MAGNETIC GEAR

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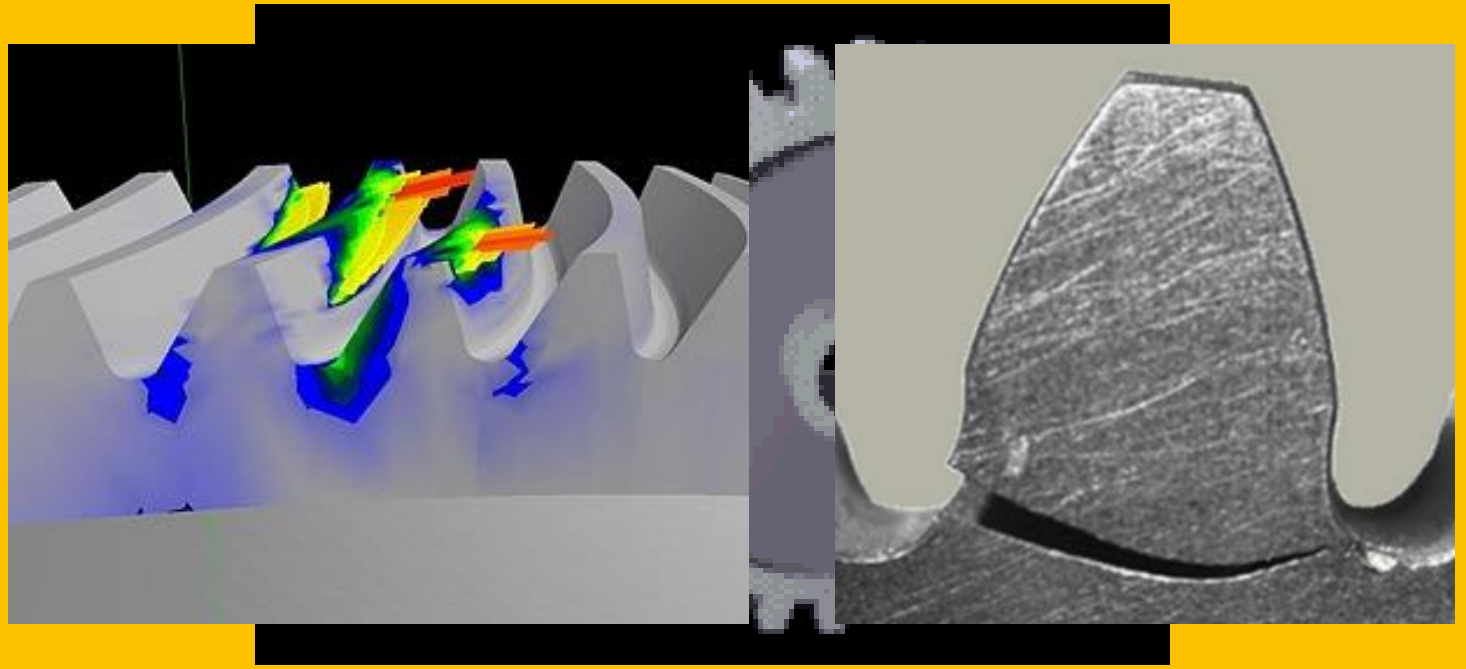
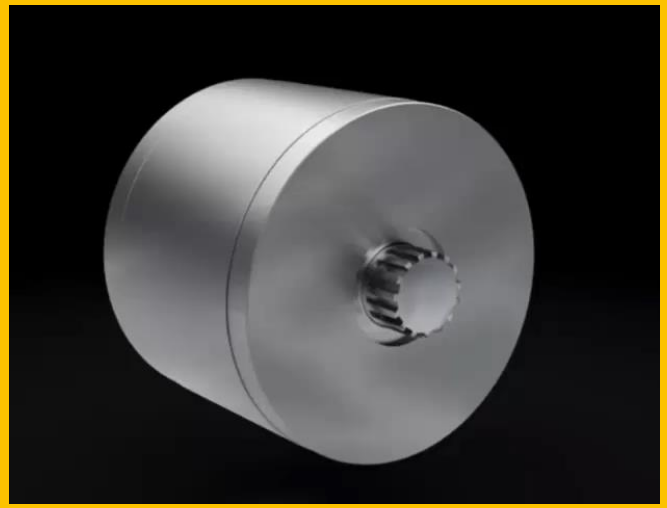
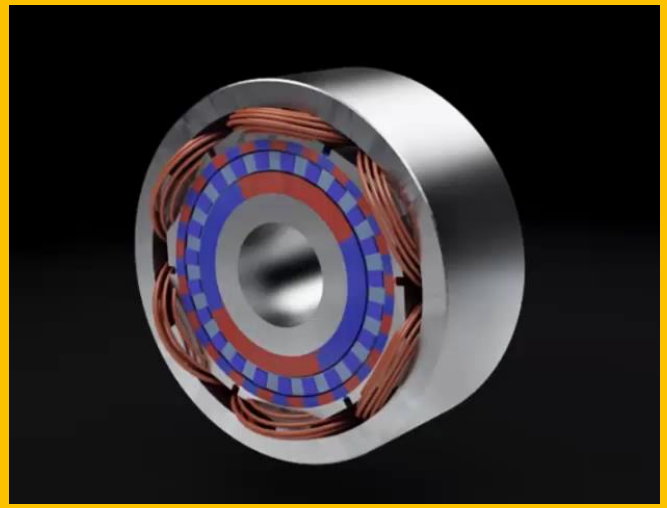
Why Magnetic Gear



