

Scilab Manual for  
Control of Electric Drive  
by Prof Priyen S. Patel  
Electrical Engineering  
Swarnim Startup And Inovation University<sup>1</sup>

Solutions provided by  
Prof Priyen S. Patel  
Electrical Engineering  
Swarnim Startup And Inovation University

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## 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:  Develop a program to plot Torque - slip
      characteristics.
9 clear all
10 clc
11 // Considering that the Stator of Induction Motor is
      Star Connected.
12 // user define parameter for Torque - slip
      Characteristic.
```

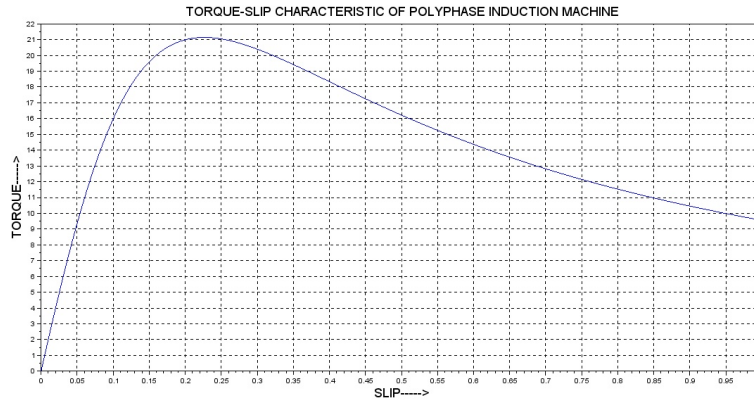


Figure 1.1: User define Torque Slip characterisitc

```

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 charecteristic 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 : ')
```

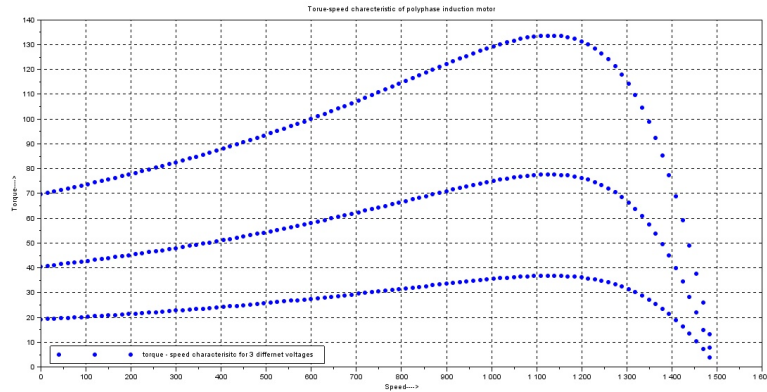


Figure 2.1: Speed Torque

```

//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
synchronous 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 ('Torue-speed charecteristic of polyphase
        induction motor')
38 xlabel('Speed——>');
39 ylabel('Torque——>');
40 xgrid;
41 legend('torque - speed characeterisite 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
8 clc
```

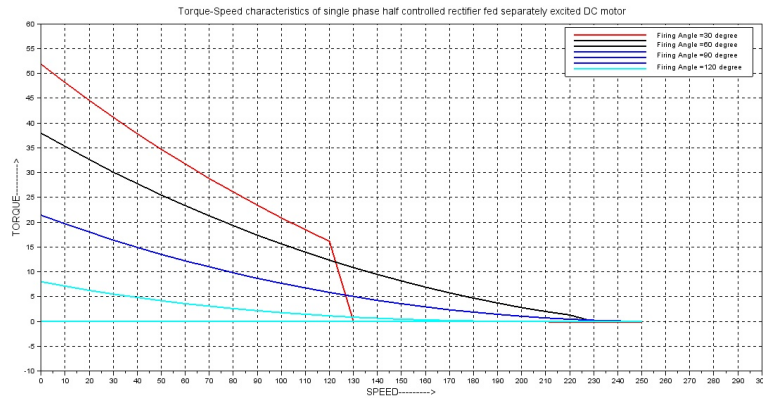


Figure 3.1: Halfwave rectifier control for different firing angle

```

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

```

```

61     ia=(Vm*exp(-(alphan)*cotg(fai))*(sin(fai)-
        sin(alphan-fai))/Z)-(E*exp(-(alphan)*cotg
        (fai))/Ra);
62     if ia<=0 then
63     for b=(alpha+0.1):0.1:360
64         betar=b*%pi/180;
65         ia=(Vm*sin(betar-fai)/Z)-(K*Wm/Ra)+(((K*
            Wm/Ra)-(Vm*sin(alphan-fai)/Z))*exp((
            alphan-betar)*cotg(fai)));
66         if ia<=1e-4 then
67             break;
68         end
69     end
70     Tor2(j,i)=((Vm*K*(cos(alphan)-cos(betar)
        ))-(Wm*K^2*(betar-alphan)))/(%pi*Ra);
71     else
72     Tor2(j,i)=((Vm*K*(1+cos(alphan))/pi)-(Wm
        *K^2))/Ra;
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     alphan=alpha*%pi/180;
81     i=1;
82     for Wm=0.01:10:Wmo
83         Wmi(j,i)=Wm;
84         a=%pi+alphan;
85         ia=(Vm*exp(-(alphan)*cotg(fai))*(sin(fai)-
            sin(alphan-fai))/Z)-(E*exp(-(alphan)*cotg
            (fai))/Ra);
86         if ia<=0 then
87         for b=(alpha+0.1):0.1:360
88             betar=b*%pi/180;
89             ia=(Vm*sin(betar-fai)/Z)-(K*Wm/Ra)+(((K*

```

```

        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
        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 j=j+1;
128 end
129 plot(Wmi',Tor4','c','LineWidth',2)
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)
135 xgrid
136 legend('Firing Angle =30 degree','Firing Angle =60
137     degree','','Firing Angle =90 degree','','','Firing
138     Angle =120 degree')

```

---

## Experiment: 4

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

**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
8 clc
```

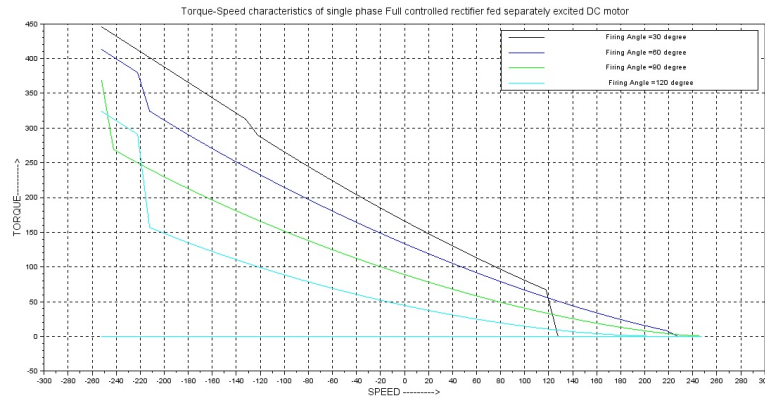


Figure 4.1: Torque Speed characteristics of single phase full controlled rectifier fed separately excited DC motor

```

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

