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EE568 - Project 1

```
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```

Analytical Calculations

Initialize

```
close all; clear all; clc;

% Variables and Constants

mu_0 = 4*pi*1e-7;
depth = 20e-3; %m
g1 = 0.5e-3; %m
r0 = 12.5e-3; %m
r1 = 12e-3; %m
g2 = 2.5e-3; %m
r2 = 10e-3; %m
L = 20e-3; %m
N = 250; %turns
I = 3; %Amps

% Reluctance of the system varies over a period. Maximum reluctance
% position is where the airgap is 2x2.5 mm, i.e. the rotor is in
 horizontal
% position. To find the varying reluctance over a period, following
 angles
% are defined (see angles.png):

a = asin(7.5/12); %rad
b = asin(7.5/12.5); %rad

alpha = pi/2-(a+b); %rad
```

Reluctance and Inductance Definitions

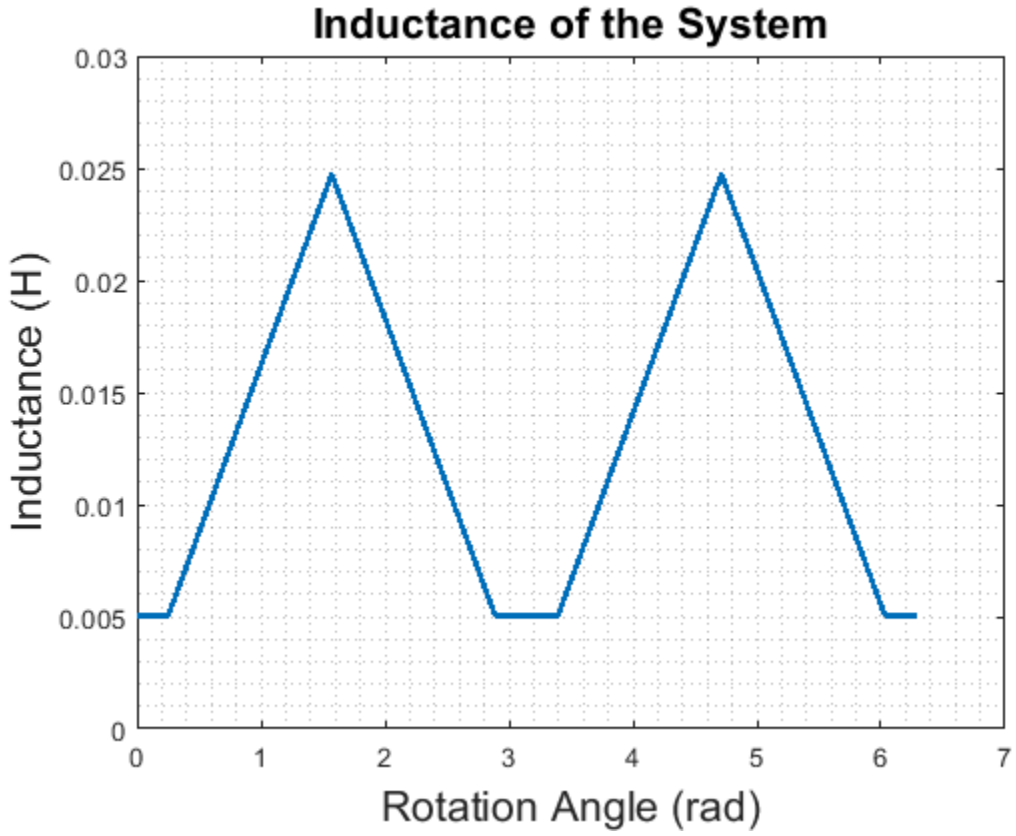
```
% Alpha is the angle where reluctance starts increasing, with respect
 to
```

```
% flux area, as a function of rotation angle. When rotor angle is
 alpha,
% corner of the salient part of the rotor is aligned with the corner
 of the
% stator. The change in the reluctance of the straight part of the
 rotor is
% ignored.

% Reluctance of the system can be defined as a pwl function.