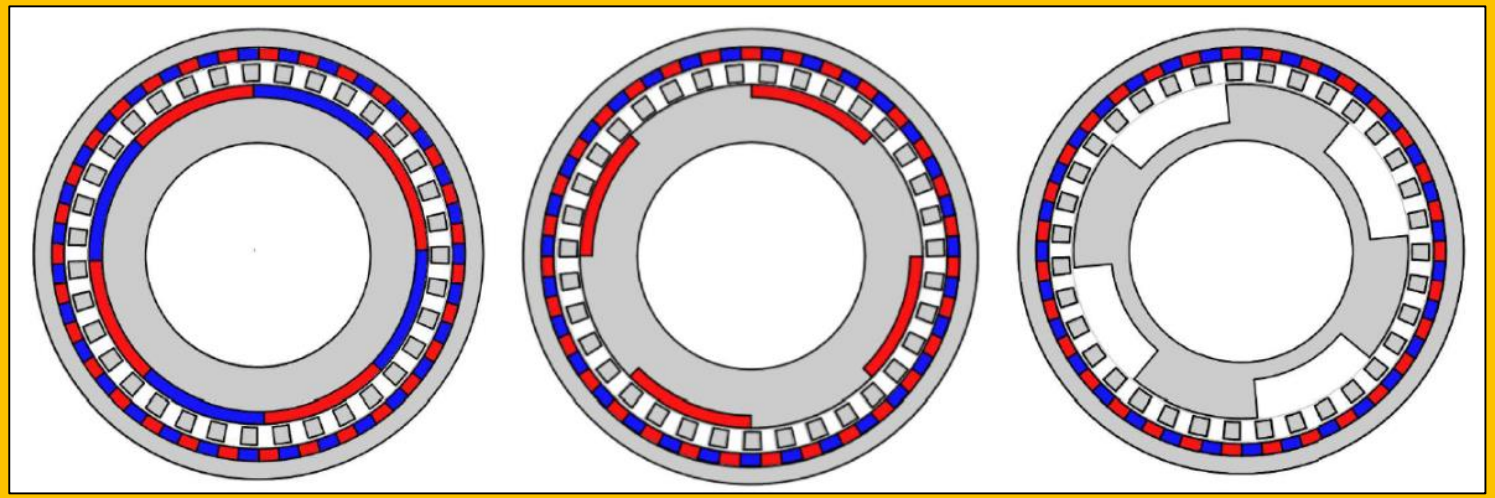
Why Magnetic Gear





$$w_i = \frac{n_p}{p_i} w_p - \frac{p_o}{p_i} w_o$$

Types of Magnetic Gear



SPMG CPMG RG

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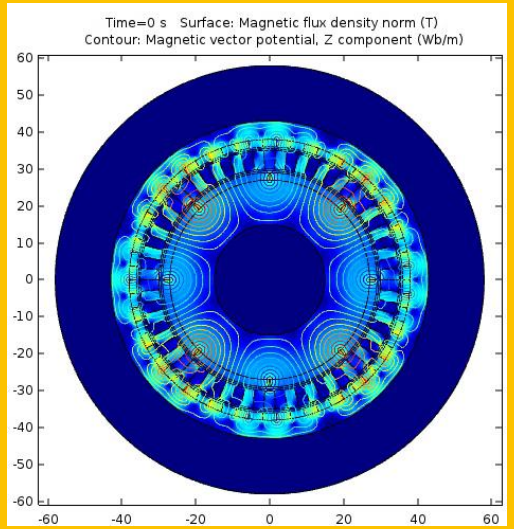
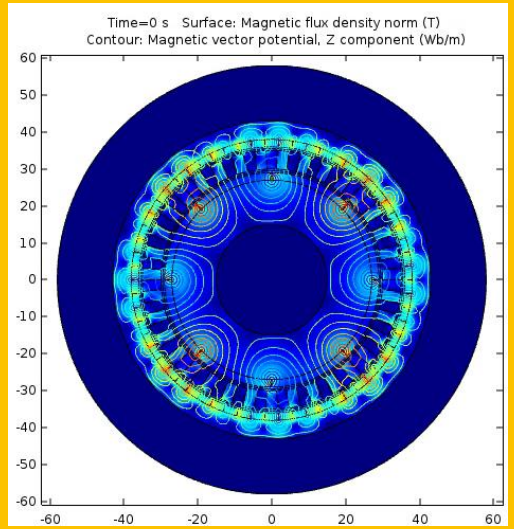
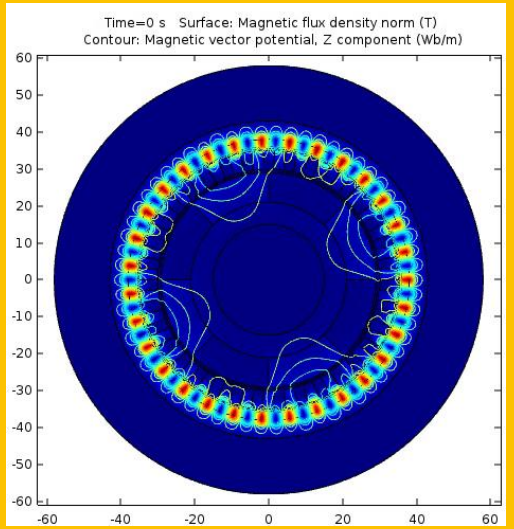


