

**Faculty of Engineering**

**Electrical Engineering Department**

**Electrical machines ENEE 2408**

**Instructor : Dr. Muhammad Abu Khizarran**

**Assignment on Induction Motors**

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Use the parameters of the Y-induction motor of problem 6-15 (5th edition) :

VT= 460 , fe= 60hz , p=4 , rated power 25 hp , R1=0.15 Ω, R2=0.154 Ω , Xm=20 Ω , X1=0.852 Ω , X2=1.066 Ω , PF&W =400 W , Pmisc.(stray) =150W , Pcore = 400 W .

to write a  Matlab code to plot the torque speed curve for s in the range {-1.0001, 2.0001}. Avoid running the simulation for s=0.0; use instead any very small value for example s=0.0005!

a) Show the torque plot versus speed and also the torque versus s at rated voltage,**Also show the converted output power versus slip.**

b) repeat a)  for VLL reduced to 75% of VLL rated, 50%, 25% then to 10% of rated voltage (show plots on the same figure)

c) repeat a) for R2 increased to have every time one of the following values: 0.1,  0.2, 0.6, 1.2, 2.8, 4.5, 8  and 15 OHMs (show plots on the same figure).

**A)**

close all; clc ; clear all ;

VT= 460 ;

fe= 60 ;

p=4 ;

ratedpower =25 ;

R1=0.15 ;

R2=0.154 ;

Xm=20 ;

X1=0.852 ;

X2=1.066 ;

Pwandf= 400 ;

Pstray =150 ;

Pcore = 400 ;

nsync= (120\*fe)/p ;

wsync=2\*3.14\*nsync/60;

Xth=X1 ;

Rth=R1\*(Xm/(Xm+X1))^2 ;

Vphase=VT/power(3,.5);

Vth=(Xm/(Xm+X1))\*Vphase;

s=-1.0001:.01:2.0001;

nm=(1-s)\*nsync ;

wm=(1-s)\*wsync ;

for i = 1:length(s)

Tind(i)=3\*(Vth.^2)\*(R2./s(i))/(wsync\*((Rth+(R2./s(i))).^2+(Xth+X2).^2));

Pconv(i)=Tind(i)\*wm(i) ;

end

figure

plot (nm,Tind,'--k');

xlabel('nm');

ylabel('Tind');

figure

plot (s,Tind,'-b');

xlabel('s');

ylabel('Tind');

figure

plot (s,Pconv,':r');

xlabel('s');

ylabel('Pconv');







**b)**

close all; clc ; clear all ;

fe= 60 ;

p=4 ;

ratedpower =25 ;

R1=0.15 ;

R2=0.154 ;

Xm=20 ;

X1=0.852 ;

X2=1.066 ;

Pwandf= 400 ;

Pstray =150 ;

Pcore = 400 ;

nsync= (120\*fe)/p ;

wsync=2\*3.14\*nsync/60;

Xth=X1 ;

Rth=R1\*(Xm/(Xm+X1))^2 ;

% 75% of VT Tind vs nm

VT= 460\*0.75 ;

Vphase=VT/power(3,.5);

Vth=(Xm/(Xm+X1))\*Vphase;

s=-1.0001:.01:2.0001;

for i = 1:length(s)

Tind(i)=3\*(Vth.^2)\*(R2./s(i))/(wsync\*((Rth+(R2./s(i))).^2+(Xth+X2).^2));

end

nm=(1-s)\*nsync ;

plot (nm,Tind,'-k');

xlabel('nm');

ylabel('Tind');

hold on

% 50% of VT Tind vs nm

VT= 460\*0.50 ;

Vphase=VT/power(3,.5);

Vth=(Xm/(Xm+X1))\*Vphase;

s=-1.0001:.01:2.0001;

for i = 1:length(s)

Tind(i)=3\*(Vth.^2)\*(R2./s(i))/(wsync\*((Rth+(R2./s(i))).^2+(Xth+X2).^2));

end

nm=(1-s)\*nsync ;

plot (nm,Tind,'-b');

hold on

% 25% of VT Tind vs nm

VT= 460\*0.25 ;

Vphase=VT/power(3,.5);

Vth=(Xm/(Xm+X1))\*Vphase;

s=-1.0001:.01:2.0001;

for i = 1:length(s)

Tind(i)=3\*(Vth.^2)\*(R2./s(i))/(wsync\*((Rth+(R2./s(i))).^2+(Xth+X2).^2));

end

nm=(1-s)\*nsync ;

plot (nm,Tind,'-g');

hold on

% 10% of VT Tind vs nm

VT= 460\*0.10 ;

Vphase=VT/power(3,.5);

Vth=(Xm/(Xm+X1))\*Vphase;

s=-1.0001:.01:2.0001;

for i = 1:length(s)

