

Programy MATLAB dotyczące falownika napięcia INV

```
% % Inv_SVM_6C_Prc_03
% 3 phase Inverter RLE load
% frequency & voltage control
% obliczanie strat w rezystancjach Rc: diff()
clearvars;
format shortg;
c1=clock
step=0.5e-5;
tfin=0.12-step;
tRange=[0:step:tfin-step];
Nst=round(tfin/step); Su2=0;
global Udc; Udc=500.0; global C; C=0.80e-3;
Ldc=0.2e-3; Ls= 0.5e-1; Ld=0.2e-3;
L=[Ldc+2*Ld, 2*Ld, Ld, 2*Ld, Ld; 2*Ld, 4*Ld, 2*Ld, 2*Ld, Ld; Ld, 2*Ld,
2*(Ld+Ls), Ld, Ld+Ls;...
2*Ld, 2*Ld, Ld, 4*Ld, 2*Ld; Ld, Ld, Ld+Ls, 2*Ld, 2*(Ld+Ls)];
global Rdc; Rdc=0.1; global Rs; Rs=10;
global f; f=40.0; global N; N=90; global ku; ku=0.8;
global Rc; Rc=0.1e6; global st1; st1=sqrt(3.0)/pi;
global Tf; Tf=1/f; global Tp; Tp=Tf/N;
global Rp; Rp=0.01;
% Nxt to jest odstęp różniczkowania w wielokrotności 'step'
Nxt=250;
global Lod; Lod=inv(L); global Rb; Rb=10000;
global R1; R1=Rb; global R2; R2=Rb; global R3; R3=Rb;
global R4; R4=Rb; global R5; R5=Rb; global R6; R6=Rb;
Q0=0.5*Udc*C;
i0=[0., 0., 0., 0., 0., Q0, Q0, Q0, Q0, Q0, Q0, 0., 0., 0., 0., 0., 0.];
options=odeset('AbsTol',1e-7,'RelTol',1e-6);
[tSol,YSol]=ode113(@Inv6C,tRange,i0);
% source current iDC
f0=figure;
plot(tSol,YSol(:,1))
grid on;
N1=round(0.6*Nst); Np=Nst-N1;
xlabel('time [s]');
ylabel('DC current [A]');
title('DC source current; f=20 [Hz], ku=1.0, N=120, Udc=500 V, Rc=0.1M');
DCAv=sum(YSol(Np:Nst,1))/N1
% is1 load current
f1=figure;
plot(tSol,YSol(:,3),'Linewidth',1)
grid on;
hold on
xlabel('time [s]');
ylabel('[currents [A]]');
title('Output AC currents; f=20 [Hz], ku=1.0, N=120, Udc=500 V,
Rc=0.1M');
is1rms=sqrt(sum(YSol(Np:Nst,3).^2)/N1)
% is3 load current
plot(tSol,YSol(:,5),'Linewidth',1)
is3rms=sqrt(sum(YSol(Np:Nst,5).^2)/N1)
% is2 load current
AC=[-YSol(:,3)-YSol(:,5)];
plot(tSol,AC,'Linewidth',1)
legend('is1','is3','is2');
hold off
is2rms=sqrt(sum(AC(Np:Nst).^2)/N1)
f2=figure;
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plot(tSol,YSol(:,6)/C,'Linewidth',1)
grid on
title('Capacitor voltages; f=20 [Hz], ku=1.0, N=120, Udc=500 V, Rc=0.1M');
xlabel('time [s]');
ylabel('[V]');
