EE568 Project-2

EBRU GENÇ

1. Integral Slot Winding Design

Machine design was made according to the below mentioned features.

- 20 pole
- 120 slots
- Full pitch.

$$q = \frac{Q}{p * m} = \frac{120}{20 * 3} = 2$$

$$\alpha = \frac{2\pi}{\left(\frac{Q}{p}\right)} = \frac{360}{\frac{120}{10}} = 30°$$

Table 1: Winding diagram for full pitched

A1	A2	-C1	-C2	B1	B2	-A3	-A4	C3	C4	-B3	-B4
A39	A40	-C39	-C40	B39	B40	-A1	-A2	C1	C2	-B1	-B2

$$k_{p(n)} = \sin\left(\frac{n\lambda}{2}\right)$$

$$k_{d(n)} = \sin\left(qn\left(\frac{\alpha}{2}\right)\right) / (q \sin\left(n\frac{\alpha}{2}\right))$$

$$k_w = k_p * k_d$$

- For $n = 1$

$$k_p = \sin\left(\frac{180}{2}\right) = 1$$

$$k_d = \sin\left(2\left(\frac{30}{2}\right)\right) / (2 \sin\left(\frac{30}{2}\right)) = 0.966$$

$$k_w = k_p * k_d = 0.966$$

- For $n = 3$

  $k_{p(3)} = \sin\left(\frac{3 * 180}{2}\right) = -1$

  $k_{d(3)} = \sin\left(2 * 3\left(\frac{30}{2}\right)\right)/(2 * \sin\left(3 * \frac{30}{2}\right)) = 0.707$

  $k_w = k_p * k_d = -0.707$

- For $n = 5$

  $k_{p(5)} = \sin\left(\frac{5 * 180}{2}\right) = 1$

  $k_{d(3)} = \sin\left(2 * 5\left(\frac{30}{2}\right)\right)/(2 * \sin\left(5 * \frac{30}{2}\right)) = 0.258$

  $k_w = k_p * k_d = 0.258$

2.Fractional Slot Winding Design

- For 24 slots 22 pole machine

$$\alpha = \frac{2\pi}{\left(\frac{Q}{p}\right)} = \frac{360}{\frac{24}{11}} = 165°$$

$$k_{p(n)} = \sin\left(\frac{n\lambda}{2}\right) = \sin(165/2) = 0.99$$

Slot number	1	2	3	4	5	6	7	8	9	10	11	12
Electrical angle (°)	0	165	330	135	300	105	270	75	240	45	210	15

Slot number	13	14	15	16	17	18	19	20	21	22	23	24
Electrical angle (°)	180	345	150	315	120	285	90	255	60	225	30	195

- For 24 slots 20 pole machine

$$\alpha = \frac{2\pi}{\left(\frac{Q}{p}\right)} = \frac{360}{\frac{24}{10}} = 150°$$

$$k_{p(n)} = \sin\left(\frac{n\lambda}{2}\right) = \sin(150/2) = 0.96$$

Slot number	1	2	3	4	5	6	7	8	9	10	11	12
Electrical angle (°)	0	150	300	90	240	30	180	330	120	270	60	210

Slot number	13	14	15	16	17	18	19	20	21	22	23	24
Electrical angle (°)	0	150	300	90	240	30	180	330	120	270	60	210

2. 2D FEA Modeling

Machine design was made according to the below mentioned features.

