PRE-DETERMINATION OF PERFORMANCE CHARACTERISTICS OF A THREE PHASE INDUCTION MACHINE USING MATLAB

AC & SPECIAL MACHINES ASSIGNMENT-2

SUBMITTED BY-

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This is a program written using MATLAB, to pre-determine the performance of a three phase induction machine operated either as a generator or a motor. The only inputs required from the user are no-load and blocked-rotor test results, measured stator resistance. The behavior is analyzed at different slips of operation.

PROGRAM CODE:

```
clc
clear all
close all
disp('This is a program that evaluates the performance characteristics
of a three-phase induction machine from N.L. and B.R. test results');
fs=input('Enter the supplied frequency:');
P=input('Enter the number of poles created by the stator winding:');
Ns=120*fs/P;
s=0:0.001:0.18;
Nr=Ns*(1.-s);
ws=2*pi*Ns/60;
wr=2*pi.*Nr/60;

%Accepting data from the user:
V=input('Please enter the value of rated line voltage of the
machine:\n');
a=menu('How is the stator of the machine connected?','Star','Delta');
if a==1
    Vr=V/sqrt(3);
elseif a==2
    Vr=V;
End
%To get the single phase equivalent circuit parameters from no-load
%and blocked-rotor test results
Voc=input('Enter the no-load terminal voltage per phase:');
Ioc=input('Enter the no-load current per phase:');
Woc=input('Enter the no-load single phase wattmeter reading:');
Vsc=input('Enter the blocked-rotor terminal voltage per phase:');
Isc=input('Enter the blocked-rotor current per phase:');
Wsc=input('Enter the blocked-rotor single phase wattmeter reading:');
R1=input('Enter the measured stator resistance(a.c.) per phase:');
```

```
%No load parameter determination
pfoc=Woc/Voc/Ioc;
Iw=Ioc*pfoc;
Im=Ioc*sqrt(1-pfoc^2);
R0=Voc/Iw;
X0=Voc/Im;
%Blocked rotor parameter determination
Z01=Vsc/Isc;
R01=Wsc/Isc^2;
X01=sqrt(Z01^2-R01^2);
R2dash=R01-R1;

%Calculation
Rldash=R2dash*(1./s-1);
I2dash=Vr./(R01+Rldash+X01*i);
Z0=(R0*X0*i)/(R0+X0*i);
I0=Vr/Z0;
I1=I0+I2dash; %This is the total load current drawn per phase
Pir=3*(abs(I2dash).^2)*R2dash./s;  %Three-phase  power  input  to  the
%rotor
%abs returns the magnitude of a complex number)
Pd=3*(abs(I2dash).^2).*Rldash; %Total power developed
Td=Pir./ws; %Developed torque
Wm=3*(Woc/3); %Assuming 1/3rd of no-load losses is mechanical losses
%Woc is per phase, hence multiplying it by three
Wi=3*(Woc*2/3); %Assuming 2/3rd of no-load losses is iron losses
%Woc is per phase, hence multiplying it by three
Wcu1=3*(abs(I1).^2)*R1; %Stator copper losses
Po=Pd-Wm; %Total output power
Pi=Pir+Wcu1+Wi; %Total input power (three phase)
n=Po./Pi*100; %Efficiency
pf=(Pi/3)./(Vr*abs(I1));
```

```
%Plots
m=1;
while m~=2
    k=menu('Choose:','Torque-Slip','Power-Slip','Speed-Torque','Slip-
Output Power','Load current-Output Power','Speed-Output
Power','Efficiency-Output Power','Power Factor-Output Power');
switch k
    case 1
        plot(s*100,Td);
        grid on;
        xlabel('% Slip,s ------>');
        ylabel('Developed Torque,Td (N-m)------>');
        title('Torque-Slip Characteristic');
    case 2
        plot(s*100,Pd);
        grid on;
        xlabel('% Slip,s ------>');
        ylabel('Developed Power,Pd (W) ------>');
        title('Power-Slip Characteristic');
    case 3
        plot(Td,Nr);
        grid on;
        xlabel('Developed Torque,Td (N-m) ------>');
        ylabel('Speed,Nr (RPM) ------>');
        title('Speed-Torque Characteristic');
    case 4
        plot(Po,s*100);
        grid on;
        xlabel('Output Power,Po (W) ------>');
        ylabel('% Slip,s ------>');
        title('Slip-Output Power Characteristic');
    case 5
        plot(Po,sqrt(3)*abs(I1));
        grid on;
        xlabel('Output Power,Po (W) ------>');
```

```
        ylabel('Load current,I (A) ------>');
        title('Load Current-Output Power Characteristic');
    case 6
        plot(Po,Nr);
        grid on;
        xlabel('Output Power,Po (W) ------>');
        ylabel('Speed,Nr (RPM) ------>');
        title('Speed-Output Power Characteristic');
    case 7
        plot(Po,n);
        grid on;
        xlabel('Output Power,Po (W) ------>');
        ylabel('% Efficiency,n ------>');
        title('Efficiency-Output Power Characteristic');
    case 8
        plot(Po,pf);
        grid on;
        xlabel('Output Power,Po (W) ------>');
        ylabel('Power Factor,P.F. ------>');
        title('Power Factor-Output Power Characteristic');
end
m=menu('Would you like to plot another characteristic?','Yes','No');
end
```

OUTPUT:

This is a program that evaluates the performance characteristics of a three-phase induction machine from N.L. and B.R. test results

Enter the supplied frequency:50

Enter the number of poles created by the stator winding:4

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

415

Enter the no-load terminal voltage per phase:408

Enter the no-load current per phase:4.2/sqrt(3)

Enter the no-load single phase wattmeter reading:256/3

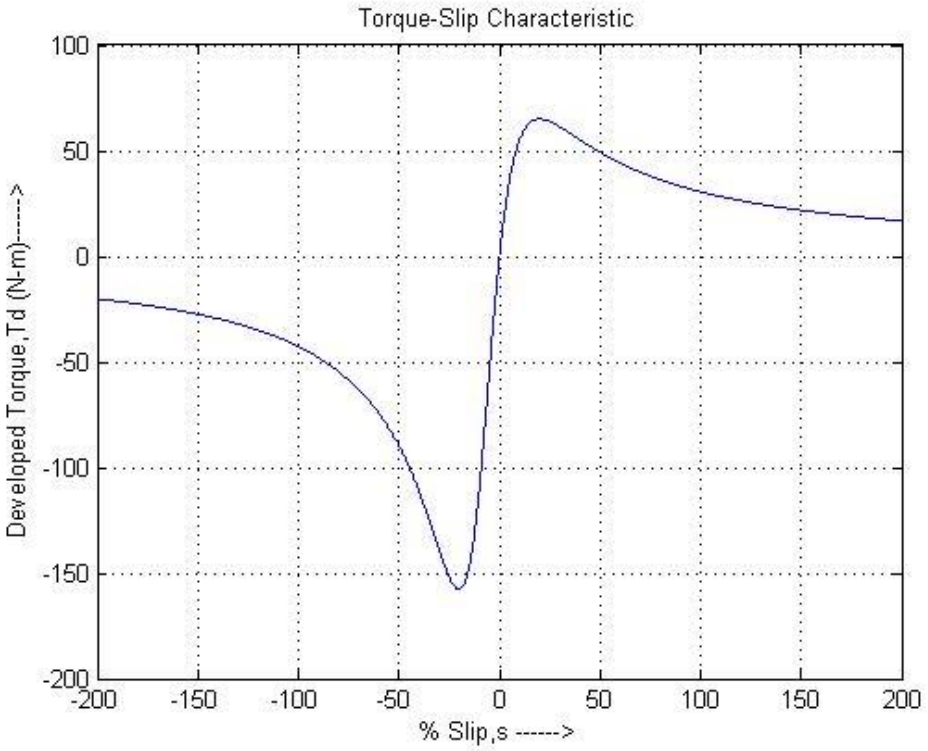
Enter the blocked-rotor terminal voltage per phase:85

