Scilab Manual for Digital Control And Instrumentation Laboratory

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Experiment: 1

Simulation Of Single Phase Full Wave Controlled Rectifier

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

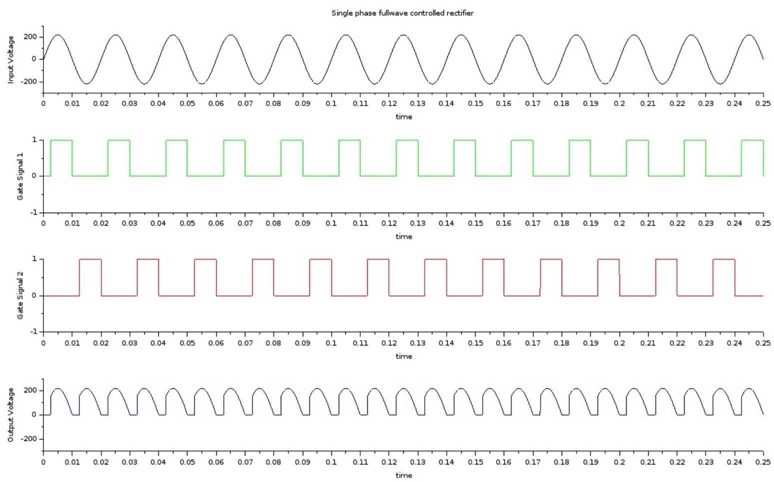

Figure 1.1: Single phase Full wave Controlled Rectifier

Experiment: 2

Simulation Of Single Phase Half Wave Controlled Rectifier

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

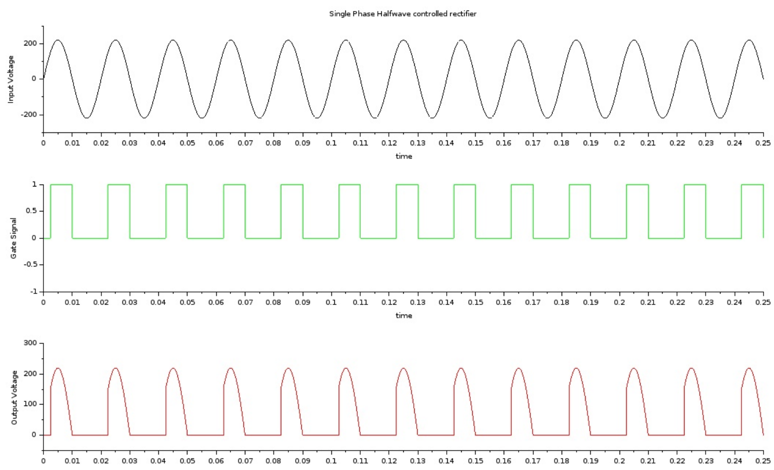

Figure 2.1: Single phase Half wave Controlled Rectifier

Experiment: 3

Simulation Of Three Phase Full Wave Controlled Rectifier

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

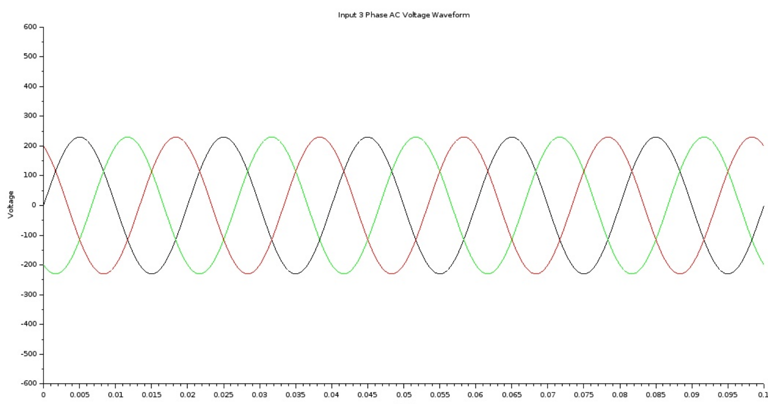

Figure 3.1: Three Phase Full Wave Controlled Rectifier

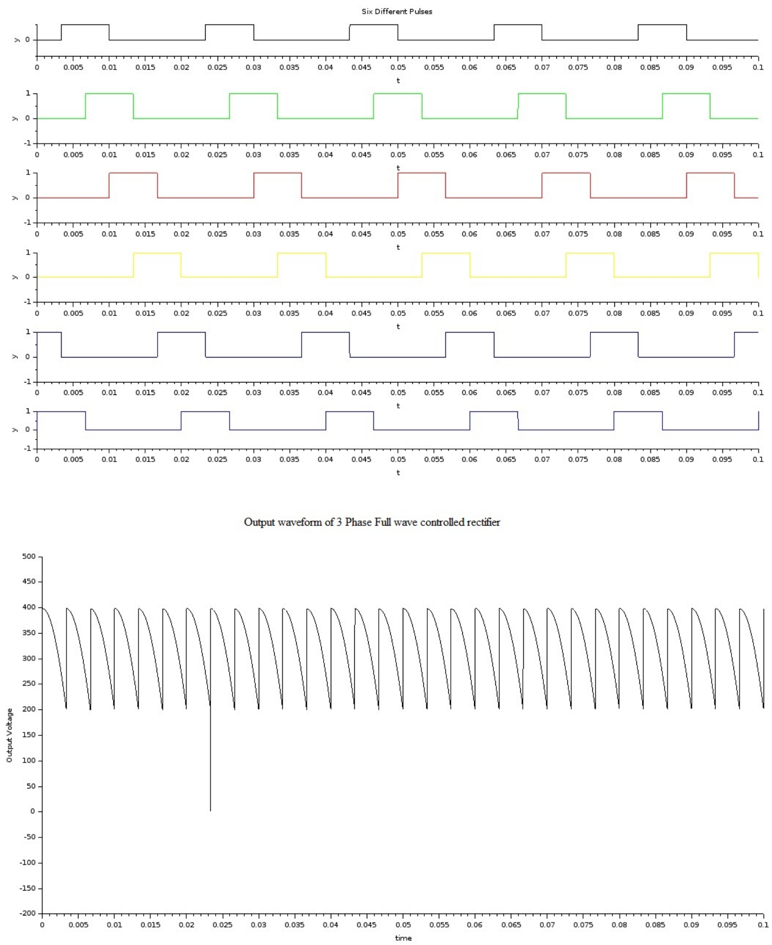

Figure 3.2: Three Phase Full Wave Controlled Rectifier

Experiment: 4

Simulation Of Three Phase Half Wave Controlled Rectifier

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

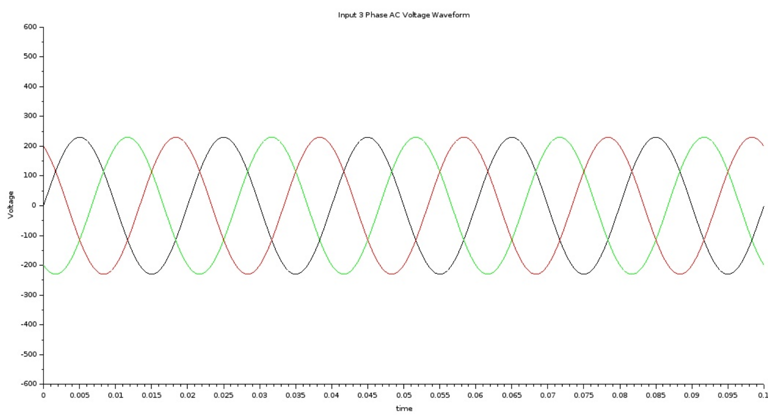

Figure 4.1: Three Phase Half Wave Controlled Rectifier

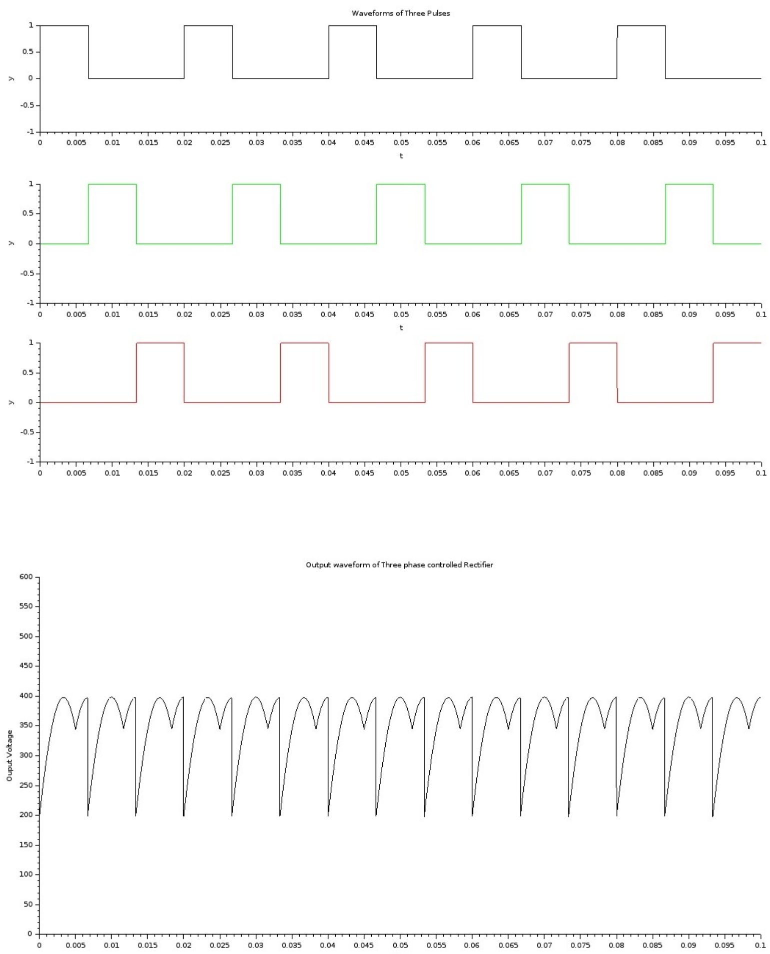

Figure 4.2: Three Phase Half Wave Controlled Rectifier

Experiment: 5

Frequency Response Of Single Area Power System

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

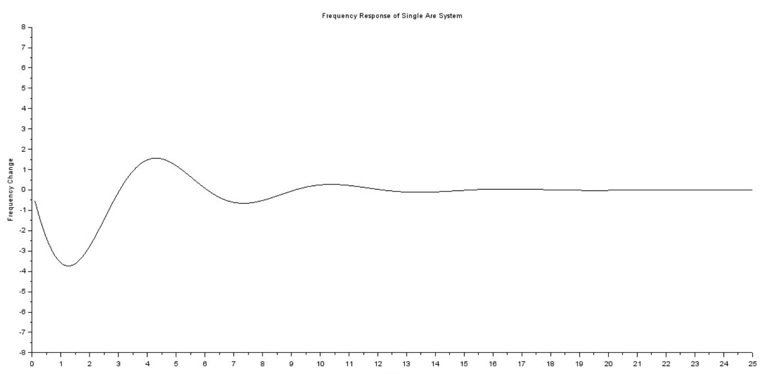

Figure 5.1: Single Area System

Experiment: 6

Frequency Response Of Two Area Power System

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

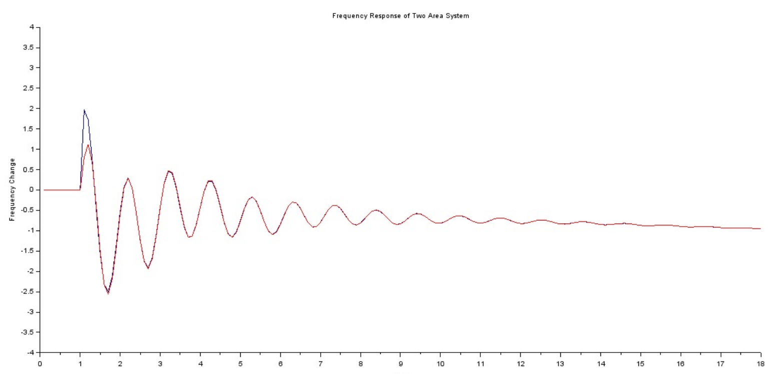

Figure 6.1: Two Area System

