1. MATLAB CODE OF DIFFERENTIAL PROTECTION FOR ALL FAULTS

clear;

clc;

close all;

a= cosd(120)+ sind(120)\*i ;a2 =cosd(240)+1i\*sind(240) ;

f\_sampling=1600;

fo=50;

N=f\_sampling/fo;

theta= 2\*pi/N;

% For Wave Current before

Delta\_T=1/f\_sampling;

DATA=load('LG1INT.MAT');

T=DATA.t;

S\_a=DATA.iTi1aTi2a;

S\_b=DATA.iTi1bTi2b;

S\_c=DATA.iTi1cTi2c;

S\_A=DATA.iTo3aTo4a;

S\_B=DATA.iTo3bTo4b;

S\_C=DATA.iTo3cTo4c;

%Fundamental Basis Functions

cof\_cos=cos(theta\*(0:(320)));

cof\_sin=sin(theta\*(0:(320)));

% DFT for Current

window\_a=zeros(1,N);

Real\_aOld=0;

Imag\_aOld=0;

for kk=1:321

S\_aold=window\_a(N);

S\_anew=S\_a(kk);

for n\_w=N:-1:2

window\_a(n\_w)=window\_a(n\_w-1); % sliding for the window

end

window\_a(1)=S\_a(kk);

Real\_a(kk)=Real\_aOld+(S\_anew-S\_aold)\*cof\_cos(kk)\*2/N;

Imag\_a(kk)=Imag\_aOld+(S\_anew-S\_aold)\*cof\_sin(kk)\*2/N;

Amp\_a(kk)=sqrt(Real\_a(kk)^2+Imag\_a(kk)^2);

Ang\_a(kk)=atan2(Real\_a(kk),Imag\_a(kk))\*180/pi;

Real\_aOld=Real\_a(kk);

Imag\_aOld=Imag\_a(kk);

end

window\_b=zeros(1,N);

Real\_bOld=0;

Imag\_bOld=0;

for kk=1:321

S\_bold=window\_b(N);

S\_bnew=S\_b(kk);

for n\_w=N:-1:2

window\_b(n\_w)=window\_b(n\_w-1); % sliding for the window

end

window\_b(1)=S\_b(kk);

Real\_b(kk)=Real\_bOld+(S\_bnew-S\_bold)\*cof\_cos(kk)\*2/N;

Imag\_b(kk)=Imag\_bOld+(S\_bnew-S\_bold)\*cof\_sin(kk)\*2/N;

Amp\_b(kk)=sqrt(Real\_b(kk)^2+Imag\_b(kk)^2);

Ang\_b(kk)=atan2(Real\_b(kk),Imag\_b(kk))\*180/pi;

Real\_bOld=Real\_b(kk);

Imag\_bOld=Imag\_b(kk);

end

window\_c=zeros(1,N);

Real\_cOld=0;

Imag\_cOld=0;

for kk=1:321

S\_cold=window\_c(N);

S\_cnew=S\_c(kk);

for n\_w=N:-1:2

window\_c(n\_w)=window\_c(n\_w-1); % sliding for the window

end

window\_c(1)=S\_c(kk);

Real\_c(kk)=Real\_cOld+(S\_cnew-S\_cold)\*cof\_cos(kk)\*2/N;

Imag\_c(kk)=Imag\_cOld+(S\_cnew-S\_cold)\*cof\_sin(kk)\*2/N;

Amp\_c(kk)=sqrt(Real\_c(kk)^2+Imag\_c(kk)^2);

Ang\_c(kk)=atan2(Real\_c(kk),Imag\_c(kk))\*180/pi;

Real\_cOld=Real\_c(kk);

Imag\_cOld=Imag\_c(kk);

end

% DFT For current

window\_A=zeros(1,N);

Real\_AOld=0;

Imag\_AOld=0;

for kk=1:321

S\_Aold=window\_A(N);

S\_Anew=S\_A(kk);

for n\_w=N:-1:2

window\_A(n\_w)=window\_A(n\_w-1); % sliding for the window

end

window\_A(1)=S\_A(kk);

Real\_A(kk)=Real\_AOld+(S\_Anew-S\_Aold)\*cof\_cos(kk)\*2/N;

Imag\_A(kk)=Imag\_AOld+(S\_Anew-S\_Aold)\*cof\_sin(kk)\*2/N;

Amp\_A(kk)=sqrt(Real\_A(kk)^2+Imag\_A(kk)^2);

Ang\_A(kk)=atan2(Real\_A(kk),Imag\_A(kk))\*180/pi;

Real\_AOld=Real\_A(kk);

Imag\_AOld=Imag\_A(kk);

end

window\_B=zeros(1,N);

Real\_BOld=0;

Imag\_BOld=0;

for kk=1:321

S\_Bold=window\_B(N);

S\_Bnew=S\_B(kk);

for n\_w=N:-1:2

window\_B(n\_w)=window\_B(n\_w-1); % sliding for the window

end

window\_B(1)=S\_B(kk);

Real\_B(kk)=Real\_BOld+(S\_Bnew-S\_Bold)\*cof\_cos(kk)\*2/N;

Imag\_B(kk)=Imag\_BOld+(S\_Bnew-S\_Bold)\*cof\_sin(kk)\*2/N;

Amp\_B(kk)=sqrt(Real\_B(kk)^2+Imag\_B(kk)^2);

Ang\_B(kk)=atan2(Real\_B(kk),Imag\_B(kk))\*180/pi;

Real\_BOld=Real\_B(kk);

Imag\_BOld=Imag\_B(kk);

end

window\_C=zeros(1,N);

Real\_COld=0;

Imag\_COld=0;

for kk=1:321

S\_Cold=window\_C(N);

S\_Cnew=S\_C(kk);

for n\_w=N:-1:2

window\_C(n\_w)=window\_C(n\_w-1); % sliding for the window

end

window\_C(1)=S\_C(kk);

Real\_C(kk)=Real\_COld+(S\_Cnew-S\_Cold)\*cof\_cos(kk)\*2/N;

Imag\_C(kk)=Imag\_COld+(S\_Cnew-S\_Cold)\*cof\_sin(kk)\*2/N;

