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Industrial Electronics

Assignment-1

Evaluate the performance of the separately excited dc motor using phase controlled semi-converter and full converter. The motor parameters are:

DC Motor: 110 V, 1800 RPM, Torque = 10N.m, 25HP, R_a = 0.6 Ω and L_a = 6mH.

M-code:

```
% Industrial Electronics Assignment
% Sambhav R Jain
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clc;
clear all;
close all;

fprintf('Performance Analysis of a single phase separately excited DC motor
drive - Analytical Solution\n');
fprintf(' - Sambhav R Jain (107108103)\n\n');

% fprintf('Enter the following parameters:\n');
% V = input('Supply rms voltage (V): ');
% Ra = input('Enter the armature resistance (Ohm): ');
% La = input('Enter the armature inductance (Henry): ');
% f = input('Enter the supply frequency (Hz): ');
% del_i = input('Enter the maximum current error (A): ');
% del_alpha = input('Enter the incremental alpha (deg): ');
% alpha_max = input('Enter the maximum firing angle (deg): ');

V = 110;
Ra = 0.6;
La = 6e-3;
f = 50;
del_i = 0.001;
del_alpha = deg2rad(15);
alpha_max = deg2rad(150);

Vm = sqrt(2)*V;

w = 2*pi*f;
Z = sqrt(Ra^2 + (w*La)^2);
```

```
theta_z = atan(w*La/Ra);
alpha = 0;
alpha = deg2rad(alpha);
N = 1;
while 1
Eg = Vm*N;
if(Eg < Vm*sin(alpha))
if(alpha < pi/2)
break
end
end
N = N - 0.0001;
end

theta_s = max(alpha,asin(Eg/Vm));
Ia_s = 0;
% A1 = (Ia_s - (Vm/Z)*sin(theta_s-theta_z) + Eg/Ra)*exp(Ra/(w*La)*theta_s);
Ia_pi = Vm/Z*(sin(pi-theta_z) - sin(theta_s-
theta_z)*exp(Ra/(w*La)*(theta_s-pi))) + Eg/Ra*(exp(Ra/(w*La)*(theta_s-pi))-
1) + Ia_s*exp(Ra/(w*La)*(theta_s-pi))
% A2 = (Ia_pi+Eg/Ra)*exp(Ra/w*La*pi);

ch = menu('Choose:','Semi-converter','Full-converter');
if ch == 1
Ia_pi_alpha = Ia_pi*exp(Ra/(w*La)*(pi-pi-alpha)) +
Eg/Ra*(exp(Ra/(w*La)*(pi-pi-alpha))-1)
Ia_pi_theta_s = Ia_pi*exp(Ra/(w*La)*(pi-pi-theta_s)) +
Eg/Ra*(exp(Ra/(w*La)*(pi-pi-theta_s))-1)
end
if ch == 2
Ia_pi_alpha = Vm/Z*(sin(pi+alpha-theta_z) - sin(theta_s-
theta_z)*exp(Ra/(w*La)*(theta_s-pi-alpha))) +
Eg/Ra*(exp(Ra/(w*La)*(theta_s-pi-alpha))-1) + Ia_s*exp(Ra/(w*La)*(theta_s-
pi-alpha))
Ia_pi_theta_s = Vm/Z*(sin(pi+theta_s-theta_z) - sin(theta_s-
theta_z)*exp(Ra/(w*La)*(theta_s-pi-theta_s))) +
Eg/Ra*(exp(Ra/(w*La)*(theta_s-pi-theta_s))-1) +
Ia_s*exp(Ra/(w*La)*(theta_s-pi-theta_s))
end

if Ia_pi_alpha > 0
if Ia_pi_theta_s > 0
theta_s = alpha;
while 1
Ia_s = Ia_pi_alpha;
% A1 = (Ia_s - (Vm/Z)*sin(theta_s-theta_z) + Eg/Ra)*exp(Ra/(w*La)*theta_s);
Ia_pi = Vm/Z*(sin(pi-theta_z) - sin(theta_s-
theta_z)*exp(Ra/(w*La)*(theta_s-pi))) + Eg/Ra*(exp(Ra/(w*La)*(theta_s-pi))-
1) + Ia_s*exp(Ra/(w*La)*(theta_s-pi))
% A2 = (Ia_pi+Eg/Ra)*exp(Ra/w*La*pi);
I_old = Ia_pi_alpha;
% ch = menu('Choose:','Semi-converter','Full-converter');
```

