02ELMA - Homework 10

Assigned for the week of Apr 21, 2025

Questions

- 1. Find the self-inductance per unit length of a long solenoid of radius R with n turns per unit length.
- 2. A sufficiently long solenoid with radius a and n turns per unit length carries a time-dependent current I(t) in the $\hat{\phi}$ direction. Find the electric field (direction and magnitude) at a distance s from the axis of the solenoid (both inside and outside the solenoid) in the quasi-static approximation.
 - *Sufficiently long*: There is a uniform magnetic field inside the solenoid and negligible field outside.
 - *Quasi-static approximation*: The change in the magnetic field is slow enough that the rules of magnetostatics apply to determine the magnetic field at a given time.
- 3. A parallel-plate capacitor of plate radius R and plate separation d is being driven by a sinusoidal voltage $V(t) = V_0 \cos(\omega t)$ across its plates. The space between the plates is vacuum.
 - (a) Compute the displacement current $\vec{J}_d(t)$ flowing between the plates.
 - (b) Compute the magnitude of magnetic field B(r,t) at a distance from the capacitor axis.