

Scilab Manual for
Control of Electric Drive
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<http://spoken-tutorial.org/NMEICT-Intro>. This Scilab Manual and Scilab codes
written in it can be downloaded from the "Migrated Labs" section at the website
<http://scilab.in>

Contents

List of Scilab Solutions	3
1 Develop a program, to plot Torque-Slip characteristics of poly phase induction motor.	5
2 Develop a program, to plot Torque-Speed characteristics of poly phase induction motor.	8
3 Develop a program to plot torque-speed characteristics of single phase half controlled rectifier fed separately excited DC motor	11
4 Develop a program to plot torque-speed characteristics of single phase fully controlled rectifier fed separately excited DCmotor	17
5 Develop a program, to plot Torque-Slip characteristics of poly phase induction motor using VVVF control.	23
6 To Study and Simulation of the single phase half controlled AC to DC Converter and effect of firing angle on load voltage	26
7 To Study and Simulation of the single phase fully controlled AC to DC Converter and effect of firing angle on load voltage	28

List of Experiments

Solution 1.01	User define Torque Slip characterisite	5
Solution 2.01	Speed Torque	8
Solution 3.01	Halfwave rectifier control for different firing angle	11
Solution 4.01	Torque Speed characteristics of single phase full controlled rectifier fed separately excited DC motor	17
Solution 5.01	VVVF Control	23

List of Figures

1.1	User define Torque Slip characterisite	6
2.1	Speed Torque	9
3.1	Halfwave rectifier control for different firing angle	12
4.1	Torque Speed characteristics of single phase full controlled rectifier fed separately excited DC motor	18
5.1	VVVF Control	24
6.1	Halfwave uncontrolled Rectifier	27
6.2	Halfwave Controlled Rectifier	27
7.1	Fullwave Uncontrolled Rectifier	29
7.2	Fullwave Uncontrolled Rectifier	29
7.3	Fullwave Controlled Rectifier For 45 alpha	30
7.4	Fullwave Controlled Rectifier For 90 alpha	31

Experiment: 1

**Develop a program, to plot
Torque-Slip characteristics of
poly phase induction motor.**

Scilab code Solution 1.01 User define Torque Slip characterisitc

```
1
2
3 //Experiment-1
4 // windows - 7 - 64-Bit
5 //Scilab - 5.4.1
6
7
8 //AIM: Devlop a program to plot Torque - slip
   characteristics .
9 clear all
10clc
11 // Considering that the Stator of Induction Motor is
   Star Connected .
12 // user define parameter for Torque - slip
   Characteristic .
```

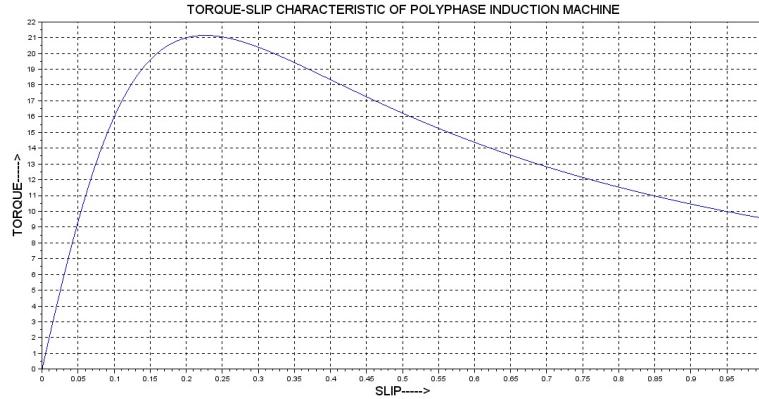


Figure 1.1: User define Torque Slip characterisitc

```

13 V = input('Enter the value of Voltage in volts : ')
           // Example v= 400 Volt
14 f = input('Enter the value of frequency in Hertz : ')
           // Example f=50 Hz
15 p = input('Enter the nos. of Poles : ')           //
           Example Pole = 4
16 N = input('Enter the Rated Speed in rpm : ')
           // Example speed = 1500 rpm
17 Rs = input('Enter the value of Stator Resistance : ')
           // Example Rs = 2 ohm
18 Rr = input('Enter the value of Rotor Resistance with
           referred to Stator : ')           // Example Rr= 5
           ohm
19 Xs = input('Enter the value of Stator Reactance : ')
           // Example Xs = 12
20 Xr = input('Enter the value of Rotor Reactance with
           referred to Stator : ')           // Example xr = 10
21 V1 = V/sqrt(3)
22 Ns = (120*f/p)
23 s = (Ns - N)/Ns
24 Wms = Ns*(2*pi/60)
25 s = [0.0001:0.001:1];

```

```

26 R1 = Rr./s;
27 R = (Rs + R1);
28 X = (Xs + Xr);
29 T = (3 * V1^2 .* R1)./(Wms*(R.^2 + X.^2));
30 plot(s,T)
31 //Smax = Rr/sqrt((Rs)^2+(Xs+Xr)^2)
32 title('TORQUE-SLIP CHARACTERISTIC OF POLYPHASE
        INDUCTION MACHINE', 'fontsize', 4);
33 xlabel("SLIP————>", "fontsize", 4);
34 ylabel("TORQUE————>", "fontsize", 4);
35 // plot(Smax, max(T), '*')
36 xgrid

```

Experiment: 2

Develop a program, to plot
Torque-Speed characteristics of
poly phase induction motor.