Experiment: 7

Symmetrical Fault Analysis In Power Systems

Scilab code Solution 7.10 Analysis of Symmetrical Fault

```
//Analysis of Symmetrical Fault in Power Systems//
//This program requires user input. A sample problem with user input and output is available in the result file
clc;
clear;
linedata=input('enter the line data values in the order of starting bus, Ending bus, resistance and reactance:')
f=input('enter the bus at wich fault occurs:')
fi=input('Enter the fault impedance:')
bv=input('enter the pre-fault bus voltage:')
sb=linedata(:,1)  //Starting bus number of all the lines
eb=linedata(:,2)  //Ending bus number of all the lines
z=linedata(:,3)+linedata(:,4)*%i  //line impedance, Z=R+jX
zbus=[];
```

```
check=[];
nb=max(max(sb),max(eb))
for i=1:length(sb)  //starting of impedance matrix calculation part//
    m=sb(i);
    n=eb(i);
    mn=min(m,n);
    nm=max(m,n);
    ncheck=length(find(check==nm));
    mcheck=length(find(check==mn));
    [rows columns]=size(zbus);
    if mn==0 & ncheck==0
        zbus=[zbus zeros(rows,1);zeros(1,rows) z(i)];
        check=[check nm];
         else if mcheck>0 & ncheck==0
            zbus=[zbus zbus(:,mn);zbus(mn,:) zbus(mn,mn)+z(i)];
            check=[check nm];
            elseif mn==0 & ncheck>0
            zbus=[zbus zbus(:,nm);zbus(nm,:) zbus(nm,nm)+z(i)];
            zbusn=zeros(rows,rows);
            for r=1:rows
                for t=1:columns
                    zbusn(r,t)=zbus(r,t)-(zbus(r,rows+1)*zbus(rows+1,t))/(zbus(rows+1,rows+1));
                end
            end
            zbus=zbusn
        elseif mcheck>0 & ncheck>0