hold on
plot(tSol,YSol(:,7)/C,'Linewidth',1)
plot(tSol,YSol(:,8)/C,'Linewidth',1)
plot(tSol,YSol(:,9)/C,'Linewidth',1)
plot(tSol,YSol(:,10)/C,'Linewidth',1)
plot(tSol,YSol(:,11)/C,'Linewidth',1)
legend('V7','V8','V9','V10','V11','V12');
hold off
% calculations of Rc power losses
% Nxt difference is # of steps
kf=floor(Nst/Nxt);
for k=1:kf WRc7(k)=YSol(Nxt*k,12);
           tNxt(k)=tSol(Nxt*k);
           WRc8(k)=YSol(Nxt*k,13);
           WRc9(k)=YSol(Nxt*k,14);
           WRc10(k)=YSol(Nxt*k,15);
           WRc11(k)=YSol(Nxt*k,16);
           WRc12(k)=YSol(Nxt*k,17);
end
PRc7=diff(WRc7)/(Nxt*step);
PRc8=diff(WRc8)/(Nxt*step);
PRc9=diff(WRc9)/(Nxt*step);
PRc10=diff(WRc10)/(Nxt*step);
PRc11=diff(WRc11)/(Nxt*step);
PRc12=diff(WRc12)/(Nxt*step);
figure;
plot(tNxt(1:kf-1),PRc11)
grid on
hold on
title('PRc11 & PRc12 losses [W], Nxt=450, Rc=1M');
xlabel('time [s]');
ylabel('power [W]');
plot(tNxt(1:kf-1),PRc12)
hold off
f8=figure;
plot(tNxt(1:kf-1),PRc7)
grid on
title('PRc7 & PRc8 losses [W], Nxt=450, Rc=1M');
xlabel('time [s]');
ylabel('power [W]');
hold on
plot(tNxt(1:kf-1),PRc8)
hold off

f9=figure;
plot(tNxt(1:kf-1),PRc9)
title('PRc9 & PRc10 losses [W], Nxt=450, Rc=1M');
xlabel('time [s]');
ylabel('power [W]');
grid on
hold on
plot(tNxt(1:kf-1),PRc10)
hold off

% Rc resistors energy losses

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plot(tSol,YSol(:,12))
grid on
title('WRc7,...WRc12 energy losses [Ws]');
xlabel('time [s]');
ylabel('W [Ws]');
hold on
plot(tSol,YSol(:,13))
plot(tSol,YSol(:,14))
plot(tSol,YSol(:,15))
plot(tSol,YSol(:,16))
plot(tSol,YSol(:,17))
hold off
c2=clock
czas=c2-c1
function dYdt=Inv6C(t,Y)
global Tf; global Tp; global Rc; global f;
global Rb; global Rdc; global Rs; global iprog;
global Rblock; global Lod; global st1;
global Rp; global ku; global Udc;
global C;
global R1; global R2; global R3; global R4;
global R5; global R6;
Rblock=1000.0; iprog=0.0002;
function Rez=rezystancja(x)
if x>0.1*iprog Rez=0.0002*Rblock;
elseif x>0.07*iprog Rez=0.05*Rblock;
elseif x>0.05*iprog Rez=0.1*Rblock;
elseif x>0.03*iprog Rez=0.2*Rblock;