Scilab code Solution 2.01 Speed Torque

```
1 //Experiment -2
2 // windows - 7 - 64-Bit
3 // Scilab - 5.4.1
4
5
6 // .... Torque-speed characteristic of a polyphase
   induction motor .....
7 clear
8 clc
9 //-----Enter Data
-----  

10
11 Po = input('Enter the value of Output Power : ') //
      Enter: 2.8
12 v = input('Enter the value of Voltage in volts : ')
```

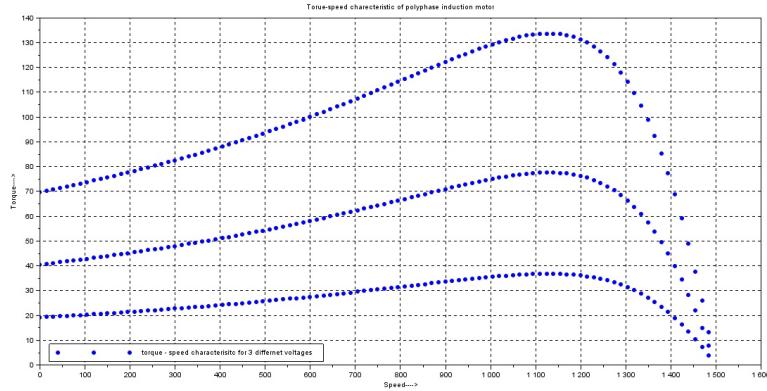


Figure 2.1: Speed Torque

```

//Enter: 420
13 f =input('Enter the value of frequency in Hertz : ')
//Enter: 50
14 p = input('Enter the nos. of Poles : ') //Enter: 4
15 n = input('Enter the Rated Speed in rpm : ') //Enter:
1500
16 Rs =input('Enter the value of Stator Resistance : ')
//Enter: 2.5
17 Rr = input('Enter the value of Rotor Resistance with
referred to Stator : ') //Enter: 2.5
18 Xs =input('Enter the value of Stator Reactance : ')
//Enter: 4.9
19 Xr =input('Enter the value of Rotor Reactance with
referred to Stator : ') //Enter: 4.9
20 Xm = input('Enter the value of Magnetizing Reactance
: ') //Enter: 80
21 Ns=((120*f)/p); //Synchronous
speed ,rpm
22 Ws=((2*pi)/60)*Ns; //Angular
synchoronous speed ,rad/sec
23 for s=0.01:0.01:1;
24 for v=(v-200):100:v;
```

```

25     Sm=(Rr/sqrt(Rs^2+(Xs+Xr)^2));
26     N=(1-s)*Ns;
27     a=(3/Ws);
28     b=((v^2)/((Rs+(Rr/s))^2+(Xs+Xr)^2));
29     c=(Rr/s);
30     T=a*b*c;
31     Tm=(3/(2*Ws))*(v^2/(Rs+sqrt(Rs^2+(Xs+Xr)^2)));
32     plot(N,T,'.');
33
34 end
35 end
36
37 title ('Torque-speed characteristic of polyphase
           induction motor')
38 xlabel('Speed-->');
39 ylabel('Torque-->');
40 xgrid;
41 legend('torque - speed characterisite for 3
           differnet voltages',3)

```

Experiment: 3

Develop a program to plot torque-speed characteristics of single phase half controlled rectifier fed separately excited DC motor

Scilab code Solution 3.01 Halfwave rectifier control for different firing angle

```
1 //Experiment -3
2 // windows - 7 - 64-Bit
3 //Scilab - 5.4.1
4
5
6 //AIM: Develop a program to plot torque-speed
    characteristics of single phase half controlled
    rectifier fed separately excited DC motor
7 clear
8clc
```