            zbus=[zbus zbus(:,nm)-zbus(:,mn);zbus(nm,:)-zbus(mn,:),z(i)+zbus(mn,nm)+zbus(nm,nm)-2*zbus(nm,mn)];
            zbusn=zeros(rows,rows);
            for r=1:rows
                for t=1:columns
```

```
                    zbusn(r,t)=zbus(r,t)-(zbus(r,rows+1)*zbus(rows+1,t))/(zbus(rows+1,rows+1));
                end
            end
            zbus=zbusn;
        end
    end
end   //ending of impedance bus matrix calculation part//
disp(zbus,'the impedance matrix is:');
ifa=bv/(zbus(f,f)+fi)  //calculation of fault current//
disp(ifa,'the fault current is:')
disp('Post fault voltages v1,v2,v3 respectively are:');
for i=1:nb
v(i)=bv-(ifa*zbus(i,f)); //calculation of post fault bus voltages//
disp(v(i));
end
a=input('enter the starting bus to calculate the line flow:');
b=input('enter the ending bus to calculate the line flow:');
zs=input('enter the impedance between the above buses:');
i13=(v(a)-v(b))/zs; //calculation of line flow current//
disp(i13,'the line flow current is:')

//SAMPLE INPUT and OUTPUT

//enter the line data values in the order of starting bus, Ending bus, resistance and reactance:[1 0 0 0.1; 1 2 0 0.2; 2 0 0 0.1; 0 3 0 0.1; 3 1 0 0.1]
//enter the bus at wich fault occurs:1
```

```
//Enter the fault impedance:0.08*%i
//enter the pre-fault bus voltage:2

// the impedance matrix is:

//     0.046875i     0.015625i     0.0375i
//     0.015625i     0.071875i     0.0125i
//     0.0375i       0.0125i       0.05i

// the fault current is:

//  - 15.763547i

// Post fault voltages v1,v2,v3 respectively are:

//     1.2610837

//     1.7536946