elseif x>0.01*iprog Rez=0.5*Rblock;
elseif x>0 Rez=Rblock;
elseif x>-0.01*iprog Rez=2*Rblock;
elseif x>-0.03*iprog Rez=3*Rblock;
elseif x>-0.05*iprog Rez=4*Rblock;
elseif x>-0.07*iprog Rez=5*Rblock;
elseif x>-0.09*iprog Rez=6*Rblock;
elseif x>-0.11*iprog Rez=8*Rblock;
else Rez=10*Rblock;
end
end
NS=ceil(6*t/Tf);
xs=t-(NS-1)*Tf/6;
NS6=mod(NS,6);
NP=ceil(xs/Tp);
xp=xs-(NP-1)*Tp;
i1=Y(1); i3=Y(2); i4=Y(3); i5=Y(4); i6=Y(5);
Q7=Y(6); Q8=Y(7); Q9=Y(8); Q10=Y(9); Q11=Y(10); Q12=Y(11);
i7=(-Q7/C-R1*i3)/(R1+Rc);
i8=(-Q8/C-R2*(i3+i4))/(R2+Rc);
i9=(-Q9/C+R3*(i1+i3+i5))/(R3+Rc);
i10=(-Q10/C+R4*(i1+i3+i4+i5+i6))/(R4+Rc);
i11=(-Q11/C-R5*i5)/(R5+Rc);
i12=(-Q12/C-R6*(i5+i6))/(R6+Rc);
R1=Rb; R2=Rb; R3=Rb; R4=Rb; R5=Rb; R6=Rb;
alpha1=2*pi*f*(NP-0.5)*Tp;
%
t12=st1*ku*Tp*sin(pi/3-alpha1);
t22=st1*ku*Tp*sin(alpha1);
t2=0.25*(Tp-2*(t12+t22));
S1=false; S2=false; S3=false;
%
if xp>=t2 && xp<Tp-t2 S1=true; end

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if xp>=t2+t12 && xp<Tp-t2-t12 S2=true; end
if xp>=t2+t12+t22 && xp<Tp-t2-t12-t22 S3=true; end
Z1=false; Z2=false; Z3=false; Z4=false; Z5=false; Z6=false;
%
if NS6==1 Z2=true; Z4=true; Z6=true; end
if NS6==1 && S1 Z1=true; Z2=false; end
if NS6==1 && S2 Z3=true; Z4=false; end
if NS6==1 && S3 Z5=true; Z6=false; end
if NS6==2 Z1=true; Z3=true; Z5=true; end
if NS6==2 && S1 Z6=true; Z5=false; end
if NS6==2 && S2 Z2=true; Z1=false; end
if NS6==2 && S3 Z4=true; Z3=false; end
if NS6==3 Z2=true; Z4=true; Z6=true; end
if NS6==3 && S1 Z3=true; Z4=false; end
if NS6==3 && S2 Z5=true; Z6=false; end
if NS6==3 && S3 Z1=true; Z2=false; end
if NS6==4 Z1=true; Z3=true; Z5=true; end
if NS6==4 && S1 Z2=true; Z1=false; end
if NS6==4 && S2 Z4=true; Z3=false; end
if NS6==4 && S3 Z6=true; Z5=false; end
if NS6==5 Z2=true; Z4=true; Z6=true; end
if NS6==5 && S1 Z5=true; Z6=false; end
if NS6==5 && S2 Z1=true; Z2=false; end
if NS6==5 && S3 Z3=true; Z4=false; end
if NS6==0 Z1=true; Z3=true; Z5=true; end
if NS6==0 && S1 Z4=true; Z3=false; end
if NS6==0 && S2 Z6=true; Z5=false; end
if NS6==0 && S3 Z2=true; Z1=false; end