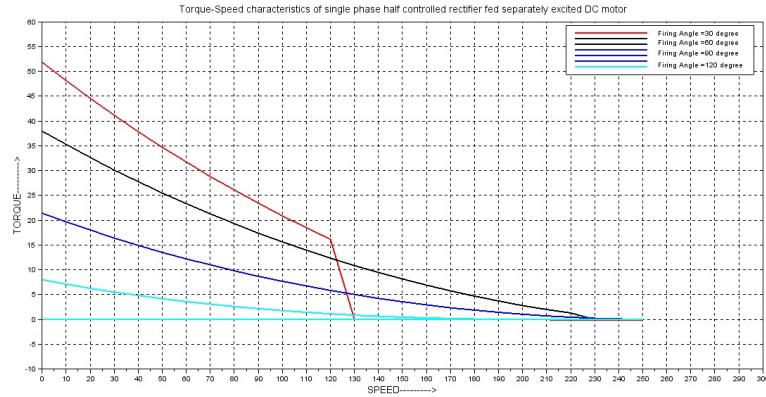


Figure 3.1: Halfwave rectifier control for different firing angle

```

9
10 Vs=230; // SUPPLY VOLTAGE IN VOLT
11 Va=220; //ARMATURE VOLTAGE IN VOLT
12 f=50; // FREQUENCY IN Hz
13 Wr=1500*%pi/30; // RATED SPEED IN r.p.s.
14 Ia=11.6; // ARMATURE CURRENT IN AMP
15 Ra=2; // ARMATURE RESISTANCE IN OHM
16 La=28.36e-3; // ARMAURE INDUCTANCE IN HENRY
17
18 Vm=Vs*sqrt(2); //MAXIMUM VOLTAGE IN VOLT
19 E=Va-Ia*Ra; // BACK EMF IN VOLT
20 Tr=E*Ia/Wr; // RATED TORQUE IN Nm
21
22 K=E/Wr;
23 Wmo=Vm/K; // NO LOAD SPEED IN r.p.s.
24 w=2*%pi*f;
25
26 Z=sqrt(Ra^2+(w*La)^2); // Calculation of impedance
27 fai=atan((w*La)/Ra);
28
29 j=1;
30 for alpha=30 //
```

```

For Firing angle = 30 degree
31    alphar=alpha*pi/180;
32    i=1;
33    for Wm=0.01:10:Wmo
34        Wmi(j,i)=Wm;
35        a=%pi+alphar;
36        ia=(Vm*exp(-(alphar)*cotg(fai))*(sin(fai)-
37            sin(alphar-fai))/Z)-(E*exp(-(alphar)*cotg
38            (fai))/Ra);
39        if ia<=0 then
40            for b=(alpha+0.1):0.1:360
41                betar=b*pi/180;
42                ia=(Vm*sin(betar-fai)/Z)-(K*Wm/Ra)+(((K*
43                    Wm/Ra)-(Vm*sin(alphar-fai)/Z))*exp((
44                    alphar-betar)*cotg(fai)));
45                if ia<=1e-4 then
46                    break;
47                end
48            end
49            Tor1(j,i)=((Vm*K*(cos(alphar)-cos(betar)
50                )-(Wm*K^2*(betar-alphar)))/(%pi*Ra));
51        else
52            Tor1(j,i)=((Vm*K*(1+cos(alphar))/pi)-(Wm
53                *K^2))/Ra;
54        end
55        i=i+1;
56    end
57    j=j+1;
58 end
59 plot(Wmi',Tor1', 'r', 'LineWidth', 2)
60
61 for alpha=60 //
```

```

61      ia=(Vm*exp(-(alphar)*cotg(fai))*(sin(fai)-
62          sin(alphar-fai))/Z)-(E*exp(-(alphar)*cotg
63          (fai))/Ra);
64      if ia<=0 then
65          for b=(alpha+0.1):0.1:360
66              betar=b*pi/180;
67              ia=(Vm*sin(betar-fai)/Z)-(K*Wm/Ra)+(((K*
68                  Wm/Ra)-(Vm*sin(alphar-fai)/Z))*exp((
69                  alphar-betar)*cotg(fai)));
70              if ia<=1e-4 then
71                  break;
72              end
73          end
74          i=i+1;
75      end
76      j=j+1;
77  end
78  plot(Wmi',Tor2', 'k', 'LineWidth', 2)
79  for alpha=90 //  

     For Firing angle = 90 degree
80      alphar=alpha*pi/180;
81      i=1;
82      for Wm=0.01:10:Wmo
83          Wmi(j,i)=Wm;
84          a=%pi+alphar;
85          ia=(Vm*exp(-(alphar)*cotg(fai))*(sin(fai)-
86              sin(alphar-fai))/Z)-(E*exp(-(alphar)*cotg
87              (fai))/Ra);
88          if ia<=0 then
89              for b=(alpha+0.1):0.1:360