SPMG



CPMG



RG

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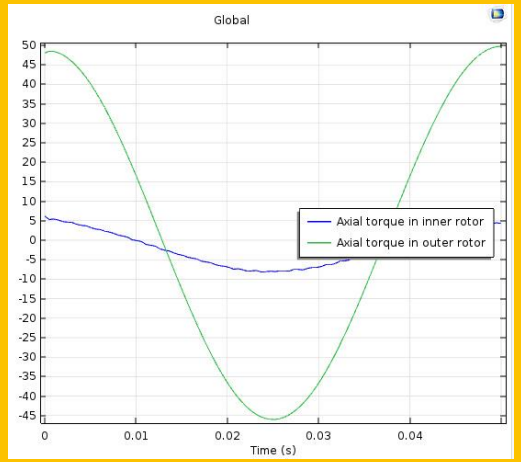
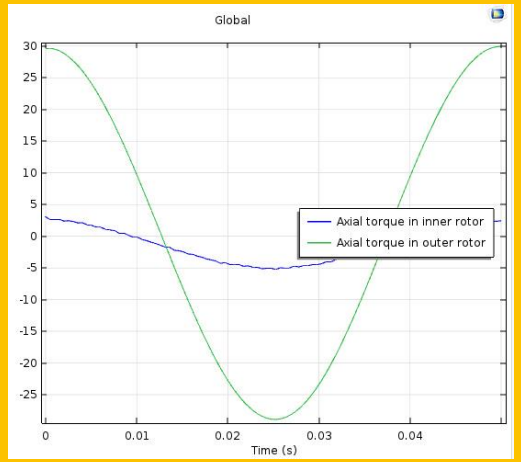
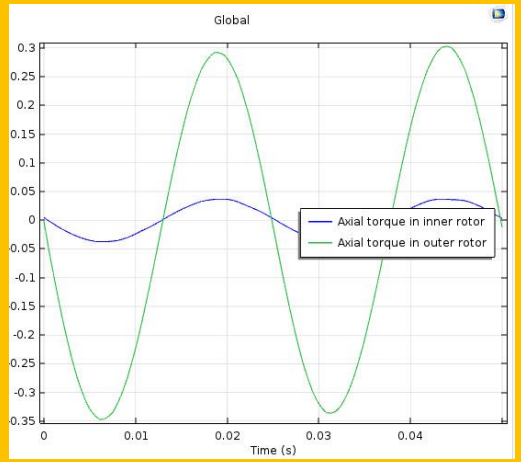
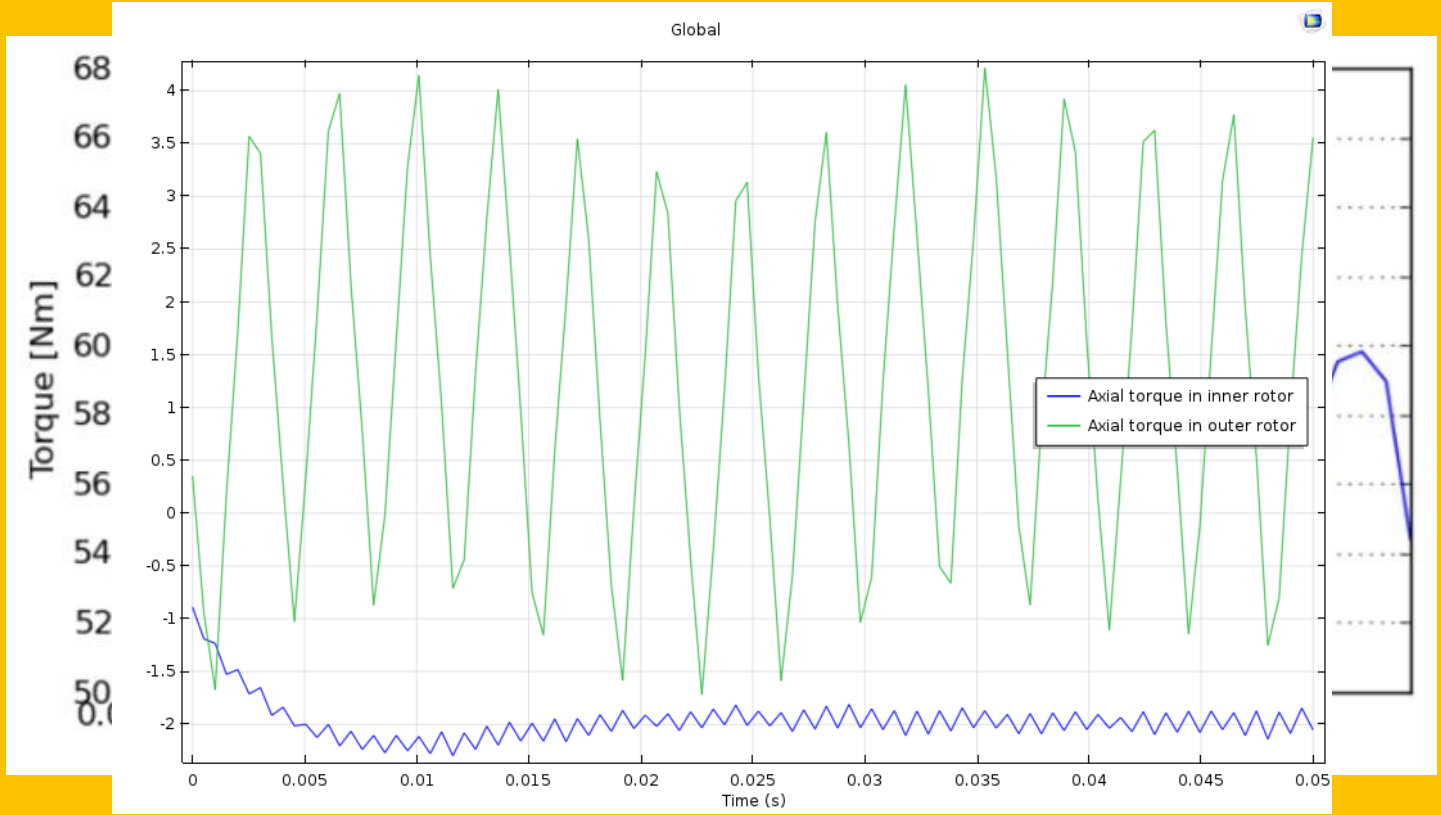