```

```

57     Wmi(j,i)=Wm;
58     eta=%pi+alphan;
59     ia=(Vm*sin(eta-fai)/Z)-(K*Wm/Ra)+(((K*Wm/Ra)-(Vm
        *sin(alphan-fai)/Z))*exp((alphan-eta)*cotg(
        fai)));
60         if ia<=0     then                                     // if
                                                    current is discontinuous
61             for beta=(alpha+0.1):0.1:360
62                 betar=beta*%pi/180;
63                 ia=(Vm*sin(betar-fai)/Z)-(K*Wm/Ra)+(((K*
                    Wm/Ra)-(Vm*sin(alphan-fai)/Z))*exp((
                    alphan-betar)*cotg(fai)));
64                     if ia<=0.00001 then
65                         break;
66                     end
67                 end
68                 Tor2(j,i)=((Vm*K*(cos(alphan)-cos(betar)))-(
                    Wm*K^2*(betar-alphan)))/(%pi*Ra);
69             else
70                 Tor2(j,i)=((Vm*K*(1+cos(alphan))/%pi)-(Wm*K
                    ^2))/Ra;
71             end
72             i=i+1;
73         end
74     j=j+1;
75 end
76 plot(Wmi',Tor2', 'b', 'LineWidth',2)
77
78 for alpha=90                                     // For Firing
    angle = 90 degree
79 alphan=alpha*%pi/180;
80 i=1;
81     for Wm = - Wmo:10:Wmo;
82         Wmi(j,i)=Wm;
83         eta=%pi+alphan;
84         ia=(Vm*sin(eta-fai)/Z)-(K*Wm/Ra)+(((K*Wm/Ra)-(Vm
            *sin(alphan-fai)/Z))*exp((alphan-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     alphas=alpha*%pi/180;
105     i=1;
106         for Wm = - Wmo:10:Wmo;
107             Wmi(j,i)=Wm;
108             eta=%pi+alphas;
109             ia=(Vm*sin(eta-fai)/Z)-(K*Wm/Ra)+(((K*Wm/Ra)-(Vm
                *sin(alphas-fai)/Z))*exp((alphas-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*
                Wm/Ra)-(Vm*sin(alphar-fai)/Z))*exp((
                alphar-betar)*cotg(fai)));
114                 if ia<=0.00001 then
115                     break;
116                 end
117             end
118             Tor4(j,i)=((Vm*K*(cos(alphar)-cos(betar)))-
                (Wm*K^2*(betar-alphar)))/(%pi*Ra);
119         else
120             Tor4(j,i)=((Vm*K*(1+cos(alphar))/%pi)-(Wm*K
                ^2))/Ra;
121         end
122         i=i+1;
123     end
124     j=j+1;
125 end
126 plot(Wmi',Tor4','c','LineWidth',2)
127 //legend('Firing Angle =30 degree','','Firing Angle
    =60 degree','','Firing Angle =90 degree','','
    Firing Angle =120 degree')
128 xgrid
129 title(' Torque-Speed characteristics of single phase
    Full controlled rectifier fed separately excited
    DC motor ','fontsize',3)
130 xlabel("SPEED ----->","fontsize',3)
131 ylabel("TORQUE ----->","fontsize',3)
132 //legends([" pqr ";" xyz "],[[5;2],[3;4]], with_box=%f,
    opt="??")
133 legends([" Firing Angle =30 degree ";" Firing Angle =60
    degree ";" Firing Angle =90 degree ";" Firing Angle
    =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:  Develop 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
```