Tind(i)=3\*(Vth.^2)\*(R2./s(i))/(wsync\*((Rth+(R2./s(i))).^2+(Xth+X2).^2));

end

nm=(1-s)\*nsync ;

plot (nm,Tind,'-r');

figure

% 75% of VT Tind vs s

VT= 460\*0.75 ;

Vphase=VT/power(3,.5);

Vth=(Xm/(Xm+X1))\*Vphase;

s=-1.0001:.01:2.0001;

for i = 1:length(s)

Tind(i)=3\*(Vth.^2)\*(R2./s(i))/(wsync\*((Rth+(R2./s(i))).^2+(Xth+X2).^2));

end

plot (s,Tind,'-k');

xlabel('s');

ylabel('Tind');

hold on

% 50% of VT Tind vs s

VT= 460\*0.50 ;

Vphase=VT/power(3,.5);

Vth=(Xm/(Xm+X1))\*Vphase;

s=-1.0001:.01:2.0001;

for i = 1:length(s)

Tind(i)=3\*(Vth.^2)\*(R2./s(i))/(wsync\*((Rth+(R2./s(i))).^2+(Xth+X2).^2));

end

plot (s,Tind,'-b');

hold on

% 25% of VT Tind vs s

VT= 460\*0.25 ;

Vphase=VT/power(3,.5);

Vth=(Xm/(Xm+X1))\*Vphase;

s=-1.0001:.01:2.0001;

for i = 1:length(s)

Tind(i)=3\*(Vth.^2)\*(R2./s(i))/(wsync\*((Rth+(R2./s(i))).^2+(Xth+X2).^2));

end

plot (s,Tind,'-g');

hold on

% 10% of VT Tind vs s

VT= 460\*0.10 ;

Vphase=VT/power(3,.5);

Vth=(Xm/(Xm+X1))\*Vphase;

s=-1.0001:.01:2.0001;

for i = 1:length(s)

Tind(i)=3\*(Vth.^2)\*(R2./s(i))/(wsync\*((Rth+(R2./s(i))).^2+(Xth+X2).^2));

end

plot (s,Tind,'-r');

figure

% 75% of VT Pconv vs s

VT= 460\*0.75 ;

Vphase=VT/power(3,.5);

Vth=(Xm/(Xm+X1))\*Vphase;

s=-1.0001:.01:2.0001;

for i = 1:length(s)

Tind(i)=3\*(Vth.^2)\*(R2./s(i))/(wsync\*((Rth+(R2./s(i))).^2+(Xth+X2).^2));

wm=(1-s)\*wsync ;

Pconv(i)=Tind(i)\*wm(i) ;

end

plot (s,Pconv,'-k');

xlabel('s');

ylabel('Pconv');

hold on

% 50% of VT Pconv vs s

VT= 460\*0.50 ;

Vphase=VT/power(3,.5);

s=-1.0001:.01:2.0001;

for i = 1:length(s)

Tind(i)=3\*(Vth.^2)\*(R2./s(i))/(wsync\*((Rth+(R2./s(i))).^2+(Xth+X2).^2));

wm=(1-s)\*wsync ;

Pconv(i)=Tind(i)\*wm(i) ;

end

plot (s,Pconv,'-b');

hold on

% 25% of VT Pconv vs s

VT= 460\*0.25 ;

Vphase=VT/power(3,.5);

Vth=(Xm/(Xm+X1))\*Vphase;

s=-1.0001:.01:2.0001;

for i = 1:length(s)

Tind(i)=3\*(Vth.^2)\*(R2./s(i))/(wsync\*((Rth+(R2./s(i))).^2+(Xth+X2).^2));

wm=(1-s)\*wsync ;

Pconv(i)=Tind(i)\*wm(i) ;

end

plot (s,Pconv,'-g');

hold on

% 10% of VT Pconv vs s

VT= 460\*0.10 ;

Vphase=VT/power(3,.5);

Vth=(Xm/(Xm+X1))\*Vphase;

s=-1.0001:.01:2.0001;

for i = 1:length(s)

Tind(i)=3\*(Vth.^2)\*(R2./s(i))/(wsync\*((Rth+(R2./s(i))).^2+(Xth+X2).^2));

wm=(1-s)\*wsync ;

Pconv(i)=Tind(i)\*wm(i) ;

end

plot (s,Pconv,'-r');

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**C)**

close all; clc ; clear all ;

VT= 460 ;

fe= 60 ;

p=4 ;

ratedpower =25 ;

R1=0.15 ;

Xm=20 ;

X1=0.852 ;

X2=1.066 ;

Pwandf= 400 ;

Pstray =150 ;

Pcore = 400 ;

nsync= (120\*fe)/p ;

wsync=2\*3.14\*nsync/60;

Xth=X1 ;

Rth=R1\*(Xm/(Xm+X1))^2 ;

