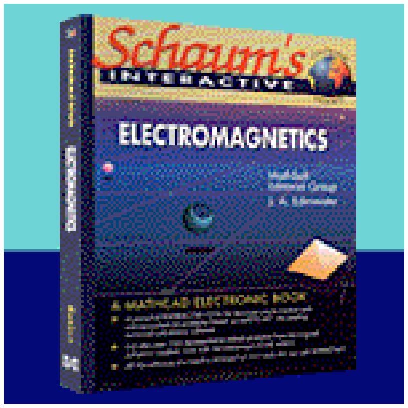
# Schaums Interactive Outline Series:

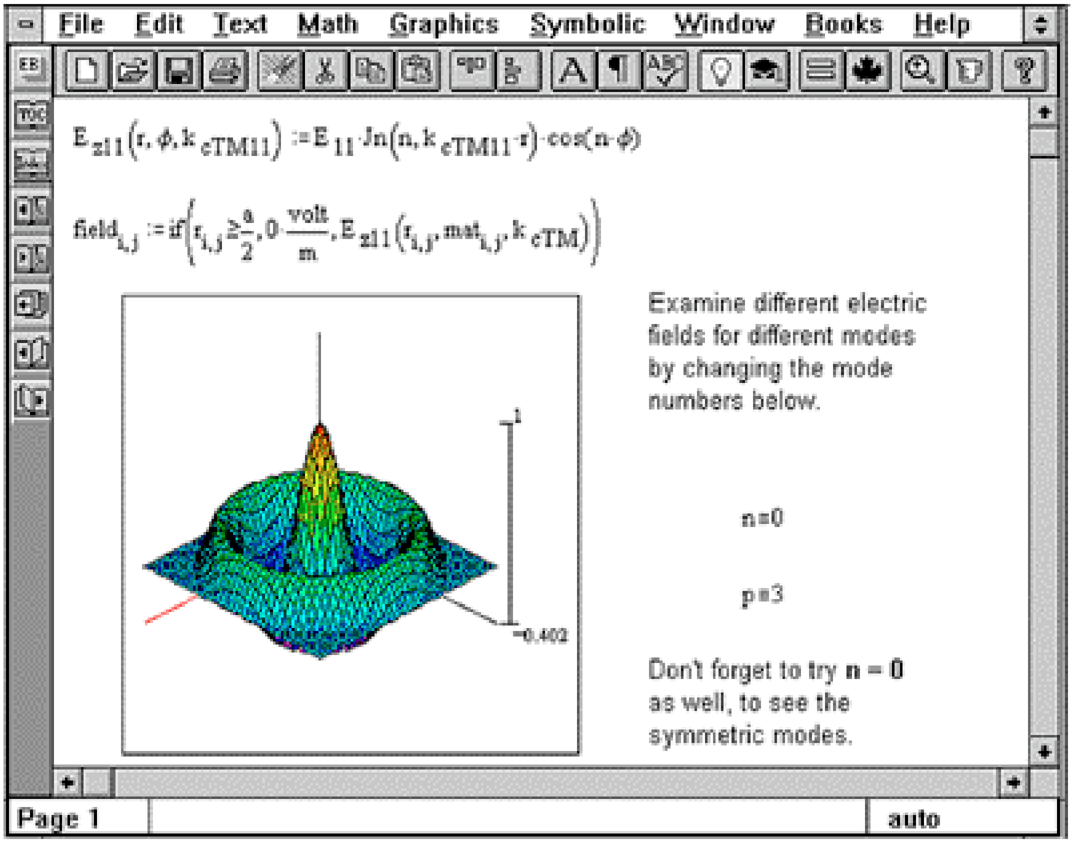
# Electromagnetics




Platform: Windows
Includes the Mathcad Engine; requires 4 MB hard disk space
Available for ground shipment

The student will find this an excellent tool for exploring the universal laws governing electromagnetic waves and for gaining intuition about how various parameters affect the solutions to problems. The educator in physics and engineering will find a comprehensive selection of laboratory and homework exercises in Mathcad, with plenty of room for creativity and expansion. The seasoned professional can experiment with advanced graphing techniques, Bessel function solutions to Laplace's equation and the wave equation, and numerical techniques, as well as interpolated B-H data sets for magnetic circuit analysis.