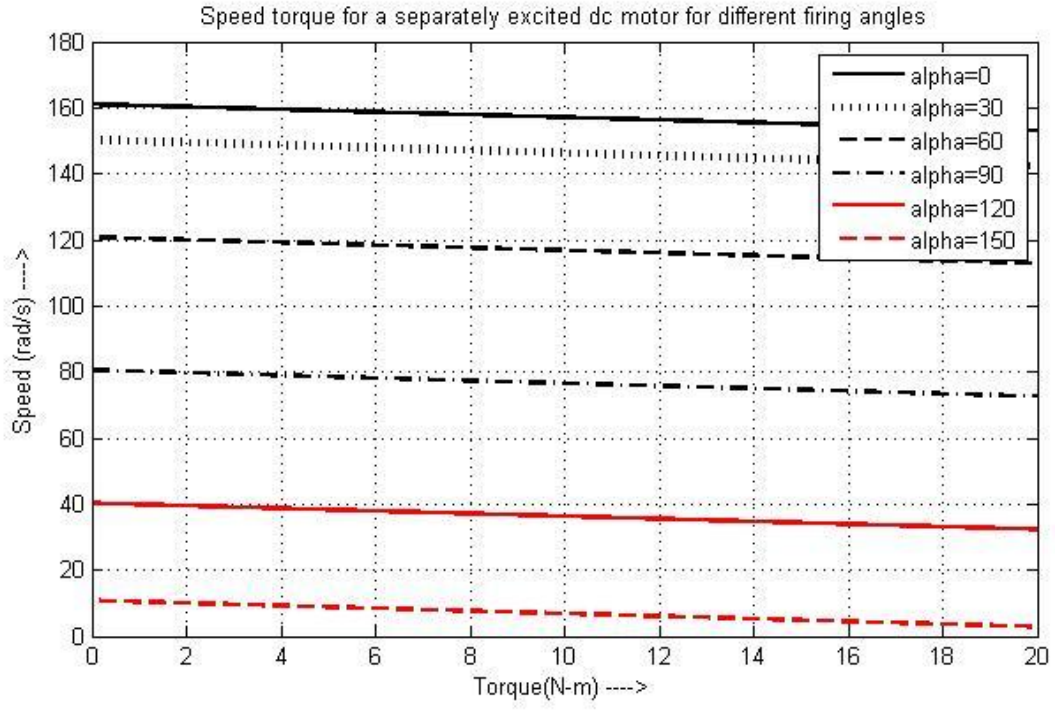
```
if ch == 1
Ia_pi_alpha = Ia_pi*exp(Ra/(w*La)*(pi-pi-alpha)) +
Eg/Ra*(exp(Ra/(w*La)*(pi-pi-alpha))-1)
Ia_pi_theta_s = Ia_pi*exp(Ra/(w*La)*(pi-pi-theta_s)) +
Eg/Ra*(exp(Ra/(w*La)*(pi-pi-theta_s))-1)
end
if ch == 2
Ia_pi_alpha = Vm/Z*(sin(pi+alpha-theta_z) - sin(theta_s-
theta_z)*exp(Ra/(w*La)*(theta_s-pi-alpha))) +
Eg/Ra*(exp(Ra/(w*La)*(theta_s-pi-alpha))-1) + Ia_s*exp(Ra/(w*La)*(theta_s-
pi-alpha))
Ia_pi_theta_s = Vm/Z*(sin(pi+theta_s-theta_z) - sin(theta_s-
theta_z)*exp(Ra/(w*La)*(theta_s-pi-theta_s))) +
Eg/Ra*(exp(Ra/(w*La)*(theta_s-pi-theta_s))-1) +
Ia_s*exp(Ra/(w*La)*(theta_s-pi-theta_s))
end
abs(I_old - Ia_pi_alpha)
if abs(I_old - Ia_pi_alpha) <= del_i
break
end
end

end
end
```

Characteristics:

1. Semiconverter

```
% Sambhav R Jain (107108103)
clc;
clear all;
close all;

V = input('Enter the rms voltage: ');
k_phi = input('Enter the field constant: ');
Ra = input('Enter the armature resistance: ');

td = 0:0.01:20;
Vm = sqrt(2)*V;

for a=0:30:150
    Va = Vm/pi*(1+cosd(a));
    w = Va/k_phi - td*Ra/k_phi^2;
    plot(td,w);
    xlabel('Torque(N-m) ---->'); ylabel('Speed (rad/s) ---->');
title('Speed torque for a separately excited dc motor for different firing
angles');

    % legend(sprintf('alpha = %d',a));
    hold on
    grid
end
```

Speed-Torque Plot:



2. Full converter

```
% Sambhav R Jain (107108103)
clc;
clear all;
close all;

V = input('Enter the rms voltage: ');
k_phi = input('Enter the field constant: ');
Ra = input('Enter the armature resistance: ');

td = 0:0.01:20;
Vm = sqrt(2)*V;

for a=0:30:150
    Va = 2*Vm/pi*(cosd(a));
    w = Va/k_phi - td*Ra/k_phi^2;
    plot(td,w);
    xlabel('Torque(N-m) ---->'); ylabel('Speed (rad/s) ---->');
title('Speed torque for a separately excited dc motor for different firing
angles');

    % legend(sprintf('alpha = %d',a));
    hold on
    grid
end
```

Speed-Torque Plot: