EE568 Project-1

EBRU GENÇ

1) Between 2 yellow line angle is 77 degree. At figure 1 position is assumed as initial.

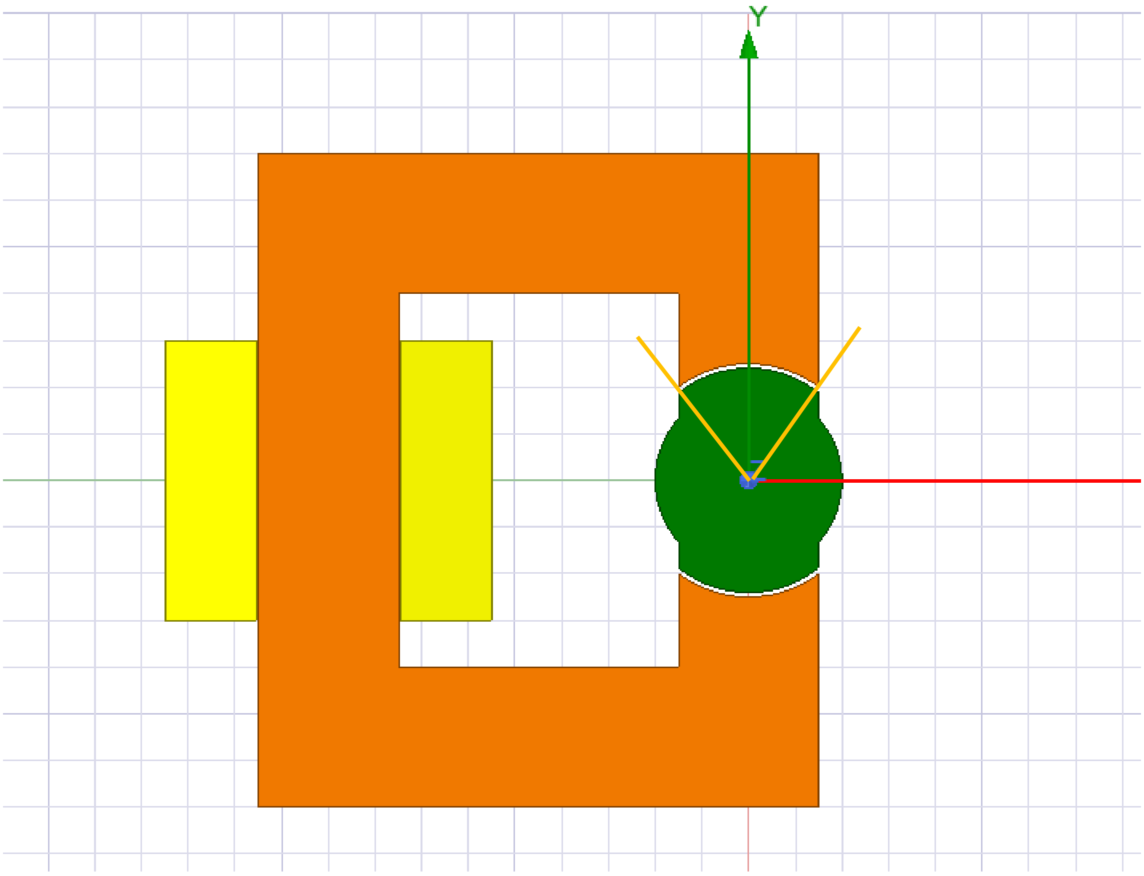

Figure 1. 2D Model

- Coils are wound within 30mmx10mm rectangle areas
- Each airgap clearance is 0.5mm
- Depth of the core is 20mm
- Number of turns = 250
- Coil Current = 3 A DC

$$\varphi * R = N * I$$

$$\lambda = N * \varphi$$

$$\varphi = \frac{N * I}{R}$$

$$\lambda = \frac{N^2 * I}{R}$$

$$L = \frac{d\lambda}{dI}$$

For linear system we can assumed $L = \frac{\lambda}{I}$

$$L = \frac{N^2}{R_\theta}$$

$$E = \frac{I^2 * L}{2}$$

$$E = \frac{I^2 * N^2}{2 * R_\theta}$$

$$T = \frac{dE_\theta}{d\theta}$$

$$T = \frac{\left(\frac{1}{2}\right) * I^2 * \ N^2 * d\left(\frac{1}{R_\theta}\right)}{d\theta}$$

