LAB06

i)ROTATING MAGNETIC FIELD

%M-file: mag\_field.m

% This script calculates the net magnetic field produced

% by a three-phase stator.

% Set up the basic conditions

bmax = 1; % Normalize bmax to 1

freq = 60; % 60 Hz

w = 2 \* pi \* freq; % Angular velocity (rad/s)

% Generate the three component magnetic fields

t = 0:1/6000:1/60; % Time vector

theta = 0; % Initial phase

% Define the three-phase magnetic fields

Baa = sin(w \* t) .\* (cos(theta) + 1j \* sin(theta));

Ebb = sin(w \* t - 2 \* pi / 3) .\* (cos(2 \* pi / 3) + 1j \* sin(2 \* pi / 3));

Ecc = sin(w \* t + 2 \* pi / 3) .\* (cos(-2 \* pi / 3) + 1j \* sin(-2 \* pi / 3));

% Calculate the net magnetic field

Enet = Baa + Ebb + Ecc;

% Calculate a circle representing the expected maximum value of Enet

circle = 1.5 \* (cos(w \* t) + 1j \* sin(w \* t));

% Plot the magnitude and direction of the resulting magnetic fields

% Baa is black, Ebb is blue, Ecc is magenta, and Enet is red.

figure;

for ii = 1:length(t)

% Plot the reference circle

plot(real(circle), imag(circle), 'k');

hold on;

% Plot the three-phase magnetic field vectors

plot([0 real(Baa(ii))], [0 imag(Baa(ii))], 'k', 'LineWidth', 2);

plot([0 real(Ebb(ii))], [0 imag(Ebb(ii))], 'b', 'LineWidth', 2);

plot([0 real(Ecc(ii))], [0 imag(Ecc(ii))], 'm', 'LineWidth', 2);

plot([0 real(Enet(ii))], [0 imag(Enet(ii))], 'r', 'LineWidth', 3);

axis square;

axis([-2 2 -2 2]);

drawnow;

hold off;

end

ii)

2)Interaction of the magnetic field produced by a current carrying one-loop rotor with the rotating magnetic field of the three-phase stator windings.

clc; clear; close all;

% Set up the basic conditions

bmax = 1; % Normalize bmax to 1

freq = 60; % 60 Hz

P = 2; % Number of poles (set to 2 for standard operation)

w = 2 \* pi \* freq \* P / 2; % Adjusted angular velocity (pole dependent)

% Rotor parameters

rotor\_speed = w / P; % Mechanical speed of rotor magnetic field

initial\_angle = pi/4; % Initial misalignment angle

t = 0:1/6000:1/60; % Time vector

% Define phase parameters

A1 = 1.2; % Amplitude modification for phase A

A2 = 0.8; % Amplitude modification for phase B

A3 = 1.0; % Amplitude modification for phase C

phi1 = 0; % Phase shift for A

phi2 = -pi/2; % Phase shift for B (experimenting with different shifts)

phi3 = pi/4; % Phase shift for C

% Generate the three-phase magnetic fields

Baa = A1 \* sin(w\*t + phi1) .\* (cos(0) + j\*sin(0));

Bbb = A2 \* sin(w\*t + phi2) .\* (cos(2\*pi/3) + j\*sin(2\*pi/3));

Bcc = A3 \* sin(w\*t + phi3) .\* (cos(-2\*pi/3) + j\*sin(-2\*pi/3));

% Calculate Bnet

Bnet = Baa + Bbb + Bcc;

% Rotor magnetic field (one-loop rotor interaction)

Brotor = bmax \* (cos(rotor\_speed \* t + initial\_angle) + j \* sin(rotor\_speed \* t + initial\_angle));

% Calculate a reference circle representing the expected maximum

circle = 1.5 \* (cos(w\*t) + j\*sin(w\*t));

% Plot the magnitude and direction of the resulting magnetic fields

figure;

for ii = 1:length(t)

clf;

% Plot the reference circle

plot(circle, 'k');

hold on;

% Plot the three-phase stator magnetic fields

plot([0 real(Baa(ii))], [0 imag(Baa(ii))], 'k', 'LineWidth', 2);

plot([0 real(Bbb(ii))], [0 imag(Bbb(ii))], 'b', 'LineWidth', 2);

plot([0 real(Bcc(ii))], [0 imag(Bcc(ii))], 'm', 'LineWidth', 2);

% Plot the net rotating magnetic field

plot([0 real(Bnet(ii))], [0 imag(Bnet(ii))], 'r', 'LineWidth', 3);

% Plot the rotor magnetic field

plot([0 real(Brotor(ii))], [0 imag(Brotor(ii))], 'g', 'LineWidth', 3);

axis square;

axis([-2 2 -2 2]);

drawnow;

hold off;

end

**LAB07**

Objective:

Create and execute a Matlab Program that models the Synchronous Generator operating alone.