Table of Contents | Product Sample | Back to Product List

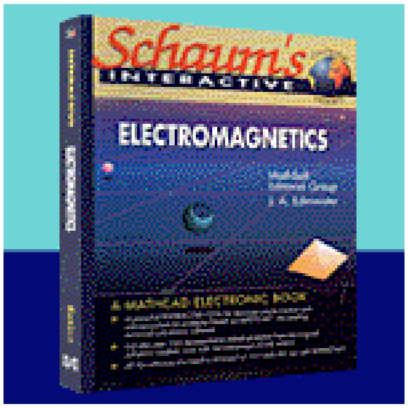



*You can examine different electric fields for different modes by changing the mode numbers.*

Sample topics: Coulomb Forces and Electric Field Intensity; Electric Flux and Gauss' Law; Work, Energy and Potential; Current, Current Density and Conductors; Capacitance and Dielectric Materials; Ampere's Law and Magnetic Field; Inductance and Magnetic Circuits; Maxwell's Equations and Boundary Conditions; Transmission Lines; Waveguides; Antennas.

## Schaums Interactive Outline Series:

# Electromagnetics




## *TABLE OF CONTENTS (page 1 of 5)*

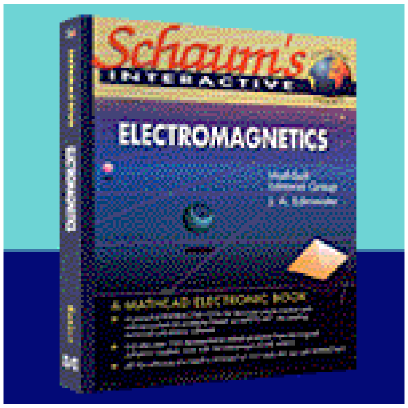


Product Sample

Back to Product List

*Schaums Interactive Outline Series:*

# *Electromagnetics*




## *TABLE OF CONTENTS (page 2 of 5)*

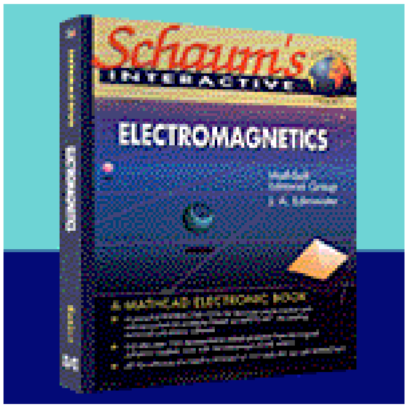


Product Sample

Back to Product List

## Schaums Interactive Outline Series:

# Electromagnetics




### *TABLE OF CONTENTS (page 3 of 5)*

## Schaums Interactive Outline Series:

# Electromagnetics

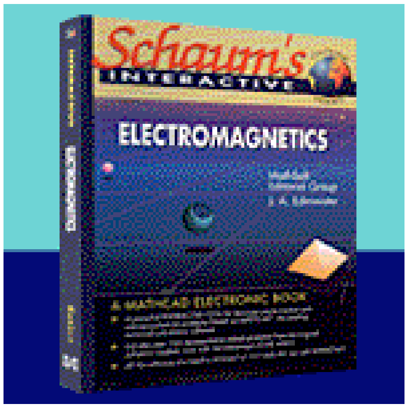


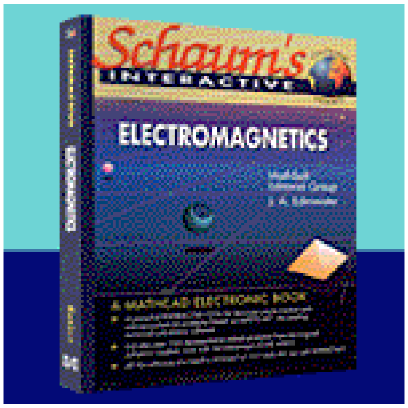

*TABLE OF CONTENTS (page 4 of 5)*



Product Sample
Back to Product List

# Schaums Interactive Outline Series:

# Electromagnetics

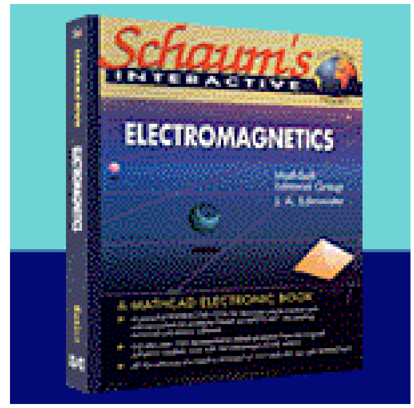



## TABLE OF CONTENTS (page 5 of 5)

# Schaums Interactive Outline Series:

# Electromagnetics

*SAMPLE PAGE (page 1 of 3)*