SPMG	CPMG	RG
49.74[Nm]	29.96	0.606

Torque Ripple About Gear Ratio



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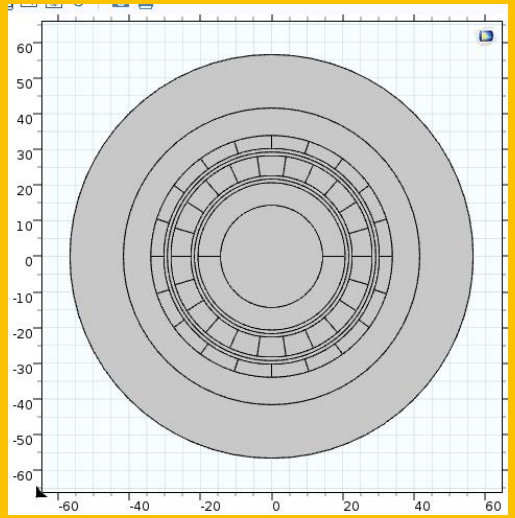
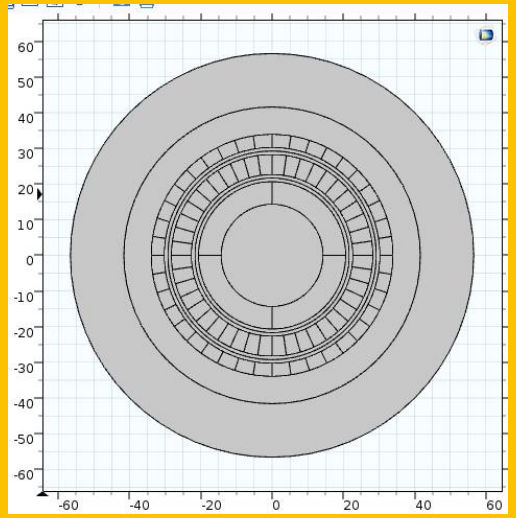
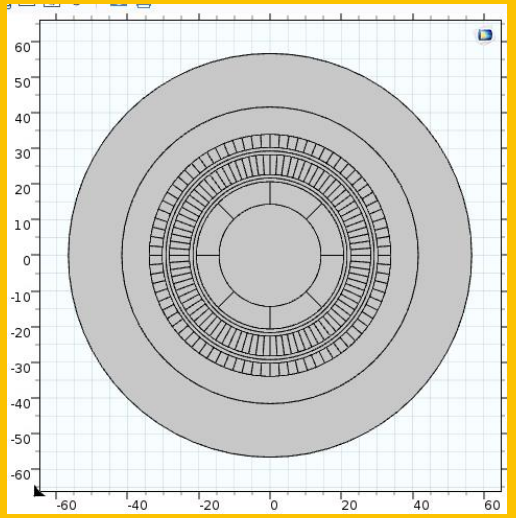
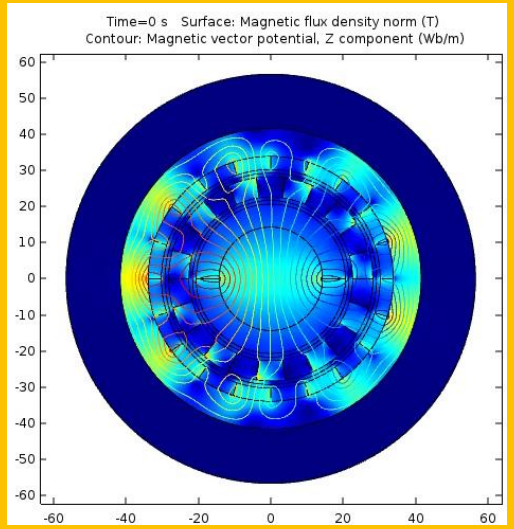




