((t/1000)^2))/((sg*1000)
      *(6*r)) // eddy current loss per kg
24 \text{ Ph=hl*f/(sg*1e3)}
25 Pi=Pe+Ph
26 mprintf ('Eddy Current Loss per kg for given material
       is %f W', Pe)
27 mprintf(' \ n')
28 mprintf ('Hysterisis Loss per kg for given material
      is %f W', Ph)
29 mprintf(' \ n')
30 mprintf('Total Iron Loss per kg for given material
      is %f W', Pi)
```

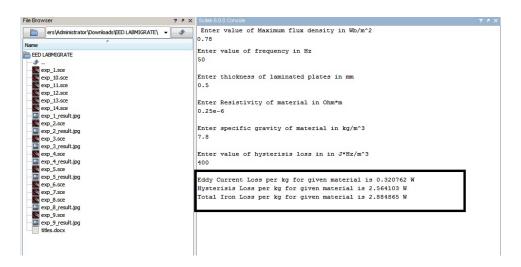


Figure 10.1: Experiment10

A SCILAB program for Computation of slot leakage reactance in induction motor

Scilab code Solution 11.11 Experiment11

```
1 //Experiment-11
2 // windows 8.1 - 64-Bit
3 //Scilab - 6.0.0
4
5 //Aim : A SCILAB program for Computation of slot
    leakage reactance in induction motor
6 // Data: Find out slot leakage reactance for
    induction motor from given slot dimensions
7
8 clc;
9 clear all;
10
11 // Data to be taken from user
12
13 T=input('Enter no. of turns per phase') // turns per
    phase for induction motor (in the range of 200 -
    300)
```

```
14 s=input('Enter no. of slots per phase') // slots per
       phase for induction motor (in the range of 12 -
      24)
15 bs=input('Enter slot width in mm') // slot opening
      in mm (in the range of 10 -30 \text{ mm})
16 L=input('Enter core / slot length in mm') // slot
      length in mm (in the range of 150 - 650 mm)
17 wo=input ('Enter lip opening in mm') // width of lip
      in mm (in the range of 2-6 mm)
18 h1=input ('Enter heigth of conductor in slot in mm')
      // heigth of conductor portion in mm (in the
      range of 20 - 80 \text{ mm})
19 h2=input ('Enter Value of clearance between
      conductors and wedge') // clearnace in mm (in the
       range of 1 - 4 \text{ mm})
20 h3=input('Enter heigth of wedge in mm') // wedge
      height in mm (in the range of 2-6 mm)
21 h4=input('Enter height of lip in mm') // lip height
      in mm (in the range of 1-4 mm)
22
23 // Actual calculations begin
24
25 f=50; // frequency of supply
26 uo=4*%pi*1e-7; // pearmeabilty of free space
27 \text{ Ls} = (h1/(3*bs)) + (h2/(bs)) + (2*h3/(bs+wo)) + (h4/wo)
28 \text{ xs} = 8 * \% \text{pi} * f * uo * T^2 * (L/1000) * Ls/s
29
30 mprintf ('Leakage reactance for given machine is %f
      Ohms', xs)
```

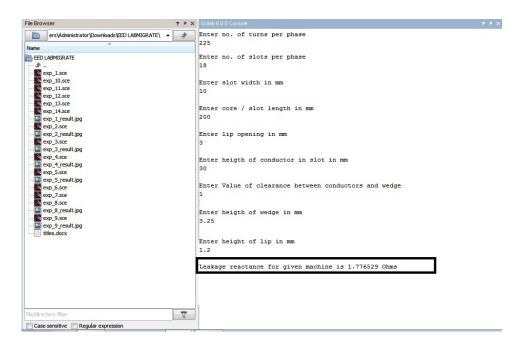


Figure 11.1: Experiment11

A SCILAB program for Design of Electromagnet

Scilab code Solution 12.12 Experiment12

```
1 / Experiment -12
2 //windows 8.1 - 64-Bit
3 // Scilab - 6.0.0
5 //Aim : A SCILAB program for Design of Electromagnet
6 //Data:Design a flat faced armature type of circular
      electromagnet
8 clc
9 clear
10
11 //Following data is to be taken form the user
13 F=input('Enter Amount of force in kg') // force to
     be exerted by electromagnet in kg(in the range of
      100 - 250 \text{ kg}
14 s=input('Enter value of stroke in mm') // stroke in
     mm (in the range of 0.5 - 1.5 mm)
15 v=input('Enter supply volage') // in the range of 5
```

```
- 15 volts
16 ta=input ('Enter ambient temperature in degree
      celcius') // general value is 20 oC
17 t=input('Enter permissible temperature rise above
      ambient temperature') // 50 - 80 oC
18
19 // Actual Calculations begin
20
21 Bm = 1.1 // maximum flux density in Wb/m<sup>2</sup>
22 uo = 4*\%pi*1e-7
23 ro_0=0.01734 // resistib=vity at 0 degree
24 alp_0=0.00393 // temperature coefficient of
      resistance
25 h_by_d=3 // heigth to depth ratio of coil
26 \quad C=0.085 \quad // \quad constant
27 Sf=0.5 // assumed space factor
28
29 A = F*uo/(0.102*Bm^2) // are of central limb
30 r1 = sqrt(A/%pi) // radius of central limb
31 / disp(r1)
32 AT=(1600000*Bm*s*1e-3)/0.85 // total mmf required
33 \text{ ro}_{70}=\text{ro}_{0}*(1+(alp_{0}*t))
34 \text{ hc} = ((3*ro_70*C*AT^2)/(2*Sf*t)*1e-6)^(1/3) // \text{heigth}
      of coil
35 // disp (hc)
36 \text{ dc=hc/3} //\text{depth of coil}
37 // disp (dc)
38 r2 = dc + r1
39 // disp(r2)
40 \text{ t1=r1/2}
41 // disp(t1)
42 t2=(r1^2)/(2*r2)
43 // disp(t2)
44 r3=sqrt(r1^2+r2^2)
45 //disp(r3)
46 \ a=(AT*ro_70*\%pi*(r1+r2))*1e-3/v // cross sectional
      area of conductor
47 // disp (a)
```

```
48 d=sqrt(4*a*1000/%pi) // diameter of conductor
49 //disp(d)
50 dc1=dc*1000-2 // depth of coil considering clearance
51 // \operatorname{disp}(\operatorname{dc1})
52 nd=ceil(dc1/d) // no. of layers in depth
53 //disp(nd)
54 hc1=hc*1000-3 // height of coil considering
      clearance
55 nh=ceil(hc1/d) // no o flayers in height
\frac{1}{6} // disp(nh)
57 T=nd*nh // no. of turns in coil
58 // \operatorname{disp}(T)
59 ab=(%pi/4*d^2) // diameter of bare conductor
60 R=T*ro_70*(\%pi*(r1+r2))/ab // resistance of coil
61 // disp (R)
62 I=v/R; // current in coil
63 // disp(I)
64 mmf=I*T // actual mmf developed by coil
65 // \operatorname{disp}(\mathrm{mmf})
66 sf=T*ab/(hc*dc) // actual space factor
67 // \operatorname{disp}(sf)
68 theta = (ro_70*C*mmf^2*1e-6)*1e6/(2*sf*dc*hc^2)
69 //disp(theta)
70
71 mprintf('heigth of coil is %f mm',hc*1000)
72 mprintf(' \ n')
73 mprintf('depth of coil is %f mm', dc*1000)
74 mprintf(' \ n')
75 mprintf('total no. of turns in the coil are %d',T)
76 mprintf (' \ n')
77 mprintf('Current flowing through the coil is %f Amp
      ',I)
78 mprintf('\n')
79 mprintf('MMF developed by the coil is %d AT', mmf)
80 mprintf('\n')
81 mprintf('Temperature rise of the coil is %f oC',
      theta)
82 mprintf('\n')
```

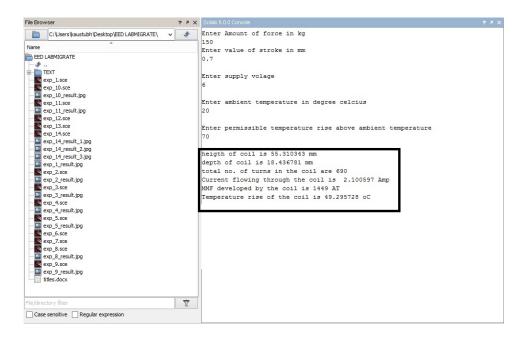


Figure 12.1: Experiment12

Computation of winding factor and distribution factor in armature winding using SCILAB programming

Scilab code Solution 13.13 Exp13

```
1 //Experiment-13
2 // windows 8.1 - 64-Bit
3 //Scilab - 6.0.0
4
5 //Aim : Computation of winding factor and distribution factor in armature winding using SCILAB programming
6 //Data: Calculate winding factor and distribution factor for armature winding of synchronous machine
7
8 clc;
9 clear all;
10
11 // Data to be taken from the user
```

```
12
13 p=input('Enter no. of poles') // no. of poles in
      synchronous machine (in the range of 2-12)
14 s=input('Enter no. of slots') // no. of slots in
      synchronous machine (in the range of 16 - 96)
15 pitch=input('Enter No. of short pitch slots') // no.
       of slots by which short pitching is required (
      in the range of 1 to 4)
16
17 // Actual calculations start
18
19 sp = s/p // slots per pole
20 spp = sp/3 // slots per pole per phase
21 \text{ dist} = \% \text{pi/spp} //
22 spread = %pi/sp // phase spread angle
23 alpha = spread*pitch // angle of short pitch
24 bet = %pi/p // distribution angle
25
26 kp1=cos(alpha/2) // pitch factor for fundamental
27 kp5=cos(5*alpha/2) // pitch factor for 5th harmonic
28
29 kd1=(sin(spp*bet/2))/(spp*sin(bet/2)) //
      distribution factor for fundamental
30 \text{ kd5} = (\sin(\text{spp}*5*\text{bet}/2))/(\text{spp}*\sin(5*\text{bet}/2)) //
      distribution factor for 5th harmonic
31
32 mprintf('Pitch factor for fundamental is %f',kp1)
33 mprintf('\n')
34 mprintf('Pitch factor for 5th harmonic is %f',kp5)
35 mprintf('\n')
36 mprintf('Distribution factor for fundamental is %f',
     kd1)
37 \text{ mprintf}(' \ n')
38 mprintf('Distribution factor for 5th harmonic is %f'
      ,kd5)
39 mprintf('\n')
```

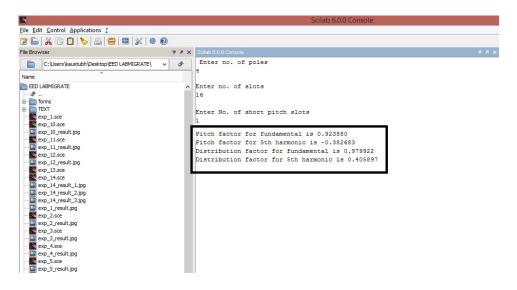


Figure 13.1: Exp13

Analyzing variation of slot leakage reactance in induction motor using SCILAB code

Scilab code Solution 14.14 Experiment14

```
1 / Experiment -14
2 // windows 8.1 - 64-Bit
3 // Scilab - 6.0.0
4 //Aim : Analyzing variation of slot leakage reactance
       in induction motor using SCILAB code
5 // Data: Plot graphs showing effect of no. of slots,
      length of armature core and no. of turns on slot
      leakage reactance
6
7 clc;
8 clear;
10 // Assumed data
11
12
13
14 bs=10 // slot opening in mm (in the range of 10 -30
```