//     1.408867
//enter the starting bus to calculate the line flow
    :1
//enter the ending bus to calculate the line flow:2
//enter the impedance between the above buses:0.2*%i

// the line flow current is:

//     2.4630542i
```

```
enter the line data values in the order of starting bus, Ending bus, resistance and reactance:[1 0 0 0.1; 1 2 0 0.2; 2 0
0 0.1; 0 3 0 0.1; 3 1 0 0.1]
enter the bus at wich fault occurs:1
Enter the fault impedance:0.08*%i
enter the pre-fault bus voltage:2

 the impedance matrix is:

    0.046875i    0.015625i    0.0375i
    0.015625i    0.071875i    0.0125i
    0.0375i      0.0125i      0.05i

 the fault current is:

  - 15.763547i

 Post fault voltages v1,v2,v3 respectively are:

    1.2610837

    1.7536946

    1.408867
enter the starting bus to calculate the line flow:1
enter the ending bus to calculate the line flow:2
enter the impedance between the above buses:0.2*%i

 the line flow current is:

    2.4630542i
```

Figure 7.1: Analysis of Symmetrical Fault

//Analysis of Symmetrical Fault in Power Systems//

Problem: The one line diagram of a simple power system is shown below. Each generator is represented by an emf behind the transient reactance. All impedances are expressed in per unit on a common MVA base. All resistances and shunt capacitances are neglected. The generators are operating on no load at their rated voltage with their emfs in phase. A three phase fault occurs at bus 1 through a fault impedance of Zf = j0.08 per unit. Determine the fault current in per unit and the current flow from bus 1 to bus 2 after the occurrence of fault.