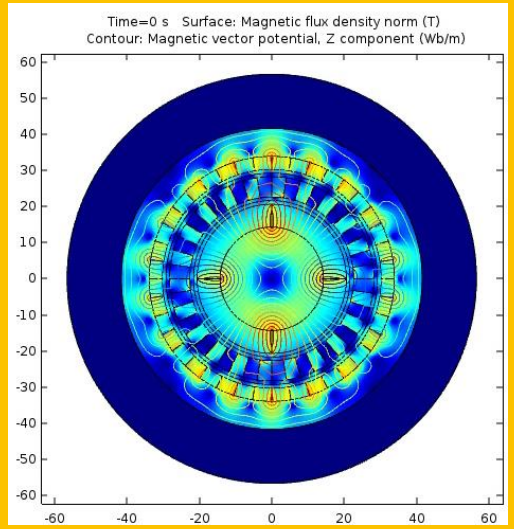


	K1	K2	K3
P_i	1	2	4
P_o	10	20	40

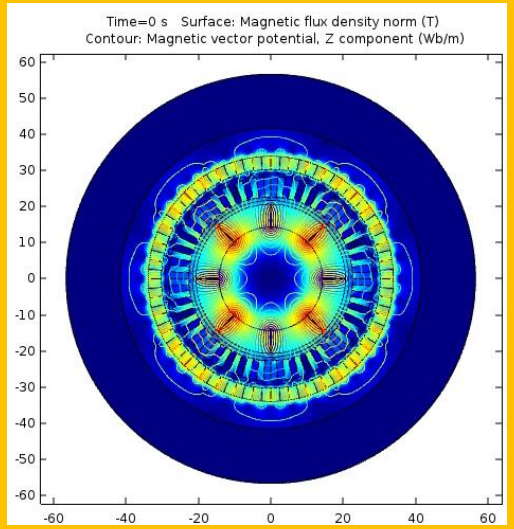
Torque Ripple About Gear Ratio



K1

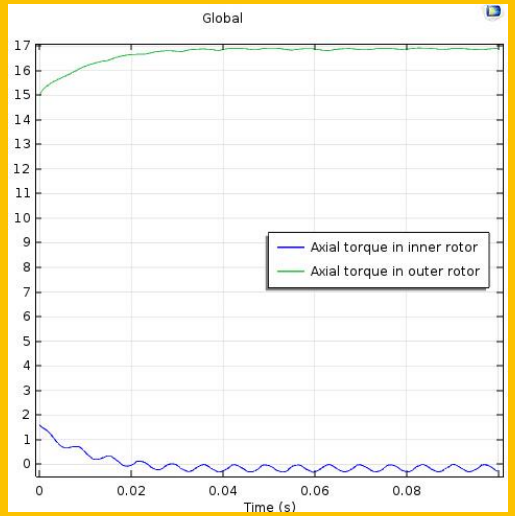


K2

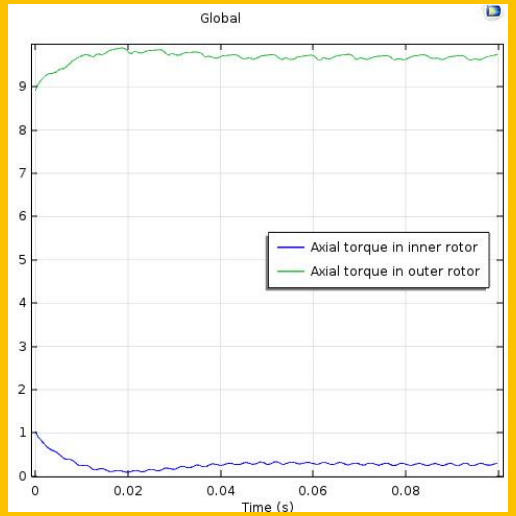


K3

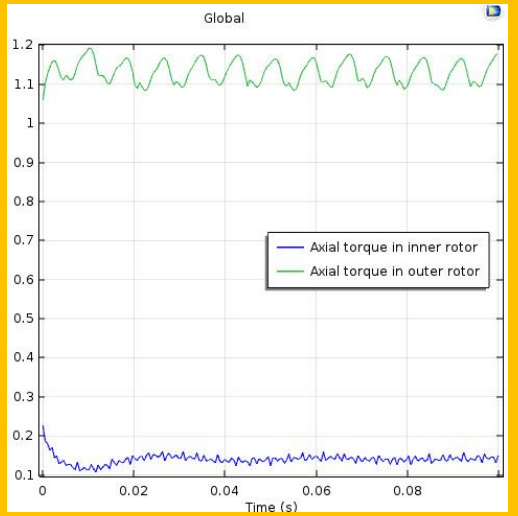
Torque Ripple About Gear Ratio



K1



K2



K3

Torque Ripple About Gear Ratio

```
load('Torque_K.mat');

w_in=500*pi/30;
w_out=200*pi/30;

P_in1 = w_in * Torque_K1(:,3);
P_out1 = w_out * Torque_K1(:,2);

P_in2 = w_in * Torque_K2(:,3);
P_out2 = w_out * Torque_K2(:,2);

P_in3 = w_in * Torque_K3(:,3);
P_out3 = w_out * Torque_K3(:,2);

Pinavg1=mean(P_in1);
Poutavg1=mean(P_out1);

Pinavg2=mean(P_in2);
Poutavg2=mean(P_out2);

Pinavg3=mean(P_in3);
Poutavg3=mean(P_out3);

e1=Poutavg1/Pinavg1;
e2=Pinavg2/Poutavg2;
e3=Pinavg3/Poutavg3;

max(abs(Torque_K1(:,2)-mean(Torque_K1(:,2))))/abs(mean(Torque_K1(:,2)))*100;
max(abs(Torque_K2(:,2)-mean(Torque_K2(:,2))))/abs(mean(Torque_K2(:,2)))*100;
max(abs(Torque_K3(:,2)-mean(Torque_K3(:,2))))/abs(mean(Torque_K3(:,2)))*100;


max(abs(Torque_K1(:,2)-mean(Torque_K1(:,2))))
max(abs(Torque_K2(:,2)-mean(Torque_K2(:,2))))
max(abs(Torque_K3(:,2)-mean(Torque_K3(:,2))))
```

```
K1_r =

    0.2332


K2_r =

    0.4775


K3_r =

    2.2091
```

Torque Ripple About Gear Ratio

$$C_f = \frac{p_s \times 2p_i}{LCM(2p_i, p_s)} \quad (3)$$

where *LCM* is a "least common multiple". The best configuration is the one with the minimum cogging torque which is obtained with $C_f = 1$. In this model example, the poles p_i and p_s are selected so as to obtain the cogging factor of 1.

	K1	K2	K3
P_i	1	2	4
P_o	10	20	40
P_s	11	22	44

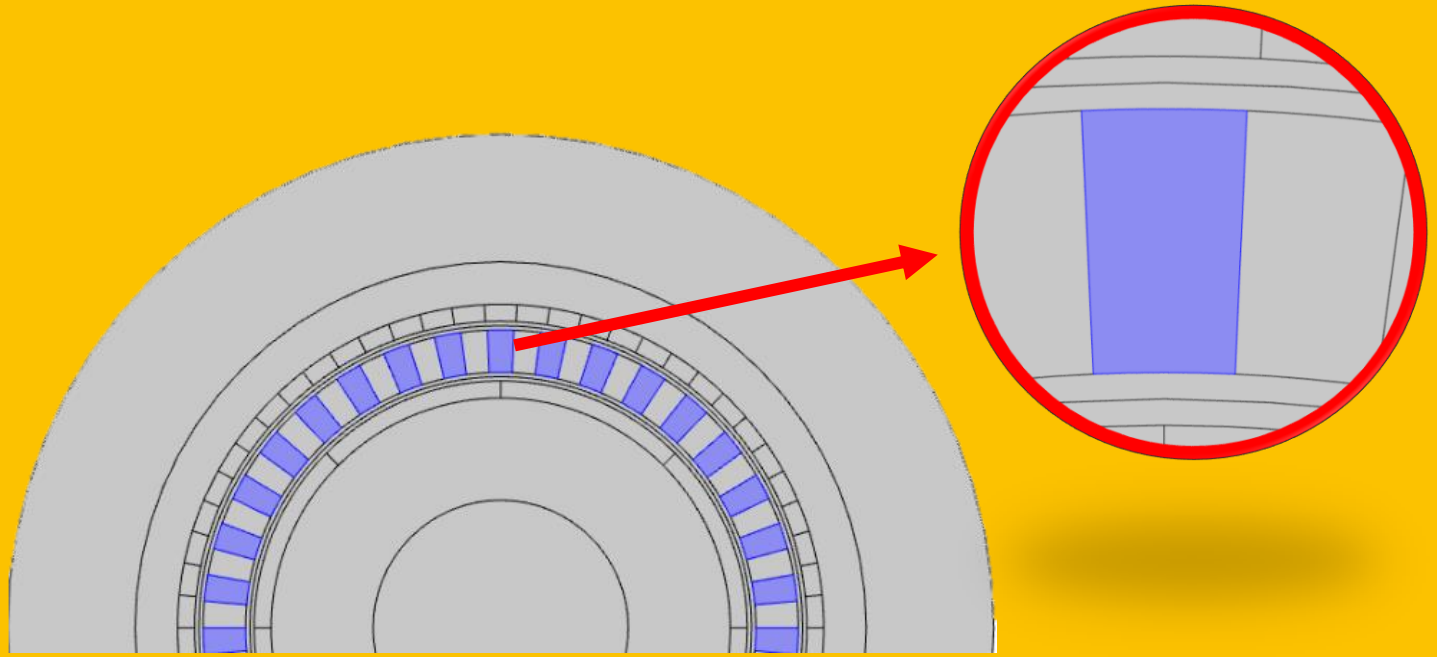
Torque Ripple About Gear Ratio

$$C_f = \frac{p_s \times 2p_i}{LCM(2p_i, p_s)} \quad (3)$$

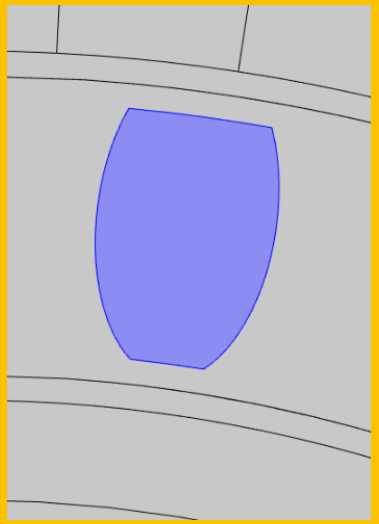
where *LCM* is a "least common multiple". The best configuration is the one with the minimum cogging torque which is obtained with $C_f = 1$. In this model example, the poles p_i and p_s are selected so as to obtain the cogging factor of 1.