Vphase=VT/power(3,.5);

Vth=(Xm/(Xm+X1))\*Vphase;

s=-1.0001:.01:2.0001;

%Tind vs nm at R2=0.1

R2= 0.1;

s=-1.0001:.01:2.0001;

for i = 1:length(s)

Tind(i)=3\*(Vth.^2)\*(R2./s(i))/(wsync\*((Rth+(R2./s(i))).^2+(Xth+X2).^2));

end

nm=(1-s)\*nsync ;

plot (nm,Tind,'-k');

xlabel('nm');

ylabel('Tind');

hold on

%Tind vs nm at R2=0.2

R2= 0.2;

s=-1.0001:.01:2.0001;

for i = 1:length(s)

Tind(i)=3\*(Vth.^2)\*(R2./s(i))/(wsync\*((Rth+(R2./s(i))).^2+(Xth+X2).^2));

end

nm=(1-s)\*nsync ;

plot (nm,Tind,'-b');hold on

%Tind vs nm at R2=0.6

R2= 0.6;

s=-1.0001:.01:2.0001;

for i = 1:length(s)

Tind(i)=3\*(Vth.^2)\*(R2./s(i))/(wsync\*((Rth+(R2./s(i))).^2+(Xth+X2).^2));

end

nm=(1-s)\*nsync ;

plot (nm,Tind,'-g');

hold on

%Tind vs nm at R2=1.2

R2= 1.2;

s=-1.0001:.01:2.0001;

for i = 1:length(s)

Tind(i)=3\*(Vth.^2)\*(R2./s(i))/(wsync\*((Rth+(R2./s(i))).^2+(Xth+X2).^2));

end

nm=(1-s)\*nsync ;

plot (nm,Tind,'-r');

hold on

%Tind vs nm at R2=2.8

R2=2.8;

s=-1.0001:.01:2.0001;

for i = 1:length(s)

Tind(i)=3\*(Vth.^2)\*(R2./s(i))/(wsync\*((Rth+(R2./s(i))).^2+(Xth+X2).^2));

end

nm=(1-s)\*nsync ;

plot (nm,Tind,'-y');

hold on

%Tind vs nm at R2=4.5

R2=4.5;

s=-1.0001:.01:2.0001;

for i = 1:length(s)

Tind(i)=3\*(Vth.^2)\*(R2./s(i))/(wsync\*((Rth+(R2./s(i))).^2+(Xth+X2).^2));

end

nm=(1-s)\*nsync ;

plot (nm,Tind,'-m');

hold on

%Tind vs nm at R2=8

R2=8;

s=-1.0001:.01:2.0001;

for i = 1:length(s)

Tind(i)=3\*(Vth.^2)\*(R2./s(i))/(wsync\*((Rth+(R2./s(i))).^2+(Xth+X2).^2));

end

nm=(1-s)\*nsync ;

plot (nm,Tind,'-c');

hold on

%Tind vs nm at R2=15

R2=15;

s=-1.0001:.01:2.0001;

for i = 1:length(s)

Tind(i)=3\*(Vth.^2)\*(R2./s(i))/(wsync\*((Rth+(R2./s(i))).^2+(Xth+X2).^2));

end

nm=(1-s)\*nsync ;

plot (nm,Tind,':k');

figure

%Tind vs s at R2=0.1

R2= 0.1;

s=-1.0001:.01:2.0001;

for i = 1:length(s)

Tind(i)=3\*(Vth.^2)\*(R2./s(i))/(wsync\*((Rth+(R2./s(i))).^2+(Xth+X2).^2));

end

plot (s,Tind,'-k');

xlabel('s');

ylabel('Tind');

hold on

%Tind vs s at R2=0.2

R2= 0.2;

s=-1.0001:.01:2.0001;

for i = 1:length(s)

Tind(i)=3\*(Vth.^2)\*(R2./s(i))/(wsync\*((Rth+(R2./s(i))).^2+(Xth+X2).^2));

end

plot (s,Tind,'-b');

hold on

%Tind vs s at R2=0.6

R2= 0.6;

s=-1.0001:.01:2.0001;

for i = 1:length(s)

Tind(i)=3\*(Vth.^2)\*(R2./s(i))/(wsync\*((Rth+(R2./s(i))).^2+(Xth+X2).^2));

end

plot (s,Tind,'-g');

hold on

%Tind vs s at R2=1.2

R2= 1.2;

s=-1.0001:.01:2.0001;

for i = 1:length(s)

Tind(i)=3\*(Vth.^2)\*(R2./s(i))/(wsync\*((Rth+(R2./s(i))).^2+(Xth+X2).^2));

end

plot (s,Tind,'-r');

hold on

%Tind vs s at R2=2.8

R2=2.8;

s=-1.0001:.01:2.0001;

for i = 1:length(s)