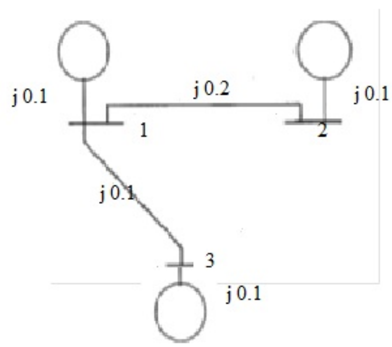

Figure 7.2: Analysis of Symmetrical Fault

Experiment: 8

Unsymmetrical Fault Analysis In Power Systems

Scilab code Solution 8.9 Analysis of Unsymmetrical Fault

```
//Analysis of Unsymmetrical Fault in Power Systems//
//This program requires user input. A sample problem
    with user input and output is available in the
   result file//
clc ;
clear;
a=input('Enter the positve,negative  and zero
   sequence of first generator in matrix form:')
PSG1=a(:,1); //positive sequence of Generator 1
NSG1=a(:,2); //negative sequence of Generator 1
ZSG1=a(:,3); //zero sequence of Generator 1
b=input('Enter the positve,negative and zero
   sequence of first transformer in matrix form:')
PST1=b(:,1); //positive sequence of Transformer 1
NST1=b(:,2); //negative sequence of Transformer 1
ZST1=b(:,3); //zero sequence of Transformer 1
c=input('Enter the positve,negative and zero
   sequence of first transmission line in matrix
   form:')
```

```
PSTL=c(:,1); //positive sequence of Transmission Line
NSTL=c(:,2); //negative sequence of Transmission Line
ZSTL=c(:,3); //zero sequence of Transmission Line
d=input('Enter the positve,negative and zero sequence of second transformer in matrix form:')
PST2=d(:,1); //positive sequence of Transformer 2
NST2=d(:,2); //negative sequence of Transformer 2
ZST2=d(:,3); //zero sequence of Transformer 2
e=input('Enter the positive,negative and zero sequence of second generator in matrix form:')
PSG2=e(:,1); //positive sequence of Generator 2
NSG2=e(:,2); //negative sequence of Generator 2
ZSG2=e(:,3); //zero sequence of Generator 2
MVAB=input('Enter the value of base MVA:');
KVB=input('Enter the value of base KV:');
z1=((PSG1*%i+PST1*%i)*(PSTL*%i+PST2*%i+PSG2*%i))/((PSG1*%i+PST1*%i)+(PSTL*%i+PST2*%i+PSG2*%i));//positive Sequence impedence
z2=((NSG1*%i+NST1*%i)*(NSTL*%i+NST2*%i+NSG2*%i))/((NSG1*%i+NST1*%i)+(NSTL*%i+NST2*%i+NSG2*%i));//Negative Sequence impedence
z0=((ZSG1*%i+ZST1*%i)*(ZSTL*%i+ZST2*%i+ZSG2*%i))/((ZSG1*%i+ZST1*%i)+(ZSTL*%i+ZST2*%i+ZSG2*%i));//Zero Sequence impedence
Ib=(MVAB*(10^6))/((1.732*KVB*(10^3)))//calculating base current
disp(z0,z2,z1,'The values of Positive(z1) Negative(z2) and Zero(z0) sequence impedances are respectively');
disp('OPTION','LG FAULT=1','LL FAULT=2','LLG FAULT=3');
MENU=input('Enter the choice of fault:')
if MENU==1 //calculating Line to Ground fault
    If=(3*(1))/(z0+z1+z2)
    Faultycurrent=If*Ib;
    disp(Faultycurrent,'The fault current is :');
```

```
end
if MENU==2//Calculating Line to Line Fault
    If=((-1.732*(%i))*(1))/(z1+z2)
    Faultycurrent=If*Ib;
disp(Faultycurrent,'The fault current is :');
end
if MENU==3//calculating Line-Line-Ground fault
    z=(z0*z2)/(z0+z2);
    Ia1=(1)/(z1+z);
    Ia0=((-1+(Ia1*z1))/z0);
    If=3*Ia0;
    Faultycurrent=If*Ib;
 disp(Faultycurrent,'The fault current is :');
end

 //Sample Input and Output
//Enter the positve,negative  and zero sequence of first generator in matrix form:[0.25 0.29 0.28]
//Enter the positve,negative and zero sequence of first transformer in matrix form:[0.48 0.47 0.49]
//Enter the positve,negative and zero sequence of first transmission line in matrix form:[0.20 0.22 0.24]
//Enter the positve,negative and zero sequence of second transformer in matrix form:[0.18 0.22 0.24]
//Enter the positive,negative and zero sequence of second generator in matrix form:[0.19 0.17 0.20]
//Enter the value of base MVA:100
//Enter the value of base KV:110

//The values of Positive(z1) Negative(z2) and Zero(z0) sequence impedances are respectively

//    0.3200769i

//    0.3383942i

