Induction Moter Modeling in MATLAB

Table of Contents

Defining parameters of a induction machine. 1
3-phase voltage source input of induction motor 1
Plotting 3phase input to stator 2
abc to alpha beta transformation 2
Plotting Valpha and Vbeta for stator 3
Calculation of rotating anlge theta 3
alpha beta to d q transfromation 3
Plotting Vd and Vq for stator 4
Calculating Ids, Iqs, Idr, Iqr using ODE45 solver 4
Plotting Id and Iq of stator 5
Plotting Id and Iq of rotor 5
d q to alpha beta transformation 6
Plotting Ialpha and Ibeta of stator 6
Plotting Ialpha and Ibeta of rotor 7
alpha beta to a b c transformation 8
Plotting Ia Ib and Ic of stator 8
plotting Ia Ib and Ic of rotor 9
Calculating torque (Te) 10
Plotting electromechanical torque of induction motor 10
Function for ODE45 solver 11

2017-FYP-14

Defining parameters of a induction machine.

```
clear all; clc;
Vs=400; %Stator voltage
Rs=0.12; %Stator resistance
Rr=0.02; %Rotor resistance
Lls=0.0001; %Stator inductance
Llr=0.0001; %Rotor inductance
Lm=0.01;
P=2; %Number of Poles
Ws=2*pi*50; %synchronous speed
s1=0.02; % 2% slip
s2=0.03; % 3% slip
time=2; %Simulation speed
Wr1= repmat((1-s1)*Ws,[1,5000]);%Wr at 2% slip for 1 sec
Wr2= repmat((1-s2)*Ws,[1,5001]);%Wr at 3% slip for 1 sec
Wr=[Wr1 Wr2];%wr at 2% slip for 0 to 1 sec and 3% for 1 to 2 sec
```

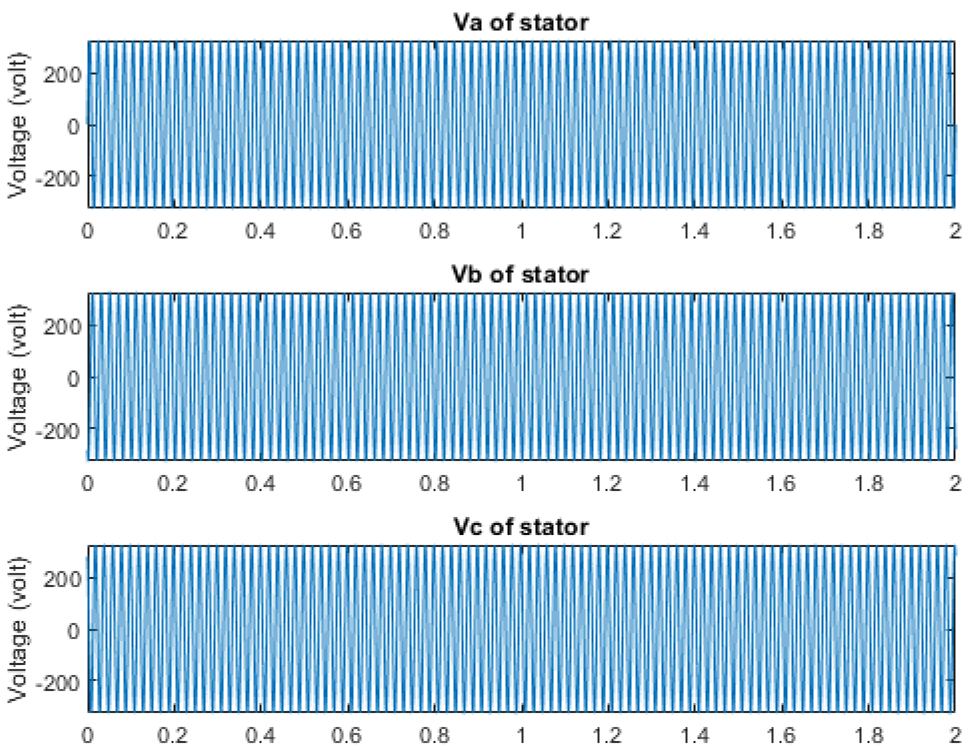
3-phase voltage source input of induction motor

```
t=0:0.0002:time;
```

```
Vamp=Vs*sqrt(2)/sqrt(3);
Vas=Vamp*sin(Ws*t);
Vbs=Vamp*sin(Ws*t-2*pi/3);
Vcs=Vamp*sin(Ws*t+2*pi/3);
```