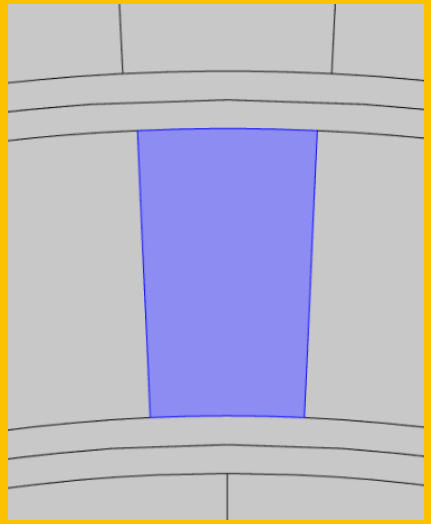
	K1	K2	K3
C_f	1	2	4

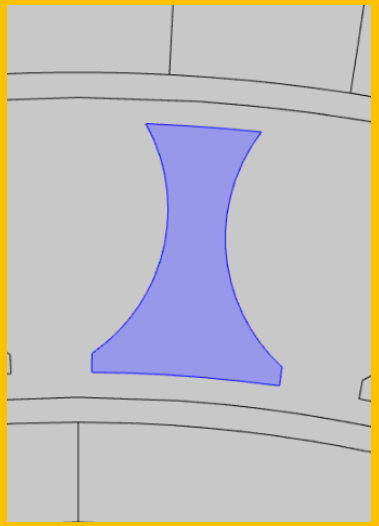
Effect of Steel Pole Shape



Effect of Steel Pole Shape







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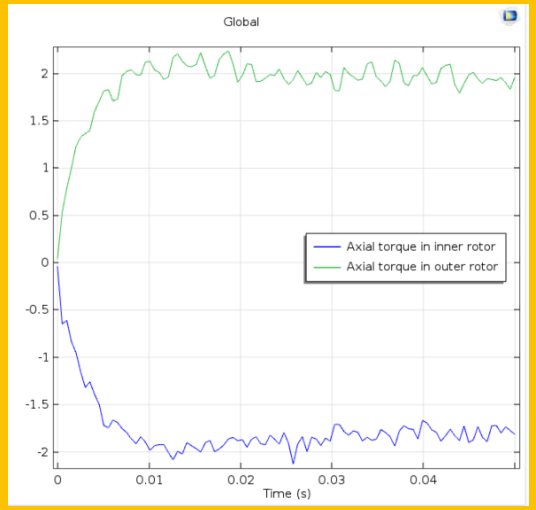
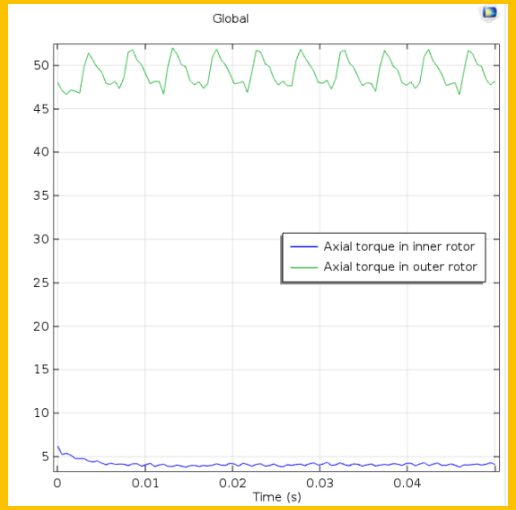
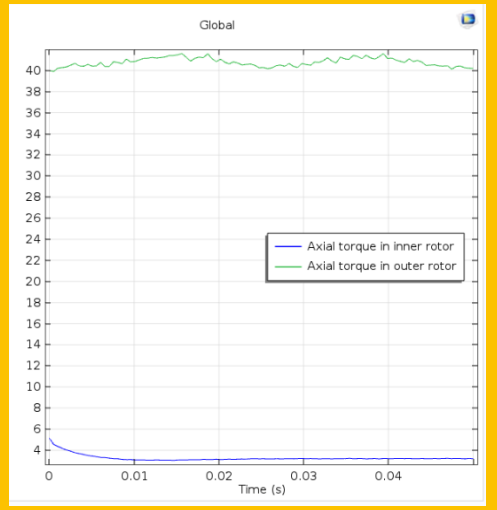