```

```

Wm/Ra)-(Vm*sin(alphar-fai)/Z))*exp((
alphar-betar)*cotg(fai)));
90    if ia<=1e-4 then
91        break;
92    end
93    end
94    Tor3(j,i)=((Vm*K*(cos(alphar)-cos(betar)
))-(Wm*K^2*(betar-alphar))/(%pi*Ra);
95 else
96    Tor3(j,i)=((Vm*K*(1+cos(alphar))/pi)-(Wm
*K^2))/Ra;
97 end
98 i=i+1;
99 end
100 j=j+1;
101 end
102 plot(Wmi',Tor3', 'b', 'LineWidth', 2)
103
104 for alpha=120 // 
    For Firing angle = 120 degree
105     alphar=alpha*pi/180;
106     i=1;
107     for Wm=0.01:10:Wmo
108         Wmi(j,i)=Wm;
109         a=%pi+alphar;
110         ia=(Vm*exp(-(alphar)*cotg(fai))*(sin(fai)-
            sin(alphar-fai))/Z)-(E*exp(-(alphar)*cotg
            (fai))/Ra);
111         if ia<=0 then
112             for b=(alpha+0.1):0.1:360
113                 betar=b*pi/180;
114                 ia=(Vm*sin(betar-fai)/Z)-(K*Wm/Ra)+(((K*
                    Wm/Ra)-(Vm*sin(alphar-fai)/Z))*exp((
                    alphar-betar)*cotg(fai)));
115             if ia<=1e-4 then
116                 break;
117             end
118         end

```

```

119      Tor4(j,i)=((Vm*K*(cos(alphar)-cos(betar)
120                  ))-(Wm*K^2*(betar-alphar)))/(%pi*Ra);
121      else
122          Tor4(j,i)=((Vm*K*(1+cos(alphar))/pi)-(Wm*K
123                      ^2))/Ra;
124      end
125      i=i+1;
126  end
127
128 plot(Wmi',Tor4', 'c', 'LineWidth',2)
129
130 title(' Torque-Speed characteristics of single phase
131 half controlled rectifier fed separately excited
132 DC motor ', 'fontsize',3)
133 xlabel("SPEED————>", 'fontsize',3)
134 ylabel("TORQUE————>", 'fontsize',3)
133 xgrid
134 legend('Firing Angle =30 degree', 'Firing Angle =60
135 degree', ' ', 'Firing Angle =90 degree', ' ', ' ',
136 Firing Angle =120 degree')

```

Experiment: 4

Develop a program to plot torque-speed characteristics of single phase fully controlled rectifier fed separately excited DCmotor

Scilab code Solution 4.01 Torque Speed characteristics of single phase full controlled rectifier fed separately excited DC motor

```
1 //Experiment -4
2 // windows - 7 - 64-Bit
3 //Scilab - 5.4.1
4
5
6 //AIM: Develop a program to plot torque-speed
    characteristics of single phase full controlled
    rectifier fed separately excited DC motor
7 clear
8clc
```

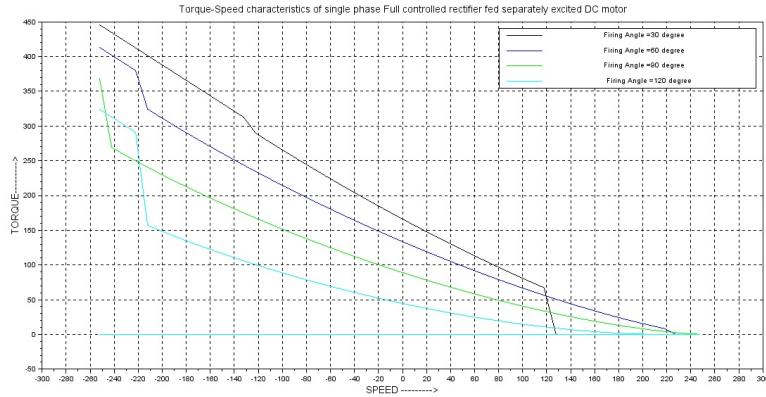


Figure 4.1: Torque Speed characteristics of single phase full controlled rectifier fed separately excited DC motor

```

9 Vs=230;                                // SUPPLY VOLTAGE
IN VOLT
10 Vm=Vs*sqrt(2);                      //MAXIMUM VOLTAGE IN VOLT
11 f=50 ;                               // FREQUENCY IN Hz
12 w=2*pi*f
13
14 Wr=1500*pi/30;                     // RATED SPEED IN r.p.s.
15 Ia=11.6;                            // ARMATURE CURRENT IN AMP
16 Ra=1.5;                             // ARMATURE RESISTANCE IN OHM
17 La=0.6e-6;                          // ARMAURE INDUCTANCE IN HENRY
18
19 Va=220;                            //ARMATURE VOLTAGE IN VOLT
20 E = Va-(Ia*Ra);                   // BACK EMF IN VOLT
21 K = E/Wr
22 Wmo=Vm/K;                         // NO LOAD SPEED IN r.p.s.
23 Z=sqrt(Ra^2+(w*La)^2);           // Calculation of impedance
24 fai=atan((w*La)/Ra)
25 Tr=E*Ia/Wr;                        // RATED TORQUE IN Nm
26 j=1;
27
28 for alpha=30                       // For Firing

```

```

        angle = 30 degree
29 alpha=alpha*%pi/180;
30 i=1;
31   for Wm = - Wmo:10:Wmo ;
32     Wmi(j,i)=Wm;
33     eta=%pi+alpha;
34     ia=(Vm*sin(eta-fai)/Z)-(K*Wm/Ra)+(((K*Wm/Ra)-(Vm
           *sin(alpha-fai)/Z))*exp((alpha-eta)*cotg(
           fai)));
35       if ia<=0      then
36         current is discontinuous
37         for beta=(alpha+0.1):0.1:360
38           betar=beta*%pi/180;
39           ia=(Vm*sin(betar-fai)/Z)-(K*Wm/Ra)+(((K*
               Wm/Ra)-(Vm*sin(alpha-fai)/Z))*exp((
               alpha-betar)*cotg(fai)));
40           if ia<=0.00001 then
41             break;
42           end
43         end
44       Tor1(j,i)=((Vm*K*(cos(alpha)-cos(betar)))-(Wm*K^2*(betar-alpha))/(%pi*Ra));
45     else
46       Tor1(j,i)=((Vm*K*(1+cos(alpha))/%pi)-(Wm*K^2))/Ra;
47     end
48   i=i+1;
49 end
50 j=j+1;
51 end
52 plot(Wmi',Tor1', 'k', 'LineWidth', 2)
53 for alpha=60                                // For Firing
      angle = 60 degree
54 alpha=alpha*%pi/180;
55 i=1;
56   for Wm = - Wmo:10:Wmo ;

```

```

57     Wmi(j,i)=Wm;
58     eta=%pi+alphar;
59     ia=(Vm*sin(eta-fai)/Z)-(K*Wm/Ra)+(((K*Wm/Ra)-(Vm
      *sin(alphar-fai)/Z))*exp((alphar-eta)*cotg(
      fai)));
60     if ia<=0      then
61         // if
62         current is discontinuous
63         for beta=(alpha+0.1):0.1:360
64             betar=beta*%pi/180;
65             ia=(Vm*sin(betar-fai)/Z)-(K*Wm/Ra)+(((K*
      Wm/Ra)-(Vm*sin(alphar-fai)/Z))*exp((
      alphar-betar)*cotg(fai)));
66             if ia<=0.00001 then
67                 break;
68             end
69         end
70         Tor2(j,i)=((Vm*K*(cos(alphar)-cos(betar)))-(Wm*K^2*(betar-alphar)))/(%pi*Ra);
71     else
72         Tor2(j,i)=((Vm*K*(1+cos(alphar))/%pi)-(Wm*K
      ^2))/Ra;
73     end
74     i=i+1;
75   end
76   plot(Wmi',Tor2', 'b', 'LineWidth', 2)
77
78   for alpha=90                                // For Firing
79     angle = 90 degree
80     alphar=alpha*%pi/180;
81     i=1;
82     for Wm = - Wmo:10:Wmo;
83       Wmi(j,i)=Wm;
84       eta=%pi+alphar;
85       ia=(Vm*sin(eta-fai)/Z)-(K*Wm/Ra)+(((K*Wm/Ra)-(Vm
      *sin(alphar-fai)/Z))*exp((alphar-eta)*cotg(

```

```

fai));
85      if ia<=0      then                                // if
        current is discontinuous
86      for beta=(alpha+0.1):0.1:360
87          betar=beta*%pi/180;
88          ia=(Vm*sin(betar-fai)/Z)-(K*Wm/Ra)+(((K*
              Wm/Ra)-(Vm*sin(alphar-fai)/Z))*exp((
              alphar-betar)*cotg(fai)));
89          if ia<=0.00001 then
90              break;
91          end
92      end
93      Tor3(j,i)=((Vm*K*(cos(alphar)-cos(betar)))-((
              Wm*K^2*(betar-alphar)))/(%pi*Ra);
94  else
95      Tor3(j,i)=((Vm*K*(1+cos(alphar))/%pi)-(Wm*K
              ^2))/Ra;
96  end
97  i=i+1;
98 end
99 j=j+1;
100 end
101 plot(Wmi',Tor3', 'g', 'LineWidth', 2)
102
103 for alpha=120                                // For Firing
    angle = 120 degree
104 alphar=alpha*%pi/180;
105 i=1;
106 for Wm = - Wmo:10:Wmo;
107 Wmi(j,i)=Wm;
108 eta=%pi+alphar;
109 ia=(Vm*sin(eta-fai)/Z)-(K*Wm/Ra)+(((K*Wm/Ra)-(Vm
              *sin(alphar-fai)/Z))*exp((alphar-eta)*cotg(
              fai)));
110 if ia<=0      then                                // if
        current is discontinuous