Amp\_C(kk)=sqrt(Real\_C(kk)^2+Imag\_C(kk)^2);

Ang\_C(kk)=atan2(Real\_C(kk),Imag\_C(kk))\*180/pi;

Real\_COld=Real\_C(kk);

Imag\_COld=Imag\_C(kk);

end

% Seq. Compantant for Current

S\_a\_dft = Amp\_a.\*exp(i\*Ang\_a\*pi/180) ;

S\_b\_dft = Amp\_b.\*exp(i\*Ang\_b\*pi/180) ;

S\_c\_dft = Amp\_c.\*exp(i\*Ang\_c\*pi/180) ;

S0\_seq = (S\_a\_dft+ S\_b\_dft+S\_c\_dft)/3;

S1\_seq = (S\_a\_dft+a\* S\_b\_dft+a2\*S\_c\_dft)/3;

S2\_seq = (S\_a\_dft+a2\* S\_b\_dft+a\* S\_c\_dft)/3;

Ang0=angle(S0\_seq)\*180/pi;

Ang1=angle(S1\_seq)\*180/pi;

Ang2=angle(S2\_seq)\*180/pi;

%Amp\_a is value of magnuite of phase "a" of Current Prob

%Amp\_b is value of magnuite of phase "b" of Current Prob

%Amp\_c is value of magnuite of phase "c" of Current Prob

%Ang\_a is value of angle of phase "a" of Current Prob

%Ang\_b is value of angle of phase "b" of Current Prob

%Ang\_c is value of angle of phase "c" of Current Prob

%abs(Amp0) is value of magnuite of zero seq. of Current Prob

%abs(Amp1) is value of magnuite of +ve seq. of Current Prob

%abs(Amp2) is value of magnuite of -ve seq. of Current Prob

%Ang0 is value of angle of zero seq. of Current Prob

%Ang1 is value of angle of +ve seq. of Current Prob

%Ang2 is value of angle of -ve seq. of Current Prob

% Seq. Compantant for current after transformer

S\_A\_dft = Amp\_A.\*exp(i\*Ang\_A\*pi/180) ;

S\_B\_dft = Amp\_B.\*exp(i\*Ang\_B\*pi/180) ;

S\_C\_dft = Amp\_C.\*exp(i\*Ang\_C\*pi/180) ;

S00\_seq = (S\_A\_dft+ S\_B\_dft+S\_C\_dft)/3;

S11\_seq = (S\_A\_dft+a\* S\_B\_dft+a2\*S\_C\_dft)/3;

S22\_seq = (S\_A\_dft+a2\* S\_B\_dft+a\* S\_C\_dft)/3;

Ang00=angle(S00\_seq)\*180/pi;

Ang11=angle(S11\_seq)\*180/pi;

Ang22=angle(S22\_seq)\*180/pi;

%Amp\_A is value of magnuite of phase "a" of Voltage Prob

%Amp\_B is value of magnuite of phase "b" of Voltage Prob

%Amp\_C is value of magnuite of phase "c" of Voltage Prob

%Ang\_A is value of angle of phase "a" of Voltage Prob

%Ang\_B is value of angle of phase "b" of Voltage Prob

%Ang\_C is value of angle of phase "c" of Voltage Prob

%abs(Amp00) is value of magnuite of zero seq. of Voltage Prob

%abs(Amp11) is value of magnuite of +ve seq. of Voltage Prob

%abs(Amp22) is value of magnuite of -ve seq. of Voltage Prob

%Ang00 is value of angle of zero seq. of Voltage Prob

%Ang11 is value of angle of +ve seq. of Voltage Prob

%Ang22 is value of angle of -ve seq. of Voltage Prob

I1=(S\_a\_dft/298)-(S\_A\_dft/1093.5);

I2=(S\_b\_dft/298)-(S\_B\_dft/1093.5);

I3=(S\_c\_dft/298)-(S\_C\_dft/1093.5);

I4=(S\_a\_dft/298)+(S\_A\_dft/1093.5);

I5=(S\_b\_dft/298)+(S\_B\_dft/1093.5);

I6=(S\_c\_dft/298)+(S\_C\_dft/1093.5);

x1=S\_a\_dft/298;

x2=S\_A\_dft/1093.5;

figure(18);

plot(T,abs(x1),T,abs(x2));

title('CURRENT BEFORE AND AFTER TRANSFORMER IN P.U')

xlabel('T(sec.)'); ylabel('CURRENT (AMP)');

figure(1);

plot(T,S\_a,T,S\_b,T,S\_c);

title('Two cycles of Signal s(t)')

xlabel('s(t)');

ylabel('time (sec.)');

figure(2)

plot(T,Amp\_a,T,Amp\_b,T,Amp\_c)

title('DFT of the magnuite of Current Prob');

figure(3)

plot(T,Ang\_a,T,Ang\_b,T,Ang\_c)

title('DFT of the angle of Current Prob');

figure(4)

plot(T,abs(S0\_seq),T,abs(S1\_seq),T,abs(S2\_seq));

xlabel('T(sec.)'); ylabel('magnetuite of Seq. Companant');

title('Magnuite of Seq. Compantant of Current Prob');

figure(5)

plot(T,Ang0,T,Ang1,T,Ang2)

xlabel('T(sec.)'); ylabel('Angle of Seq. companant ');

title('Angle of Seq. Compantant of Current Prob');

figure(6)

plot(T,S\_A,T,S\_B,T,S\_C)

figure(7)

plot(T,Amp\_A,T,Amp\_B,T,Amp\_C)

title('DFT of the magnuite of Voltage Prob');

figure(8)

plot(T,Ang\_A,T,Ang\_B,T,Ang\_C)

title('DFT of the angle of Voltage Prob');

figure(9)

plot(T,abs(S00\_seq),T,abs(S11\_seq),T,abs(S22\_seq))

title('Magnuite of Seq. Compantant of Voltage Prob');

xlabel('T(sec.)'); ylabel('Voltage (volt)');

figure(10)

plot(T,Ang00,T,Ang11,T,Ang22)

title('Angle of Seq. Compantant of Voltage Prob');