$$R = \frac{L}{\mu_0 * \mu_r * A}$$

$$A = \pi * D * L * \left(\frac{77}{360}\right)$$

$$A = \pi * 12.5 * 20 * \frac{77}{360} * 10^{-6} = 168 * 10^{-6}\ m^2$$

$$A_\theta = 168 * 10^{-6}\left(\frac{77 - \theta}{77}\right)$$

$$R_\theta = \frac{L}{\mu_0 * \mu_r * A_\theta} = \frac{0.5 * 10^{-3}}{(4 * \pi * 10^{-7}) * (1) * A_\theta}$$

Reluctance funtion for rotation anle θ;

$$R_\theta = 2.37 * 10^6 * \left(\frac{77}{77 - \theta}\right)$$

Inductance funtion for rotation anle θ;

$$L_\theta = \frac{N^2}{R_\theta} = \frac{250^2}{2.37 * 10^6 * \left(\frac{77}{77 - \theta}\right)} = 0.026 * \left(\frac{77 - \theta}{77}\right)$$

At initial position ($\theta = 0$) Inductance will be 26 mH according to calculated formula. FEA 2D modeling results and analytical calculated results are nearly same.

$$E = \frac{I^2 * L}{2}$$

$$T = \frac{dE_\theta}{d\theta}$$

$$T = \frac{d\left(0.026\left(1 - \frac{\theta}{77}\right) * \frac{3^2}{2}\right)}{d\theta} = \frac{0.117}{77 * \frac{\pi}{180}} = 0.087\ Nm$$

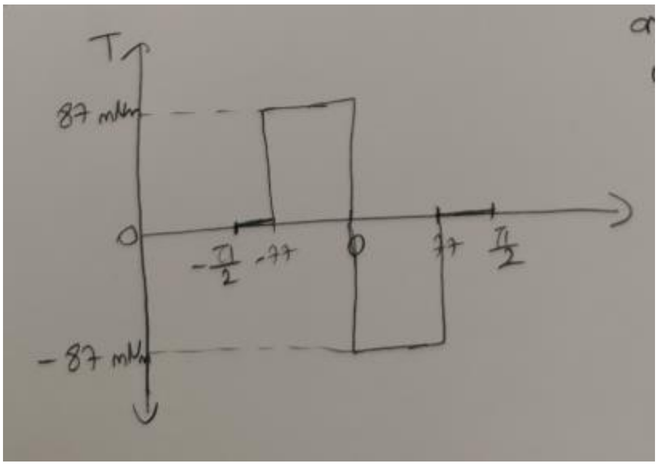

Figure 2. Generated Torque

2) FEA Modeling (2D-Linear Materials)