```

```

111     for beta=(alpha+0.1):0.1:360
112         betar=beta*%pi/180;
113         ia=(Vm*sin(betar-fai)/Z)-(K*Wm/Ra)+(((K*
114             Wm/Ra)-(Vm*sin(alphar-fai)/Z))*exp(((
115                 alphar-betar)*cotg(fai)));
116             if ia<=0.00001 then
117                 break;
118             end
119         end
120         Tor4(j,i)=((Vm*K*(cos(alphar)-cos(betar)))-((
121             Wm*K^2*(betar-alphar)))/(%pi*Ra);
122         else
123             Tor4(j,i)=((Vm*K*(1+cos(alphar))/%pi)-(Wm*K
124                 ^2))/Ra;
125             end
126             i=i+1;
127         end
128         j=j+1;
129     end
130 plot(Wmi',Tor4', 'c', 'LineWidth', 2)
131 //legend('Firing Angle =30 degree', ' ', 'Firing Angle
132     =60 degree', ' ', 'Firing Angle =90 degree', ' ', '
133     Firing Angle =120 degree')
134 xgrid
135 title(' Torque-Speed characteristics of single phase
136     Full controlled rectifier fed separately excited
137     DC motor', 'fontsize', 3)
138 xlabel("SPEED ----->", 'fontsize', 3)
139 ylabel("TORQUE ----->", 'fontsize', 3)
140 // legends(["pqr";"xyz"], [[5;2],[3;4]], with_box=%f,
141     opt="?")
142 legends(["Firing Angle =30 degree";"Firing Angle =60
143     degree";"Firing Angle =90 degree";"Firing Angle
144     =120 degree"], [1 2 3 4], opt=1, font_size=1)

```

Experiment: 5

Develop a program, to plot
Torque-Slip characteristics of
poly phase induction motor
using VVVF control.

Scilab code Solution 5.01 VVVF Control

```
1 //Experiment-5
2 // windows - 7 - 64-Bit
3 //Scilab - 5.4.1
4
5
6 //AIM: Devlop a program to plot Torque - speed
    characteristics (VVVF Mode included).
7 clear
8 clc
9 Po = input('Enter the value of Output Power : ') //
    Enter: 3.7
10 V = input('Enter the value of Voltage in volts : ')
    //Enter: 415
```

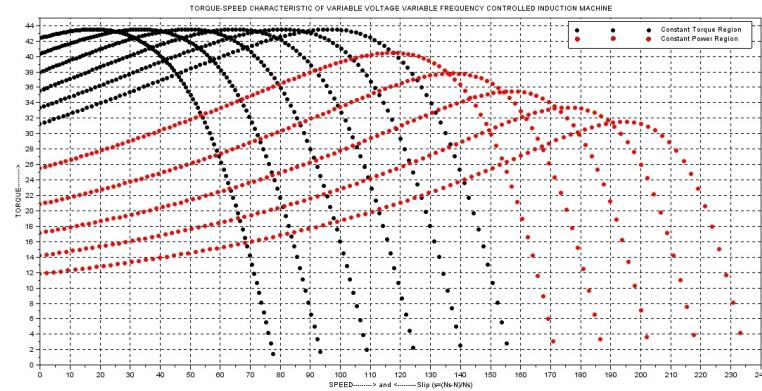


Figure 5.1: VVVF Control

```

11 fb =input('Enter the value of frequency in Hertz : '
           )//Enter: 50
12 P = input('Enter the nos. of Poles : ')//Enter: 4
13 N = input('Enter the Rated Speed in rpm : ')//Enter:
      1420
14 Rs =input('Enter the value of Stator Resistance : ')
       //Enter: 2.5
15 Rr = input('Enter the value of Rotor Resistance with
      referred to Stator : ')//Enter: 3.9
16 Xs =input('Enter the value of Stator Reactance : ')
       //Enter: 4.9
17 Xr =input('Enter the value of Rotor Reactance with
      referred to Stator : ')//Enter: 4.9
18 Xm = input('Enter the value of Magnetizing Reactance
      : ')//Enter: 30
19 Ns=120*fb/P          //Synchronous Speed of Motor
20 Wms=(2*pi*Ns)/120   //Angular Velocity of Motor rad/
      sec
21 S=(Ns-N)/Ns         //Slip
22 V1 = V/sqrt(3)
23 for f=25:5:75        // frequency range from 25 to 75
      Hz ( Can vary based on drive )