%
ir1=-i3-i7; ir2=-i3-i4-i8; ir3=i3+i5+i1-i9;
ir4=i1+i3+i4+i5+i6-i10;
ir5=-i5-i11; ir6=-i5-i6-i12;
%
if Z1 R1=rezystancja(ir1); end
if ir1<0 R1=Rp; end
if Z2 R2=rezystancja(ir2); end
if ir2<0 R2=Rp; end
if Z3 R3=rezystancja(ir3); end
if ir3<0 R3=Rp; end
if Z4 R4=rezystancja(ir4); end
if ir4<0 R4=Rp; end
if Z5 R5=rezystancja(ir5); end
if ir5<0 R5=Rp; end
if Z6 R6=rezystancja(ir6); end
if ir6<0 R6=Rp; end
%
i7=(-Q7/C-R1*i3)/(R1+Rc);
i8=(-Q8/C-R2*(i3+i4))/(R2+Rc);
i9=(-Q9/C+R3*(i1+i3+i5))/(R3+Rc);
i10=(-Q10/C+R4*(i1+i3+i4+i5+i6))/(R4+Rc);
i11=(-Q11/C-R5*i5)/(R5+Rc);
i12=(-Q12/C-R6*(i5+i6))/(R6+Rc);
R34=R3+R4; R12=R1+R2; R24=R2+R4; R56=R5+R6; R46=R4+R6;
%
Uzy(1)=Udc-(Rdc+R34)*i1-R34*i3-R4*i4-R34*i5-R4*i6+R3*i9+R4*i10;
Uzy(2)=-R34*i1-(R12+R34)*i3-R24*i4-R34*i5-R4*i6-R1*i7-R2*i8+R3*i9+R4*i10;
Uzy(3)=-R4*i1-R24*i3-(R24+2*Rs)*i4-R4*i5-(R4+Rs)*i6-R2*i8+R4*i10;
Uzy(4)=-R34*i1-R34*i3-R4*i4-(R34+R56)*i5-R46*i6+R3*i9+R4*i10-R5*i11-R6*i12;
Uzy(5)=-R4*i1-R4*i3-(R4+Rs)*i4-R46*i5-(R46+2*Rs)*i6+R4*i10-R6*i12;
%
for j=1:5

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        Ps=0.0;
    for i=1:5
        Ps=Ps+Lod(j,i)*Uzy(i);
    end
    der(j)=Ps;
end
der(6)=i7;
der(7)=i8;
der(8)=i9;
der(9)=i10;
der(10)=i11;
der(11)=i12;
der(12)=i7*i7*Rc;
der(13)=i8*i8*Rc;
der(14)=i9*i9*Rc;
der(15)=i10*i10*Rc;
der(16)=i11*i11*Rc;
der(17)=i12*i12*Rc;
k=1:17;
dYdt=(der(k))';
end

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% Inverter_SVM_6C_VoltCsF_07
% 3 phase Inverter RLE load
% frequency & voltage control
% obliczanie prądów kondensatorów: diff()
% obliczanie napięć odbiornika uAB,uCB%
% 2 kondensatory Cs na wyjściu
% fitr na is, uAB, uBC
clearvars;
format shortg;
c1=clock
step=0.25e-4;
tfin=0.1-step;
tRange=[0:step:tfin-step];
Nst=round(tfin/step); Su2=0;
global Udc; Udc=500.0; global C; C=1.5e-3;
Ldc=0.2e-3; Ls= 1e-1; Ld=0.2e-3;
L=[Ldc+2*Ld, 2*Ld, Ld, 2*Ld, Ld, 0, 0; 2*Ld, 4*Ld, 2*Ld, 2*Ld, Ld, 0, 0;...
    Ld, 2*Ld, 2*(Ld+Ls), Ld, Ld+Ls, -2*Ls, -Ls;...
    2*Ld, 2*Ld, Ld, 4*Ld, 2*Ld, 0, 0; Ld, Ld, Ld+Ls, 2*Ld, 2*(Ld+Ls), -Ls,
    -2*Ls;...