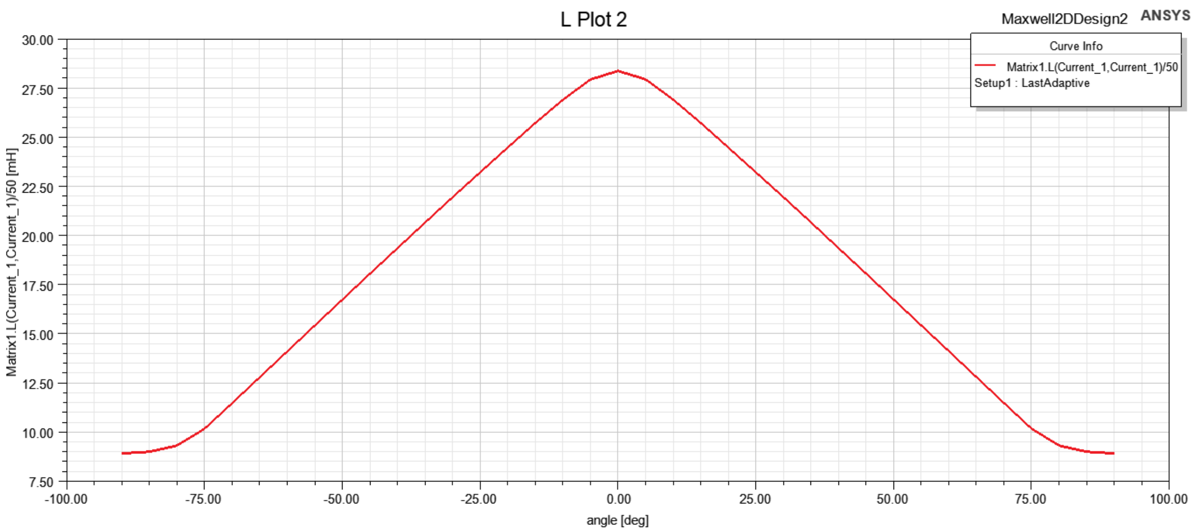

Figure 1. Inductance for linear Materials System

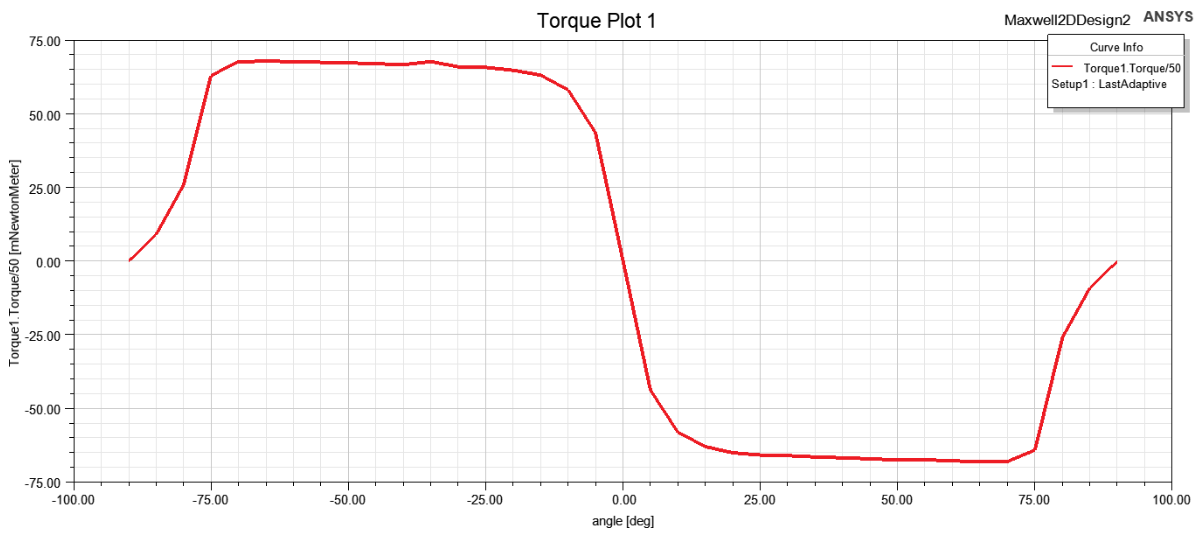

Figure 2. Torque for linear Materials System