xlabel('T(sec.)'); ylabel('Angle (degree) ');

figure(11);

plot(T,abs(I1),'k','LineWidth',2)

title('SUBTRACT THE CURRENTS BEFORE AND AFTER TRANSFORMER FOR PHASE A');

xlabel('T(sec.)'); ylabel('CURRENT (AMP)');

figure(12);

plot(T,abs(I2),'k','LineWidth',2)

title('SUBTRACT THE CURRENTS BEFORE AND AFTER TRANSFORMER FOR PHASE B');

xlabel('T(sec.)'); ylabel('CURRENT (AMP)');

figure(13);

plot(T,abs(I3),'k','LineWidth',2)

title('SUBTRACT THE CURRENTS BEFORE AND AFTER TRANSFORMER FOR PHASE C');

xlabel('T(sec.)'); ylabel('CURRENT (AMP)');

figure(14);

plot(T,abs(I4),'k','LineWidth',2)

title('SUM THE CURRENTS BEFORE AND AFTER TRANSFORMER FOR PHASE A');

xlabel('T(sec.)'); ylabel('CURRENT (AMP)');

figure(15);

plot(T,abs(I5),'k','LineWidth',2)

title('SUM THE CURRENTS BEFORE AND AFTER TRANSFORMER FOR PHASE B');

xlabel('T(sec.)'); ylabel('CURRENT (AMP)');

figure(16);

plot(T,abs(I6),'k','LineWidth',2)

title('SUM THE CURRENTS BEFORE AND AFTER TRANSFORMER FOR PHASE C');

xlabel('T(sec.)'); ylabel('CURRENT (AMP)');

figure(17);

plot(T,abs(I4),T,abs(I5),T,abs(I6))

xlabel('T(sec.)'); ylabel('CURRENT (AMP)');

figure('Name','charachtarstics');

title('Zone');

diffcharc1(abs(I1),abs(I4));

hold on

diffcharc1(abs(I3),abs(I6));

hold on

diffcharc1(abs(I2),abs(I5));

hold on

xlabel('RESTRAINING CURRENT Ir (pu)'); ylabel('DIFFERENTIAL CURRENT Id (pu)');

hold off

lgd1=legend({'','','','','','phase A','','','','','','phase c','','','','','','phase b'},'FontSize',20);

k1=0;k2=0;k3=0;k4=0;k5=0;k6=0;k7=0;k8=0;k9=0;

if abs(I4(240))<=0.8

if abs(I1(240))>=0.2

k1=1;

end

elseif abs(I4(240))<=(3+1/3)

if abs(I1(240))>=(0.25\*abs(I4(240)))

k2=1;

end

else

if abs(I1(240))>=(0.5\*abs(I4(240))-0.8+0.1/3)

k3=1;

end

end

if abs(I5(240))<=0.8

if abs(I2(240))>=0.2

k4=1;

end

elseif abs(I5(240))<=(3+1/3)

if abs(I2(240))>=(0.25\*abs(I5(240)))

k5=1;

end

else

if abs(I2(240))>=(0.5\*abs(I5(240))-0.8+0.1/3)

k6=1;

end

end

if abs(I6(240))<=0.8

if abs(I3(240))>=0.2

k7=1;

end

elseif abs(I6(240))<=(3+1/3)

if abs(I3(240))>=(0.25\*abs(I6(240)))

k8=1;

end

else

if abs(I3(240))>=(0.5\*abs(I6(240))-0.8+0.1/3)

k9=1;

end

end

if (k1==1||k4==1||k7==1)

if (k1==1 && k4==1 && k7==1)

fprintf('L-L-L fault above line 0 ')

trip1=1;

elseif (k1==1 && k4==1)

fprintf('L-L fault between a-b above line 0 ')

trip1=1;

elseif (k1==1 && k7==1)

fprintf('L-L fault between at a-c above line 0 ')

trip1=1;

elseif (k4==1 && k7==1)

fprintf('L-L fault between at b-c above line 0 ')

trip1=1;

elseif (k4==1)

fprintf('L-G fault at line A above line 0 ')

trip1=1;

elseif (k7==1)

fprintf('L-G fault at line B above line 0 ')

trip1=1;

elseif (k1==1)

fprintf('L-G fault at line C above line 0 ')

trip1=1;

end

elseif(k2==1||k5==1||k8==1)

if (k2==1 && k5==1 && k8==1)

fprintf('L-L-L fault above line 1 ')

trip1=1;

elseif (k2==1 && k5==1)

fprintf('L-L fault between a-b above line 1 ')

trip1=1;

elseif (k2==1 && k8==1)

fprintf('L-L fault between a-c above line 1 ')

trip1=1;

elseif (k5==1 && k8==1)

fprintf('L-L fault between b-c above line 1 ')

trip1=1;

elseif (k2==1)

fprintf('L-G fault at line A above line 1 ')

trip1=1;

elseif (k5==1)

fprintf('L-G fault at line B above line 1 ')

trip1=1;

elseif (k8==1)

fprintf('L-G fault at line C above line 1 ')

trip1=1;

end

elseif(k3==1||k6==1||k9==1)

if (k3==1 && k6==1 && k9==1)

fprintf('L-L-L fault above line 2 ')

trip1=1;

elseif (k3==1 && k6==1)

fprintf('L-L fault between a-b above line 2 ')

trip1=1;

elseif (k3==1 && k9==1)

fprintf('L-L fault between a-c above line 2 ')

trip1=1;

elseif (k6==1 && k9==1)

fprintf('L-L fault between b-c above line 2 ')

trip1=1;

elseif (k3==1)

fprintf('L-G fault at line A above line 2 ')

trip1=1;

elseif (k6==1)

fprintf('L-G fault at line B above line 2 ')

trip1=1;

elseif (k9==1)

fprintf('L-G fault at line C above line 2 ')

trip1=1;

end

else

fprintf('nothing detected')

trip1=0;

end

fprintf('\n trip signal is %d\n',trip1)

trip=zeros(1,length(I4));

for kkk=1:length(I4)

k1=0;k2=0;k3=0;k4=0;k5=0;k6=0;k7=0;k8=0;k9=0;