    0, 0, -2*Ls, 0, -Ls, 2*Ls, Ls; 0, 0, -Ls, 0, -2*Ls, Ls, 2*Ls];
global Rdc; Rdc=0.1; global Rs; Rs=10;
global f; f=50.0; global N; N=36; global ku; ku=1.0;
global Rc; Rc=0.01e6; global st1; st1=sqrt(3.0)/pi;
global Tf; Tf=1/f; global Tp; Tp=Tf/N;
global Rp; Rp=0.01;
global RV; RV=1.0e3; global Cs; Cs=1.0e-8;
% Nxt to jest odstęp różniczkowania w wielokrotności 'step'
Nxt=10; Nxt2=10;
global Lod; Lod=inv(L); global Rb; Rb=10000;
global R1; R1=Rb; global R2; R2=Rb; global R3; R3=Rb;
global R4; R4=Rb; global R5; R5=Rb; global R6; R6=Rb;
Q0=0.5*Udc*C;

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i0=[0.,0.,0.,0.,0.,0.,0.,0., Q0, Q0, Q0, Q0, Q0, Q0, 0., 0., 0., 0., 0.,
0.,0.,0.];
opt=odeset('AbsTol',1e-7,'RelTol',1e-7);
[tSol,YSol]=ode113(@Inv6C,tRange,i0,opt);
kf2=floor(Nst/Nxt2);
for k=1:kf2 tNxt2(k)=tSol(Nxt2*k);
            Is1(k)=YSol(Nxt2*k,3);
            Is3(k)=YSol(Nxt2*k,5);
            IV1(k)=YSol(Nxt2*k,6);
            IV2(k)=YSol(Nxt2*k,7);
            Qx1(k)=YSol(Nxt2*k,20);
            Qx2(k)=YSol(Nxt2*k,21);
end
Is2=-Is1-Is3;
% source current iDC
f0=figure;
plot(tSol,YSol(:,1))
grid on;
Nl=round(0.6*Nst); Np=Nst-Nl;
xlabel('time [s]');
ylabel('DC current [A]');
title('DC source current; f=50 [Hz], ku=1.0, N=36, Udc=500 V');
DCAv=sum(YSol(Np:Nst,1))/Nl
% is1 load current
f1=figure;
plot(tSol,YSol(:,3),'Linewidth',1)
grid on;
hold on
xlabel('time [s]');
ylabel('[currents [A]]');
title('Output AC currents; f=50 [Hz], ku=1.0, N=36, Udc=500 V');
is1rms=sqrt(sum(YSol(Np:Nst,3).^2)/Nl)
% is3 load current
plot(tSol,YSol(:,5),'Linewidth',1)
is3rms=sqrt(sum(YSol(Np:Nst,5).^2)/Nl)
% is2 load current
AC=[-YSol(:,3)-YSol(:,5)];
plot(tSol,AC,'Linewidth',1)
legend('is1','is3','is2');
hold off
is2rms=sqrt(sum(AC(Np:Nst).^2)/Nl)
% is currents filtered by Nxt2 steps
f1b=figure;
plot(tNxt2,Is1,'Linewidth',1)
grid on;
hold on
xlabel('time [s]');
ylabel('[currents [A]]');
title('Output AC currents filtered; f=50 [Hz], ku=1.0, N=36, Udc=500
V,Nxt2=10');
is1rms=sqrt(sum(YSol(Np:Nst,3).^2)/Nl)
plot(tNxt2,Is3,'Linewidth',1)
is3rms=sqrt(sum(YSol(Np:Nst,5).^2)/Nl)
plot(tNxt2,Is2,'Linewidth',1)
legend('is1','is3','is2');
hold off
% napięcia uAB, uBC
f23=figure;
plot(tSol,RV*YSol(:,6)+YSol(:,20)/Cs);
hold on
plot(tSol,-RV*YSol(:,7)-YSol(:,21)/Cs);