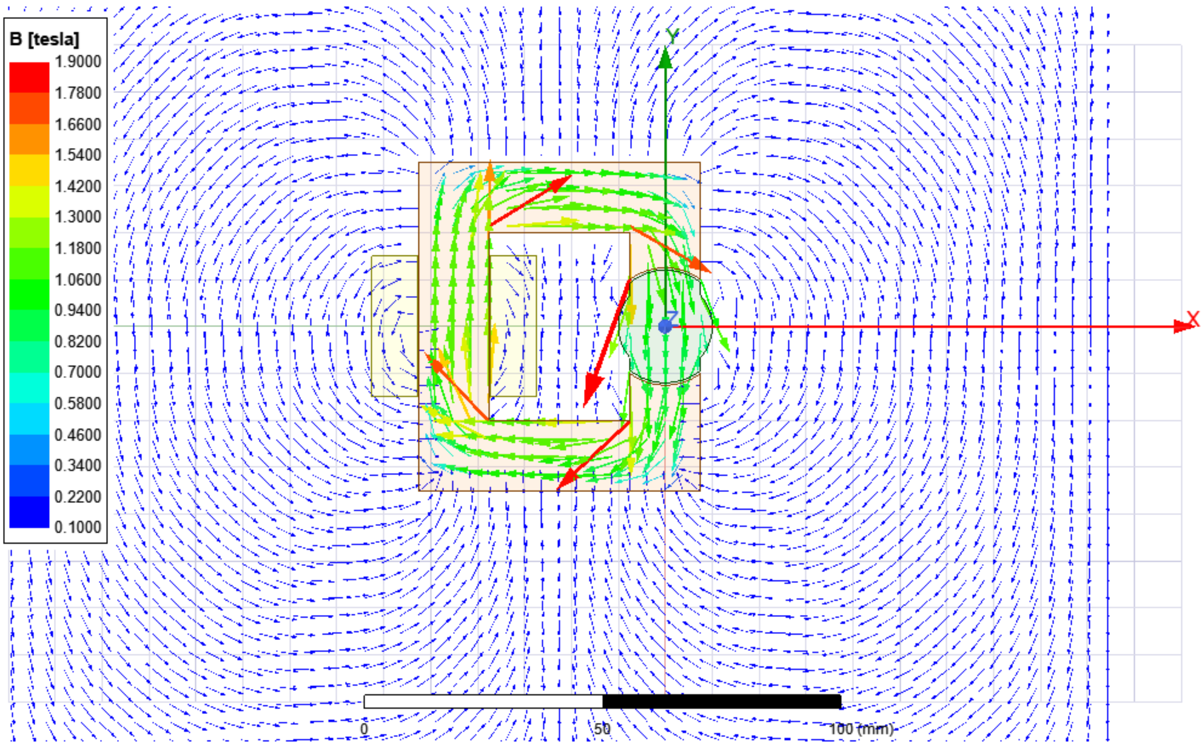

Figure 3. Flux Density Vectors at 0 position for linear Materials System

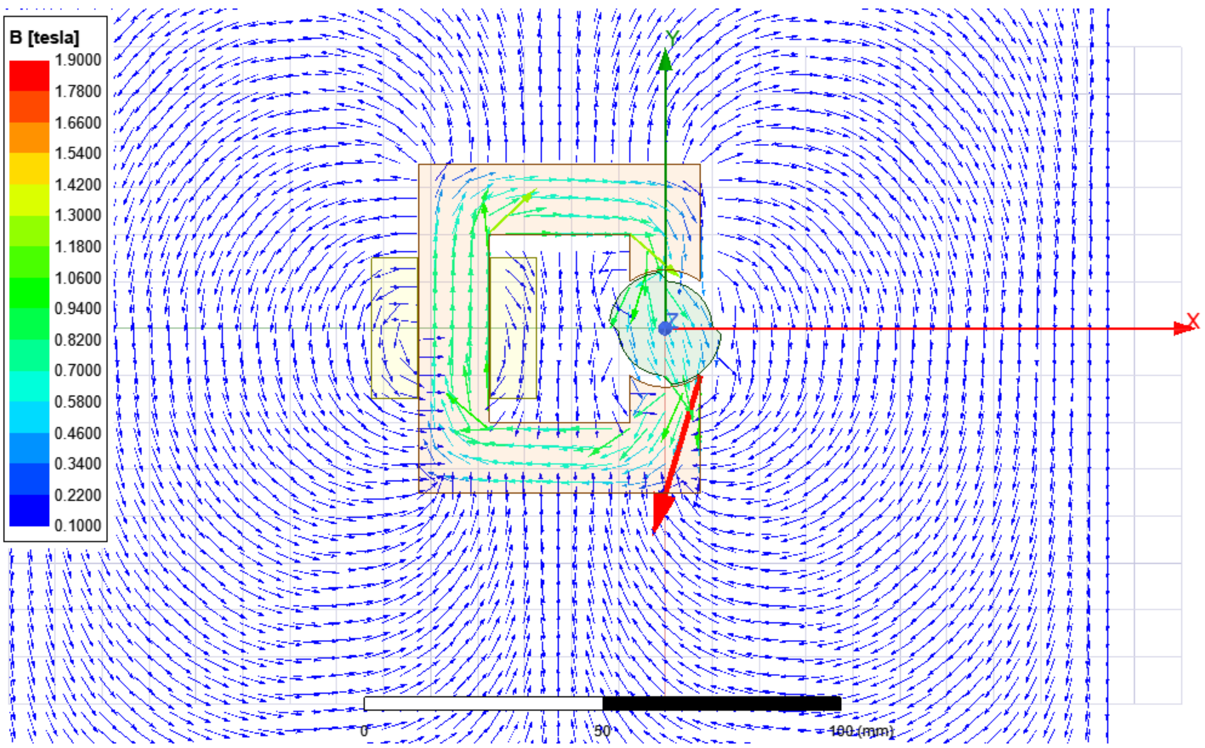

Figure 4. Flux Density Vectors at 45 position for linear Materials System