Plotting 3phase input to stator

```
figure();
subplot(3,1,1);
plot(t,Vas);
title('Va of stator');
ylabel('Voltage (volt)');
subplot(3,1,2);
plot(t,Vbs);
title('Vb of stator');
ylabel('Voltage (volt)');
subplot(3,1,3);
plot(t,Vas,t,Vbs,t,Vcs);
plot(t,Vcs);
title('Vc of stator');
ylabel('Voltage (volt)');
```



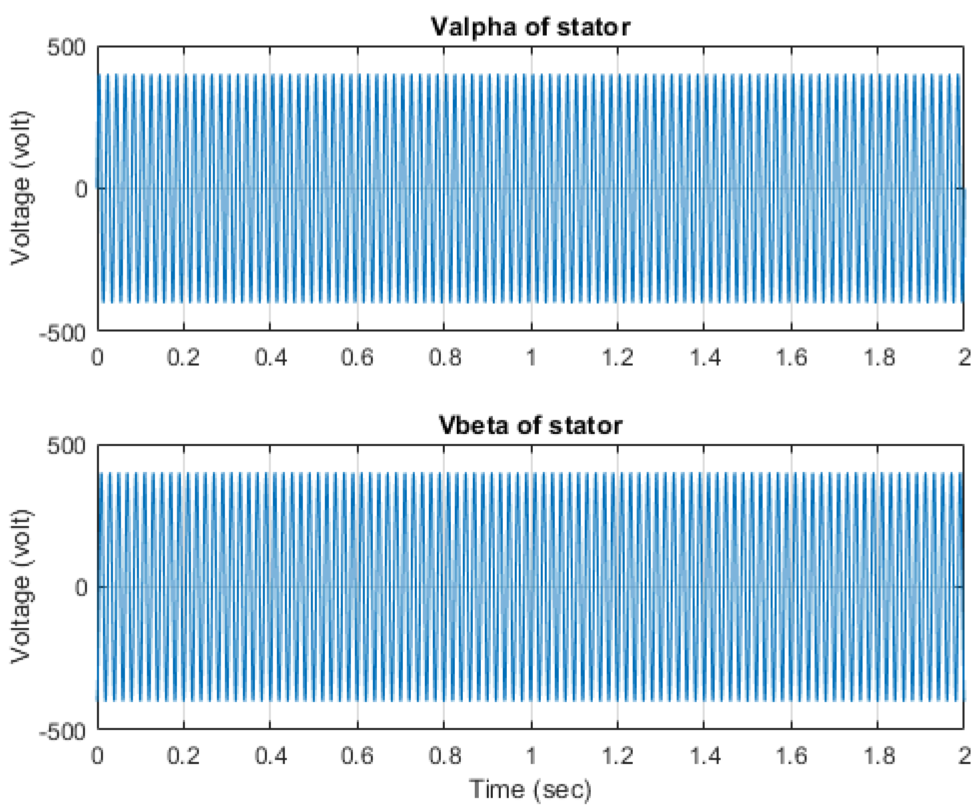
abc to alpha beta transformation

```
Valphas=sqrt(2/3)*((Vas)-(Vbs/2)-(Vcs/2));
```

```
Vbetas=sqrt(2/3)*((sqrt(3)*Vbs/2)-((sqrt(3)*Vcs/2)));
```

Plotting Valpha and Vbeta for stator

```
figure();
subplot(2,1,1);
plot(t,Valphas);
grid;
title('Valpha of stator');
ylabel('Voltage (volt)');
subplot(2,1,2);
plot(t,Vbetas);
grid;
title('Vbeta of stator');
xlabel('Time (sec)');
ylabel('Voltage (volt)');
```