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title('Load voltages, RV=10k, AbsTol=1e-6, RelTol=1e-6, Nxt2=10');
xlabel('time [s]');
ylabel('Voltage [V]');
legend('uAB voltage', 'uBC voltage');
hold off
% napięcia uAB, uBC filtered
f23b=figure;
plot(tNxt2,RV*IV1+Qx1/Cs);
hold on
plot(tNxt2,-RV*IV2-Qx2/Cs);
title('Load voltages filtered, RV=10k, AbsTol=1e-8, RelTol=1e-7, step=0.2e-4');
xlabel('time [s]');
ylabel('Voltage [V]');
legend('uAB voltage', 'uBC voltage');
hold off
f2=figure;
plot(tSol,YSol(:,8)/C,'Linewidth',1)
grid on
title('Capacitor voltages;      f=20 [Hz], ku=0.5, N=180, Udc=500 V');
xlabel('time [s]');
ylabel(' [V] ');
hold on
plot(tSol,YSol(:,9)/C,'Linewidth',1)
plot(tSol,YSol(:,10)/C,'Linewidth',1)
plot(tSol,YSol(:,11)/C,'Linewidth',1)
plot(tSol,YSol(:,12)/C,'Linewidth',1)
plot(tSol,YSol(:,13)/C,'Linewidth',1)
legend('V7', 'V8', 'V9', 'V10', 'V11', 'V12');
hold off
% calculations of iC currents by differentiation
% Nxt difference is # of steps
kf=floor(Nst/Nxt);
for k=1:kf Qc7(k)=YSol(Nxt*k,8);
          tNxt(k)=tSol(Nxt*k);
          Qc8(k)=YSol(Nxt*k,9);
          Qc9(k)=YSol(Nxt*k,10);
          Qc10(k)=YSol(Nxt*k,11);
          Qc11(k)=YSol(Nxt*k,12);
          Qc12(k)=YSol(Nxt*k,13);
end
uc7a=diff(Qc7)/(Nxt*step);
uc8a=diff(Qc8)/(Nxt*step);
uc9a=diff(Qc9)/(Nxt*step);
uc10a=diff(Qc10)/(Nxt*step);
uc11a=diff(Qc11)/(Nxt*step);
uc12a=diff(Qc12)/(Nxt*step);
f8=figure;
plot(tNxt(1:kf-1),uc7a*1000)
grid on
title('iC7 & iC8 currents [mA],step=0.25e-4, Nxt=50, Rc=100k');
xlabel('time [s]');
ylabel('current [mA]');
hold on
plot(tNxt(1:kf-1),uc8a*1000)
hold off
f9=figure;
plot(tNxt(1:kf-1),uc9a*1000)
title('iC9 & iC10 currents [mA],step=0.25e-4, Nxt=50, Rc=100k');
xlabel('time [s]');
ylabel('current [mA]');

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grid on
hold on
plot(tNxt(1:kf-1),uc10a*1000)
hold off
f10=figure;
plot(tNxt(1:kf-1),uc11a*1000)
title('iC11 & iC12 currents [mA], step=0.25e-4, Nxt=50, Rc=100k');
xlabel('time [s]');
ylabel('current [mA]');
grid on
hold on
plot(tNxt(1:kf-1),uc12a*1000)
hold off

% capacitors' charges
f18=figure;
plot(tSol,YSol(:,8))
title('Q7,...Q12 electric charges [C]');
xlabel('time [s]');
ylabel('charge [C]');
hold on
plot(tSol,YSol(:,9))
plot(tSol,YSol(:,10))
plot(tSol,YSol(:,11))
plot(tSol,YSol(:,12))
plot(tSol,YSol(:,13))
hold off
c2=clock
czas=c2-c1