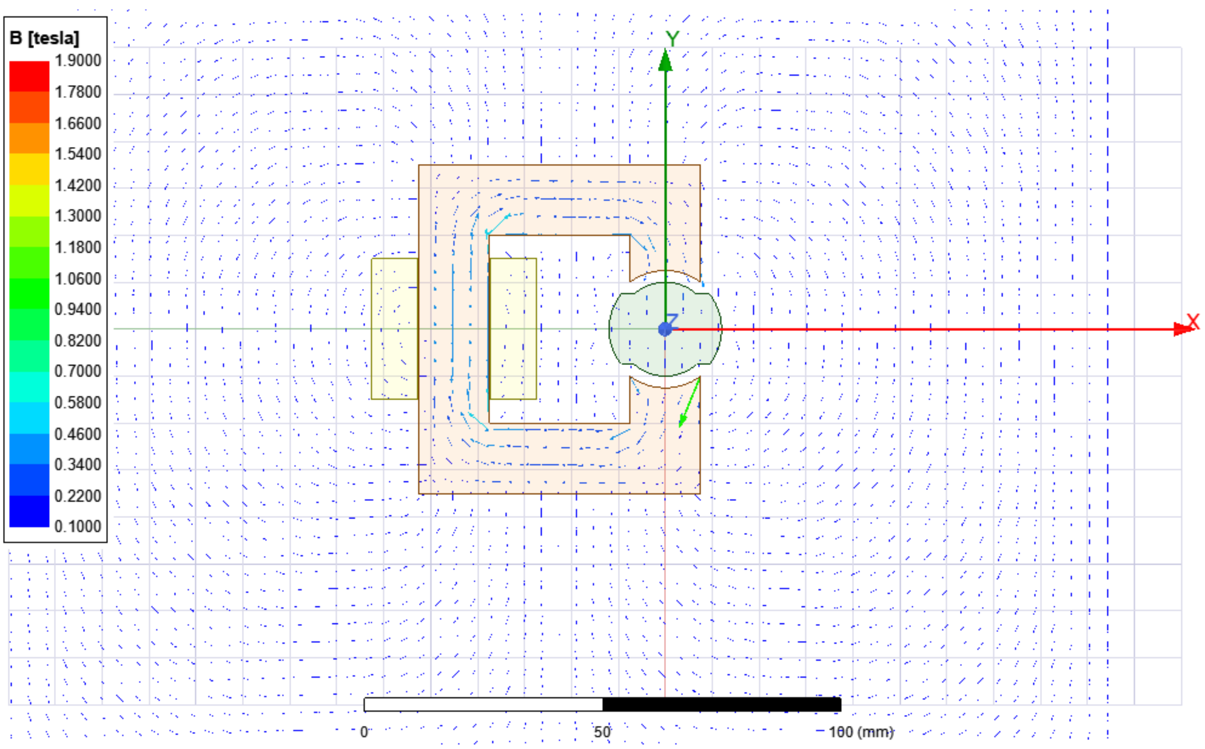

***Figure 5*. Flux Density Vectors at 90 position for linear Materials System**

3) FEA Modeling (2D-Nonlinear Materials)

