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| PRE-DETERMINATION OF VOLTAGE REGULATION OF A THREE PHASE ALTERNATOR using MATLAB |
| AC MACHINES PROJECT REPORT |
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| This is a program written using MATLAB, to pre-determine the voltage regulation of a three phase alternator using the ampere turns method and the synchronous impedance method. The only inputs required from the user are the open-circuit and short-circuit test results, stator resistance and machine ratings. |

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PROGRAM CODE:

clear all;

close all;

clc;

disp('This is a program which pre-determines the voltage regulation of a three phase alternator');

%Accepting data from the user:

V=input('Please enter the value of rated line voltage of the machine:\n');

I=input('Please enter the value of rated line current of the machine:\n');

a=menu('How is the stator of the machine connected?','Star','Delta');

if a==1

Vr=V/sqrt(3);

Ir=I;

elseif a==2

Vr=V;

Ir=I/sqrt(3);

end

If0=input('Please enter the open-circuit field currents recorded in a row matrix form:\n');

E0=input('Please enter the corresponding values of open circuit voltages in a row matrix form:\n');

Ifs=input('Enter the field current during short circuit test (including the zero value)\nin a row matrix form:');

Isc=input('Enter the corresponding short circuit line current that is circulated (including the zero value)\nin a row matrix form:');

b=menu('Please select one of these:','Ampere-turn method(M.M.F)','Synchronous impedance method(E.M.F)');

if b==1 %M.M.F. Method

%Getting the best fitting 3rd degree curve by method of least squares:

P0=polyfit(If0,E0,3);

%To plot the O.C.C. and S.C.C.:

a=0:.01:max(If0);

b=polyval(P0,a);

plotyy(a,b,Ifs,Isc./sqrt(3)); %This function is used to plot both on the same graph, utilizing two different Y-axes.

ylim([0 1.5\*Vr]);

xlabel('Field current(A) ------>');

ylabel('Open circuit terminal voltage(V) ------>');

title('O.C.C and S.C.C of a three phase alternator')

grid on;

%Finding out the value of field current at rated terminal voltage(If1):

%To find the root of the above polynomial fit at the rated voltage:

P1=[P0(1) P0(2) P0(3) P0(4)-Vr];

c=roots(P1); %This gives out three roots, out of which we need to select the appropriate one:

i=1;

while E0(i)<=Vr

i=i+1;

end

if Vr==E0(i-1);

If1=If0(i-1);

else

if (If0(i-2)<c(1))&&(If0(i)>c(1))

If1=c(1);

elseif (If0(i-2)<c(2))&&(If0(i)>c(2))

If1=c(2);

elseif (If0(i-2)<c(3))&&(If0(i)>c(3))

If1=c(3);

end

end

disp('Thus the magnitude of field current corresponding to rated terminal voltage is:');

disp(If1);

%To find the field current when rated short circuit current flows(If2):

m=(Isc(2)/sqrt(3))/Ifs(2); %Slope 'm' is found assuming the S.C.C. to be a straight line variation.

If2=Ir/m;

disp('The magnitude of field current required to overcome armature reaction effect is:');

disp(If2);

c=1;

while c~=2

If2=Ir/m;

k=menu('Select the type of load:','Lag','UPF', 'Lead');

switch(k)

case 1

pf=input('Enter the power factor of load:');

phi=(acosd(pf)); %Returns the cos inverse in degrees

If2=complex(If2\*cosd(90-phi),If2\*sind(90-phi));

case 2

If2=complex(0,If2);

case 3

pf=input('Enter the power factor of load:');

phi=(acosd(pf)); %Returns the cos inverse in degrees

If2=complex(-If2\*cosd(90-phi),If2\*sind(90-phi));

end

If=If1+If2;

mag=sqrt((real(If))^2+(imag(If))^2);

disp('The magnitude of the resultant vector sum of two field currents is:');

disp(mag);

E=polyval(P0,mag);

disp('The corresponding value of generated voltage(E) to overcome all loading effects is:');

disp(E);

VR=(E-Vr)\*100/Vr;

disp('Hence the pre-determined voltage regulation is:');

disp(VR);

c=menu('Would you like to pre-determine at a different power factor?','Yes','No');

end

elseif b==2 %E.M.F. Method

R=input('Enter the value of measured stator resistance(a.c.):');

%Getting the best fitting 3rd degree curve by method of least squares:

P0=polyfit(If0,E0,3);

disp('The rated phase current of the machine is given to be:');

disp(Ir);

%To find the field current when rated short circuit current flows:

m=(Isc(2)/sqrt(3))/Ifs(2); %Slope 'm' is found assuming the S.C.C. to be a straight line variation.