```

```
//      0.3611034i

// LLG FAULT=3

// LL FAULT=2

// LG FAULT=1

// OPTION
//Enter the choice of fault:1

// The fault current is :

//  - 1544.4068i
```

```
Enter the positve,negative  and zero sequence of first generator in matrix form:[0.25 0.29 0.28]
Enter the positve,negative and zero sequence of first transformer in matrix form:[0.48 0.47 0.49]
Enter the positve,negative and zero sequence of first transmission line in matrix form:[0.20 0.22 0.24]
Enter the positve,negative and zero sequence of second transformer in matrix form:[0.18 0.22 0.24]
Enter the positive,negative and zero sequence of second generator in matrix form:[0.19 0.17 0.20]
Enter the value of base MVA:100
Enter the value of base KV:110

 The values of Positive(z1) Negative(z2) and Zero(z0) sequence impedances are respectively

    0.3200769i

    0.3383942i

    0.3611034i

 LLG FAULT=3

 LL FAULT=2

 LG FAULT=1

 OPTION
Enter the choice of fault:1

 The fault current is :

  - 1544.4068i
```

Figure 8.1: Analysis of Unsymmetrical Fault

//__Analysis of Unsymmetrical Fault in Power Systems__//

Determine the line to line fault, line to ground fault and double line to ground fault currents for the given impedance of positive, negative and zero sequences.

COMPONENTS	Positive Sequence Impedance (Z1)	Negative Sequence Impedance (Z2)	Zero Sequence Impedance (Z3)
Generator 1	0.25	0.29	0.28
Generator 2	0.19	0.17	0.20
Transformer 1	0.48	0.47	0.49
Transformer 2	0.18	0.22	0.23
Transmission Line	0.20	0.22	0.24

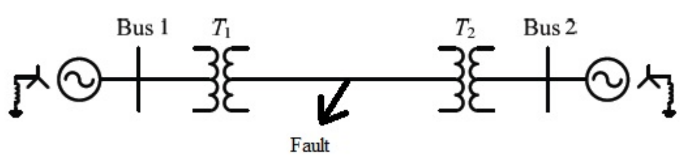

Figure 8.2: Analysis of Unsymmetrical Fault

Experiment: 9

Digital Simulation Of P, PI And PID Controllers.

Scilab code Solution 9.4 Digital Simulation of P PI PID Controllers

```
//Digital Simulation of P, PI, PD, and PID controllers
//Scilab Version 5.5.2 ; OS:Windows

//Program for Open Loop control system
num=poly([20],'s','coeff');//Numerator input
den=poly([30 20 2],'s','coeff');//Denominator input
q=syslin('c',num/den)//Ratio of the numerator to the denominator
t=0:0.05:2.5;//time interval
p=csim('step',t,q);
subplot(221)
plot2d(t,p);
xlabel('Time(Sec)')
ylabel('Amplitude')
xtitle('Digital Simulation of Open Loop control system')
```