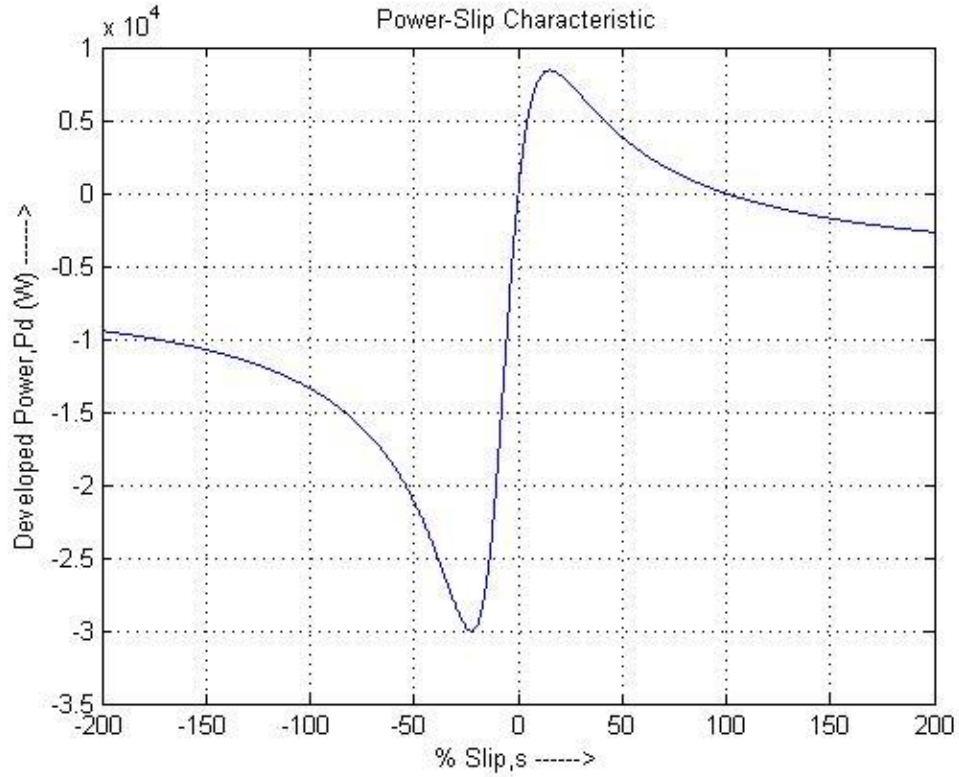
Enter the blocked-rotor current per phase:7.5/sqrt(3)

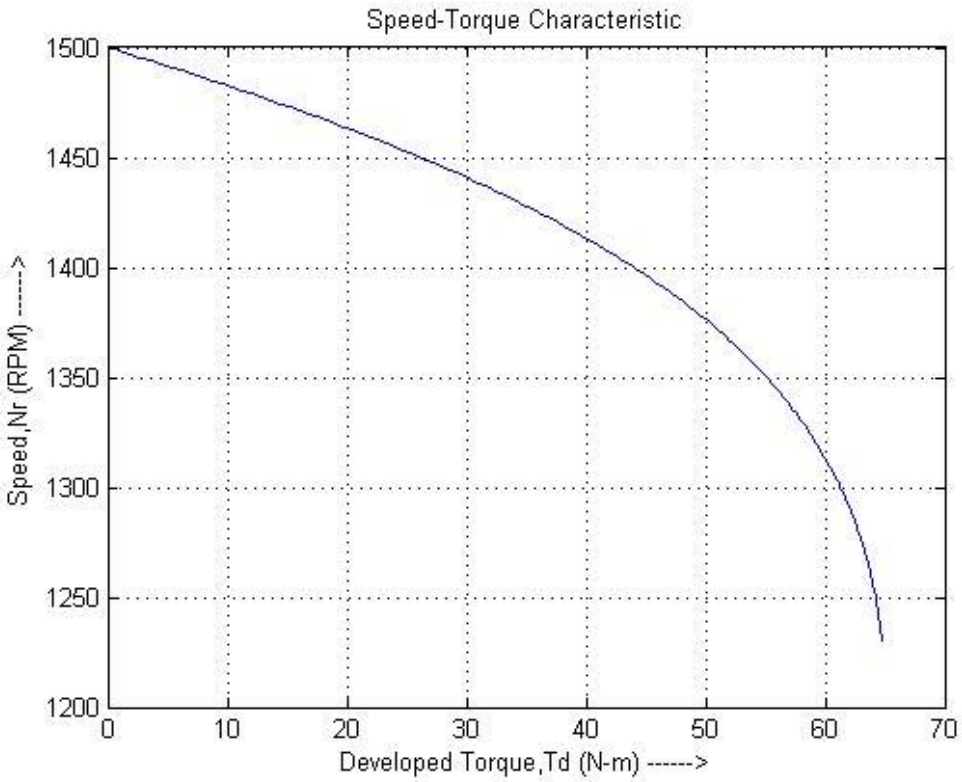
Enter the blocked-rotor single phase wattmeter reading:620/3

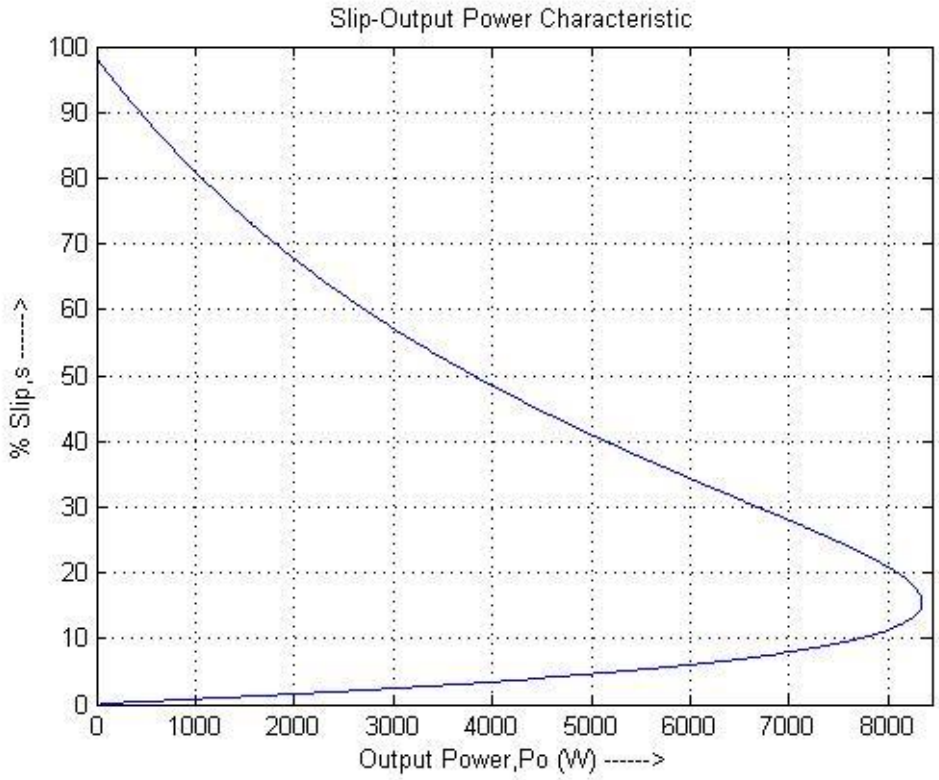
Enter the measured stator resistance(a.c.) per phase:7.425

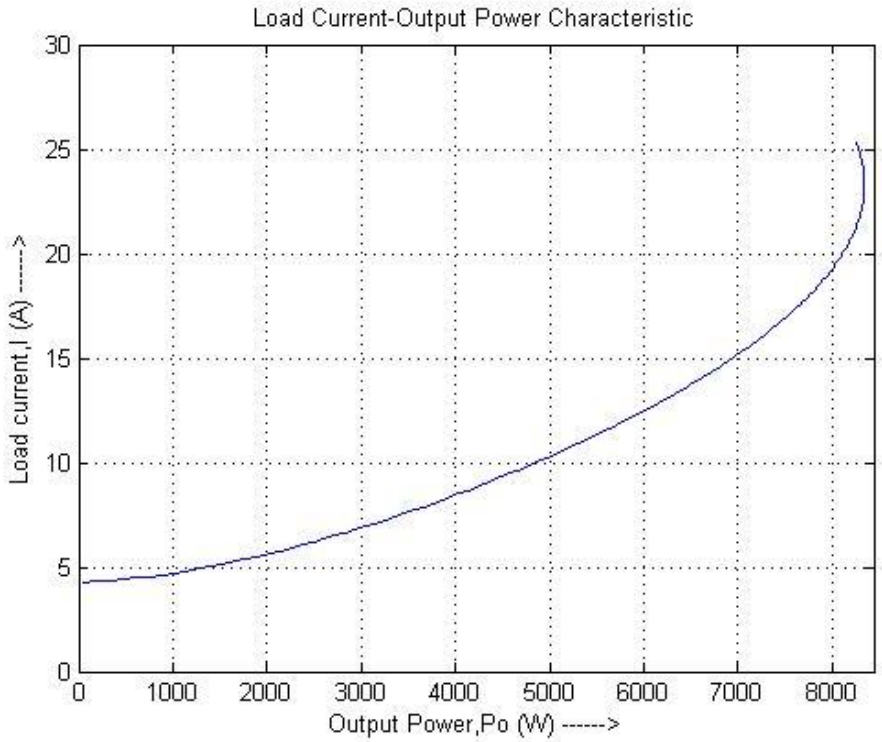
PLOTS:

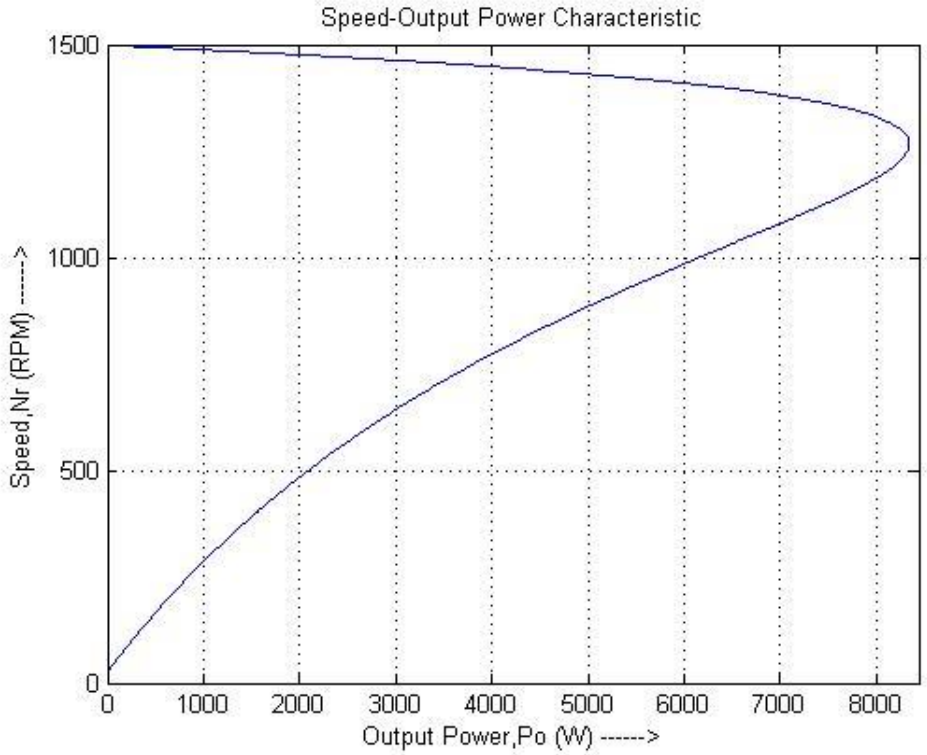

Torque-Slip Characteristic
Developed Torque,Td (N-m)----->
% Slip,s ------>
100
50
0
-50
-100
-150
-200
-200
-150
-100
-50
0
50
100
150
200

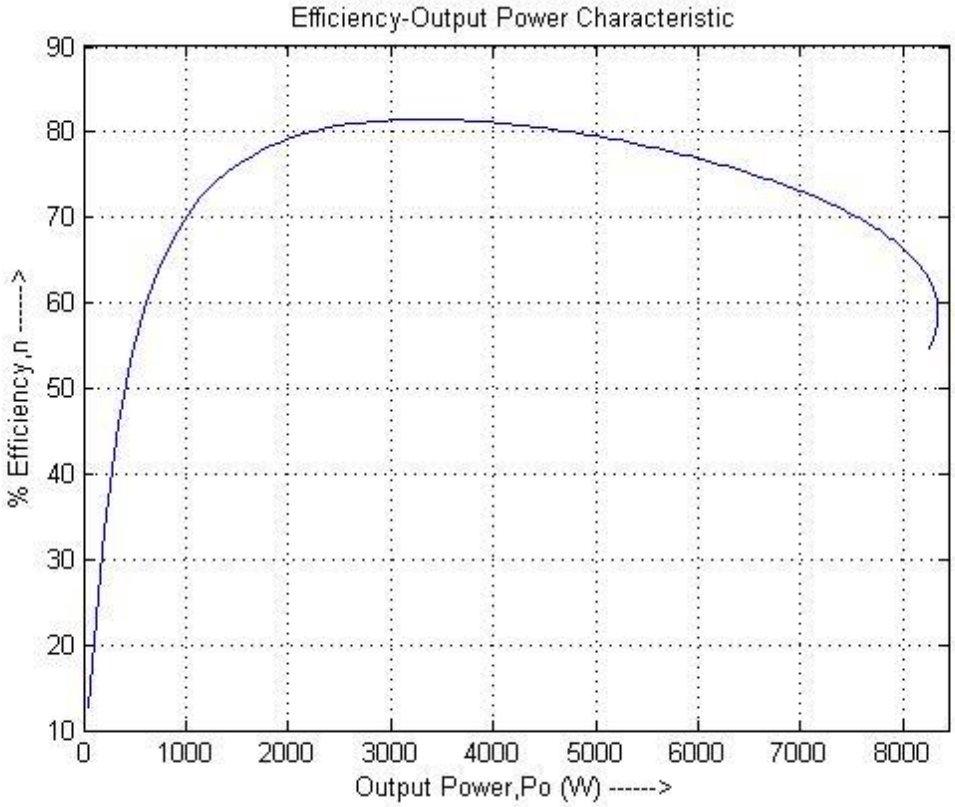

Power-Slip Characteristic
x 10^4
Developed Power,Pd (W) ------>
% Slip,s ------>
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
-200
-150
-100
-50
0
50
100
150
200