Calculation of rotating anlge theta

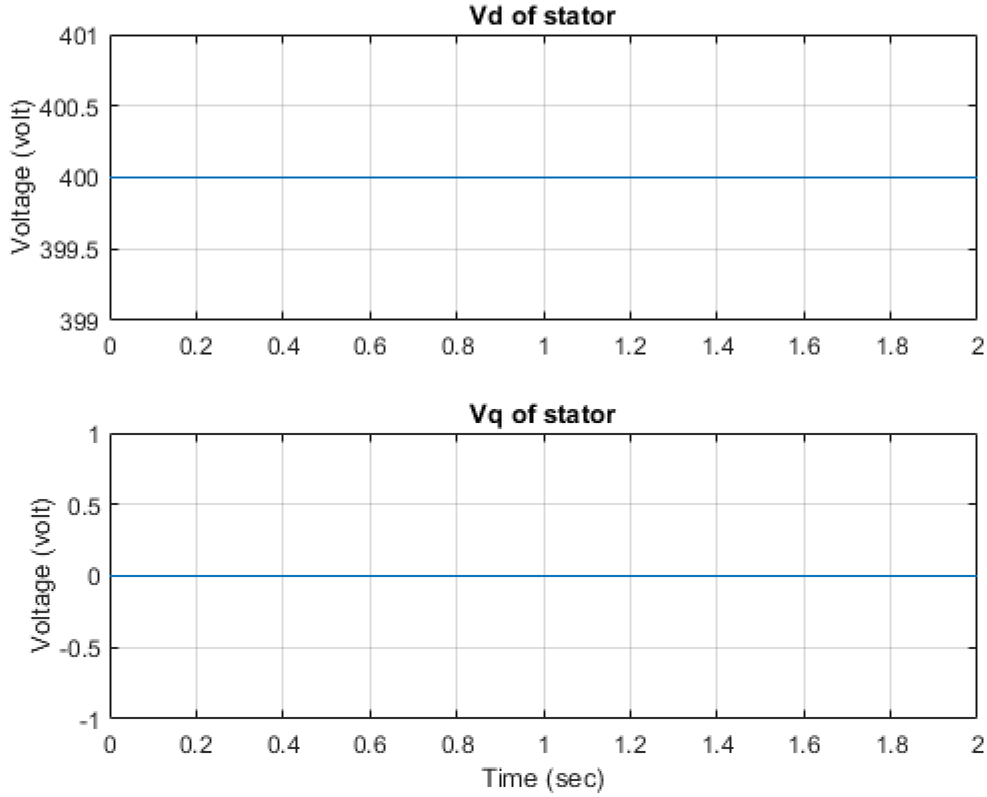
```
theta=angle(Valphas+1j*Vbetas);%rotating angle theta
```

alpha beta to d q transfromation

```
Vds=round(Valphas.*cos(theta)+Vbetas.*sin(theta),1);
Vqs=round(-Valphas.*sin(theta)+Vbetas.*cos(theta),1);
```

Plotting Vd and Vq for stator

```
figure();
subplot(2,1,1)
plot(t,Vds);
grid;
title('Vd of stator');
ylabel('Voltage (volt)');
subplot(2,1,2)
plot(t,Vqs);
grid;
title('Vq of stator');
xlabel('Time (sec)');
ylabel('Voltage (volt)');
```



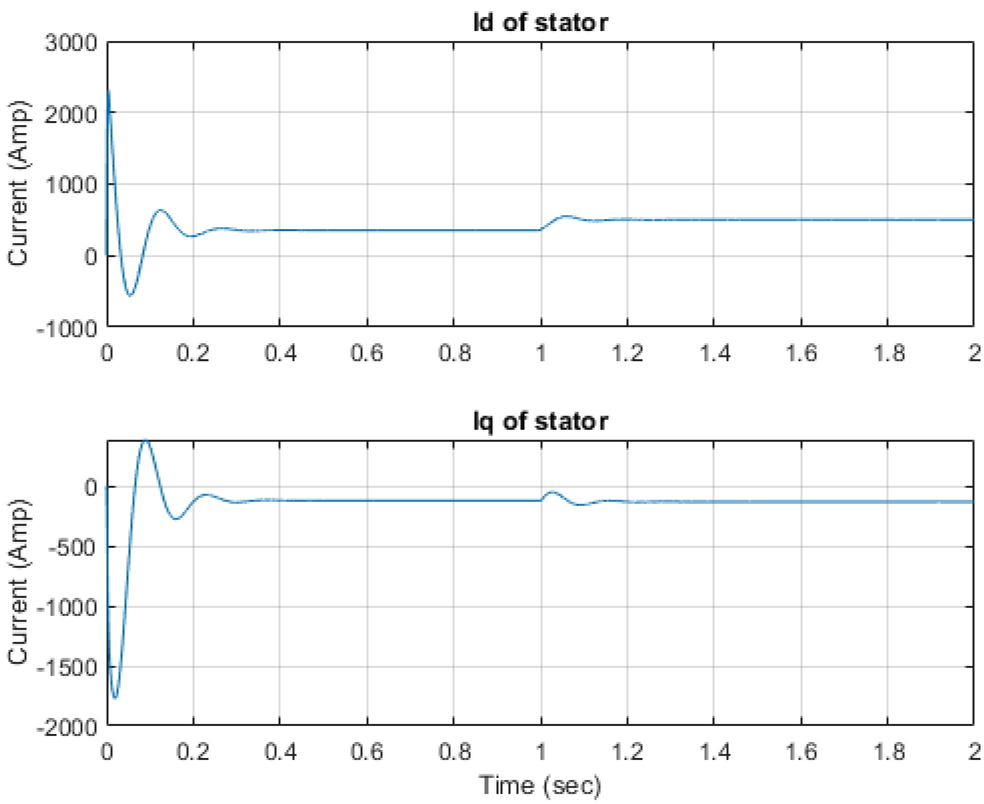
Calculating Ids, Iqs, Idr, Iqr using ODE45 solver

```
tspan=0:0.0002:2;%time span
Vdsi=@(t)interp1(tspan,Vds,t);
Vqsi=@(t)interp1(tspan,Vqs,t);
Wri=@(t)interp1(tspan,Wr,t);
IC=[0 0 0 0];%initial conditions
%using ODE45 matlab solver to solve differential equations
[tsol,ysol] = ode45(@(t,s)
 g(t,s,Rs,Rr,Lls,Llr,Lm,Ws,Wri,Vdsi,Vqsi),tspan,IC);
```

```
Ids=ysol(:,1)';%Id for stator
Iqs=ysol(:,2)';%Iq for stator
Idr=ysol(:,3)';%Id for rotor
Iqr=ysol(:,4)';%Iq for rotor
```