% M-file: term\_char\_all.m

% M-file to plot the terminal characteristics of the generator

% for various power factors (both leading and lagging)

% Initialize the current amplitudes (21 values in the range 0-60 A)

i\_a = (0:1:20) \* 3;

% Initialize other parameters

e\_a = 277.0; % Internal generated voltage

x\_s = 1.0; % Synchronous reactance

% Define power factor angles (in radians) for lagging and leading cases

pf\_values = [0.2, 0.4, 0.6, 0.8];

theta\_lagging = acos(pf\_values); % Lagging power factor (current lags voltage)

theta\_leading = acos(-pf\_values); % Corrected Leading power factor calculation

% Colors for different plots

colors = ['r', 'g', 'b', 'm'];

figure;

hold on;

% Plot terminal characteristics for lagging power factors

for idx = 1:length(pf\_values)

v\_phase = zeros(1, 21);

theta = theta\_lagging(idx);

for ii = 1:21

v\_phase(ii) = sqrt(e\_a^2 - (x\_s \* i\_a(ii) \* sin(theta))^2) ...

- (x\_s \* i\_a(ii) \* cos(theta));

end

v\_t = v\_phase \* sqrt(3);

plot(i\_a, v\_t, 'Color', colors(idx), 'Linewidth', 2.0, 'DisplayName', ...

sprintf('Lagging PF = %.1f', pf\_values(idx)));

end

% Plot terminal characteristics for leading power factors

for idx = 1:length(pf\_values)

v\_phase = zeros(1, 21);

theta = theta\_leading(idx);

for ii = 1:21

v\_phase(ii) = sqrt(e\_a^2 - (x\_s \* i\_a(ii) \* sin(theta))^2) ...

- (x\_s \* i\_a(ii) \* cos(theta));

end

v\_t = v\_phase \* sqrt(3);

plot(i\_a, v\_t, '--', 'Color', colors(idx), 'Linewidth', 2.0, 'DisplayName', ...

sprintf('Leading PF = %.1f', pf\_values(idx)));

end

% Add labels, title, and legend

xlabel('Line Current (A)', 'Fontweight', 'Bold');

ylabel('Terminal Voltage (V)', 'Fontweight', 'Bold');

title('Terminal Characteristics for Various Power Factors', 'Fontweight', 'Bold');

grid on;

axis([0 60 400 550]);

legend show;

hold off;

**LAB08**

clc;

clear;

% Motor parameters (based on Chapman Example 7-5)

f = 60; % Frequency in Hz

p = 4; % Number of poles

ns = 120\*f/p; % Synchronous speed in RPM

ws = 2\*pi\*ns/60; % Synchronous speed in rad/s

V\_th = 208.2; % Thevenin voltage in volts

R\_th = 0.255; % Thevenin resistance in ohms

X\_th = 0.435; % Thevenin reactance in ohms

X\_r = 0.816; % Rotor reactance referred to stator

% Rotor resistances to consider

RR\_base = 0.15; % Chosen base rotor resistance (example)

RR\_values = [0.5, 1, 2]\*RR\_base; % Half, Base, and Double RR

s = linspace(0.001, 1, 1000); % Slip from near 0 to 1

% Initialize figure

figure;

hold on;

grid on;

colors = ['r', 'g', 'b'];

legends = {};

% Loop over each rotor resistance

for i = 1:length(RR\_values)

RR = RR\_values(i);

T = (3 \* V\_th^2 .\* RR ./ s) ./ ...

(ws \* ((R\_th + RR./s).^2 + (X\_th + X\_r)^2)); % Torque equation

plot((1-s)\*ns, T, colors(i), 'LineWidth', 2); % Speed in RPM vs Torque

legends{end+1} = ['R\_r = ' num2str(RR, '%.3f') ' \Omega'];

end

xlabel('Rotor Speed (RPM)');

ylabel('Torque (Nm)');

title('Torque-Speed Characteristics of Induction Motor');

legend(legends, 'Location', 'NorthEast');