## Inductance for Common Geometries

### Statement

The following figures give exact or approximate inductances of some common non-coaxial arrangements. Consider specific cases for several of these configurations: (a) Find the inductance per unit length of the parallel cylindrical conductors where **d >> a**. (b) Now consider the cylindrical conductor over the infinite plane at a distance **d/2**. Find the inductance. (c) Assume that the air-core toroid shown has a circular cross section of radius **c**. Find the inductance with **N** turns and mean radius **r**.

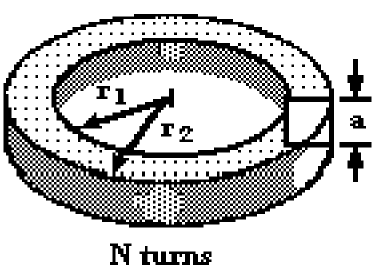
### System Parameters

$d := 25 \cdot ft$ $\qquad a := 0.803 \cdot in$

$\mu H := 10^{-6} \cdot henry$ $\qquad c := 4 \cdot mm$

$N := 2500$ $\qquad r := 20 \cdot mm$

Permeability of free space: $\mu_0 := 4 \cdot \pi \cdot 10^{-7} \cdot \frac{henry}{m}$




$$L = \frac{\mu_0 \cdot N^2 \cdot a}{2 \cdot \pi} \cdot \ln\left(\frac{r_2}{r_1}\right) \cdot (H)$$

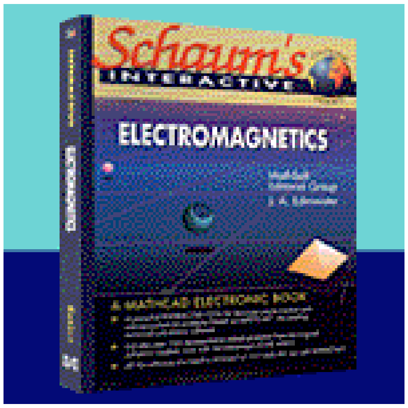
(a)

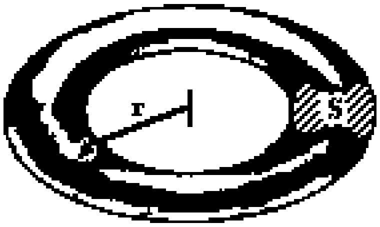
Table of Contents

Back to Product List

# *Electromagnetics*

*SAMPLE PAGE (page 2 of 3)*

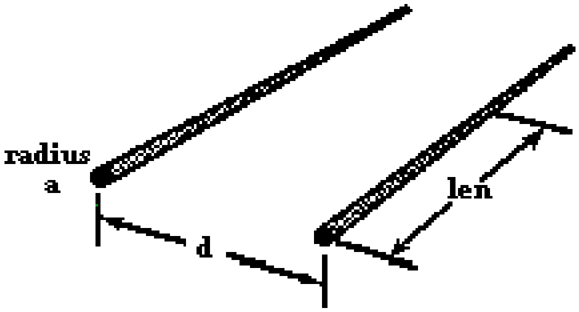





$$L \approx \frac{\mu_0 \cdot N^2 \cdot S}{2 \cdot \pi \cdot r} \cdot (H)$$

**(assuming average flux density at average radius r)**

**(b)**

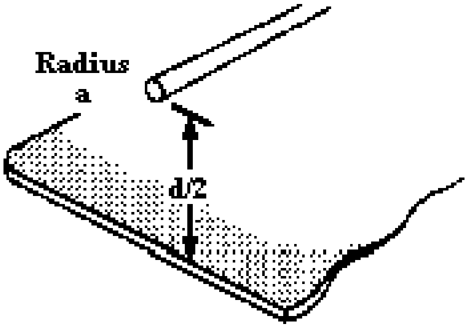



$$\frac{L}{len} = \frac{\mu_0}{\pi} \cdot \operatorname{acosh}\left(\frac{d}{2 \cdot a}\right) \cdot \left(\frac{H}{m}\right)$$