Plotting Id and Iq of stator

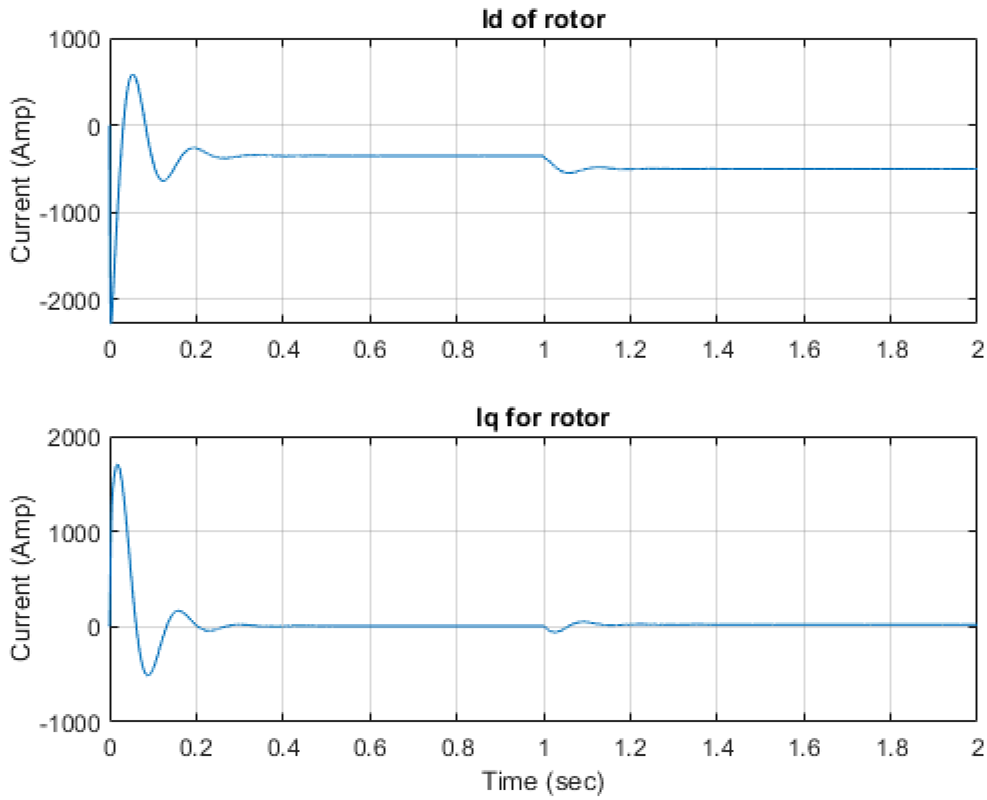
```
figure();
subplot(2,1,1);
plot(t,Ids);
grid;
title('Id of stator');
ylabel('Current (Amp)');
subplot(2,1,2);
plot(t,Iqs);
grid;
title('Iq of stator');
xlabel('Time (sec)');
ylabel('Current (Amp)');
```



Plotting Id and Iq of rotor

```
figure();
subplot(2,1,1);
plot(t,Idr);
```

```
grid;
title('Id of rotor');
ylabel('Current (Amp)');
subplot(2,1,2);
plot(t,Iqr);
grid;
title('Iq for rotor');
xlabel('Time (sec)');
ylabel('Current (Amp)');
```