% Reluctance for theta = 0:alpha and theta = 180-alpha:180

Rel_min = @(thet) (2*g2)/(mu_0*(2*b-thet)*r0*L);

% Reluctance for theta = alpha:90

Rel_rise = @(thet) (2*g1)/(mu_0*r1*(thet-alpha)*L);

% Reluctance for theta = 90:180-alpha

Rel_fall = @(thet) (2*g1)/(mu_0*r1*(pi-alpha-thet)*L);

L_min = @(thet) N^2./Rel_min(thet);

L_rise = @(thet) N^2./(1/Rel_rise(thet)+1/Rel_min(thet-alpha))^(-1);

L_fall = @(thet) N^2./(1/Rel_fall(thet)+1/Rel_min(pi-alpha-
thet))^(-1);
```

Plot the inductance

```
rot_angle = linspace(0,pi,1000);
Inductance = zeros(1,length(rot_angle));

for i=1:length(rot_angle)
    t = rot_angle(i);
    if(t<=alpha)
        Inductance(i) = L_min(0);
    end
    if(t>alpha && t<=pi/2)
        Inductance(i) = L_rise(t);
    end
    if (t>pi/2 && t<=(pi-alpha))
        Inductance(i) = L_fall(t);
    end
    if (t>(pi-alpha) && t<=(pi))
        Inductance(i) = L_min(0);
    end

end

rot = linspace(0,2*pi,2000);
Ind_full_rot = [Inductance,Inductance];
```

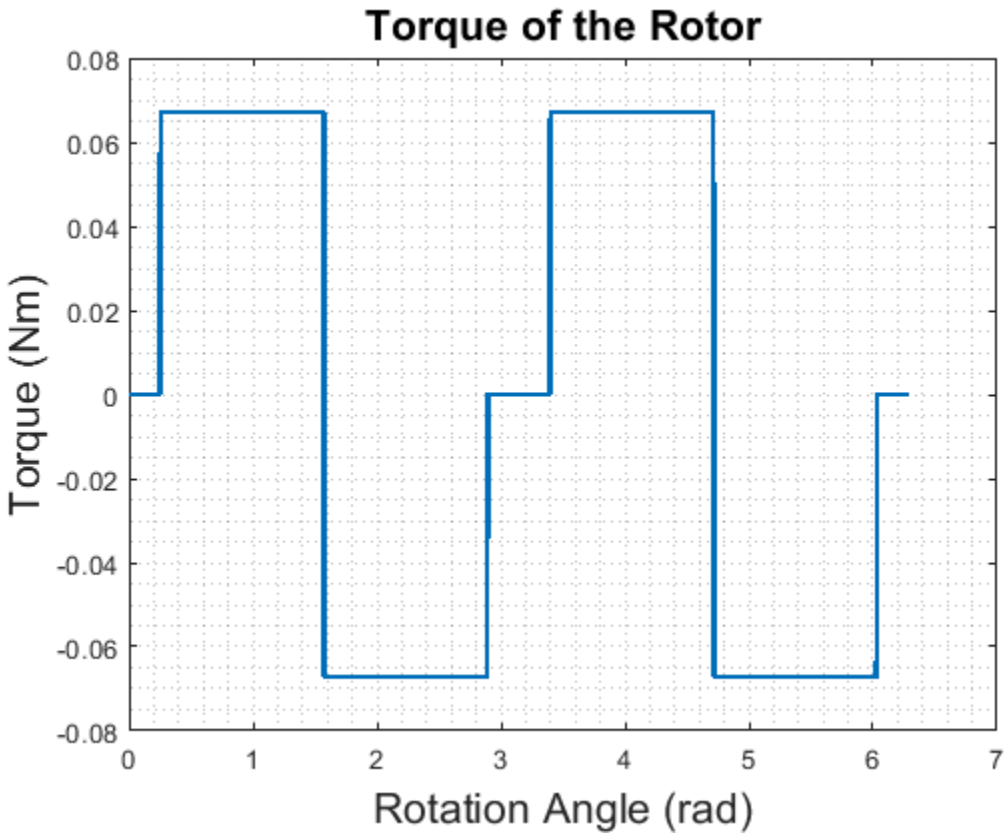
```
figure;
plot(rot,Ind_full_rot,'LineWidth',2);
grid minor;
xlabel('Rotation Angle (rad)','FontSize',16);
ylabel('Inductance (H)','FontSize',16);
ylim([0 0.03]);
title('Inductance of the System','FontSize',16);
saveas(gcf,'inductance_analytical','epsc');
```



Torque Calculation

```
% T = 1/2*I^2*dL(thet)/dthet

Torque_full_rot = zeros(size(Ind_full_rot));

for i = 1:length(Torque_full_rot)-1
    Torque_full_rot(i+1) = (Ind_full_rot(i+1)-Ind_full_rot(i))/(rot(i
+1)-rot(i));
end

Torque_full_rot = Torque_full_rot*I^2/2;

figure;
plot(rot,Torque_full_rot,'LineWidth',2);
```

```
grid minor;
xlabel('Rotation Angle (rad)','FontSize',16);
ylabel('Torque (Nm)','FontSize',16);
% ylim([0 0.03]);
title('Torque of the Rotor','FontSize',16);
saveas(gcf,'torque_analytical','epsc');
```



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