if abs(I4(kkk))<=0.8

if abs(I1(kkk))>=0.2

k1=1;

end

elseif abs(I4(kkk))<=(3+1/3)

if abs(I1(kkk))>=(0.25\*abs(I4(kkk)))

k2=1;

end

elseif abs(I4(kkk))>=(3+1/3)

if abs(I1(kkk))>=(0.5\*abs(I4(kkk))-0.8+0.1/3)

k3=1;

end

end

if abs(I5(kkk))<=0.8

if abs(I2(kkk))>=0.2

k4=1;

end

elseif abs(I5(kkk))<=(3+1/3)

if abs(I2(kkk))>=(0.25\*abs(I5(kkk)))

k5=1;

end

else

if abs(I2(kkk))>=(0.5\*abs(I5(kkk))-0.8+0.1/3)

k6=1;

end

end

if abs(I6(kkk))<=0.8

if abs(I3(kkk))>=0.2

k7=1;

end

elseif abs(I6(kkk))<=(3+1/3)

if abs(I3(kkk))>=(0.25\*abs(I6(kkk)))

k8=1;

end

else

if abs(I3(kkk))>=(0.5\*abs(I6(kkk))-0.8+0.1/3)

k9=1;

end

end

if (k1==1||k4==1||k7==1)

if (k1==1 && k4==1)

trip(kkk)=1;

elseif (k1==1 && k7==1)

trip(kkk)=1;

elseif (k4==1 && k7==1)

trip(kkk)=1;

elseif (k1==1)

trip(kkk)=1;

elseif (k4==1)

trip(kkk)=1;

elseif (k7==1)

trip(kkk)=1;

end

elseif(k2==1||k5==1||k8==1)

if (k2==1 && k5==1)

trip(kkk)=1;

elseif (k2==1 && k8==1)

trip(kkk)=1;

elseif (k5==1 && k8==1)

trip(kkk)=1;

elseif (k2==1)

trip(kkk)=1;

elseif (k5==1)

trip(kkk)=1;

elseif (k8==1)

trip(kkk)=1;

end

elseif(k3==1||k6==1||k9==1)

if (k3==1 && k6==1)

trip(kkk)=1;

elseif (k3==1 && k9==1)

trip(kkk)=1;

elseif (k6==1 && k9==1)

trip(kkk)=1;

elseif (k3==1)

trip(kkk)=1;

elseif (k6==1)

trip(kkk)=1;

elseif (k9==1)

trip(kkk)=1;

end

else

trip(kkk)=0;

end

end

figure(20)

plot(((1:length(trip))-1)\*1000\*Delta\_T,trip)

title('OUTPUT OF RELAY');

xlabel('TIME'); ylabel('MAGNITUDE OF PULSE')

Diff Characteristic 1 for matlab code 1

function diffcharc(I1,I4)

plot([0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30],[0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0],'k','LineWidth',2)

hold on

plot([0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0],[0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30],'k','LineWidth',2)

hold on

plot([0,0.8],[0.2,0.2],'k','LineWidth',2)

hold on

plot([0.8,3.33333],[0.2,0.83333333],'k','LineWidth',2)

hold on

plot([3.3333,26],[0.8333333333,12.6666667],'K','LineWidth',2)

grid on

plot([26,30],[12.6666667,12.6666667],'K','LineWidth',2)

hold ON

plot (I4,I1,'r','LineWidth',2)

hold off

Diff Characteristic 2 for matlab code 1

function diffcharc(I1,I4)

plot([0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30],[0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0],'k','LineWidth',2)

hold on

plot([0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0],[0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30],'k','LineWidth',2)

hold on

plot([0,0.8],[0.2,0.2],'k','LineWidth',2)

hold on

plot([0.8,3.33333],[0.2,0.83333333],'k','LineWidth',2)

hold on

plot([3.3333,26],[0.8333333333,12.6666667],'K','LineWidth',2)

grid on

plot([26,30],[12.6666667,12.6666667],'K','LineWidth',2)

hold ON

plot (I4,I1,'r','LineWidth',2)

hold off

1. EFFECT OF VARABIABLE VALUES OF RF ON FAULT CURRENT (LINE TO GROUND)

figure(30);

semilogx([0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35],[0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0],'k','LineWidth',2)

hold on

semilogx([0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0],[0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35],'k','LineWidth',2)

grid on

hold on

semilogx([0,0.8],[0.2,0.2],'k','LineWidth',2)

hold on

semilogx([0.8,3.33333],[0.2,0.83333333],'k','LineWidth',2)

hold on

semilogx([3.3333,26],[0.8333333333,12.6666667],'k','LineWidth',2)

hold on

X=[20.6452,5.86172,3.575,2.78617,2.15107,1.83395,1.67601,1.51882,1.44062,1.30077,1.25148]

Y=[20.0422,4.72159,2.41551,1.61908,0.975023,0.651222,0.488974,0.326545,0.245287,0.0991519,0.0508419]

semilogx(X,Y,'--\*','LineWidth',2)

title('SUM AND SUBTRACT OF CURRENTS');

xlabel('RESTRAINING CURRENT Ir (pu)'); ylabel('DIFFERENTIAL CURRENT Id (pu)');

hold off

legend({'','','','','','phase A','','','','','','phase b','','','','','','phase c'},'FontSize',30);

1. EFFECT OF VARABIABLE VALUES OF RF ON FAULT CURRENT (LINE TO LINE)

figure(40);

semilogx([0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35],[0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0],'k','LineWidth',2)

hold on

semilogx([0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0],[0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35],'k','LineWidth',2)

hold on

semilogx([0,0.8],[0.2,0.2],'k','LineWidth',2)

hold on

semilogx([0.8,3.33333],[0.2,0.83333333],'k','LineWidth',2)

hold on

semilogx([3.3333,26],[0.8333333333,12.6666667],'k','LineWidth',2)

hold on

X1=[19.7518,8.56093,5.04388,3.73566,2.67086,2.1466,1.8918,1.64612,1.52834,1.32888,1.26712]

Y1=[19.6321,7.58716,4.07792,2.76299,1.67286,1.11812,0.838877,0.55861,0.418154,0.164971,0.0806914]

semilogx(X1,Y1,'--\*','LineWidth',2)

hold on

X2=[18.7666,8.44578,5.11876,3.86197,2.81676,2.28417,2.01606,1.74711,1.61243,1.3691,1.2891]

Y2=[19.0342,7.59651,4.08802,2.77328,1.68326,1.12856,0.849336,0.569082,0.428628,0.175417,0.0910509]

semilogx(X2,Y2,'--\*','LineWidth',2)

title('SUM AND SUBTRACT OF CURRENTS');

xlabel('CURRENT (AMP)'); ylabel('CURRENT (AMP)');

hold off

legend({'','','','','','phase a','phase b'},'FontSize',30);

1. MATLAB CODE FOR DELTA STAR TRANSFORMER (LINE TO GROUND)

clear;

clc;

close all;

a= cosd(120)+ sind(120)\*i ;a2 =cosd(240)+1i\*sind(240) ;

f\_sampling=1600;

fo=50;

N=f\_sampling/fo;

theta= 2\*pi/N;

% For Wave Current before

Delta\_T=1/f\_sampling;

DATA=load('DSLG.MAT');

T=DATA.t;

S\_a=DATA.iTi1aTi2a;

S\_b=DATA.iTi1bTi2b;

S\_c=DATA.iTi1cTi2c;

S\_A=DATA.iTo3aTo4a;

S\_B=DATA.iTo3bTo4b;

S\_C=DATA.iTo3cTo4c;

%Fundamental Basis Functions

cof\_cos=cos(theta\*(0:(320)));

cof\_sin=sin(theta\*(0:(320)));

% DFT for Current

window\_a=zeros(1,N);

Real\_aOld=0;

Imag\_aOld=0;

for kk=1:321

S\_aold=window\_a(N);

S\_anew=S\_a(kk);

for n\_w=N:-1:2

window\_a(n\_w)=window\_a(n\_w-1); % sliding for the window

end

window\_a(1)=S\_a(kk);

Real\_a(kk)=Real\_aOld+(S\_anew-S\_aold)\*cof\_cos(kk)\*2/N;

Imag\_a(kk)=Imag\_aOld+(S\_anew-S\_aold)\*cof\_sin(kk)\*2/N;

Amp\_a(kk)=sqrt(Real\_a(kk)^2+Imag\_a(kk)^2);

Ang\_a(kk)=atan2(Real\_a(kk),Imag\_a(kk))\*180/pi;

Real\_aOld=Real\_a(kk);

Imag\_aOld=Imag\_a(kk);

end

window\_b=zeros(1,N);

Real\_bOld=0;

Imag\_bOld=0;

for kk=1:321

S\_bold=window\_b(N);

S\_bnew=S\_b(kk);

for n\_w=N:-1:2

window\_b(n\_w)=window\_b(n\_w-1); % sliding for the window

end

window\_b(1)=S\_b(kk);

Real\_b(kk)=Real\_bOld+(S\_bnew-S\_bold)\*cof\_cos(kk)\*2/N;

Imag\_b(kk)=Imag\_bOld+(S\_bnew-S\_bold)\*cof\_sin(kk)\*2/N;

Amp\_b(kk)=sqrt(Real\_b(kk)^2+Imag\_b(kk)^2);

Ang\_b(kk)=atan2(Real\_b(kk),Imag\_b(kk))\*180/pi;

Real\_bOld=Real\_b(kk);

Imag\_bOld=Imag\_b(kk);

end

window\_c=zeros(1,N);

Real\_cOld=0;

Imag\_cOld=0;

for kk=1:321

S\_cold=window\_c(N);

S\_cnew=S\_c(kk);

for n\_w=N:-1:2

window\_c(n\_w)=window\_c(n\_w-1); % sliding for the window

end

window\_c(1)=S\_c(kk);

Real\_c(kk)=Real\_cOld+(S\_cnew-S\_cold)\*cof\_cos(kk)\*2/N;

Imag\_c(kk)=Imag\_cOld+(S\_cnew-S\_cold)\*cof\_sin(kk)\*2/N;

Amp\_c(kk)=sqrt(Real\_c(kk)^2+Imag\_c(kk)^2);

Ang\_c(kk)=atan2(Real\_c(kk),Imag\_c(kk))\*180/pi;

Real\_cOld=Real\_c(kk);

Imag\_cOld=Imag\_c(kk);

end

% DFT For current

window\_A=zeros(1,N);

Real\_AOld=0;

Imag\_AOld=0;

for kk=1:321

S\_Aold=window\_A(N);

S\_Anew=S\_A(kk);

for n\_w=N:-1:2

window\_A(n\_w)=window\_A(n\_w-1); % sliding for the window

end

window\_A(1)=S\_A(kk);

Real\_A(kk)=Real\_AOld+(S\_Anew-S\_Aold)\*cof\_cos(kk)\*2/N;

Imag\_A(kk)=Imag\_AOld+(S\_Anew-S\_Aold)\*cof\_sin(kk)\*2/N;

Amp\_A(kk)=sqrt(Real\_A(kk)^2+Imag\_A(kk)^2);

Ang\_A(kk)=atan2(Real\_A(kk),Imag\_A(kk))\*180/pi;

Real\_AOld=Real\_A(kk);

Imag\_AOld=Imag\_A(kk);

end

window\_B=zeros(1,N);

Real\_BOld=0;

Imag\_BOld=0;

for kk=1:321

S\_Bold=window\_B(N);

S\_Bnew=S\_B(kk);

for n\_w=N:-1:2

window\_B(n\_w)=window\_B(n\_w-1); % sliding for the window

end

window\_B(1)=S\_B(kk);

Real\_B(kk)=Real\_BOld+(S\_Bnew-S\_Bold)\*cof\_cos(kk)\*2/N;

Imag\_B(kk)=Imag\_BOld+(S\_Bnew-S\_Bold)\*cof\_sin(kk)\*2/N;

Amp\_B(kk)=sqrt(Real\_B(kk)^2+Imag\_B(kk)^2);

Ang\_B(kk)=atan2(Real\_B(kk),Imag\_B(kk))\*180/pi;

Real\_BOld=Real\_B(kk);

Imag\_BOld=Imag\_B(kk);

end

window\_C=zeros(1,N);

Real\_COld=0;

Imag\_COld=0;

for kk=1:321

S\_Cold=window\_C(N);

S\_Cnew=S\_C(kk);

for n\_w=N:-1:2

window\_C(n\_w)=window\_C(n\_w-1); % sliding for the window

end

window\_C(1)=S\_C(kk);

Real\_C(kk)=Real\_COld+(S\_Cnew-S\_Cold)\*cof\_cos(kk)\*2/N;

Imag\_C(kk)=Imag\_COld+(S\_Cnew-S\_Cold)\*cof\_sin(kk)\*2/N;

Amp\_C(kk)=sqrt(Real\_C(kk)^2+Imag\_C(kk)^2);

Ang\_C(kk)=atan2(Real\_C(kk),Imag\_C(kk))\*180/pi;

Real\_COld=Real\_C(kk);

Imag\_COld=Imag\_C(kk);

end

% Seq. Compantant for Current

S\_a\_dft = Amp\_a.\*exp(i\*Ang\_a\*pi/180) ;

S\_b\_dft = Amp\_b.\*exp(i\*Ang\_b\*pi/180) ;

S\_c\_dft = Amp\_c.\*exp(i\*Ang\_c\*pi/180) ;

S0\_seq = (S\_a\_dft+ S\_b\_dft+S\_c\_dft)/3;

S1\_seq = (S\_a\_dft+a\* S\_b\_dft+a2\*S\_c\_dft)/3;

S2\_seq = (S\_a\_dft+a2\* S\_b\_dft+a\* S\_c\_dft)/3;

Ang0=angle(S0\_seq)\*180/pi;

Ang1=angle(S1\_seq)\*180/pi;

Ang2=angle(S2\_seq)\*180/pi;

%Amp\_a is value of magnuite of phase "a" of Current Prob

%Amp\_b is value of magnuite of phase "b" of Current Prob

%Amp\_c is value of magnuite of phase "c" of Current Prob

%Ang\_a is value of angle of phase "a" of Current Prob

%Ang\_b is value of angle of phase "b" of Current Prob

%Ang\_c is value of angle of phase "c" of Current Prob

%abs(Amp0) is value of magnuite of zero seq. of Current Prob

%abs(Amp1) is value of magnuite of +ve seq. of Current Prob

%abs(Amp2) is value of magnuite of -ve seq. of Current Prob

%Ang0 is value of angle of zero seq. of Current Prob

%Ang1 is value of angle of +ve seq. of Current Prob

%Ang2 is value of angle of -ve seq. of Current Prob

% Seq. Compantant for current after transformer

S\_A\_dft = Amp\_A.\*exp(i\*Ang\_A\*pi/180) ;

S\_B\_dft = Amp\_B.\*exp(i\*Ang\_B\*pi/180) ;

S\_C\_dft = Amp\_C.\*exp(i\*Ang\_C\*pi/180) ;

S00\_seq = (S\_A\_dft+ S\_B\_dft+S\_C\_dft)/3;

S11\_seq = (S\_A\_dft+a\* S\_B\_dft+a2\*S\_C\_dft)/3;

S22\_seq = (S\_A\_dft+a2\* S\_B\_dft+a\* S\_C\_dft)/3;

Ang00=angle(S00\_seq)\*180/pi;

Ang11=angle(S11\_seq)\*180/pi;

Ang22=angle(S22\_seq)\*180/pi;

%Amp\_A is value of magnuite of phase "a" of Voltage Prob

%Amp\_B is value of magnuite of phase "b" of Voltage Prob

%Amp\_C is value of magnuite of phase "c" of Voltage Prob

%Ang\_A is value of angle of phase "a" of Voltage Prob

%Ang\_B is value of angle of phase "b" of Voltage Prob

%Ang\_C is value of angle of phase "c" of Voltage Prob

%abs(Amp00) is value of magnuite of zero seq. of Voltage Prob

%abs(Amp11) is value of magnuite of +ve seq. of Voltage Prob

%abs(Amp22) is value of magnuite of -ve seq. of Voltage Prob

%Ang00 is value of angle of zero seq. of Voltage Prob

%Ang11 is value of angle of +ve seq. of Voltage Prob

%Ang22 is value of angle of -ve seq. of Voltage Prob

I1=6.06\*(S\_a\_dft/298)-((S\_A\_dft-S\_B\_dft)/1093.5);

I2=6.06\*(S\_b\_dft/298)-((S\_B\_dft-S\_C\_dft)/1093.5);

I3=6.06\*(S\_c\_dft/298)-((S\_C\_dft-S\_A\_dft)/1093.5);

I4=6.06\*(S\_a\_dft/298)+((S\_A\_dft-S\_B\_dft)/1093.5);

I5=6.06\*(S\_b\_dft/298)+((S\_B\_dft-S\_C\_dft)/1093.5);

I6=6.06\*(S\_c\_dft/298)+((S\_C\_dft-S\_A\_dft)/1093.5);

x1=6.06\*S\_a\_dft/298;

x2=S\_A\_dft/1093.5;

figure(18);

plot(T,abs(x1),T,abs(x2));

title('CURRENT BEFORE AND AFTER TRANSFORMER IN P.U')

xlabel('T(sec.)'); ylabel('CURRENT (AMP)');

figure(1);

plot(T,S\_a,T,S\_b,T,S\_c);

title('Two cycles of Signal s(t)')

xlabel('s(t)');

ylabel('time (sec.)');

figure(2)

plot(T,Amp\_a,T,Amp\_b,T,Amp\_c)

title('DFT of the magnuite of Current Prob');

figure(3)

plot(T,Ang\_a,T,Ang\_b,T,Ang\_c)

title('DFT of the angle of Current Prob');

figure(4)

plot(T,abs(S0\_seq),T,abs(S1\_seq),T,abs(S2\_seq));

xlabel('T(sec.)'); ylabel('magnetuite of Seq. Companant');

title('Magnuite of Seq. Compantant of Current Prob');

figure(5)

plot(T,Ang0,T,Ang1,T,Ang2)