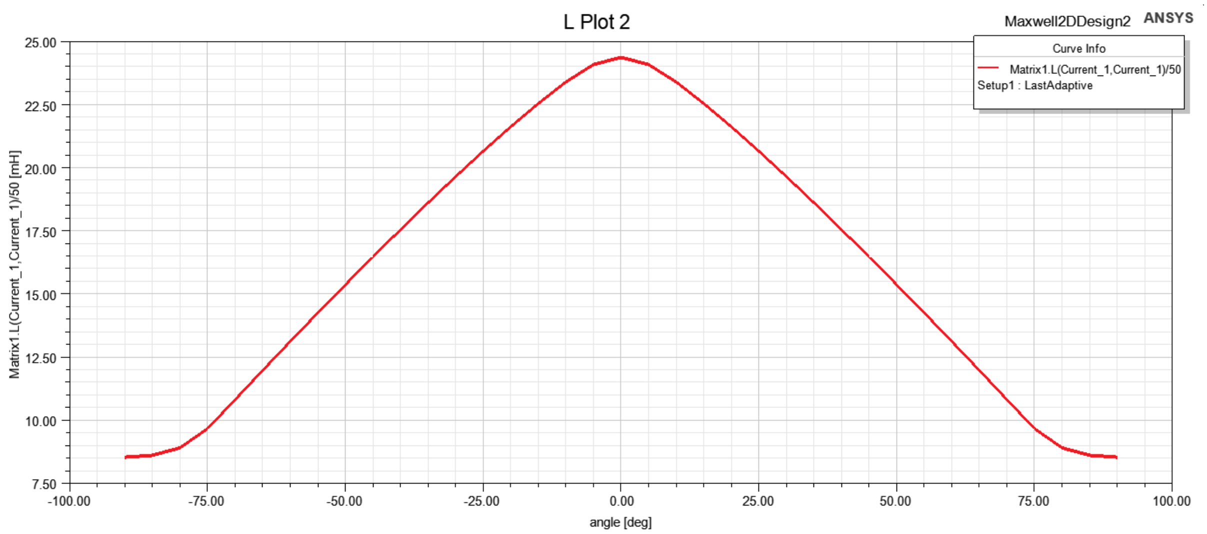

Figure 6. Inductance for Nonlinear Materials System

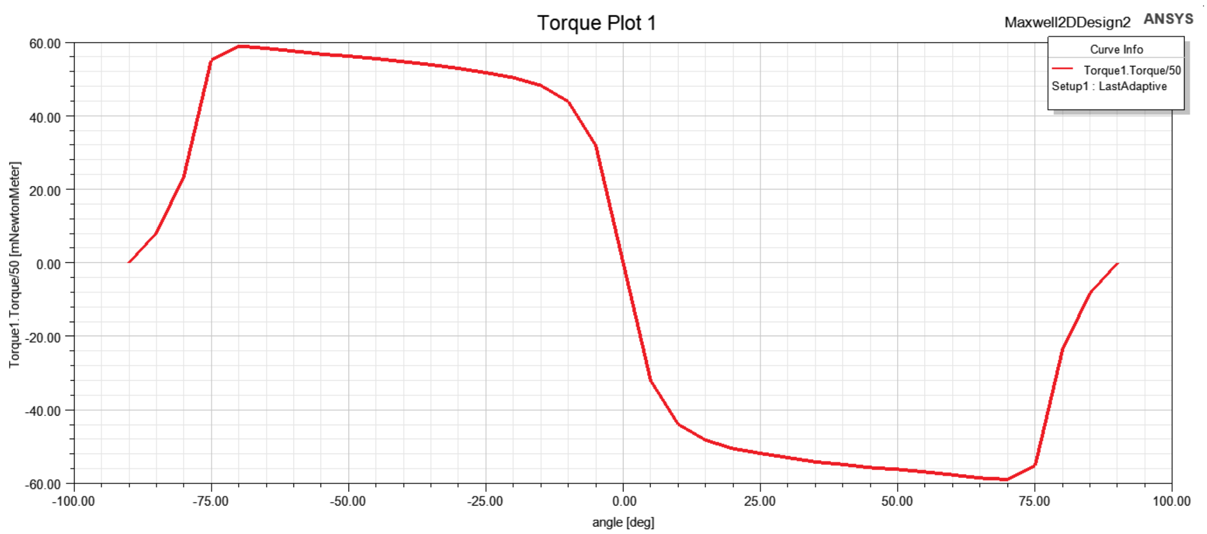

Figure 7. Torque for Nonlinear Materials System