```

```

24 Wms=4*pi*f/P;
25 if(f<=fb) then
26   for s=1:-0.01:0.01
27     Ws=4*pi*f/P;
28     Wm=(1-s)*Ws;
29     k=f/fb;
30     T1=(3/Ws)*(V1^2*(Rr/s))/((Rs+(Rr/(k*s)))
31       ^2+(Xs+Xr)^2);
32     plot(Wm,T1,'k.');
33   end
34 else
35   for s=1:-0.01:0.01
36     Ws=4*pi*f/P;
37     Wm=(1-s)*Ws;
38     k=f/fb;
39     T2=(3/Ws)*(V1^2*(Rr/s))/(((Rs+(Rr/(k*s))
40       )^2+(k*Xs+k*Xr)^2));
41     plot(Wm,T2,'r.');
42   end
43 end
44 xlabel("SPEED—————> and <————Slip ( s=(Ns-N)
45 /Ns )")
46 ylabel("TORQUE—————>")
47 xgrid
48 legend("Constant Torque Region", "Constant Power
Region")

```

Experiment: 6

To Study and Simulation of the single phase half controlled AC to DC Converter and effect of firing angle on load voltage

This code can be downloaded from the website www.scilab.in

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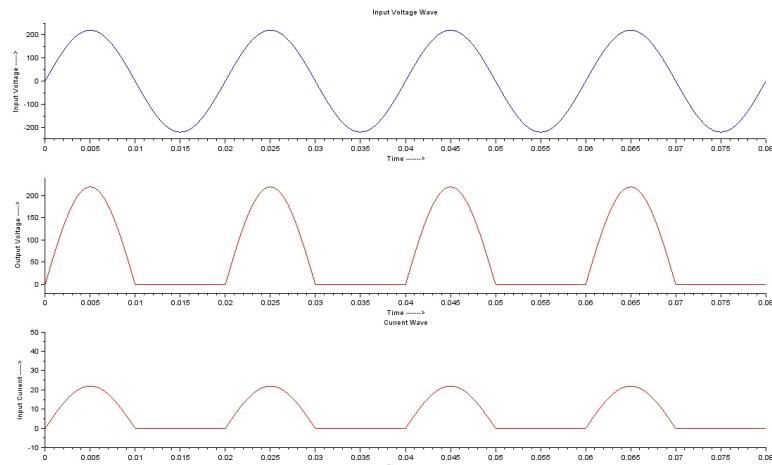


Figure 6.1: Halfwave uncontrolled Rectifier

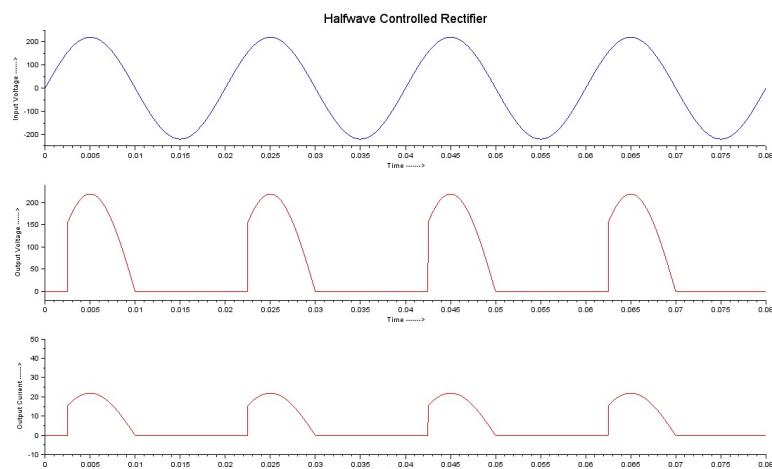


Figure 6.2: Halfwave Controlled Rectifier

Experiment: 7

To Study and Simulation of the single phase fully controlled AC to DC Converter and effect of firing angle on load voltage

This code can be downloaded from the website www.scilab.in This code

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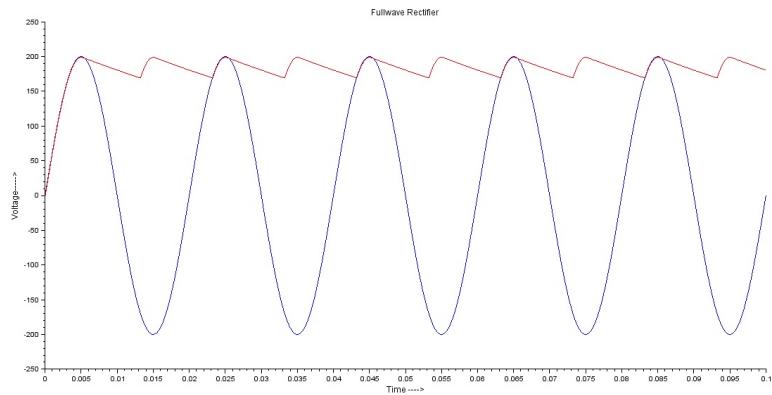