- 22 pole
- 24 slots

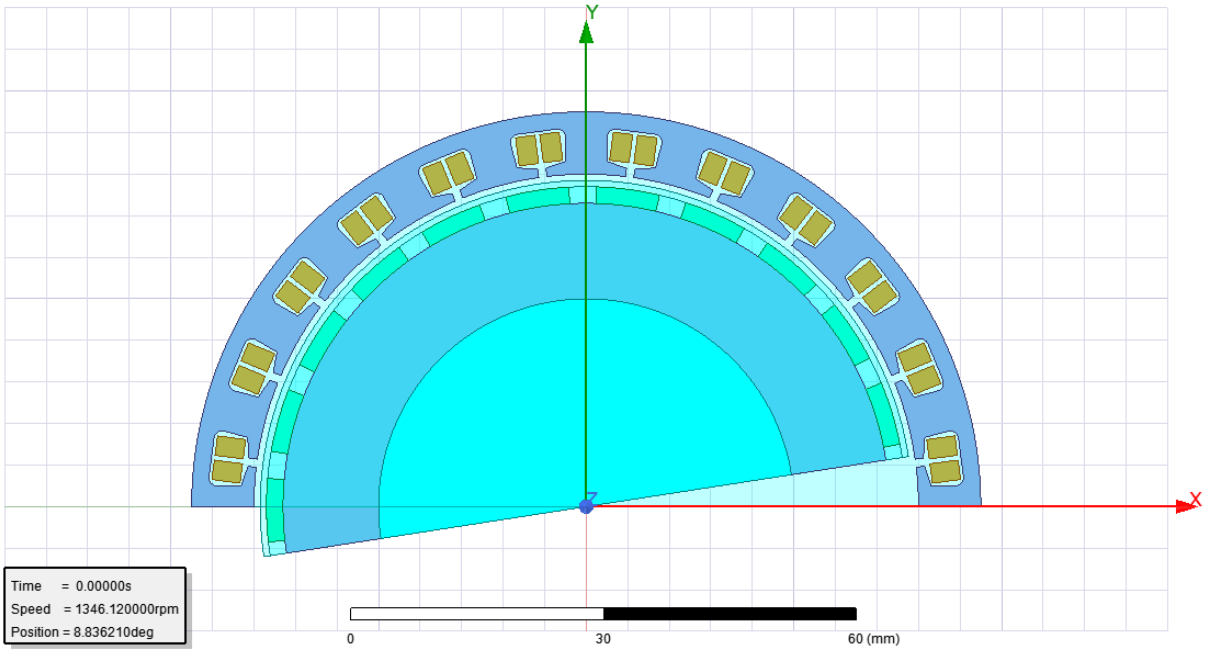

Figure 1: 2D FEA Modeling

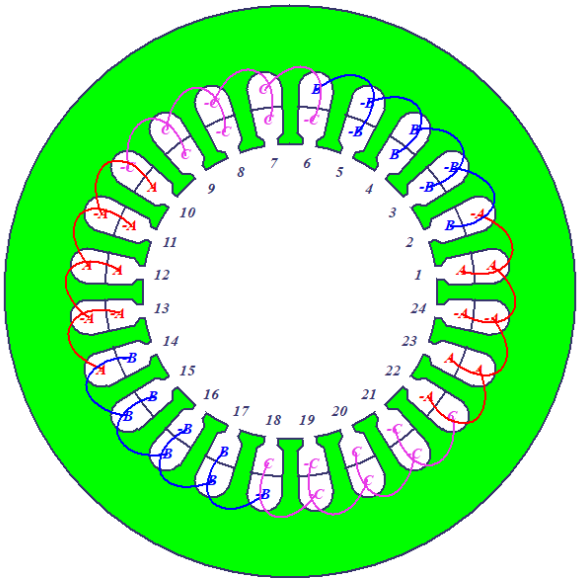

Figure 2: Winding Diagram