xlabel('T(sec.)'); ylabel('Angle of Seq. companant ');

title('Angle of Seq. Compantant of Current Prob');

figure(6)

plot(T,S\_A,T,S\_B,T,S\_C)

figure(7)

plot(T,Amp\_A,T,Amp\_B,T,Amp\_C)

title('DFT of the magnuite of Voltage Prob');

figure(8)

plot(T,Ang\_A,T,Ang\_B,T,Ang\_C)

title('DFT of the angle of Voltage Prob');

figure(9)

plot(T,abs(S00\_seq),T,abs(S11\_seq),T,abs(S22\_seq))

title('Magnuite of Seq. Compantant of Voltage Prob');

xlabel('T(sec.)'); ylabel('Voltage (volt)');

figure(10)

plot(T,Ang00,T,Ang11,T,Ang22)

title('Angle of Seq. Compantant of Voltage Prob');

xlabel('T(sec.)'); ylabel('Angle (degree) ');

figure(11);

plot(T,abs(I1),'k','LineWidth',2)

title('SUBTRACT THE CURRENTS BEFORE AND AFTER TRANSFORMER FOR PHASE A');

xlabel('T(sec.)'); ylabel('CURRENT (AMP)');

figure(12);

plot(T,abs(I2),'k','LineWidth',2)

title('SUBTRACT THE CURRENTS BEFORE AND AFTER TRANSFORMER FOR PHASE B');

xlabel('T(sec.)'); ylabel('CURRENT (AMP)');

figure(13);

plot(T,abs(I3),'k','LineWidth',2)

title('SUBTRACT THE CURRENTS BEFORE AND AFTER TRANSFORMER FOR PHASE C');

xlabel('T(sec.)'); ylabel('CURRENT (AMP)');

figure(14);

plot(T,abs(I4),'k','LineWidth',2)

title('SUM THE CURRENTS BEFORE AND AFTER TRANSFORMER FOR PHASE A');

xlabel('T(sec.)'); ylabel('CURRENT (AMP)');

figure(15);

plot(T,abs(I5),'k','LineWidth',2)

title('SUM THE CURRENTS BEFORE AND AFTER TRANSFORMER FOR PHASE B');

xlabel('T(sec.)'); ylabel('CURRENT (AMP)');

figure(16);

plot(T,abs(I6),'k','LineWidth',2)

title('SUM THE CURRENTS BEFORE AND AFTER TRANSFORMER FOR PHASE C');

xlabel('T(sec.)'); ylabel('CURRENT (AMP)');

figure(17);

plot(T,abs(I4),T,abs(I5),T,abs(I6))

xlabel('T(sec.)'); ylabel('CURRENT (AMP)');

figure('Name','charachtarstics');

title('Zone');

diffcharc1(abs(I1),abs(I4));

hold on

diffcharc1(abs(I3),abs(I6));

hold on

diffcharc1(abs(I2),abs(I5));

hold on

xlabel('RESTRAINING CURRENT Ir (pu)'); ylabel('DIFFERENTIAL CURRENT Id (pu)');

hold off

lgd1=legend({'','','','','','phase A','','','','','','phase c','','','','','','phase b'},'FontSize',20);

k1=0;k2=0;k3=0;k4=0;k5=0;k6=0;k7=0;k8=0;k9=0;

if abs(I4(240))<=0.8

if abs(I1(240))>=0.2

k1=1;

end

elseif abs(I4(240))<=(3+1/3)

if abs(I1(240))>=(0.25\*abs(I4(240)))

k2=1;

end

else

if abs(I1(240))>=(0.5\*abs(I4(240))-0.8+0.1/3)

k3=1;

end

end

if abs(I5(240))<=0.8

if abs(I2(240))>=0.2

k4=1;

end

elseif abs(I5(240))<=(3+1/3)

if abs(I2(240))>=(0.25\*abs(I5(240)))

k5=1;

end

else

if abs(I2(240))>=(0.5\*abs(I5(240))-0.8+0.1/3)

k6=1;

end

end

if abs(I6(240))<=0.8

if abs(I3(240))>=0.2

k7=1;

end

elseif abs(I6(240))<=(3+1/3)

if abs(I3(240))>=(0.25\*abs(I6(240)))

k8=1;

end

else

if abs(I3(240))>=(0.5\*abs(I6(240))-0.8+0.1/3)

k9=1;

end

end

if (k1==1||k4==1||k7==1)

if (k1==1 && k4==1 && k7==1)

fprintf('L-L-L fault above line 0 ')

trip1=1;

elseif (k1==1 && k4==1)

fprintf('L-L fault between a-b above line 0 ')

trip1=1;

elseif (k1==1 && k7==1)

fprintf('L-L fault between at a-c above line 0 ')

trip1=1;

elseif (k4==1 && k7==1)

fprintf('L-L fault between at b-c above line 0 ')

trip1=1;

elseif (k4==1)

fprintf('L-G fault at line A above line 0 ')

trip1=1;

elseif (k7==1)

fprintf('L-G fault at line B above line 0 ')

trip1=1;

elseif (k1==1)

fprintf('L-G fault at line C above line 0 ')

trip1=1;

end

elseif(k2==1||k5==1||k8==1)

if (k2==1 && k5==1 && k8==1)

fprintf('L-L-L fault above line 1 ')

trip1=1;

elseif (k2==1 && k5==1)

fprintf('L-L fault between a-b above line 1 ')

trip1=1;

elseif (k2==1 && k8==1)

fprintf('L-L fault between a-c above line 1 ')

trip1=1;

elseif (k5==1 && k8==1)

fprintf('L-L fault between b-c above line 1 ')

trip1=1;

elseif (k2==1)

fprintf('L-G fault at line A above line 1 ')

trip1=1;

elseif (k5==1)

fprintf('L-G fault at line B above line 1 ')

trip1=1;

elseif (k8==1)

fprintf('L-G fault at line C above line 1 ')

trip1=1;

end

elseif(k3==1||k6==1||k9==1)

if (k3==1 && k6==1 && k9==1)

fprintf('L-L-L fault above line 2 ')

trip1=1;