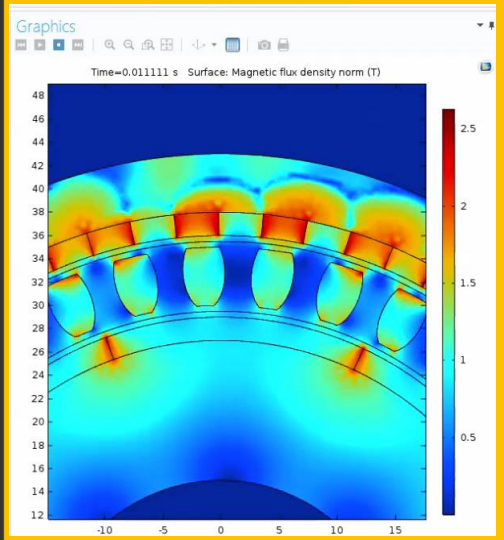


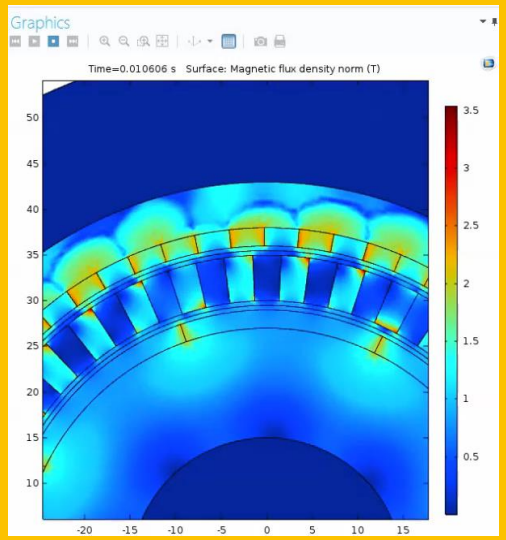
26.71%

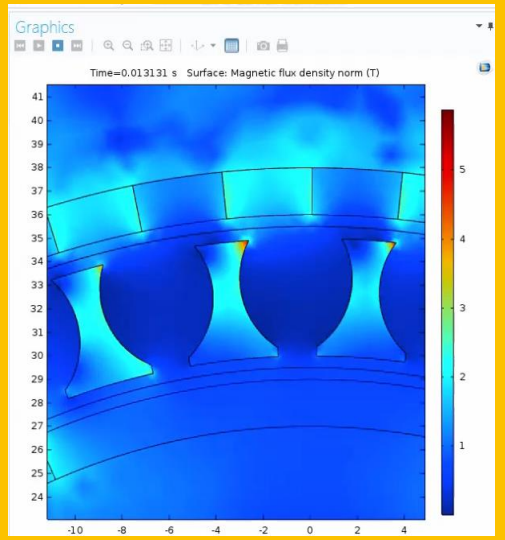
10.94%

4.18%

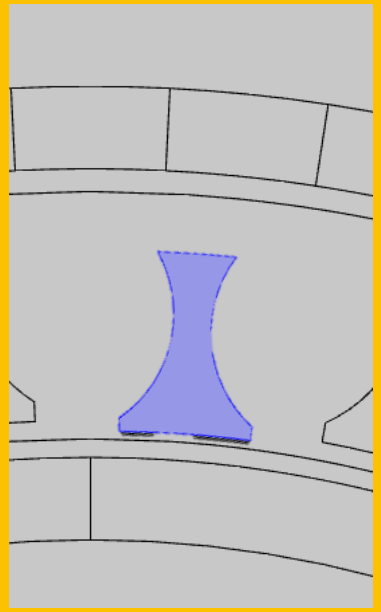
Effect of Steel Pole Shape

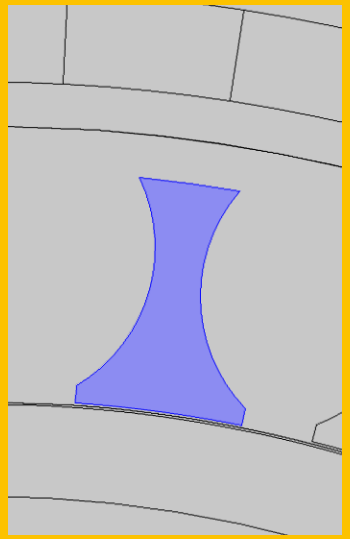




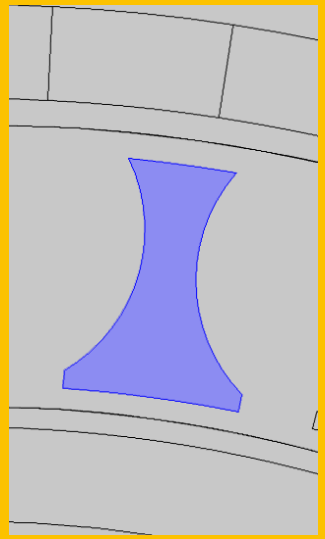


Effect of Steel Pole Shape

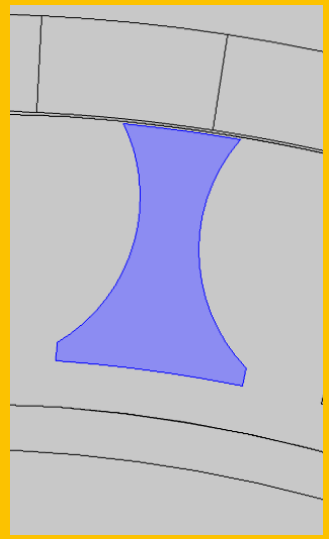




0.1mm



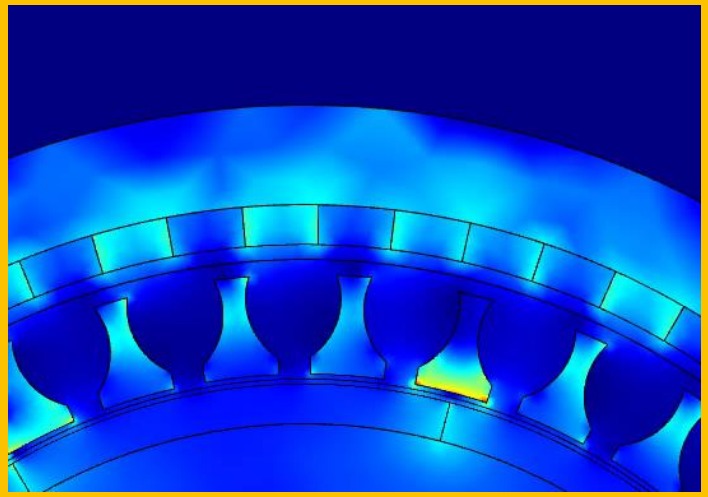
0.7mm



1.9mm

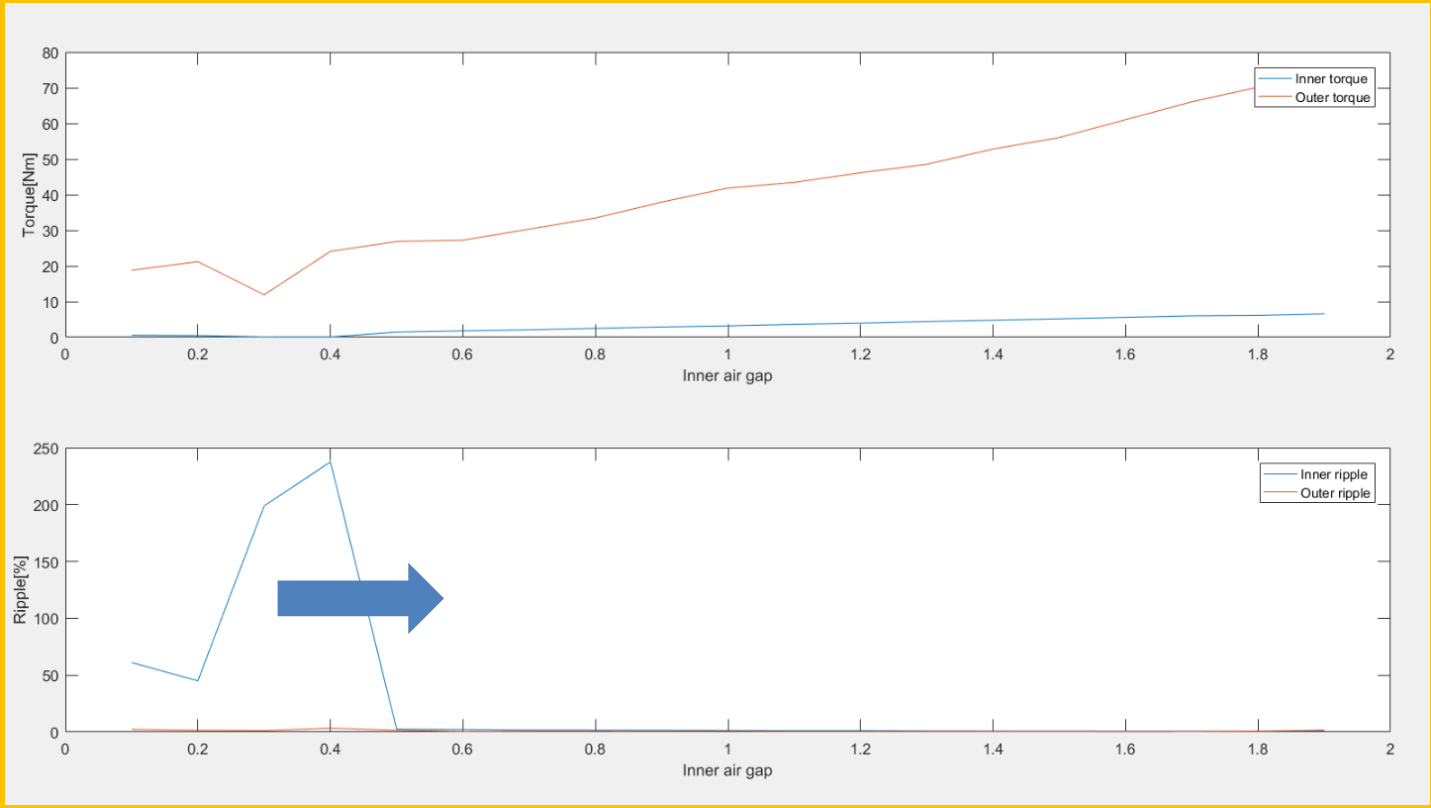
(내측 공극의 폭)

Effect of Steel Pole Shape



```
clear all; clc;
format long;

load('G_para');

gap = 0.1:0.1:1.9;

G_para16 = (G_para15 + G_para17)/2;

%% 정상상태만 뽑음
t = 21;

G_para1 = G_para1(t:100,:);
G_para2 = G_para2(t:100,:);
G_para3 = G_para3(t:100,:);
G_para4 = G_para4(t:100,:);
G_para5 = G_para5(t:100,:);
G_para6 = G_para6(t:100,:);
G_para7 = G_para7(t:100,:);
G_para8 = G_para8(t:100,:);