If=Ir/m;

disp('The field current(If) required to circulate rated short-circuit current is:');

disp(If);

%To find the value of open circuit voltage corresponding to the above field current If

E=polyval(P0,If);

disp('The corresponding open-circuit voltage(E) is:');

disp(E);

Zs=E/Ir;

disp('Thus the value of synchronous impedance(Zs) is');

disp(Zs);

Xs=sqrt(Zs^2-R^2);

disp('The value of synchronous reactance(Xs) calculated is:');

disp(Xs);

%To plot the O.C.C. and S.C.C.:

a=0:.01:max(If0);

b=polyval(P0,a);

plotyy(a,b,Ifs,Isc./sqrt(3)); %This function is used to plot both on the same graph, utilizing two different Y-axes.

ylim([0 1.5\*Vr]);

xlabel('Field current(A) ------>');

ylabel('Open circuit terminal voltage(V) ------>');

title('O.C.C and S.C.C of a three phase alternator')

grid on;

c=1;

while c~=2

k=menu('Select the type of load:','Lag','UPF', 'Lead');

switch(k)

case 1

pf=input('Enter the power factor of load:');

phi=(acosd(pf)); %Returns the cos inverse in degrees

E1=sqrt((Vr\*cosd(phi)+Ir\*R)^2+(Vr\*sind(phi)+Ir\*Xs)^2);

case 2

E1=sqrt((Vr+Ir\*R)^2+(Ir\*Xs)^2);

case 3

pf=input('Enter the power factor of load:');

phi=(acosd(pf)); %Returns the cos inverse in degrees

E1=sqrt((Vr\*cosd(phi)+Ir\*R)^2+(Vr\*sind(phi)-Ir\*Xs)^2);

end

disp('The corresponding value of generated voltage(E) to overcome all loading effects is:');

disp(E1);

VR=(E1-Vr)\*100/Vr;

disp('Hence the pre-determined voltage regulation is:');

disp(VR);

c=menu('Would you like to pre-determine at a different power factor?','Yes','No');

end

end

OUTPUT:

**Ampere-Turns Method:**

This is a program which pre-determines the voltage regulation of a three phase alternator

Please enter the value of rated line voltage of the machine:

400

Please enter the value of rated line current of the machine:

13.5

Please enter the open-circuit field currents recorded in a row matrix form:

[0 0.64 0.76 0.92 1.08 1.20 1.28 1.60 1.84 1.96 2.20 2.32 2.60 2.80 2.96 3.20 3.40 3.56 3.84];

Please enter the corresponding values of open circuit voltages in a row matrix form:

[0 160 184 212 248 276 292 348 380 400 424 440 464 480 488 504 512 520 536];

Enter the field current during short circuit test (including the zero value)

in a row matrix form:[0 3.56];

Enter the corresponding short circuit line current that is circulated (including the zero value)

in a row matrix form:[0 13.5];

Thus the magnitude of field current corresponding to rated terminal voltage is:

1.9600

The magnitude of field current required to overcome armature reaction effect is:

3.5600

Enter the power factor of load: 0.8

The magnitude of the resultant vector sum of two field currents is:

4.9888

The corresponding value of generated voltage(E) to overcome all loading effects is:

522.0814

Hence the pre-determined voltage regulation is:

30.5204

**Synchronous Impedance Method:**

This is a program which pre-determines the voltage regulation of a three phase alternator

Please enter the value of rated line voltage of the machine:

400

Please enter the value of rated line current of the machine:

13.5

Please enter the open-circuit field currents recorded in a row matrix form:

[0 0.64 0.76 0.92 1.08 1.20 1.28 1.60 1.84 1.96 2.20 2.32 2.60 2.80 2.96 3.20 3.40 3.56 3.84];

Please enter the corresponding values of open circuit voltages in a row matrix form:

[0 160 184 212 248 276 292 348 380 400 424 440 464 480 488 504 512 520 536];

Enter the field current during short circuit test (including the zero value)

in a row matrix form:[0 3.56];

Enter the corresponding short circuit line current that is circulated (including the zero value)

in a row matrix form:[0 13.5];

Enter the value of measured stator resistance(a.c.):3.425

The rated phase current of the machine is given to be:

7.7942

The field current(If) required to circulate rated short-circuit current is:

3.5600

The corresponding open-circuit voltage(E) is:

522.2105

Thus the value of synchronous impedance(Zs) is

66.9996

The value of synchronous reactance(Xs) calculated is:

66.9120

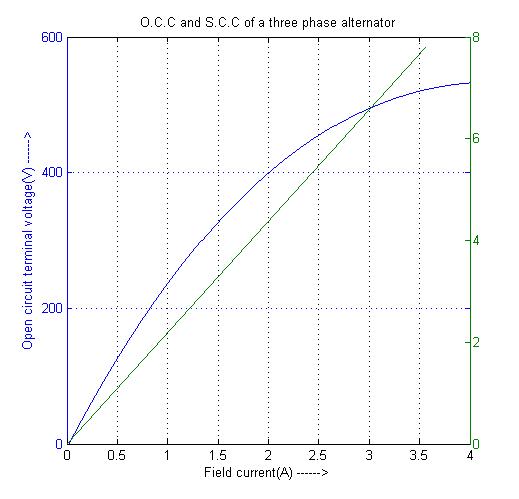
Enter the power factor of load:0.8

The corresponding value of generated voltage(E) to overcome all loading effects is:

446.6043

Hence the pre-determined voltage regulation is:

11.6511

PLOT:

RESULT:

Hence MATLAB is employed to pre-determine the voltage regulation of an alternator subject to various power factors under different loading conditions.