elseif (k3==1 && k6==1)

fprintf('L-L fault between a-b above line 2 ')

trip1=1;

elseif (k3==1 && k9==1)

fprintf('L-L fault between a-c above line 2 ')

trip1=1;

elseif (k6==1 && k9==1)

fprintf('L-L fault between b-c above line 2 ')

trip1=1;

elseif (k3==1)

fprintf('L-G fault at line A above line 2 ')

trip1=1;

elseif (k6==1)

fprintf('L-G fault at line B above line 2 ')

trip1=1;

elseif (k9==1)

fprintf('L-G fault at line C above line 2 ')

trip1=1;

end

else

fprintf('nothing detected')

trip1=0;

end

fprintf('\n trip signal is %d\n',trip1)

trip=zeros(1,length(I4));

for kkk=1:length(I4)

k1=0;k2=0;k3=0;k4=0;k5=0;k6=0;k7=0;k8=0;k9=0;

if abs(I4(kkk))<=0.8

if abs(I1(kkk))>=0.2

k1=1;

end

elseif abs(I4(kkk))<=(3+1/3)

if abs(I1(kkk))>=(0.25\*abs(I4(kkk)))

k2=1;

end

elseif abs(I4(kkk))>=(3+1/3)

if abs(I1(kkk))>=(0.5\*abs(I4(kkk))-0.8+0.1/3)

k3=1;

end

end

if abs(I5(kkk))<=0.8

if abs(I2(kkk))>=0.2

k4=1;

end

elseif abs(I5(kkk))<=(3+1/3)

if abs(I2(kkk))>=(0.25\*abs(I5(kkk)))

k5=1;

end

else

if abs(I2(kkk))>=(0.5\*abs(I5(kkk))-0.8+0.1/3)

k6=1;

end

end

if abs(I6(kkk))<=0.8

if abs(I3(kkk))>=0.2

k7=1;

end

elseif abs(I6(kkk))<=(3+1/3)

if abs(I3(kkk))>=(0.25\*abs(I6(kkk)))

k8=1;

end

else

if abs(I3(kkk))>=(0.5\*abs(I6(kkk))-0.8+0.1/3)

k9=1;

end

end

if (k1==1||k4==1||k7==1)

if (k1==1 && k4==1)

trip(kkk)=1;

elseif (k1==1 && k7==1)

trip(kkk)=1;

elseif (k4==1 && k7==1)

trip(kkk)=1;

elseif (k1==1)

trip(kkk)=1;

elseif (k4==1)

trip(kkk)=1;

elseif (k7==1)

trip(kkk)=1;

end

elseif(k2==1||k5==1||k8==1)

if (k2==1 && k5==1)

trip(kkk)=1;

elseif (k2==1 && k8==1)

trip(kkk)=1;

elseif (k5==1 && k8==1)

trip(kkk)=1;

elseif (k2==1)

trip(kkk)=1;

elseif (k5==1)

trip(kkk)=1;

elseif (k8==1)

trip(kkk)=1;

end

elseif(k3==1||k6==1||k9==1)

if (k3==1 && k6==1)

trip(kkk)=1;

elseif (k3==1 && k9==1)

trip(kkk)=1;

elseif (k6==1 && k9==1)

trip(kkk)=1;

elseif (k3==1)

trip(kkk)=1;

elseif (k6==1)

trip(kkk)=1;

elseif (k9==1)

trip(kkk)=1;

end

else

trip(kkk)=0;

end

end

figure(20)

plot(((1:length(trip))-1)\*1000\*Delta\_T,trip)

title('OUTPUT OF RELAY');

xlabel('TIME'); ylabel('MAGNITUDE OF PULSE');

1. EFFECT OF RF ON FAULT CURRENT AT 100 KM FROM 220KV T.L (LINE TO GROUND)

figure(50);

semilogx([0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25],[0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0],'k','LineWidth',2)

hold on

semilogx([0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0],[0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25],'k','LineWidth',2)

grid on

semilogx([0,0.8],[0.2,0.2],'k','LineWidth',2)

hold on

semilogx([0.8,3.33333],[0.2,0.83333333],'k','LineWidth',2)

hold on

semilogx([3.3333,26],[0.8333333333,12.6666667],'k','LineWidth',2)

hold on

X=[13.231,6.25372,2.78898,1.51858,1.51858,1.14341,0.451107,0.217473]

Y=[30.1871,14.3467,6.5431,3.54067,2.68778,1.13822,0.651517,0.651517]

semilogx(X,Y,'--\*','LineWidth',2)

title('SUM AND SUBTRACT OF CURRENTS');

xlabel('RESTRAINING CURRENT Ir (pu)'); ylabel('DIFFERENTIAL CURRENT Id (pu)');

hold off

legend({'','','','','','phase A','','','','','','phase b','','','','','','phase c'},'FontSize',30);

1. EFFECT OF RF ON FAULT CURRENT AT 100 KM FROM 220KV T.L (LINE TO LINE)

figure(60);

semilogx([0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25],[0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0],'k','LineWidth',2)

hold on

semilogx([0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0],[0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25],'k','LineWidth',2)

hold on

semilogx([0,0.8],[0.2,0.2],'k','LineWidth',2)

hold on

semilogx([0.8,3.33333],[0.2,0.83333333],'k','LineWidth',2)

hold on

semilogx([3.3333,26],[0.8333333333,12.6666667],'k','LineWidth',2)

hold on

x6=[24.9929,10.9615,5.1214,2.07076,2.02199,0.822315,0.41495]

y6=[57.5313,25.282,11.913,6.30646,4.8211,2.08572,1.16936]

semilogx(x6,y6,'--\*','LineWidth',2)

hold on

X9=[25.0022,10.9348,5.08667,2.63313,1.98363,0.782193,0.37354]

Y9=[57.4171,24.9499,11.554,5.94053,4.45642,1.72399,0.821461]

semilogx(X9,Y9,'--\*','LineWidth',2)

title('SUM AND SUBTRACT OF CURRENTS');

xlabel('CURRENT (AMP)'); ylabel('CURRENT (AMP)');

hold off

legend({'','','','','','phase a','phase b'},'FontSize',30);