G_para9 = G_para9(t:100,:);
G_para10 = G_para10(t:100,:);
G_para11 = G_para11(t:100,:);
G_para12 = G_para12(t:100,:);
G_para13 = G_para13(t:100,:);
G_para14 = G_para14(t:100,:);
G_para15 = G_para15(t:100,:);
```

Effect of Steel Pole Shape



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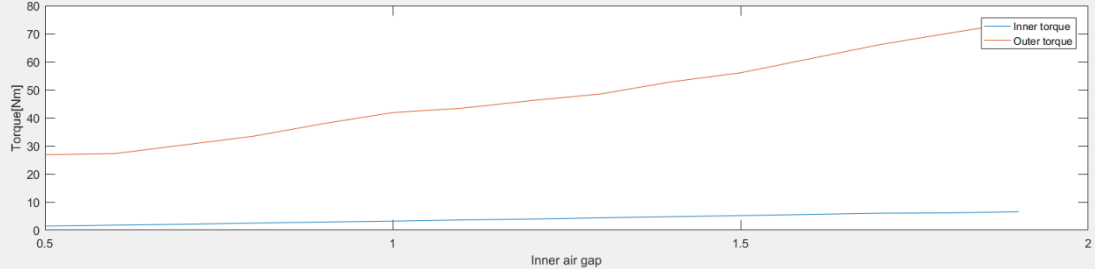

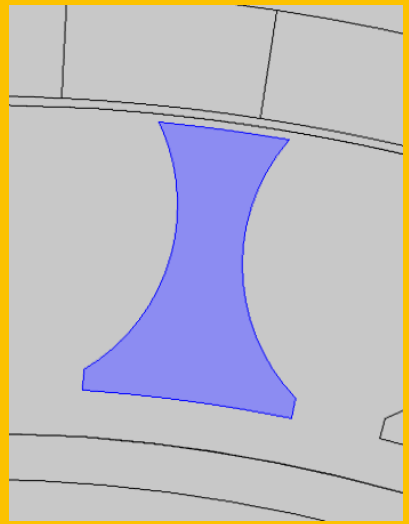

Reference

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- Comparison of Rotor Shape of Magnetic Gears – H.J Choi, KIEE (Jul. 2017)
- Magnetic Gear in 2D (https://www.comsol.com/model/magnetic-gear-in-2d-14583)
- A Study on Transmission Torque Improvement of Non-Contact Permanent Magnet Gear with Concentrated Magnetic Flux Type Structure – C.H Kim, KIEE (Apr. 2014)
- A Study on Optimal Design of Flux Concentrating Pole Piece for Magnetic Gear – C.H Kim, Chosun University (Nov. 2015)