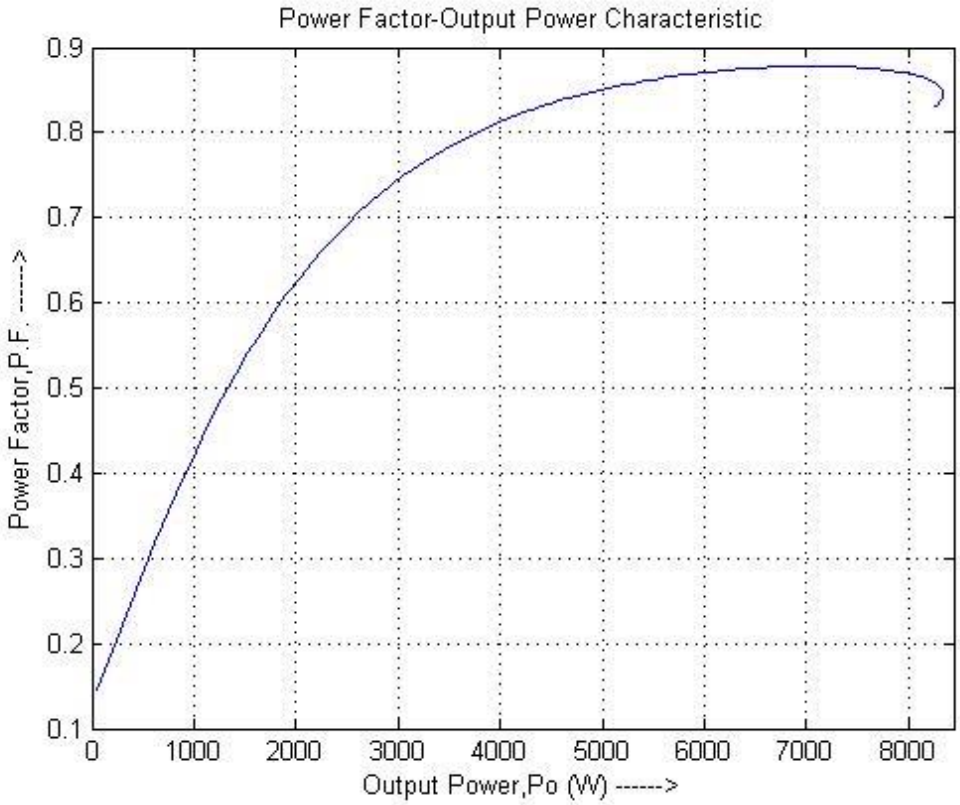

Speed-Torque Characteristic
Speed,Nr (RPM) ------>
Developed Torque,Td (N-m) ------>
1500
1450
1400
1350
1300
1250
1200
0
10
20
30
40
50
60
70


Slip-Output Power Characteristic
% Slip,s ------>
Output Power,Po (W) ------>
100
90
80
70
60
50
40
30
20
10
0
0
1000
2000
3000
4000
5000
6000
7000
8000


Load Current-Output Power Characteristic
Load current,I (A) ------>
Output Power,Po (W) ------>
0
5
10
15
20
25
30
0
1000
2000
3000
4000
5000
6000
7000
8000


Speed-Output Power Characteristic
Speed,Nr (RPM) ------>
Output Power,Po (W) ------>
0
500
1000
1500
0
1000
2000
3000
4000
5000
6000
7000
8000


Efficiency-Output Power Characteristic
% Efficiency,n ------>
Output Power,Po (W) ------>
10
20
30
40
50
60
70
80
90
0
1000
2000
3000
4000
5000
6000
7000
8000


Power Factor-Output Power Characteristic
Power Factor,P.F. ------>
Output Power,Po (W) ------>
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
0
1000
2000
3000
4000
5000
6000
7000
8000

RESULT:

Hence the performance characteristics of a three phase induction machine are pre-determined using MATLAB, and its behavior is analyzed at various slips of operation.