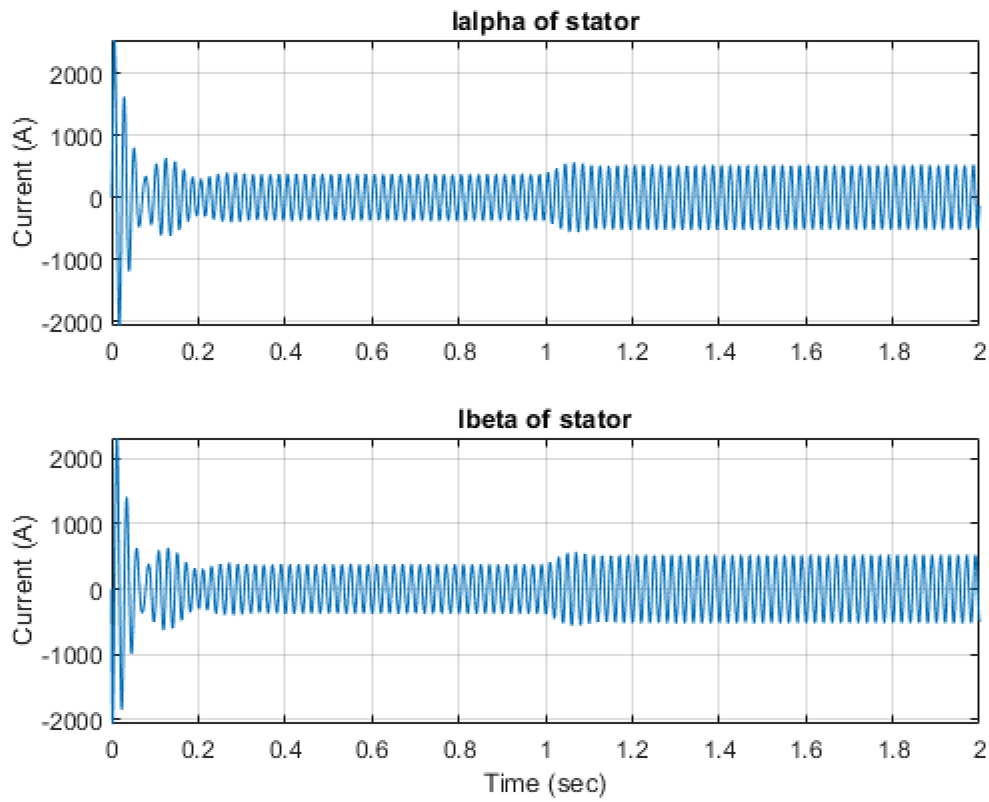
d q to alpha beta transformation

```
%stator current transformation
Ialphas=Ids.*cos(theta)-Iqs.*sin(theta);
Ibetas=Ids.*sin(theta)+Iqs.*cos(theta);
%rotor current transformation
Ialphar=Idr.*cos(theta)-Iqr.*sin(theta);
Ibetar=Idr.*sin(theta)+Iqr.*cos(theta);
```