```
mm)
15 wo=3 // width of lip in mm (in the range of 2-6 mm
16 h1=30 // heigth of conductor portion in mm (in the
      range of 20 - 80 \text{ mm})
17 h2=1 // clearnace in mm (in the range of 1-4 \text{ mm})
18 h3=3.25 // wedge height in mm (in the range of 2-6
      mm)
19 h4=1.2 // lip height in mm (in the range of 1-4 mm
20
21 f=50; // frequency of supply
22 uo=4*%pi*1e-7; // pearmeabilty of free space
23 Ls=(h1/(3*bs))+(h2/(bs))+(2*h3/(bs+wo))+(h4/wo)
24
25 // Evaluating variation in leakage reactance with
      change in no. of slots
26 L=200
27 T=225
28 \text{ for s} = 1:25
29
       xs(s)=8*\%pi*f*uo*T^2*(L/1000)*Ls/s
30 end
31
32 x = 1:25
33 figure(1)
34 plot(x,xs)
35 xlabel('No. of slots')
36 ylabel ('Leakage reactance in Ohms')
37 title ('Variation of leakage reactance with change in
       no. of slots')
38
39 clear xs s T L
40 // Evaluating variation in leakage reactance with
      change in length of core
41 L = 100:10:2000
42 	 s = 20
43 T = 225
44 for i = 1:length(L)
```

```
xs(i)=8*\%pi*f*uo*T^2*(L(i)/1000)*Ls/s
45
46 \text{ end}
47 figure (2)
48 \text{ plot}(L,xs)
49 xlabel('length of core in mm')
50 ylabel ('Leakage reactance in Ohms')
51 title('Variation of leakage reactance with change in
       length of core')
52
53 clear xs s T L
54 // Evaluating variation in leakage reactance with
      change in no. of turns per phase
55 L = 200
56 s = 20
57 T = 100:400
58 \text{ for } i = 1:length(T)
       xs(i)=8*\%pi*f*uo*T(i)^2*(L/1000)*Ls/s
59
60 \text{ end}
61 figure (3)
62 plot(T,xs)
63 xlabel('No. of turns per phase')
64 ylabel ('Leakage reactance in Ohms')
65 title('Variation of leakage reactance with change in
       no. of turns per phase')
```

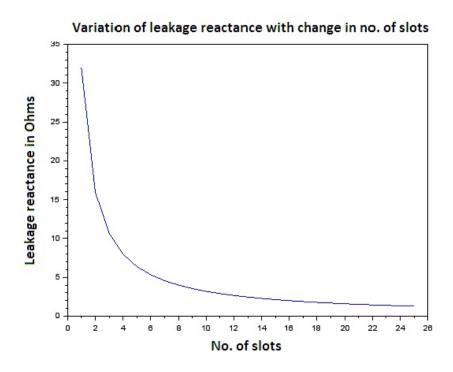
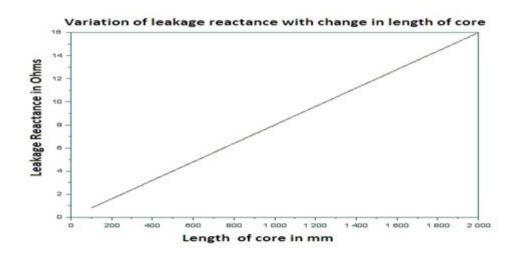


Figure 14.1: Experiment14



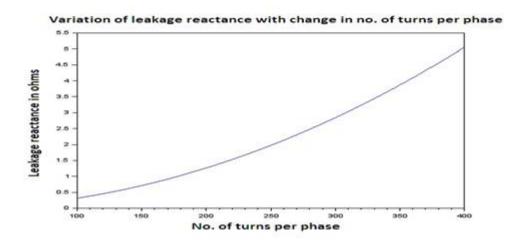


Figure 14.2: Experiment14