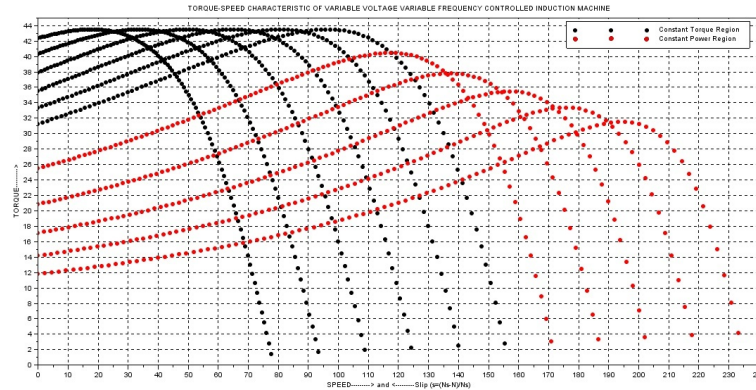


Figure 5.1: VVVF Control

```

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)))
                ^2+(Xs+Xr)^2);
31             plot(Wm,T1,'k.')
32         end
33     else
34         for s=1:-0.01:0.01
35             Ws=4*%pi*f/P;
36             Wm=(1-s)*Ws;
37             k=f/fb;
38             T2=(3/Ws)*(V1^2*(Rr/s))/(((Rs+(Rr/(k*s))
                )^2+(k*Xs+k*Xr)^2));
39             plot(Wm,T2,'r.')
40         end
41     end
42 end
43 title('TORQUE-SPEED CHARACTERISTIC OF VARIABLE
        VOLTAGE VARIABLE FREQUENCY CONTROLLED INDUCTION
        MACHINE')
44 xlabel("SPEED—————> and <—————Slip (s=(Ns-N)
        /Ns)")
45 ylabel("TORQUE—————>")
46 xgrid
47 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](http://www.scilab.in)

