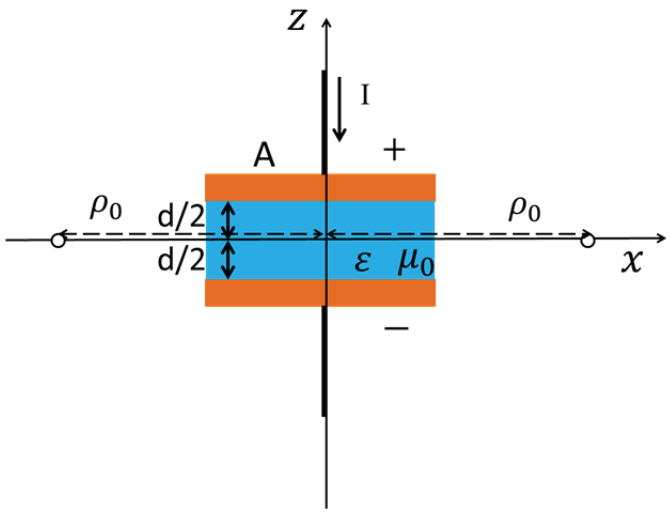
Problem 4: (20 points) Again consider the parallel plate capacitor in Problem 3. This time, assume that we are charging the capacitor with a constant current of I, starting at time t=0, as shown in the figure. (At t<0, I is zero). We also know that the initial voltage of the capacitor is zero at time t=0.



A) Calculate electric field within the capacitor as a function of time.

B) Calculate the total EM energy stored within the capacitor as a function of time. Also use circuit law to calculate the total energy provided by the current source as a function of time.

C) Now assume the wire is straight, infinitely long, and is located along the z axis. You can easily calculate the magnetic field value along the circle shown in the figure, using Ampere's Law. The circle is located within the x-y plane, with z=0. The radius of the circle is ρ_0. (The two dots on the x axis indicate the intersections between the circle and the x axis.)

Evaluate both sides of the integral equation $\oint \vec{H} \cdot d\vec{L} = \iint d\vec{S} \cdot \left[\frac{\partial \vec{D}}{\partial t} + \vec{J}\right]$.

The line integration is along the circle defined in the figure. The surface is the area enclosed within the circle, and is located within the x-y plane.