Plotting Ialpha and Ibeta of stator

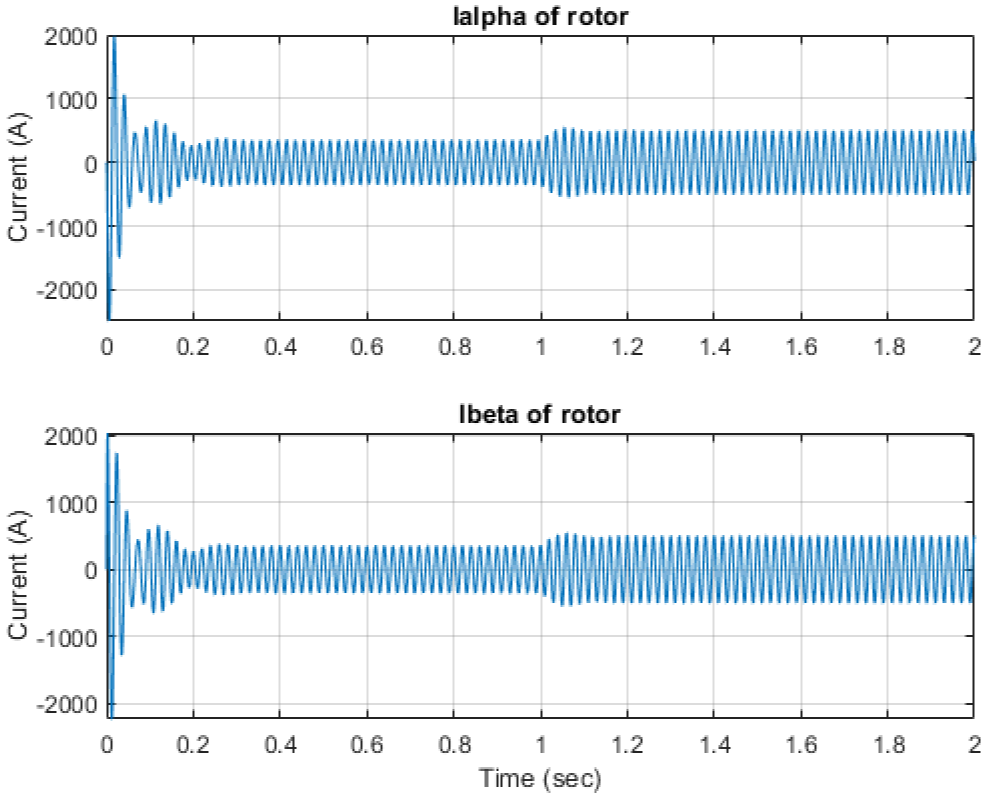
```
figure();
subplot(2,1,1);
plot(t,Ialphas);
grid;
```

```
title('Ialpha of stator');
ylabel('Current (A)');
subplot(2,1,2);
plot(t,Ibetas);
grid;
title('Ibeta of stator');
xlabel('Time (sec)');
ylabel('Current (A)');
```



Plotting Ialpha and Ibeta of rotor

```
figure();
subplot(2,1,1);
plot(t,Ialphar);
grid;
title('Ialpha of rotor');
ylabel('Current (A)');
subplot(2,1,2);
plot(t,Ibetar);
grid;
title('Ibeta of rotor');
xlabel('Time (sec)');
ylabel('Current (A)');
```



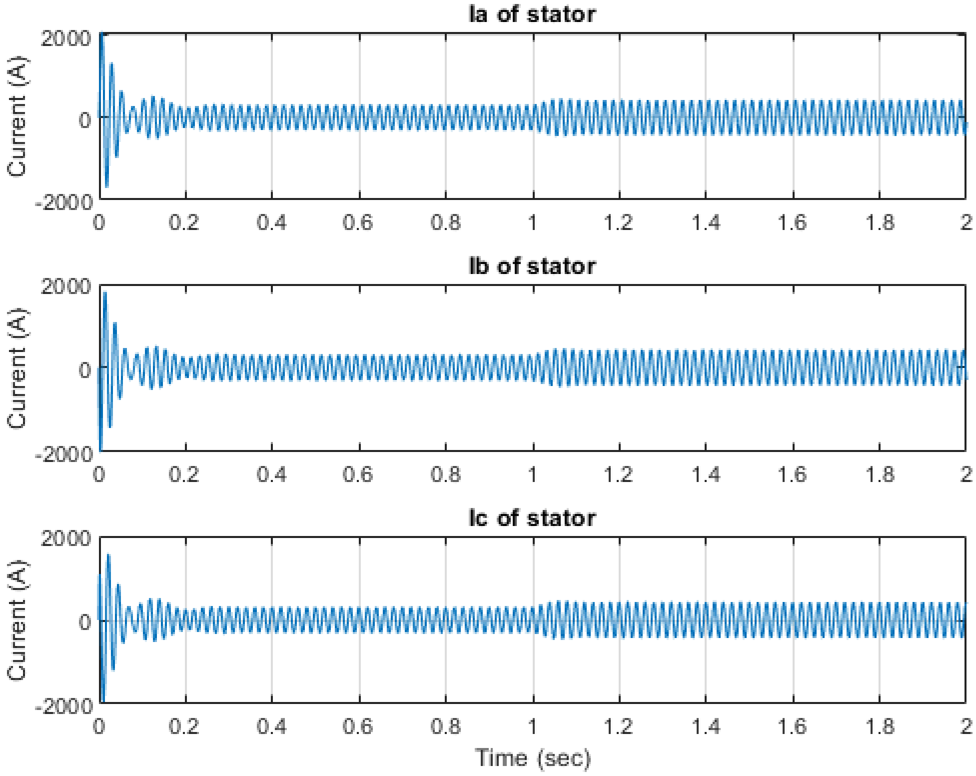
alpha beta to a b c transformation

```
%stator current transformation
Ias=sqrt(2/3)*Ialphas;
Ibs=sqrt(2/3)*(-Ialphas/2+Ibetas*sqrt(3)/2);
Ics=sqrt(2/3)*(-Ialphas/2-Ibetas*sqrt(3)/2);
%rotor current transformation
Iar=sqrt(2/3)*Ialphar;
Ibr=sqrt(2/3)*(-Ialphar/2+Ibetar*sqrt(3)/2);
Icr=sqrt(2/3)*(-Ialphar/2-Ibetar*sqrt(3)/2);
```

