Reading

Chapter 8, pp. 381-392.
Chapter 9, pp. 441-461.

Problems 1 and 2 – Inductors

Problem #1

A toroidal core has a rectangular cross section defined by the surfaces bound by $2 \text{ cm} < \rho < 3 \text{ cm}$, $4 \text{ cm} < z < 4.5 \text{ cm}$ such that $\rho_1 = 2 \text{ cm}$, $\rho_2 = 3 \text{ cm}$, $z_1 = 4 \text{ cm}$ and $z_2 = 4.5 \text{ cm}$ The core material has a relative permeability of $\mu_r = 80$. If the core is wound with a coil containing 8000 turns of wire, find its inductance.
Problem #2

Conducting planes in air at $z = 0$ m and $z = d$ carry surface currents of $\pm K_0 \hat{a}_x$ A/m in the region defined by length $(0 \text{ m} < x < 1 \text{ m})$ and width $w$ $(0 \text{ m} < y < w)$.

a) Find the energy stored in the magnetic field per unit length $(0 \text{ m} < x < 1 \text{ m})$ in a width $w$ $(0 \text{ m} < y < w)$.

b) Calculate the inductance per unit length of this structure.
EXTRA CREDIT Problems 3 and 4 – Wave Equation

Problem #3

Derive the full vector electromagnetic wave equation in terms of the magnetic field \( \vec{B} \) that is valid for linear, inhomogeneous, and isotropic materials.

Problem #4

From the results above, derive the full vector electromagnetic wave equation in terms of the magnetic field \( \vec{B} \) that is valid for linear, homogeneous, and isotropic materials. From this equation, extract and calculate the speed of light in a vacuum.