

PHYS 3320 Electricity & Magnetism I
Fall 2018
Assignment 9

1. Starting with Maxwell's equations, show that the continuity equation

$$\operatorname{div} \mathbf{J} = -\frac{\partial \rho}{\partial t}$$

is automatically satisfied.

2. A straight wire is made from a conducting material with a conductivity σ , length L , and radius r . There is a voltage V between the two ends of the wire, causing a current I to flow.
- What is the electric field at all point in the wire, assumed to uniform?
 - What is the magnetic field at the surface of the wire?
 - What is the Poynting vector at the surface of the wire?
 - What is the total energy flow at the surface of the wire?
3. A long solenoid of length L and radius R has N turns of wire. There is a current I flowing in the wire.
- What is the energy density in the solenoid?
 - What is the total energy stored in the solenoid?
 - Consider the time when the current is first turned on. Find the induced emf in the solenoid, and hence the rate at which energy is supplied ($P = \mathcal{E} I$, equivalent to $V I$). From that show that the total work is $\frac{1}{2}LI^2$, and by equating the work to the total energy find an expression for the self inductance of the solenoid.