Plotting Ia Ib and Ic of stator

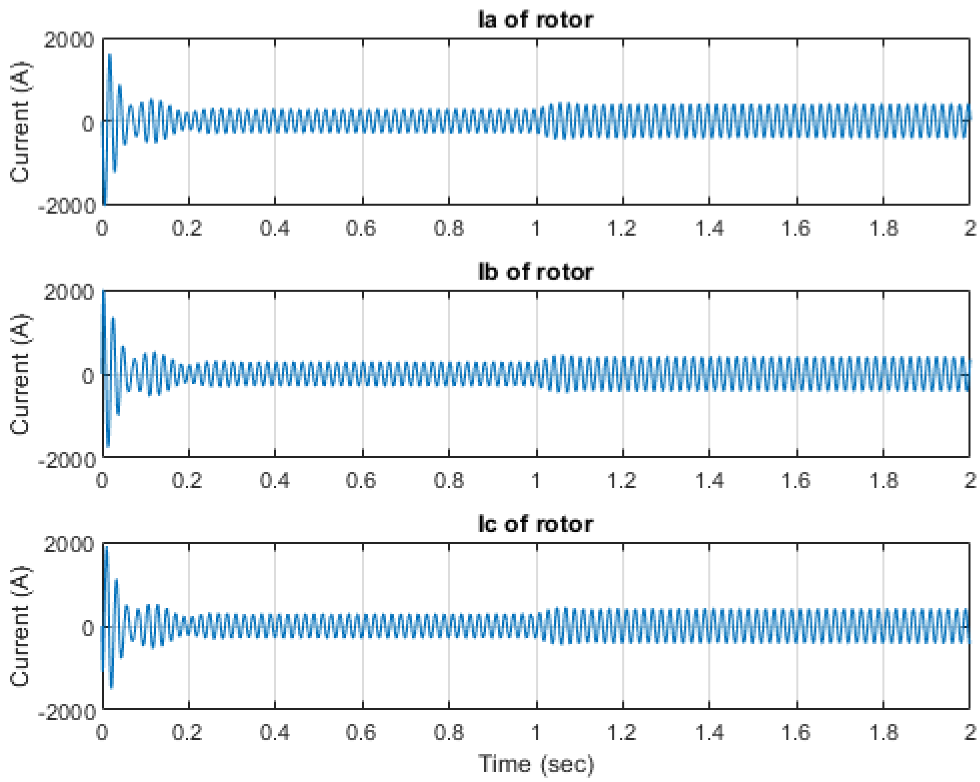
```
figure();
subplot(3,1,1);
plot(t,Ias);
grid;
title('Ia of stator');
ylabel('Current (A)');
subplot(3,1,2);
plot(t,Ibs);
title('Ib of stator');
ylabel('Current (A)');
subplot(3,1,3);
plot(t,Ics);
```

```
grid;
title('Ic of stator');
xlabel('Time (sec)');
ylabel('Current (A)');
```



plotting Ia Ib and Ic of rotor

```
figure();
subplot(3,1,1);
plot(t,Iar);
grid;
title('Ia of rotor');
ylabel('Current (A)');
subplot(3,1,2);
plot(t,Ibr);
grid;
title('Ib of rotor');
ylabel('Current (A)');
subplot(3,1,3);
plot(t,Icr);
grid;
title('Ic of rotor');
xlabel('Time (sec)');
ylabel('Current (A)');
```