function dYdt=Inv6C(t,Y)
global Tf; global Tp; global Rc; global f;
global Rb; global Rdc; global Rs; global iprog;
global Rblock; global Lod; global st1;
global Rp; global ku; global Udc;
global C; global RV; global Cs;
global R1; global R2; global R3; global R4;
global R5; global R6;
Rblock=1000.0; iprog=0.0002;
function Rez=rezystancja(x)
if x>0.1*iprog Rez=0.0002*Rblock;
elseif x>0.07*iprog Rez=0.05*Rblock;
elseif x>0.05*iprog Rez=0.1*Rblock;
elseif x>0.03*iprog Rez=0.2*Rblock;
elseif x>0.01*iprog Rez=0.5*Rblock;
elseif x>0 Rez=Rblock;
elseif x>-0.01*iprog Rez=2*Rblock;
elseif x>-0.03*iprog Rez=3*Rblock;
elseif x>-0.05*iprog Rez=4*Rblock;
elseif x>-0.07*iprog Rez=5*Rblock;
elseif x>-0.09*iprog Rez=6*Rblock;
elseif x>-0.11*iprog Rez=8*Rblock;
else Rez=10*Rblock;
end
end
NS=ceil(6*t/Tf);
xs=t-(NS-1)*Tf/6;
NS6=mod(NS,6);
NP=ceil(xs/Tp);
xp=xs-(NP-1)*Tp;
i1=Y(1); i3=Y(2); i4=Y(3); i5=Y(4); i6=Y(5);
iV1=Y(6); iV2=Y(7); Q1=Y(20); Q2=Y(21);

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```

Q7=Y(8); Q8=Y(9); Q9=Y(10); Q10=Y(11); Q11=Y(12); Q12=Y(13);
i7=(-Q7/C-R1*i3)/(R1+Rc);
i8=(-Q8/C-R2*(i3+i4))/(R2+Rc);
i9=(-Q9/C+R3*(i1+i3+i5))/(R3+Rc);
i10=(-Q10/C+R4*(i1+i3+i4+i5+i6))/(R4+Rc);
i11=(-Q11/C-R5*i5)/(R5+Rc);
i12=(-Q12/C-R6*(i5+i6))/(R6+Rc);
R1=Rb; R2=Rb; R3=Rb; R4=Rb; R5=Rb; R6=Rb;
alpha1=2*pi*f*(NP-0.5)*Tp;
%
t12=st1*ku*Tp*sin(pi/3-alpha1);
t22=st1*ku*Tp*sin(alpha1);
t2=0.25*(Tp-2*(t12+t22));
S1=false; S2=false; S3=false;
%
if xp>=t2 && xp<Tp-t2 S1=true; end
if xp>=t2+t12 && xp<Tp-t2-t12 S2=true; end
if xp>=t2+t12+t22 && xp<Tp-t2-t12-t22 S3=true; end
Z1=false; Z2=false; Z3=false; Z4=false; Z5=false; Z6=false;
%
if NS6==1 Z2=true; Z4=true; Z6=true; end
if NS6==1 && S1 Z1=true; Z2=false; end
if NS6==1 && S2 Z3=true; Z4=false; end
if NS6==1 && S3 Z5=true; Z6=false; end
if NS6==2 Z1=true; Z3=true; Z5=true; end
if NS6==2 && S1 Z6=true; Z5=false; end
if NS6==2 && S2 Z2=true; Z1=false; end
if NS6==2 && S3 Z4=true; Z3=false; end
if NS6==3 Z2=true; Z4=true; Z6=true; end
if NS6==3 && S1 Z3=true; Z4=false; end
if NS6==3 && S2 Z5=true; Z6=false; end
if NS6==3 && S3 Z1=true; Z2=false; end
if NS6==4 Z1=true; Z3=true; Z5=true; end
if NS6==4 && S1 Z2=true; Z1=false; end
if NS6==4 && S2 Z4=true; Z3=false; end
if NS6==4 && S3 Z6=true; Z5=false; end
if NS6==5 Z2=true; Z4=true; Z6=true; end
