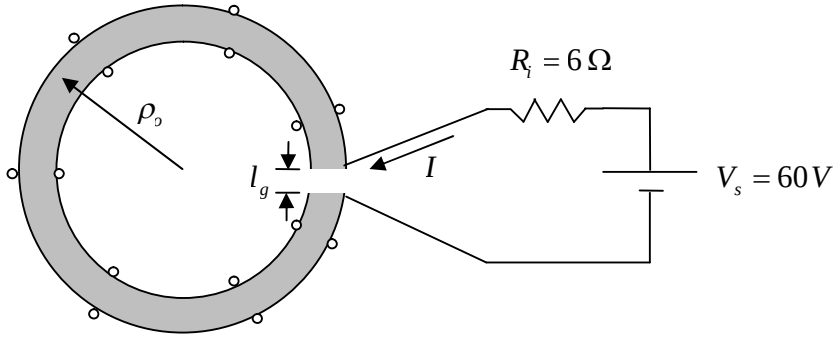
EE 340 (01) Design Project
Summer Session (073)

The diagram below shows a toroidal core with a square cross-sectional area. The toroidal core has a mean radius $\rho_o = 10\,cm$ and a *small* air gap of length $l_g = 3mm$. *The air gap is necessary in order to access the generated magnetic field*. The square cross-sectional area of the toroid has a dimension of $a \times a$. The core is made of a material with a relative permeability $\mu_r = 150$. A thin conducting wire is wrapped uniformly around the toroidal core using a total of N turns. The resistance per unit length of this wire is $\bar{R} = 0.05\Omega/m$.

The magnetic field is generated by directly connecting the coil to a *practical* D.C. voltage source $V_s = 60V$ with an internal resistance $R_i = 6\Omega$.



N turns

Design a circuit (by calculating the value of the unknown parameters a and N) that satisfies the following requirements:

1- The magnetic field density in the air gap $B_g = 2.3\,T$.
2- The toroidal coil's inductance $L = 45\,mH$.

[You can assume that $\rho_o >> a$ and $2\pi\rho_o >> l_g$ to simplify analysis and consider the fact that $\mu_r >> 1$].

Other Requirements:

1- Show all work in detail including derivation of the necessary relations.
2- Summarize your results in the table provided below.
3- Work Alone. You can only discuss the design project with the course instructor, as much as you like. **An automatic zero will be given if this rule is violated**.
4- Deadline for project submission is **Saturday August 23, 2008**.

Design Results

N	a (cm)	B_g (T)	L (H)	I (A)