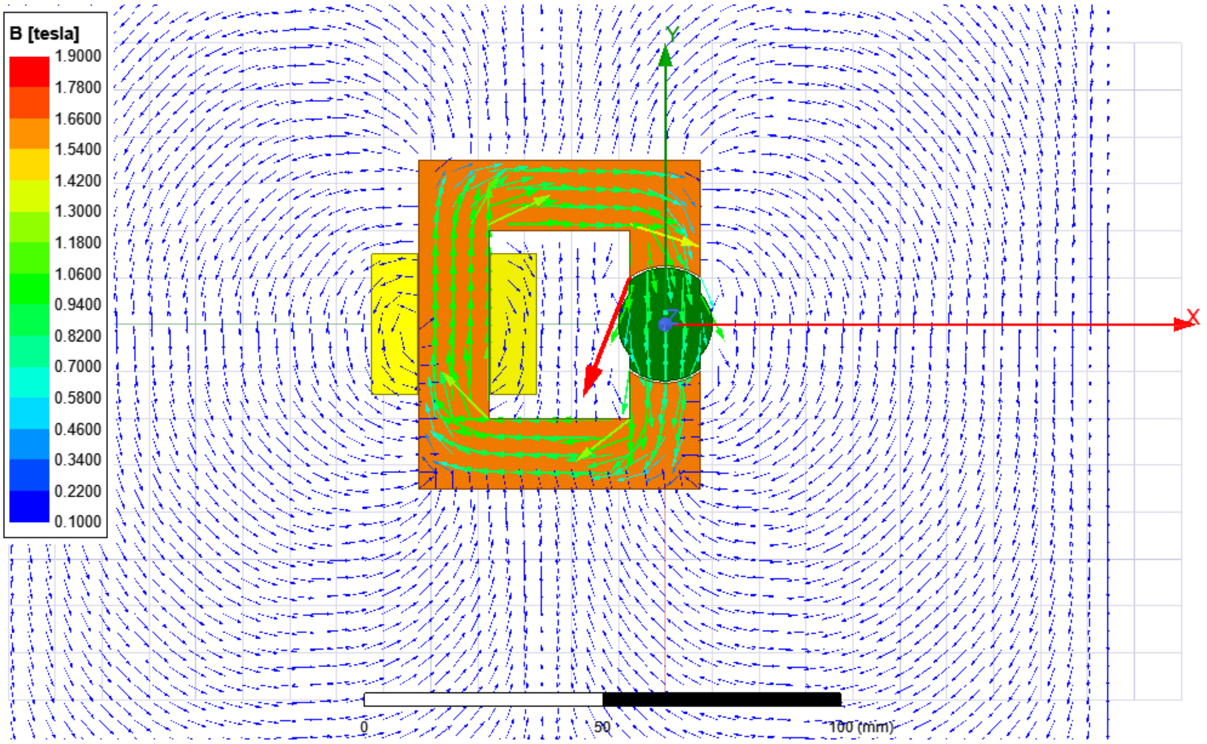

Figure 8. Flux Density Vectors at 0 position for Nonlinear Materials System

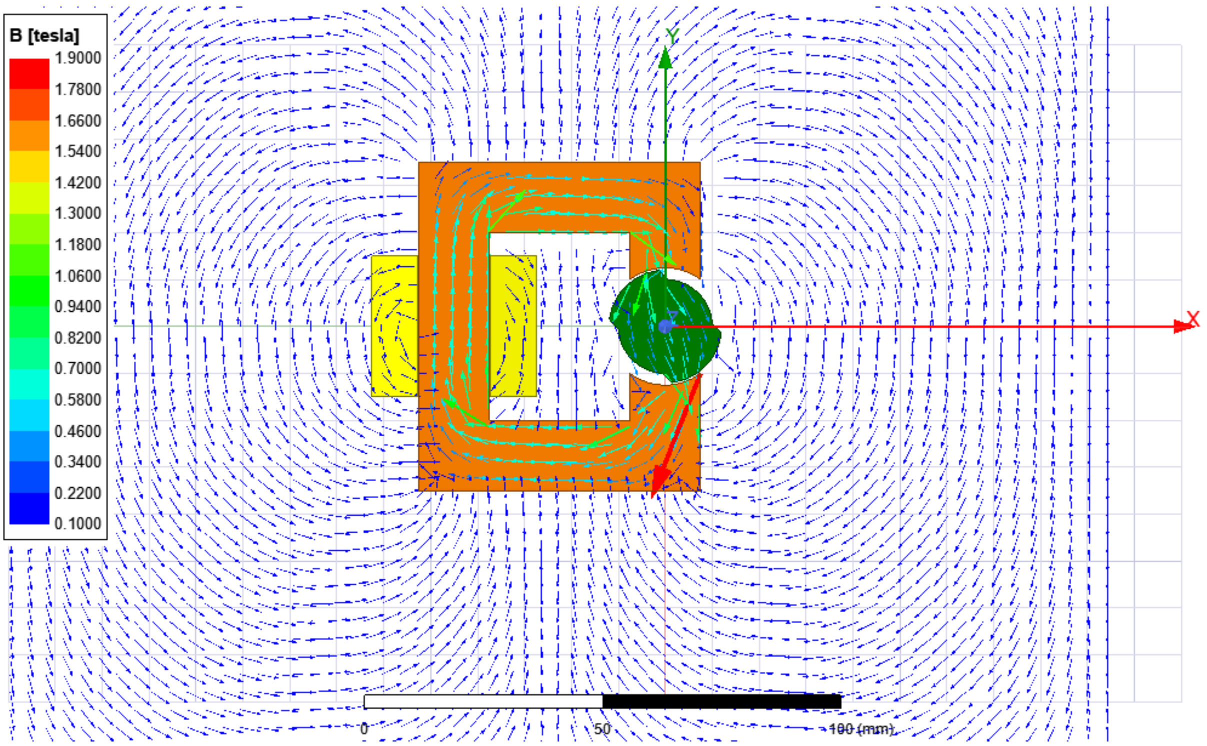