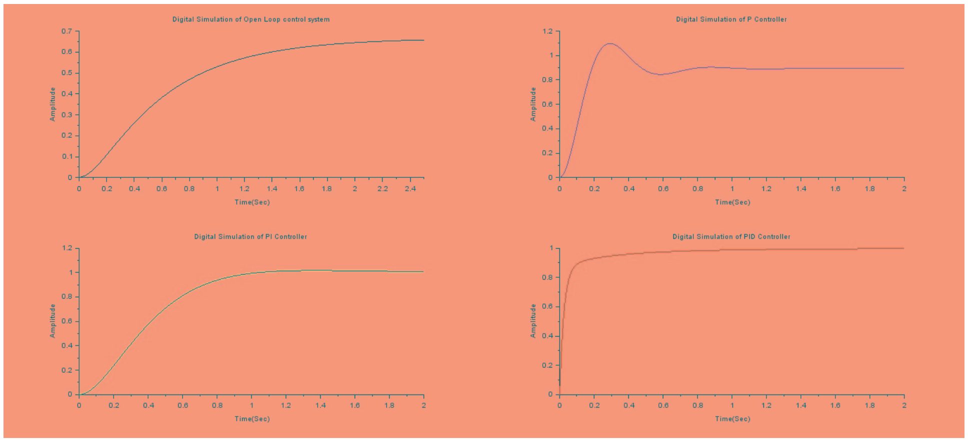

Figure 9.1: Digital Simulation of P PI PID Controllers

```

// Program for P Controller
kp=250;
num=poly([kp],'s','coeff');
den=poly([30+kp 20 2],'s','coeff');
q=syslin('c',num/den)
t=0:0.01:2;
p=csim('step',t,q);
subplot(222)
plot2d(t,p,style=color("red"));
xlabel('Time(Sec)')
ylabel('Amplitude')
xtitle('Digital Simulation of P Controller')

// Program for PI Controller
kp=40;
ki=80;
num=poly([ki kp],'s','coeff');
den=poly([ki 30+kp 20 2],'s','coeff');
q=syslin('c',num/den)
t=0:0.01:2;
p=csim('step',t,q);
subplot(223)
```

```
plot2d(t,p,style=color("blue"));
xlabel('Time(Sec)')
ylabel('Amplitude')
xtitle('Digital Simulation of PI Controller')

// Program for PID Controller
kp=400;
kd=70;
ki=400;
num=poly([ki kp kd],'s','coeff');
den=poly([ki 30+kp 20+kd 2],'s','coeff');
q=syslin('c',num/den)
t=0:0.01:2;
p=csim('step',t,q);
subplot(224)
plot2d(t,p,style=color("green"));
xlabel('Time(Sec)')
ylabel('Amplitude')
xtitle('Digital Simulation of PID Controller')
```

Experiment: 10

Simulation Of The Performance Of Single Phase Transformer

Scilab code Solution 10.3 Performance Characteristics of Single Phase Transformer

```
//Program to Find the Performance Characteristics of
    Single Phase Transformer By Conducting Open
   Circuit test and Short Circuit Test
//This program requires user input. A sample problem
    with user input and output is available in the
   result files.
//Scilab Version 5.5.2 ; OS:Windows
clc;
clear;
//Getting the Rated values of Single Phase
   Transformer
disp('Name Plate Details')
cap=input('Enter the rated capacity of Tansformer in
    KVA:')
```

Question

Obtain the Performance Charatceristics of a Single Phase Transformer for 0.6 and 0.8 lagging power factors with the following data:

Capacity = 3 KVA, Voltage ratio = 230 / 115 V

Scilab 5.5.2 Console

```
 Name Plate Details
Enter the rated capacity of Tansformer in KVA:3000
Enter the primary voltage of a Single Phase Transformer(HV) in Volts:230

 The Primary current of transformer =

    13.043478
Enter the Secondary voltage of a Single Phase Transformer(LV) in Volts:115

 The secondary current of transformer =

    26.086957

 Open Circut Test

 The Iron Loss from Open circuit Test W0 = Wi =

    30.

 Short Circut Test

 The Copper Loss from Open circuit Test Wsc = Wcu =

    150.
Enter the power factor = [0.6 0.8]

 Output     Eff/PF=0.6    EFF/PF=0.8

    0.        0.            0.
    240.      85.106383     88.39779
    480.      90.909091     93.023256
    720.      92.544987     94.302554
    960.      93.023256     94.674556
    1200.     93.023256     94.674556
    1440.     92.783505     94.488189
    1680.     92.409241     94.196804
    1920.     91.954023     93.841642
    2160.     91.447925     93.445814
    2400.     90.909091     93.023256
```

