Assignment 2

Calculation

By using this calculator: `http://deepfriedneon.com/tesla_f_calcspiral.html`; we obtained acceptable inductances for our coils at the coil parameters as given in Table 1. Target parameters were an inner diameter of 50 mm for both coils and inductances of 22 µH for the secondary coil and 100 µH for the primary coil. The diameter of the given Litz-wire is 1.8 mm and we estimated an average wire spacing of 0.5 mm between each winding.

Table 1: Calculated coil parameters

Coil	Windings	Inductance	Outer diameter	Total wire length
Primary	30	101.6 µH	188 mm	11.2 m
Secondary	15	22 µH	119 mm	4 m

Measurements

After winding these coils we obtained the following inductances for the individual coils using an LCR-meter:

Table 2: Measured coil parameters

Coil	Inductance	DC-resistance
Primary	94.5 µH	250 mΩ
Secondary	25.2 µH	65 mΩ

Then, we calculated the coils' mutual inductance and coupling factor via the ostrich approach as given in the Student Manual. [1] This meant measuring the inductance of both of the coils while connected in *series-aiding* and *series-opposing* at a varying distance between the coils. The results are shown in Table 3.

Table 3: Mutual inductance and coupling factor at varying distance

Distance	Aiding inductance	Opposing inductance	Mutual inductance	Coupling factor
0 cm	184.3 μH	58.6 μH	314.2 μH	0.6443
2 cm	151.5 μH	86.8 μH	161.8 μH	0.3318
4 cm	135.6 μH	100.0 μH	88.9 μH	0.1823
6 cm	127.5 μH	107.0 μH	51.2 μH	0.1051

Lastly, we performed some measurements on the entire converter, including coils, to see how much power could be delivered to a 10.08 Ω load, with a distance of 2 cm between the coils:

Table 4: Power transfer measurements

Source voltage	Source current	Source power	Load voltage	Load power	Efficiency
19.998 V	0.0835 A	1.67 W	2.02 V	0.405 W	24.2 %

Questions

1. The open and short circuit test is not well suited for the air core transformer, because that method depends on the coupling factor being very high and thus leakage flux being really low. For a ferrite-core transformer this assumption may hold, but for an air core transformer it does not, since the coupling factor decreases very fast, as the distance between the coils increases (see table 3).

2. ?

3. As the distance between the two coils increases, less flux lines go through the secondary coil. Because of this, the magnetising inductance decreases while the leaking inductance increases.

4. As shown in Table 4, the power transfer of the transformer is very low. This is due to the low coupling factor, especially at higher distances between the two coils.