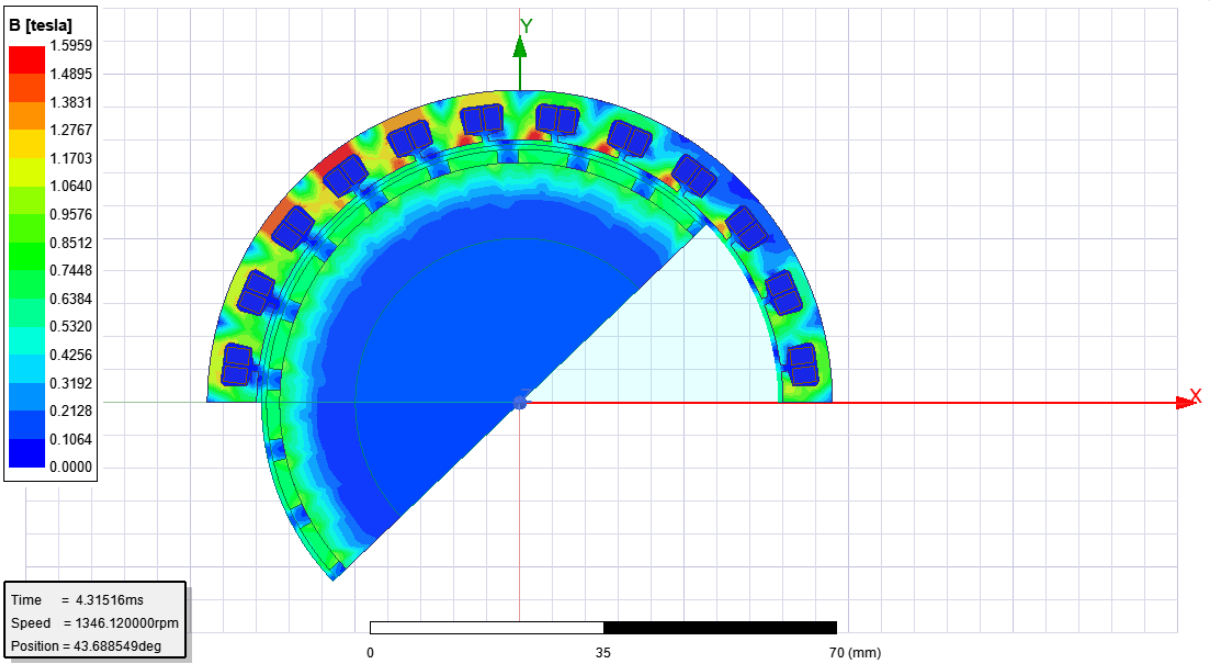

Figure 3. Flux Density Distribution

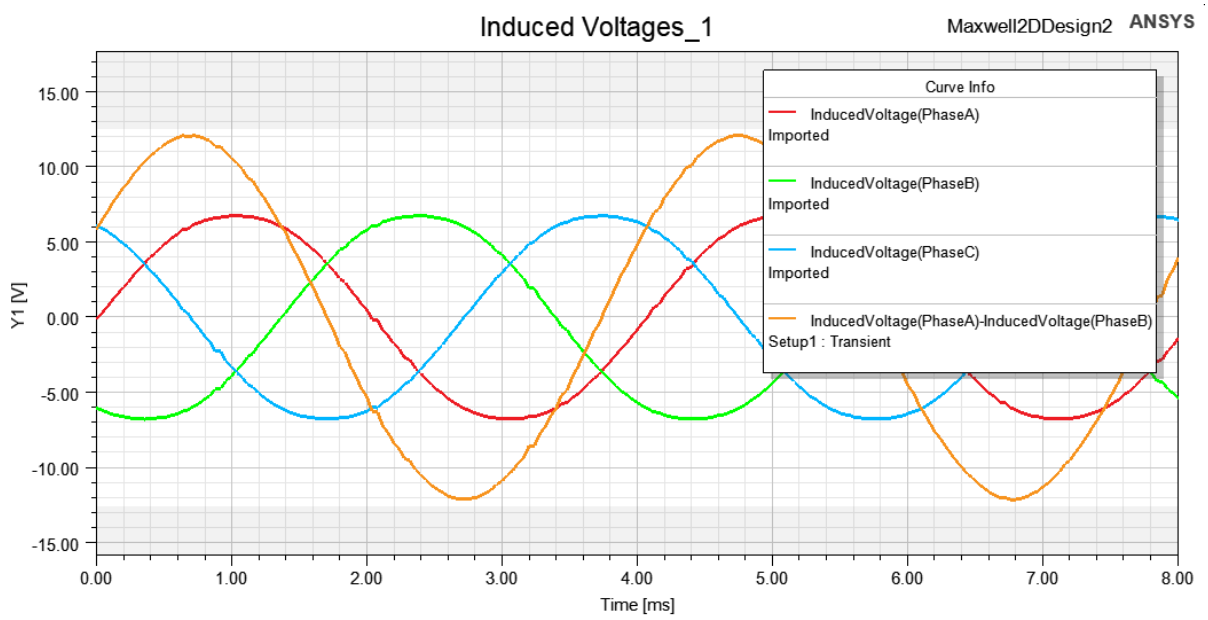

Figure 4. Induced voltage waveforms (for phase and line-to-line)