**For d >> a,**

$$\frac{L}{len} \approx \frac{\mu_0}{\pi} \cdot \ln\left(\frac{d}{a}\right) \cdot \left(\frac{H}{m}\right)$$

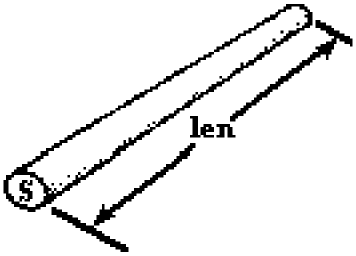
**(c)**




$$\frac{L}{len} = \frac{\mu_0}{2 \cdot \pi} \cdot \operatorname{acosh}\left(\frac{d}{2 \cdot a}\right) \cdot \left(\frac{H}{m}\right)$$

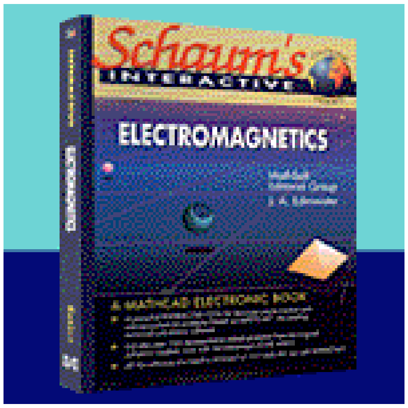
$$\frac{L}{len} \approx \frac{\mu_0}{2 \cdot \pi} \cdot \ln\left(\frac{d}{a}\right) \cdot \left(\frac{H}{m}\right)$$

**(d)**




$$L = \frac{\mu_0 \cdot N^2 \cdot S}{len} \cdot (H)$$

**(e)**




**Solution**

**(a)** The expression for **H** derived in Chapter 9 from a straight current filament applies here. The magnitude of **H** and **B** are

$$H(r)=\frac{I}{2\cdot\pi\cdot r}\cdot a_{\phi} \qquad B(r)=\mu_0\cdot H(r)$$

The inductance per unit length is then the surface integral over

$$\frac{B\cdot H}{I^2} \quad \text{or} \quad \frac{\mu_0}{I^2}\cdot\left(\frac{I}{2\cdot\pi\cdot r}\right)^2 \quad \text{in air}$$

The inductance per unit length is, as shown in the figure,

$$L:=\frac{\mu_0}{\pi}\cdot\ln\left(\frac{d}{a}\right) \qquad L=2.37\cdot\frac{\mu H}{m}$$

Compare the exact formula:

$$\frac{\mu_0}{\pi}\cdot\mathrm{acosh}\left(\frac{d}{2\cdot a}\right)=2.37\cdot\frac{\mu H}{m}$$

Try changing the values of **d** and **a** to see the difference between the exact and approximate formulas.

**(b)** The method of images (Problem 7.5) can be used on the case of an infinite conducting plane with a circular conductor. As expected, the inductance formula is half that for the two conductor case.

$$L:=\frac{\mu_0}{2\cdot\pi}\cdot\ln\left(\frac{d}{a}\right) \qquad L=1.18\cdot\frac{\mu H}{m}$$

**(c)** Calculating the inductance for the air-core toroid is based on the magnetic field derived in Problem 9.2 times the number of turns, **N** (neglecting any deviations caused by the spiraling of the wire and considering the field as entirely in the center of the loops).

$$L:=\frac{\mu_0\cdot N^2\cdot\left(\pi\cdot c^2\right)}{2\cdot\pi\cdot r} \qquad L=3.14\cdot 10^3\cdot\mu H$$