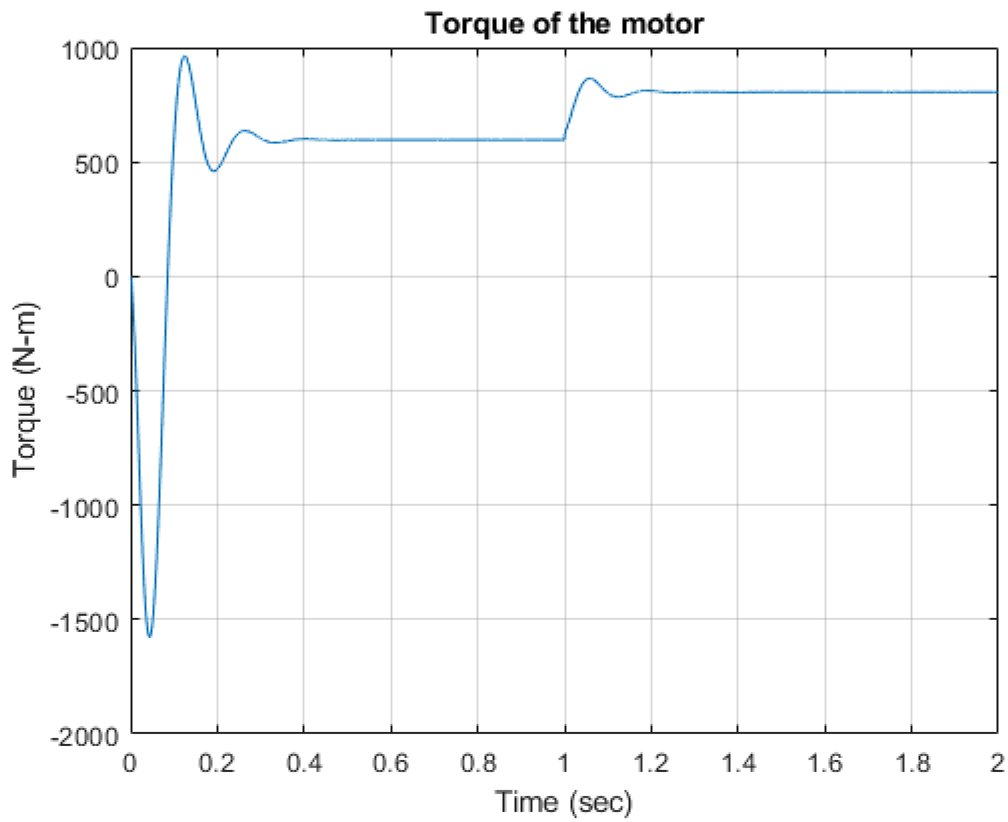


Calculating torque (Te)

```
Te=(3*P*Lm/4)*(Iqs.*Idr-Ids.*Iqr);
```

Plotting electromechanical torque of induction motor

```
figure();
plot(t,Te);
grid;
title('Torque of the motor');
xlabel('Time (sec)');
ylabel('Torque (N-m)');
```



Function for ODE45 solver

```
%equation written in terms of state varivables
function sdot = g(t,s,Rs,Rr,Lls,Llr,Lm,Ws,Wri,Vdsi,Vqsi)
sdot(1,1) = [(Llr+Lm)/((Lls+Llr)*Lm+Lls*Llr)]*[Vdsi(t)-
Rs*s(1)+Ws*[(Lls+Lm)*s(2)+Lm*s(4)]] ...
         -[Lm/((Lls+Llr)*Lm+Lls*Llr)]*[-Rr*s(3)+(Ws-Wri(t))*[(Llr
+Lm)*s(4)+Lm*s(2)]];

sdot(2,1) =  [(Llr+Lm)/((Lls+Llr)*Lm+Lls*Llr)]*[Vqsi(t)-Rs*s(2)-
Ws*[(Lls+Lm)*s(1)+Lm*s(3)]] ...
         -[Lm/((Lls+Llr)*Lm+Lls*Llr)]*[-Rr*s(4)-(Ws-Wri(t))*[(Llr
+Lm)*s(3)+Lm*s(1)]];

sdot(3,1) = [(Lls+Lm)/((Lls+Llr)*Lm+Lls*Llr)]*[-Rr*s(3)+(Ws-
Wri(t))*[(Llr+Lm)*s(4)+Lm*s(2)]] ...
         -[Lm/((Lls+Llr)*Lm+Lls*Llr)]*[Vdsi(t)-Rs*s(1)+Ws*[(Lls
+Lm)*s(2)+Lm*s(4)]];

sdot(4,1) = [(Lls+Lm)/((Lls+Llr)*Lm+Lls*Llr)]*[-Rr*s(4)-(Ws-
Wri(t))*[(Llr+Lm)*s(3)+Lm*s(1)]] ...
         -[Lm/((Lls+Llr)*Lm+Lls*Llr)]*[Vqsi(t)-Rs*s(2)-Ws*[(Lls
+Lm)*s(1)+Lm*s(3)]];

end
```

Published with MATLAB® R2018a