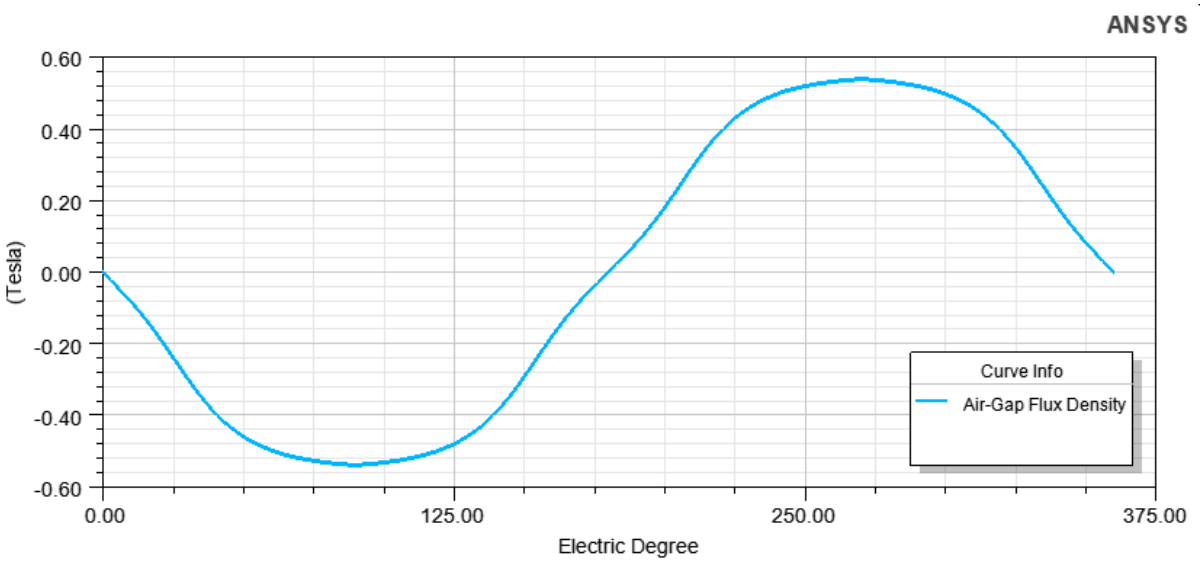

Figure 5. Air-gap Flux Density

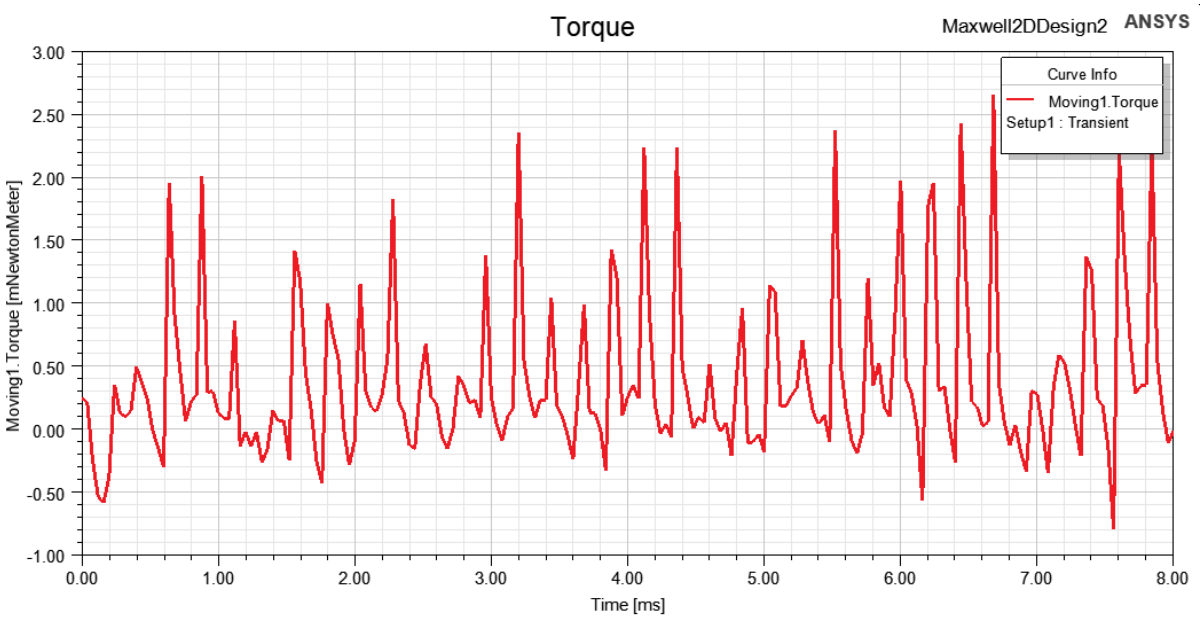

Figure 6.Cogging Torque