Tind(i)=3\*(Vth.^2)\*(R2./s(i))/(wsync\*((Rth+(R2./s(i))).^2+(Xth+X2).^2));

end

plot (s,Tind,'-y');

hold on

%Tind vs s at R2=4.5

R2=4.5;

s=-1.0001:.01:2.0001;

for i = 1:length(s)

Tind(i)=3\*(Vth.^2)\*(R2./s(i))/(wsync\*((Rth+(R2./s(i))).^2+(Xth+X2).^2));

end

plot (s,Tind,'-m');

hold on

%Tind vs s at R2=8

R2=8;

s=-1.0001:.01:2.0001;

for i = 1:length(s)

Tind(i)=3\*(Vth.^2)\*(R2./s(i))/(wsync\*((Rth+(R2./s(i))).^2+(Xth+X2).^2));

end

plot (s,Tind,'-c');

hold on

%Tind vs s at R2=15

R2=15;

s=-1.0001:.01:2.0001;

for i = 1:length(s)

Tind(i)=3\*(Vth.^2)\*(R2./s(i))/(wsync\*((Rth+(R2./s(i))).^2+(Xth+X2).^2));

end

plot (s,Tind,':k');

figure

%Pconv vs s at R2=0.1

R2= 0.1;

s=-1.0001:.01:2.0001;

for i = 1:length(s)

Tind(i)=3\*(Vth.^2)\*(R2./s(i))/(wsync\*((Rth+(R2./s(i))).^2+(Xth+X2).^2));

wm=(1-s)\*wsync ;

Pconv(i)=Tind(i)\*wm(i) ;

end

plot (s,Pconv,'-k');

xlabel('s');

ylabel('Pconv');

hold on

%Pconv vs s at R2=0.2

R2= 0.2;

s=-1.0001:.01:2.0001;

for i = 1:length(s)

Tind(i)=3\*(Vth.^2)\*(R2./s(i))/(wsync\*((Rth+(R2./s(i))).^2+(Xth+X2).^2));

wm=(1-s)\*wsync ;

Pconv(i)=Tind(i)\*wm(i) ;

end

plot (s,Pconv,'-b');

hold on

%Pconv vs s at R2=0.6

R2= 0.6;

s=-1.0001:.01:2.0001;

for i = 1:length(s)

Tind(i)=3\*(Vth.^2)\*(R2./s(i))/(wsync\*((Rth+(R2./s(i))).^2+(Xth+X2).^2));

wm=(1-s)\*wsync ;

Pconv(i)=Tind(i)\*wm(i) ;

end

plot (s,Pconv,'-g');

%axis([-1.0001 2.0001

hold on

%Pconv vs s at R2=1.2

R2= 1.2;

s=-1.0001:.01:2.0001;

for i = 1:length(s)

Tind(i)=3\*(Vth.^2)\*(R2./s(i))/(wsync\*((Rth+(R2./s(i))).^2+(Xth+X2).^2));

wm=(1-s)\*wsync ;

Pconv(i)=Tind(i)\*wm(i) ;

end

plot (s,Pconv,'-r');

hold on

%Pconv vs s at R2=2.8

R2=2.8;

s=-1.0001:.01:2.0001;

for i = 1:length(s)

Tind(i)=3\*(Vth.^2)\*(R2./s(i))/(wsync\*((Rth+(R2./s(i))).^2+(Xth+X2).^2));

wm=(1-s)\*wsync ;

Pconv(i)=Tind(i)\*wm(i) ;

end

plot (s,Pconv,'-y');

hold on

%Pconv vs s at R2=4.5

R2=4.5;

s=-1.0001:.01:2.0001;

for i = 1:length(s)

Tind(i)=3\*(Vth.^2)\*(R2./s(i))/(wsync\*((Rth+(R2./s(i))).^2+(Xth+X2).^2));

wm=(1-s)\*wsync ;

Pconv(i)=Tind(i)\*wm(i) ;

end

plot (s,Pconv,'-m');

hold on

%Pconv vs s at R2=8

R2=8;

s=-1.0001:.01:2.0001;

for i = 1:length(s)

Tind(i)=3\*(Vth.^2)\*(R2./s(i))/(wsync\*((Rth+(R2./s(i))).^2+(Xth+X2).^2));

wm=(1-s)\*wsync ;

Pconv(i)=Tind(i)\*wm(i) ;

end

plot (s,Pconv,'-c');

hold on

%Pconv vs s at R2=15

R2=15;

s=-1.0001:.01:2.0001;

for i = 1:length(s)

Tind(i)=3\*(Vth.^2)\*(R2./s(i))/(wsync\*((Rth+(R2./s(i))).^2+(Xth+X2).^2));

wm=(1-s)\*wsync ;

Pconv(i)=Tind(i)\*wm(i) ;

end

plot (s,Pconv,':k');