Figure 9. Flux Density Vectors at 45 position for Nonlinear Materials System

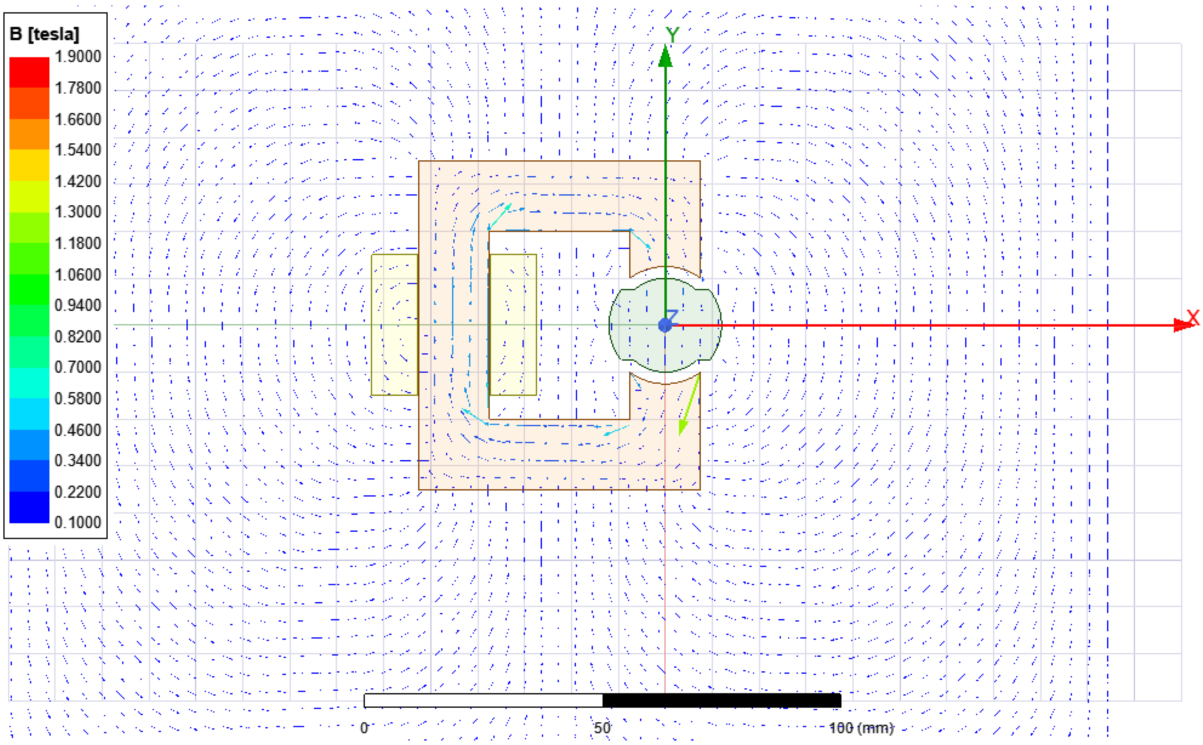

Figure 10. Flux Density Vectors at 90 position for Nonlinear Materials System