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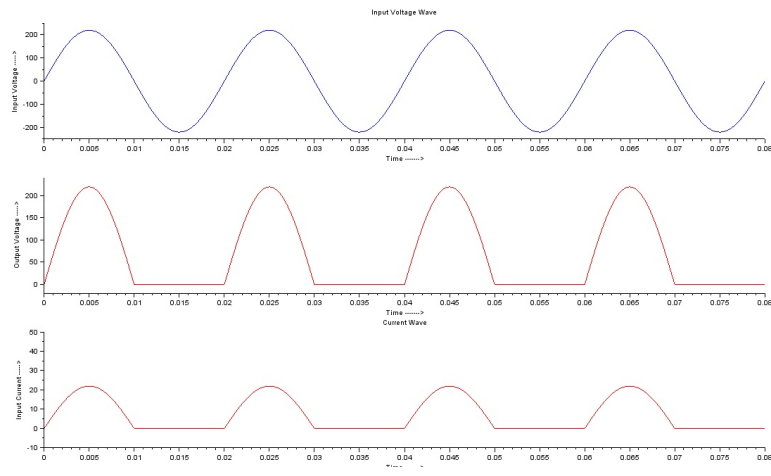


Figure 6.1: Halfwave uncontrolled Rectifier

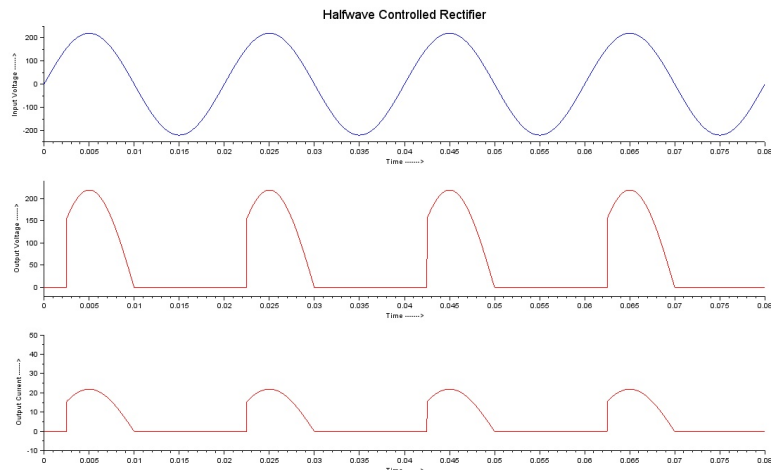


Figure 6.2: Halfwave Controlled Rectifier

## **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](http://www.scilab.in) This code

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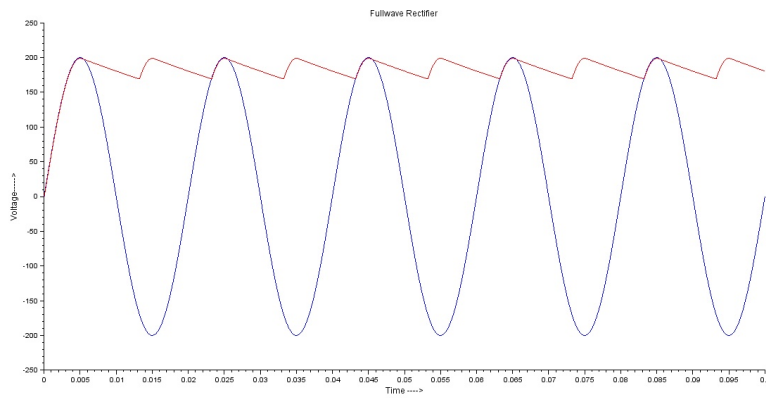


Figure 7.1: Fullwave Uncontrolled Rectifier

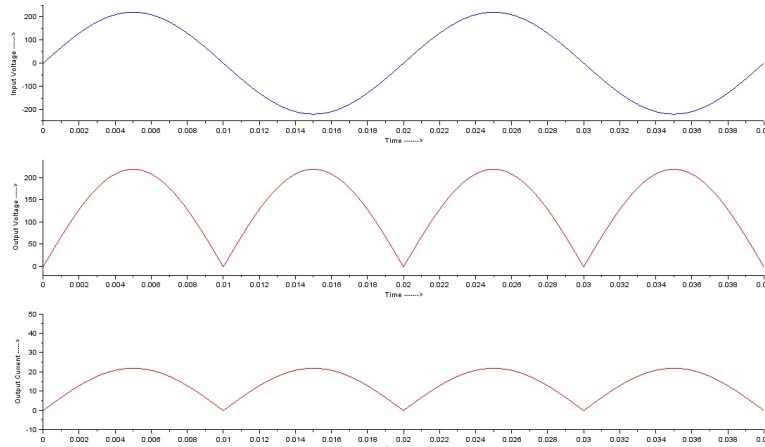


Figure 7.2: Fullwave Uncontrolled Rectifier

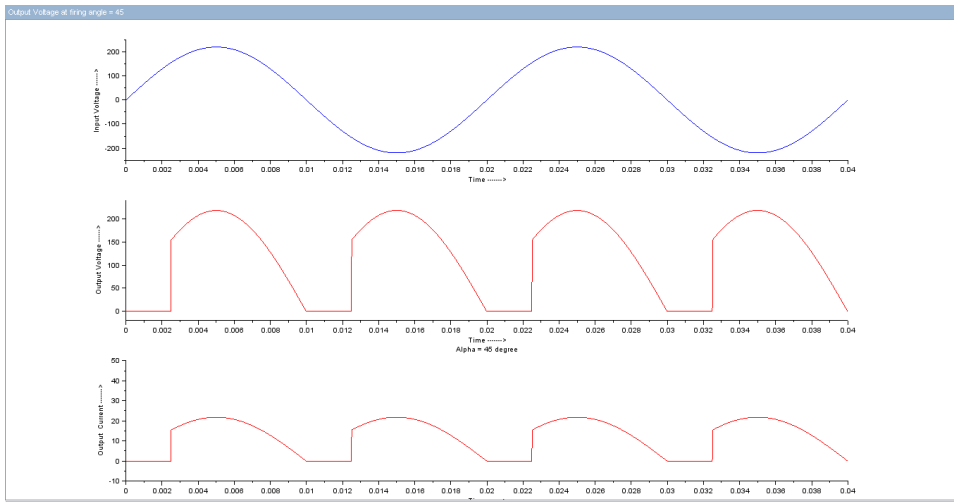


Figure 7.3: Fullwave Controlled Rectifier For 45 alpha

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

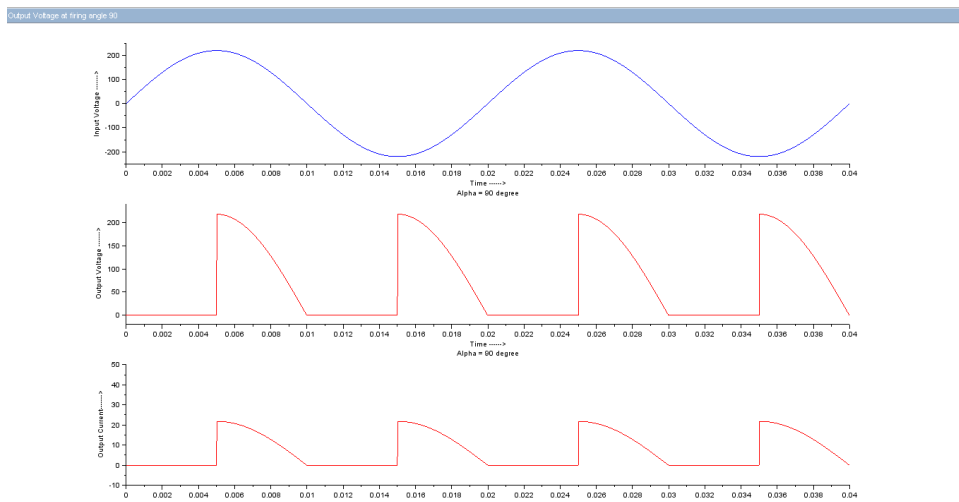


Figure 7.4: Fullwave Controlled Rectifier For 90 alpha