Figure 10.1: Performance Characteristics of Single Phase Transformer

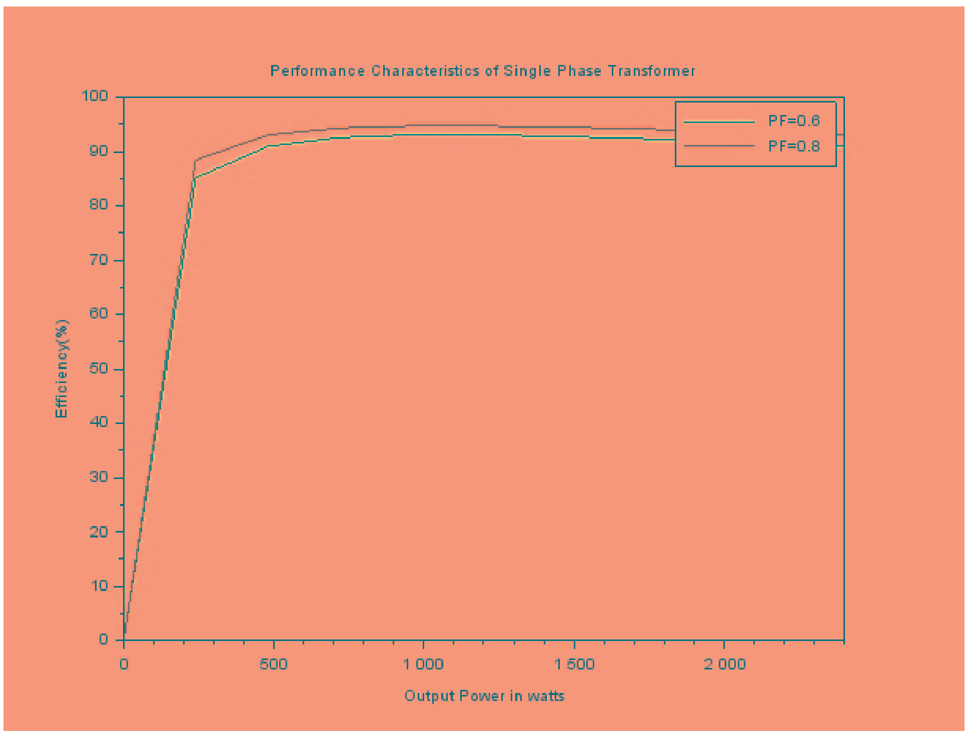

Figure 10.2: Performance Characteristics of Single Phase Transformer

```
pv=input('Enter the primary voltage of a Single Phase Transformer(HV) in Volts:')
pc=cap/pv//calculation of primary current, capacity/Primary voltage
disp(pc, 'The Primary current of transformer =')
sv=input('Enter the Secondary voltage of a Single Phase Transformer(LV) in Volts:')
sc=cap/sv//calculation of secondary current, capacity/secondary voltage
disp(sc, 'The secondary current of transformer =')
//open Circuit Test
//For open circuit test, Consider the LV side as primary, HV side is kept open
disp('Open Circut Test')
v0=sv//open circuit voltage
i0=0.01*sc//for practical case, there will be negligible amount ofopen circuit current
w0=v0*i0//calculation of Primary power, voltage*current
disp(w0, 'The Iron Loss from Open circuit Test W0 = Wi = ')
//Short Circuit Test
//For Short circuit test, Consider the HV side as primary, LV side is shorted
disp('Short Circut Test')
vsc=pv*0.05//for practical case, there will be negligible amount of short circuit voltage
isc=pc//short circuit current
wsc=vsc*isc//calculation of secondary power, voltage*current
disp(wsc, 'The Copper Loss from Open circuit Test Wsc = Wcu = ')
//Predetermine the efficiency
t=1;
pf=input('Enter the power factor = ')
for j=1:length(pf)
//l=input('Enter the fraction of load = ')
i=1;
```

```
for l=0:0.1:1
op(i)=cap*l*pf(j)
//disp(op, 'Output Power of Transformer is ')
//total loss in a transformer = copper loss + Iron loss
los(i)=w0+(wsc*l^2)
ip(i)=op(i)+los(i)
//disp(ip, 'Input Power of Transformer is ')
eff(i,t)=(op(i)/ip(i))*100
i=i+1;
//disp(eff, 'Efficiency of Transformer is ')
end
//plotting the curve of the Performannce Characteristics of transformer
//between Output power and Efficiency for different values of fraction of load
t=t+1;
end
disp([op   eff(:,1)   eff(:,2)],'Output      Eff/PF=0.6      EFF/PF=0.8')
plot(op,eff(:,1),op,eff(:,2));
legend('PF=0.6','PF=0.8');
xlabel('Output Power in watts')
ylabel('Efficiency(%)')
title('Performance Characteristics of Single Phase Transformer')

//SAMPLE INPUT and OUTPUT

//Name Plate Details
//Enter the rated capacity of Tansformer in KVA:3000
//Enter the primary voltage of a Single Phase Transformer(HV) in Volts:230

//The Primary current of transformer =

//     13.043478
//Enter the Secondary voltage of a Single Phase
```

```
    Transformer(LV) in Volts:115

// The secondary current of transformer =

//     26.086957

// Open Circut Test

// The Iron Loss from Open circuit Test W0 = Wi =

//     30.

// Short Circut Test

// The Copper Loss from Open circuit Test Wsc = Wcu
    =

//     150.
//Enter the power factor = [0.6 0.8]

 //Output      Eff/PF=0.6     EFF/PF=0.8

//     0.         0.             0.
//     240.       85.106383      88.39779
//     480.       90.909091      93.023256
//     720.       92.544987      94.302554
//     960.       93.023256      94.674556
//     1200.      93.023256      94.674556
//     1440.      92.783505      94.488189
//     1680.      92.409241      94.196804
//     1920.      91.954023      93.841642
//     2160.      91.447925      93.445814
//     2400.      90.909091      93.023256

//efficieny curve will be obtained in figure
```