Figure 7.1: Fullwave Uncontrolled Rectifier

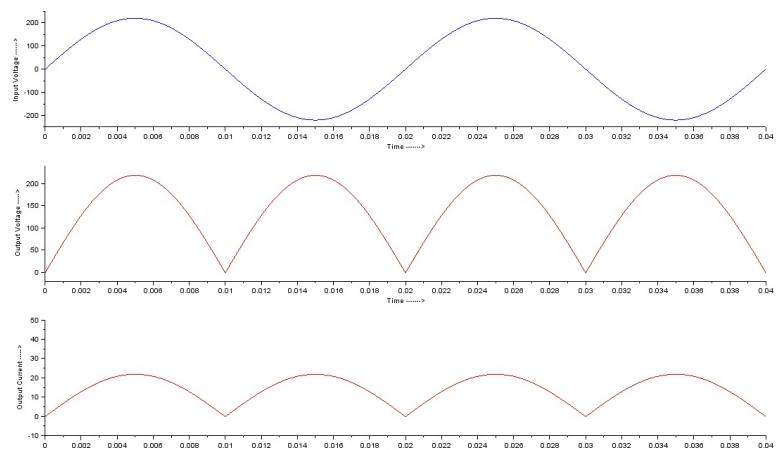


Figure 7.2: Fullwave Uncontrolled Rectifier

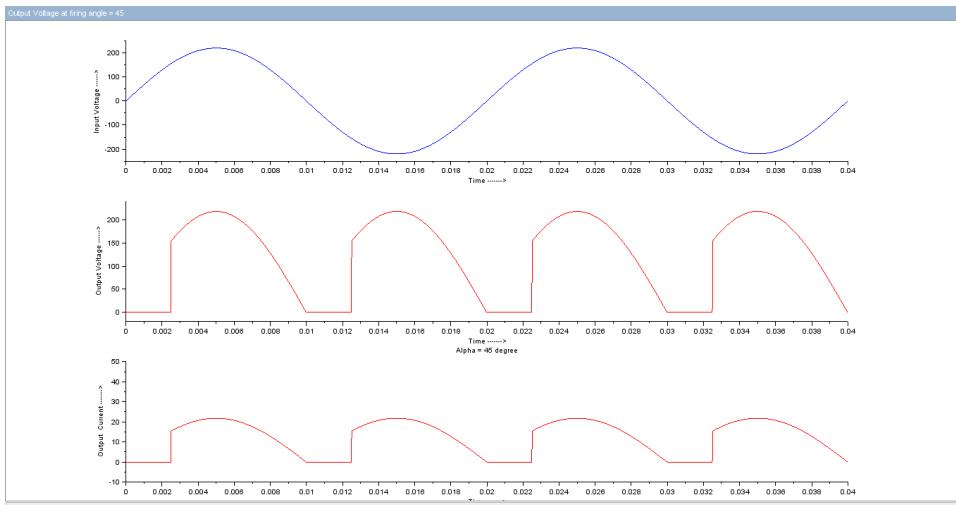


Figure 7.3: Fullwave Controlled Rectifier For 45 alpha

This code can be downloaded from the website www.scilab.in

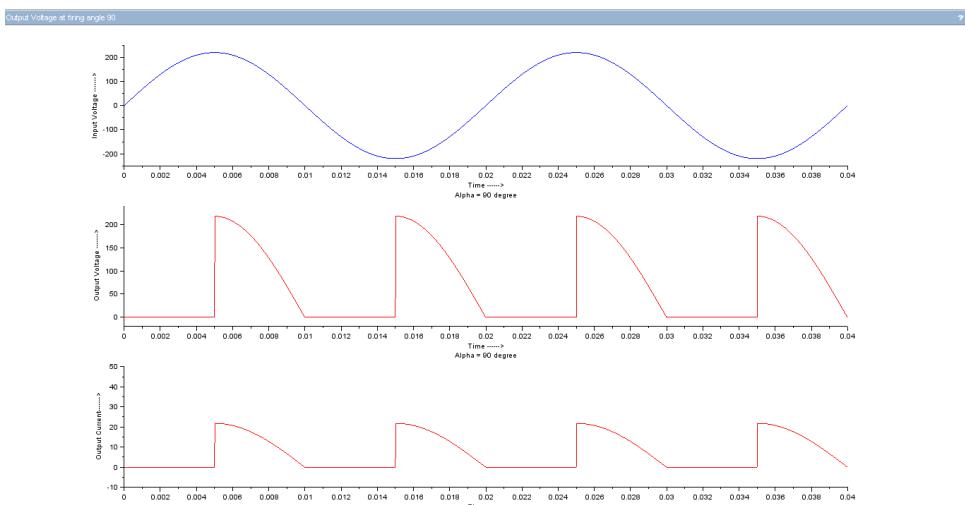


Figure 7.4: Fullwave Controlled Rectifier For 90 alpha