if NS6==5 && S1 Z5=true; Z6=false; end
if NS6==5 && S2 Z1=true; Z2=false; end
if NS6==5 && S3 Z3=true; Z4=false; end
if NS6==0 Z1=true; Z3=true; Z5=true; end
if NS6==0 && S1 Z4=true; Z3=false; end
if NS6==0 && S2 Z6=true; Z5=false; end
if NS6==0 && S3 Z2=true; Z1=false; end
%
ir1=-i3-i7; ir2=-i3-i4-i8; ir3=i3+i5+i1-i9;
ir4=i1+i3+i4+i5+i6-i10;
ir5=-i5-i11; ir6=-i5-i6-i12;
%
if Z1 R1=rezystancja(ir1); end
if ir1<0 R1=Rp; end
if Z2 R2=rezystancja(ir2); end
if ir2<0 R2=Rp; end
if Z3 R3=rezystancja(ir3); end
if ir3<0 R3=Rp; end
if Z4 R4=rezystancja(ir4); end
if ir4<0 R4=Rp; end
if Z5 R5=rezystancja(ir5); end
if ir5<0 R5=Rp; end
if Z6 R6=rezystancja(ir6); end
if ir6<0 R6=Rp; end

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%
i7=(-Q7/C-R1*i3)/(R1+Rc);
i8=(-Q8/C-R2*(i3+i4))/(R2+Rc);
i9=(-Q9/C+R3*(i1+i3+i5))/(R3+Rc);
i10=(-Q10/C+R4*(i1+i3+i4+i5+i6))/(R4+Rc);
i11=(-Q11/C-R5*i5)/(R5+Rc);
i12=(-Q12/C-R6*(i5+i6))/(R6+Rc);
R34=R3+R4; R12=R1+R2; R24=R2+R4; R56=R5+R6; R46=R4+R6;
%
Uzy(1)=Udc-(Rdc+R34)*i1-R34*i3-R4*i4-R34*i5-R4*i6+R3*i9+R4*i10; % (-R3-R4-
Rdc)*i1+(-R3-R4)*i3-R4*i4+(-R3-R4)*i5+R3*i9+R4*i10-R4*i6+Udc;
Uzy(2)=-R34*i1-(R12+R34)*i3-R24*i4-R34*i5-R4*i6-R1*i7-R2*i8+R3*i9+R4*i10;
% (-R3-R4)*i1+(-R1-R2-R3-R4)*i3+(-R2-R4)*i4+(-R3-R4)*i5-R1*i7-
R2*i8+R3*i9+R4*i10-R4*i6
Uzy(3)=-R4*i1-R24*i3-(R24+2*Rs)*i4-R4*i5-(R4+Rs)*i6-
R2*i8+R4*i10+2*Rs*iV1+Rs*iV2; % -R4*i1+(-R2-R4)*i3+(-R2-R4-2*Rs)*i4-
R4*i5+(-R4-Rs)*i6-R2*i8+R4*i10+2*Rs*iV1+Rs*iV2
Uzy(4)=-R34*i1-R34*i3-R4*i4-(R34+R56)*i5-R46*i6+R3*i9+R4*i10-R5*i11-R6*i12;
% (-R3-R4)*i1+(-R3-R4)*i3-R4*i4+(-R3-R4-R5-R6)*i5+(-R4-R6)*i6+R3*i9+R4*i10-
R5*i11-R6*i12
Uzy(5)=-R4*i1-R4*i3-(R4+Rs)*i4-R46*i5-(R46+2*Rs)*i6+R4*i10-
R6*i12+Rs*iV1+2*Rs*iV2; % -R4*i1-R4*i3+(-R4-Rs)*i4+(-R4-R6)*i5+(-R4-R6-
2*Rs)*i6+R4*i10-R6*i12+Rs*iV1+2*Rs*iV2
Uzy(6)=2*Rs*i4+Rs*i6+(-RV-2*Rs)*iV1-Rs*iV2-1.0*Q1/Cs; % 2*Rs*i4+Rs*i6+(-
RV-2*Rs)*iV1-Rs*iV2-1.0*Q1/Cs
Uzy(7)=Rs*i4+2*Rs*i6-Rs*iV1+(-RV-2*Rs)*iV2-1.0*Q2/Cs; % Rs*i4+2*Rs*i6-
Rs*iV1+(-RV-2*Rs)*iV2-1.0*Q2/Cs
%
for j=1:7
    Ps=0.0;
for i=1:7
    Ps=Ps+Lod(j,i)*Uzy(i);
end
der(j)=Ps;
end
der(8)=i7;
der(9)=i8;
der(10)=i9;
der(11)=i10;
der(12)=i11;
der(13)=i12;
der(14)=i7*i7*Rc;
der(15)=i8*i8*Rc;
der(16)=i9*i9*Rc;
der(17)=i10*i10*Rc;
der(18)=i11*i11*Rc;
der(19)=i12*i12*Rc;
der(20)=iV1;
der(21)=iV2;
k=1:21;
dYdt=(der(k)');
end

```